

Blender Basics

Using version 4.0

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If you don't have Blender yet, get it from <http://www.blender.org> (on Windows or Mac OS) or use your package manager on Linux distributions. It's free and open source. For older versions prior to 4.0, the graphical user interface will be different. Version 4.0 is therefore recommended. We have also tested with version 3.0 and there were no major changes, but keep in mind the figures were extracted from version 4.0.

In this document, you will find necessary usage inside Blender for this course. More detailed and complete information can be retrieved via the online Blender Manual.

1 Interface

When in doubt, press **Esc**. If you press the wrong key and unwanted things happen, press **Esc** to get out of the unwanted mode. If **Esc** doesn't seem to work, try **Ctrl+Z** or the last button you toggled before the situation. The former will undo the changes you made to the content while the latter will switch between interface modes. To redo changes you could use shortcut **Shift+Ctrl+Z**. Both undo and redo functions are accessible via the interface under **Edit** dropdown menu. Some interactions will pop up small dialogs that are only visible when the mouse hovers over some interface items (text, button, etc.). If you want to know what some interface items mean, stopping the cursor over them is recommended. See ?? for the default start screen of Blender. The first time you run the program, there will be a dialogue asking your preferences. Things should look identical once your preference is recorded.

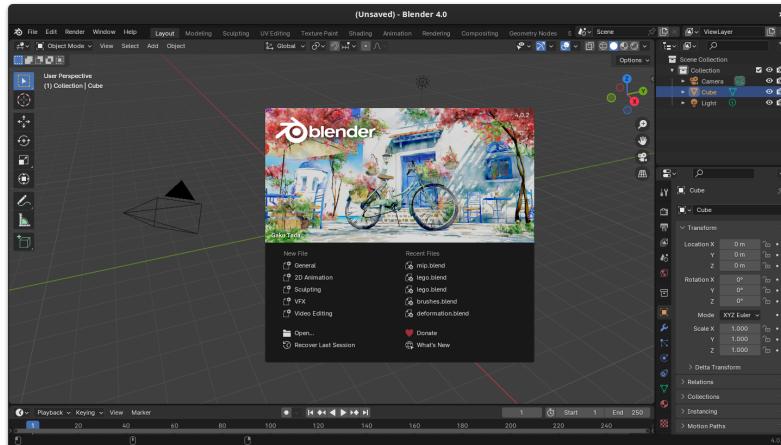


Figure 1: Blender 4.0 splash screen. The splash will go away after selecting a function therein or clicking anywhere else in the interface.

1.1 Areas

The blender interface is split into resizable and rearrangeable *Areas*. Areas are different panels of the interface, separated by small vertical and horizontal space. ?? shows different areas in the default Blender interface. At the top left corner of each area, there is a dropdown menu button to change editor type. You can select what content to show in the current area from the dropdown list. See ?? for an example dropdown menu inside the 3D view area.

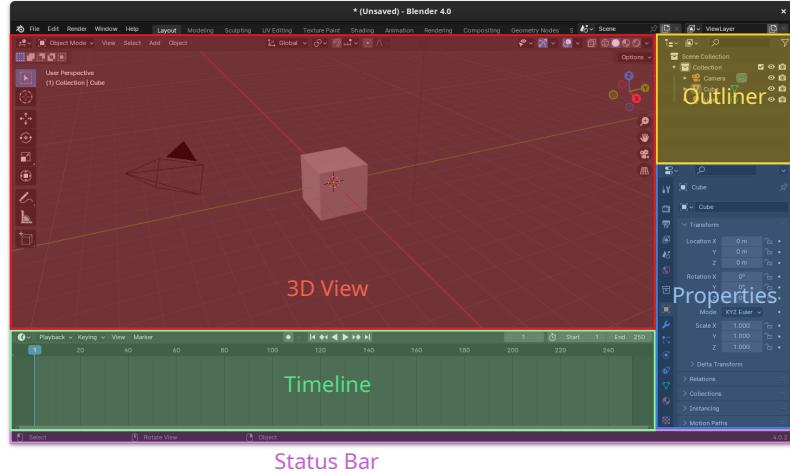


Figure 2: Default Interface, areas are highlighted

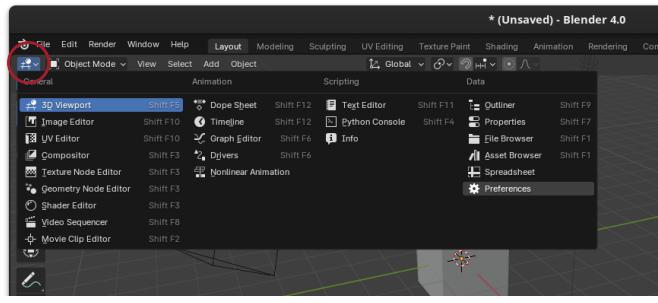


Figure 3: Dropdown menu to switch area type

You can scale each area in the interface by clicking and dragging the edges or corners. To add or remove an area you can use the split/join area functions by right-clicking in the in-between space amongst areas.

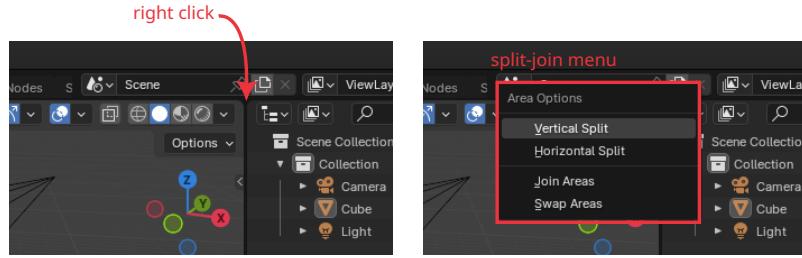


Figure 4: Split and join areas

The **3D Viewport** and **Properties** areas are the most important. In the former you view and edit your content (including objects, lights, and cameras), in the latter, you change the properties of the current selection.

The **Outliner** area can be used to assist your selection. It highlights your current selection. You can make your selection by both left-clicking in the 3D Viewport and Outliner. It is more useful when your scene is relatively complex with many objects and lights, etc.

All functions are relative to the context. This means you need to be inside the correct area for a desired function to be executed correctly. For example, you can delete an object from the scene, but you must hover your cursor over the 3D Viewport area for it to happen.

2 3D Viewport

The most important area is the 3D Viewport, which allows you to manipulate and view the scene in 3D.

2.1 Viewport Camera and Navigation

Viewport and Render Cameras In the 3D Viewport area, you see the scene viewed from the viewport camera. You will see another camera in the scene which is the *render* camera. Generally, you edit the scene content with the viewport cameras but make final shots with the render camera. You can switch to/from the render camera with the  button inside the area (next to the right edge).

Orthographic views The neighboring  button will toggle the between perspective and orthographic view. There are six other default orthographic cameras: Top/Bottom, Left/Right, and Front/Back views. Each can be enabled by clicking on the corresponding axis in the top right corner.

Click for front orthographic

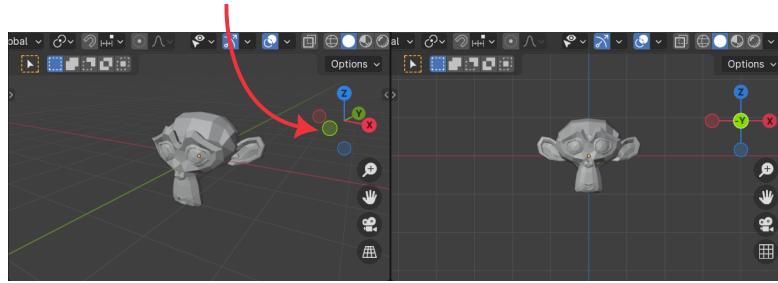


Figure 5: Orthographic view selection with wheel

Alternatively, you can use the shortcuts in the table below:

Function	Shortcut
To/From render camera	Numpad 0
To Top View	Numpad 7
To Bottom view	Ctrl + Numpad 7
To Front view	Numpad 1
To Back view	Ctrl + Numpad 1
To Right view	Numpad 3
To Left view	Ctrl + Numpad 3
To/From perspective	Numpad 5

Table 1: Changing camera viewpoint keyboard shortcuts

Navigating in the Viewport To move the current viewpoint (not the object) around in the 3D Viewport area, the following keyboard-mouse combinations are predefined by Blender.

Function	Shortcut
Rotation	MMB click and drag
Panning	Shift + MMB click and drag
Zoom	Mouse Wheel
Switch view	Alt + MMB click and drag
Show all content	Shift + C
Focus on Selection	Numpad .

Table 2: Navigating 3D viewport keyboard shortcuts

You can also use shortcuts **Ctrl**+**Numpad 4/8/6/2** to perform view panning and **Shift**+**Numpad 4/8** to tilt the view.

Viewport Rendering modes Inside the 3D View area you can quickly switch between *Wireframe* / *Solid* / *Material Preview* and *Rendered* shading modes of the current view. This can be done by pressing the **Z** key and moving the mouse cursor accordingly.

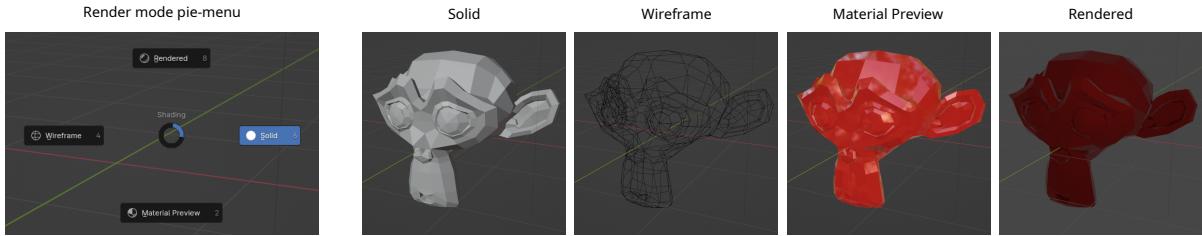


Figure 6: Shading modes pie-menu: switch shading mode by pressing **Z** in the 3D viewport and moving cursor

2.2 Selection

Inside the 3D View, selected objects are outlined with orange color. Corresponding entries are highlighted in the Outliner.

Selecting an object: left-clicking on the object (this is different in older versions). For multiple objects, you could hold shift and click on new objects to add to/remove from the current selection. You can also use the lasso tool by clicking and dragging the left mouse button around the objects. Note that you could only add to the selection with the lasso tool, not removal. There are few default select methods that you can choose from. It can be accessed in the Drag dropdown menu. See below.

2.3 Viewport Modes

The 3D Viewport area has multiple *modes*, which determine the “level” we are working on. It is very important that you are working on the correct level, thus the right mode. Some of the modes are:

- **Object mode:** Create, Transform, and delete the objects in a scene
- **Edit mode:** Create, Transform, and delete the mesh vertices, edges, and faces of a given object
- **Sculpt mode:** Edit a given object with a sculpting-like interface

Switching between modes can be done in two ways:

1. **Dropdown menu:** Click in the dropdown menu in ?? and select the correct one.
2. **Pie Menu:** Inside the viewport, use shortcut **Ctrl**+**Tab** and select a mode by either moving the mouse cursor to the correct direction as indicated in the interface or typing in the Numpad. ??

Tip: Toggling in and out of Edit mode

It is very common to toggle from your current mode to Edit mode, and then back to your current mode again, so Blender provides the shortcut **Tab**

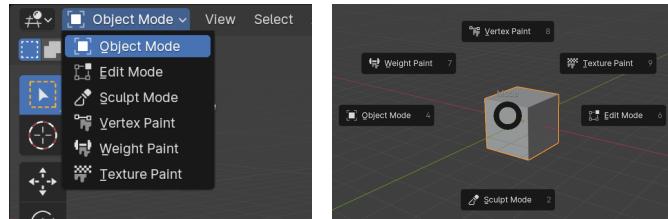


Figure 7: Mode-selection menus

2.3.1 Object Mode

In *Object mode* you can create, delete, and transform the objects in the scene. An object in a blender is any entity with a position, rotation, and scale in 3D, such as meshes, lights, armatures, and even empty objects.

Adding and deleting objects To create a new object, you can use the `Add` button, or the shortcut `Shift + A` in the 3d Viewport. From the menu, you can select the type of object to add. To delete an object, select it in the 3D Viewport or Outliner, and press `delete` or `x`.

Translating, Rotating and Scaling Every object in blender has a *Transform* which specifies the position, rotation, and scale of the object in 3D space. There are two main ways to edit the transform of objects in blender:

You can specify the exact position, rotation, and scale of the object by setting the values in the Object Properties panel after selecting the object.

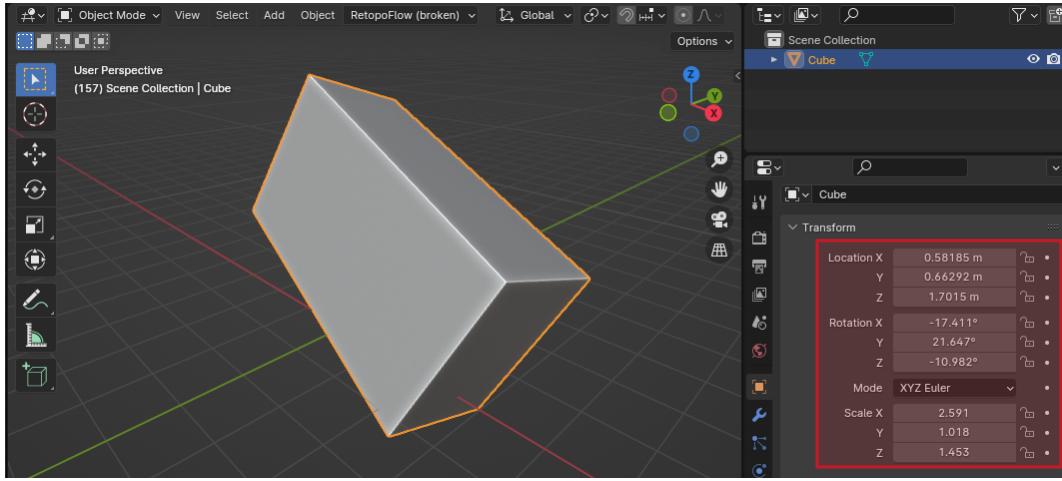


Figure 8: Object Transform

Alternatively, you can use the mouse, and the graphical transformation tools. After selecting the object, you can select one of the four translation tools in the top right of the 3D viewport. The tools are shown in ??

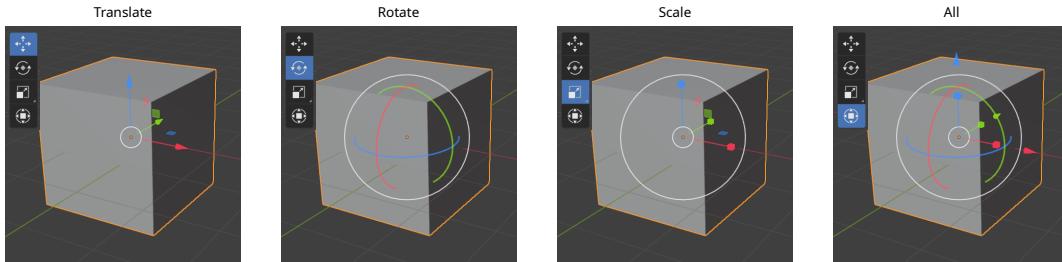


Figure 9: Transform tools

Lastly, you can use keyboard shortcuts. To initiate a transformation, press one of `g` (for “grab”) for translation, `r` for rotation, or `s` for scale. You can now move your mouse to perform the desired translation/rotation/scale and left-click to finish, or right-click to cancel.

At this point, you can further restrict the transformation by pressing `x/y/z`, this will restrict the transformation to moving/rotating/scaling along only the specified axis. Alternatively, if you want to restrict the transformation to all axes but one, you can press `Shift + x/y/z`

Lastly, instead of using the mouse to specify by how much to translate/rotate/scale, you can type the exact unit amount with the keyboard.

2.3.2 Edit Mode

In *Edit Mode*, you can make changes to units that are one level lower than in the Object Mode. This means you can select, remove, and transform mesh vertices, surface curves, etc. Before switching to Edit Mode, make sure you have target objects selected.

In Edit Mode, you can toggle between object components. Press **1** for vertices, **2** for edges and **3** for faces. Deleting the current selection will bring up a dialogue to confirm the type of deletion.

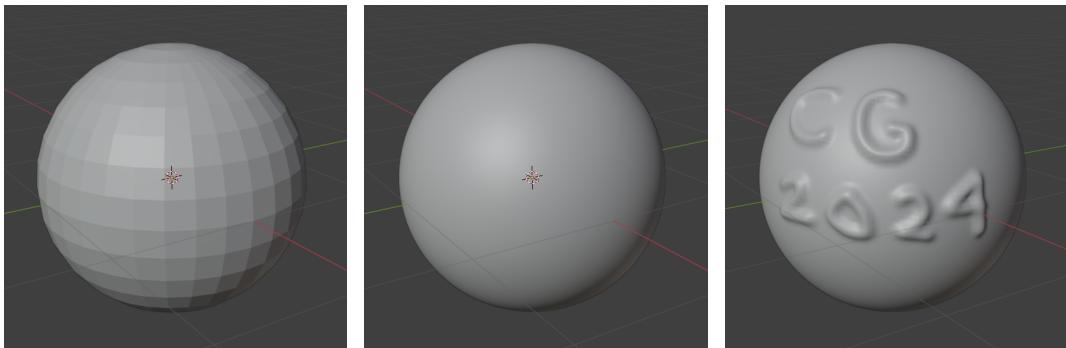
To create, transform, and delete vertices/edges/etc, you can use the same tools and keyboard shortcuts explained [??](#).

Tools for the current selection will pop up once switched to Edit Mode. It will appear to the left of the 3D View, below the transformation tools.

2.3.3 Sculpt Mode

You can use your mouse as a sculpting tool in Blender. This requires a mesh object with relatively high resolution. This can be done by adding a Multiresolution Modifier in the properties area by selecting [\[Add Modifier\] > Generate > Multiresolution](#).

Multiple tools can be used in the Sculpt Mode. For instance, you can draw clay. In the former, you can see the mesh being “pulled” out from the surface (e.g., “CG” in the image above), while in the latter “pushed” into the surface (e.g., “2024” in the image above). You could also change the size and intensity of your brush. This mode can help you roughly get the mesh in shape and subsequently add details.



Useful tools include: Draw, Clay, Crease, Grab, and Smooth. Read more on sculpting at [Blender doc](#).

3 Materials

Each object in the scene is assigned a material by default. This is usually the default Blender material. Users can make new material and assign it to objects in the current selection. Below you can find the relationship between common concepts related to materials inside Blender.

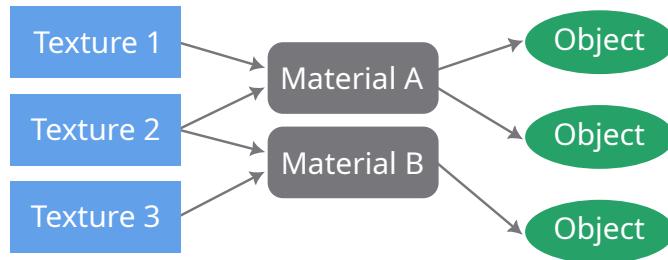


Figure 10: Each material may use any amount of textures, and every object may use any amount of materials

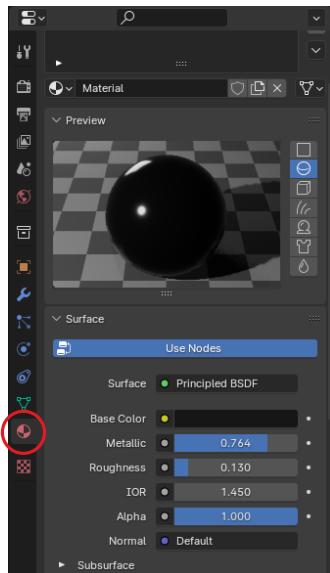


Figure 11: The Material tab inside the Properties area

4 Light and Camera Objects

Lights and cameras are special objects inside Blender with their properties compared to other geometry objects. The common transformations work with cameras and lights. Cameras have properties such as viewing angle, focal distance, and aperture. Lights have properties such as color and power.

You can choose point light, virtual sun, spotlights, and area light for light sources. Each has its properties and effects. All light sources can cast shadows, which are enabled by default.

You can choose perspective, orthographic, and panoramic cameras for your cameras. There can be multiple cameras of different types, but only one will be the final render camera - the active camera. You can tell a camera is the active camera by the dark frame inside the viewport when switched to one.

Special transformation and shortcuts for cameras:

1. You can click or **Numpad 0** in the 3D Viewport to switch to the active camera.
2. You can quickly transform your active camera to your current camera view with **Ctrl**+**Alt**+**Numpad 0**
3. You can quickly change the current viewing camera as active camera with **Ctrl**+**Numpad 0**

5 Rendering

Once you are happy with the content you have created, you can select to render the active camera view to an image or image sequence. You can use Blender's default viewport to preview the scene using Eevee engine. This will provide a rasterized preview which is an approximation to the final render. If your hardware supports CUDA, you could opt for Cycles with GPU compute as your preview. This will be slightly slower than Eevee but will give you the same result as the final render. If you have RTX hardware, you could turn on Experimental features inside Cycles to make use of the hardware accelerated ray intersection engine. You can check if your hardware supports these features in `Edit > Preferences > System`.

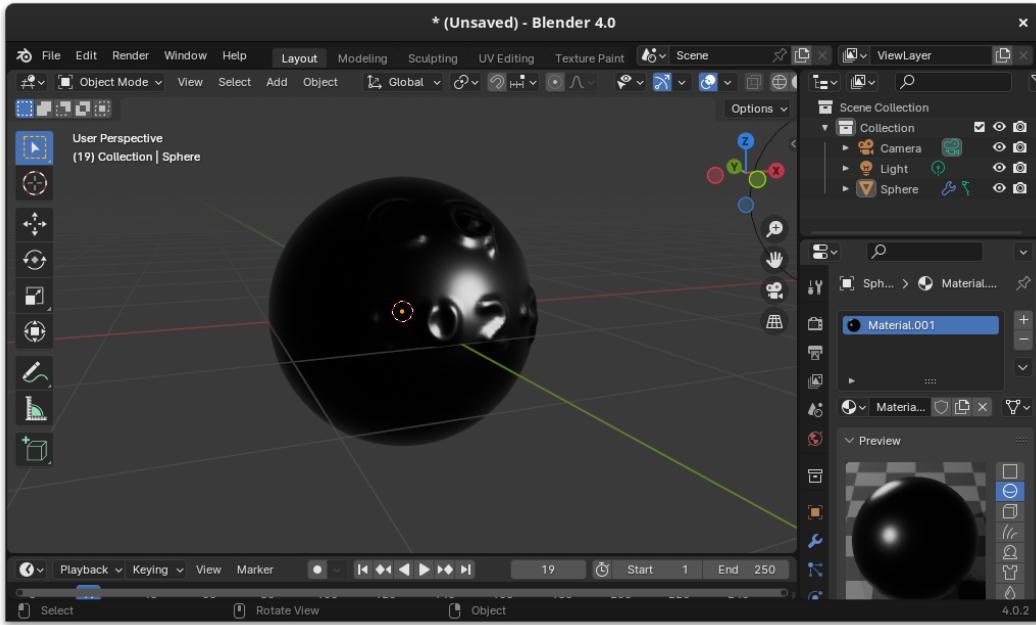


Figure 12: Render Preview using Cycles engine

You can call out the render view window by pressing `F12`. This will bring you directly to the standalone BlenderRender window with the scene rendered at current settings. Most settings before renderer settings, lighting, materials, and animation, should be readily configured. Renderer-related settings can be accessed via the Render Properties tab inside the Properties Area.

6 Scene and World Properties

In the Properties area, you can find two tabs: scene and world. You can make high-level changes that are not specified to objects. These changes can be: which camera is the active camera, what the background color in the render should be, world units, etc.

7 Saving and Opening Documents

During editing, it is recommended to regularly save your document. File operations can be accessed in the File dropdown menu and with common shortcuts `Ctrl + S` (save), `Ctrl + O` (open), `Ctrl + N` (new doc), etc.

8 Rigging and Animating a Character

Creating the rig for a mesh consists of basically two things. The first is the armature, the second is the skinning weights. Once the rig is created, you can use it to pose the character and animate it.

If you haven't selected the mesh you want to rig, now is the perfect time ;). You can start with `bird/mesh.blend` or use your own ideas.

8.1 Creating and assigning the Armature

Creating an armature Press `Shift + A` in object mode to open the add menu and select Armature. It should now be the active object. Enter Edit Mode by selecting it from the mode selection menu. When you select a joint, you can press `E` to extrude it and form bone chains. You can use `X / Y / Z` and numbers in the same way as for the basic object transformations above.

Tip: X-ray mode

When editing the armature it is useful to see-through the mesh. You can toggle x-ray mode with `Alt + Z`.

The bones of an armature do not need necessarily all be connected. `Shift + A` will create a new unconnected bone. You can then parent a selection to the active bone, `Shift + click` will make the last selection active, by hitting `Ctrl + P` and select keep offset. This will help to bridge larger gaps between areas you want to control independently and keep your armature neat and tidy.

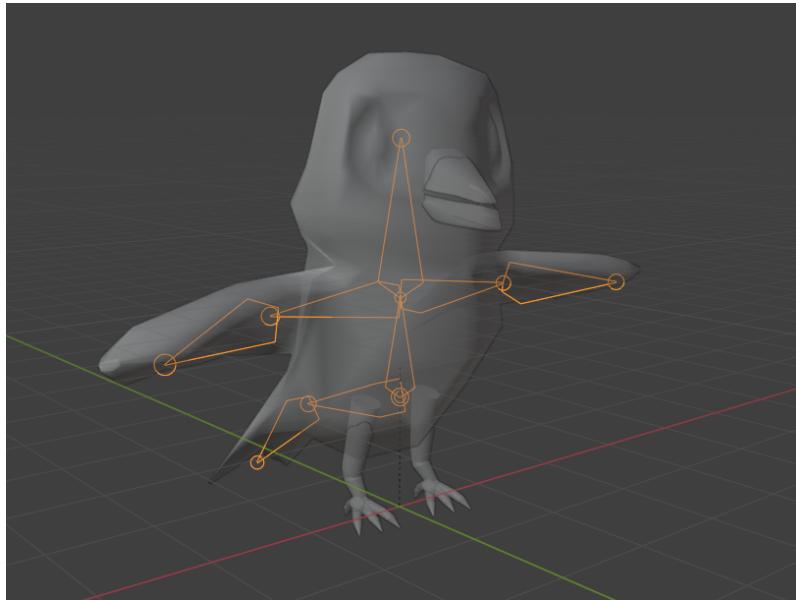


Figure 13: Example armature for Bird mesh

Applying the Armature to the Mesh: Now that you have created an armature, we can deform a target mesh according to it. In Blender, an armature deformation is a Modifier, which is the term for non-destructive operations in Blender. Select your mesh, go to the modifier tab in the properties area, and add a `Deform > Armature` modifier from the add modifier menu. You'll need to select the armature object that shall influence the deformation, this is the red overlayed field in the figure below.

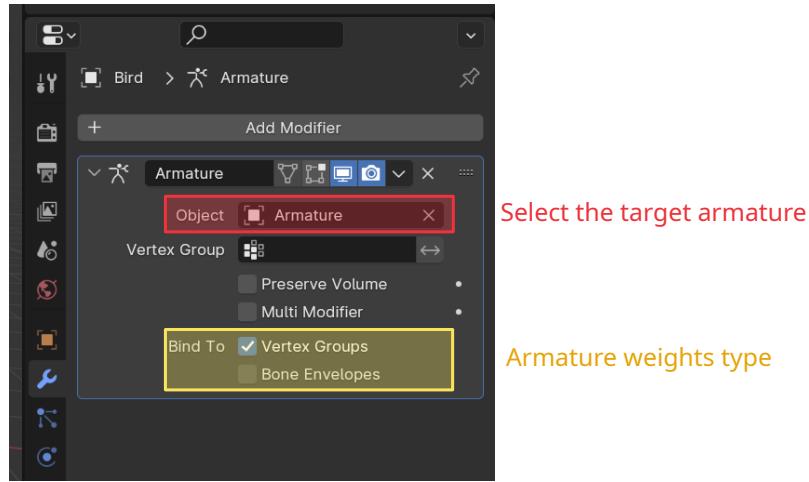


Figure 14: Armature modifier options

8.2 Skinning Weights

Once you have created the armature, and assigned it to an object, we can define the skinning weights. Blender implements two ways to define the influence of armatures, see the yellow overlay in ???. One is envelopes around the bones of the armature which can be adjusted in size and influence. This method will displace vertices of the rigged mesh within the envelopes interior. The second is, in Blender, called the vertex groups method. Each bone is associated with one group and only influences the vertices in the group. Vertex groups are part of the mesh's data and essentially independent of the whole armature idea. The figure below shows the vertex group table of a mesh filled with groups for the bones. Groups and bones are identified by their name. The names of bones of your mesh can be changed in the outliner area. I've used the vertex group variant in the sample, but you can, of course, try the envelopes. I'd guess that you'll need more bones for the same flexibility but would love to see alternative solutions.

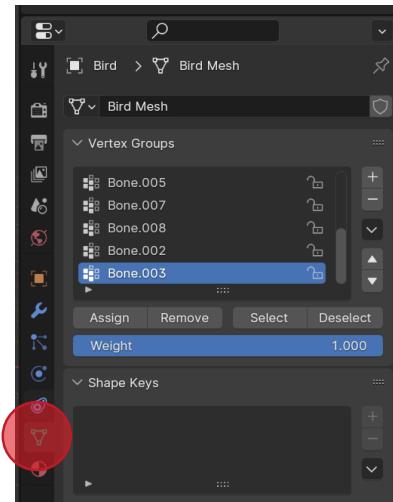


Figure 15: Vertex Groups

Tip: Automatic Skinning

There's a shortcut for the vertex group procedure so that one doesn't need to create all vertex groups manually. Select, in object mode, your mesh, then the armature, hit `ctrl + p` and select `armature deform > with empty groups`. This will set the armature modifier, initialize vertex groups and parent the mesh to the armature. You can try `with automatic weights` from the same menu and see how it looks. Automatic weights didn't quite work for me.

Painting Weights When the mesh is selected, click `ctrl + tab` to enter weight paint mode. You influence the weights of the currently selected vertex group. You can play around a bit with the weights, by swapping between pose mode (`ctrl + tab` with the armature selected) and weight paint mode to see how it works.

8.3 Posing and Animating

Now that we have created an armature, assigned it to a mesh, and defined the skinning weights we can pose the armature to animate the character.

Inverse Kinematics With an armature selected, you can enter the pose mode by `Ctrl + Tab` which lets you set the transformations for the armature that are to be transferred to the mesh. Also, you can set bone constraints here. The IK constraint is one particular kind, that lets the selected bone (and its predecessors in a chain) follow a target, which greatly simplifies advanced animations. Once you've added the IK constraint to a bone, you need to select its target, yellow overlay in the figure above. Optionally, you can set the chain length, green overlay, and a pole target, red overlay. While the target lets you position the tip of a bone chain, the pole target will let you steer its orientation.

Making a Keyframe Animation Once your skinning rig is set up, we can create a basic animation. With the armature selected and the timeline editor open, select a frame in the timeline editor and pose your character. Pressing `i` will open the insert keyframe menu, from which you can select which transformation should be keyed. The bones can be keyframed individually so that the parts of the mesh can be edited individually. The dope sheet editor view will give you finer control over the animation as it lists all actions on a timeline and is neatly separated by all references that have been inserted.