Images and Sprites

pyglet provides functions for loading and saving images in various formats using native operating system services. If the Pillow library is installed, many additional formats can be supported. pyglet also includes built-in codecs for loading PNG and BMP without external dependencies.

In addition to loading, pyglet also supports the following operations for both OpenGL textures and framebuffers:

- converting to pyglet image objects
- saving to disk as screenshots
- manipulation as image data
- converting to `bytes` of raw pixel data

For most users, the `Sprite` class is the best way to draw an image. One or more instances may draw the same image data with individually configured values for position, scaling, rotation, and more.

Loading an image

Images can be loaded using the `pyglet.image.load()` function:

```
kitten = pyglet.image.load('kitten.png')
```

If you are distributing your application with included images, consider using the `pyglet.resource` module (see Application resources).

Without any additional arguments, `pyglet.image.load()` will attempt to load the filename specified using any available image decoder. This will allow you to load PNG, GIF, JPEG, BMP and DDS files, and possibly other files as well, depending on your operating system and additional installed modules (see the next section for details). If the image cannot be loaded, an `ImageDecodeException` will be raised.

;

You can load an image from any file-like object providing a *read* method by specifying the *file* keyword parameter:

```
kitten_stream = open('kitten.png', 'rb')
kitten = pyglet.image.load('kitten.png', file=kitten_stream)
```

In this case the filename `kitten.png` is optional, but gives a hint to the decoder as to the file type (it is otherwise unused when a file object is provided).

Displaying images

Image drawing is usually done in the window's `on_draw()` event handler. It is possible to draw individual images directly, but usually you will want to create a "sprite" for each appearance of the image on-screen.

Sprites

A Sprite is a full featured class for displaying instances of Images or Animations in the window. Image and Animation instances are mainly concerned with the image data (size, pixels, etc.), wheras Sprites also include additional properties. These include x/y location, scale, rotation, opacity, color tint, visibility, and both horizontal and vertical scaling. Multiple sprites can share the same image; for example, hundreds of bullet sprites might share the same bullet image.

A Sprite is constructed given an image or animation, and can be directly drawn with the `draw()` method:

```
sprite = pyglet.sprite.Sprite(img=image, x=100, y=50)

@window.event
def on_draw():
    window.clear()
    sprite.draw()
```

If created with an animation, sprites automatically handle displaying the most up-to-date frame of the animation. The following example uses a scheduled function to gradually move the Sprite across the screen:

```
def update(dt):
    # Move 10 pixels per second
    sprite.x += dt * 10

# Call update 60 times a second
pyglet.clock.schedule_interval(update, 1/60.)
```

If you need to draw many sprites, using a `Batch` to draw them all at once is strongly recommended. This is far more efficient than calling `draw()` on each of them in a loop:

```
batch = pyglet.graphics.Batch()

sprites = [pyglet.sprite.Sprite(image, batch=batch),
           pyglet.sprite.Sprite(image, batch=batch),
           # ...  ]

@window.event
def on_draw():
    window.clear()
    batch.draw()
```

When sprites are collected into a batch, no guarantee is made about the order in which they will be drawn. If you need to ensure some sprites are drawn before others (for example, landscape tiles might be drawn before character sprites, which might be drawn before some particle effect sprites), use two or more `Group` objects to specify the draw order:

```
batch = pyglet.graphics.Batch()
background = pyglet.graphics.Group(order=0)
foreground = pyglet.graphics.Group(order=1)

sprites = [pyglet.sprite.Sprite(image, batch=batch, group=background),
           pyglet.sprite.Sprite(image, batch=batch, group=background),
           pyglet.sprite.Sprite(image, batch=batch, group=foreground),
           pyglet.sprite.Sprite(image, batch=batch, group=foreground),
           # ...]

@window.event
def on_draw():
    window.clear()
    batch.draw()
```

For best performance, you should use as few batches and groups as required. (See the Shaders and Rendering section for more details on batch and group rendering). This will r number of internal and OpenGL operations for drawing each frame.

In addition, try to combine your images into as few textures as possible; for example, by loading images with `pyglet.resource.image()` (see Application resources) or with Texture bins and atlases). A common pitfall is to use the `pyglet.image.load()` method to load a large number of images. This will cause a seperate texture to be created for each image loaded, resulting in a lot of OpenGL texture binding overhead for each frame.

Simple image blitting

Drawing images directly is less efficient, but may be adequate for simple cases. Images can be drawn into a window with the `blit()` method:

```
@window.event
def on_draw():
    window.clear()
    image.blit(x, y)
```

The *x* and *y* coordinates locate where to draw the anchor point of the image. For example, to center the image at `(x, y)`:

```
kitten.anchor_x = kitten.width // 2
kitten.anchor_y = kitten.height // 2
kitten.blit(x, y)
```

You can also specify an optional *z* component to the `blit()` method. This has no effect unless you have enabled depth testing. In the following example, the second image is drawn *behind* the first, even though it is drawn after it:

```
from pyglet.gl import *
glEnable(GL_DEPTH_TEST)

kitten.blit(x, y, 0)
kitten.blit(x, y, -0.5)
```

The default pyglet projection has a depth range of (-8192, 8192) – images drawn with a z value outside this range will not be visible, regardless of whether depth testing is enabled or not. (You can create your own Window projection matrix if you have specific needs).

Images with an alpha channel can be blended with the existing framebuffer. To d to supply OpenGL with a blend equation. The following code fragment implemer common form of alpha blending, however other techniques are also possible:

```
from pyglet.gl import *
glEnable(GL_BLEND)
glBlendFunc(GL_SRC_ALPHA, GL_ONE_MINUS_SRC_ALPHA)
```

You would only need to call the code above once during your program, before you draw any images (this is not necessary when using only sprites).

Supported image decoders

The following table shows which codecs are available in pyglet.

Module	Class	Description
`pyglet.image.codecs.dds`	`DDSImageDecoder`	Reads Microsoft DirectDraw Surf
`pyglet.image.codecs.wic`	`WICDecoder`	Uses Windows Imaging Compon
`pyglet.image.codecs.gdiplus`	`GDIPlusDecoder`	Uses Windows GDI+ services to
`pyglet.image.codecs.gdkpixbuf2`	`GdkPixbuf2ImageDecoder`	Uses the GTK-2.0 GDK function
`pyglet.image.codecs.pil`	`PILImageDecoder`	Wrapper interface around PIL Im
`pyglet.image.codecs.quicktime`	`QuickTimeImageDecoder`	Uses Mac OS X QuickTime to de
`pyglet.image.codecs.png`	`PNGImageDecoder`	PNG decoder written in pure Pyt
`pyglet.image.codecs.bmp`	`BMPImageDecoder`	BMP decoder written in pure Pyt

Each of these classes registers itself with `pyglet.image` with the filename extensions it supports. The `load()` function will try each image decoder with a matching file extension first, before attempting the other decoders. Only if every image decoder fails to load an image will `ImageDecodeException` be raised (the origin of the exception will be the first decoder that was attempted).

You can override this behaviour and specify a particular decoding instance to use. For example, in the following example the pure Python PNG decoder is always used rather than the operating system's decoder:

```
from pyglet.image.codecs.png import PNGImageDecoder
kitten = pyglet.image.load('kitten.png', decoder=PNGImageDecoder())
```


This use is not recommended unless your application has to work around specific deficiencies in an operating system decoder.

Supported image formats

The following table lists the image formats that can be loaded on each operating system. If Pillow is installed, any additional formats it supports can also be read. See the Pillow docs for a list of such formats.

Extension	Description	Windows	Mac OS X	Linux [5]
`.bmp`	Windows Bitmap	X	X	X
`.dds`	Microsoft DirectDraw Surface [6]	X	X	X
`.exif`	Exif	X		
`.gif`	Graphics Interchange Format	X	X	X
`.jpg` `.jpeg`	JPEG/JIFF Image	X	X	X
`.jp2` `.jpx`	JPEG 2000		X	
`.pcx`	PC Paintbrush Bitmap Graphic		X	
`.png`	Portable Network Graphic	X	X	X
`.pnm`	PBM Portable Any Map Graphic Bitmap			X
`.ras`	Sun raster graphic			X
`.tga`	Truevision Targa Graphic		X	
`.tif` `.tiff`	Tagged Image File Format	X	X	X
`.xbm`	X11 bitmap		X	X
`.xpm`	X11 icon		X	X

The only supported save format is PNG, unless PIL is installed, in which case any format it supports can be written.

[5] Requires GTK 2.0 or later.

[6] Only S3TC compressed surfaces are supported. Depth, volume and cube textures are not supported.

Working with images

The `pyglet.image.load()` function returns an `AbstractImage`. The actual class of the object depends on the decoder that was used, but all loaded imageswill have the following attributes:

width

The width of the image, in pixels.

height

The height of the image, in pixels.

anchor_x

Distance of the anchor point from the left edge of the image, in pixels

anchor_y

Distance of the anchor point from the bottom edge of the image, in pixels

The anchor point defaults to (0, 0), though some image formats may contain an intrinsic anchor point. The anchor point is used to align the image to a point in space when drawing it.

You may only want to use a portion of the complete image. You can use the `get_region()` method to return an image of a rectangular region of a source image:

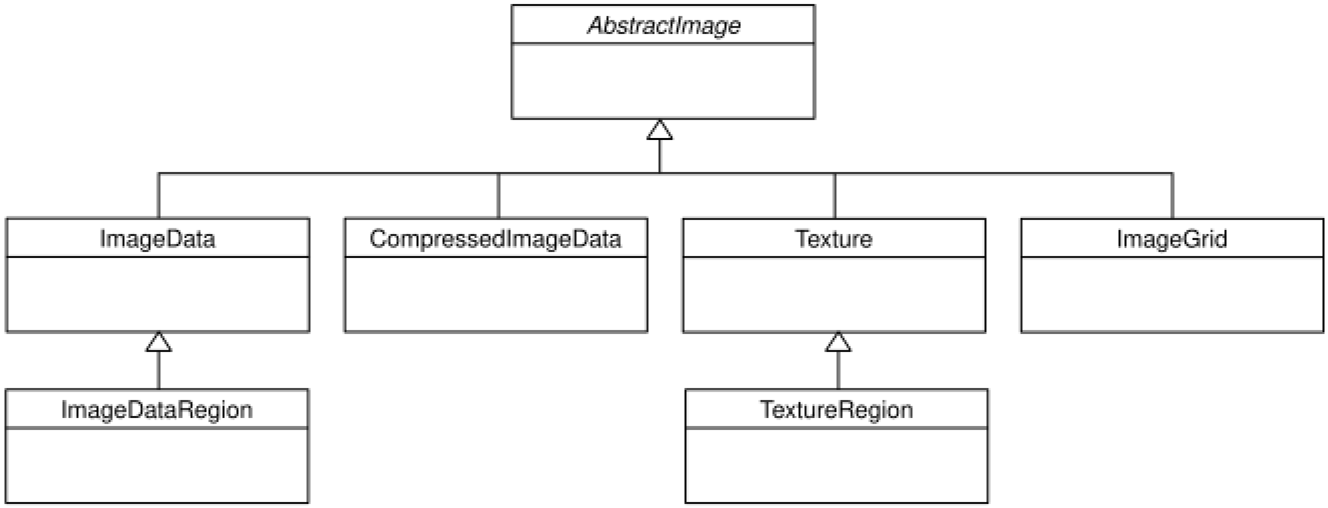
```
image_part = kitten.get_region(x=10, y=10, width=100, height=100)
```

This returns an image with dimensions 100x100. The region extracted from *kitten* is aligned such that the bottom-left corner of the rectangle is 10 pixels from the left and 10 pixels from the bottom of the image.

Image regions can be used as if they were complete images. Note that changes to an image region may or may not be reflected on the source image, and changes to the source image may or may not be reflected on any region images. You should not assume either behaviour.

The AbstractImage hierarchy

The following sections deal with the various concrete image classes. All images subclass `AbstractImage`, which provides the basic interface described in previous section



The `AbstractImage` class hierarchy.

An image of any class can be converted into a `Texture` or `ImageData` using the `get_texture()` and `get_image_data()` methods defined on `AbstractImage`. For example, to load an image and work with it as an OpenGL texture:

```
kitten = pyglet.image.load('kitten.png').get_texture()
```

There is no penalty for accessing one of these methods if object is already of the requested class. The following table shows how concrete classes are converted into other classes:

Original class	`.get_texture()`	`.get_image_data()`
`Texture`	No change	`glGetTexImage2D`
`TextureRegion`	No change	`glGetTexImage2D`, crop resulting image.
`ImageData`	`glTexImage2D` [1]	No change
`ImageDataRegion`	`glTexImage2D` [1]	No change
`CompressedImageData`	`glCompressedTexImage2D` [2]	N/A [3]
`BufferImage`	`glCopyTexSubImage2D` [4]	`glReadPixels`

You should try to avoid conversions which use `glGetTexImage2D` or `glReadPixels`, as these can impose a substantial performance penalty by transferring data in the “wrong” direction of the video bus, especially on older hardware.

[1] (*1*, *2*) `ImageData` caches the texture for future use, so there is no performance pe
repeatedly blitting an `ImageData`.

[2] If the required texture compression extension is not present, the image is decompressed in memory and then supplied to OpenGL via `glTexImage2D`.

[3] It is not currently possible to retrieve `ImageData` for compressed texture images. This feature may be implemented in a future release of pyglet. One workaround is to create a texture from the compressed image, then read the image data from the texture; i.e., `compressed_image.get_texture().get_image_data()`.

[4] `BufferImageMask` cannot be converted to `Texture`.

Accessing or providing pixel data

The `ImageData` class represents an image as a string or sequence of pixel data, or as a ctypes pointer. Details such as the pitch and component layout are also stored in the class. You can access an `ImageData` object for any image with `get_image_data()`:

```
kitten = pyglet.image.load('kitten.png').get_image_data()
```

The design of `ImageData` is to allow applications to access the detail in the format they prefer, rather than having to understand the many formats that each operating system and OpenGL make use of.

The *pitch* and *format* properties determine how the bytes are arranged. *pitch* gives the number of bytes between each consecutive row. The data is assumed to run from left-to-right, bottom-to-top, unless *pitch* is negative, in which case it runs from left-to-right, top-to-bottom. There is no need for rows to be tightly packed; larger *pitch* values are often used to align each row to machine word boundaries.

The *format* property gives the number and order of color components. It is a string of one or more of the letters corresponding to the components in the following table:

R	Red
G	Green
B	Blue
A	Alpha
L	Luminance
I	Intensity

For example, a format string of `"RGBA"` corresponds to four bytes of color data, in the order red, green, blue, alpha. Note that machine endianness has no impact on the interpretation of a format string.

The length of a format string always gives the number of bytes per pixel. So, the minimum absolute pitch for a given image is `len(kitten.format) * kitten.width`.

To retrieve pixel data in a particular format, use the *get_data* method, specifying the desired format and pitch. The following example reads tightly packed rows in `RGB` format (the alpha component, if any, will be discarded):

```
kitten = kitten.get_image_data()
data = kitten.get_data('RGB', kitten.width * 3)
```

data always returns a string, however pixel data can be set from a ctypes array, stdlib array, list of byte data, string, or ctypes pointer. To set the image data use *set_data*, again specifying the format and pitch:

```
kitten.set_data('RGB', kitten.width * 3, data)
```

You can also create **`ImageData`** directly, by providing each of these attributes to the constructor. This is any easy way to load textures into OpenGL from other programs or libraries.

Performance concerns

pyglet can use several methods to transform pixel data from one format to another. It will always try to select the most efficient means. For example, when providing texture data to OpenGL, the following possibilities are examined in order:

1. Can the data be provided directly using a built-in OpenGL pixel format such as `GL_RGB` or `GL_RGBA`?
2. Is there an extension present that handles this pixel format?
3. Can the data be transformed with a single regular expression?
4. If none of the above are possible, the image will be split into separate scanlines and a regular expression replacement done on each; then the lines will be joined together again.

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The following table shows which image formats can be used directly with steps 1 as long as the image rows are tightly packed (that is, the pitch is equal to the width times the number of components).

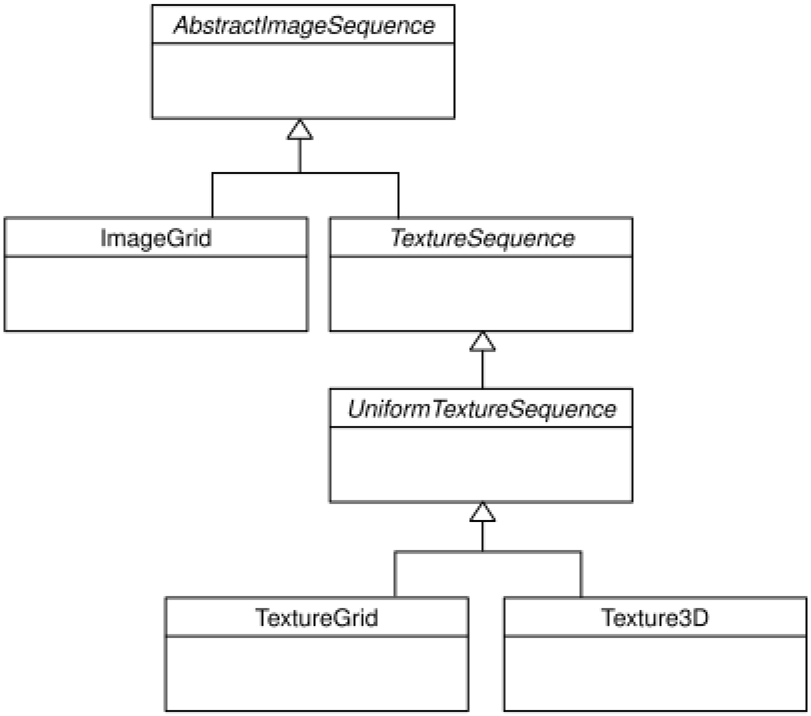
Format	Required extensions
`"I"`	
`"L"`	
`"LA"`	
`"R"`	
`"G"`	
`"B"`	
`"A"`	
`"RGB"`	
`"RGBA"`	
`"ARGB"`	`GL_EXT_bgra` and `GL_APPLE_packed_pixels`
`"ABGR"`	`GL_EXT_abgr`
`"BGR"`	`GL_EXT_bgra`
`"BGRA"`	`GL_EXT_bgra`

If the image data is not in one of these formats, a regular expression will be constructed to pull it into one. If the rows are not tightly packed, or if the image is ordered from top-to-bottom, the rows will be split before the regular expression is applied. Each of these may incur a performance penalty – you should avoid such formats for real-time texture updates if possible.

Image sequences and atlases

Sometimes a single image is used to hold several images. For example, a “sprite sheet” is an image that contains each animation frame required for a character sprite animation.

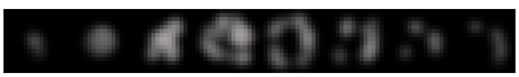
pyglet provides convenience classes for extracting the individual images from such a composite image as if it were a simple Python sequence. Discrete images can also be packed into one or more larger textures with texture bins and atlases.



The AbstractImageSequence class hierarchy.

Image grids

An "image grid" is a single image which is divided into several smaller images by drawing an imaginary grid over it. The following image shows an image that can be used for an asteroid explosion animation.


An image consisting of eight animation frames arranged in a grid.

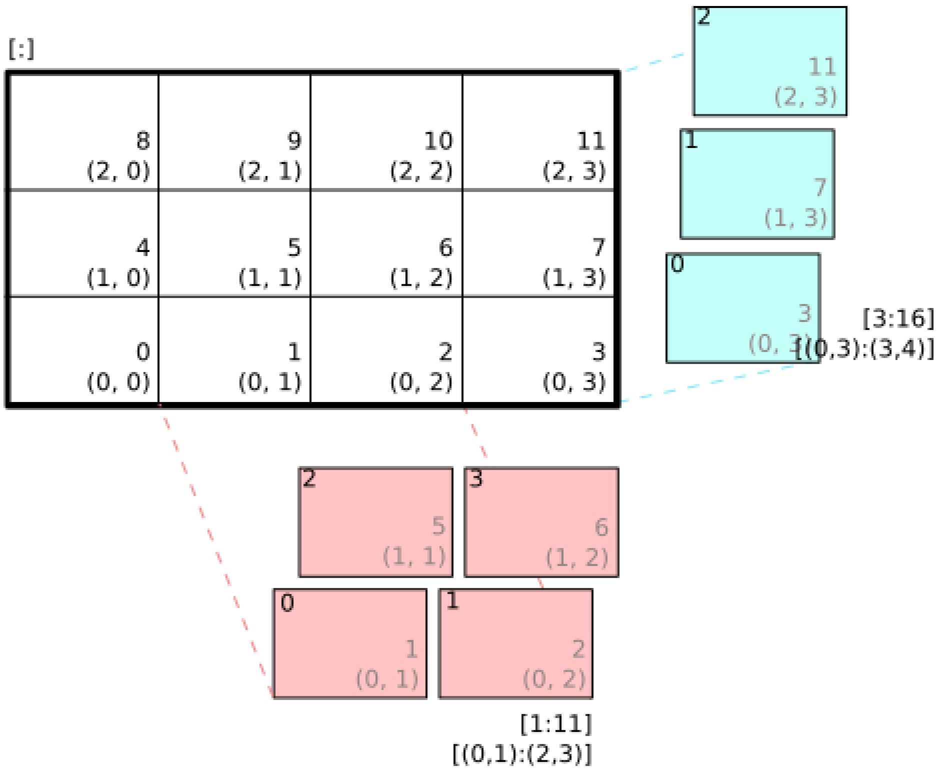
This image has one row and eight columns. This is all the information you need to create an `ImageGrid` with:

```
explosion = pyglet.image.load('explosion.png')
explosion_seq = pyglet.image.ImageGrid(explosion, 1, 8)
```

The images within the grid can now be accessed as if they were their own images:

```
frame_1 = explosion_seq[0]
frame_2 = explosion_seq[1]
```


Images with more than one row can be accessed either as a single-dimensional sequence, or as a (row, column) tuple; as shown in the following diagram.



An image grid with several rows and columns, and the slices that can be used to access it.

Image sequences can be sliced like any other sequence in Python. For example, the following obtains the first four frames in the animation:

```
start_frames = explosion_seq[:4]
```

For efficient rendering, you should use a `TextureGrid`. This uses a single texture for the grid, and each individual image returned from a slice will be a `TextureRegion`:

```
explosion_tex_seq = image.TextureGrid(explosion_seq)
```

Because `TextureGrid` is also a `Texture`, you can use it either as individual images or as the whole grid at once.

3D textures

`TextureGrid` is extremely efficient for drawing many sprites from a single texture. One problem you may encounter, however, is bleeding between adjacent images.

When OpenGL renders a texture to the screen, by default it obtains each pixel c interpolating nearby texels. You can disable this behaviour by switching to the `GL_NEAREST` interpolation mode, however you then lose the benefits of smooth scaling, distortion, rotation and sub-pixel positioning.

You can alleviate the problem by always leaving a 1-pixel clear border around each image frame. This will not solve the problem if you are using mipmapping, however. At this stage you will need a 3D texture.

You can create a 3D texture from any sequence of images, or from an `ImageGrid`. The images must all be of the same dimension, however they need not be powers of two (pyglet takes care of this by returning `TextureRegion` as with a regular `Texture`).

In the following example, the explosion texture from above is uploaded into a 3D texture:

```
explosion_3d = pyglet.image.Texture3D.create_for_image_grid(explosion_seq)
```

You could also have stored each image as a separate file and used `pyglet.image.Texture3D.create_for_images()` to create the 3D texture.

Once created, a 3D texture behaves like any other `AbstractImageSequence`; slices return `TextureRegion` for an image plane within the texture. Unlike a `TextureGrid`, though, you cannot blit a `Texture3D` in its entirety.

Texture bins and atlases

Image grids are useful when the artist has good tools to construct the larger images of the appropriate format, and the contained images all have the same size. However it is often simpler to keep individual images as separate files on disk, and only combine them into larger textures at runtime for efficiency.

A `TextureAtlas` is initially an empty texture, but images of any size can be added to it at any time. The atlas takes care of tracking the “free” areas within the texture, and of placing images at appropriate locations within the texture to avoid overlap.

It’s possible for a `TextureAtlas` to run out of space for new images, so applications will need to either know the correct size of the texture to allocate initally, or maintain multiple atlases as each one fills up.

The `TextureBin` class provides a simple means to manage multiple atlases. The following example loads a list of images, then inserts those images into a texture bin. The r
list of `TextureRegion` images that map into the larger shared texture atlases:

```
images = [
    pyglet.image.load('img1.png'),
    pyglet.image.load('img2.png'),
    # ...
]

bin = pyglet.image.atlas.TextureBin()
images = [bin.add(image) for image in images]
```

The `pyglet.resource` module (see Application resources) uses texture bins internally to efficiently pack images automatically.

Animations

While image sequences and atlases provide storage for related images, they alone are not enough to describe a complete animation.

The `Animation` class manages a list of `AnimationFrame` objects, each of which references an image and a duration (in seconds). The storage of the images is up to the application developer: they can each be discrete, or packed into a texture atlas, or any other technique.

An animation can be loaded directly from a GIF 89a image file with `load_animation()` (supported on Linux, Mac OS X and Windows) or constructed manually from a list of images or an image sequence using the class methods (in which case the timing information will also need to be provided). The `add_to_texture_bin()` method provides a convenient way to pack the image frames into a texture bin for efficient access.

Individual frames can be accessed by the application for use with any kind of rendering, or the entire animation can be used directly with a `Sprite` (see next section).

The following example loads a GIF animation and packs the images in that animation into a texture bin. A sprite is used to display the animation in the window:

```
window = pyglet.window.Window()

animation = pyglet.image.load_animation('animation.gif')
bin = pyglet.image.atlas.TextureBin()
animation.add_to_texture_bin(bin)
sprite = pyglet.sprite.Sprite(img=animation)

@window.event
def on_draw():
    window.clear()
    sprite.draw()

pyglet.app.run()
```

When animations are loaded with `pyglet.resource` (see Application resources) the frames are automatically packed into a texture bin.

The `examples/programming_guide/` folder of the GitHub repository includes:

- this example program (`animation.py`)
- a sample GIF animation file (`dinosaur.gif`)

Framebuffers

To simplify working with framebuffers, pyglet provides the `FrameBuffer` and `RenderBuffer` classes. These work as you would expect, and allow a simple way to add texture attachments. Attachment and target types can be specified as

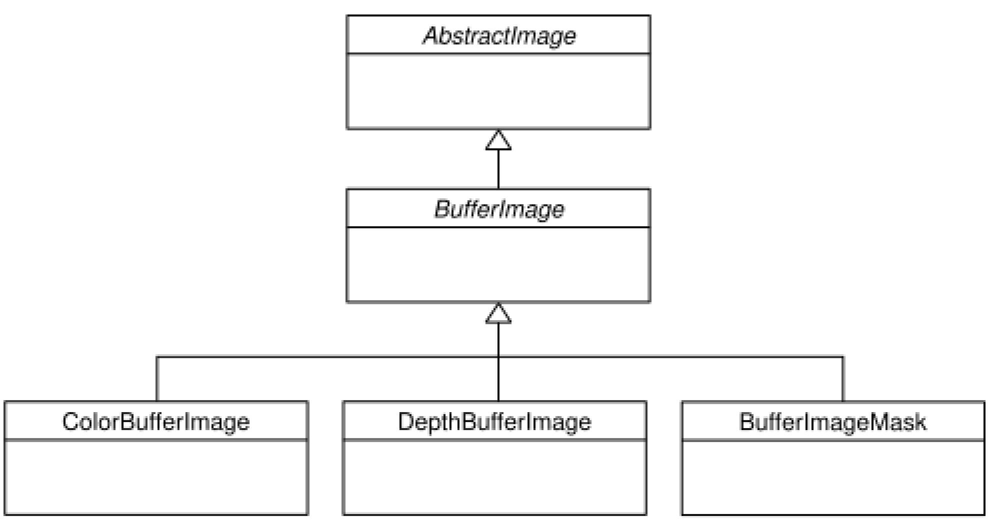
```
from pyglet.gl import *

# Prepare the buffers. One texture (for easy access), and one Renderbuffer:
color_buffer = pyglet.image.Texture.create(width, height, min_filter=GL_NEAREST,
mag_filter=GL_NEAREST)
depth_buffer = pyglet.image.Renderbuffer(width, height, GL_DEPTH_COMPONENT)

# Create a Framebuffer, and attach:
framebuffer = pyglet.image.Framebuffer()
framebuffer.attach_texture(color_buffer, attachment=GL_COLOR_ATTACHMENT0)
framebuffer.attach_renderbuffer(depth_buffer, attachment=GL_DEPTH_ATTACHMENT)

# When drawing:
framebuffer.bind()
```

pyglet also provides a simple abstraction over the “default” framebuffer, as components of the `AbstractImage` hierarchy.



The `BufferImage` hierarchy.

- One or more color buffers, represented by `ColorBufferImage`
- An optional depth buffer, represented by `DepthBufferImage`
- An optional stencil buffer, with each bit represented by `BufferImageMask`

You cannot create the buffer images directly; instead you must obtain instances via the `BufferManager`. Use `get_buffer_manager()` to get this singleton:

```
buffers = image.get_buffer_manager()
```

Only the back-left color buffer can be obtained (i.e., the front buffer is inaccessible, and stereo contexts are not supported by the buffer manager):

```
color_buffer = buffers.get_color_buffer()
```

This buffer can be treated like any other image. For example, you could copy it to a texture, obtain its pixel data, save it to a file, and so on. This can be useful if you want to save a "screen shot" of the running application:

```
image_data = color_buffer.get_image_data()
image_data.save("screenshot.png")
```

The depth buffer can be obtained similarly:

```
depth_buffer = buffers.get_depth_buffer()
```

The auxiliary buffers and stencil bits are obtained by requesting one, which will then be marked as "in-use". This permits multiple libraries and your application to work together without clashes in stencil bits or auxiliary buffer names. For example, to obtain a free stencil bit:

```
mask = buffers.get_buffer_mask()
```

The buffer manager maintains a weak reference to the buffer mask, so that when you release all references to it, it will be returned to the pool of available masks.

Similarly, a free auxiliary buffer is obtained:

```
aux_buffer = buffers.get_aux_buffer()
```

When using the stencil or auxiliary buffers, make sure you explicitly request these when creating the window. See *OpenGL configuration options* for details.

OpenGL imaging

This section assumes you are familiar with texture mapping in OpenGL (for example, chapter 9 of the OpenGL Programming Guide).

To create a texture from any `AbstractImage`, call `get_texture()`:

```
kitten = image.load('kitten.jpg')
texture = kitten.get_texture()
```

Textures are automatically created and used by `ImageData` when blitted. Itis useful to use textures directly when aiming for high performance or 3D applications.

The `Texture` class represents any texture object. The `target` attribute gives the texture target (for example, `GL_TEXTURE_2D`) and `id` the texturename. For example, to bind a texture:

```
glBindTexture(texture.target, texture.id)
```

Texture dimensions

Implementations of OpenGL prior to 2.0 require textures to have dimensions that are powers of two (i.e., 1, 2, 4, 8, 16, ...). Because of this restriction, pyglet will always create textures of these dimensions (there are several non-conformant post-2.0 implementations). This could have unexpected results for a user blitting a texture loaded from a file of non-standard dimensions. To remedy this, pyglet returns a `TextureRegion` of the larger texture corresponding to just the part of the texture covered by the original image.

A `TextureRegion` has an *owner* attribute that references the larger texture. The following session demonstrates this:

```
>>> rgba = image.load('tests/image/rgba.png')
>>> rgba
<ImageData 235x257>         # The image is 235x257
>>> rgba.get_texture()
<TextureRegion 235x257>     # The returned texture is a region
>>> rgba.get_texture().owner
<Texture 256x512>           # The owning texture has power-2 dimensions
>>>
```

A `TextureRegion` defines a `tex_coords` attribute that gives the texture coordinates to use for a quad mapping the whole image. `tex_coords` is a 4-tuple of 3-tuple of floats; i.e., each texture coordinate is given in 3 dimensions. The following code can be used to render a quad for a texture region:

```
texture = kitten.get_texture()
t = texture.tex_coords
w, h = texture.width, texture.height
array = (GLfloat * 32)(
     t[0][0], t[0][1], t[0][2], 1.,
     x,       y,       z,       1.,
     t[1][0], t[1][1], t[1][2], 1.,
     x + w,   y,       z,       1.,
     t[2][0], t[2][1], t[2][2], 1.,
     x + w,   y + h,   z,       1.,
     t[3][0], t[3][1], t[3][2], 1.,
     x,       y + h,   z,       1.)

glPushClientAttrib(GL_CLIENT_VERTEX_ARRAY_BIT)
glInterleavedArrays(GL_T4F_V4F, 0, array)
glDrawArrays(GL_QUADS, 0, 4)
glPopClientAttrib()
```

The `blit()` method does this.

Use the `pyglet.image.Texture.create()` method to create either a texture region from a larger power-2 sized texture, or a texture with the exact dimensions using the `GL_texture_rectangle_ARB` extension.

Texture internal format

pyglet automatically selects an internal format for the texture based on the sour latest

format attribute. The following table describes how it is selected.

Format	Internal format
Any format with 3 components	`GL_RGB`
Any format with 2 components	`GL_LUMINANCE_ALPHA`
`"A"`	`GL_ALPHA`
`"L"`	`GL_LUMINANCE`
`"I"`	`GL_INTENSITY`
Any other format	`GL_RGBA`

Note that this table does not imply any mapping between format components and their OpenGL counterparts. For example, an image with format `"RG"` will use `GL_LUMINANCE_ALPHA` as its internal format; the luminance channel will be averaged from the red and green components, and the alpha channel will be empty (maximal).

Use the `pyglet.image.Texture.create()` class method to create a texture with a specific internal format.

Texture filtering

By default, all textures are created with smooth (`GL_LINEAR`) filtering.

To use a different filter for a specific texture, pass the filtering constant(s) to the `pyglet.image.Texture` class via the `min_filter` and `mag_filter` arguments.

Pixel art

To enable nearest-neighbor filtering for retro-style games, set the corresponding variables of `pyglet.image.Texture` to `GL_NEAREST` :

```
pyglet.image.Texture.default_min_filter = GL_LINEAR
pyglet.image.Texture.default_mag_filter = GL_LINEAR
```

Afterward, all textures pyglet creates will default to nearest-neighbor sampling.

Saving an image

Any image can be saved using the *save* method:


```
kitten.save('kitten.png')
```

or, specifying a file-like object:

```
kitten_stream = open('kitten.png', 'wb')
kitten.save('kitten.png', file=kitten_stream)
```

The following example shows how to grab a screenshot of your application window:

```
pyglet.image.get_buffer_manager().get_color_buffer().save('screenshot.png')
```

Note that images can only be saved in the PNG format unless the Pillow library is installed.