TU Delft

Computer Graphics and Visualization

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Blender basics

Using version 2.82a

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 2.8, the graphical user interface will be different. Version 2.8 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 2.8.

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.

Interface

When in doubt, press `Esc`. If you pressed 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, stop the cursor over them is recommended. See Figure 1 below 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.

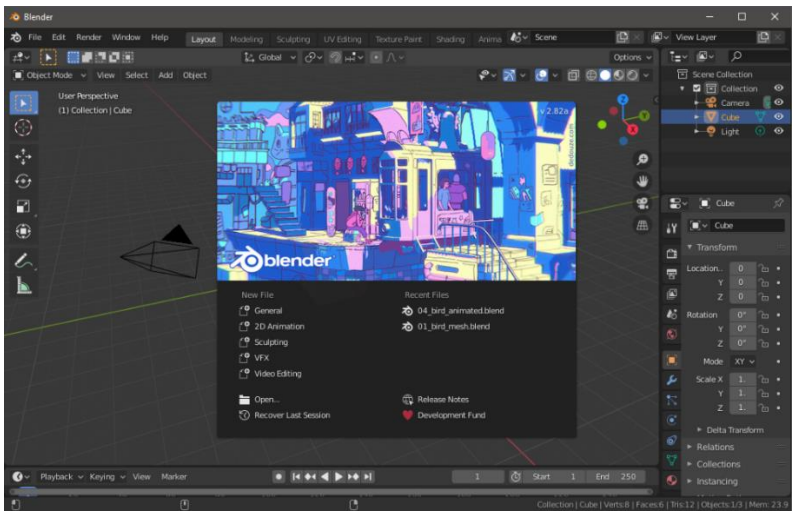


Figure 1 Blender *default start screen (or splash screen). The* splash *will go away once you select a function therein or click anywhere in the interface. It provides shortcuts to basic functionalities and recent projects.*

Areas

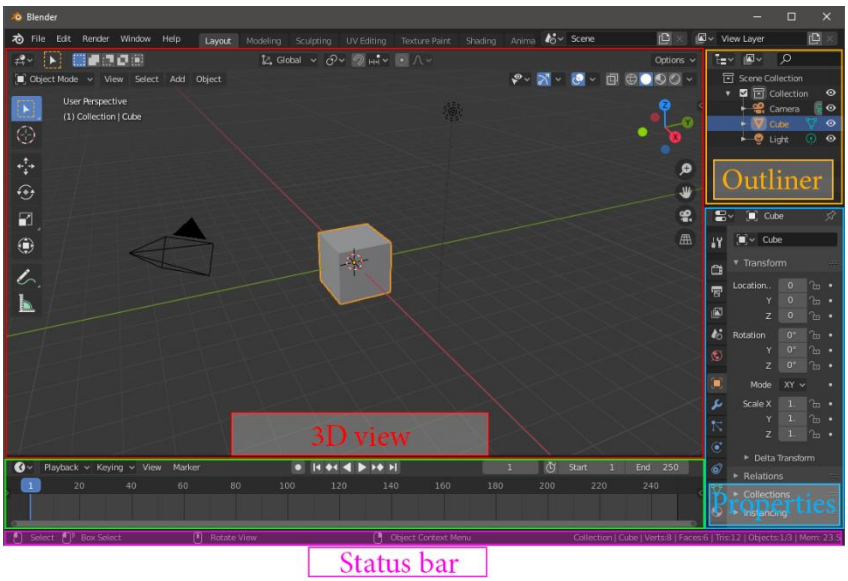


Figure 2 Default interface. Each area is highlighted.

Areas are different panels of the interface, separated by small vertical and horizontal space. Figure 2 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 current area from the dropdown list. See Figure 3 for an example dropdown menu inside the 3D view area.

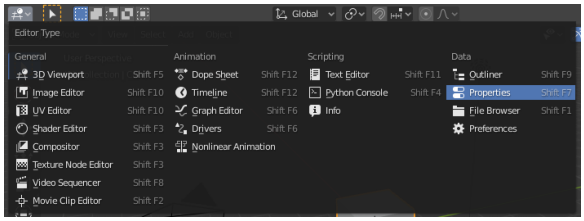


Figure 3 Dropdown menu inside the 3D view area.

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.

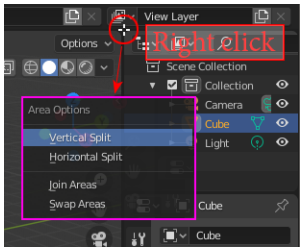


Figure 4 Split and join areas.

The *3D View* 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 section. It highlights your current selection. You can make your selection by both left clicking in the 3D View and in the 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 a 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 View area for it to happen.

Camera and 3D View

In the default 3D View area, you see the content viewed from the default blender camera. You will see another camera and that one is the render camera. It is generally the practice that you edit the scene content with the default cameras but make final shots with the render camera. You can switch to/from the render camera view by toggle the  button inside the area (next to the right edge). Neighboring button  will switch the current view to/from perspective.

There are six other default orthographic cameras, each representing a unique viewpoint: Top/Bottom, Left/Right and Front/Back. Each can be switched to by clicking in the interface as shown in Figure 5. All default cameras can be switched quickly with the shortcuts in the table provided below.

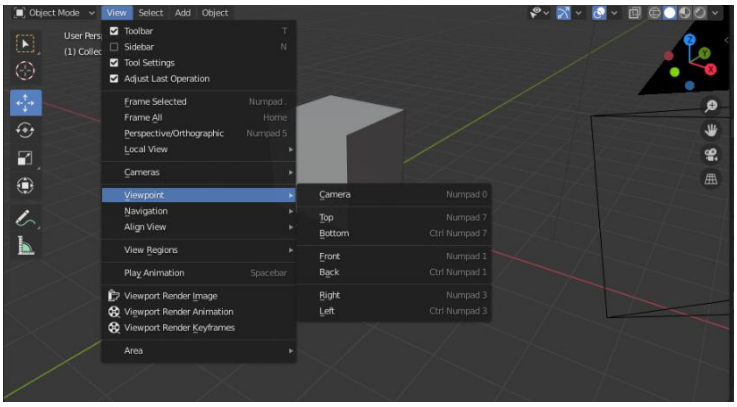


Figure 5 Changing viewpoint inside the 3D View area.

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

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

View control	Combinations
Rotation	MMB click and drag
Panning	`Shift` + MMB click and drag
Zoom	Mouse wheel
Switching view	`Alt` + MMB click and drag
Show all content	`Shift` + `C`
Focus on selection	Numpad .

You could also use shortcuts `Ctrl` + Numpad 4/8/6/2 to perform view panning, `Shift` + Numpad 4/8 to tilt view.

Inside the 3D View area you could quickly switch between *Wireframe/Solid/MaterialPrev./Rendered* shading modes of the **current view**. This can be done by keep pressing the `Z` key and move the mouse cursor accordingly.

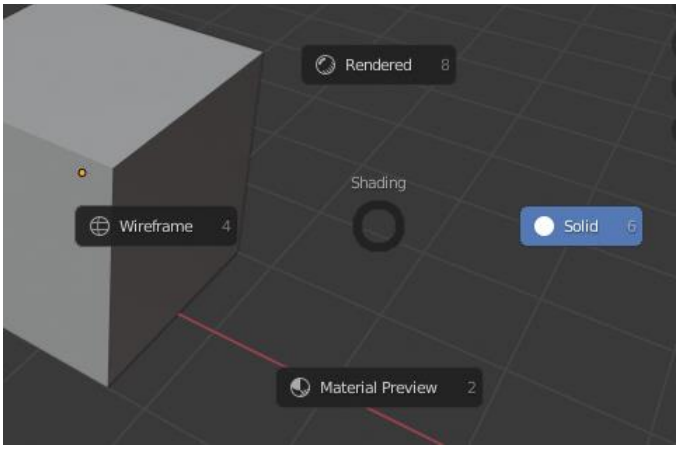


Figure 6 Toggle between shading modes in 3D View by keep pressing Z move mouse cursor.

Selection

Inside the 3D View, selected objects are outlined with orange color around the object silhouettes. 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 current selection. You can also use the lasso tool by clicking and dragging left mouse button around the objects. Note that you could only add to selection with the lasso tool, not removal.

There few default select methods that you can choose from. It can be accessed in the `Drag` dropdown menu. See below.

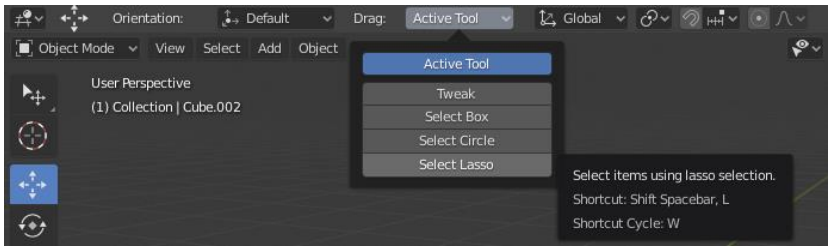
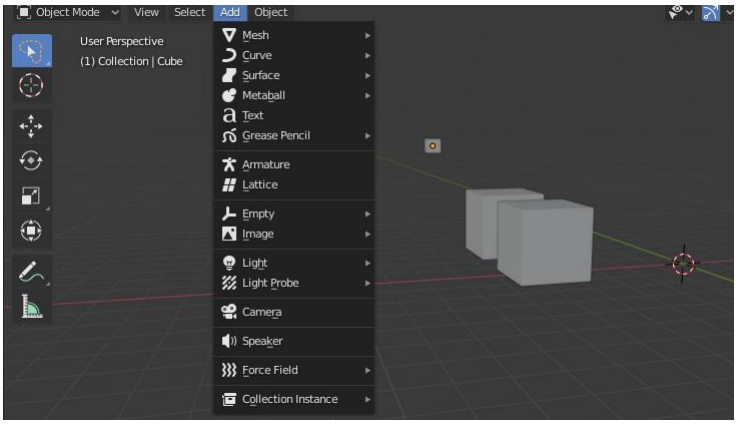


Figure 7 Different select methods.

Adding/removing objects

Inside 3D View, you can add an object (mesh, light, camera, etc) by clicking the *Add* button. The same can be done with shortcut `Shift + A` inside this area. See below.



Removing an object can be done by pressing `Del` or `X` key inside 3D View. You need to make sure desired objects (and only desired objects) are in active selection.

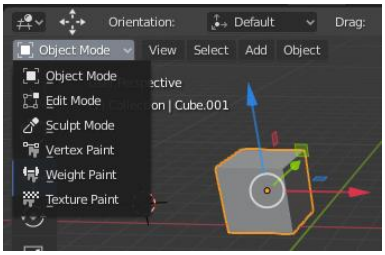


Figure 8 Different modes inside Blender 3D View.

There are few *mode*s inside Blender 3D View where you can make changes. They represent the level you are working on. It is **very important** that you are working on the correct level, thus the right mode.

Switching between modes can be done in two ways:

1. Click in the dropdown menu in Figure 8 and select the correct one.
2. Inside the viewport, use shortcut `Ctrl + Tab` and select a mode by either moving the mouse curser to the correct direction as indicated in the interface or type in the numpad. See Figure 9.

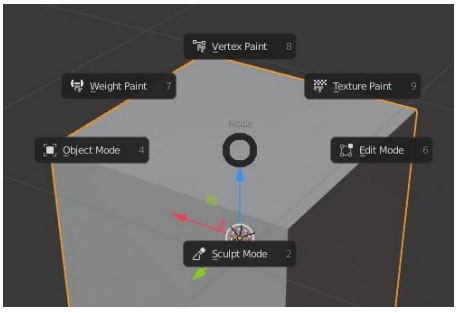


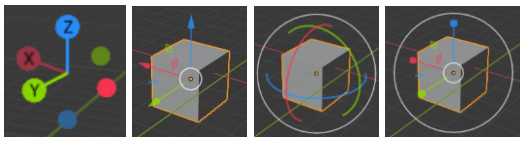
Figure 9 Switching between modes with `Ctrl+Tab`.

Object Mode

In *Object Mode*, you can make changes to the object position (Move, `G` key) and orientation (Rotate, `R` key) while preserving ratios. You could also scale object per axis (Scale, `S` key), which can change object ratio. All transformations are performed with respected to object pivot points, which are highlighted with an orange dot with black outline. Pivot points are by default the bounding box center but can be modified by user.

To constrain transformations in Blender there are three ways:

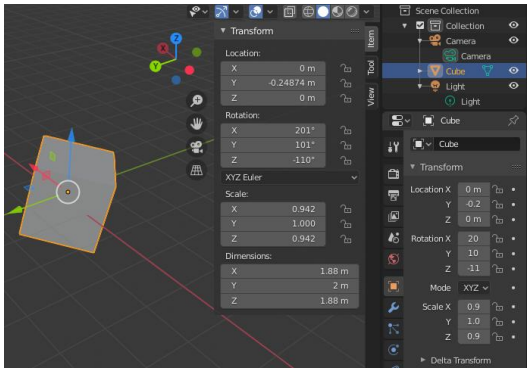
1. Inside 3D View, make changes only using transformation handle that has the same color as desired axis. All transformations handles are color coded according to system axis. For translation and scaling, constraint to plain is possible by using the small semi-transparent square handle. See below.



2. Make changes in orthogonal views.
3. While entering transformation by pressing `G`/`S` keys, press `X`/`Y`/`Z` key to indicate which axis the transformation goes to. For plane constraint, press `shift` + `X`/`Y`/`Z` key will indicate the orthogonal axis of the desired plane. E.g., `shift` + `X` means YZ-plane constraint.

You can specify the exact value of your transformation in two ways:

1. Type in values in corresponding fields in the Properties area->Transform tab. This does not require entering any transformation modes. A quick interface for object transformation can be called out inside 3D View by pressing `N` key after selection. See below.



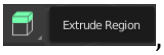
2. While entering a transformation mode by pressing `G`/`S`/`R` keys, type in the exact value. Holding `Ctrl` while transforming will snap transformations to discrete values.

Edit Mode

In *Edit Mode*, you can make changes to units that are one level lower than in the **Object Mode**. This means you are able to 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 current selection will bring up a dialogue to confirm the type of deletion.

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

Useful tools for mesh objects: 

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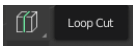
, 

and 

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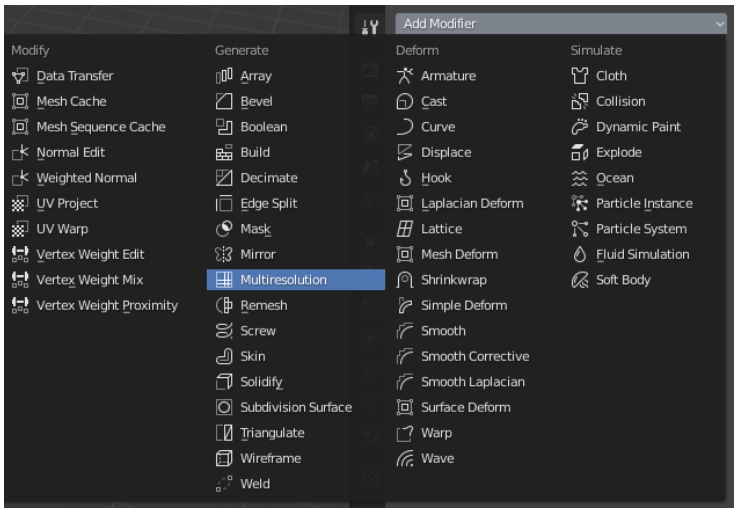
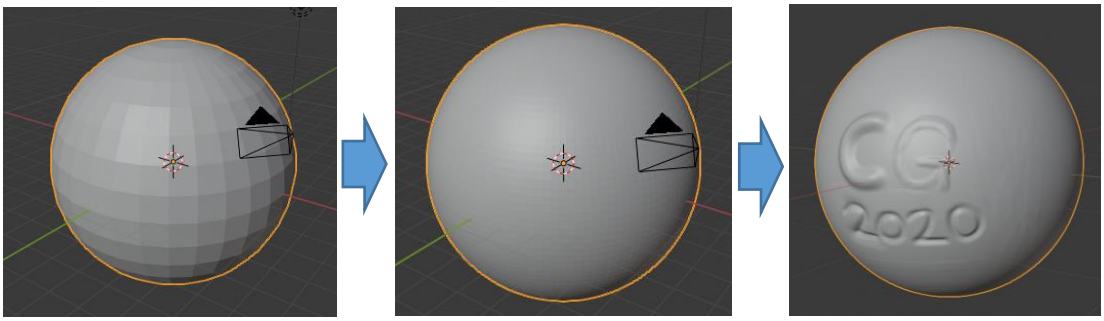
Sculpt Mode

You can use your mouse as a sculpt 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 ().





There are multiple tools that can be used in the Sculpt Mode. For instance, you can draw or 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., "2020" 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.

Materials

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

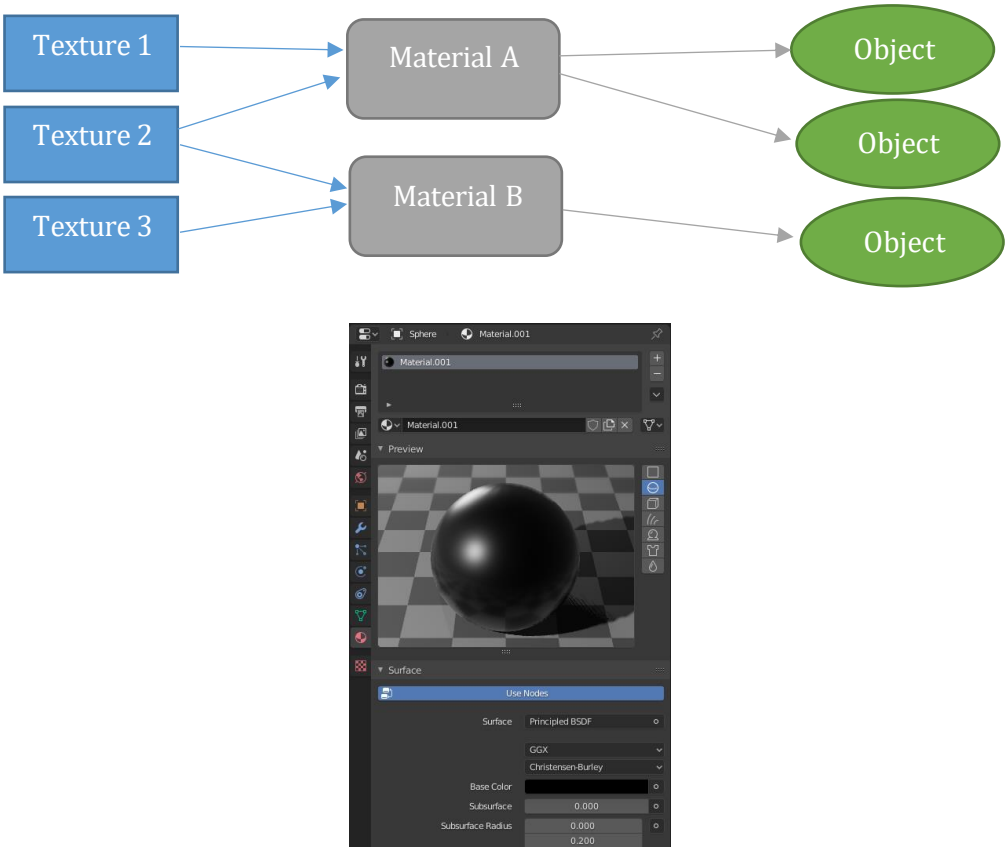


Figure 10 The Material tab inside the Properties area.

Light and Camera Objects

Lights and cameras are special objects inside Blender with their own properties comparing 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.

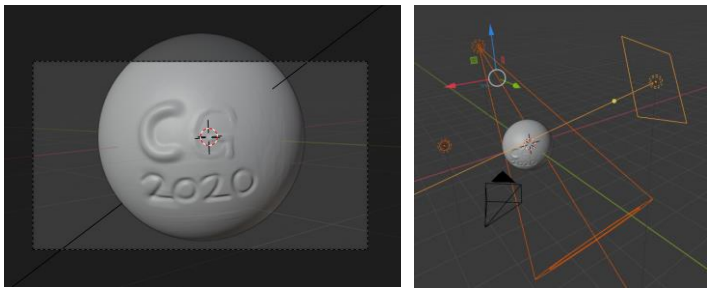
You can choose point light, virtual sun, spotlights and area light for light sources. Each has its own properties and effect. All light sources can cast shadows, which are enabled by default.

You can choose perspective, orthographic and panoramic camera 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 active camera by the dark frame inside the viewport when switched to one.

Special transformation and shortcuts for cameras:

1. You can click inside 3D View to switch to the active camera, which will be the render camera. This can also be done with shortcut `Numpad 0`.
2. You can quickly transform your active camera to current non-active camera view with shortcut `Ctrl+Alt+Numpad 0`.

3. You can quickly change current viewing camera as active camera with shortcut `Ctrl+Numpad 0`.



Left: view from the active camera. Right: Sphere lit by a point light, a spot light and an area light, viewed by the active camera.

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 sequences. You can use Blender 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 hardware accelerated ray intersection engine. You can check if your hardware supports these features in `Edit/Preferences/System`.

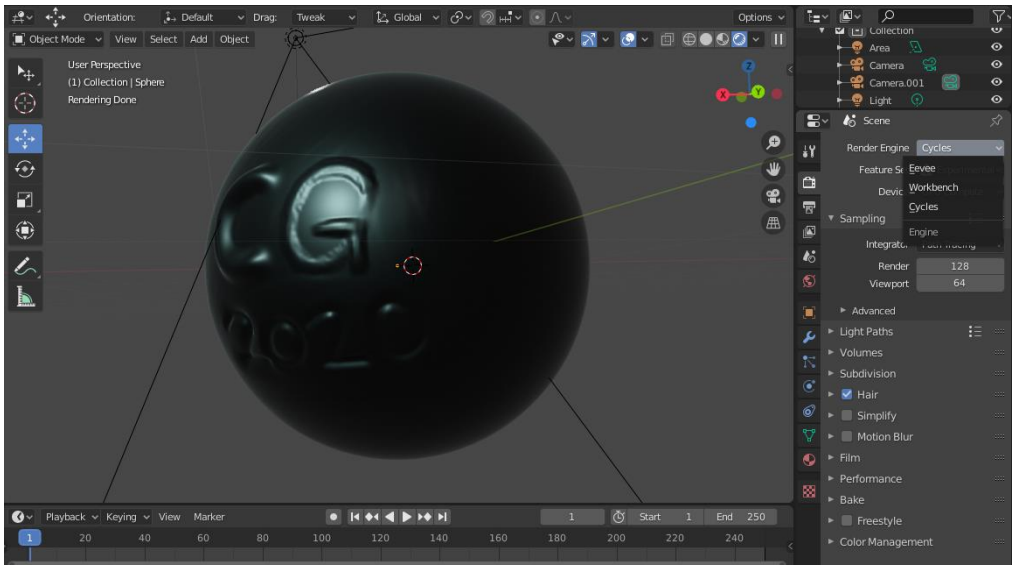


Figure 11 Preview render using Cycles engine with RTX GPU support.

You can callout 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 prior to 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.

Complete render settings can be referenced via the Blender manual, and this video also shows what are most relevant to us.

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.

Saving and Opening Documents

During edit, 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.

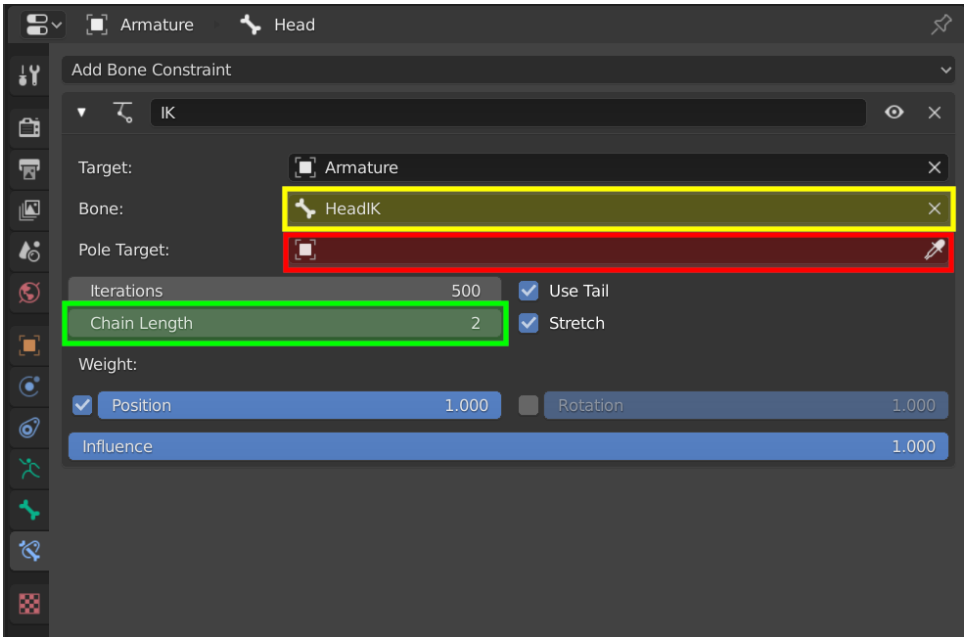
Rigging and Animating a Character

Creating the rig for a mesh consists of basically two things. The first is the armature, the second are the skinning weights.

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.

Creating an Armature: Press `shift+a` in object mode to open the add menu and *select armature* > *single bone* to create an armature object. 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.

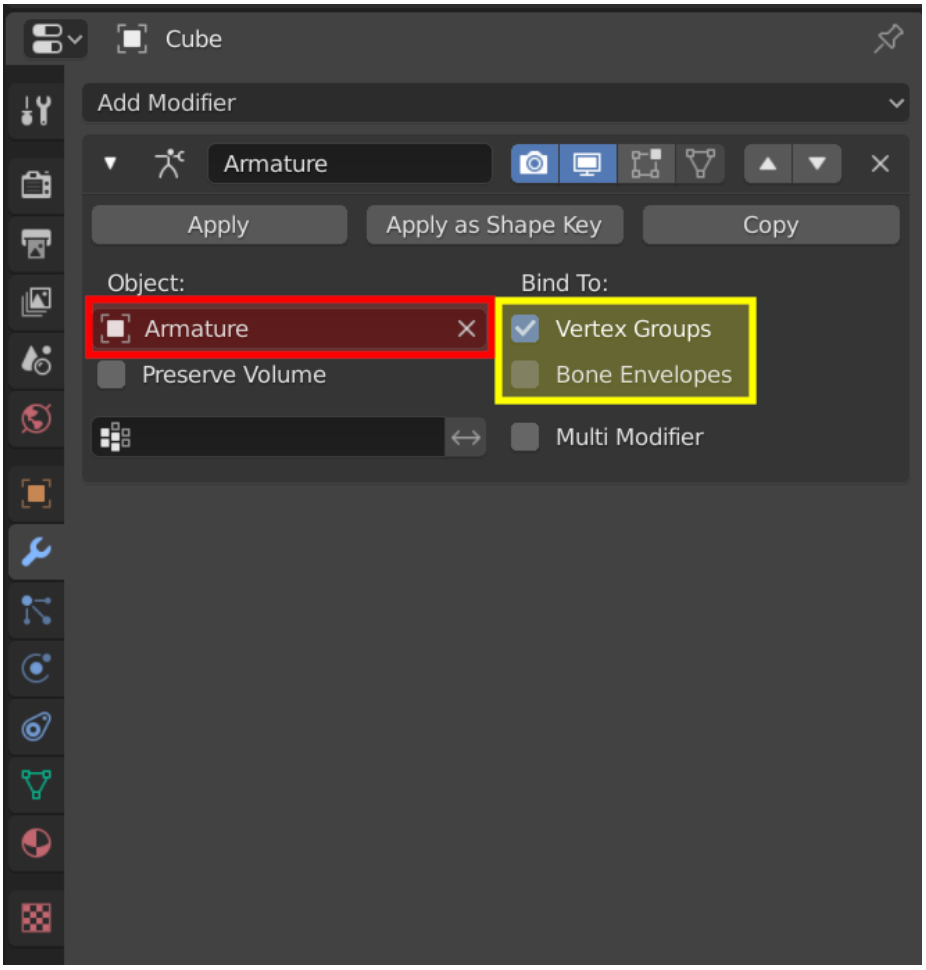
Bones of an armature do not need necessarily all be connected. `shift+a` will create a new unconnected bone. You can then parent a selection to the active bone, `shift+click` will make the last selection active, by hitting `ctrl+p` and select keep offset. This will help to bridge larger gaps between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



The bone constraint properties tab with an IK constraint set.

Inverse Kinematics: With an armature selected, you can enter the pose mode by `ctrl+tab` which lets you set the transformations for the armature which 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.

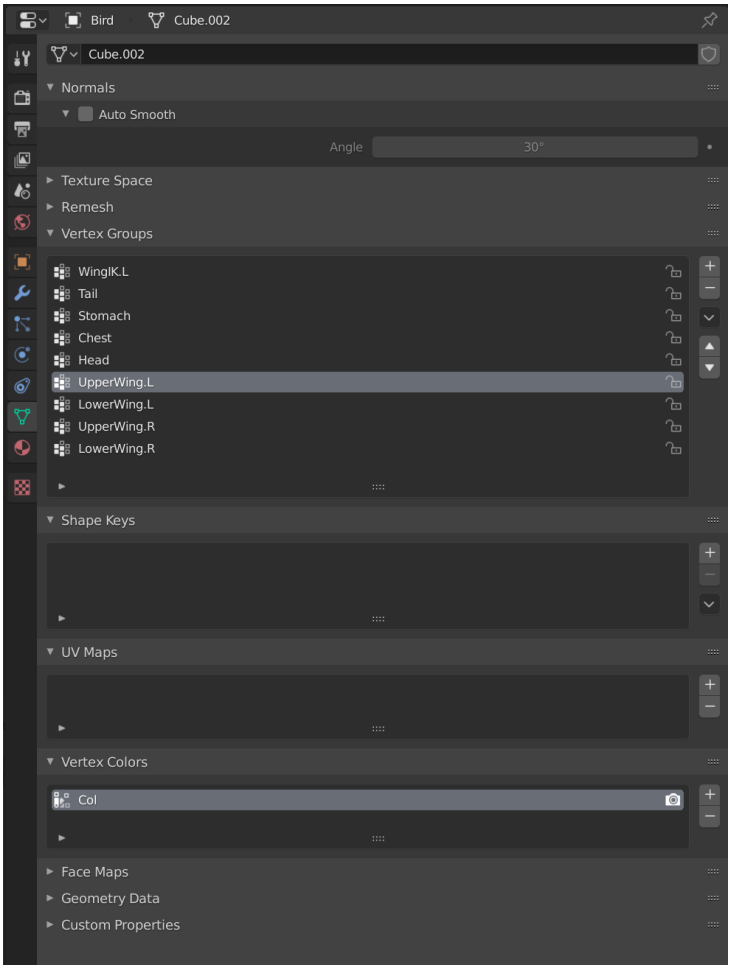
Applying the Armature to the Mesh: An armature deformation is a Modifier, which is the term that groups the non-destructive operations in Blender. Select your mesh, go to the modifier tab in the properties area, and add an armature modifier from the add modifier menu. You'll need to select the armature object that shall influence the deformation, this is the red overlayed field in the figure below.



The bird's modifier tab with one armature modifier.

Skinning Weights Blender implements two ways to define the influence of armatures, see the yellow overlay in the figure above. 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.

Hint: 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.



The vertex groups panel in the mesh's data properties tab.

Painting Weights When the mesh is selected, click `ctrl+tab` to enter weight paint mode. You can easily change the brush type and its parameters using the top menu. The brush painting influences 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.

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 editing individually. The dope sheet editor view will give you finer control over the animation as it lists all actions on a timeline and neatly separated by the all references that have been inserted.

- A video tutorial on how to set up a simple, but effective rig and how to animate it:
  - https://www.youtube.com/watch?v=srpOeu9UUBU

- Good rigging and animation tutorials using older versions:
  - on rigging: https://www.youtube.com/watch?v=cGvalWG8HBU
  - on animation: https://www.youtube.com/watch?v=d-wQ8nRWTBs