
moderngl_window Documentation

Release 2.2.3

Einar Forselv

Jul 24, 2020

PROGRAMMING GUIDE

1	Installation	3
1.1	Installing with pip	3
1.2	Optional dependencies	3
1.3	Installing from source	4
1.4	Running examples	4
1.5	Running tests	4
2	Basic usage (WindowConfig)	5
2.1	Basic example	5
2.2	Resource loading	6
2.3	Generic events and window types	6
2.4	Command line arguments	6
2.5	Window events	7
2.6	Keyboard input	7
2.7	Mouse input	7
3	Window Guide	9
3.1	Using built in window types	9
4	Old Guide	11
4.1	Register the moderngl.Context	11
4.2	Register resource directories	11
5	Event Guide	13
6	The Resource System	15
6.1	Resource types	15
6.2	Resource paths	15
6.3	Resource descriptions	16
6.4	Loading resources	16
6.4.1	Textures	17
6.4.2	Programs	17
6.4.3	Scenes	17
6.4.4	Data	17
7	moderngl_window	19
8	moderngl_window.conf.Settings	21
8.1	Methods	21
8.2	Attributes	23

9	moderngl_window.screenshot	27
10	moderngl_window.context	29
10.1	base.window.WindowConfig	29
10.1.1	Methods	30
10.1.2	Attributes	34
10.2	base.BaseWindow	36
10.2.1	Methods	36
10.2.2	Attributes	37
10.3	glfw.Window	42
10.3.1	Methods	42
10.3.2	Attributes	43
10.3.3	Window Specific Methods	48
10.4	headless.Window	49
10.4.1	Methods	49
10.4.2	Attributes	50
10.5	pyglet.Window	55
10.5.1	Methods	55
10.5.2	Window Specific Methods	56
10.5.3	Attributes	58
10.6	pyqt5.Window	63
10.6.1	Methods	63
10.6.2	Window Specific Methods	64
10.6.3	Attributes	65
10.7	pyside2.Window	70
10.7.1	Methods	70
10.7.2	Window Specific Methods	71
10.7.3	Attributes	72
10.8	sdl2.Window	77
10.8.1	Methods	77
10.8.2	Window Specific Methods	78
10.8.3	Attributes	78
11	moderngl_window.geometry	85
12	moderngl_window.loaders	87
12.1	base.BaseLoader	87
12.1.1	Method	87
12.1.2	Attributes	88
12.2	texture.t2d.Loader	88
12.2.1	Method	88
12.2.2	Attributes	89
12.3	program.single.Loader	89
12.3.1	Method	89
12.3.2	Attributes	90
12.4	program.separate.Loader	91
12.4.1	Method	91
12.4.2	Attributes	92
12.5	texture.array.Loader	92
12.5.1	Method	92
12.5.2	Attributes	93
12.6	scene.wavefront.Loader	93
12.6.1	Method	93
12.6.2	Attributes	94

12.7	scene.gltf2.Loader	94
12.7.1	Method	94
12.7.2	Loader Specific Methods	95
12.7.3	Attributes	95
12.7.4	Loader Specific Attributes	95
12.8	scene.stl.Loader	95
12.8.1	Method	95
12.8.2	Attributes	96
12.9	data.json.Loader	96
12.9.1	Method	96
12.9.2	Attributes	97
12.10	data.text.Loader	97
12.10.1	Method	97
12.10.2	Attributes	98
12.11	data.binary.Loader	98
12.11.1	Method	98
12.11.2	Attributes	99
13	moderngl_window.meta	101
13.1	base.ResourceDescription	101
13.1.1	Methods	101
13.1.2	Attributes	101
13.2	texture.TextureDescription	102
13.2.1	Methods	102
13.2.2	Attributes	103
13.2.3	Inherited Attributes	104
13.3	program.ProgramDescription	105
13.3.1	Methods	105
13.3.2	Attributes	106
13.3.3	Inherited Attributes	106
13.4	scene.SceneDescription	107
13.4.1	Methods	107
13.4.2	Attributes	108
13.4.3	Inherited Attributes	108
13.5	data.DataDescription	109
13.5.1	Methods	109
13.5.2	Attributes	109
14	moderngl_window.finders	111
14.1	base.BaseFilesystemFinder	111
14.1.1	Methods	111
14.1.2	Attributes	111
14.2	texture.FilesystemFinder	111
14.2.1	Methods	111
14.2.2	Attributes	112
14.3	program.FilesystemFinder	112
14.3.1	Methods	112
14.3.2	Attributes	112
14.4	scene.FilesystemFinder	112
14.4.1	Methods	112
14.4.2	Attributes	112
14.5	data.FilesystemFinder	113
14.5.1	Methods	113
14.5.2	Attributes	113

15 moderngl_window.opengl	115
15.1 opengl.projection.Projection3D	115
15.1.1 Methods	115
15.1.2 Attributes	115
15.2 opengl.vao.VAO	116
15.2.1 Methods	117
15.2.2 Attributes	118
16 moderngl_window.resources	119
16.1 base.BaseRegistry	119
16.1.1 Methods	119
16.1.2 Attributes	120
16.2 textures.Textures	120
16.2.1 Methods	120
16.2.2 Attributes	121
16.3 programs.Programs	121
16.3.1 Methods	121
16.3.2 Attributes	122
16.4 scenes.Scenes	122
16.4.1 Methods	122
16.4.2 Attributes	123
16.5 base.DataFiles	123
16.5.1 Methods	123
16.5.2 Attributes	123
17 moderngl_window.timers	125
17.1 base.BaseTimer	125
17.1.1 Methods	125
17.1.2 Attributes	125
17.2 clock.Timer	126
17.2.1 Methods	126
17.2.2 Attributes	126
18 moderngl_window.scene	127
18.1 Camera	127
18.1.1 Methods	127
18.1.2 Attributes	128
18.2 KeyboardCamera	128
18.2.1 Methods	129
18.2.2 Attributes	130
18.3 Scene	131
18.3.1 Methods	131
18.3.2 Attributes	132
18.4 Node	133
18.4.1 Methods	133
18.4.2 Attributes	134
18.5 Mesh	134
18.5.1 Methods	134
18.6 Material	136
18.6.1 Methods	136
18.6.2 Attributes	136
18.7 MaterialTexture	136
18.7.1 Methods	137
18.7.2 Attributes	137

18.8	MeshProgram	137
18.8.1	Methods	137
18.8.2	Attributes	138
19	Indices and tables	139
	Python Module Index	141
	Index	143

A cross platform helper library for ModernGL making window creation and resource loading simple.

Note: Please report documentation improvements/issues on github. Writing documentation is difficult and we can't do it without you. Pull requests with documentation improvements are also greatly appreciated.

INSTALLATION

1.1 Installing with pip

moderngl-window is available on PyPI:

```
pip install moderngl-window
```

1.2 Optional dependencies

We try to have as few requirements as possible and instead offer optional dependencies. You can create your own window types and loaders and don't want to force installing unnecessary dependencies.

By default we install pyglet as this is the default window type as it small and pretty much work out of the box on all platforms.

Optional dependencies for loaders:

```
# Wavefront / obj loading
pip install moderngl-window[pywavefront]
# STL loading
pip install moderngl-window[trimesh]
```

Installing dependencies for window types:

```
pip install moderngl-window[PySide2]
pip install moderngl-window[pyqt5]
pip install moderngl-window[glfw]
pip install moderngl-window[PySDL2]
```

Installing optional dependencies this way should ensure a compatible version is installed.

For glfw and sdl2 windows you also need install the library itself. Thees are also available as packages on linux and homebrew on OS X. For windows the DLLs can simply be placed in the root of your project.

- GLFW : <https://www.glfw.org/>
- SDL2 : <https://www.libsdl.org/download-2.0.php>

1.3 Installing from source

```
# clone repo (optionally clone over https)
git clone git@github.com:moderngl/moderngl-window.git
cd moderngl-window

# Create your virtualenv and activate
# We assume the user knows how to work with virtualenvs

# Install moderngl-window in editable mode
pip install -e .

# Install optional dev dependencies covering all window and loader types
pip install -r requirements.txt
```

Installing the package in editable mode will make you able to run tests and examples. We highly recommend using virtualenvs.

1.4 Running examples

Assuming you installed from source you should be able to run the examples in the *examples* directory directly after installing the dev requirements in the root of the project:

```
pip install -r requirements.txt
```

1.5 Running tests

Install test requirements:

```
pip install -r tests/requirements.txt
```

Run tests with tox:

```
# Run for specific environment
tox -e py35
tox -e py36
tox -e py37

# pep8 run
tox -e pep8

# Run all environments
tox
```

BASIC USAGE (WINDOWCONFIG)

Note: This section is only relevant when using *WindowConfig*. Go to the Custom Usage section if you provide your own window and context or want more control.

Using the *WindowConfig* interface is the simplest way to start with moderngl-window. This can work for projects smaller projects and implies that this library provides the window and moderngl context.

The API docs for this class alone should cover a lot of ground, but we'll go through the basics here.

2.1 Basic example

The *WindowConfig* is simply a class you extend to customize/implement initialization, window parameters, rendering code, keyboard input, mouse input and access simpler shortcut methods for loading resources.

```
import moderngl_window as mglw

class Test(mglw.WindowConfig):
    gl_version = (3, 3)
    window_size = (1920, 1080)

    def __init__(self, **kwargs):
        super().__init__(**kwargs)
        # Do initialization here
        self.prog = self.ctx.program(...)
        self.vao = self.ctx.vertex_array(...)
        self.texture = self.ctx.texture(self.wnd.size, 4)

    def render(self, time, frametime):
        # This method is called every frame
        self.vao.render()

# Blocking call entering rendering/event loop
mglw.run_window_config(Test)
```

The *WindowConfig* instance will by default receive three external instances in `__init__` that can be accessed later with `self`.

- `self.ctx`: The `moderngl.Context` created by the configured window type
- `self.wnd`: The window instance
- `self.timer`: The `moderngl_window.timers.clock.Timer` instance to control the current time (Values passed into `render`)

2.2 Resource loading

The `WindowConfig` class has built in shortcuts to the resource loading system.

```
self.load_texture('background.png')
self.load_texture_array('tiles.png', layers=16)
self.load_program('myprogram.glsl')
self.load_text('textfile.txt')
self.load_json('config.json')
self.load_binary('data.bin')
self.load_scene('cube.obj')
self.load_scene('city.glTF')
```

All paths used in resource loading are relative to an absolute path provided in the `WindowConfig`.

```
from pathlib import Path

class Test(mglw.WindowConfig):
    resource_dir = (Path(__file__).parent / 'resources').resolve()
```

If you need more than one search path for your resources, the `moderngl_window.resources` module has methods for this.

2.3 Generic events and window types

The `WindowConfig` interface depends on the built in window types or a self-provided window implementation of `BaseWindow`. These window implementations convert window, key and mouse events into a unified system so the user can switch between different window types without altering the code.

Window libraries are not perfect and may at times work sub-optimally on some platforms. They might also have different performance profiles. The ability to switch between window types by just changing a config value can be an advantage.

You can change what window class is used by passing in the `--window` option. Optionally you can modify the `WINDOW` attribute directly.

2.4 Command line arguments

The `run_window_config()` method also reads arguments from `sys.argv` making the user able to override config values in the class.

Example:

```
python test.py --window glfw --fullscreen --vsync --samples 16 --cursor false --size_
↪ 800x600
```

See code for `moderngl_window.parse_args()` for more details.

2.5 Window events

```
def resize(self, width: int, height: int):
    print("Window was resized. buffer size is {} x {}".format(width, height))

def close(self):
    print("The window is closing")

def iconify(self, iconify: bool):
    print("Window was iconified:", iconify)
```

2.6 Keyboard input

Implement the `key_event` and `unicode_char_entered` method to handle key events.

```
def key_event(self, key, action, modifiers):
    # Key presses
    if action == self.wnd.keys.ACTION_PRESS:
        if key == self.wnd.keys.SPACE:
            print("SPACE key was pressed")

        # Using modifiers (shift and ctrl)

        if key == self.wnd.keys.Z and modifiers.shift:
            print("Shift + Z was pressed")

        if key == self.wnd.keys.Z and modifiers.ctrl:
            print("ctrl + Z was pressed")

    # Key releases
    elif action == self.wnd.keys.ACTION_RELEASE:
        if key == self.wnd.keys.SPACE:
            print("SPACE key was released")

def unicode_char_entered(self, char: str):
    print('character entered:', char)
```

2.7 Mouse input

Implement the `mouse_*` methods to handle mouse input.

```
def mouse_position_event(self, x, y, dx, dy):
    print("Mouse position:", x, y, dx, dy)

def mouse_drag_event(self, x, y, dx, dy):
    print("Mouse drag:", x, y, dx, dy)

def mouse_scroll_event(self, x_offset: float, y_offset: float):
    print("Mouse wheel:", x_offset, y_offset)

def mouse_press_event(self, x, y, button):
    print("Mouse button {} pressed at {}, {}".format(button, x, y))
```

(continues on next page)

(continued from previous page)

```
def mouse_release_event(self, x: int, y: int, button: int):  
    print("Mouse button {} released at {}, {}".format(button, x, y))
```


WINDOW GUIDE

We support the following window types:

- `pyglet`
- `glfw`
- `sdl2`
- `pyside2`
- `pyqt5`
- `headless`

3.1 Using built in window types

The library provides shortcuts for window creation in the `moderngl_window` module that will also handle context activation.

The `moderngl_window.conf.Settings` instance has sane default parameters for a window. See the `WINDOW` attribute.

```
import moderngl_window
from moderngl_window.conf import settings

settings.WINDOW['class'] = 'moderngl_window.context.glfw.Window'
settings.WINDOW['gl_version'] = (4, 1)
# ... etc ...

# Creates the window instance and activates its context
window = moderngl_window.create_window_from_settings()
```

There are more sane ways to apply different configuration values through convenient methods in the `Settings` class.

Window classes can of course also be instantiated manually if preferred, but this can generate a bit of extra work.

```
import moderngl_window

window_str = 'moderngl_window.context.pyglet.Window'
window_cls = moderngl_window.get_window_cls(window_str)
window = window_cls(
    title="My Window",
    gl_version=(4, 1),
    size=(1920, 1080),
```

(continues on next page)

(continued from previous page)

```
    ...  
)  
moderngl_window.activate_context(ctx=window.ctx)
```

You could also simply import the class directory and instantiate it, but that defeats the purpose of trying to be independent of a specific window library.

The rendering loop for built in windows is simple:

```
while not window.is_closing:  
    window.clear()  
    # Render stuff here  
    window.swap_buffers()
```

The `swap_buffers` method is important as it also pulls new input events for the next frame.

When not using a *WindowConfig* instance, there are a few simple steps to get started.

4.1 Register the moderngl.Context

When not using the built in window types you need to at least tell moderngl_window what your moderngl.Context is.

```
import moderngl
import moderngl_window

# Somewhere in your application a standalone or normal context is created
ctx = moderngl.create_standalone_context(require=330)
ctx = moderngl.create_context(require=330)

# Make sure you activate this context
moderngl_window.activate_context(ctx=ctx)
```

If there is no context activated the library will raise an exception when doing operations that requires one, such as texture and scene loading.

When using the built in window types the context activation is normally done for you on creation.

4.2 Register resource directories

The resource loading system uses relative paths. These paths are relative to one or multiple directories we registered in the resource system.

The *moderngl_window.resources* module has methods for this.

```
from pathlib import Path
from moderngl_window import resources

# We recommend using pathlib
resources.register_dir(Path('absolute/path/to/resource/dir').resolve())
# .. but strings also works
resources.register_dir('absolute/path/to/resource/dir')
```

These need to be absolute paths or an exception is raised. You can register as many paths as you want. The resource system will simply look for the file in every registered directory in the order they were added until it finds a match.

This library also supports separate search directories for shader programs, textures, scenes and various data files.

EVENT GUIDE

Work in progress

THE RESOURCE SYSTEM

6.1 Resource types

The resource system has four different resource types/categories it can load.

- **Programs** : Shader programs (vertex, geometry, fragment, tessellation, compute)
- **Textures** : Textures of all different variations
- **Scenes**: Wavefront, GLTF2 and STL scenes/objects
- **Data**: A generic “lane” for everything else

Each of these resource categories have separate search directories, one or multiple loader classes and a *ResourceDescription* class we use to describe the resource we are loading with all its parameters.

6.2 Resource paths

Resources are loaded using relative paths. These paths are relative to one or multiple search directories we register using the *resources* module.

For simple usage were we have one or multiple resource directories with mixed resource types (programs, textures etc.) we can use the simplified version, *register_dir()*.

```
from pathlib import Path
from moderngl_window import resources

# pathlib.Path (recommended)
resources.register_dir(Path('absoulte/path/using/pathlib'))

# Strings and/or os.path
resources.register_dir('absolute/string/path')
```

A resource finder system will scan through the registered directories in the order they were added loading the first resource found.

For more advanced usage were resources of different types are separated we can register resource type specific search directories:

- *register_program_dir()*
- *register_texture_dir()*
- *register_scene_dir()*
- *register_data_dir()*

This can be handy when dealing with larger quantities of files. These search directories are stored in the *Settings* instance and can for example be temporarily altered if needed. This means you can separate local and global resources in more complex situations. It could even be used to support themes by promoting a theme directory overriding global/default resources or some default theme directory.

6.3 Resource descriptions

Resource descriptions are basically just classes acting as bags of attributes describing the resource we are requesting. We have four standard classes.

- *ProgramDescription*
- *TextureDescription*
- *SceneDescription*
- *DataDescription*

Example:

```
from moderngl_window.meta import TextureDescription

# We are aiming to load wood.png horizontally flipped
# with generated mipmaps and high anisotropic filtering.
TextureDescription(
    path='wood.png',
    flip=True,
    mipmap=True,
    anisotropy=16.0,
)
```

New resource description classes can be created by extending the base *ResourceDescription* class. This is not uncommon when for example making a new loader class.

6.4 Loading resources

Now that we know about the different resource categories, search paths and resource descriptions, we're ready to actually load something.

Loading resources can in some situation be a bit verbose, but you can simplify by wrapping them in your own functions if needed. The *WindowConfig* class is already doing this and can be used as a reference.

```
from moderngl_window.resources import (
    textures,
    programs,
    scenes,
    data,
)
from moderngl_window.meta import (
    TextureDescription,
    ProgramDescription,
    SceneDescription,
    DataDescription,
)
```


6.4.1 Textures

```
# Load a 2D texture
texture = textures.load(TextureDescription(path='wood.png'))

# Load wood.png horizontally flipped with generated mipmaps and high anisotropic
↳ filtering.
textures.load(TextureDescription(path='wood.png', flip=True, mipmap=True,
↳ anisotropy=16.0))

# Load a texture array containing 10 vertically stacked tile textures
textures.load(TextureDescription(path='tiles.png', layers=10, mipmap=True,
↳ anisotropy=8.0))
```

6.4.2 Programs

```
# Load a shader program in a single glsl file
program = programs.load(ProgramDescription(path='fun.glsl'))

# Load a shader program from multiple glsl files
program = programs.load(
    ProgramDescription(
        vertex_shader='sphere_vert.glsl',
        geometry_shader='sphere_geo.glsl',
        fragment_shader='sphere_fs.glsl',
    )
)
```

6.4.3 Scenes

```
# Load a GLTF2 scene
scene = scenes.load(SceneDescription(path="city.gltf"))

# Load a wavefront scene
scene = scenes.load(SceneDescription(path="earth.obj"))

# Load an STL file
scene = scenes.load(SceneDescription(path="apollo_landing_site_18.stl"))
```

6.4.4 Data

```
# Load text file
text = data.load(DataDescription(path='notes.txt'))

# Load config file as a dict
config_dict = data.load(DataDescription(path='config.json'))

# Load binary data
data = data.load(DataDescription(path='data.bin', kind='binary'))
```

For more information about supported parameters see the [api documentation](#).

MODERNGL_WINDOW

General helper functions aiding in the bootstrapping of this library.

`moderngl_window.setup_basic_logging(level: int)`

Set up basic logging

Parameters `level` (*int*) – The log level

`moderngl_window.activate_context(window: moderngl_window.context.base.window.BaseWindow
= None, ctx: moderngl.context.Context = None)`

Register the active window and context. If only a window is supplied the context is taken from the window. Only a context can also be passed in.

Keyword Arguments

- **window** (*window*) – The window to activate
- **ctx** (*moderngl.Context*) – The moderngl context to activate

`moderngl_window.window()`

Obtain the active window

`moderngl_window.ctx()`

Obtain the active context

`moderngl_window.get_window_cls(window: str = None) →
Type[moderngl_window.context.base.window.BaseWindow]`

Attempt to obtain a window class using the full dotted python path. This can be used to import custom or modified window classes.

Parameters `window` (*str*) – Name of the window

Returns A reference to the requested window class. Raises exception if not found.

`moderngl_window.get_local_window_cls(window: str = None) →
Type[moderngl_window.context.base.window.BaseWindow]`

Attempt to obtain a window class in the moderngl_window package using short window names such as `pyglet` or `glfw`.

Parameters `window` (*str*) – Name of the window

Returns A reference to the requested window class. Raises exception if not found.

`moderngl_window.find_window_classes() → List[str]`

Find available window packages

Returns A list of available window packages

`moderngl_window.create_window_from_settings()` → `moderngl_window.context.base.window.BaseWindow`
Creates a window using configured values in `moderngl_window.conf.Settings.WINDOW`. This will also activate the window/context.

Returns The Window instance

`moderngl_window.run_window_config` (*config_cls: moderngl_window.context.base.window.WindowConfig*, *timer=None, args=None*) → None
Run an WindowConfig entering a blocking main loop

Parameters

- **config_cls** – The WindowConfig class to render
- **args** – Override sys.args

`moderngl_window.create_parser()`
Create an argparser parsing the standard arguments for WindowConfig

`moderngl_window.parse_args` (*args=None, parser=None*)
Parse arguments from sys.argv

Passing in your own argparser can be user to extend the parser.

Keyword Arguments

- **args** – override for sys.argv
- **parser** – Supply your own argparser instance

MODERNGL_WINDOW.CONF.SETTINGS

`moderngl_window.conf.Settings`

Bag of settings values. New attributes can be freely added runtime. Various `apply*` methods are supplied so the user have full control over how settings values are initialized. This is especially useful for more custom usage. And instance of the *Settings* class is created when the *conf* module is imported.

Attribute names must currently be in upper case to be recognized.

Some examples of usage:

```
from moderngl_window.conf import settings

# Mandatory settings values
try:
    value = settings.VALUE
except KeyError:
    raise ValueError("This settings value is required")

# Fallback in code
value = getattr(settings, 'VALUE', 'default_value')

# Pretty printed string representation for easy inspection
print(settings)
```

8.1 Methods

`Settings.__init__()`

Initialize settings with default values

`Settings.apply_default_settings()` → None

Apply keys and values from the default settings module located in this package. This is to ensure we always have the minimal settings for the system to run.

If replacing or customizing the settings class you must always apply default settings to ensure compatibility when new settings are added.

`Settings.apply_settings_from_env()` → None

Apply settings from `MODERNGL_WINDOW_SETTINGS_MODULE` environment variable. If the environment variable is undefined no action will be taken. Normally this would be used to easily be able to switch between different configuration by setting env vars before executing the program.

Example:

```
import os
from moderngl_window.conf import settings

os.environ['MODERNGL_WINDOW_SETTINGS_MODULE'] = 'python.path.to.module'
settings.apply_settings_from_env()
```

Raises ImproperlyConfigured if the module was not found –

`Settings.apply_from_module_name(settings_module_name: str) → None`

Apply settings from a python module by supplying the full pythonpath to the module.

Parameters `settings_module_name` (*str*) – Full python path to the module

Raises ImproperlyConfigured if the module was not found –

`Settings.apply_from_dict(data: dict) → None`

Apply settings values from a dictionary

Example:

```
>> from moderngl_window.conf import settings
>> settings.apply_dict({'SOME_VALUE': 1})
>> settings.SOME_VALUE
1
```

`Settings.apply_from_module(module: module) → None`

Apply settings values from a python module

Example:

```
my_settings.py module containing the following line:
SOME_VALUE = 1

>> from moderngl_window.conf import settings
>> import my_settings
>> settings.apply_module(my_settings)
>> settings.SOME_VALUE
1
```

`Settings.apply_from_cls(cls) → None`

Apply settings values from a class namespace

Example:

```
>> from moderngl_window.conf import settings
>> class MySettings:
>>     SOME_VALUE = 1
>>
>> settings.apply(MySettings)
>> settings.SOME_VALUE
1
```

`Settings.apply_from_iterable(iterable: Union[collections.abc.Iterable, generator]) → None`

Apply (key, value) pairs from an iterable or generator

`Settings.to_dict()`

Create a dict representation of the settings Only uppercase attributes are included

Returns dict representation

Return type dict

8.2 Attributes

Settings.WINDOW

Window/screen properties. Most importantly the `class` attribute decides what class should be used to handle the window.

```
# Default values
WINDOW = {
    "gl_version": (3, 3),
    "class": "moderngl_window.context.pyglet.Window",
    "size": (1280, 720),
    "aspect_ratio": 16 / 9,
    "fullscreen": False,
    "resizable": True,
    "title": "ModernGL Window",
    "vsync": True,
    "cursor": True,
    "samples": 0,
}
```

Other Properties:

- `gl_version`: The minimum required major/minor OpenGL version
- `size`: The window size to open.
- `aspect_ratio` is the enforced aspect ratio of the viewport.
- `fullscreen`: True if you want to create a context in fullscreen mode
- `resizable`: If the window should be resizable. This only applies in windowed mode.
- `vsync`: Only render one frame per screen refresh
- `title`: The visible title on the window in windowed mode
- `cursor`: Should the mouse cursor be visible on the screen? Disabling this is also useful in windowed mode when controlling the camera on some platforms as moving the mouse outside the window can cause issues.
- `Samples`: Number if samples used in multisampling. Values above 1 enables multisampling.

The created window frame buffer will by default use:

- RGBA8 (32 bit per pixel)
- 24 bit depth buffer
- Double buffering
- color and depth buffer is cleared for every frame

Settings.SCREENSHOT_PATH

Absolute path to the directory screenshots will be saved by the screenshot module. Screenshots will end up in the project root of not defined. If a path is configured, the directory will be auto-created.

Settings.PROGRAM_FINDERS

Finder classes for locating programs/shaders.

```
# Default values
PROGRAM_FINDERS = [
    "moderngl_window.finders.program.FileSystemFinder",
]
```

Settings.TEXTURE_FINDERS

Finder classes for locating textures.

```
# Default values
TEXTURE_FINDERS = [
    "moderngl_window.finders.texture.FileSystemFinder",
]
```

Settings.SCENE_FINDERS

Finder classes for locating scenes.

```
# Default values
SCENE_FINDERS = [
    "moderngl_window.finders.scene.FileSystemFinder",
]
```

Settings.DATA_FINDERS

Finder classes for locating data files.

```
# Default values
DATA_FINDERS = [
    "moderngl_window.finders.data.FileSystemFinder",
]
```

Settings.PROGRAM_DIRS

Lists of *str* or *pathlib.Path* used by `FileSystemFinder` to look for programs/shaders.

Settings.TEXTURE_DIRS

Lists of *str* or *pathlib.Path* used by `FileSystemFinder` to look for textures.

Settings.SCENE_DIRS

Lists of *str* or *pathlib.Path* used by `FileSystemFinder` to look for scenes (obj, gltf, stl etc).

Settings.DATA_DIRS

Lists of *str* or *pathlib.Path* used by `FileSystemFinder` to look for data files.

Settings.PROGRAM_LOADERS

Classes responsible for loading programs/shaders.

```
# Default values
PROGRAM_LOADERS = [
    'moderngl_window.loaders.program.single.Loader',
    'moderngl_window.loaders.program.separate.Loader',
]
```

Settings.TEXTURE_LOADERS

Classes responsible for loading textures.

```
# Default values
TEXTURE_LOADERS = [
    'moderngl_window.loaders.texture.t2d.Loader',
    'moderngl_window.loaders.texture.array.Loader',
]
```


Settings.SCENE_LOADERS

Classes responsible for loading scenes.

```
# Default values
SCENE_LOADERS = [
    "moderngl_window.loaders.scene.gltf.GLTF2",
    "moderngl_window.loaders.scene.wavefront.ObjLoader",
    "moderngl_window.loaders.scene.stl_loader.STLLoader",
]
```

Settings.DATA_LOADERS

Classes responsible for loading data files.

```
# Default values
DATA_LOADERS = [
    'moderngl_window.loaders.data.binary.Loader',
    'moderngl_window.loaders.data.text.Loader',
    'moderngl_window.loaders.data.json.Loader',
]
```


MODERNGL_WINDOW.SCREENSHOT

```
moderngl_window.screenshot.create(source: Union[moderngl.framebuffer.Framebuffer, moderngl.texture.Texture], file_format='png', name: str = None, mode='RGB', alignment=1)
```

Create a screenshot from a `moderngl.Framebuffer` or `moderngl.Texture`. The screenshot will be written to `SCREENSHOT_PATH` if set or `cwd` or an absolute path can be used.

Parameters

- **source** – The framebuffer or texture to screenshot
- **file_format** (*str*) – formats supported by PIL (png, jpeg etc)
- **name** (*str*) – Optional file name with relative or absolute path
- **mode** (*str*) – Components/mode to use
- **alignment** (*int*) – Buffer alignment

MODERNGL_WINDOW.CONTEXT

10.1 base.window.WindowConfig

`moderngl_window.context.base.window.WindowConfig`

Creating a `WindowConfig` instance is the simplest interface this library provides to open and window, handle inputs and provide simple shortcut method for loading basic resources. It's appropriate for projects with basic needs.

Example:

```
import moderngl_window

class MyConfig(moderngl_window.WindowConfig):
    gl_version = (3, 3)
    window_size = (1920, 1080)
    aspect_ratio = 16 / 9
    title = "My Config"
    resizable = False
    samples = 8

    def __init__(self, **kwargs):
        super().__init__(**kwargs)
        # Do other initialization here

    def render(self, time: float, frametime: float):
        # Render stuff here with ModernGL

    def resize(self, width: int, height: int):
        print("Window was resized. buffer size is {} x {}".format(width, height))

    def mouse_position_event(self, x, y, dx, dy):
        print("Mouse position:", x, y)

    def mouse_press_event(self, x, y, button):
        print("Mouse button {} pressed at {}, {}".format(button, x, y))

    def mouse_release_event(self, x: int, y: int, button: int):
        print("Mouse button {} released at {}, {}".format(button, x, y))

    def key_event(self, key, action, modifiers):
        print(key, action, modifiers)
```

10.1.1 Methods

`WindowConfig.__init__` (*ctx: moderngl.context.Context = None, wnd: moderngl_window.context.base.window.BaseWindow = None, timer: moderngl_window.timers.base.BaseTimer = None, **kwargs*)

Initialize the window config

Keyword Arguments

- **ctx** (*moderngl.Context*) – The moderngl context
- **wnd** – The window instance
- **timer** – The timer instance

classmethod `WindowConfig.run()`

Shortcut for running a `WindowConfig`.

This executes the following code:

```
import moderngl_window
moderngl_window.run_window_config(cls)
```

`WindowConfig.render` (*time: float, frame_time: float*)

Renders the assigned effect

Parameters

- **time** (*float*) – Current time in seconds
- **frame_time** (*float*) – Delta time from last frame in seconds

`WindowConfig.resize` (*width: int, height: int*)

Called every time the window is resized in case the we need to do internal adjustments.

Parameters

- **width** (*int*) – width in buffer size (not window size)
- **height** (*int*) – height in buffer size (not window size)

`WindowConfig.close()`

Called when the window is closed

`WindowConfig.key_event` (*key: Any, action: Any, modifiers: moderngl_window.context.base.keys.KeyModifiers*)

Called for every key press and release. Depending on the library used, key events may trigger repeating events during the pressed duration based on the configured key repeat on the users operating system.

Parameters

- **key** – The key that was press. Compare with `self.wnd.keys`.
- **action** – `self.wnd.keys.ACTION_PRESS` or `ACTION_RELEASE`
- **modifiers** – Modifier state for shift, ctrl and alt

`WindowConfig.mouse_position_event` (*x: int, y: int, dx: int, dy: int*)

Reports the current mouse cursor position in the window

Parameters

- **x** (*int*) – X postion of the mouse cursor
- **y** (*int*) – Y position of the mouse cursor
- **dx** (*int*) – X delta postion

- **dy** (*int*) – Y delta position

WindowConfig.**mouse_press_event** (*x: int, y: int, button: int*)

Called when a mouse button is pressed

Parameters

- **x** (*int*) – X position the press occurred
- **y** (*int*) – Y position the press occurred
- **button** (*int*) – 1 = Left button, 2 = right button

WindowConfig.**mouse_release_event** (*x: int, y: int, button: int*)

Called when a mouse button is released

Parameters

- **x** (*int*) – X position the release occurred
- **y** (*int*) – Y position the release occurred
- **button** (*int*) – 1 = Left button, 2 = right button

WindowConfig.**mouse_drag_event** (*x: int, y: int, dx: int, dy: int*)

Called when the mouse is moved while a button is pressed.

Parameters

- **x** (*int*) – X position of the mouse cursor
- **y** (*int*) – Y position of the mouse cursor
- **dx** (*int*) – X delta position
- **dy** (*int*) – Y delta position

WindowConfig.**mouse_scroll_event** (*x_offset: float, y_offset: float*)

Called when the mouse wheel is scrolled.

Some input devices also support horizontal scrolling, but vertical scrolling is fairly universal.

Parameters

- **x_offset** (*int*) – X scroll offset
- **y_offset** (*int*) – Y scroll offset

WindowConfig.**unicode_char_entered** (*char: str*)

Called when the user entered a unicode character.

Parameters **char** (*str*) – The character entered

WindowConfig.**load_texture_2d** (*path: str, flip=True, mipmap=False, mipmap_levels: Tuple[int, int]*
*= None, anisotropy=1.0, **kwargs*) → moderngl.texture.Texture

Loads a 2D texture

Parameters **path** (*str*) – Path to the texture relative to search directories

Keyword Arguments

- **flip** (*boolean*) – Flip the image horizontally
- **mipmap** (*bool*) – Generate mipmaps. Will generate max possible levels unless *mipmap_levels* is defined.
- **mipmap_levels** (*tuple*) – (base, max_level) controlling mipmap generation. When defined the *mipmap* parameter is automatically *True*

- **anisotropy** (*float*) – Number of samples for anisotropic filtering
- ****kwargs** – Additional parameters to TextureDescription

Returns Texture instance

Return type moderngl.Texture

WindowConfig.**load_texture_array** (*path: str, layers: int = 0, flip=True, mipmap=False, mipmap_levels: Tuple[int, int] = None, anisotropy=1.0, **kwargs*) → moderngl.texture_array.TextureArray

Loads a texture array.

Parameters **path** (*str*) – Path to the texture relative to search directories

Keyword Arguments

- **layers** (*int*) – How many layers to split the texture into vertically
- **flip** (*boolean*) – Flip the image horizontally
- **mipmap** (*bool*) – Generate mipmaps. Will generate max possible levels unless *mipmap_levels* is defined.
- **mipmap_levels** (*tuple*) – (base, max_level) controlling mipmap generation. When defined the *mipmap* parameter is automatically *True*
- **anisotropy** (*float*) – Number of samples for anisotropic filtering
- ****kwargs** – Additional parameters to TextureDescription

Returns The texture instance

Return type moderngl.TextureArray

WindowConfig.**load_texture_cube** (*pos_x: str = None, pos_y: str = None, pos_z: str = None, neg_x: str = None, neg_y: str = None, neg_z: str = None, flip=False, mipmap=False, mipmap_levels: Tuple[int, int] = None, anisotropy=1.0, **kwargs*) → moderngl.texture_cube.TextureCube

Loads a texture cube.

Keyword Arguments

- **pos_x** (*str*) – Path to texture representing positive x face
- **pos_y** (*str*) – Path to texture representing positive y face
- **pos_z** (*str*) – Path to texture representing positive z face
- **neg_x** (*str*) – Path to texture representing negative x face
- **neg_y** (*str*) – Path to texture representing negative y face
- **neg_z** (*str*) – Path to texture representing negative z face
- **flip** (*boolean*) – Flip the image horizontally
- **mipmap** (*bool*) – Generate mipmaps. Will generate max possible levels unless *mipmap_levels* is defined.
- **mipmap_levels** (*tuple*) – (base, max_level) controlling mipmap generation. When defined the *mipmap* parameter is automatically *True*
- **anisotropy** (*float*) – Number of samples for anisotropic filtering
- ****kwargs** – Additional parameters to TextureDescription

Returns Texture instance

Return type moderngl.TextureCube

WindowConfig.**load_program**(*path=None*, *vertex_shader=None*, *geometry_shader=None*,
fragment_shader=None, *tess_control_shader=None*,
tess_evaluation_shader=None, *defines: dict = None*) → moderngl.program.Program

Loads a shader program.

Note that *path* should only be used if all shaders are defined in the same glsl file separated by defines.

Keyword Arguments

- **path** (*str*) – Path to a single glsl file
- **vertex_shader** (*str*) – Path to vertex shader
- **geometry_shader** (*str*) – Path to geometry shader
- **fragment_shader** (*str*) – Path to fragment shader
- **tess_control_shader** (*str*) – Path to tessellation control shader
- **tess_evaluation_shader** (*str*) – Path to tessellation eval shader
- **defines** (*dict*) – #define values to replace in the shader source. Example:
{'VALUE1': 10, 'VALUE2': '3.1415'}.

Returns The program instance

Return type moderngl.Program

WindowConfig.**load_compute_shader**(*path*, *defines: dict = None*, ***kwargs*) → moderngl.compute_shader.ComputeShader

Loads a compute shader.

Parameters

- **path** (*str*) – Path to a single glsl file
- **defines** (*dict*) – #define values to replace in the shader source. Example:
{'VALUE1': 10, 'VALUE2': '3.1415'}.

Returns The compute shader

Return type moderngl.ComputeShader

WindowConfig.**load_text**(*path: str*, ***kwargs*) → str

Load a text file.

Parameters

- **path** (*str*) – Path to the file relative to search directories
- ****kwargs** – Additional parameters to DataDescription

Returns Contents of the text file

Return type str

WindowConfig.**load_json**(*path: str*, ***kwargs*) → dict

Load a json file

Parameters

- **path** (*str*) – Path to the file relative to search directories
- ****kwargs** – Additional parameters to DataDescription

Returns Contents of the json file

Return type dict

WindowConfig.**load_binary** (*path*: str, ***kwargs*) → bytes

Load a file in binary mode.

Parameters

- **path** (*str*) – Path to the file relative to search directories
- ****kwargs** – Additional parameters to DataDescription

Returns The byte data of the file

Return type bytes

WindowConfig.**load_scene** (*path*: str, *cache*=False, *attr_names*=<class 'moderngl_window.geometry.attributes.AttributeNames'>, *kind*=None, ***kwargs*) → moderngl_window.scene.scene.Scene

Loads a scene.

Keyword Arguments

- **path** (*str*) – Path to the file relative to search directories
- **cache** (*str*) – Use the loader caching system if present
- **attr_names** (*AttributeNames*) – Attrib name config
- **kind** (*str*) – Override loader kind
- ****kwargs** – Additional parameters to SceneDescription

Returns The scene instance

Return type Scene

10.1.2 Attributes

WindowConfig.**window_size**

Size of the window.

```
# Default value
window_size = (1280, 720)
```

WindowConfig.**vsync**

Enable or disable vsync.

```
# Default value
vsync = True
```

WindowConfig.**fullscreen**

Open the window in fullscreen mode.

```
# Default value
fullscreen = False
```

WindowConfig.**resizable**

Determines if the window should be resizable

```
# Default value
resizable = True
```

WindowConfig.gl_version

The minimum required OpenGL version required

```
# Default value
gl_version = (3, 3)
```

WindowConfig.title

Title of the window

```
# Default value
title = "Example"
```

WindowConfig.aspect_ratio

The enforced aspect ratio of the viewport. When specified back borders will be calculated both vertically and horizontally if needed.

This property can be set to `None` to disable the fixed viewport system.

```
# Default value
aspect_ratio = 16 / 9
```

WindowConfig.cursor

Determines if the mouse cursor should be visible inside the window. If enabled on some platforms

```
# Default value
cursor = True
```

WindowConfig.clear_color

The color the active framebuffer is cleared with. This attribute is expected to be in the form of `(r, g, b, a)` in the range `[0.0, 1.0]`

If the value is `None` the screen will not be cleared every frame.

```
# Default value
clear_color = (0.0, 0.0, 0.0, 0.0)
# Disable screen clearing
clear_color = None
```

WindowConfig.samples

Number of samples to use in multisampling.

```
# Default value
samples = 4
```

WindowConfig.resource_dir

Absolute path to your resource directory containing textures, scenes, shaders/programs or data files. The `load_` methods in this class will look for resources in this path. This attribute can be a `str` or a `pathlib.Path`.

```
# Default value
resource_dir = None
```

WindowConfig.log_level

Sets the log level for this library using the standard *logging* module.

```
# Default value
log_level = logging.INFO
```

WindowConfig.**argv**

The parsed command line arguments.

10.2 base.BaseWindow

10.2.1 Methods

BaseWindow.**__init__**(*title='ModernGL', gl_version=(3, 3), size=(1280, 720), resizable=True, fullscreen=False, vsync=True, aspect_ratio: float = None, samples=0, cursor=True, **kwargs*)

Initialize a window instance.

Parameters

- **title** (*str*) – The window title
- **gl_version** (*tuple*) – Major and minor version of the opengl context to create
- **size** (*tuple*) – Window size x, y
- **resizable** (*bool*) – Should the window be resizable?
- **fullscreen** (*bool*) – Open window in fullscreen mode
- **vsync** (*bool*) – Enable/disable vsync
- **aspect_ratio** (*float*) – The desired fixed aspect ratio. Can be set to None to make aspect ratio be based on the actual window size.
- **samples** (*int*) – Number of MSAA samples for the default framebuffer
- **cursor** (*bool*) – Enable/disable displaying the cursor inside the window

BaseWindow.**init_mgl_context**() → None

Create or assign a ModernGL context. If no context is supplied a context will be created using the window's gl_version.

Keyword Arguments **ctx** – An optional custom ModernGL context

BaseWindow.**is_key_pressed**(*key*) → bool

Returns: The press state of a key

BaseWindow.**close**() → None

Signal for the window to close

BaseWindow.**use**()

Bind the window's framebuffer

BaseWindow.**clear**(*red=0.0, green=0.0, blue=0.0, alpha=0.0, depth=1.0, viewport=None*)

Binds and clears the default framebuffer

Parameters

- **red** (*float*) – color component
- **green** (*float*) – color component
- **blue** (*float*) – color component

- **alpha** (*float*) – alpha component
- **depth** (*float*) – depth value
- **viewport** (*tuple*) – The viewport

`BaseWindow.render (time=0.0, frame_time=0.0) → None`

Renders a frame by calling the configured render callback

Keyword Arguments

- **time** (*float*) – Current time in seconds
- **frame_time** (*float*) – Delta time from last frame in seconds

`BaseWindow.swap_buffers () → None`

Library specific buffer swap method. Must be overridden.

`BaseWindow.resize (width, height) → None`

Should be called every time window is resized so the example can adapt to the new size if needed

`BaseWindow.destroy () → None`

A library specific destroy method is required

`BaseWindow.set_default_viewport () → None`

Calculates the and sets the viewport based on window configuration.

The viewport will based on the configured fixed aspect ratio if set. If no fixed aspect ratio is set the viewport will be scaled to the entire window size regardless of size.

Will add black borders and center the viewport if the window do not match the configured viewport (fixed only)

`BaseWindow.print_context_info ()`

Prints moderngl context info.

10.2.2 Attributes

`BaseWindow.name = None`

Name of the window. For example pyglet, glfw

`BaseWindow.keys`

Window specific key constants

`BaseWindow.ctx`

The ModernGL context for the window

Type moderngl.Context

`BaseWindow.fbo`

The default framebuffer

Type moderngl.Framebuffer

`BaseWindow.title`

Window title.

This property can also be set:

```
window.title = "New Title"
```

Type str

BaseWindow.exit_key

Get or set the exit/close key for the window.

Pressing this key will close the window.

By default the ESCAPE is set, but this can be overridden or disabled:

```
# Default exit key
window.exit_key = window.keys.ESCAPE

# Set some other random exit key
window.exit_key = window.keys.Q

# Disable the exit key
window.exit_key = None
```

BaseWindow.gl_version

(major, minor) required OpenGL version

Type Tuple[int, int]

BaseWindow.width

The current window width

Type int

BaseWindow.height

The current window height

Type int

BaseWindow.size

current window size.

This property also support assignment:

```
# Resize the window to 1000 x 1000
window.size = 1000, 1000
```

Type Tuple[int, int]

BaseWindow.position

The current window position.

This property can also be set to move the window:

```
# Move window to 100, 100
window.position = 100, 100
```

Type Tuple[int, int]

BaseWindow.buffer_width

the current window buffer width

Type int

BaseWindow.buffer_height

the current window buffer height

Type int

`BaseWindow.buffer_size`
tuple with the current window buffer size

Type Tuple[int, int]

`BaseWindow.pixel_ratio`
The framebuffer/window size ratio

Type float

`BaseWindow.viewport`
current window viewport

Type Tuple[int, int, int, int]

`BaseWindow.viewport_size`
Size of the viewport.

Equivalent to `self.viewport[2], self.viewport[3]`

Type Tuple[int,int]

`BaseWindow.viewport_width`
The width of the viewport.

Equivalent to `self.viewport[2]`.

Type int

`BaseWindow.viewport_height`
The height of the viewport

Equivalent to `self.viewport[3]`.

Type int

`BaseWindow.frames`
Number of frames rendered

Type int

`BaseWindow.resizable`
Window is resizable

Type bool

`BaseWindow.fullscreen`
Window is in fullscreen mode

Type bool

`BaseWindow.config`
Get the current WindowConfig instance

This property can also be set. Assigning a WindowConfig instance will automatically set up the necessary event callback methods:

```
window.config = window_config_instance
```

`BaseWindow.vsync`
vertical sync enabled/disabled

Type bool

BaseWindow.aspect_ratio

The current aspect ratio of the window. If a fixed aspect ratio was passed to the window initializer this value will always be returned. Otherwise `width / height` will be returned.

This property is read only.

Type float

BaseWindow.fixed_aspect_ratio

The fixed aspect ratio for the window.

Can be set to `None` to disable fixed aspect ratio making the aspect ratio adjust to the actual window size

This will affects how the viewport is calculated and the reported value from the `aspect_ratio` property:

```
# Enabled fixed aspect ratio
window.fixed_aspect_ratio = 16 / 9

# Disable fixed aspect ratio
window.fixed_aspect_ratio = None
```

Type float

BaseWindow.samples

Number of Multisample anti-aliasing (MSAA) samples

Type float

BaseWindow.cursor

Should the mouse cursor be visible inside the window?

This property can also be assigned to:

```
# Disable cursor
window.cursor = False
```

Type bool

BaseWindow.mouse_exclusivity

If mouse exclusivity is enabled.

When you enable mouse-exclusive mode, the mouse cursor is no longer available. It is not merely hidden – no amount of mouse movement will make it leave your application. This is for example useful when you don't want the mouse leaving the screen when rotating a 3d scene.

This property can also be set:

```
window.mouse_exclusivity = True
```

Type bool

BaseWindow.render_func

The render callable

This property can also be used to assign a callable.

Type callable

BaseWindow.resize_func

Get or set the resize callable

Type callable

`BaseWindow.close_func`

Get or set the close callable

Type callable

`BaseWindow.iconify_func`

Get or set the iconify/show/hide callable

Type callable

`BaseWindow.key_event_func`

Get or set the key_event callable

Type callable

`BaseWindow.mouse_position_event_func`

Get or set the mouse_position callable

Type callable

`BaseWindow.mouse_press_event_func`

Get or set the mouse_press callable

Type callable

`BaseWindow.mouse_release_event_func`

Get or set the mouse_release callable

Type callable

`BaseWindow.mouse_drag_event_func`

Get or set the mouse_drag callable

Type callable

`BaseWindow.mouse_scroll_event_func`

Get or set the mouse_scroll_event callable

Type callable

`BaseWindow.unicode_char_entered_func`

Get or set the unicode_char_entered callable

Type callable

`BaseWindow.is_closing`

Is the window about to close?

Type bool

`BaseWindow.mouse = <class 'moderngl_window.context.base.window.MouseButtons'>`

Mouse button enum

`BaseWindow.mouse_states`

Mouse button state structure.

The current mouse button states.

```

window.mouse_buttons.left
window.mouse_buttons.right
window.mouse_buttons.middle

```

Type MouseButtonStates

`BaseWindow.modifiers`

(KeyModifiers) The current keyboard modifiers

`BaseWindow.gl_version_code`

Generates the version code integer for the selected OpenGL version.

`gl_version(4, 1)` returns 410

Type int

10.3 glfw.Window

10.3.1 Methods

`Window.__init__ (**kwargs)`

Initialize a window instance.

Parameters

- **title** (*str*) – The window title
- **gl_version** (*tuple*) – Major and minor version of the opengl context to create
- **size** (*tuple*) – Window size x, y
- **resizable** (*bool*) – Should the window be resizable?
- **fullscreen** (*bool*) – Open window in fullscreen mode
- **vsync** (*bool*) – Enable/disable vsync
- **aspect_ratio** (*float*) – The desired fixed aspect ratio. Can be set to `None` to make aspect ratio be based on the actual window size.
- **samples** (*int*) – Number of MSAA samples for the default framebuffer
- **cursor** (*bool*) – Enable/disable displaying the cursor inside the window

`Window.init_mgl_context ()` → `None`

Create or assign a ModernGL context. If no context is supplied a context will be created using the window's `gl_version`.

Keyword Arguments **ctx** – An optional custom ModernGL context

`Window.is_key_pressed (key)` → `bool`

Returns: The press state of a key

`Window.close ()` → `None`

Suggest to glfw the window should be closed soon

`Window.use ()`

Bind the window's framebuffer

`Window.clear (red=0.0, green=0.0, blue=0.0, alpha=0.0, depth=1.0, viewport=None)`

Binds and clears the default framebuffer

Parameters

- **red** (*float*) – color component
- **green** (*float*) – color component
- **blue** (*float*) – color component

- **alpha** (*float*) – alpha component
- **depth** (*float*) – depth value
- **viewport** (*tuple*) – The viewport

Window.**render** (*time=0.0, frame_time=0.0*) → None
 Renders a frame by calling the configured render callback

Keyword Arguments

- **time** (*float*) – Current time in seconds
- **frame_time** (*float*) – Delta time from last frame in seconds

Window.**swap_buffers** ()
 Swap buffers, increment frame counter and pull events

Window.**resize** (*width, height*) → None
 Should be called every time window is resized so the example can adapt to the new size if needed

Window.**destroy** ()
 Gracefully terminate GLFW

Window.**set_default_viewport** () → None
 Calculates the and sets the viewport based on window configuration.

The viewport will based on the configured fixed aspect ratio if set. If no fixed aspect ratio is set the viewport will be scaled to the entire window size regardless of size.

Will add black borders and center the viewport if the window do not match the configured viewport (fixed only)

Window.**print_context_info** ()
 Prints moderngl context info.

10.3.2 Attributes

Window.**name** = 'glfw'
 Name of the window

Window.**keys**
 GLFW specific key constants

Window.**ctx**
 The ModernGL context for the window
Type moderngl.Context

Window.**fbo**
 The default framebuffer
Type moderngl.Framebuffer

Window.**title**
 Window title.
 This property can also be set:

```
window.title = "New Title"
```

Type str

Window.exit_key

Get or set the exit/close key for the window.

Pressing this key will close the window.

By default the ESCAPE is set, but this can be overridden or disabled:

```
# Default exit key
window.exit_key = window.keys.ESCAPE

# Set some other random exit key
window.exit_key = window.keys.Q

# Disable the exit key
window.exit_key = None
```

Window.gl_version

(major, minor) required OpenGL version

Type Tuple[int, int]

Window.width

The current window width

Type int

Window.height

The current window height

Type int

Window.size

current window size.

This property also support assignment:

```
# Resize the window to 1000 x 1000
window.size = 1000, 1000
```

Type Tuple[int, int]

Window.position

The current window position.

This property can also be set to move the window:

```
# Move window to 100, 100
window.position = 100, 100
```

Type Tuple[int, int]

Window.buffer_width

the current window buffer width

Type int

Window.buffer_height

the current window buffer height

Type int

`Window.buffer_size`

tuple with the current window buffer size

Type Tuple[int, int]

`Window.pixel_ratio`

The framebuffer/window size ratio

Type float

`Window.viewport`

current window viewport

Type Tuple[int, int, int, int]

`Window.viewport_size`

Size of the viewport.

Equivalent to `self.viewport[2], self.viewport[3]`

Type Tuple[int,int]

`Window.viewport_width`

The width of the viewport.

Equivalent to `self.viewport[2]`.

Type int

`Window.viewport_height`

The height of the viewport

Equivalent to `self.viewport[3]`.

Type int

`Window.frames`

Number of frames rendered

Type int

`Window.resizable`

Window is resizable

Type bool

`Window.close_func`

Get or set the close callable

Type callable

`Window.fullscreen`

Window is in fullscreen mode

Type bool

`Window.config`

Get the current WindowConfig instance

This property can also be set. Assigning a WindowConfig instance will automatically set up the necessary event callback methods:

```
window.config = window_config_instance
```

`Window.vsync`

vertical sync enabled/disabled

Type bool

Window.**aspect_ratio**

The current aspect ratio of the window. If a fixed aspect ratio was passed to the window initializer this value will always be returned. Otherwise width / height will be returned.

This property is read only.

Type float

Window.**fixed_aspect_ratio**

The fixed aspect ratio for the window.

Can be set to None to disable fixed aspect ratio making the aspect ratio adjust to the actual window size

This will affects how the viewport is calculated and the reported value from the `aspect_ratio` property:

```
# Enabled fixed aspect ratio
window.fixed_aspect_ratio = 16 / 9

# Disable fixed aspect ratio
window.fixed_aspect_ratio = None
```

Type float

Window.**samples**

Number of Multisample anti-aliasing (MSAA) samples

Type float

Window.**cursor**

Should the mouse cursor be visible inside the window?

This property can also be assigned to:

```
# Disable cursor
window.cursor = False
```

Type bool

Window.**mouse_exclusivity**

If mouse exclusivity is enabled.

When you enable mouse-exclusive mode, the mouse cursor is no longer available. It is not merely hidden – no amount of mouse movement will make it leave your application. This is for example useful when you don't want the mouse leaving the screen when rotating a 3d scene.

This property can also be set:

```
window.mouse_exclusivity = True
```

Type bool

Window.**render_func**

The render callable

This property can also be used to assign a callable.

Type callable

Window.**resize_func**

Get or set the resize callable

Type callable

Window.**iconify_func**

Get or set the iconify/show/hide callable

Type callable

Window.**key_event_func**

Get or set the key_event callable

Type callable

Window.**mouse_position_event_func**

Get or set the mouse_position callable

Type callable

Window.**mouse_press_event_func**

Get or set the mouse_press callable

Type callable

Window.**mouse_release_event_func**

Get or set the mouse_release callable

Type callable

Window.**mouse_drag_event_func**

Get or set the mouse_drag callable

Type callable

Window.**mouse_scroll_event_func**

Get or set the mouse_scroll_event callable

Type callable

Window.**unicode_char_entered_func**

Get or set the unicode_char_entered callable

Type callable

Window.**is_closing**

Checks if the window is scheduled for closing

Type bool

Window.**mouse** = <class 'moderngl_window.context.base.window.MouseButtons'>

Window.**mouse_states**

Mouse button state structure.

The current mouse button states.

```
window.mouse_buttons.left
window.mouse_buttons.right
window.mouse_buttons.middle
```

Type MouseButtonStates

Window.**modifiers**

(KeyModifiers) The current keyboard modifiers

Window.**gl_version_code**

Generates the version code integer for the selected OpenGL version.

gl_version (4, 1) returns 410

Type int

10.3.3 Window Specific Methods

Window.**glfw_window_resize_callback** (*window, width, height*)

Window resize callback for glfw

Parameters

- **window** – The window
- **width** – New width
- **height** – New height

Window.**glfw_mouse_event_callback** (*window, xpos, ypos*)

Mouse position event callback from glfw. Translates the events forwarding them to `cursor_event()`.

Screen coordinates relative to the top-left corner

Parameters

- **window** – The window
- **xpos** – viewport x pos
- **ypos** – viewport y pos

Window.**glfw_mouse_button_callback** (*window, button, action, mods*)

Handle mouse button events and forward them to the example

Parameters

- **window** – The window
- **button** – The button creating the event
- **action** – Button action (press or release)
- **mods** – They modifiers such as ctrl or shift

Window.**glfw_mouse_scroll_callback** (*window, x_offset: float, y_offset: float*)

Handle mouse scroll events and forward them to the example

Parameters

- **window** – The window
- **x_offset** (*float*) – x wheel offset
- **y_offset** (*float*) – y wheel offset

Window.**glfw_key_event_callback** (*window, key, scancode, action, mods*)

Key event callback for glfw. Translates and forwards keyboard event to `keyboard_event()`

Parameters

- **window** – Window event origin
- **key** – The key that was pressed or released.
- **scancode** – The system-specific scancode of the key.

- **action** – GLFW_PRESS, GLFW_RELEASE or GLFW_REPEAT
- **mods** – Bit field describing which modifier keys were held down.

Window.**glfw_char_callback** (*window*, *codepoint*: *int*)

Handle text input (only unicode charaters)

Parameters

- **window** – The glfw window
- **codepoint** (*int*) – The unicode codepoint

Window.**glfw_cursor_enter** (*window*, *enter*: *int*)

called when the cursor enters or leaves the content area of the window.

Parameters

- **window** – the window instance
- **enter** (*int*) – 0: leave, 1: enter

Window.**glfw_window_focus** (*window*, *focused*: *int*)

Called when the window focus is changed.

Parameters

- **window** – The window instance
- **focused** (*int*) – 0: de-focus, 1: focused

Window.**glfw_window_iconify** (*window*, *iconified*: *int*)

Called when the window is minimized or restored.

Parameters

- **window** – The window
- **iconified** (*int*) – 1 = minimized, 0 = restored.

10.4 headless.Window

10.4.1 Methods

Window.**__init__** (***kwargs*)

Initialize a window instance.

Parameters

- **title** (*str*) – The window title
- **gl_version** (*tuple*) – Major and minor version of the opengl context to create
- **size** (*tuple*) – Window size x, y
- **resizable** (*bool*) – Should the window be resizable?
- **fullscreen** (*bool*) – Open window in fullscreen mode
- **vsync** (*bool*) – Enable/disable vsync
- **aspect_ratio** (*float*) – The desired fixed aspect ratio. Can be set to `None` to make aspect ratio be based on the actual window size.
- **samples** (*int*) – Number of MSAA samples for the default framebuffer

- **cursor** (*bool*) – Enable/disable displaying the cursor inside the window

`Window.init_mgl_context()` → None

Create an standalone context and framebuffer

`Window.is_key_pressed(key)` → bool

Returns: The press state of a key

`Window.close()` → None

Signal for the window to close

`Window.use()`

Bind the window's framebuffer

`Window.clear(red=0.0, green=0.0, blue=0.0, alpha=0.0, depth=1.0, viewport=None)`

Binds and clears the default framebuffer

Parameters

- **red** (*float*) – color component
- **green** (*float*) – color component
- **blue** (*float*) – color component
- **alpha** (*float*) – alpha component
- **depth** (*float*) – depth value
- **viewport** (*tuple*) – The viewport

`Window.render(time=0.0, frame_time=0.0)` → None

Renders a frame by calling the configured render callback

Keyword Arguments

- **time** (*float*) – Current time in seconds
- **frame_time** (*float*) – Delta time from last frame in seconds

`Window.swap_buffers()` → None

Placeholder. We currently don't do double buffering in headless mode. This may change in the future.

`Window.resize(width, height)` → None

Should be called every time window is resized so the example can adapt to the new size if needed

`Window.destroy()` → None

Destroy the context

`Window.set_default_viewport()` → None

Calculates the and sets the viewport based on window configuration.

The viewport will based on the configured fixed aspect ratio if set. If no fixed aspect ratio is set the viewport will be scaled to the entire window size regardless of size.

Will add black borders and center the viewport if the window do not match the configured viewport (fixed only)

`Window.print_context_info()`

Prints moderngl context info.

10.4.2 Attributes

`Window.name = 'headless'`

Name of the window

Window.**keys**

Window.**ctx**

The ModernGL context for the window

Type moderngl.Context

Window.**fbo**

The default framebuffer

Type moderngl.Framebuffer

Window.**title**

Window title.

This property can also be set:

```
window.title = "New Title"
```

Type str

Window.**exit_key**

Get or set the exit/close key for the window.

Pressing this key will close the window.

By default the ESCAPE is set, but this can be overridden or disabled:

```
# Default exit key
window.exit_key = window.keys.ESCAPE

# Set some other random exit key
window.exit_key = window.keys.Q

# Disable the exit key
window.exit_key = None
```

Window.**gl_version**

(major, minor) required OpenGL version

Type Tuple[int, int]

Window.**width**

The current window width

Type int

Window.**height**

The current window height

Type int

Window.**size**

current window size.

This property also support assignment:

```
# Resize the window to 1000 x 1000
window.size = 1000, 1000
```

Type Tuple[int, int]

Window.position

The current window position.

This property can also be set to move the window:

```
# Move window to 100, 100
window.position = 100, 100
```

Type Tuple[int, int]

Window.buffer_width

the current window buffer width

Type int

Window.buffer_height

the current window buffer height

Type int

Window.buffer_size

tuple with the current window buffer size

Type Tuple[int, int]

Window.pixel_ratio

The framebuffer/window size ratio

Type float

Window.viewport

current window viewport

Type Tuple[int, int, int, int]

Window.viewport_size

Size of the viewport.

Equivalent to `self.viewport[2], self.viewport[3]`

Type Tuple[int,int]

Window.viewport_width

The width of the viewport.

Equivalent to `self.viewport[2]`.

Type int

Window.viewport_height

The height of the viewport

Equivalent to `self.viewport[3]`.

Type int

Window.frames

Number of frames rendered

Type int

Window.resizable

Window is resizable

Type bool

Window.fullscreen

Window is in fullscreen mode

Type bool

Window.config

Get the current WindowConfig instance

This property can also be set. Assigning a WindowConfig instance will automatically set up the necessary event callback methods:

```
window.config = window_config_instance
```

Window.vsync

vertical sync enabled/disabled

Type bool

Window.aspect_ratio

The current aspect ratio of the window. If a fixed aspect ratio was passed to the window initializer this value will always be returned. Otherwise width / height will be returned.

This property is read only.

Type float

Window.fixed_aspect_ratio

The fixed aspect ratio for the window.

Can be set to None to disable fixed aspect ratio making the aspect ratio adjust to the actual window size

This will affects how the viewport is calculated and the reported value from the aspect_ratio property:

```
# Enabled fixed aspect ratio
window.fixed_aspect_ratio = 16 / 9

# Disable fixed aspect ratio
window.fixed_aspect_ratio = None
```

Type float

Window.samples

Number of Multisample anti-aliasing (MSAA) samples

Type float

Window.cursor

Should the mouse cursor be visible inside the window?

This property can also be assigned to:

```
# Disable cursor
window.cursor = False
```

Type bool

Window.mouse_exclusivity

If mouse exclusivity is enabled.

When you enable mouse-exclusive mode, the mouse cursor is no longer available. It is not merely hidden – no amount of mouse movement will make it leave your application. This is for example useful when you don't want the mouse leaving the screen when rotating a 3d scene.

This property can also be set:

```
window.mouse_exclusivity = True
```

Type bool

Window.**render_func**

The render callable

This property can also be used to assign a callable.

Type callable

Window.**resize_func**

Get or set the resize callable

Type callable

Window.**close_func**

Get or set the close callable

Type callable

Window.**iconify_func**

Get or set the iconify/show/hide callable

Type callable

Window.**key_event_func**

Get or set the key_event callable

Type callable

Window.**mouse_position_event_func**

Get or set the mouse_position callable

Type callable

Window.**mouse_press_event_func**

Get or set the mouse_press callable

Type callable

Window.**mouse_release_event_func**

Get or set the mouse_release callable

Type callable

Window.**mouse_drag_event_func**

Get or set the mouse_drag callable

Type callable

Window.**mouse_scroll_event_func**

Get or set the mouse_scroll_event callable

Type callable

Window.**unicode_char_entered_func**

Get or set the unicode_char_entered callable

Type callable

`Window.is_closing`

Is the window about to close?

Type bool

`Window.mouse = <class 'moderngl_window.context.base.window.MouseButtons'>`

`Window.mouse_states`

Mouse button state structure.

The current mouse button states.

```

window.mouse_buttons.left
window.mouse_buttons.right
window.mouse_buttons.middle

```

Type MouseButtonStates

`Window.modifiers`

(KeyModifiers) The current keyboard modifiers

`Window.gl_version_code`

Generates the version code integer for the selected OpenGL version.

`gl_version (4, 1)` returns 410

Type int

10.5 pyglet.Window

10.5.1 Methods

`Window.__init__ (**kwargs)`

Initialize a window instance.

Parameters

- **title** (*str*) – The window title
- **gl_version** (*tuple*) – Major and minor version of the opengl context to create
- **size** (*tuple*) – Window size x, y
- **resizable** (*bool*) – Should the window be resizable?
- **fullscreen** (*bool*) – Open window in fullscreen mode
- **vsync** (*bool*) – Enable/disable vsync
- **aspect_ratio** (*float*) – The desired fixed aspect ratio. Can be set to `None` to make aspect ratio be based on the actual window size.
- **samples** (*int*) – Number of MSAA samples for the default framebuffer
- **cursor** (*bool*) – Enable/disable displaying the cursor inside the window

`Window.init_mgl_context ()` → `None`

Create or assign a ModernGL context. If no context is supplied a context will be created using the window's `gl_version`.

Keyword Arguments **ctx** – An optional custom ModernGL context

`Window.is_key_pressed(key) → bool`

Returns: The press state of a key

`Window.close() → None`

Close the pyglet window directly

`Window.use()`

Bind the window's framebuffer

`Window.clear(red=0.0, green=0.0, blue=0.0, alpha=0.0, depth=1.0, viewport=None)`

Binds and clears the default framebuffer

Parameters

- **red** (*float*) – color component
- **green** (*float*) – color component
- **blue** (*float*) – color component
- **alpha** (*float*) – alpha component
- **depth** (*float*) – depth value
- **viewport** (*tuple*) – The viewport

`Window.render(time=0.0, frame_time=0.0) → None`

Renders a frame by calling the configured render callback

Keyword Arguments

- **time** (*float*) – Current time in seconds
- **frame_time** (*float*) – Delta time from last frame in seconds

`Window.swap_buffers() → None`

Swap buffers, increment frame counter and pull events

`Window.resize(width, height) → None`

Should be called every time window is resized so the example can adapt to the new size if needed

`Window.destroy()`

Destroy the pyglet window

`Window.set_default_viewport() → None`

Calculates the and sets the viewport based on window configuration.

The viewport will based on the configured fixed aspect ratio if set. If no fixed aspect ratio is set the viewport will be scaled to the entire window size regardless of size.

Will add black borders and center the viewport if the window do not match the configured viewport (fixed only)

`Window.print_context_info()`

Prints moderngl context info.

10.5.2 Window Specific Methods

`Window.on_mouse_press(x: int, y: int, button, mods)`

Handle mouse press events and forward to standard methods

Parameters

- **x** – x position of the mouse when pressed

- **y** – y position of the mouse when pressed
- **button** – The pressed button
- **mods** – Modifiers

Window.**on_key_release** (*symbol, modifiers*)

Pyglet specific key release callback.

Forwards and translates the events to standard methods.

Parameters

- **symbol** – The symbol of the pressed key
- **modifiers** – Modifier state (shift, ctrl etc.)

Window.**on_mouse_drag** (*x, y, dx, dy, buttons, modifiers*)

Pyglet specific mouse drag event.

When a mouse button is pressed this is the only way to capture mouse position events

Window.**on_key_press** (*symbol, modifiers*)

Pyglet specific key press callback.

Forwards and translates the events to the standard methods.

Parameters

- **symbol** – The symbol of the pressed key
- **modifiers** – Modifier state (shift, ctrl etc.)

Window.**on_mouse_release** (*x: int, y: int, button, mods*)

Handle mouse release events and forward to standard methods

Parameters

- **x** – x position when mouse button was released
- **y** – y position when mouse button was released
- **button** – The button pressed
- **mods** – Modifiers

Window.**on_mouse_motion** (*x, y, dx, dy*)

Pyglet specific mouse motion callback.

Forwards and translates the event to the standard methods.

Parameters

- **x** – x position of the mouse
- **y** – y position of the mouse
- **dx** – delta x position
- **dy** – delta y position of the mouse

Window.**on_mouse_scroll** (*x, y, x_offset: float, y_offset: float*)

Handle mouse wheel.

Parameters

- **x_offset** (*float*) – X scroll offset
- **y_offset** (*float*) – Y scroll offset

`Window.on_text(text)`

Pyglet specific text input callback

Forwards and translates the events to the standard methods.

Parameters `text` (*str*) – The unicode character entered

`Window.on_resize(width: int, height: int)`

Pyglet specific callback for window resize events forwarding to standard methods

Parameters

- **width** – New window width
- **height** – New window height

`Window.on_show()`

Called when window first appear or restored from hidden state

`Window.on_hide()`

Called when window is minimized

`Window.on_close()`

Pyglet specific window close callback

10.5.3 Attributes

`Window.name = 'pyglet'`

Name of the window

`Window.keys`

Pyglet specific key constants

`Window.ctx`

The ModernGL context for the window

Type `moderngl.Context`

`Window.fbo`

The default framebuffer

Type `moderngl.Framebuffer`

`Window.title`

Window title.

This property can also be set:

```
window.title = "New Title"
```

Type `str`

`Window.exit_key`

Get or set the exit/close key for the window.

Pressing this key will close the window.

By default the ESCAPE is set, but this can be overridden or disabled:

```
# Default exit key
window.exit_key = window.keys.ESCAPE

# Set some other random exit key
window.exit_key = window.keys.Q

# Disable the exit key
window.exit_key = None
```

Window.**gl_version**

(major, minor) required OpenGL version

Type Tuple[int, int]

Window.**width**

The current window width

Type int

Window.**height**

The current window height

Type int

Window.**size**

current window size.

This property also support assignment:

```
# Resize the window to 1000 x 1000
window.size = 1000, 1000
```

Type Tuple[int, int]

Window.**position**

The current window position.

This property can also be set to move the window:

```
# Move window to 100, 100
window.position = 100, 100
```

Type Tuple[int, int]

Window.**buffer_width**

the current window buffer width

Type int

Window.**buffer_height**

the current window buffer height

Type int

Window.**buffer_size**

tuple with the current window buffer size

Type Tuple[int, int]

Window.**pixel_ratio**

The framebuffer/window size ratio

Type float

Window.**viewport**

current window viewport

Type Tuple[int, int, int, int]

Window.**viewport_size**

Size of the viewport.

Equivalent to `self.viewport[2], self.viewport[3]`

Type Tuple[int,int]

Window.**viewport_width**

The width of the viewport.

Equivalent to `self.viewport[2]`.

Type int

Window.**viewport_height**

The height of the viewport

Equivalent to `self.viewport[3]`.

Type int

Window.**frames**

Number of frames rendered

Type int

Window.**resizable**

Window is resizable

Type bool

Window.**fullscreen**

Window is in fullscreen mode

Type bool

Window.**config**

Get the current WindowConfig instance

This property can also be set. Assigning a WindowConfig instance will automatically set up the necessary event callback methods:

```
window.config = window_config_instance
```

Window.**vsync**

vertical sync enabled/disabled

Type bool

Window.**aspect_ratio**

The current aspect ratio of the window. If a fixed aspect ratio was passed to the window initializer this value will always be returned. Otherwise `width / height` will be returned.

This property is read only.

Type float

Window.fixed_aspect_ratio

The fixed aspect ratio for the window.

Can be set to `None` to disable fixed aspect ratio making the aspect ratio adjust to the actual window size

This will affects how the viewport is calculated and the reported value from the `aspect_ratio` property:

```
# Enabled fixed aspect ratio
window.fixed_aspect_ratio = 16 / 9

# Disable fixed aspect ratio
window.fixed_aspect_ratio = None
```

Type float

Window.samples

Number of Multisample anti-aliasing (MSAA) samples

Type float

Window.cursor

Should the mouse cursor be visible inside the window?

This property can also be assigned to:

```
# Disable cursor
window.cursor = False
```

Type bool

Window.mouse_exclusivity

If mouse exclusivity is enabled.

When you enable mouse-exclusive mode, the mouse cursor is no longer available. It is not merely hidden – no amount of mouse movement will make it leave your application. This is for example useful when you don't want the mouse leaving the screen when rotating a 3d scene.

This property can also be set:

```
window.mouse_exclusivity = True
```

Type bool

Window.render_func

The render callable

This property can also be used to assign a callable.

Type callable

Window.resize_func

Get or set the resize callable

Type callable

Window.close_func

Get or set the close callable

Type callable

Window.iconify_func

Get or set the iconify/show/hide callable

Type callable

Window.key_event_func

Get or set the key_event callable

Type callable

Window.mouse_position_event_func

Get or set the mouse_position callable

Type callable

Window.mouse_press_event_func

Get or set the mouse_press callable

Type callable

Window.mouse_release_event_func

Get or set the mouse_release callable

Type callable

Window.mouse_drag_event_func

Get or set the mouse_drag callable

Type callable

Window.unicode_char_entered_func

Get or set the unicode_char_entered callable

Type callable

Window.mouse_scroll_event_func

Get or set the mouse_scroll_event callable

Type callable

Window.is_closing

Check pygame's internal exit state

Window.mouse = <class 'moderngl_window.context.base.window.MouseButtons'>

Window.mouse_states

Mouse button state structure.

The current mouse button states.

```
window.mouse_buttons.left
window.mouse_buttons.right
window.mouse_buttons.middle
```

Type MouseButtonStates

Window.modifiers

(KeyModifiers) The current keyboard modifiers

Window.gl_version_code

Generates the version code integer for the selected OpenGL version.

gl_version (4, 1) returns 410

Type int

10.6 PyQt5.Window

10.6.1 Methods

`Window.__init__ (**kwargs)`

Initialize a window instance.

Parameters

- **title** (*str*) – The window title
- **gl_version** (*tuple*) – Major and minor version of the opengl context to create
- **size** (*tuple*) – Window size x, y
- **resizable** (*bool*) – Should the window be resizable?
- **fullscreen** (*bool*) – Open window in fullscreen mode
- **vsync** (*bool*) – Enable/disable vsync
- **aspect_ratio** (*float*) – The desired fixed aspect ratio. Can be set to `None` to make aspect ratio be based on the actual window size.
- **samples** (*int*) – Number of MSAA samples for the default framebuffer
- **cursor** (*bool*) – Enable/disable displaying the cursor inside the window

`Window.init_mgl_context ()` → `None`

Create or assign a ModernGL context. If no context is supplied a context will be created using the window's `gl_version`.

Keyword Arguments **ctx** – An optional custom ModernGL context

`Window.is_key_pressed (key)` → `bool`

Returns: The press state of a key

`Window.close ()`

Close the window

`Window.use ()`

Bind the window's framebuffer

`Window.clear (red=0.0, green=0.0, blue=0.0, alpha=0.0, depth=1.0, viewport=None)`

Binds and clears the default framebuffer

Parameters

- **red** (*float*) – color component
- **green** (*float*) – color component
- **blue** (*float*) – color component
- **alpha** (*float*) – alpha component
- **depth** (*float*) – depth value
- **viewport** (*tuple*) – The viewport

`Window.render (time=0.0, frame_time=0.0)` → `None`

Renders a frame by calling the configured render callback

Keyword Arguments

- **time** (*float*) – Current time in seconds

- **frame_time** (*float*) – Delta time from last frame in seconds

Window.**swap_buffers**() → None

Swap buffers, set viewport, trigger events and increment frame counter

Window.**resize**(*width: int, height: int*) → None

Replacement for Qt's `resizeGL` method.

Parameters

- **width** – New window width
- **height** – New window height

Window.**destroy**() → None

Quit the Qt application to exit the window gracefully

Window.**set_default_viewport**() → None

Calculates the and sets the viewport based on window configuration.

The viewport will based on the configured fixed aspect ratio if set. If no fixed aspect ratio is set the viewport will be scaled to the entire window size regardless of size.

Will add black borders and center the viewport if the window do not match the configured viewport (fixed only)

Window.**print_context_info**()

Prints moderngl context info.

10.6.2 Window Specific Methods

Window.**close_event**(*event*) → None

The standard PyQt close events

Parameters **event** – The qtevent instance

Window.**mouse_release_event**(*event*) → None

Forward mouse release events to standard methods

Parameters **event** – The qtevent instance

Window.**key_release_event**(*event*) → None

Process Qt key release events forwarding them to standard methods

Parameters **event** – The qtevent instance

Window.**mouse_move_event**(*event*) → None

Forward mouse cursor position events to standard methods

Parameters **event** – The qtevent instance

Window.**key_pressed_event**(*event*) → None

Process Qt key press events forwarding them to standard methods

Parameters **event** – The qtevent instance

Window.**mouse_press_event**(*event*) → None

Forward mouse press events to standard methods

Parameters **event** – The qtevent instance

Window.**mouse_wheel_event**(*event*)

Forward mouse wheel events to standard methods.

From Qt docs:

Returns the distance that the wheel is rotated, in eighths of a degree. A positive value indicates that the wheel was rotated forwards away from the user; a negative value indicates that the wheel was rotated backwards toward the user.

Most mouse types work in steps of 15 degrees, in which case the delta value is a multiple of 120; i.e., 120 units * 1/8 = 15 degrees.

However, some mice have finer-resolution wheels and send delta values that are less than 120 units (less than 15 degrees). To support this possibility, you can either cumulatively add the delta values from events until the value of 120 is reached, then scroll the widget, or you can partially scroll the widget in response to each wheel event.

Parameters `event` (*QWheelEvent*) – Mouse wheel event

`Window.show_event(event)`
The standard Qt show event

`Window.hide_event(event)`
The standard Qt hide event

10.6.3 Attributes

`Window.name = 'pyqt5'`
Name of the window

`Window.keys`
PyQt5 specific key constants

`Window.ctx`
The ModernGL context for the window

Type `moderngl.Context`

`Window.fbo`
The default framebuffer

Type `moderngl.Framebuffer`

`Window.title`
Window title.

This property can also be set:

```
window.title = "New Title"
```

Type `str`

`Window.exit_key`
Get or set the exit/close key for the window.

Pressing this key will close the window.

By default the ESCAPE is set, but this can be overridden or disabled:

```
# Default exit key
window.exit_key = window.keys.ESCAPE

# Set some other random exit key
window.exit_key = window.keys.Q
```

(continues on next page)

(continued from previous page)

```
# Disable the exit key
window.exit_key = None
```

Window.gl_version

(major, minor) required OpenGL version

Type Tuple[int, int]**Window.width**

The current window width

Type int**Window.height**

The current window height

Type int**Window.size**

current window size.

This property also support assignment:

```
# Resize the window to 1000 x 1000
window.size = 1000, 1000
```

Type Tuple[int, int]**Window.position**

The current window position.

This property can also be set to move the window:

```
# Move window to 100, 100
window.position = 100, 100
```

Type Tuple[int, int]**Window.buffer_width**

the current window buffer width

Type int**Window.buffer_height**

the current window buffer height

Type int**Window.buffer_size**

tuple with the current window buffer size

Type Tuple[int, int]**Window.pixel_ratio**

The framebuffer/window size ratio

Type float**Window.viewport**

current window viewport

Type Tuple[int, int, int, int]

Window.**viewport_size**

Size of the viewport.

Equivalent to `self.viewport[2], self.viewport[3]`

Type Tuple[int,int]

Window.**viewport_width**

The width of the viewport.

Equivalent to `self.viewport[2]`.

Type int

Window.**viewport_height**

The height of the viewport

Equivalent to `self.viewport[3]`.

Type int

Window.**frames**

Number of frames rendered

Type int

Window.**resizable**

Window is resizable

Type bool

Window.**fullscreen**

Window is in fullscreen mode

Type bool

Window.**config**

Get the current WindowConfig instance

This property can also be set. Assigning a WindowConfig instance will automatically set up the necessary event callback methods:

```
window.config = window_config_instance
```

Window.**vsync**

vertical sync enabled/disabled

Type bool

Window.**aspect_ratio**

The current aspect ratio of the window. If a fixed aspect ratio was passed to the window initializer this value will always be returned. Otherwise `width / height` will be returned.

This property is read only.

Type float

Window.**fixed_aspect_ratio**

The fixed aspect ratio for the window.

Can be set to `None` to disable fixed aspect ratio making the aspect ratio adjust to the actual window size

This will affects how the viewport is calculated and the reported value from the `aspect_ratio` property:

```
# Enabled fixed aspect ratio
window.fixed_aspect_ratio = 16 / 9

# Disable fixed aspect ratio
window.fixed_aspect_ratio = None
```

Type float

Window.**samples**

Number of Multisample anti-aliasing (MSAA) samples

Type float

Window.**cursor**

Should the mouse cursor be visible inside the window?

This property can also be assigned to:

```
# Disable cursor
window.cursor = False
```

Type bool

Window.**mouse_exclusivity**

If mouse exclusivity is enabled.

When you enable mouse-exclusive mode, the mouse cursor is no longer available. It is not merely hidden – no amount of mouse movement will make it leave your application. This is for example useful when you don't want the mouse leaving the screen when rotating a 3d scene.

This property can also be set:

```
window.mouse_exclusivity = True
```

Type bool

Window.**render_func**

The render callable

This property can also be used to assign a callable.

Type callable

Window.**resize_func**

Get or set the resize callable

Type callable

Window.**close_func**

Get or set the close callable

Type callable

Window.**iconify_func**

Get or set the iconify/show/hide callable

Type callable

Window.**key_event_func**

Get or set the key_event callable

Type callable

`Window.mouse_position_event_func`

Get or set the mouse_position callable

Type callable

`Window.mouse_press_event_func`

Get or set the mouse_press callable

Type callable

`Window.mouse_release_event_func`

Get or set the mouse_release callable

Type callable

`Window.mouse_drag_event_func`

Get or set the mouse_drag callable

Type callable

`Window.unicode_char_entered_func`

Get or set the unicode_char_entered callable

Type callable

`Window.mouse_scroll_event_func`

Get or set the mouse_scroll_event callable

Type callable

`Window.is_closing`

Is the window about to close?

Type bool

`Window.mouse = <class 'moderngl_window.context.base.window.MouseButtons'>`

`Window.mouse_states`

Mouse button state structure.

The current mouse button states.

```

window.mouse_buttons.left
window.mouse_buttons.right
window.mouse_buttons.middle

```

Type MouseButtonStates

`Window.modifiers`

(KeyModifiers) The current keyboard modifiers

`Window.gl_version_code`

Generates the version code integer for the selected OpenGL version.

gl_version (4, 1) returns 410

Type int

10.7 pyside2.Window

10.7.1 Methods

`Window.__init__ (**kwargs)`

Initialize a window instance.

Parameters

- **title** (*str*) – The window title
- **gl_version** (*tuple*) – Major and minor version of the opengl context to create
- **size** (*tuple*) – Window size x, y
- **resizable** (*bool*) – Should the window be resizable?
- **fullscreen** (*bool*) – Open window in fullscreen mode
- **vsync** (*bool*) – Enable/disable vsync
- **aspect_ratio** (*float*) – The desired fixed aspect ratio. Can be set to `None` to make aspect ratio be based on the actual window size.
- **samples** (*int*) – Number of MSAA samples for the default framebuffer
- **cursor** (*bool*) – Enable/disable displaying the cursor inside the window

`Window.init_mgl_context ()` → `None`

Create or assign a ModernGL context. If no context is supplied a context will be created using the window's `gl_version`.

Keyword Arguments **ctx** – An optional custom ModernGL context

`Window.is_key_pressed (key)` → `bool`

Returns: The press state of a key

`Window.close ()`

Close the window

`Window.use ()`

Bind the window's framebuffer

`Window.clear (red=0.0, green=0.0, blue=0.0, alpha=0.0, depth=1.0, viewport=None)`

Binds and clears the default framebuffer

Parameters

- **red** (*float*) – color component
- **green** (*float*) – color component
- **blue** (*float*) – color component
- **alpha** (*float*) – alpha component
- **depth** (*float*) – depth value
- **viewport** (*tuple*) – The viewport

`Window.render (time=0.0, frame_time=0.0)` → `None`

Renders a frame by calling the configured render callback

Keyword Arguments

- **time** (*float*) – Current time in seconds

- **frame_time** (*float*) – Delta time from last frame in seconds

Window.**swap_buffers**() → None

Swap buffers, set viewport, trigger events and increment frame counter

Window.**resize**(*width: int, height: int*) → None

Replacement for Qt's `resizeGL` method.

Parameters

- **width** – New window width
- **height** – New window height

Window.**destroy**() → None

Quit the Qt application to exit the window gracefully

Window.**set_default_viewport**() → None

Calculates the and sets the viewport based on window configuration.

The viewport will based on the configured fixed aspect ratio if set. If no fixed aspect ratio is set the viewport will be scaled to the entire window size regardless of size.

Will add black borders and center the viewport if the window do not match the configured viewport (fixed only)

Window.**print_context_info**()

Prints moderngl context info.

10.7.2 Window Specific Methods

Window.**close_event**(*event*) → None

The standard PyQt close events

Parameters **event** – The qtevent instance

Window.**mouse_release_event**(*event*) → None

Forward mouse release events to standard methods

Parameters **event** – The qtevent instance

Window.**key_release_event**(*event*)

Process Qt key release events forwarding them to standard methods

Parameters **event** – The qtevent instance

Window.**mouse_move_event**(*event*) → None

Forward mouse cursor position events to standard methods

Parameters **event** – The qtevent instance

Window.**key_pressed_event**(*event*)

Process Qt key press events forwarding them to standard methods

Parameters **event** – The qtevent instance

Window.**mouse_press_event**(*event*) → None

Forward mouse press events to standard methods

Parameters **event** – The qtevent instance

Window.**mouse_wheel_event**(*event*)

Forward mouse wheel events to standard methods.

From Qt docs:

Returns the distance that the wheel is rotated, in eighths of a degree. A positive value indicates that the wheel was rotated forwards away from the user; a negative value indicates that the wheel was rotated backwards toward the user.

Most mouse types work in steps of 15 degrees, in which case the delta value is a multiple of 120; i.e., 120 units * 1/8 = 15 degrees.

However, some mice have finer-resolution wheels and send delta values that are less than 120 units (less than 15 degrees). To support this possibility, you can either cumulatively add the delta values from events until the value of 120 is reached, then scroll the widget, or you can partially scroll the widget in response to each wheel event.

Parameters `event` (*QWheelEvent*) – Mouse wheel event

`Window.show_event(event)`
The standard Qt show event

`Window.hide_event(event)`
The standard Qt hide event

10.7.3 Attributes

`Window.name = 'pyside2'`
Name of the window

`Window.keys`
PySide2 specific key constants

`Window.ctx`
The ModernGL context for the window

Type `moderngl.Context`

`Window.fbo`
The default framebuffer

Type `moderngl.Framebuffer`

`Window.title`
Window title.

This property can also be set:

```
window.title = "New Title"
```

Type `str`

`Window.exit_key`
Get or set the exit/close key for the window.

Pressing this key will close the window.

By default the ESCAPE is set, but this can be overridden or disabled:

```
# Default exit key
window.exit_key = window.keys.ESCAPE

# Set some other random exit key
window.exit_key = window.keys.Q
```

(continues on next page)

(continued from previous page)

```
# Disable the exit key
window.exit_key = None
```

Window.gl_version

(major, minor) required OpenGL version

Type Tuple[int, int]**Window.width**

The current window width

Type int**Window.height**

The current window height

Type int**Window.size**

current window size.

This property also support assignment:

```
# Resize the window to 1000 x 1000
window.size = 1000, 1000
```

Type Tuple[int, int]**Window.position**

The current window position.

This property can also be set to move the window:

```
# Move window to 100, 100
window.position = 100, 100
```

Type Tuple[int, int]**Window.buffer_width**

the current window buffer width

Type int**Window.buffer_height**

the current window buffer height

Type int**Window.buffer_size**

tuple with the current window buffer size

Type Tuple[int, int]**Window.pixel_ratio**

The framebuffer/window size ratio

Type float**Window.viewport**

current window viewport

Type Tuple[int, int, int, int]

Window.**viewport_size**

Size of the viewport.

Equivalent to `self.viewport[2], self.viewport[3]`

Type Tuple[int,int]

Window.**viewport_width**

The width of the viewport.

Equivalent to `self.viewport[2]`.

Type int

Window.**viewport_height**

The height of the viewport

Equivalent to `self.viewport[3]`.

Type int

Window.**frames**

Number of frames rendered

Type int

Window.**resizable**

Window is resizable

Type bool

Window.**fullscreen**

Window is in fullscreen mode

Type bool

Window.**config**

Get the current WindowConfig instance

This property can also be set. Assigning a WindowConfig instance will automatically set up the necessary event callback methods:

```
window.config = window_config_instance
```

Window.**vsync**

vertical sync enabled/disabled

Type bool

Window.**aspect_ratio**

The current aspect ratio of the window. If a fixed aspect ratio was passed to the window initializer this value will always be returned. Otherwise `width / height` will be returned.

This property is read only.

Type float

Window.**fixed_aspect_ratio**

The fixed aspect ratio for the window.

Can be set to `None` to disable fixed aspect ratio making the aspect ratio adjust to the actual window size

This will affects how the viewport is calculated and the reported value from the `aspect_ratio` property:

```
# Enabled fixed aspect ratio
window.fixed_aspect_ratio = 16 / 9

# Disable fixed aspect ratio
window.fixed_aspect_ratio = None
```

Type float

Window.**samples**

Number of Multisample anti-aliasing (MSAA) samples

Type float

Window.**cursor**

Should the mouse cursor be visible inside the window?

This property can also be assigned to:

```
# Disable cursor
window.cursor = False
```

Type bool

Window.**mouse_exclusivity**

If mouse exclusivity is enabled.

When you enable mouse-exclusive mode, the mouse cursor is no longer available. It is not merely hidden – no amount of mouse movement will make it leave your application. This is for example useful when you don't want the mouse leaving the screen when rotating a 3d scene.

This property can also be set:

```
window.mouse_exclusivity = True
```

Type bool

Window.**render_func**

The render callable

This property can also be used to assign a callable.

Type callable

Window.**resize_func**

Get or set the resize callable

Type callable

Window.**close_func**

Get or set the close callable

Type callable

Window.**iconify_func**

Get or set the iconify/show/hide callable

Type callable

Window.**key_event_func**

Get or set the key_event callable

Type callable

`Window.mouse_position_event_func`

Get or set the mouse_position callable

Type callable

`Window.mouse_press_event_func`

Get or set the mouse_press callable

Type callable

`Window.mouse_release_event_func`

Get or set the mouse_release callable

Type callable

`Window.mouse_drag_event_func`

Get or set the mouse_drag callable

Type callable

`Window.unicode_char_entered_func`

Get or set the unicode_char_entered callable

Type callable

`Window.mouse_scroll_event_func`

Get or set the mouse_scroll_event callable

Type callable

`Window.is_closing`

Is the window about to close?

Type bool

`Window.mouse = <class 'moderngl_window.context.base.window.MouseButtons'>`

`Window.mouse_states`

Mouse button state structure.

The current mouse button states.

```
window.mouse_buttons.left  
window.mouse_buttons.right  
window.mouse_buttons.middle
```

Type MouseButtonStates

`Window.modifiers`

(KeyModifiers) The current keyboard modifiers

`Window.gl_version_code`

Generates the version code integer for the selected OpenGL version.

gl_version (4, 1) returns 410

Type int

10.8 sdl2.Window

10.8.1 Methods

`Window.__init__ (**kwargs)`

Initialize a window instance.

Parameters

- **title** (*str*) – The window title
- **gl_version** (*tuple*) – Major and minor version of the opengl context to create
- **size** (*tuple*) – Window size x, y
- **resizable** (*bool*) – Should the window be resizable?
- **fullscreen** (*bool*) – Open window in fullscreen mode
- **vsync** (*bool*) – Enable/disable vsync
- **aspect_ratio** (*float*) – The desired fixed aspect ratio. Can be set to `None` to make aspect ratio be based on the actual window size.
- **samples** (*int*) – Number of MSAA samples for the default framebuffer
- **cursor** (*bool*) – Enable/disable displaying the cursor inside the window

`Window.init_mgl_context ()` → `None`

Create or assign a ModernGL context. If no context is supplied a context will be created using the window's `gl_version`.

Keyword Arguments **ctx** – An optional custom ModernGL context

`Window.is_key_pressed (key)` → `bool`

Returns: The press state of a key

`Window.close ()`

Close the window

`Window.use ()`

Bind the window's framebuffer

`Window.clear (red=0.0, green=0.0, blue=0.0, alpha=0.0, depth=1.0, viewport=None)`

Binds and clears the default framebuffer

Parameters

- **red** (*float*) – color component
- **green** (*float*) – color component
- **blue** (*float*) – color component
- **alpha** (*float*) – alpha component
- **depth** (*float*) – depth value
- **viewport** (*tuple*) – The viewport

`Window.render (time=0.0, frame_time=0.0)` → `None`

Renders a frame by calling the configured render callback

Keyword Arguments

- **time** (*float*) – Current time in seconds

- **frame_time** (*float*) – Delta time from last frame in seconds

Window.**swap_buffers**() → None

Swap buffers, set viewport, trigger events and increment frame counter

Window.**resize**(*width*, *height*) → None

Resize callback.

Parameters

- **width** – New window width
- **height** – New window height

Window.**destroy**() → None

Gracefully close the window

Window.**set_default_viewport**() → None

Calculates the and sets the viewport based on window configuration.

The viewport will based on the configured fixed aspect ratio if set. If no fixed aspect ratio is set the viewport will be scaled to the entire window size regardless of size.

Will add black borders and center the viewport if the window do not match the configured viewport (fixed only)

Window.**print_context_info**()

Prints moderngl context info.

10.8.2 Window Specific Methods

Window.**process_events**() → None

Handle all queued events in sdl2 dispatching events to standard methods

10.8.3 Attributes

Window.**name** = 'sdl2'

Name of the window

Window.**keys**

SDL2 specific key constants

Window.**ctx**

The ModernGL context for the window

Type moderngl.Context

Window.**fbo**

The default framebuffer

Type moderngl.Framebuffer

Window.**title**

Window title.

This property can also be set:

```
window.title = "New Title"
```

Type str

Window.exit_key

Get or set the exit/close key for the window.

Pressing this key will close the window.

By default the ESCAPE is set, but this can be overridden or disabled:

```
# Default exit key
window.exit_key = window.keys.ESCAPE

# Set some other random exit key
window.exit_key = window.keys.Q

# Disable the exit key
window.exit_key = None
```

Window.gl_version

(major, minor) required OpenGL version

Type Tuple[int, int]

Window.width

The current window width

Type int

Window.height

The current window height

Type int

Window.size

current window size.

This property also support assignment:

```
# Resize the window to 1000 x 1000
window.size = 1000, 1000
```

Type Tuple[int, int]

Window.position

The current window position.

This property can also be set to move the window:

```
# Move window to 100, 100
window.position = 100, 100
```

Type Tuple[int, int]

Window.buffer_width

the current window buffer width

Type int

Window.buffer_height

the current window buffer height

Type int

Window.**buffer_size**

tuple with the current window buffer size

Type Tuple[int, int]

Window.**pixel_ratio**

The framebuffer/window size ratio

Type float

Window.**viewport**

current window viewport

Type Tuple[int, int, int, int]

Window.**viewport_size**

Size of the viewport.

Equivalent to `self.viewport[2], self.viewport[3]`

Type Tuple[int,int]

Window.**viewport_width**

The width of the viewport.

Equivalent to `self.viewport[2]`.

Type int

Window.**viewport_height**

The height of the viewport

Equivalent to `self.viewport[3]`.

Type int

Window.**frames**

Number of frames rendered

Type int

Window.**resizable**

Window is resizable

Type bool

Window.**fullscreen**

Window is in fullscreen mode

Type bool

Window.**config**

Get the current WindowConfig instance

This property can also be set. Assigning a WindowConfig instance will automatically set up the necessary event callback methods:

```
window.config = window_config_instance
```

Window.**vsync**

vertical sync enabled/disabled

Type bool

Window.aspect_ratio

The current aspect ratio of the window. If a fixed aspect ratio was passed to the window initializer this value will always be returned. Otherwise `width / height` will be returned.

This property is read only.

Type float

Window.fixed_aspect_ratio

The fixed aspect ratio for the window.

Can be set to `None` to disable fixed aspect ratio making the aspect ratio adjust to the actual window size

This will affects how the viewport is calculated and the reported value from the `aspect_ratio` property:

```
# Enabled fixed aspect ratio
window.fixed_aspect_ratio = 16 / 9

# Disable fixed aspect ratio
window.fixed_aspect_ratio = None
```

Type float

Window.samples

Number of Multisample anti-aliasing (MSAA) samples

Type float

Window.cursor

Should the mouse cursor be visible inside the window?

This property can also be assigned to:

```
# Disable cursor
window.cursor = False
```

Type bool

Window.mouse_exclusivity

If mouse exclusivity is enabled.

When you enable mouse-exclusive mode, the mouse cursor is no longer available. It is not merely hidden – no amount of mouse movement will make it leave your application. This is for example useful when you don't want the mouse leaving the screen when rotating a 3d scene.

This property can also be set:

```
window.mouse_exclusivity = True
```

Type bool

Window.render_func

The render callable

This property can also be used to assign a callable.

Type callable

Window.resize_func

Get or set the resize callable

Type callable

Window.**close_func**

Get or set the close callable

Type callable

Window.**iconify_func**

Get or set the iconify/show/hide callable

Type callable

Window.**key_event_func**

Get or set the key_event callable

Type callable

Window.**mouse_position_event_func**

Get or set the mouse_position callable

Type callable

Window.**mouse_press_event_func**

Get or set the mouse_press callable

Type callable

Window.**mouse_release_event_func**

Get or set the mouse_release callable

Type callable

Window.**mouse_drag_event_func**

Get or set the mouse_drag callable

Type callable

Window.**unicode_char_entered_func**

Get or set the unicode_char_entered callable

Type callable

Window.**mouse_scroll_event_func**

Get or set the mouse_scroll_event callable

Type callable

Window.**is_closing**

Is the window about to close?

Type bool

Window.**mouse** = <class 'moderngl_window.context.base.window.MouseButtons'>

Window.**mouse_states**

Mouse button state structure.

The current mouse button states.

```
window.mouse_buttons.left
window.mouse_buttons.right
window.mouse_buttons.middle
```

Type MouseButtonStates

Window.**modifiers**

(KeyModifiers) The current keyboard modifiers

Window.**gl_version_code**

Generates the version code integer for the selected OpenGL version.

gl_version (4, 1) returns 410

Type int

MODERNGL_WINDOW.GEOMETRY

`moderngl_window.geometry.bbox` (*size*=(1.0, 1.0, 1.0), *name*=None, *attr_names*=<class 'moderngl_window.geometry.attributes.AttributeNames'>)

Generates a bounding box with (0.0, 0.0, 0.0) as the center. This is simply a box with `LINE_STRIP` as draw mode.

Keyword Arguments

- **size** (*tuple*) – x, y, z size of the box
- **name** (*str*) – Optional name for the VAO
- **attr_names** (*AttributeNames*) – Attribute names

Returns A `moderngl_window.opengl.vao.VAO` instance

`moderngl_window.geometry.quad_fs` (*attr_names*=<class 'moderngl_window.geometry.attributes.AttributeNames'>, *normals*=True, *uvs*=True, *name*=None) → `moderngl_window.opengl.vao.VAO`

Creates a screen aligned quad using two triangles with normals and texture coordinates.

Keyword Arguments

- **attr_names** (*AttributeNames*) – Attrib name config
- **normals** (*bool*) – Include normals in VAO
- **uvs** (*bool*) – Include normals in VAO
- **name** (*str*) – Optional name for the VAO

Returns A `VAO` instance.

`moderngl_window.geometry.quad_2d` (*size*=(1.0, 1.0), *pos*=(0.0, 0.0), *normals*=True, *uvs*=True, *attr_names*=<class 'moderngl_window.geometry.attributes.AttributeNames'>, *name*=None) → `moderngl_window.opengl.vao.VAO`

Creates a 2D quad VAO using 2 triangles with normals and texture coordinates.

Keyword Arguments

- **size** (*tuple*) – width and height
- **pos** (*float*) – Center position x and y
- **normals** (*bool*) – Include normals in VAO
- **uvs** (*bool*) – Include normals in VAO
- **attr_names** (*AttributeNames*) – Attrib name config
- **name** (*str*) – Optional name for the VAO

Returns A *VAO* instance.

```
moderngl_window.geometry.cube(size=(1.0, 1.0, 1.0), center=(0.0, 0.0, 0.0), normals=True,
                             uvs=True, name=None, attr_names=<class 'moderngl_window.geometry.attributes.AttributeNames'>) → moderngl_window.opengl.vao.VAO
```

Creates a cube VAO with normals and texture coordinates

Keyword Arguments

- **width** (*float*) – Width of the cube
- **height** (*float*) – Height of the cube
- **depth** (*float*) – Depth of the cube
- **center** – center of the cube as a 3-component tuple
- **normals** – (bool) Include normals
- **uvs** – (bool) include uv coordinates
- **name** (*str*) – Optional name for the VAO
- **attr_names** (*AttributeNames*) – Attribute names

Returns A *moderngl_window.opengl.vao.VAO* instance

```
moderngl_window.geometry.sphere(radius=0.5, sectors=32, rings=16, normals=True,
                                uvs=True, name: str = None, attr_names=<class 'moderngl_window.geometry.attributes.AttributeNames'>) → moderngl_window.opengl.vao.VAO
```

Creates a sphere.

Keyword Arguments

- **radius** (*float*) – Radius of the sphere
- **rings** (*int*) – number of horizontal rings
- **sectors** (*int*) – number of vertical segments
- **normals** (*bool*) – Include normals in the VAO
- **uvs** (*bool*) – Include texture coordinates in the VAO
- **name** (*str*) – An optional name for the VAO
- **attr_names** (*AttributeNames*) – Attribute names

Returns A VAO instance

MODERNGL_WINDOW.LOADERS

12.1 base.BaseLoader

12.1.1 Method

`BaseLoader.__init__(meta)`
Initialize loader.

Loaders take a `ResourceDescription` instance containing all the parameters needed to load and initialize this data.

Parameters `meta` (*ResourceDescription*) – The resource to load

classmethod `BaseLoader.supports_file(meta)`
Check if the loader has a supported file extension.

What extensions are supported can be defined in the `file_extensions` class attribute.

`BaseLoader.load()` → Any
Loads a resource.

When creating a loader this is the only method that needs to be implemented.

Returns The loaded resource

`BaseLoader.find_data(path)`
Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`BaseLoader.find_program(path)`
Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`BaseLoader.find_texture(path)`
Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`BaseLoader.find_scene(path)`
Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

12.1.2 Attributes

`BaseLoader.kind = None`

The kind of resource this loader supports. This can be used when file extensions is not enough to decide what loader should be selected.

`BaseLoader.file_extensions = []`

A list defining the file extensions accepted by this loader.

Example:

```
# Loader will match .xyz and .xyz.gz files.
file_extensions = [
    ['.xyz'],
    ['.xyz', '.gz'],
]
```

`BaseLoader.ctx`

ModernGL context

Type `moderngl.Context`

12.2 texture.t2d.Loader

12.2.1 Method

`Loader.__init__(meta)`

Initialize loader.

Loaders take a `ResourceDescription` instance containing all the parameters needed to load and initialize this data.

Parameters `meta` (*ResourceDescription*) – The resource to load

classmethod `Loader.supports_file(meta)`

Check if the loader has a supported file extension.

What extensions are supported can be defined in the `file_extensions` class attribute.

`Loader.load()`

Load a 2d texture as configured in the supplied `TextureDescription`

Returns The Texture instance

Return type `moderngl.Texture`

`Loader.find_data(path)`

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_program(path)`

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_texture(path)`

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_scene(path)`

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

12.2.2 Attributes

`Loader.kind = '2d'`

`Loader.file_extensions = []`

`Loader.ctx`

ModernGL context

Type `moderngl.Context`

12.3 program.single.Loader

12.3.1 Method

`Loader.__init__(meta)`

Initialize loader.

Loaders take a `ResourceDescription` instance containing all the parameters needed to load and initialize this data.

Parameters `meta (ResourceDescription)` – The resource to load

classmethod `Loader.supports_file(meta)`

Check if the loader has a supported file extension.

What extensions are supported can be defined in the `file_extensions` class attribute.

`Loader.load()` → `moderngl.program.Program`

Loads a shader program from a single glsl file.

Each shader type is separated by preprocessors

- `VERTEX_SHADER`
- `FRAGMENT_SHADER`
- `GEOMETRY_SHADER`
- `TESS_CONTROL_SHADER`
- `TESS_EVALUATION_SHADER`

Example:

```
#version 330

#ifdef VERTEX_SHADER

in vec3 in_position;
in vec2 in_texcoord_0;
out vec2 uv0;

void main() {
    gl_Position = vec4(in_position, 1);
    uv0 = in_texcoord_0;
}

#elif defined FRAGMENT_SHADER

out vec4 fragColor;
uniform sampler2D texture0;
in vec2 uv0;

void main() {
    fragColor = texture(texture0, uv0);
}

#endif
```

Returns The Program instance

Return type moderngl.Program

Loader.**find_data** (*path*)

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

Loader.**find_program** (*path*)

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

Loader.**find_texture** (*path*)

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

Loader.**find_scene** (*path*)

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

12.3.2 Attributes

Loader.**kind** = 'single'

```
Loader.file_extensions = []
```

```
Loader.ctx
```

ModernGL context

Type moderngl.Context

12.4 program.separate.Loader

12.4.1 Method

```
Loader.__init__(meta)
```

Initialize loader.

Loaders take a ResourceDescription instance containing all the parameters needed to load and initialize this data.

Parameters *meta* (*ResourceDescription*) – The resource to load

```
classmethod Loader.supports_file(meta)
```

Check if the loader has a supported file extension.

What extensions are supported can be defined in the *file_extensions* class attribute.

```
Loader.load() → Union[moderngl.program.Program, moderngl.compute_shader.ComputeShader, moderngl_window.opengl.program.ReloadableProgram]
```

Loads a shader program where each shader is a separate file.

This is detected and dictated by the *kind* in the *ProgramDescription*.

Returns The Program instance

Return type moderngl.Program

```
Loader.find_data(path)
```

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

```
Loader.find_program(path)
```

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

```
Loader.find_texture(path)
```

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

```
Loader.find_scene(path)
```

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

12.4.2 Attributes

`Loader.kind = 'separate'`

`Loader.file_extensions = []`

`Loader.ctx`

ModernGL context

Type moderngl.Context

12.5 texture.array.Loader

12.5.1 Method

`Loader.__init__(meta)`

Initialize loader.

Loaders take a ResourceDescription instance containing all the parameters needed to load and initialize this data.

Parameters `meta` (*ResourceDescription*) – The resource to load

classmethod `Loader.supports_file(meta)`

Check if the loader has a supported file extension.

What extensions are supported can be defined in the `file_extensions` class attribute.

`Loader.load()`

Load a texture array as described by the supplied TextureDescription`

Returns The TextureArray instance

Return type moderngl.TextureArray

`Loader.find_data(path)`

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_program(path)`

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_texture(path)`

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_scene(path)`

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

12.5.2 Attributes

```
Loader.kind = 'array'
Loader.file_extensions = []
Loader.ctx
    ModernGL context
    Type moderngl.Context
```

12.6 scene.wavefront.Loader

12.6.1 Method

`Loader.__init__` (*meta: moderngl_window.meta.scene.SceneDescription*)
Initialize loader.

Loaders take a ResourceDescription instance containing all the parameters needed to load and initialize this data.

Parameters *meta* (*ResourceDescription*) – The resource to load

classmethod `Loader.supports_file` (*meta*)
Check if the loader has a supported file extension.

What extensions are supported can be defined in the `file_extensions` class attribute.

`Loader.load` ()
Loads a wavefront/obj file including materials and textures

Returns The Scene instance

Return type Scene

`Loader.find_data` (*path*)
Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_program` (*path*)
Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_texture` (*path*)
Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_scene` (*path*)
Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

12.6.2 Attributes

`Loader.kind = 'wavefront'`

`Loader.file_extensions = [['.obj'], ['.obj', '.gz'], ['.bin']]`

`Loader.ctx`

ModernGL context

Type `moderngl.Context`

12.7 scene.glTF2.Loader

12.7.1 Method

`Loader.__init__(meta: moderngl_window.meta.scene.SceneDescription)`

Initialize loading GLTF 2 scene.

Supported formats:

- gltf json format with external resources
- gltf embedded buffers
- glb Binary format

classmethod `Loader.supports_file(meta)`

Check if the loader has a supported file extension.

What extensions are supported can be defined in the `file_extensions` class attribute.

`Loader.load()` → `moderngl_window.scene.scene.Scene`

Load a GLTF 2 scene including referenced textures.

Returns The scene instance

Return type `Scene`

`Loader.find_data(path)`

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_program(path)`

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_texture(path)`

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_scene(path)`

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

12.7.2 Loader Specific Methods

`Loader.load_gltf()`

Loads a gltf json file parsing its contents

`Loader.load_glb()`

Loads a binary gltf file parsing its contents

`Loader.load_materials()`

Load materials referenced in gltf metadata

`Loader.load_nodes()`

Load nodes referenced in gltf metadata

`Loader.load_node(meta, parent=None)`

Load a single node

`Loader.load_images()`

Load images referenced in gltf metadata

`Loader.load_textures()`

Load textures referenced in gltf metadata

`Loader.load_samplers()`

Load samplers referenced in gltf metadata

`Loader.load_meshes()`

Load meshes referenced in gltf metadata

12.7.3 Attributes

`Loader.kind = 'gltf'`

`Loader.file_extensions = [['.gltf'], ['.glb']]`

`Loader.ctx`

ModernGL context

Type moderngl.Context

12.7.4 Loader Specific Attributes

`Loader.supported_extensions = []`

Supported GLTF extensions <https://github.com/KhronosGroup/glTF/tree/master/extensions>

12.8 scene.stl.Loader

12.8.1 Method

`Loader.__init__(meta)`

Initialize loader.

Loaders take a ResourceDescription instance containing all the parameters needed to load and initialize this data.

Parameters *meta* (*ResourceDescription*) – The resource to load

classmethod `Loader.supports_file(meta)`

Check if the loader has a supported file extension.

What extensions are supported can be defined in the *file_extensions* class attribute.

`Loader.load()` → `moderngl_window.scene.scene.Scene`

Loads and stl scene/file

Returns The Scene instance

Return type Scene

`Loader.find_data(path)`

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_program(path)`

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_texture(path)`

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_scene(path)`

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

12.8.2 Attributes

`Loader.kind = 'stl'`

`Loader.file_extensions = [['.stl'], ['.stl', '.gz']]`

`Loader.ctx`

ModernGL context

Type `moderngl.Context`

12.9 data.json.Loader

12.9.1 Method

`Loader.__init__(meta)`

Initialize loader.

Loaders take a `ResourceDescription` instance containing all the parameters needed to load and initialize this data.

Parameters *meta* (*ResourceDescription*) – The resource to load

classmethod `Loader.supports_file(meta)`

Check if the loader has a supported file extension.

What extensions are supported can be defined in the `file_extensions` class attribute.

`Loader.load()` → dict

Load a file as json

Returns The json contents

Return type dict

`Loader.find_data(path)`

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_program(path)`

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_texture(path)`

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_scene(path)`

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

12.9.2 Attributes

`Loader.kind = 'json'`

`Loader.file_extensions = [['.json']]`

`Loader.ctx`

ModernGL context

Type `moderngl.Context`

12.10 data.text.Loader

12.10.1 Method

`Loader.__init__(meta)`

Initialize loader.

Loaders take a `ResourceDescription` instance containing all the parameters needed to load and initialize this data.

Parameters *meta* (*ResourceDescription*) – The resource to load

classmethod `Loader.supports_file` (*meta*)

Check if the loader has a supported file extension.

What extensions are supported can be defined in the *file_extensions* class attribute.

`Loader.load()` → str

Load a file in text mode.

Returns The string contents of the file

Return type str

`Loader.find_data` (*path*)

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_program` (*path*)

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_texture` (*path*)

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

`Loader.find_scene` (*path*)

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters *path* – Path to resource

12.10.2 Attributes

`Loader.kind = 'text'`

`Loader.file_extensions = ['.txt']`

`Loader.ctx`

ModernGL context

Type moderngl.Context

12.11 data.binary.Loader

12.11.1 Method

`Loader.__init__` (*meta*)

Initialize loader.

Loaders take a ResourceDescription instance containing all the parameters needed to load and initialize this data.

Parameters `meta` (*ResourceDescription*) – The resource to load

classmethod `Loader.supports_file` (*meta*)

Check if the loader has a supported file extension.

What extensions are supported can be defined in the `file_extensions` class attribute.

`Loader.load()` → bytes

Load a file in binary mode

Returns The bytes contents of the file

Return type bytes

`Loader.find_data` (*path*)

Find resource using data finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_program` (*path*)

Find resource using program finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_texture` (*path*)

Find resource using texture finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

`Loader.find_scene` (*path*)

Find resource using scene finders.

This is mainly a shortcut method to simplify the task.

Parameters `path` – Path to resource

12.11.2 Attributes

`Loader.kind` = 'binary'

`Loader.file_extensions` = []

`Loader.ctx`

ModernGL context

Type moderngl.Context

MODERNGL_WINDOW.META

13.1 base.ResourceDescription

`moderngl_window.meta.base.ResourceDescription`

Description of any resource. Resource descriptions are required to load a resource. This class can be extended to add more specific properties.

13.1.1 Methods

`ResourceDescription.__init__ (**kwargs)`

Initialize a resource description

Parameters ****kwargs** – Attributes describing the resource to load

13.1.2 Attributes

`ResourceDescription.path`

The path to a resource when a single file is specified

Type str

`ResourceDescription.resolved_path`

The resolved path by a finder.

The absolute path to the resource can optionally be assigned by a loader class.

Type pathlib.Path

`ResourceDescription.attrs`

All keywords arguments passed to the resource

Type dict

`ResourceDescription.label`

optional name for the resource

Assigning a label is not mandatory but can help when aliasing resources. Some prefer to preload all needed resources and fetch them later by the label. This can be a lot less chaotic in larger applications.

Type str

`ResourceDescription.kind`

default resource kind.

The resource kind is directly matched with the kind in loader classes.

This property also supports assignment and is useful if the `kind` is detected based in the the attribute values.

```
description.kind = 'something'
```

Type `str`

`ResourceDescription.loader_cls`

The loader class for this resource.

This property is assigned to during the loading stage were a loader class is assigned based on the *kind*.

Type `Type`

`ResourceDescription.default_kind = None`

The default kind for this resource type

Type `str`

`ResourceDescription.resource_type = None`

A unique identifier for the resource type

Type `str`

13.2 texture.TextureDescription

`moderngl_window.meta.texture.TextureDescription`

Describes a texture to load.

Example:

```
# Loading a 2d texture
TextureDescription(path='textures/wood.png')

# Loading a 2d texture with mipmapmaps with anisotropy
TextureDescription(path='textures/wood.png', mipmap=True, anisotropy=16.0)

# Loading texture array containing 10 layers
TextureDescription(path='textures/tiles.png', layers=10, kind='array')
```

13.2.1 Methods

`TextureDescription.__init__` (*path: str = None, kind: str = None, flip=True, mipmap=False, mipmap_levels: Tuple[int, int] = None, anisotropy=1.0, image=None, layers=None, pos_x: str = None, pos_y: str = None, pos_z: str = None, neg_x: str = None, neg_y: str = None, neg_z: str = None, **kwargs*)

Describes a texture resource

Parameters

- **path** (*str*) – path to resource relative to search directories
- **flip** (*boolean*) – Flip the image horizontally
- **mipmap** (*bool*) – Generate mipmaps. Will generate max possible levels unless *mipmap_levels* is defined.

- **mipmap_levels** (*tuple*) – (base, max_level) controlling mipmap generation. When defined the *mipmap* parameter is automatically *True*.
- **anisotropy** (*float*) – Number of samples for anisotropic filtering
- **kind** (*str*) – The kind of loader to use
- **image** – PIL image for when loading embedded resources
- **layers** – (int): Number of layers for texture arrays
- **neg_x** (*str*) – Path to negative x texture in a cube map
- **neg_y** (*str*) – Path to negative y texture in a cube map
- **neg_z** (*str*) – Path to negative z texture in a cube map
- **pos_x** (*str*) – Path to positive x texture in a cube map
- **pos_y** (*str*) – Path to positive y texture in a cube map
- **pos_z** (*str*) – Path to positive z texture in a cube map
- ****kwargs** – Any optional/custom attributes

13.2.2 Attributes

`TextureDescription.mipmap`

If mipmaps should be generated

Type bool

`TextureDescription.image`

PIL image when loading embedded resources

Type Image

`TextureDescription.layers`

Number of layers in texture array

Type int

`TextureDescription.anisotropy`

Number of samples for anisotropic filtering

Type float

`TextureDescription.mipmap_levels`

base, max_level for mipmap generation

Type Tuple[int, int]

`TextureDescription.flip`

If the image should be flipped horizontally

Type bool

`TextureDescription.pos_x`

Path to positive x in a cubemap texture

Type str

`TextureDescription.pos_y`

Path to positive y in a cubemap texture

Type str

`TextureDescription.pos_z`
Path to positive z in a cubemap texture

Type str

`TextureDescription.neg_x`
Path to negative x in a cubemap texture

Type str

`TextureDescription.neg_y`
Path to negative y in a cubemap texture

Type str

`TextureDescription.neg_z`
Path to negative z in a cubemap texture

Type str

13.2.3 Inherited Attributes

`TextureDescription.path`
The path to a resource when a single file is specified

Type str

`TextureDescription.resolved_path`
The resolved path by a finder.

The absolute path to the resource can optionally be assigned by a loader class.

Type pathlib.Path

`TextureDescription.attrs`
All keywords arguments passed to the resource

Type dict

`TextureDescription.label`
optional name for the resource

Assigning a label is not mandatory but can help when aliasing resources. Some prefer to preload all needed resources and fetch them later by the label. This can be a lot less chaotic in larger applications.

Type str

`TextureDescription.kind`
default resource kind.

The resource kind is directly matched with the `kind` in loader classes.

This property also supports assignment and is useful if the `kind` is detected based on the attribute values.

```
description.kind = 'something'
```

Type str

`TextureDescription.loader_cls`
The loader class for this resource.

This property is assigned to during the loading stage where a loader class is assigned based on the *kind*.

Type Type

TextureDescription.default_kind = '2d'

TextureDescription.resource_type = 'textures'

13.3 program.ProgramDescription

moderngl_window.meta.program.**ProgramDescription**

Describes a program to load

By default a program can be loaded in the following ways:

- By supplying a *path* to a single glsl file containing all shaders
- By supplying several paths to separate files containing each shader type. For example vertex_shader, fragment_shader .. etc.

```
# Single glsl file containing all shaders
ProgramDescription(path='programs/myprogram.glsl')

# Multiple shader files
ProgramDescription(
    vertex_shader='programs/myprogram_vs.glsl'.
    fragment_shader='programs/myprogram_fs.glsl'.
    geometry_shader='programs/myprogram_gs.glsl'.
)
```

13.3.1 Methods

ProgramDescription.__init__(path: str = None, kind: str = None, reloadable=False, vertex_shader: str = None, geometry_shader: str = None, fragment_shader: str = None, tess_control_shader: str = None, tess_evaluation_shader: str = None, compute_shader: str = None, defines: dict = None, **kwargs)

Create a program description

Keyword Arguments

- **path** (str) – path to the resource relative to search directories
- **kind** (str) – The kind of loader to use
- **reloadable** (bool) – Should this program be reloadable
- **vertex_shader** (str) – Path to vertex shader file
- **geometry_shader** (str) – Path to geometry shader
- **fragment_shader** (str) – Path to fragment shader
- **tess_control_shader** (str) –
- **tess_evaluation_shader** (str) – Path to tess eval shader
- **compute_shader** (str) – Path to compute shader
- **defines** (dict) – Dictionary with define values to replace in the source
- ****kwargs** – Optional custom attributes

13.3.2 Attributes

`ProgramDescription.tess_evaluation_shader`
Relative path to tessellation evaluation shader

Type str

`ProgramDescription.vertex_shader`
Relative path to vertex shader

Type str

`ProgramDescription.geometry_shader`
Relative path to geometry shader

Type str

`ProgramDescription.reloadable`
if this program is reloadable

Type bool

`ProgramDescription.fragment_shader`
Relative path to fragment shader

Type str

`ProgramDescription.tess_control_shader`
Relative path to tess control shader

Type str

`ProgramDescription.compute_shader`
Relative path to compute shader

Type str

`ProgramDescription.defines`
Dictionary with define values to replace in the source

Type dict

13.3.3 Inherited Attributes

`ProgramDescription.path`
The path to a resource when a single file is specified

Type str

`ProgramDescription.resolved_path`
The resolved path by a finder.

The absolute path to the resource can optionally be assigned by a loader class.

Type pathlib.Path

`ProgramDescription.attrs`
All keywords arguments passed to the resource

Type dict

`ProgramDescription.label`
optional name for the resource

Assigning a label is not mandatory but can help when aliasing resources. Some prefer to preload all needed resources and fetch them later by the label. This can be a lot less chaotic in larger applications.

Type str

`ProgramDescription.kind`
default resource kind.

The resource kind is directly matched with the kind in loader classes.

This property also supports assignment and is useful if the kind is detected based on the attribute values.

```
description.kind = 'something'
```

Type str

`ProgramDescription.loader_cls`
The loader class for this resource.

This property is assigned to during the loading stage where a loader class is assigned based on the *kind*.

Type Type

`ProgramDescription.default_kind = None`
`ProgramDescription.resource_type = 'programs'`

13.4 scene.SceneDescription

`moderngl_window.meta.scene.SceneDescription`

Describes a scene to load.

The correct loader is resolved by looking at the file extension. This can be overridden by specifying a kind that maps directly to a specific loader class.

```
# Wavefront/obj file
SceneDescription(path='scenes/cube.obj')

# stl file
SceneDescription(path='scenes/crater.stl')

# GLTF 2 file
SceneDescription(path='scenes/sponza.glTF')
```

The user can also override what buffer/attribute names should be used by specifying `attr_names`.

A cache option is also available as some scene loaders support converting the file into a different format on the fly to speed up loading.

13.4.1 Methods

`SceneDescription.__init__`(*path=None, kind=None, cache=False, attr_names=<class 'moderngl_window.geometry.attributes.AttributeNames'>, **kwargs*)

Create a scene description.

Keyword Arguments

- **path** (*str*) – Path to resource

- **kind** (*str*) – Loader kind
- **cache** (*str*) – Use the loader caching system if present
- **attr_names** (*AttributeNamees*) – Attrib name config
- ****kwargs** – Optional custom attributes

13.4.2 Attributes

`SceneDescription.attr_names`
Attribute name config

Type `AttributeNamees`

`SceneDescription.cache`
Use cache feature in scene loader

Type `bool`

13.4.3 Inherited Attributes

`SceneDescription.path`
The path to a resource when a single file is specified

Type `str`

`SceneDescription.resolved_path`
The resolved path by a finder.

The absolute path to the resource can optionally be assigned by a loader class.

Type `pathlib.Path`

`SceneDescription.attrs`
All keywords arguments passed to the resource

Type `dict`

`SceneDescription.label`
optional name for the resource

Assigning a label is not mandatory but can help when aliasing resources. Some prefer to preload all needed resources and fetch them later by the label. This can be a lot less chaotic in larger applications.

Type `str`

`SceneDescription.kind`
default resource kind.

The resource `kind` is directly matched with the `kind` in loader classes.

This property also supports assignment and is useful if the `kind` is detected based on the attribute values.

```
description.kind = 'something'
```

Type `str`

`SceneDescription.loader_cls`
The loader class for this resource.

This property is assigned to during the loading stage where a loader class is assigned based on the *kind*.

Type Type

`SceneDescription.default_kind = None`

`SceneDescription.resource_type = 'scenes'`

13.5 data.DataDescription

`moderngl_window.meta.data.DataDescription`

Describes data file to load.

This is a generic resource description type for loading resources that are not textures, programs and scenes. That loaded class is used depends on the `kind` or the file extension.

Currently used to load:

- text files
- json files
- binary files

```
# Describe a text file. Text loader is used based on file extension
DataDescription(path='data/text.txt')

# Describe a json file. Json loader is used based on file extension
DataDescription(path='data/data.json')

# Describe a binary file. Specify a binary loader should be used.
DataDescription(path='data/data.bin', kind='binary')
```

13.5.1 Methods

`DataDescription.__init__ (path=None, kind=None, **kwargs)`

Initialize the resource description.

Keyword Arguments

- **path** (*str*) – Relative path to the resource
- **kind** (*str*) – The resource kind deciding loader class
- ****kwargs** – Additional custom attributes

13.5.2 Attributes

`DataDescription.path`

The path to a resource when a single file is specified

Type str

`DataDescription.resolved_path`

The resolved path by a finder.

The absolute path to the resource can optionally be assigned by a loader class.

Type pathlib.Path

`DataDescription.attrs`

All keywords arguments passed to the resource

Type dict

`DataDescription.label`

optional name for the resource

Assigning a label is not mandatory but can help when aliasing resources. Some prefer to preload all needed resources and fetch them later by the label. This can be a lot less chaotic in larger applications.

Type str

`DataDescription.kind`

default resource kind.

The resource `kind` is directly matched with the `kind` in loader classes.

This property also supports assignment and is useful if the `kind` is detected based in the the attribute values.

```
description.kind = 'something'
```

Type str

`DataDescription.loader_cls`

The loader class for this resource.

This property is assigned to during the loading stage were a loader class is assigned based on the *kind*.

Type Type

`DataDescription.default_kind = None`

`DataDescription.resource_type = 'data'`

MODERNGL_WINDOW.FINDERS

14.1 base.BaseFileSystemFinder

`moderngl_window.finders.base.BaseFileSystemFinder`
Base class for searching filesystem directories

14.1.1 Methods

`BaseFileSystemFinder.__init__()`
Initialize finder class by looking up the paths referenced in `settings_attr`.

`BaseFileSystemFinder.find(path: pathlib.Path) → pathlib.Path`
Finds a file in the configured paths returning its absolute path.

Parameters `path` (*pathlib.Path*) – The path to find

Returns The absolute path to the file or None if not found

14.1.2 Attributes

`BaseFileSystemFinder.settings_attr = None`
Name of the attribute in *Settings* containing a list of paths the finder should search in.
Type str

14.2 texture.FileSystemFinder

`moderngl_window.finders.texture.FileSystemFinder`
Find textures in `settings.TEXTURE_DIRS`

14.2.1 Methods

`FileSystemFinder.__init__()`
Initialize finder class by looking up the paths referenced in `settings_attr`.

`FileSystemFinder.find(path: pathlib.Path) → pathlib.Path`
Finds a file in the configured paths returning its absolute path.

Parameters `path` (*pathlib.Path*) – The path to find

Returns The absolute path to the file or None if not found

14.2.2 Attributes

```
FileSystemFinder.settings_attr = 'TEXTURE_DIRS'
```

14.3 program.FileSystemFinder

```
moderngl_window.finders.program.FileSystemFinder
    Find shaders in settings.PROGRAM_DIRS
```

14.3.1 Methods

```
FileSystemFinder.__init__()
    Initialize finder class by looking up the paths referenced in settings_attr.

FileSystemFinder.find(path: pathlib.Path) → pathlib.Path
    Finds a file in the configured paths returning its absolute path.

    Parameters path (pathlib.Path) – The path to find

    Returns The absolute path to the file or None if not found
```

14.3.2 Attributes

```
FileSystemFinder.settings_attr = 'PROGRAM_DIRS'
```

14.4 scene.FileSystemFinder

```
moderngl_window.finders.scene.FileSystemFinder
    Find scenes in settings.SCENE_DIRS
```

14.4.1 Methods

```
FileSystemFinder.__init__()
    Initialize finder class by looking up the paths referenced in settings_attr.

FileSystemFinder.find(path: pathlib.Path) → pathlib.Path
    Finds a file in the configured paths returning its absolute path.

    Parameters path (pathlib.Path) – The path to find

    Returns The absolute path to the file or None if not found
```

14.4.2 Attributes

```
FileSystemFinder.settings_attr = 'SCENE_DIRS'
```


14.5 data.FilesystemFinder

`moderngl_window.finders.data.FilesystemFinder`

Find data in `settings.DATA_DIRS`

14.5.1 Methods

`FilesystemFinder.__init__()`

Initialize finder class by looking up the paths referenced in `settings_attr`.

`FilesystemFinder.find(path: pathlib.Path) → pathlib.Path`

Finds a file in the configured paths returning its absolute path.

Parameters `path` (*pathlib.Path*) – The path to find

Returns The absolute path to the file or None if not found

14.5.2 Attributes

`FilesystemFinder.settings_attr = 'DATA_DIRS'`

MODERNGL_WINDOW.OPENGL

15.1 opengl.projection.Projection3D

`moderngl_window.opengl.projection.Projection3D`
3D Projection

15.1.1 Methods

`Projection3D.__init__` (*aspect_ratio=1.7777777777777777, fov=75.0, near=1.0, far=100.0*)
Create a 3D projection

Keyword Arguments

- **aspect_ratio** (*float*) – Aspect ratio
- **fov** (*float*) – Field of view
- **near** (*float*) – Near plane value
- **far** (*float*) – Far plane value

`Projection3D.update` (*aspect_ratio: float = None, fov: float = None, near: float = None, far: float = None*) → *None*
Update the projection matrix

Keyword Arguments

- **aspect_ratio** (*float*) – Aspect ratio
- **fov** (*float*) – Field of view
- **near** (*float*) – Near plane value
- **far** (*float*) – Far plane value

`Projection3D.tobytes` () → *bytes*
Get the byte representation of the projection matrix

Returns byte representation of the projection matrix

Return type *bytes*

15.1.2 Attributes

`Projection3D.aspect_ratio`
The projection's aspect ratio

Type float

`Projection3D.fov`

Current field of view

Type float

`Projection3D.near`

Current near plane value

Type float

`Projection3D.far`

Current far plane value

Type float

`Projection3D.matrix`

Current numpy projection matrix

Type np.ndarray

`Projection3D.projection_constants`

(x, y) projection constants for the current projection. This is for example useful when reconstructing a view position of a fragment from a linearized depth value.

15.2 opengl.vao.VAO

`moderngl_window.opengl.vao.VAO`

Represents a vertex array object.

This is a wrapper class over `moderngl.VertexArray` to make interactions with programs/shaders simpler. Named buffers are added corresponding with attribute names in a vertex shader. When rendering the VAO an internal `moderngl.VertexArray` is created automatically mapping the named buffers compatible with the supplied program. This program is cached internally.

The shader program doesn't need to use all the buffers registered in this wrapper. When a subset is used only the used buffers are mapped and the appropriate padding is calculated when interleaved data is used.

You are not required to use this class, but most methods in the system creating vertexbuffers will return this type. You can obtain a single `moderngl.VertexBuffer` instance by calling `VAO.instance()` method if you prefer to work directly on `moderngl` instances.

Example:

```
# Separate buffers
vao = VAO(name="test", mode=moderngl.POINTS)
vao.buffer(positions, '3f', ['in_position'])
vao.buffer(velocities, '3f', ['in_velocities'])

# Interleaved
vao = VAO(name="test", mode=moderngl.POINTS)
vao.buffer(interleaved_data, '3f 3f', ['in_position', 'in_velocities'])
```

```
# GLSL vertex shader in attributes
in vec3 in_position;
in vec3 in_velocities;
```

15.2.1 Methods

VAO.**__init__**(*name=""*, *mode=4*)

Create and empty VAO with a name and default render mode.

Example:

```
VAO(name="cube", mode=moderngl.TRIANGLES)
```

Keyword Arguments

- **name** (*str*) – Optional name for debug purposes
- **mode** (*int*) – Default draw mode

VAO.**render**(*program: moderngl.program.Program*, *mode=None*, *vertices=-1*, *first=0*, *instances=1*)

Render the VAO.

An internal `moderngl.VertexBuffer` with compatible buffer bindings is automatically created on the fly and cached internally.

Parameters *program* – The `moderngl.Program`

Keyword Arguments

- **mode** – Override the draw mode (TRIANGLES etc)
- **vertices** (*int*) – The number of vertices to transform
- **first** (*int*) – The index of the first vertex to start with
- **instances** (*int*) – The number of instances

VAO.**render_indirect**(*program: moderngl.program.Program*, *buffer*, *mode=None*, *count=-1*, ***, *first=0*)

The render primitive (mode) must be the same as the input primitive of the GeometryShader. The draw commands are 5 integers: (count, instanceCount, firstIndex, baseVertex, baseInstance).

Parameters

- **program** – The `moderngl.Program`
- **buffer** – The `moderngl.Buffer` containing indirect draw commands

Keyword Arguments

- **mode** (*int*) – By default TRIANGLES will be used.
- **count** (*int*) – The number of draws.
- **first** (*int*) – The index of the first indirect draw command.

VAO.**transform**(*program: moderngl.program.Program*, *buffer: moderngl.buffer.Buffer*, *mode=None*, *vertices=-1*, *first=0*, *instances=1*)

Transform vertices. Stores the output in a single buffer.

Parameters

- **program** – The `moderngl.Program`
- **buffer** – The `moderngl.buffer` to store the output

Keyword Arguments

- **mode** – Draw mode (for example `moderngl.POINTS`)
- **vertices** (*int*) – The number of vertices to transform

- **first** (*int*) – The index of the first vertex to start with
- **instances** (*int*) – The number of instances

VAO.**buffer** (*buffer, buffer_format: str, attribute_names: List[str]*)

Register a buffer/vbo for the VAO. This can be called multiple times. adding multiple buffers (interleaved or not).

Parameters

- **buffer** – The buffer data. Can be `numpy.array`, `moderngl.Buffer` or `bytes`.
- **buffer_format** (*str*) – The format of the buffer. (eg. `3f 3f` for interleaved positions and normals).
- **attribute_names** – A list of attribute names this buffer should map to.

Returns The `moderngl.Buffer` instance object. This is handy when providing `bytes` and `numpy.array`.

VAO.**index_buffer** (*buffer, index_element_size=4*)

Set the index buffer for this VAO.

Parameters **buffer** – `moderngl.Buffer`, `numpy.array` or `bytes`

Keyword Arguments **index_element_size** (*int*) – Byte size of each element. 1, 2 or 4

VAO.**instance** (*program: moderngl.program.Program*) → `moderngl.vertex_array.VertexArray`

Obtain the `moderngl.VertexArray` instance for the program.

The instance is only created once and cached internally.

Parameters **program** (*moderngl.Program*) – The program

Returns instance

Return type `moderngl.VertexArray`

VAO.**release** (*buffer=True*)

Destroy all internally cached vaos and release all buffers.

Keyword Arguments **buffers** (*bool*) – also release buffers

VAO.**get_buffer_by_name** (*name: str*) → `moderngl_window.opengl.vao.BufferInfo`

Get the `BufferInfo` associated with a specific attribute name

If no buffer is associated with the name *None* will be returned.

Parameters **name** (*str*) – Name of the mapped attribute

Returns `BufferInfo` instance

Return type `BufferInfo`

15.2.2 Attributes

VAO.**ctx**

The active `moderngl` context

Type `moderngl.Context`

MODERNGL_WINDOW.RESOURCES

`moderngl_window.resources.register_dir` (*path: Union[pathlib.Path, str]*) → None

Adds a resource directory for all resource types

Parameters `path` (*Union[Path, str]*) – Directory path

`moderngl_window.resources.register_program_dir` (*path: Union[pathlib.Path, str]*) → None

Adds a resource directory specifically for programs

Parameters `path` (*Union[Path, str]*) – Directory path

`moderngl_window.resources.register_texture_dir` (*path: Union[pathlib.Path, str]*) → None

Adds a resource directory specifically for textures

Parameters `path` (*Union[Path, str]*) – Directory path

`moderngl_window.resources.register_scene_dir` (*path: Union[pathlib.Path, str]*) → None

Adds a resource directory specifically for scenes

Parameters `path` (*Union[Path, str]*) – Directory path

`moderngl_window.resources.register_data_dir` (*path: Union[pathlib.Path, str]*) → None

Adds a resource directory specifically for data files

Parameters `path` (*Union[Path, str]*) – Directory path

16.1 base.BaseRegistry

`moderngl_window.resources.base.BaseRegistry`

Base class for all resource pools

16.1.1 Methods

`BaseRegistry.__init__()`

Initialize internal attributes

`BaseRegistry.load` (*meta: moderngl_window.meta.base.ResourceDescription*) → Any

Loads a resource using the configured finders and loaders.

Parameters `meta` (*ResourceDescription*) – The resource description

`BaseRegistry.add` (*meta: moderngl_window.meta.base.ResourceDescription*) → None

Adds a resource description without loading it. The resource is loaded and returned when `load_pool()` is called.

Parameters `meta` (*ResourceDescription*) – The resource description

`BaseRegistry.load_pool()` → `Generator[Tuple[moderngl_window.meta.base.ResourceDescription, Any], None, None]`

Loads all the data files using the configured finders.

This is only relevant when resource have been added to this pool using `add()`.

Returns Generator of (meta, resource) tuples

`BaseRegistry.resolve_loader(meta: moderngl_window.meta.base.ResourceDescription)` → `None`

Attempts to assign a loader class to a `ResourceDescription`.

Parameters `meta` (*ResourceDescription*) – The resource description instance

16.1.2 Attributes

`BaseRegistry.settings_attr = None`

The name of the attribute in *Settings* containing a list of loader classes.

Type str

`BaseRegistry.count`

The number of resource descriptions added. This is only relevant when using *add* and *load_pool*.

Type int

`BaseRegistry.loaders`

Loader classes for this resource type

Type Generator

16.2 textures.Textures

`moderngl_window.resources.textures.Textures`

Handles texture resources

16.2.1 Methods

`Textures.__init__()`

Initialize internal attributes

`Textures.load(meta: moderngl_window.meta.texture.TextureDescription)` →
`Union[moderngl.texture.Texture, moderngl.texture_array.TextureArray]`

Loads a texture with the configured loaders.

Parameters `meta` (*TextureDescription*) – The resource description

Returns 2d texture

Return type `moderngl.Texture`

Returns texture array if *layers* is supplied

Return type `moderngl.TextureArray`

`Textures.add(meta: moderngl_window.meta.base.ResourceDescription)` → `None`

Adds a resource description without loading it. The resource is loaded and returned when `load_pool()` is called.

Parameters `meta` (*ResourceDescription*) – The resource description

`Textures.load_pool()` → Generator[Tuple[moderngl_window.meta.base.ResourceDescription, Any], None, None]

Loads all the data files using the configured finders.

This is only relevant when resource have been added to this pool using `add()`.

Returns Generator of (meta, resource) tuples

`Textures.resolve_loader(meta: moderngl_window.meta.base.ResourceDescription)` → None

Attempts to assign a loader class to a ResourceDescription.

Parameters `meta` (*ResourceDescription*) – The resource description instance

16.2.2 Attributes

`Textures.settings_attr = 'TEXTURE_LOADERS'`

`Textures.count`

The number of resource descriptions added. This is only relevant when using *add* and *load_pool*.

Type int

`Textures.loaders`

Loader classes for this resource type

Type Generator

16.3 programs.Programs

`moderngl_window.resources.programs.Programs`

Handle program loading

16.3.1 Methods

`Programs.__init__()`

Initialize internal attributes

`Programs.load(meta: moderngl_window.meta.program.ProgramDescription)` → moderngl.program.Program

Loads a shader program with the configured loaders

Parameters `meta` (*ProgramDescription*) – The resource description

Returns The shader program

Return type moderngl.Program

`Programs.add(meta: moderngl_window.meta.base.ResourceDescription)` → None

Adds a resource description without loading it. The resource is loaded and returned when `load_pool()` is called.

Parameters `meta` (*ResourceDescription*) – The resource description

`Programs.load_pool()` → Generator[Tuple[moderngl_window.meta.base.ResourceDescription, Any], None, None]

Loads all the data files using the configured finders.

This is only relevant when resource have been added to this pool using `add()`.

Returns Generator of (meta, resource) tuples

`Programs.resolve_loader` (*meta: moderngl_window.meta.program.ProgramDescription*) → None
 Resolve program loader.

Determines if the references resource is a single or multiple glsl files unless `kind` is specified.

Parameters *meta* (*ProgramDescription*) – The resource description

16.3.2 Attributes

`Programs.settings_attr` = 'PROGRAM_LOADERS'

`Programs.count`

The number of resource descriptions added. This is only relevant when using *add* and *load_pool*.

Type int

`Programs.loaders`

Loader classes for this resource type

Type Generator

16.4 scenes.Scenes

`moderngl_window.resources.scenes.Scenes`

Handles scene loading

16.4.1 Methods

`Scenes.__init__()`

Initialize internal attributes

`Scenes.load` (*meta: moderngl_window.meta.scene.SceneDescription*) → mod-
 `erngl_window.scene.scene.Scene`
 Load a scene with the configured loaders.

Parameters *meta* (*SceneDescription*) – The resource description

Returns The loaded scene

Return type Scene

`Scenes.add` (*meta: moderngl_window.meta.base.ResourceDescription*) → None

Adds a resource description without loading it. The resource is loaded and returned when `load_pool()` is called.

Parameters *meta* (*ResourceDescription*) – The resource description

`Scenes.load_pool()` → Generator[Tuple[moderngl_window.meta.base.ResourceDescription, Any],
 None, None]

Loads all the data files using the configured finders.

This is only relevant when resource have been added to this pool using `add()`.

Returns Generator of (meta, resource) tuples

`Scenes.resolve_loader` (*meta: moderngl_window.meta.base.ResourceDescription*) → None

Attempts to assign a loader class to a ResourceDescription.

Parameters *meta* (*ResourceDescription*) – The resource description instance

16.4.2 Attributes

`Scenes.settings_attr = 'SCENE_LOADERS'`

`Scenes.count`

The number of resource descriptions added. This is only relevant when using *add* and *load_pool*.

Type int

`Scenes.loaders`

Loader classes for this resource type

Type Generator

16.5 base.DataFiles

`moderngl_window.resources.data.DataFiles`

Registry for requested data files

16.5.1 Methods

`DataFiles.__init__()`

Initialize internal attributes

`DataFiles.load(meta: moderngl_window.meta.data.DataDescription) → Any`

Load data file with the configured loaders.

Parameters `meta` (*DataDescription*) – the resource description

Returns The loaded resource

Return type Any

`DataFiles.add(meta: moderngl_window.meta.base.ResourceDescription) → None`

Adds a resource description without loading it. The resource is loaded and returned when `load_pool()` is called.

Parameters `meta` (*ResourceDescription*) – The resource description

`DataFiles.load_pool() → Generator[Tuple[moderngl_window.meta.base.ResourceDescription, Any], None, None]`

Loads all the data files using the configured finders.

This is only relevant when resource have been added to this pool using `add()`.

Returns Generator of (meta, resource) tuples

`DataFiles.resolve_loader(meta: moderngl_window.meta.base.ResourceDescription) → None`

Attempts to assign a loader class to a ResourceDescription.

Parameters `meta` (*ResourceDescription*) – The resource description instance

16.5.2 Attributes

`DataFiles.settings_attr = 'DATA_LOADERS'`

`DataFiles.count`

The number of resource descriptions added. This is only relevant when using *add* and *load_pool*.

Type int

DataFiles.**loaders**

Loader classes for this resource type

Type Generator

MODERNGL_WINDOW.TIMERS

17.1 base.BaseTimer

`moderngl_window.timers.base.BaseTimer`

A timer controls the time passed into the the render function. This can be used in creative ways to control the current time such as basing it on current location in an audio file.

All methods must be implemented.

17.1.1 Methods

`BaseTimer.__init__()`

Initialize self. See `help(type(self))` for accurate signature.

`BaseTimer.next_frame()` → `Tuple[float, float]`

Get timer information for the next frame.

Returns The frametime and current time

Return type `Tuple[float, float]`

`BaseTimer.start()`

Start the timer initially or resume after pause

`BaseTimer.pause()`

Pause the timer

`BaseTimer.toggle_pause()`

Toggle pause state

`BaseTimer.stop()` → `Tuple[float, float]`

Stop the timer. Should only be called once when stopping the timer.

Returns `Tuple[float, float]`> Current position in the timer, actual running duration

17.1.2 Attributes

`BaseTimer.is_paused`

The pause state of the timer

Type `bool`

`BaseTimer.is_running`

Is the timer currently running?

Type bool

`BaseTimer.time`

Get or set the current time. This can be used to jump around in the timeline.

Returns The current time in seconds

Return type float

17.2 clock.Timer

`moderngl_window.timers.clock.Timer`

Timer based on python `time`.

17.2.1 Methods

`Timer.__init__(**kwargs)`

Initialize self. See `help(type(self))` for accurate signature.

`Timer.next_frame()` → `Tuple[float, float]`

Get the time and frametime for the next frame. This should only be called once per frame.

Returns current time and frametime

Return type `Tuple[float, float]`

`Timer.start()`

Start the timer by recoding the current `time.time()` preparing to report the number of seconds since this timestamp.

`Timer.pause()`

Pause the timer by setting the internal pause time using `time.time()`

`Timer.toggle_pause()`

Toggle the paused state

`Timer.stop()` → `Tuple[float, float]`

Stop the timer. Should only be called once when stopping the timer.

Returns Current position in the timer, actual running duration

Return type `Tuple[float, float]`

17.2.2 Attributes

`Timer.is_paused`

The pause state of the timer

Type bool

`Timer.is_running`

Is the timer currently running?

Type bool

`Timer.time`

Get or set the current time. This can be used to jump around in the timeline.

Returns The current time in seconds

MODERNGL_WINDOW.SCENE

18.1 Camera

`moderngl_window.scene.Camera`

Simple camera class containing projection.

```
# create a camera
camera = Camera(fov=60.0, aspect_ratio=1.0, near=1.0, far=100.0)

# Get the current camera matrix as numpy array
print(camera.matrix)

# Get projection matrix as numpy array
print(camera.projection.matrix)
```

18.1.1 Methods

`Camera.__init__(fov=60.0, aspect_ratio=1.0, near=1.0, far=100.0)`

Initialize camera using a specific projection

Keyword Arguments

- **fov** (*float*) – Field of view
- **aspect_ratio** (*float*) – Aspect ratio
- **near** (*float*) – Near plane
- **far** (*float*) – Far plane

`Camera.set_position(x, y, z) → None`

Set the 3D position of the camera.

Parameters

- **x** (*float*) – x position
- **y** (*float*) – y position
- **z** (*float*) – z position

`Camera.set_rotation(yaw, pitch) → None`

Set the rotation of the camera.

Parameters

- **yaw** (*float*) – yaw rotation

- **pitch** (*float*) – pitch rotation

Camera.**look_at** (*vec=None, pos=None*) → *numpy.ndarray*

Look at a specific point

Either *vec* or *pos* needs to be supplied.

Keyword Arguments

- **vec** (*pyrr.Vector3*) – position
- **pos** (*tuple/list*) – list of tuple *[x, y, z]* / *(x, y, z)*

Returns Camera matrix

Return type *numpy.ndarray*

18.1.2 Attributes

Camera.**pitch**

The current pitch angle.

Type *float*

Camera.**yaw**

The current yaw angle.

Type *float*

Camera.**matrix**

The current view matrix for the camera

Type *numpy.ndarray*

Camera.**projection**

The 3D projection

Type *Projection3D*

18.2 KeyboardCamera

moderngl_window.scene.**KeyboardCamera**

Camera controlled by mouse and keyboard. The class interacts with the key constants in the built in window types.

Creating a keyboard camera:

```
camera = KeyboardCamera(  
    self.wnd.keys,  
    fov=75.0,  
    aspect_ratio=self.wnd.aspect_ratio,  
    near=0.1,  
    far=1000.0,  
)
```

We can also interact with the belonging *Projection3D* instance.


```
# Update aspect ratio
camera.projection.update(aspect_ratio=1.0)

# Get projection matrix in bytes (f4)
camera.projection.tobytes()
```

18.2.1 Methods

`KeyboardCamera.__init__` (*keys*: `moderngl_window.context.base.keys.BaseKeys`, *fov*=60.0, *aspect_ratio*=1.0, *near*=1.0, *far*=100.0)

Initialize the camera

Parameters **keys** (`BaseKeys`) – The key constants for the current window type

Keyword Arguments

- **fov** (`float`) – Field of view
- **aspect_ratio** (`float`) – Aspect ratio
- **near** (`float`) – near plane
- **far** (`float`) – far plane

`KeyboardCamera.key_input` (*key*, *action*, *modifiers*) → None

Process key inputs and move camera

Parameters

- **key** – The key
- **action** – key action release/press
- **modifiers** – key modifier states such as ctrl or shift

`KeyboardCamera.set_position` (*x*, *y*, *z*) → None

Set the 3D position of the camera.

Parameters

- **x** (`float`) – x position
- **y** (`float`) – y position
- **z** (`float`) – z position

`KeyboardCamera.set_rotation` (*yaw*, *pitch*) → None

Set the rotation of the camera.

Parameters

- **yaw** (`float`) – yaw rotation
- **pitch** (`float`) – pitch rotation

`KeyboardCamera.look_at` (*vec*=None, *pos*=None) → `numpy.ndarray`

Look at a specific point

Either *vec* or *pos* needs to be supplied.

Keyword Arguments

- **vec** (`pyrr.Vector3`) – position
- **pos** (`tuple/list`) – list of tuple `[x, y, z]` / `(x, y, z)`

Returns Camera matrix

Return type numpy.ndarray

KeyboardCamera.**move_left** (*activate*) → None

The camera should be continiously moving to the left.

Parameters **activate** (*bool*) – Activate or deactivate this state

KeyboardCamera.**move_right** (*activate*) → None

The camera should be continiously moving to the right.

Parameters **activate** (*bool*) – Activate or deactivate this state

KeyboardCamera.**move_forward** (*activate*) → None

The camera should be continiously moving forward.

Parameters **activate** (*bool*) – Activate or deactivate this state

KeyboardCamera.**move_backward** (*activate*) → None

The camera should be continiously moving backwards.

Parameters **activate** (*bool*) – Activate or deactivate this state

KeyboardCamera.**move_up** (*activate*) → None

The camera should be continiously moving up.

Parameters **activate** (*bool*) – Activate or deactivate this state

KeyboardCamera.**move_down** (*activate*)

The camera should be continiously moving down.

Parameters **activate** (*bool*) – Activate or deactivate this state

KeyboardCamera.**move_state** (*direction, activate*) → None

Set the camera position move state.

Parameters

- **direction** – What direction to update
- **activate** – Start or stop moving in the direction

KeyboardCamera.**rot_state** (*dx: int, dy: int*) → None

Update the rotation of the camera.

This is done by passing in the relative mouse movement change on x and y (delta x, delta y).

In the past this method took the viewport position of the mouse. This does not work well when mouse exclusivity mode is enabled.

Parameters

- **dx** – Relative mouse position change on x
- **dy** – Relative mouse position change on y

18.2.2 Attributes

KeyboardCamera.**pitch**

The current pitch angle.

Type float

KeyboardCamera.**yaw**

The current yaw angle.

Type float

KeyboardCamera.**matrix**

The current view matrix for the camera

Type numpy.ndarray

KeyboardCamera.**mouse_sensitivity**

Mouse sensitivity (rotation speed).

This property can also be set:

```
camera.mouse_sensitivity = 2.5
```

Type float

KeyboardCamera.**velocity**

The speed this camera move based on key inputs

The property can also be modified:

```
camera.velocity = 5.0
```

Type float

KeyboardCamera.**projection**

The 3D projection

Type *Projection3D*

18.3 Scene

18.3.1 Methods

Scene.**__init__**(*name*, ***kwargs*)

Create a scene with a name.

Parameters *name* (*str*) – Unique name or path for the scene

Scene.**draw**(*projection_matrix*: *numpy.ndarray* = *None*, *camera_matrix*: *numpy.ndarray* = *None*, *time*=0.0) → *None*

Draw all the nodes in the scene.

Parameters

- **projection_matrix** (*ndarray*) – projection matrix (bytes)
- **camera_matrix** (*ndarray*) – camera_matrix (bytes)
- **time** (*float*) – The current time

Scene.**draw_bbox**(*projection_matrix*=*None*, *camera_matrix*=*None*, *children*=*True*, *color*=(0.75, 0.75, 0.75)) → *None*

Draw scene and mesh bounding boxes.

Parameters

- **projection_matrix** (*ndarray*) – mat4 projection
- **camera_matrix** (*ndarray*) – mat4 camera matrix

- **children** (*bool*) – Will draw bounding boxes for meshes as well
- **color** (*tuple*) – Color of the bounding boxes

`Scene.draw_wireframe` (*projection_matrix=None, camera_matrix=None, color=(0.75, 0.75, 0.75, 1.0)*)
Render the scene in wireframe mode.

Parameters

- **projection_matrix** (*ndarray*) – mat4 projection
- **camera_matrix** (*ndarray*) – mat4 camera matrix
- **children** (*bool*) – Will draw bounding boxes for meshes as well
- **color** (*tuple*) – Color of the wireframes

`Scene.apply_mesh_programs` (*mesh_programs=None, clear: bool = True*) → None
Applies mesh programs to meshes. If not mesh programs are passed in we assign default ones.

Parameters

- **mesh_programs** (*list*) – List of mesh programs to assign
- **clear** (*bool*) – Clear all assigned mesh programs

`Scene.calc_scene_bbox` () → None
Calculate scene bbox

`Scene.find_material` (*name: str = None*) → Material
Finds a *Material*

Keyword Arguments **name** (*str*) – Case sensitive material name

Returns A *Material* or None

`Scene.find_node` (*name: str = None*) → Node
Finds a *Node*

Keyword Arguments **name** (*str*) – Case sensitive name

Returns A *Node* or None if not found.

`Scene.prepare` () → None
prepare the scene for rendering.

Calls `apply_mesh_programs` () assigning default meshprograms if needed and sets the model matrix.

`Scene.destroy` () → None
Destroys the scene data and vertex buffers

`Scene.release` ()
Destroys the scene data and vertex buffers

18.3.2 Attributes

`Scene.ctx`
The current context

Type moderngl.Context

`Scene.matrix`
The current model matrix
This property is settable.

Type `numpy.ndarray`

18.4 Node

`moderngl_window.scene.Node`

A generic scene node containing a mesh or camera and/or a container for other nodes. Nodes and their children represents the scene tree.

18.4.1 Methods

`Node.__init__` (*name=None, camera=None, mesh=None, matrix=None*)

Create a node.

Keyword Arguments

- **name** – Name of the node
- **camera** – Camera to store in the node
- **mesh** – Mesh to store in the node
- **matrix** – The node's matrix

`Node.add_child` (*node*)

Add a child to this node

Parameters **node** (*Node*) – Node to add as a child

`Node.draw` (*projection_matrix=None, camera_matrix=None, time=0*)

Draw node and children.

Keyword Arguments

- **projection_matrix** (*bytes*) – projection matrix
- **camera_matrix** (*bytes*) – camera_matrix
- **time** (*float*) – The current time

`Node.draw_bbox` (*projection_matrix, camera_matrix, program, vao*)

Draw bounding box around the node and children.

Keyword Arguments

- **projection_matrix** (*bytes*) – projection matrix
- **camera_matrix** (*bytes*) – camera_matrix
- **program** (*moderngl.Program*) – The program to render the bbox
- **vao** – The vertex array representing the bounding box

`Node.draw_wireframe` (*projection_matrix, camera_matrix, program*)

Render the node as wireframe.

Keyword Arguments

- **projection_matrix** (*bytes*) – projection matrix
- **camera_matrix** (*bytes*) – camera_matrix
- **program** (*moderngl.Program*) – The program to render wireframe

Node.**calc_global_bbox** (*view_matrix*, *bbox_min*, *bbox_max*)

Recursive calculation of scene bbox.

Keyword Arguments

- **view_matrix** (*numpy.ndarray*) – view matrix
- **bbox_min** – min bbox values
- **bbox_max** – max bbox values

Node.**calc_model_mat** (*model_matrix*)

Calculate the model matrix related to all parents.

Parameters **model_matrix** (*numpy.ndarray*) – model matrix

18.4.2 Attributes

Node.**name**

Get or set the node name

Type str

Node.**mesh**

The mesh if present

Type *Mesh*

Node.**camera**

The camera if present

Type *Camera*

Node.**matrix**

Note matrix (local)

Type numpy.ndarray

Node.**matrix_global**

The global node matrix containing transformations from parent nodes

Type numpy.ndarray

Node.**children**

List of children

Type list

18.5 Mesh

moderngl_window.scene.**Mesh** = <class 'moderngl_window.scene.mesh.Mesh'>

Mesh info and geometry

18.5.1 Methods

Mesh.**__init__** (*name*, *vao=None*, *material=None*, *attributes=None*, *bbox_min=None*, *bbox_max=None*)

Initialize mesh.

Parameters **name** (*str*) – name of the mesh

Keyword Arguments

- **vao** (*VAO*) – geometry
- **material** (*Material*) – material for the mesh
- **attributes** (*dict*) – Details info about each mesh attribute (dict)
- **bbox_min** – xyz min values
- **bbox_max** – xyz max values

Attributes example:

```
{
  "NORMAL": {"name": "in_normal", "components": 3, "type": GL_FLOAT},
  "POSITION": {"name": "in_position", "components": 3, "type": GL_FLOAT}
}
```

`Mesh.draw` (*projection_matrix=None, model_matrix=None, camera_matrix=None, time=0.0*)

Draw the mesh using the assigned mesh program

Keyword Arguments

- **projection_matrix** (*bytes*) – projection_matrix
- **view_matrix** (*bytes*) – view_matrix
- **camera_matrix** (*bytes*) – camera_matrix

`Mesh.draw_bbox` (*proj_matrix, model_matrix, cam_matrix, program, vao*)

Renders the bounding box for this mesh.

Parameters

- **proj_matrix** – Projection matrix
- **model_matrix** – View/model matrix
- **cam_matrix** – Camera matrix
- **program** – The moderngl.Program rendering the bounding box
- **vao** – The vao mesh for the bounding box

`Mesh.draw_wireframe` (*proj_matrix, model_matrix, program*)

Render the mesh as wireframe.

proj_matrix: Projection matrix model_matrix: View/model matrix program: The moderngl.Program rendering the wireframe

`Mesh.add_attribute` (*attr_type, name, components*)

Add metadata about the mesh :param attr_type: POSITION, NORMAL etc :param name: The attribute name used in the program :param components: Number of floats

`Mesh.calc_global_bbox` (*view_matrix, bbox_min, bbox_max*)

Calculates the global bounding.

Parameters

- **view_matrix** – View matrix
- **bbox_min** – xyz min
- **bbox_max** – xyz max

Returns Combined bbox

Return type bbox_min, bbox_max

`Mesh.has_normals()` → bool

Returns Does the mesh have a normals?

Return type bool

`Mesh.has_uvs(layer=0)` → bool

Returns Does the mesh have texture coordinates?

Return type bool

18.6 Material

`moderngl_window.scene.Material`

Generic material

18.6.1 Methods

`Material.__init__(name: str = None)`

Initialize material.

Parameters `name` (*str*) – Name of the material

`Material.release()`

18.6.2 Attributes

`Material.name`

Name of the material

Type str

`Material.color`

RGBA color

Type Tuple[float, float, float, float]

`Material.mat_texture`

instance

Type MaterialTexture

`Material.double_sided`

Material surface is double sided?

Type bool

18.7 MaterialTexture

`moderngl_window.scene.MaterialTexture`

Wrapper for textures used in materials. Contains a texture and a sampler object.

18.7.1 Methods

`MaterialTexture.__init__` (*texture: moderngl.texture.Texture = None, sampler: moderngl.sampler.Sampler = None*)

Initialize instance.

Parameters

- **texture** (*moderngl.Texture*) – Texture instance
- **sampler** (*moderngl.Sampler*) – Sampler instance

18.7.2 Attributes

`MaterialTexture.texture`

Texture instance

Type `moderngl.Texture`

`MaterialTexture.sampler`

Sampler instance

Type `moderngl.Sampler`

18.8 MeshProgram

`moderngl_window.scene.MeshProgram`

Describes how a mesh is rendered using a specific shader program

18.8.1 Methods

`MeshProgram.__init__` (*program: moderngl.program.Program = None, **kwargs*)

Initialize.

Parameters **program** – The moderngl program

`MeshProgram.draw` (*mesh, projection_matrix: numpy.ndarray = None, model_matrix: numpy.ndarray = None, camera_matrix: numpy.ndarray = None, time=0.0*)

Draw code for the mesh

Parameters **mesh** (*Mesh*) – The mesh to render

Keyword Arguments

- **projection_matrix** (*numpy.ndarray*) – projection_matrix (bytes)
- **model_matrix** (*numpy.ndarray*) – view_matrix (bytes)
- **camera_matrix** (*numpy.ndarray*) – camera_matrix (bytes)
- **time** (*float*) – The current time

`MeshProgram.apply` (*mesh*)

Determine if this MeshProgram should be applied to the mesh. Can return self or some MeshProgram instance to support dynamic MeshProgram creation

Parameters **mesh** – The mesh to inspect

18.8.2 Attributes

`MeshProgram.ctx`

The current context

Type moderngl.Context

INDICES AND TABLES

- `genindex`
- `modindex`
- `search`

PYTHON MODULE INDEX

m

- `moderngl_window`, 17
- `moderngl_window.conf`, 20
- `moderngl_window.context.base.window`, 29
- `moderngl_window.context.glfw.window`, 42
- `moderngl_window.context.headless.window`, 49
- `moderngl_window.context.pyglet.window`, 55
- `moderngl_window.context.pyqt5.window`, 62
- `moderngl_window.context.pyside2.window`, 69
- `moderngl_window.context.sdl2.window`, 76
- `moderngl_window.finders.base`, 111
- `moderngl_window.finders.data`, 112
- `moderngl_window.finders.program`, 112
- `moderngl_window.finders.scene`, 112
- `moderngl_window.finders.texture`, 111
- `moderngl_window.geometry`, 83
- `moderngl_window.loaders.base`, 87
- `moderngl_window.loaders.data.binary`, 98
- `moderngl_window.loaders.data.json`, 96
- `moderngl_window.loaders.data.text`, 97
- `moderngl_window.loaders.program.separate`, 91
- `moderngl_window.loaders.program.single`, 89
- `moderngl_window.loaders.scene.gltf2`, 94
- `moderngl_window.loaders.scene.stl`, 95
- `moderngl_window.loaders.scene.wavefront`, 93
- `moderngl_window.loaders.texture.array`, 92
- `moderngl_window.loaders.texture.t2d`, 88
- `moderngl_window.meta.base`, 101
- `moderngl_window.meta.data`, 109
- `moderngl_window.meta.program`, 105
- `moderngl_window.meta.scene`, 107
- `moderngl_window.meta.texture`, 102
- `moderngl_window.opengl.projection`, 115
- `moderngl_window.opengl.vao`, 116
- `moderngl_window.resources`, 118
- `moderngl_window.resources.base`, 119
- `moderngl_window.resources.data`, 123
- `moderngl_window.resources.programs`, 121
- `moderngl_window.resources.scenes`, 122
- `moderngl_window.resources.textures`, 120
- `moderngl_window.scene`, 131
- `moderngl_window.screenshot`, 25
- `moderngl_window.timers.base`, 125
- `moderngl_window.timers.clock`, 126

INDEX

Symbols

`__init__()` (`moderngl_window.conf.Settings` method), 21
`__init__()` (`moderngl_window.context.base.window.BaseWindow` method), 36
`__init__()` (`moderngl_window.context.base.window.WindowConfig` method), 30
`__init__()` (`moderngl_window.context.glfw.window.Window` method), 42
`__init__()` (`moderngl_window.context.headless.window.Window` method), 49
`__init__()` (`moderngl_window.context.pyglet.window.Window` method), 55
`__init__()` (`moderngl_window.context.pyqt5.window.Window` method), 63
`__init__()` (`moderngl_window.context.pyside2.window.Window` method), 70
`__init__()` (`moderngl_window.context.sdl2.window.Window` method), 77
`__init__()` (`moderngl_window.finders.base.BaseFilesystemFinder` method), 111
`__init__()` (`moderngl_window.finders.data.FilesystemFinder` method), 113
`__init__()` (`moderngl_window.finders.program.FilesystemFinder` method), 112
`__init__()` (`moderngl_window.finders.scene.FilesystemFinder` method), 112
`__init__()` (`moderngl_window.finders.texture.FilesystemFinder` method), 111
`__init__()` (`moderngl_window.loaders.base.BaseLoader` method), 87
`__init__()` (`moderngl_window.loaders.data.binary.Loader` method), 98
`__init__()` (`moderngl_window.loaders.data.json.Loader` method), 96
`__init__()` (`moderngl_window.loaders.data.text.Loader` method), 97
`__init__()` (`moderngl_window.loaders.program.separate.Loader` method), 91
`__init__()` (`moderngl_window.loaders.program.single.Loader` method), 89
`__init__()` (`moderngl_window.loaders.scene.gltf2.Loader` method), 94
`__init__()` (`moderngl_window.loaders.scene.stl.Loader` method), 95
`__init__()` (`moderngl_window.loaders.scene.wavefront.Loader` method), 93
`__init__()` (`moderngl_window.loaders.texture.array.Loader` method), 92
`__init__()` (`moderngl_window.loaders.texture.t2d.Loader` method), 88
`__init__()` (`moderngl_window.meta.base.ResourceDescription` method), 101
`__init__()` (`moderngl_window.meta.data.DataDescription` method), 109
`__init__()` (`moderngl_window.meta.program.ProgramDescription` method), 105
`__init__()` (`moderngl_window.meta.scene.SceneDescription` method), 107
`__init__()` (`moderngl_window.meta.texture.TextureDescription` method), 102
`__init__()` (`moderngl_window.opengl.projection.Projection3D` method), 115
`__init__()` (`moderngl_window.opengl.vao.VAO` method), 117
`__init__()` (`moderngl_window.resources.base.BaseRegistry` method), 119
`__init__()` (`moderngl_window.resources.data.DataFiles` method), 123
`__init__()` (`moderngl_window.resources.programs.Programs` method), 121
`__init__()` (`moderngl_window.resources.scenes.Scenes` method), 122
`__init__()` (`moderngl_window.resources.textures.Textures` method), 120
`__init__()` (`moderngl_window.scene.Camera` method), 127
`__init__()` (`moderngl_window.scene.KeyboardCamera` method), 129
`__init__()` (`moderngl_window.scene.Material` method), 136
`__init__()` (`moderngl_window.scene.MaterialTexture` method), 137
`__init__()` (`moderngl_window.scene.Mesh` method),

134
 __init__() (moderngl_window.scene.MeshProgram
 method), 137
 __init__() (moderngl_window.scene.Node method),
 133
 __init__() (moderngl_window.scene.Scene method),
 131
 __init__() (moderngl_window.timers.base.BaseTimer
 method), 125
 __init__() (moderngl_window.timers.clock.Timer
 method), 126

A

activate_context() (in module mod-
 erngl_window), 19
 add() (moderngl_window.resources.base.BaseRegistry
 method), 119
 add() (moderngl_window.resources.data.DataFiles
 method), 123
 add() (moderngl_window.resources.programs.Programs
 method), 121
 add() (moderngl_window.resources.scenes.Scenes
 method), 122
 add() (moderngl_window.resources.textures.Textures
 method), 120
 add_attribute() (moderngl_window.scene.Mesh
 method), 135
 add_child() (moderngl_window.scene.Node
 method), 133
 anisotropy (moderngl_window.meta.texture.TextureDescription
 attribute), 103
 apply() (moderngl_window.scene.MeshProgram
 method), 137
 apply_default_settings() (mod-
 erngl_window.conf.Settings method), 21
 apply_from_cls() (moderngl_window.conf.Settings
 method), 22
 apply_from_dict() (mod-
 erngl_window.conf.Settings method), 22
 apply_from_iterable() (mod-
 erngl_window.conf.Settings method), 22
 apply_from_module() (mod-
 erngl_window.conf.Settings method), 22
 apply_from_module_name() (mod-
 erngl_window.conf.Settings method), 22
 apply_mesh_programs() (mod-
 erngl_window.scene.Scene method), 132
 apply_settings_from_env() (mod-
 erngl_window.conf.Settings method), 21
 argv (moderngl_window.context.base.window.WindowConfig
 attribute), 36
 aspect_ratio (mod-
 erngl_window.context.base.window.BaseWindow
 attribute), 39

aspect_ratio (mod-
 erngl_window.context.base.window.WindowConfig
 attribute), 35
 aspect_ratio (mod-
 erngl_window.context.glfw.window.Window
 attribute), 46
 aspect_ratio (mod-
 erngl_window.context.headless.window.Window
 attribute), 53
 aspect_ratio (mod-
 erngl_window.context.pyglet.window.Window
 attribute), 60
 aspect_ratio (mod-
 erngl_window.context.pyqt5.window.Window
 attribute), 67
 aspect_ratio (mod-
 erngl_window.context.pyside2.window.Window
 attribute), 74
 aspect_ratio (mod-
 erngl_window.context.sdl2.window.Window
 attribute), 80
 aspect_ratio (mod-
 erngl_window.opengl.projection.Projection3D
 attribute), 115
 attr_names (moderngl_window.meta.scene.SceneDescription
 attribute), 108
 attrs (moderngl_window.meta.base.ResourceDescription
 attribute), 101
 attrs (moderngl_window.meta.data.DataDescription
 attribute), 109
 attrs (moderngl_window.meta.program.ProgramDescription
 attribute), 106
 attrs (moderngl_window.meta.scene.SceneDescription
 attribute), 108
 attrs (moderngl_window.meta.texture.TextureDescription
 attribute), 104

B

BaseFilesystemFinder (in module mod-
 erngl_window.finders.base), 111
 BaseRegistry (in module mod-
 erngl_window.resources.base), 119
 BaseTimer (in module moderngl_window.timers.base),
 125
 bbox() (in module moderngl_window.geometry), 85
 buffer() (moderngl_window.opengl.vao.VAO
 method), 118
 buffer_height (mod-
 erngl_window.context.base.window.BaseWindow
 attribute), 38
 buffer_height (mod-
 erngl_window.context.glfw.window.Window
 attribute), 44

buffer_height	(moderngl_window.context.headless.window.Window attribute), 52	calc_global_bbox()	(moderngl_window.scene.Mesh method), 135
buffer_height	(moderngl_window.context.pyglet.window.Window attribute), 59	calc_global_bbox()	(moderngl_window.scene.Node method), 133
buffer_height	(moderngl_window.context.pyqt5.window.Window attribute), 66	calc_model_mat()	(moderngl_window.scene.Node method), 134
buffer_height	(moderngl_window.context.pyside2.window.Window attribute), 73	calc_scene_bbox()	(moderngl_window.scene.Scene method), 132
buffer_height	(moderngl_window.context.sdl2.window.Window attribute), 79	Camera	(in module moderngl_window.scene), 127
buffer_size (moderngl_window.context.base.window.BaseWindow attribute), 38		camera	(moderngl_window.scene.Node attribute), 134
buffer_size (moderngl_window.context.glfw.window.Window attribute), 44		children	(moderngl_window.scene.Node attribute), 134
buffer_size (moderngl_window.context.headless.window.Window attribute), 52		clear()	(moderngl_window.context.base.window.BaseWindow method), 36
buffer_size (moderngl_window.context.pyglet.window.Window attribute), 59		clear()	(moderngl_window.context.glfw.window.Window method), 50
buffer_size (moderngl_window.context.pyqt5.window.Window attribute), 66		clear()	(moderngl_window.context.headless.window.Window method), 56
buffer_size (moderngl_window.context.pyside2.window.Window attribute), 73		clear()	(moderngl_window.context.pyglet.window.Window method), 63
buffer_size (moderngl_window.context.sdl2.window.Window attribute), 79		clear()	(moderngl_window.context.pyqt5.window.Window method), 70
buffer_width	(moderngl_window.context.base.window.BaseWindow attribute), 38	clear()	(moderngl_window.context.pyside2.window.Window method), 77
buffer_width	(moderngl_window.context.glfw.window.Window attribute), 44	clear_color	(moderngl_window.context.base.window.WindowConfig attribute), 35
buffer_width	(moderngl_window.context.headless.window.Window attribute), 52	close()	(moderngl_window.context.base.window.BaseWindow method), 36
buffer_width	(moderngl_window.context.pyglet.window.Window attribute), 59	close()	(moderngl_window.context.base.window.WindowConfig method), 30
buffer_width	(moderngl_window.context.pyqt5.window.Window attribute), 66	close()	(moderngl_window.context.glfw.window.Window method), 42
buffer_width	(moderngl_window.context.pyside2.window.Window attribute), 73	close()	(moderngl_window.context.headless.window.Window method), 50
buffer_width	(moderngl_window.context.sdl2.window.Window attribute), 79	close()	(moderngl_window.context.pyglet.window.Window method), 56
		close()	(moderngl_window.context.pyqt5.window.Window method), 63
		close()	(moderngl_window.context.pyside2.window.Window method), 70
		close()	(moderngl_window.context.sdl2.window.Window method), 77
		close_event()	(moderngl_window.context.pyqt5.window.Window method), 64
		close_event()	(moderngl_window.context.pyside2.window.Window method), 71
		close_func	(moderngl_window.context.base.window.BaseWindow attribute), 41
		close_func	(moderngl_window.context.glfw.window.Window attribute), 45
cache	(moderngl_window.meta.scene.SceneDescription attribute), 108		

C

close_func (moderngl_window.context.headless.window.Window attribute), 54

close_func (moderngl_window.context.pyglet.window.Window attribute), 61

close_func (moderngl_window.context.pyqt5.window.Window attribute), 68

close_func (moderngl_window.context.pyside2.window.Window attribute), 75

close_func (moderngl_window.context.sdl2.window.Window attribute), 82

color (moderngl_window.scene.Material attribute), 136

compute_shader (moderngl_window.meta.program.ProgramDescription attribute), 106

config (moderngl_window.context.base.window.BaseWindow attribute), 39

config (moderngl_window.context.glfw.window.Window attribute), 45

config (moderngl_window.context.headless.window.Window attribute), 53

config (moderngl_window.context.pyglet.window.Window attribute), 60

config (moderngl_window.context.pyqt5.window.Window attribute), 67

config (moderngl_window.context.pyside2.window.Window attribute), 74

config (moderngl_window.context.sdl2.window.Window attribute), 80

count (moderngl_window.resources.base.BaseRegistry attribute), 120

count (moderngl_window.resources.data.DataFiles attribute), 123

count (moderngl_window.resources.programs.Programs attribute), 122

count (moderngl_window.resources.scenes.Scenes attribute), 123

count (moderngl_window.resources.textures.Textures attribute), 121

create() (in module moderngl_window.screenshot), 27

create_parser() (in module moderngl_window), 20

create_window_from_settings() (in module moderngl_window), 19

ctx (moderngl_window.context.base.window.BaseWindow attribute), 37

ctx (moderngl_window.context.glfw.window.Window attribute), 43

ctx (moderngl_window.context.headless.window.Window attribute), 51

ctx (moderngl_window.context.pyglet.window.Window attribute), 58

ctx (moderngl_window.context.pyqt5.window.Window attribute), 65

ctx (moderngl_window.context.pyside2.window.Window attribute), 72

ctx (moderngl_window.context.sdl2.window.Window attribute), 78

ctx (moderngl_window.loaders.base.BaseLoader attribute), 88

ctx (moderngl_window.loaders.data.binary.Loader attribute), 99

ctx (moderngl_window.loaders.data.json.Loader attribute), 97

ctx (moderngl_window.loaders.data.text.Loader attribute), 98

ctx (moderngl_window.loaders.program.separate.Loader attribute), 92

ctx (moderngl_window.loaders.program.single.Loader attribute), 91

ctx (moderngl_window.loaders.scene.gltf2.Loader attribute), 95

ctx (moderngl_window.loaders.scene.stl.Loader attribute), 96

ctx (moderngl_window.loaders.scene.wavefront.Loader attribute), 94

ctx (moderngl_window.loaders.texture.array.Loader attribute), 93

ctx (moderngl_window.loaders.texture.t2d.Loader attribute), 89

ctx (moderngl_window.opengl.vao.VAO attribute), 118

ctx (moderngl_window.scene.MeshProgram attribute), 138

ctx (moderngl_window.scene.Scene attribute), 132

ctx() (in module moderngl_window), 19

cube() (in module moderngl_window.geometry), 86

cursor (moderngl_window.context.base.window.BaseWindow attribute), 40

cursor (moderngl_window.context.base.window.WindowConfig attribute), 35

cursor (moderngl_window.context.glfw.window.Window attribute), 46

cursor (moderngl_window.context.headless.window.Window attribute), 53

cursor (moderngl_window.context.pyglet.window.Window attribute), 61

cursor (moderngl_window.context.pyqt5.window.Window attribute), 68

cursor (moderngl_window.context.pyside2.window.Window attribute), 75

cursor (moderngl_window.context.sdl2.window.Window attribute), 81

D

DATA_DIRS (moderngl_window.conf.Settings attribute), 24

DATA_FINDERS (moderngl_window.conf.Settings attribute), 24

- DATA_LOADERS (*moderngl_window.conf.Settings* attribute), 25
- DataDescription (in module *moderngl_window.meta.data*), 109
- DataFiles (in module *moderngl_window.resources.data*), 123
- default_kind (*moderngl_window.meta.base.ResourceDescription* attribute), 102
- default_kind (*moderngl_window.meta.data.DataDescription* attribute), 110
- default_kind (*moderngl_window.meta.program.ProgramDescription* attribute), 107
- default_kind (*moderngl_window.meta.scene.SceneDescription* attribute), 109
- default_kind (*moderngl_window.meta.texture.TextureDescription* attribute), 105
- defines (*moderngl_window.meta.program.ProgramDescription* attribute), 106
- destroy() (*moderngl_window.context.base.window.BaseWindow* method), 37
- destroy() (*moderngl_window.context.glfw.window.Window* method), 43
- destroy() (*moderngl_window.context.headless.window.Window* method), 50
- destroy() (*moderngl_window.context.pyglet.window.Window* method), 56
- destroy() (*moderngl_window.context.pyqt5.window.Window* method), 64
- destroy() (*moderngl_window.context.pyside2.window.Window* method), 71
- destroy() (*moderngl_window.context.sdl2.window.Window* method), 78
- destroy() (*moderngl_window.scene.Scene* method), 132
- double_sided (*moderngl_window.scene.Material* attribute), 136
- draw() (*moderngl_window.scene.Mesh* method), 135
- draw() (*moderngl_window.scene.MeshProgram* method), 137
- draw() (*moderngl_window.scene.Node* method), 133
- draw() (*moderngl_window.scene.Scene* method), 131
- draw_bbox() (*moderngl_window.scene.Mesh* method), 135
- draw_bbox() (*moderngl_window.scene.Node* method), 133
- draw_bbox() (*moderngl_window.scene.Scene* method), 131
- draw_wireframe() (*moderngl_window.scene.Mesh* method), 135
- draw_wireframe() (*moderngl_window.scene.Node* method), 133
- draw_wireframe() (*moderngl_window.scene.Scene* method), 132
- ## E
- exit_key (*moderngl_window.context.base.window.BaseWindow* attribute), 37
- exit_key (*moderngl_window.context.glfw.window.Window* attribute), 43
- exit_key (*moderngl_window.context.headless.window.Window* attribute), 51
- exit_key (*moderngl_window.context.pyglet.window.Window* attribute), 58
- exit_key (*moderngl_window.context.pyqt5.window.Window* attribute), 65
- exit_key (*moderngl_window.context.pyside2.window.Window* attribute), 72
- exit_key (*moderngl_window.context.sdl2.window.Window* attribute), 78
- ## F
- far (*moderngl_window.opengl.projection.Projection3D* attribute), 116
- fbo (*moderngl_window.context.base.window.BaseWindow* attribute), 37
- fbo (*moderngl_window.context.glfw.window.Window* attribute), 43
- fbo (*moderngl_window.context.headless.window.Window* attribute), 51
- fbo (*moderngl_window.context.pyglet.window.Window* attribute), 58
- fbo (*moderngl_window.context.pyqt5.window.Window* attribute), 65
- fbo (*moderngl_window.context.pyside2.window.Window* attribute), 72
- fbo (*moderngl_window.context.sdl2.window.Window* attribute), 78
- file_extensions (*moderngl_window.loaders.base.BaseLoader* attribute), 88
- file_extensions (*moderngl_window.loaders.data.binary.Loader* attribute), 99
- file_extensions (*moderngl_window.loaders.data.json.Loader* attribute), 97
- file_extensions (*moderngl_window.loaders.data.text.Loader* attribute), 98
- file_extensions (*moderngl_window.loaders.program.separate.Loader* attribute), 92

file_extensions (moderngl_window.loaders.program.single.Loader attribute), 90	find_data() (moderngl_window.loaders.texture.array.Loader method), 92
file_extensions (moderngl_window.loaders.scene.glTF2.Loader attribute), 95	find_data() (moderngl_window.loaders.texture.t2d.Loader method), 88
file_extensions (moderngl_window.loaders.scene.stl.Loader attribute), 96	find_material() (moderngl_window.scene.Scene method), 132
file_extensions (moderngl_window.loaders.scene.wavefront.Loader attribute), 94	find_node() (moderngl_window.scene.Scene method), 132
file_extensions (moderngl_window.loaders.texture.array.Loader attribute), 93	find_program() (moderngl_window.loaders.base.BaseLoader method), 87
file_extensions (moderngl_window.loaders.texture.t2d.Loader attribute), 89	find_program() (moderngl_window.loaders.data.binary.Loader method), 99
FilesystemFinder (in module moderngl_window.finders.data), 113	find_program() (moderngl_window.loaders.data.json.Loader method), 97
FilesystemFinder (in module moderngl_window.finders.program), 112	find_program() (moderngl_window.loaders.data.text.Loader method), 98
FilesystemFinder (in module moderngl_window.finders.scene), 112	find_program() (moderngl_window.loaders.program.separate.Loader method), 91
FilesystemFinder (in module moderngl_window.finders.texture), 111	find_program() (moderngl_window.loaders.program.single.Loader method), 90
find() (moderngl_window.finders.base.BaseFilesystemFinder method), 111	find_program() (moderngl_window.loaders.scene.glTF2.Loader method), 94
find() (moderngl_window.finders.data.FilesystemFinder method), 113	find_program() (moderngl_window.loaders.scene.stl.Loader method), 96
find() (moderngl_window.finders.program.FilesystemFinder method), 112	find_program() (moderngl_window.loaders.scene.wavefront.Loader method), 93
find() (moderngl_window.finders.scene.FilesystemFinder method), 112	find_program() (moderngl_window.loaders.texture.array.Loader method), 92
find() (moderngl_window.finders.texture.FilesystemFinder method), 111	find_program() (moderngl_window.loaders.texture.t2d.Loader method), 88
find_data() (moderngl_window.loaders.base.BaseLoader method), 87	find_scene() (moderngl_window.loaders.base.BaseLoader method), 87
find_data() (moderngl_window.loaders.data.binary.Loader method), 99	find_scene() (moderngl_window.loaders.data.binary.Loader method), 99
find_data() (moderngl_window.loaders.data.json.Loader method), 97	find_scene() (moderngl_window.loaders.data.json.Loader method), 97
find_data() (moderngl_window.loaders.data.text.Loader method), 98	find_scene() (moderngl_window.loaders.data.text.Loader method), 98
find_data() (moderngl_window.loaders.program.separate.Loader method), 91	find_scene() (moderngl_window.loaders.data.text.Loader method), 98
find_data() (moderngl_window.loaders.program.single.Loader method), 90	find_scene() (moderngl_window.loaders.data.text.Loader method), 98
find_data() (moderngl_window.loaders.scene.glTF2.Loader method), 94	find_scene() (moderngl_window.loaders.data.text.Loader method), 98
find_data() (moderngl_window.loaders.scene.stl.Loader method), 96	find_scene() (moderngl_window.loaders.data.text.Loader method), 98
find_data() (moderngl_window.loaders.scene.wavefront.Loader method), 93	find_scene() (moderngl_window.loaders.data.text.Loader method), 98

<i>erngl_window.loaders.program.separate.Loader</i> <i>method</i>), 91	<i>erngl_window</i>), 19
<i>find_scene()</i> (<i>mod-erngl_window.loaders.program.single.Loader</i> <i>method</i>), 90	<i>fixed_aspect_ratio</i> (<i>mod-erngl_window.context.base.window.BaseWindow</i> <i>attribute</i>), 40
<i>find_scene()</i> (<i>mod-erngl_window.loaders.scene.glTF2.Loader</i> <i>method</i>), 94	<i>fixed_aspect_ratio</i> (<i>mod-erngl_window.context.glfw.window.Window</i> <i>attribute</i>), 46
<i>find_scene()</i> (<i>mod-erngl_window.loaders.scene.stl.Loader</i> <i>method</i>), 96	<i>fixed_aspect_ratio</i> (<i>mod-erngl_window.context.headless.window.Window</i> <i>attribute</i>), 53
<i>find_scene()</i> (<i>mod-erngl_window.loaders.scene.wavefront.Loader</i> <i>method</i>), 93	<i>fixed_aspect_ratio</i> (<i>mod-erngl_window.context.pyglet.window.Window</i> <i>attribute</i>), 60
<i>find_scene()</i> (<i>mod-erngl_window.loaders.texture.array.Loader</i> <i>method</i>), 92	<i>fixed_aspect_ratio</i> (<i>mod-erngl_window.context.pyqt5.window.Window</i> <i>attribute</i>), 67
<i>find_scene()</i> (<i>mod-erngl_window.loaders.texture.t2d.Loader</i> <i>method</i>), 89	<i>fixed_aspect_ratio</i> (<i>mod-erngl_window.context.pyside2.window.Window</i> <i>attribute</i>), 74
<i>find_texture()</i> (<i>mod-erngl_window.loaders.base.BaseLoader</i> <i>method</i>), 87	<i>fixed_aspect_ratio</i> (<i>mod-erngl_window.context.sdl2.window.Window</i> <i>attribute</i>), 81
<i>find_texture()</i> (<i>mod-erngl_window.loaders.data.binary.Loader</i> <i>method</i>), 99	<i>flip</i> (<i>moderngl_window.meta.texture.TextureDescription</i> <i>attribute</i>), 103
<i>find_texture()</i> (<i>mod-erngl_window.loaders.data.json.Loader</i> <i>method</i>), 97	<i>fov</i> (<i>moderngl_window.opengl.projection.Projection3D</i> <i>attribute</i>), 116
<i>find_texture()</i> (<i>mod-erngl_window.loaders.data.text.Loader</i> <i>method</i>), 98	<i>fragment_shader</i> (<i>mod-erngl_window.meta.program.ProgramDescription</i> <i>attribute</i>), 106
<i>find_texture()</i> (<i>mod-erngl_window.loaders.program.separate.Loader</i> <i>method</i>), 91	<i>frames</i> (<i>moderngl_window.context.base.window.BaseWindow</i> <i>attribute</i>), 39
<i>find_texture()</i> (<i>mod-erngl_window.loaders.program.single.Loader</i> <i>method</i>), 90	<i>frames</i> (<i>moderngl_window.context.glfw.window.Window</i> <i>attribute</i>), 45
<i>find_texture()</i> (<i>mod-erngl_window.loaders.scene.glTF2.Loader</i> <i>method</i>), 94	<i>frames</i> (<i>moderngl_window.context.headless.window.Window</i> <i>attribute</i>), 52
<i>find_texture()</i> (<i>mod-erngl_window.loaders.scene.stl.Loader</i> <i>method</i>), 96	<i>frames</i> (<i>moderngl_window.context.pyglet.window.Window</i> <i>attribute</i>), 60
<i>find_texture()</i> (<i>mod-erngl_window.loaders.scene.wavefront.Loader</i> <i>method</i>), 93	<i>frames</i> (<i>moderngl_window.context.pyqt5.window.Window</i> <i>attribute</i>), 67
<i>find_texture()</i> (<i>mod-erngl_window.loaders.texture.array.Loader</i> <i>method</i>), 92	<i>frames</i> (<i>moderngl_window.context.pyside2.window.Window</i> <i>attribute</i>), 74
<i>find_texture()</i> (<i>mod-erngl_window.loaders.texture.t2d.Loader</i> <i>method</i>), 89	<i>frames</i> (<i>moderngl_window.context.sdl2.window.Window</i> <i>attribute</i>), 80
<i>find_window_classes()</i> (<i>in module mod-</i>	<i>fullscreen</i> (<i>moderngl_window.context.base.window.BaseWindow</i> <i>attribute</i>), 39
	<i>fullscreen</i> (<i>moderngl_window.context.base.window.WindowConfig</i> <i>attribute</i>), 34
	<i>fullscreen</i> (<i>moderngl_window.context.glfw.window.Window</i> <i>attribute</i>), 45
	<i>fullscreen</i> (<i>moderngl_window.context.headless.window.Window</i> <i>attribute</i>), 52
	<i>fullscreen</i> (<i>moderngl_window.context.pyglet.window.Window</i> <i>attribute</i>), 60
	<i>fullscreen</i> (<i>moderngl_window.context.pyqt5.window.Window</i>

- [attribute](#)), 67
 - [fullscreen \(moderngl_window.context.pyside2.window.Window attribute\)](#), 74
 - [fullscreen \(moderngl_window.context.sdl2.window.Window attribute\)](#), 80
- ## G
- [geometry_shader \(moderngl_window.meta.program.ProgramDescription attribute\)](#), 106
 - [get_buffer_by_name \(\) \(moderngl_window.opengl.vao.VAO method\)](#), 118
 - [get_local_window_cls \(\) \(in module moderngl_window\)](#), 19
 - [get_window_cls \(\) \(in module moderngl_window\)](#), 19
 - [gl_version \(moderngl_window.context.base.window.BaseWindow attribute\)](#), 38
 - [gl_version \(moderngl_window.context.base.window.WindowConfig attribute\)](#), 35
 - [gl_version \(moderngl_window.context.glfw.window.Window attribute\)](#), 44
 - [gl_version \(moderngl_window.context.headless.window.Window attribute\)](#), 51
 - [gl_version \(moderngl_window.context.pyglet.window.Window attribute\)](#), 59
 - [gl_version \(moderngl_window.context.pyqt5.window.Window attribute\)](#), 66
 - [gl_version \(moderngl_window.context.pyside2.window.Window attribute\)](#), 73
 - [gl_version \(moderngl_window.context.sdl2.window.Window attribute\)](#), 79
 - [gl_version_code \(moderngl_window.context.base.window.BaseWindow attribute\)](#), 42
 - [gl_version_code \(moderngl_window.context.glfw.window.Window attribute\)](#), 47
 - [gl_version_code \(moderngl_window.context.headless.window.Window attribute\)](#), 55
 - [gl_version_code \(moderngl_window.context.pyglet.window.Window attribute\)](#), 62
 - [gl_version_code \(moderngl_window.context.pyqt5.window.Window attribute\)](#), 69
 - [gl_version_code \(moderngl_window.context.pyside2.window.Window attribute\)](#), 76
 - [gl_version_code \(moderngl_window.context.sdl2.window.Window attribute\)](#), 83
 - [glfw_char_callback \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 49
 - [glfw_cursor_enter \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 49
 - [glfw_key_event_callback \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 48
 - [glfw_mouse_button_callback \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 48
 - [glfw_mouse_event_callback \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 48
 - [glfw_mouse_scroll_callback \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 48
 - [glfw_window_focus \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 49
 - [glfw_window_iconify \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 49
 - [glfw_window_resize_callback \(\) \(moderngl_window.context.glfw.window.Window method\)](#), 48
- ## H
- [h_normals \(\) \(moderngl_window.scene.Mesh method\)](#), 136
 - [h_uv \(\) \(moderngl_window.scene.Mesh method\)](#), 136
 - [height \(moderngl_window.context.base.window.BaseWindow attribute\)](#), 38
 - [height \(moderngl_window.context.glfw.window.Window attribute\)](#), 44
 - [height \(moderngl_window.context.headless.window.Window attribute\)](#), 51
 - [height \(moderngl_window.context.pyglet.window.Window attribute\)](#), 59
 - [height \(moderngl_window.context.pyqt5.window.Window attribute\)](#), 66
 - [height \(moderngl_window.context.pyside2.window.Window attribute\)](#), 73
 - [height \(moderngl_window.context.sdl2.window.Window attribute\)](#), 79
 - [hide_event \(\) \(moderngl_window.context.pyqt5.window.Window method\)](#), 65
 - [hide_event \(\) \(moderngl_window.context.pyside2.window.Window method\)](#), 72

I

- `iconify_func` (moderngl_window.context.base.window.BaseWindow attribute), 41
- `iconify_func` (moderngl_window.context.glfw.window.Window attribute), 47
- `iconify_func` (moderngl_window.context.headless.window.Window attribute), 54
- `iconify_func` (moderngl_window.context.pyglet.window.Window attribute), 61
- `iconify_func` (moderngl_window.context.pyqt5.window.Window attribute), 68
- `iconify_func` (moderngl_window.context.pyside2.window.Window attribute), 75
- `iconify_func` (moderngl_window.context.sdl2.window.Window attribute), 82
- `image` (moderngl_window.meta.texture.TextureDescription attribute), 103
- `index_buffer()` (moderngl_window.opengl.vao.VAO method), 118
- `init_mgl_context()` (moderngl_window.context.base.window.BaseWindow method), 36
- `init_mgl_context()` (moderngl_window.context.glfw.window.Window method), 42
- `init_mgl_context()` (moderngl_window.context.headless.window.Window method), 50
- `init_mgl_context()` (moderngl_window.context.pyglet.window.Window method), 55
- `init_mgl_context()` (moderngl_window.context.pyqt5.window.Window method), 63
- `init_mgl_context()` (moderngl_window.context.pyside2.window.Window method), 70
- `init_mgl_context()` (moderngl_window.context.sdl2.window.Window method), 77
- `instance()` (moderngl_window.opengl.vao.VAO method), 118
- `is_closing` (moderngl_window.context.base.window.BaseWindow attribute), 41
- `is_closing` (moderngl_window.context.glfw.window.Window attribute), 47
- `is_closing` (moderngl_window.context.headless.window.Window attribute), 55
- `is_closing` (moderngl_window.context.pyglet.window.Window attribute), 62
- `is_closing` (moderngl_window.context.pyqt5.window.Window attribute), 69
- `is_closing` (moderngl_window.context.pyside2.window.Window attribute), 76
- `is_closing` (moderngl_window.context.sdl2.window.Window attribute), 82
- `is_key_pressed()` (moderngl_window.context.base.window.BaseWindow method), 36
- `is_key_pressed()` (moderngl_window.context.glfw.window.Window method), 42
- `is_key_pressed()` (moderngl_window.context.headless.window.Window method), 50
- `is_key_pressed()` (moderngl_window.context.pyglet.window.Window method), 56
- `is_key_pressed()` (moderngl_window.context.pyqt5.window.Window method), 63
- `is_key_pressed()` (moderngl_window.context.pyside2.window.Window method), 70
- `is_key_pressed()` (moderngl_window.context.sdl2.window.Window method), 77
- `is_paused` (moderngl_window.timers.base.BaseTimer attribute), 125
- `is_paused` (moderngl_window.timers.clock.Timer attribute), 126
- `is_running` (moderngl_window.timers.base.BaseTimer attribute), 125
- `is_running` (moderngl_window.timers.clock.Timer attribute), 126

K

- `key_event()` (moderngl_window.context.base.window.WindowConfig method), 30
- `key_event_func` (moderngl_window.context.base.window.BaseWindow attribute), 41
- `key_event_func` (moderngl_window.context.glfw.window.Window attribute), 47
- `key_event_func` (moderngl_window.context.headless.window.Window attribute), 54
- `key_event_func` (moderngl_window.context.pyglet.window.Window attribute), 61

- [attribute](#)), 62
- [key_event_func \(moderngl_window.context.pyqt5.window.Window attribute\)](#), 68
- [key_event_func \(moderngl_window.context.pyside2.window.Window attribute\)](#), 75
- [key_event_func \(moderngl_window.context.sdl2.window.Window attribute\)](#), 82
- [key_input \(\) \(moderngl_window.scene.KeyboardCamera method\)](#), 129
- [key_pressed_event \(\) \(moderngl_window.context.pyqt5.window.Window method\)](#), 64
- [key_pressed_event \(\) \(moderngl_window.context.pyside2.window.Window method\)](#), 71
- [key_release_event \(\) \(moderngl_window.context.pyqt5.window.Window method\)](#), 64
- [key_release_event \(\) \(moderngl_window.context.pyside2.window.Window method\)](#), 71
- [KeyboardCamera \(in module moderngl_window.scene\)](#), 128
- [keys \(moderngl_window.context.base.window.BaseWindow attribute\)](#), 37
- [keys \(moderngl_window.context.glfw.window.Window attribute\)](#), 43
- [keys \(moderngl_window.context.headless.window.Window attribute\)](#), 50
- [keys \(moderngl_window.context.pyglet.window.Window attribute\)](#), 58
- [keys \(moderngl_window.context.pyqt5.window.Window attribute\)](#), 65
- [keys \(moderngl_window.context.pyside2.window.Window attribute\)](#), 72
- [keys \(moderngl_window.context.sdl2.window.Window attribute\)](#), 78
- [kind \(moderngl_window.loaders.base.BaseLoader attribute\)](#), 88
- [kind \(moderngl_window.loaders.data.binary.Loader attribute\)](#), 99
- [kind \(moderngl_window.loaders.data.json.Loader attribute\)](#), 97
- [kind \(moderngl_window.loaders.data.text.Loader attribute\)](#), 98
- [kind \(moderngl_window.loaders.program.separate.Loader attribute\)](#), 92
- [kind \(moderngl_window.loaders.program.single.Loader attribute\)](#), 90
- [kind \(moderngl_window.loaders.scene.gltf2.Loader attribute\)](#), 95
- [kind \(moderngl_window.loaders.scene.stl.Loader attribute\)](#), 96
- [kind \(moderngl_window.loaders.scene.wavefront.Loader attribute\)](#), 94
- [kind \(moderngl_window.loaders.texture.array.Loader attribute\)](#), 93
- [kind \(moderngl_window.loaders.texture.t2d.Loader attribute\)](#), 89
- [kind \(moderngl_window.meta.base.ResourceDescription attribute\)](#), 101
- [kind \(moderngl_window.meta.data.DataDescription attribute\)](#), 110
- [kind \(moderngl_window.meta.program.ProgramDescription attribute\)](#), 107
- [kind \(moderngl_window.meta.scene.SceneDescription attribute\)](#), 108
- [kind \(moderngl_window.meta.texture.TextureDescription attribute\)](#), 104
- L**
- [label \(moderngl_window.meta.base.ResourceDescription attribute\)](#), 101
- [label \(moderngl_window.meta.data.DataDescription attribute\)](#), 110
- [label \(moderngl_window.meta.program.ProgramDescription attribute\)](#), 106
- [label \(moderngl_window.meta.scene.SceneDescription attribute\)](#), 108
- [label \(moderngl_window.meta.texture.TextureDescription attribute\)](#), 104
- [layers \(moderngl_window.meta.texture.TextureDescription attribute\)](#), 103
- [load \(\) \(moderngl_window.loaders.base.BaseLoader method\)](#), 87
- [load \(\) \(moderngl_window.loaders.data.binary.Loader method\)](#), 99
- [load \(\) \(moderngl_window.loaders.data.json.Loader method\)](#), 97
- [load \(\) \(moderngl_window.loaders.data.text.Loader method\)](#), 98
- [load \(\) \(moderngl_window.loaders.program.separate.Loader method\)](#), 91
- [load \(\) \(moderngl_window.loaders.program.single.Loader method\)](#), 89
- [load \(\) \(moderngl_window.loaders.scene.gltf2.Loader method\)](#), 94
- [load \(\) \(moderngl_window.loaders.scene.stl.Loader method\)](#), 96
- [load \(\) \(moderngl_window.loaders.scene.wavefront.Loader method\)](#), 93
- [load \(\) \(moderngl_window.loaders.texture.array.Loader method\)](#), 92
- [load \(\) \(moderngl_window.loaders.texture.t2d.Loader method\)](#), 88

[load\(\)](#) (*moderngl_window.resources.base.BaseRegistry* method), 34
[load\(\)](#) (*moderngl_window.resources.data.DataFiles* method), 119
[load\(\)](#) (*moderngl_window.resources.data.DataFiles* method), 123
[load\(\)](#) (*moderngl_window.resources.programs.Programs* method), 121
[load\(\)](#) (*moderngl_window.resources.scenes.Scenes* method), 122
[load\(\)](#) (*moderngl_window.resources.textures.Textures* method), 120
[load_binary\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 34
[load_compute_shader\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 33
[load_glb\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[load_gltf\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[load_images\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[load_json\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 33
[load_materials\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[load_meshes\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[load_node\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[load_nodes\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[load_pool\(\)](#) (*moderngl_window.resources.base.BaseRegistry* method), 119
[load_pool\(\)](#) (*moderngl_window.resources.data.DataFiles* method), 123
[load_pool\(\)](#) (*moderngl_window.resources.programs.Programs* method), 121
[load_pool\(\)](#) (*moderngl_window.resources.scenes.Scenes* method), 122
[load_pool\(\)](#) (*moderngl_window.resources.textures.Textures* method), 120
[load_program\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 33
[load_samplers\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[load_scene\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 34
[load_text\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 33
[load_texture_2d\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 31
[load_texture_array\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 32
[load_texture_cube\(\)](#) (*moderngl_window.context.base.window.WindowConfig* method), 32
[load_textures\(\)](#) (*moderngl_window.loaders.scene.gltf2.Loader* method), 95
[loader_cls\(\)](#) (*moderngl_window.meta.base.ResourceDescription* attribute), 102
[loader_cls\(\)](#) (*moderngl_window.meta.data.DataDescription* attribute), 110
[loader_cls\(\)](#) (*moderngl_window.meta.program.ProgramDescription* attribute), 107
[loader_cls\(\)](#) (*moderngl_window.meta.scene.SceneDescription* attribute), 108
[loader_cls\(\)](#) (*moderngl_window.meta.texture.TextureDescription* attribute), 104
[loaders\(\)](#) (*moderngl_window.resources.base.BaseRegistry* attribute), 120
[loaders\(\)](#) (*moderngl_window.resources.data.DataFiles* attribute), 124
[loaders\(\)](#) (*moderngl_window.resources.programs.Programs* attribute), 122
[loaders\(\)](#) (*moderngl_window.resources.scenes.Scenes* attribute), 123
[loaders\(\)](#) (*moderngl_window.resources.textures.Textures* attribute), 121
[log_level\(\)](#) (*moderngl_window.context.base.window.WindowConfig* attribute), 35
[look_at\(\)](#) (*moderngl_window.scene.Camera* method), 128
[look_at\(\)](#) (*moderngl_window.scene.KeyboardCamera* method), 129

M

[mat_texture\(\)](#) (*moderngl_window.scene.Material* attribute), 136
[Material](#) (in module *moderngl_window.scene*), 136
[MaterialTexture](#) (in module *moderngl_window.scene*), 136
[matrix\(\)](#) (*moderngl_window.opengl.projection.Projection3D* attribute), 116
[matrix\(\)](#) (*moderngl_window.scene.Camera* attribute), 128
[matrix\(\)](#) (*moderngl_window.scene.KeyboardCamera* attribute), 131

[matrix \(moderngl_window.scene.Node attribute\), 134](#)
[matrix \(moderngl_window.scene.Scene attribute\), 132](#)
[matrix_global \(moderngl_window.scene.Node attribute\), 134](#)
[Mesh \(in module moderngl_window.scene\), 134](#)
[mesh \(moderngl_window.scene.Node attribute\), 134](#)
[MeshProgram \(in module moderngl_window.scene\), 137](#)
[mipmap \(moderngl_window.meta.texture.TextureDescription attribute\), 103](#)
[mipmap_levels \(moderngl_window.meta.texture.TextureDescription attribute\), 103](#)
[moderngl_window \(module\), 17](#)
[moderngl_window.conf \(module\), 20](#)
[moderngl_window.context.base.window \(module\), 29, 36](#)
[moderngl_window.context.glfw.window \(module\), 42](#)
[moderngl_window.context.headless.window \(module\), 49](#)
[moderngl_window.context.pyglet.window \(module\), 55](#)
[moderngl_window.context.pyqt5.window \(module\), 62](#)
[moderngl_window.context.pyside2.window \(module\), 69](#)
[moderngl_window.context.sdl2.window \(module\), 76](#)
[moderngl_window.finders.base \(module\), 111](#)
[moderngl_window.finders.data \(module\), 112](#)
[moderngl_window.finders.program \(module\), 112](#)
[moderngl_window.finders.scene \(module\), 112](#)
[moderngl_window.finders.texture \(module\), 111](#)
[moderngl_window.geometry \(module\), 83](#)
[moderngl_window.loaders.base \(module\), 87](#)
[moderngl_window.loaders.data.binary \(module\), 98](#)
[moderngl_window.loaders.data.json \(module\), 96](#)
[moderngl_window.loaders.data.text \(module\), 97](#)
[moderngl_window.loaders.program.separate \(module\), 91](#)
[moderngl_window.loaders.program.single \(module\), 89](#)
[moderngl_window.loaders.scene.glTF2 \(module\), 94](#)
[moderngl_window.loaders.scene.stl \(module\), 95](#)
[moderngl_window.loaders.scene.wavefront \(module\), 93](#)
[moderngl_window.loaders.texture.array \(module\), 92](#)
[moderngl_window.loaders.texture.t2d \(module\), 88](#)
[moderngl_window.meta.base \(module\), 101](#)
[moderngl_window.meta.data \(module\), 109](#)
[moderngl_window.meta.program \(module\), 105](#)
[moderngl_window.meta.scene \(module\), 107](#)
[moderngl_window.meta.texture \(module\), 102](#)
[moderngl_window.opengl.projection \(module\), 115](#)
[moderngl_window.opengl.vao \(module\), 116](#)
[moderngl_window.resources \(module\), 118](#)
[moderngl_window.resources.base \(module\), 119](#)
[moderngl_window.resources.data \(module\), 123](#)
[moderngl_window.resources.programs \(module\), 121](#)
[moderngl_window.resources.scenes \(module\), 122](#)
[moderngl_window.resources.textures \(module\), 120](#)
[moderngl_window.scene \(module\), 127, 128, 131, 133, 134, 136, 137](#)
[moderngl_window.screenshot \(module\), 25](#)
[moderngl_window.timers.base \(module\), 125](#)
[moderngl_window.timers.clock \(module\), 126](#)
[modifiers \(moderngl_window.context.base.window.BaseWindow attribute\), 41](#)
[modifiers \(moderngl_window.context.glfw.window.Window attribute\), 47](#)
[modifiers \(moderngl_window.context.headless.window.Window attribute\), 55](#)
[modifiers \(moderngl_window.context.pyglet.window.Window attribute\), 62](#)
[modifiers \(moderngl_window.context.pyqt5.window.Window attribute\), 69](#)
[modifiers \(moderngl_window.context.pyside2.window.Window attribute\), 76](#)
[modifiers \(moderngl_window.context.sdl2.window.Window attribute\), 82](#)
[mouse \(moderngl_window.context.base.window.BaseWindow attribute\), 41](#)
[mouse \(moderngl_window.context.glfw.window.Window attribute\), 47](#)
[mouse \(moderngl_window.context.headless.window.Window attribute\), 55](#)
[mouse \(moderngl_window.context.pyglet.window.Window attribute\), 62](#)
[mouse \(moderngl_window.context.pyqt5.window.Window attribute\), 69](#)
[mouse \(moderngl_window.context.pyside2.window.Window attribute\), 76](#)

attribute), 76	mouse_position_event() (mod- erngl_window.context.base.window.WindowConfig method), 30
mouse (moderngl_window.context.sdl2.window.Window attribute), 82	mouse_position_event_func (mod- erngl_window.context.base.window.BaseWindow attribute), 41
mouse_drag_event() (mod- erngl_window.context.base.window.WindowConfig method), 31	mouse_position_event_func (mod- erngl_window.context.glfw.window.Window attribute), 47
mouse_drag_event_func (mod- erngl_window.context.base.window.BaseWindow attribute), 41	mouse_position_event_func (mod- erngl_window.context.headless.window.Window attribute), 54
mouse_drag_event_func (mod- erngl_window.context.glfw.window.Window attribute), 47	mouse_position_event_func (mod- erngl_window.context.pyglet.window.Window attribute), 62
mouse_drag_event_func (mod- erngl_window.context.headless.window.Window attribute), 54	mouse_position_event_func (mod- erngl_window.context.pyqt5.window.Window attribute), 69
mouse_drag_event_func (mod- erngl_window.context.pyglet.window.Window attribute), 62	mouse_position_event_func (mod- erngl_window.context.pyside2.window.Window attribute), 76
mouse_drag_event_func (mod- erngl_window.context.pyqt5.window.Window attribute), 69	mouse_position_event_func (mod- erngl_window.context.sdl2.window.Window attribute), 82
mouse_drag_event_func (mod- erngl_window.context.pyside2.window.Window attribute), 76	mouse_press_event() (mod- erngl_window.context.base.window.WindowConfig method), 31
mouse_drag_event_func (mod- erngl_window.context.sdl2.window.Window attribute), 82	mouse_press_event() (mod- erngl_window.context.pyqt5.window.Window method), 64
mouse_exclusivity (mod- erngl_window.context.base.window.BaseWindow attribute), 40	mouse_press_event() (mod- erngl_window.context.pyside2.window.Window method), 71
mouse_exclusivity (mod- erngl_window.context.glfw.window.Window attribute), 46	mouse_press_event_func (mod- erngl_window.context.base.window.BaseWindow attribute), 41
mouse_exclusivity (mod- erngl_window.context.headless.window.Window attribute), 53	mouse_press_event_func (mod- erngl_window.context.glfw.window.Window attribute), 47
mouse_exclusivity (mod- erngl_window.context.pyglet.window.Window attribute), 61	mouse_press_event_func (mod- erngl_window.context.headless.window.Window attribute), 54
mouse_exclusivity (mod- erngl_window.context.pyqt5.window.Window attribute), 68	mouse_press_event_func (mod- erngl_window.context.pyglet.window.Window attribute), 62
mouse_exclusivity (mod- erngl_window.context.pyside2.window.Window attribute), 75	mouse_press_event_func (mod- erngl_window.context.pyqt5.window.Window attribute), 69
mouse_exclusivity (mod- erngl_window.context.sdl2.window.Window attribute), 81	mouse_press_event_func (mod- erngl_window.context.pyside2.window.Window attribute), 76
mouse_move_event() (mod- erngl_window.context.pyqt5.window.Window method), 64	mouse_press_event_func (mod- erngl_window.context.sdl2.window.Window attribute), 82
mouse_move_event() (mod- erngl_window.context.pyside2.window.Window method), 71	

<code>mouse_release_event()</code> (moderngl_window.context.base.window.WindowConfig method), 31	<code>mouse_sensitivity</code> (moderngl_window.scene.KeyboardCamera attribute), 131
<code>mouse_release_event()</code> (moderngl_window.context.pyqt5.window.Window method), 64	<code>mouse_states</code> (moderngl_window.context.base.window.BaseWindow attribute), 41
<code>mouse_release_event()</code> (moderngl_window.context.pyside2.window.Window method), 71	<code>mouse_states</code> (moderngl_window.context.glfw.window.Window attribute), 47
<code>mouse_release_event_func</code> (moderngl_window.context.base.window.BaseWindow attribute), 41	<code>mouse_states</code> (moderngl_window.context.headless.window.Window attribute), 55
<code>mouse_release_event_func</code> (moderngl_window.context.glfw.window.Window attribute), 47	<code>mouse_states</code> (moderngl_window.context.pyglet.window.Window attribute), 62
<code>mouse_release_event_func</code> (moderngl_window.context.headless.window.Window attribute), 54	<code>mouse_states</code> (moderngl_window.context.pyqt5.window.Window attribute), 69
<code>mouse_release_event_func</code> (moderngl_window.context.pyglet.window.Window attribute), 62	<code>mouse_states</code> (moderngl_window.context.pyside2.window.Window attribute), 76
<code>mouse_release_event_func</code> (moderngl_window.context.pyqt5.window.Window attribute), 69	<code>mouse_states</code> (moderngl_window.context.sdl2.window.Window attribute), 82
<code>mouse_release_event_func</code> (moderngl_window.context.pyside2.window.Window attribute), 76	<code>mouse_wheel_event()</code> (moderngl_window.context.pyqt5.window.Window method), 64
<code>mouse_release_event_func</code> (moderngl_window.context.sdl2.window.Window attribute), 82	<code>mouse_wheel_event()</code> (moderngl_window.context.pyside2.window.Window method), 71
<code>mouse_scroll_event()</code> (moderngl_window.context.base.window.WindowConfig method), 31	<code>move_backward()</code> (moderngl_window.scene.KeyboardCamera method), 130
<code>mouse_scroll_event_func</code> (moderngl_window.context.base.window.BaseWindow attribute), 41	<code>move_down()</code> (moderngl_window.scene.KeyboardCamera method), 130
<code>mouse_scroll_event_func</code> (moderngl_window.context.glfw.window.Window attribute), 47	<code>move_forward()</code> (moderngl_window.scene.KeyboardCamera method), 130
<code>mouse_scroll_event_func</code> (moderngl_window.context.headless.window.Window attribute), 54	<code>move_left()</code> (moderngl_window.scene.KeyboardCamera method), 130
<code>mouse_scroll_event_func</code> (moderngl_window.context.pyglet.window.Window attribute), 62	<code>move_right()</code> (moderngl_window.scene.KeyboardCamera method), 130
<code>mouse_scroll_event_func</code> (moderngl_window.context.pyqt5.window.Window attribute), 69	<code>move_state()</code> (moderngl_window.scene.KeyboardCamera method), 130
<code>mouse_scroll_event_func</code> (moderngl_window.context.pyside2.window.Window attribute), 76	<code>move_up()</code> (moderngl_window.scene.KeyboardCamera method), 130
<code>mouse_scroll_event_func</code> (moderngl_window.context.sdl2.window.Window attribute), 82	N
	<code>name</code> (moderngl_window.context.base.window.BaseWindow attribute), 37
	<code>name</code> (moderngl_window.context.glfw.window.Window attribute), 43

name (*moderngl_window.context.headless.window.Window* attribute), 50

name (*moderngl_window.context.pyglet.window.Window* attribute), 58

name (*moderngl_window.context.pyqt5.window.Window* attribute), 65

name (*moderngl_window.context.pyside2.window.Window* attribute), 72

name (*moderngl_window.context.sdl2.window.Window* attribute), 78

name (*moderngl_window.scene.Material* attribute), 136

name (*moderngl_window.scene.Node* attribute), 134

near (*moderngl_window.opengl.projection.Projection3D* attribute), 116

neg_x (*moderngl_window.meta.texture.TextureDescription* attribute), 104

neg_y (*moderngl_window.meta.texture.TextureDescription* attribute), 104

neg_z (*moderngl_window.meta.texture.TextureDescription* attribute), 104

next_frame() (*moderngl_window.timers.base.BaseTimer* method), 125

next_frame() (*moderngl_window.timers.clock.Timer* method), 126

Node (in module *moderngl_window.scene*), 133

O

on_close() (*moderngl_window.context.pyglet.window.Window* method), 58

on_hide() (*moderngl_window.context.pyglet.window.Window* method), 58

on_key_press() (*moderngl_window.context.pyglet.window.Window* method), 57

on_key_release() (*moderngl_window.context.pyglet.window.Window* method), 57

on_mouse_drag() (*moderngl_window.context.pyglet.window.Window* method), 57

on_mouse_motion() (*moderngl_window.context.pyglet.window.Window* method), 57

on_mouse_press() (*moderngl_window.context.pyglet.window.Window* method), 56

on_mouse_release() (*moderngl_window.context.pyglet.window.Window* method), 57

on_mouse_scroll() (*moderngl_window.context.pyglet.window.Window* method), 57

on_resize() (*moderngl_window.context.pyglet.window.Window* method), 58

on_show() (*moderngl_window.context.pyglet.window.Window* method), 58

on_text() (*moderngl_window.context.pyglet.window.Window* method), 57

P

parse_args() (in module *moderngl_window*), 20

path (*moderngl_window.meta.base.ResourceDescription* attribute), 101

path (*moderngl_window.meta.data.DataDescription* attribute), 109

path (*moderngl_window.meta.program.ProgramDescription* attribute), 106

path (*moderngl_window.meta.scene.SceneDescription* attribute), 108

path (*moderngl_window.meta.texture.TextureDescription* attribute), 104

pause() (*moderngl_window.timers.base.BaseTimer* method), 125

pause() (*moderngl_window.timers.clock.Timer* method), 126

pitch (*moderngl_window.scene.Camera* attribute), 128

pitch (*moderngl_window.scene.KeyboardCamera* attribute), 130

pixel_ratio (*moderngl_window.context.base.window.BaseWindow* attribute), 39

pixel_ratio (*moderngl_window.context.glfw.window.Window* attribute), 45

pixel_ratio (*moderngl_window.context.headless.window.Window* attribute), 52

pixel_ratio (*moderngl_window.context.pyglet.window.Window* attribute), 59

pixel_ratio (*moderngl_window.context.pyqt5.window.Window* attribute), 66

pixel_ratio (*moderngl_window.context.pyside2.window.Window* attribute), 73

pixel_ratio (*moderngl_window.context.sdl2.window.Window* attribute), 80

pos_x (*moderngl_window.meta.texture.TextureDescription* attribute), 103

pos_y (*moderngl_window.meta.texture.TextureDescription* attribute), 103

pos_z (*moderngl_window.meta.texture.TextureDescription* attribute), 103

position (*moderngl_window.context.base.window.BaseWindow* attribute), 38

position (*moderngl_window.context.glfw.window.Window* attribute), 44

position (*moderngl_window.context.headless.window.Window* attribute), 51

position (*moderngl_window.context.pyglet.window.Window* attribute), 59

- `position(moderngl_window.context.pyqt5.window.Window attribute)`, 66
 - `position(moderngl_window.context.pyside2.window.Window attribute)`, 73
 - `position(moderngl_window.context.sdl2.window.Window attribute)`, 79
 - `prepare()` (*moderngl_window.scene.Scene* method), 132
 - `print_context_info()` (*moderngl_window.context.base.window.BaseWindow* method), 37
 - `print_context_info()` (*moderngl_window.context.glfw.window.Window* method), 43
 - `print_context_info()` (*moderngl_window.context.headless.window.Window* method), 50
 - `print_context_info()` (*moderngl_window.context.pyglet.window.Window* method), 56
 - `print_context_info()` (*moderngl_window.context.pyqt5.window.Window* method), 64
 - `print_context_info()` (*moderngl_window.context.pyside2.window.Window* method), 71
 - `print_context_info()` (*moderngl_window.context.sdl2.window.Window* method), 78
 - `process_events()` (*moderngl_window.context.sdl2.window.Window* method), 78
 - `PROGRAM_DIRS` (*moderngl_window.conf.Settings* attribute), 24
 - `PROGRAM_FINDERS` (*moderngl_window.conf.Settings* attribute), 23
 - `PROGRAM_LOADERS` (*moderngl_window.conf.Settings* attribute), 24
 - `ProgramDescription` (in module *moderngl_window.meta.program*), 105
 - `Programs` (in module *moderngl_window.resources.programs*), 121
 - `projection(moderngl_window.scene.Camera attribute)`, 128
 - `projection(moderngl_window.scene.KeyboardCamera attribute)`, 131
 - `Projection3D` (in module *moderngl_window.opengl.projection*), 115
 - `projection_constants` (*moderngl_window.opengl.projection.Projection3D* attribute), 116
 - `quad_2d()` (in module *moderngl_window.geometry*), 85
 - `quad_fs()` (in module *moderngl_window.geometry*), 85
- ## R
- `register_data_dir()` (in module *moderngl_window.resources*), 119
 - `register_dir()` (in module *moderngl_window.resources*), 119
 - `register_program_dir()` (in module *moderngl_window.resources*), 119
 - `register_scene_dir()` (in module *moderngl_window.resources*), 119
 - `register_texture_dir()` (in module *moderngl_window.resources*), 119
 - `release()` (*moderngl_window.opengl.vao.VAO* method), 118
 - `release()` (*moderngl_window.scene.Material* method), 136
 - `release()` (*moderngl_window.scene.Scene* method), 132
 - `reloadable(moderngl_window.meta.program.ProgramDescription attribute)`, 106
 - `render()` (*moderngl_window.context.base.window.BaseWindow* method), 37
 - `render()` (*moderngl_window.context.base.window.WindowConfig* method), 30
 - `render()` (*moderngl_window.context.glfw.window.Window* method), 43
 - `render()` (*moderngl_window.context.headless.window.Window* method), 50
 - `render()` (*moderngl_window.context.pyglet.window.Window* method), 56
 - `render()` (*moderngl_window.context.pyqt5.window.Window* method), 63
 - `render()` (*moderngl_window.context.pyside2.window.Window* method), 70
 - `render()` (*moderngl_window.context.sdl2.window.Window* method), 77
 - `render()` (*moderngl_window.opengl.vao.VAO* method), 117
 - `render_func(moderngl_window.context.base.window.BaseWindow attribute)`, 40
 - `render_func(moderngl_window.context.glfw.window.Window attribute)`, 46
 - `render_func(moderngl_window.context.headless.window.Window attribute)`, 54
 - `render_func(moderngl_window.context.pyglet.window.Window attribute)`, 61
 - `render_func(moderngl_window.context.pyqt5.window.Window attribute)`, 68
 - `render_func(moderngl_window.context.pyside2.window.Window attribute)`, 75
- ## Q
- `quad_2d()` (in module *moderngl_window.geometry*), 85

[render_func\(moderngl_window.context.sdl2.window.Window attribute\), 81](#)
[render_indirect\(moderngl_window.opengl.vao.VAO method\), 117](#)
[resizable\(moderngl_window.context.base.window.BaseWindow attribute\), 39](#)
[resizable\(moderngl_window.context.base.window.WindowConfig attribute\), 34](#)
[resizable\(moderngl_window.context.glfw.window.Window attribute\), 45](#)
[resizable\(moderngl_window.context.headless.window.Window attribute\), 52](#)
[resizable\(moderngl_window.context.pyglet.window.Window attribute\), 60](#)
[resizable\(moderngl_window.context.pyqt5.window.Window attribute\), 67](#)
[resizable\(moderngl_window.context.pyside2.window.Window attribute\), 74](#)
[resizable\(moderngl_window.context.sdl2.window.Window attribute\), 80](#)
[resize\(moderngl_window.context.base.window.BaseWindow method\), 37](#)
[resize\(moderngl_window.context.base.window.WindowConfig method\), 30](#)
[resize\(moderngl_window.context.glfw.window.Window method\), 43](#)
[resize\(moderngl_window.context.headless.window.Window method\), 50](#)
[resize\(moderngl_window.context.pyglet.window.Window method\), 56](#)
[resize\(moderngl_window.context.pyqt5.window.Window method\), 64](#)
[resize\(moderngl_window.context.pyside2.window.Window method\), 71](#)
[resize\(moderngl_window.context.sdl2.window.Window method\), 78](#)
[resize_func\(moderngl_window.context.base.window.BaseWindow attribute\), 40](#)
[resize_func\(moderngl_window.context.glfw.window.Window attribute\), 46](#)
[resize_func\(moderngl_window.context.headless.window.Window attribute\), 54](#)
[resize_func\(moderngl_window.context.pyglet.window.Window attribute\), 61](#)
[resize_func\(moderngl_window.context.pyqt5.window.Window attribute\), 68](#)
[resize_func\(moderngl_window.context.pyside2.window.Window attribute\), 75](#)
[resize_func\(moderngl_window.context.sdl2.window.Window attribute\), 81](#)
[resolve_loader\(moderngl_window.resources.base.BaseRegistry method\), 120](#)
[resolve_loader\(moderngl_window.resources.data.DataFiles method\), 123](#)
[resolve_loader\(moderngl_window.resources.programs.Programs method\), 117](#)
[resolve_loader\(moderngl_window.resources.scenes.Scenes method\), 122](#)
[resolve_loader\(moderngl_window.resources.textures.Textures method\), 121](#)
[resolved_path\(moderngl_window.meta.base.ResourceDescription attribute\), 101](#)
[resolved_path\(moderngl_window.meta.data.DataDescription attribute\), 109](#)
[resolved_path\(moderngl_window.meta.program.ProgramDescription attribute\), 106](#)
[resolved_path\(moderngl_window.meta.scene.SceneDescription attribute\), 108](#)
[resolved_path\(moderngl_window.meta.texture.TextureDescription attribute\), 104](#)
[resource_dir\(moderngl_window.context.base.window.WindowConfig attribute\), 35](#)
[resource_type\(moderngl_window.meta.base.ResourceDescription attribute\), 102](#)
[resource_type\(moderngl_window.meta.data.DataDescription attribute\), 110](#)
[resource_type\(moderngl_window.meta.program.ProgramDescription attribute\), 107](#)
[resource_type\(moderngl_window.meta.scene.SceneDescription attribute\), 109](#)
[resource_type\(moderngl_window.meta.texture.TextureDescription attribute\), 105](#)
[ResourceDescription \(in module moderngl_window.meta.base\), 101](#)
[update\(moderngl_window.scene.KeyboardCamera method\), 130](#)
[update\(moderngl_window.context.base.window.WindowConfig class method\), 30](#)
[run_window_config\(moderngl_window\), 20](#)

S

- sampler (*moderngl_window.scene.MaterialTexture attribute*), 137
- samples (*moderngl_window.context.base.window.BaseWindow attribute*), 40
- samples (*moderngl_window.context.base.window.Window attribute*), 35
- samples (*moderngl_window.context.glfw.window.Window attribute*), 46
- samples (*moderngl_window.context.headless.window.Window attribute*), 53
- samples (*moderngl_window.context.pyglet.window.Window attribute*), 61
- samples (*moderngl_window.context.pyqt5.window.Window attribute*), 68
- samples (*moderngl_window.context.pyside2.window.Window attribute*), 75
- samples (*moderngl_window.context.sdl2.window.Window attribute*), 81
- SCENE_DIRS (*moderngl_window.conf.Settings attribute*), 24
- SCENE_FINDERS (*moderngl_window.conf.Settings attribute*), 24
- SCENE_LOADERS (*moderngl_window.conf.Settings attribute*), 24
- SceneDescription (in module *moderngl_window.meta.scene*), 107
- Scenes (in module *moderngl_window.resources.scenes*), 122
- SCREENSHOT_PATH (*moderngl_window.conf.Settings attribute*), 23
- set_default_viewport () (mod-*erngl_window.context.base.window.BaseWindow method*), 37
- set_default_viewport () (mod-*erngl_window.context.glfw.window.Window method*), 43
- set_default_viewport () (mod-*erngl_window.context.headless.window.Window method*), 50
- set_default_viewport () (mod-*erngl_window.context.pyglet.window.Window method*), 56
- set_default_viewport () (mod-*erngl_window.context.pyqt5.window.Window method*), 64
- set_default_viewport () (mod-*erngl_window.context.pyside2.window.Window method*), 71
- set_default_viewport () (mod-*erngl_window.context.sdl2.window.Window method*), 78
- set_position () (mod-*erngl_window.scene.Camera method*), 127
- set_position () (mod-*erngl_window.scene.KeyboardCamera method*), 129
- set_rotation () (mod-*erngl_window.scene.Camera method*), 127
- set_rotation () (mod-*erngl_window.scene.KeyboardCamera method*), 129
- Settings (in module *moderngl_window.conf*), 21
- settings_attr (mod-*erngl_window.finders.base.BaseFilesystemFinder attribute*), 111
- settings_attr (mod-*erngl_window.finders.data.FilesystemFinder attribute*), 113
- settings_attr (mod-*erngl_window.finders.program.FilesystemFinder attribute*), 112
- settings_attr (mod-*erngl_window.finders.scene.FilesystemFinder attribute*), 112
- settings_attr (mod-*erngl_window.finders.texture.FilesystemFinder attribute*), 112
- settings_attr (mod-*erngl_window.resources.base.BaseRegistry attribute*), 120
- settings_attr (mod-*erngl_window.resources.data.DataFiles attribute*), 123
- settings_attr (mod-*erngl_window.resources.programs.Programs attribute*), 122
- settings_attr (mod-*erngl_window.resources.scenes.Scenes attribute*), 123
- settings_attr (mod-*erngl_window.resources.textures.Textures attribute*), 121
- setup_basic_logging () (in module *moderngl_window*), 19
- show_event () (mod-*erngl_window.context.pyqt5.window.Window method*), 65
- show_event () (mod-*erngl_window.context.pyside2.window.Window method*), 72
- size (*moderngl_window.context.base.window.BaseWindow attribute*), 38
- size (*moderngl_window.context.glfw.window.Window attribute*), 44
- size (*moderngl_window.context.headless.window.Window attribute*), 51
- size (*moderngl_window.context.pyglet.window.Window attribute*), 51

- attribute*), 59
 - `size` (*moderngl_window.context.pyqt5.window.Window attribute*), 66
 - `size` (*moderngl_window.context.pyside2.window.Window attribute*), 73
 - `size` (*moderngl_window.context.sdl2.window.Window attribute*), 79
 - `sphere()` (in module *moderngl_window.geometry*), 86
 - `start()` (*moderngl_window.timers.base.BaseTimer method*), 125
 - `start()` (*moderngl_window.timers.clock.Timer method*), 126
 - `stop()` (*moderngl_window.timers.base.BaseTimer method*), 125
 - `stop()` (*moderngl_window.timers.clock.Timer method*), 126
 - `supported_extensions` (*moderngl_window.loaders.scene.glTF2.Loader attribute*), 95
 - `supports_file()` (*moderngl_window.loaders.base.BaseLoader class method*), 87
 - `supports_file()` (*moderngl_window.loaders.data.binary.Loader class method*), 99
 - `supports_file()` (*moderngl_window.loaders.data.json.Loader class method*), 97
 - `supports_file()` (*moderngl_window.loaders.data.text.Loader class method*), 98
 - `supports_file()` (*moderngl_window.loaders.program.separate.Loader class method*), 91
 - `supports_file()` (*moderngl_window.loaders.program.single.Loader class method*), 89
 - `supports_file()` (*moderngl_window.loaders.scene.glTF2.Loader class method*), 94
 - `supports_file()` (*moderngl_window.loaders.scene.stl.Loader class method*), 96
 - `supports_file()` (*moderngl_window.loaders.scene.wavefront.Loader class method*), 93
 - `supports_file()` (*moderngl_window.loaders.texture.array.Loader class method*), 92
 - `supports_file()` (*moderngl_window.loaders.texture.t2d.Loader class method*), 88
 - `swap_buffers()` (*moderngl_window.context.base.window.BaseWindow method*), 37
 - `swap_buffers()` (*moderngl_window.context.glfw.window.Window method*), 43
 - `swap_buffers()` (*moderngl_window.context.headless.window.Window method*), 50
 - `swap_buffers()` (*moderngl_window.context.pyglet.window.Window method*), 56
 - `swap_buffers()` (*moderngl_window.context.pyqt5.window.Window method*), 64
 - `swap_buffers()` (*moderngl_window.context.pyside2.window.Window method*), 71
 - `swap_buffers()` (*moderngl_window.context.sdl2.window.Window method*), 78
- ## T
- `tess_control_shader` (*moderngl_window.meta.program.ProgramDescription attribute*), 106
 - `tess_evaluation_shader` (*moderngl_window.meta.program.ProgramDescription attribute*), 106
 - `texture` (*moderngl_window.scene.MaterialTexture attribute*), 137
 - `TEXTURE_DIRS` (*moderngl_window.conf.Settings attribute*), 24
 - `TEXTURE_FINDERS` (*moderngl_window.conf.Settings attribute*), 24
 - `TEXTURE_LOADERS` (*moderngl_window.conf.Settings attribute*), 24
 - `TextureDescription` (in module *moderngl_window.meta.texture*), 102
 - `Textures` (in module *moderngl_window.resources.textures*), 120
 - `time` (*moderngl_window.timers.base.BaseTimer attribute*), 126
 - `time` (*moderngl_window.timers.clock.Timer attribute*), 126
 - `Timer` (in module *moderngl_window.timers.clock*), 126
 - `title` (*moderngl_window.context.base.window.BaseWindow attribute*), 37
 - `title` (*moderngl_window.context.base.window.WindowConfig attribute*), 35
 - `title` (*moderngl_window.context.glfw.window.Window attribute*), 43
 - `title` (*moderngl_window.context.headless.window.Window attribute*), 51
 - `title` (*moderngl_window.context.pyglet.window.Window attribute*), 58

[title \(moderngl_window.context.pyqt5.window.Window attribute\), 65](#)
[title \(moderngl_window.context.pyside2.window.Window attribute\), 72](#)
[title \(moderngl_window.context.sdl2.window.Window attribute\), 78](#)
[to_dict\(\) \(moderngl_window.conf.Settings method\), 22](#)
[tobytes\(\) \(moderngl_window.opengl.projection.Projection3D method\), 115](#)
[toggle_pause\(\) \(moderngl_window.timers.base.BaseTimer method\), 125](#)
[toggle_pause\(\) \(moderngl_window.timers.clock.Timer method\), 126](#)
[transform\(\) \(moderngl_window.opengl.vao.VAO method\), 117](#)

U

[unicode_char_entered\(\) \(moderngl_window.context.base.window.WindowConfig method\), 31](#)
[unicode_char_entered_func \(moderngl_window.context.base.window.BaseWindow attribute\), 41](#)
[unicode_char_entered_func \(moderngl_window.context.glfw.window.Window attribute\), 47](#)
[unicode_char_entered_func \(moderngl_window.context.headless.window.Window attribute\), 54](#)
[unicode_char_entered_func \(moderngl_window.context.pyglet.window.Window attribute\), 62](#)
[unicode_char_entered_func \(moderngl_window.context.pyqt5.window.Window attribute\), 69](#)
[unicode_char_entered_func \(moderngl_window.context.pyside2.window.Window attribute\), 76](#)
[unicode_char_entered_func \(moderngl_window.context.sdl2.window.Window attribute\), 82](#)
[update\(\) \(moderngl_window.opengl.projection.Projection3D method\), 115](#)
[use\(\) \(moderngl_window.context.base.window.BaseWindow method\), 36](#)
[use\(\) \(moderngl_window.context.glfw.window.Window method\), 42](#)
[use\(\) \(moderngl_window.context.headless.window.Window method\), 50](#)
[use\(\) \(moderngl_window.context.pyglet.window.Window method\), 56](#)

V

[vao \(in module moderngl_window.opengl.vao\), 116](#)
[velocity \(moderngl_window.scene.KeyboardCamera attribute\), 131](#)
[vertex_shader \(moderngl_window.meta.program.ProgramDescription attribute\), 106](#)
[viewport \(moderngl_window.context.base.window.BaseWindow attribute\), 39](#)
[viewport \(moderngl_window.context.glfw.window.Window attribute\), 45](#)
[viewport \(moderngl_window.context.headless.window.Window attribute\), 52](#)
[viewport \(moderngl_window.context.pyglet.window.Window attribute\), 60](#)
[viewport \(moderngl_window.context.pyqt5.window.Window attribute\), 66](#)
[viewport \(moderngl_window.context.pyside2.window.Window attribute\), 73](#)
[viewport \(moderngl_window.context.sdl2.window.Window attribute\), 80](#)
[viewport_height \(moderngl_window.context.base.window.BaseWindow attribute\), 39](#)
[viewport_height \(moderngl_window.context.glfw.window.Window attribute\), 45](#)
[viewport_height \(moderngl_window.context.headless.window.Window attribute\), 52](#)
[viewport_height \(moderngl_window.context.pyglet.window.Window attribute\), 60](#)
[viewport_height \(moderngl_window.context.pyqt5.window.Window attribute\), 67](#)
[viewport_height \(moderngl_window.context.pyside2.window.Window attribute\), 74](#)
[viewport_height \(moderngl_window.context.sdl2.window.Window attribute\), 80](#)
[viewport_size \(moderngl_window.context.base.window.BaseWindow attribute\), 39](#)
[viewport_size \(moderngl_window.context.glfw.window.Window attribute\), 45](#)

[attribute](#)), 45
[viewport_size](#) ([moderngl_window.context.headless.window.Window](#) [attribute](#)), 52
[viewport_size](#) ([moderngl_window.context.pyglet.window.Window](#) [attribute](#)), 60
[viewport_size](#) ([moderngl_window.context.pyqt5.window.Window](#) [attribute](#)), 67
[viewport_size](#) ([moderngl_window.context.pyside2.window.Window](#) [attribute](#)), 74
[viewport_size](#) ([moderngl_window.context.sdl2.window.Window](#) [attribute](#)), 80
[viewport_width](#) ([moderngl_window.context.base.window.BaseWindow](#) [attribute](#)), 39
[viewport_width](#) ([moderngl_window.context.glfw.window.Window](#) [attribute](#)), 45
[viewport_width](#) ([moderngl_window.context.headless.window.Window](#) [attribute](#)), 52
[viewport_width](#) ([moderngl_window.context.pyglet.window.Window](#) [attribute](#)), 60
[viewport_width](#) ([moderngl_window.context.pyqt5.window.Window](#) [attribute](#)), 67
[viewport_width](#) ([moderngl_window.context.pyside2.window.Window](#) [attribute](#)), 74
[viewport_width](#) ([moderngl_window.context.sdl2.window.Window](#) [attribute](#)), 80
[vsync](#) ([moderngl_window.context.base.window.BaseWindow](#) [attribute](#)), 39
[vsync](#) ([moderngl_window.context.base.window.WindowConfig](#) [attribute](#)), 34
[vsync](#) ([moderngl_window.context.glfw.window.Window](#) [attribute](#)), 45
[vsync](#) ([moderngl_window.context.headless.window.Window](#) [attribute](#)), 53
[vsync](#) ([moderngl_window.context.pyglet.window.Window](#) [attribute](#)), 60
[vsync](#) ([moderngl_window.context.pyqt5.window.Window](#) [attribute](#)), 67
[vsync](#) ([moderngl_window.context.pyside2.window.Window](#) [attribute](#)), 74
[vsync](#) ([moderngl_window.context.sdl2.window.Window](#) [attribute](#)), 80

W

[width](#) ([moderngl_window.context.base.window.BaseWindow](#) [attribute](#)), 38
[width](#) ([moderngl_window.context.glfw.window.Window](#) [attribute](#)), 44
[width](#) ([moderngl_window.context.headless.window.Window](#) [attribute](#)), 51
[width](#) ([moderngl_window.context.pyglet.window.Window](#) [attribute](#)), 59
[width](#) ([moderngl_window.context.pyqt5.window.Window](#) [attribute](#)), 66
[width](#) ([moderngl_window.context.pyside2.window.Window](#) [attribute](#)), 73
[width](#) ([moderngl_window.context.sdl2.window.Window](#) [attribute](#)), 79
[WINDOW](#) ([moderngl_window.conf.Settings](#) [attribute](#)), 23
[window\(\)](#) (in module [moderngl_window](#)), 19
[window_size](#) ([moderngl_window.context.base.window.WindowConfig](#) [attribute](#)), 34
[WindowConfig](#) (in module [moderngl_window.context.base.window](#)), 29

Y

[yaw](#) ([moderngl_window.scene.Camera](#) [attribute](#)), 128
[yaw](#) ([moderngl_window.scene.KeyboardCamera](#) [attribute](#)), 130