LAB TWO

Intro to Blender

Requirement

1. **Blender** (using version 2.80+)

Blender is an electric mixing machine used in food preparation for liquefying, chopping, or pureeing. We're kidding of course! Blender is a free license computer graphics toolkit that is primarily used in creating films, art, and (most importantly for us) 3D models.

Before we go over the basics, we will review some terms you may not be familiar with. You will encounter them throughout the lab. Read the glossary in Table 1 below to get a brief understanding of what these terms mean.

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Glossary

Workspace	These are containers with different editors and controls. Some workspaces include "Layout," "Sculpting," and "Animation" controls.
Editor	Editors are specialized windows that display data that can be modified.
Object	Like Unity's GameObject, this is a virtual object that exists within the scene.
Collection	These are containers for objects. They can be used like folders.
Mode	The different editing modes which allow you to edit the model in different ways depending on the mode. Some modes include "Object," "Edit." and "Sculpt."
Vertex, Edge, & Face	A vertex is a single point, an edge is a line segment between two vertices, and a face is a flat surface. These three make up a mesh and can be selected and manipulated within the "Edit" mode.

Glossary of common terms. Table 1

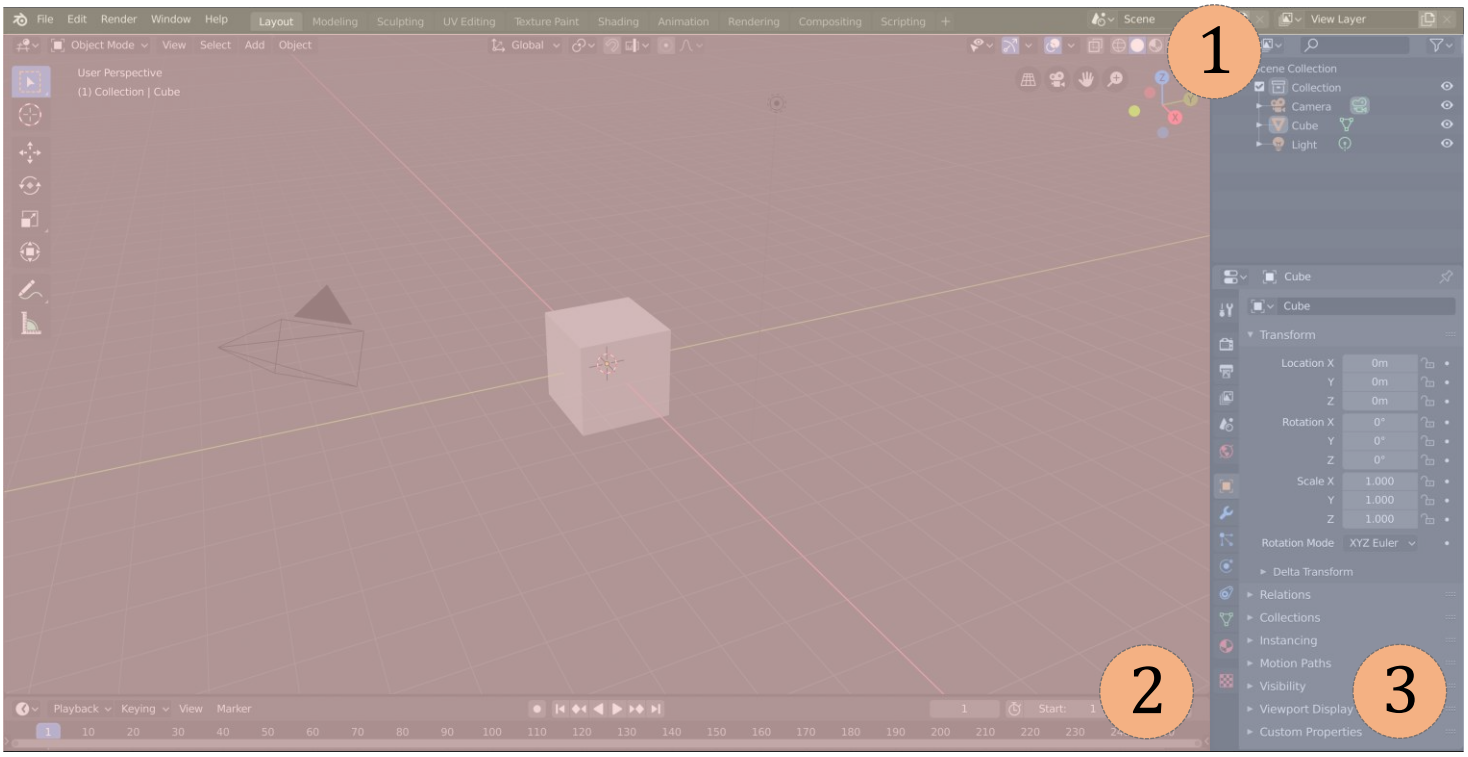
Blender has a very large set of powerful features and tools and is even used professionally. Blender provides a detailed **user manual** which provides guidance in navigating the UI and utilization of the available tools.

The primary purpose of this Lab is to teach you the fundamentals on how to create custom models that will be exported and used within Unity. In the advanced section, we will also cover animations. After you complete this Lab and the homework assignment, we encourage you to continue to explore and play around with creating more complex things on your free time.

New Blender Project

Let's begin with a brand-new project. To begin, open the Blender application. After it finishes loading, you will be presented with a splash screen where you can create a new project or open existing ones. We will be creating a general-purpose project so you can click on "General" under new project or click outside the splash screen to close it. The default screen you are presented with is shown in **Figure 1** (minus the coloration).

New Blender



Default view after creating a new project: (1) top bar, (2) main workspace editor, (3) side workspace editors. Figure 1

Blender Interface Navigation

Similar to Unity, the Blender interface can be changed, resized, and moved however you like. We will first start with the top bar **[Figure 1, #1]** since the layout will change to the default layout of each workspace. This section will be divided into three parts seen in **Table 2**.

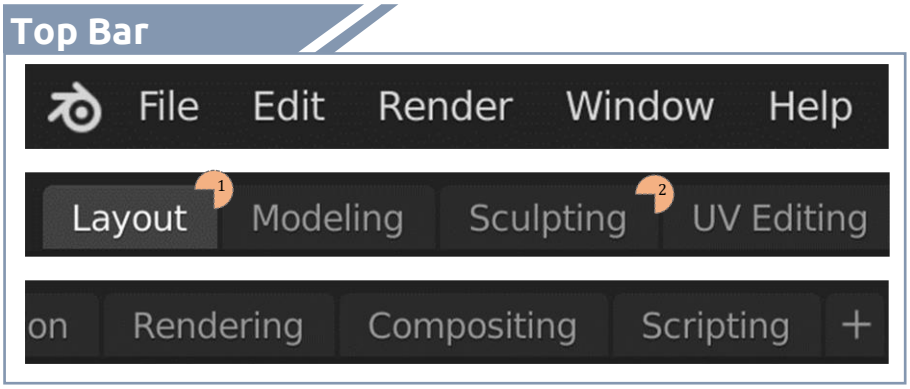
Blender UI

1	**Top Bar (Menus & Tabs)**	Editor options and controls. Tabs for workspaces.
2	**Main Workspace Editors**	Primary display of workspace editors
3	**Side Workspace Editors**	Side display of editors (normally only Outliner & Properties)

Table of primary UI sections. Table 2

Top Bar & Tabs

The top bar allows you to access different menus and navigate the workspaces.



A few snippets of the top bar. Figure 2

The menu bar gives access to more advanced actions and settings. The workspaces can be navigated by clicking on the named tabs.

We will not go over all of them, but you can find out more in the User Manual. **Table 3** has brief descriptions of important menus and workspaces.

Menus & Tabs

File > Export	Usable export file types are .fbx & .obj
Layout	The primary workspace you will likely be using for the Labs. Consists of the 3D viewport which allows you to manipulate objects within the scene.
Sculpting	This workspace has the 3D viewport set to sculpting mode. This mode allows you to sculpt the object's mesh using various tools.
Texture Paint	This workspace contains the 3D viewport set to texture paint mode. This mode allows you to change the texture of an object and paint over it.
Animation	This workspace contains the dope sheet which allows you to see and manipulate keyframes. Blender interpolates these keyframes to create animations between them.

Table 3

Main Workspace Editors

The workspace editors can be seen in **[Figure 1, #2 & 3]**. Each workspace will have a different default layout or modes for the editors. You could work from the same workspace by just changing the editors every time. However, having dedicated workspaces makes it easier to have multiple complex layouts set up, each for a different task. This way you don't have to keep changing the editors.

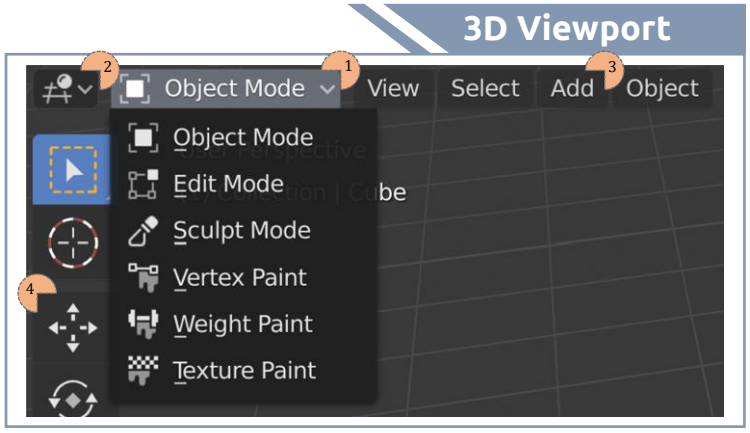
Many workspaces will have the "Outliner" and "Properties" editors on the side. The Outliner is similar to the hierarchy window in Unity. It shows collections of objects within the project and allows you to move or copy them. The Properties editor works like the Inspector Menu. It changes depending on what object is currently selected and allows you to modify the transform, material, modifiers, and more. It also has other options such as scene settings. As seen from **[Figure 1, #3]** a cube is currently selected, and its name and data show up in the properties editor. It can also be seen within the outliner along with the camera and light objects.

The workspace editors **[Figure 1, #2]** take up most of the screen. You can see that for the "Layout" workspace, the editors that are being used is "3D Viewport" and "Timeline" which is mainly used for animation or physics simulations.

The editor you will be using the most is the 3D Viewport . This editor has different modes to choose from. The ones you will be using are Object, Edit, Sculpt, and Texture Paint. You can change these by going to the top left corner and clicking the drop-down menu, as seen in [**Figure 3, #1]** .

Along with being able to change the mode, you can also see other options in this area. The one to the left of the mode drop-down is the editor drop-down **[Figure 3, #2]**. You can change the editor that is being displayed to a selection of other editors.

There is also the "Add" button **[Figure 3, #3]** which allows you to add new objects (mesh, light, camera, etc.). You will use this a lot, so it is a good idea to know the shortcut key binding for it.



Top left corner of 3D viewport showing mode selection. Figure 3

The default key binding for Add is **Shift+A**. There are many other shortcut key bindings that you can learn more about in the Manual. It is also important to note that some common key bindings are different than what you would expect. Refer to **Table 4** for some of these key bindings. Then, in **Table 5**, there are controls for moving the viewport camera, which works differently than in Unity.

Shortcut Keys

Ctrl+Shift+Z	Undo
Shift+LMB	Multi-select
Shift+A	Add
Tab	Edit mode toggle

Table 4

Move View

MMB	Rotate around view center
Alt+MMB	Set view center to cursor
Shift+MMB	Pan view
Shift+Ctrl+MMB	Dolly view

Table 5

Hovering over most buttons will also give you the corresponding shortcut key bindings if one is available. After you figured out how to move the viewport camera around, try to move the default cube around.

When you select the cube (or any object), an orange outline should appear indicating that it had been selected. The buttons on the left side **[Figure 3, #4]** work just like the ones in Unity's tool bar. Selecting them will bring up control points where you can click and drag to manipulate. They also have key bindings which are **G**, **R**, & **S** for move, rotate, & scale, respectively. When using the key bindings, holding down the MMB will allow you to snap the movement to one axis. You can manipulate the object's position this way through the transform menu in the properties editor, for exact numbers.

There are other buttons and options on this side of the editor that you can explore on your own. For example, the annotate tool is useful for planning out your design or marking something down.

Top right corner of the 3D viewport. Figure 4

On the top right-hand corner of the editor there are a few more controls and options that manipulate the viewport camera and the shading of the scene.

We will go over a few important options. Viewport shading controls are shown in **[Figure 4, #1]** They change how the scene is displayed and can be useful when modeling or moving objects around. There are 4 presets and the dropdown allow for complete control of shading settings.

Try changing them and notice the differences while noting the different names when you hover over them. You will mainly be using the "Wireframe" and "Solid" shaders but viewing the "Look Dev" or "Rendered" shaders will show the textures and/or materials of the models as well.

> **TIP:** You can use the wireframe shading option when lining objects up or to see through solid meshes. Similarly, the Solid option (directly to the left of the wireframe option) makes everything in the scene appear translucent such as solid object.

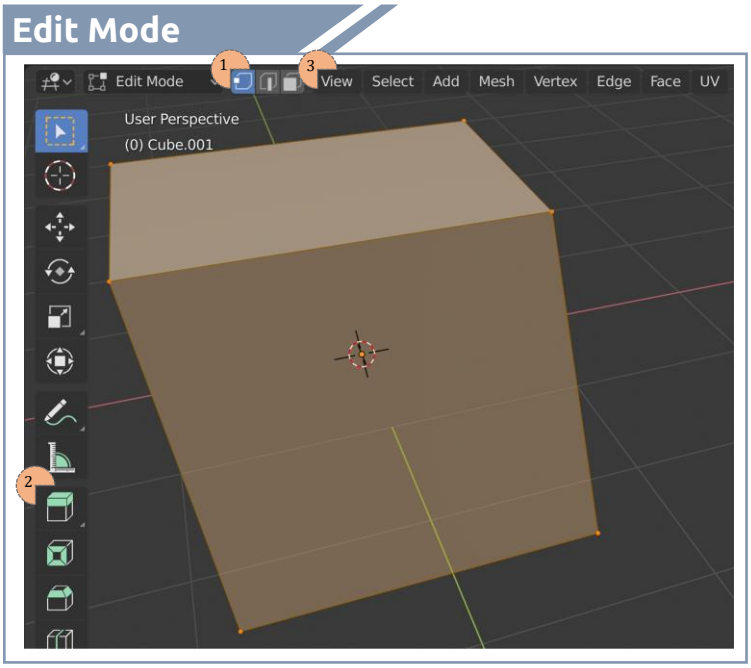
Similar to Unity's UI, displayed on the top right is the "Orbit" gizmo **[Figure 4, #2]**. This gizmo shows the current directions of the 3 axis (X, Y, Z) and allows you to rotate or align the viewport.

Clicking directly on one of the circles snaps the viewport into a flat perspective aligning with the direction of the axis that is clicked. This is very useful when creating models since it allows you to align or move things into place without 3D perspective involved (which can make it hard to judge size and distance).

Another workspace that you may use is called "Sculpting" **[Figure 2, #2]**. You can either use that workspace or simply change the mode to "Sculpt Mode," as seen in **[Figure 3, #1]**. This mode allows you to sculpt your mesh, as if it were clay. To do this, the mesh must have more facets than the default cube has. If you tried to sculpt the default cube, little to nothing will change. This is because of it has a single facet on each side.

We will cover sculpting in more detail in a later section of this Lab.

"Edit" mode is the main mode where modeling is done. You can use the tab key to toggle between your current mode and the edit mode. You can only edit the object or objects that you have currently selected when entering this mode from Object mode. In this mode, you should be able to see the facets, edges, and vertices of the selected object(s).



Left hand corner of editor mode in 3D viewport. Figure 5

Figure 5 shows how the cube changes the way it looks once it had been selected in edit mode. Anything that is orange is selected while anything that is gray is not.

There are a few options at the top that change what you had selected **[Figure 5, #1]**. The three options (from left to right) are vertex, edge, and face select. Try selecting the different parts of the mesh. Selecting an already selected part will deselect it and to select multiple, you will need to hold down the shift key. You can also deselect everything by clicking outside the mesh.

You may also have noticed that selecting two vertices will select the connecting edge or selecting four edges of a face will select the entire face.

There are also different useful quick tools that you can use to manipulate the selected parts of the mesh on the side as seen in **[Figure 5, #2]** and more category specific tools in **[Figure 5, #3]**. There are a lot of tools that are useful here, so it is important to read the documentation to find out more. We will cover a few of these tools in an upcoming section.

Side Workspace Editors

As mentioned previously the editors found on the side of the interface are the "Outliner" and "Properties" editors **[Figure 6, #1 & 2]** which are very similar to Unity's Hierarchy and Inspector windows, respectively.

In **Figure 5**, you can see that once a cube is selected it os highlighted and its name is displayed in the properties editor.

In the Outliner editor **[Figure 6, #1]**, you can see collections of objects. You can create more collections by right-clicking on any existing collection and selecting "New." This will create a collection that is a child of the collection you clicked on. A "Scene Collection" is the top-level collection, which contains all objects and collections in the project.

Adding objects will add to the currently selected collection, so be aware of this when creating new objects and organizing collections.

You can drag and move objects around in this editor which allows for organization. You can hide or show entire collections by clicking the eye symbol on the right. Similarly, you can hide individual objects by re-clicking the eye on the right.

The checkbox to the left of the collection name has similar functionality, by controlling whether all objects within that collection appear in a rendering.

In the properties editor ❷ **[Figure 6, #2]**, the name of the currently selected object is at the top (in this case "Cube"). There are a lot of tabs and options in this editor, so we will only cover the main options that you will be using.

The "Object" tab ❸ **[Figure 6, #3]** is where transform properties are. This allows you to edit or see the position, rotation, and scaling of the selected object (much like in Unity).

The "Modifiers" tab ❹ **[Figure 6, #4]** allows you to add operations to the selected object. These operations apply various effects that are non-destructive unless you apply them. This means you can remove modifiers to reverse their effects.

Finally, the "Material" tab ❺ **[Figure 6, #5]** allows you to add or edit the material properties of the object. Materials, as you have previously learned, change the appearance of the mesh.

We will use these options in more detail in an upcoming section.

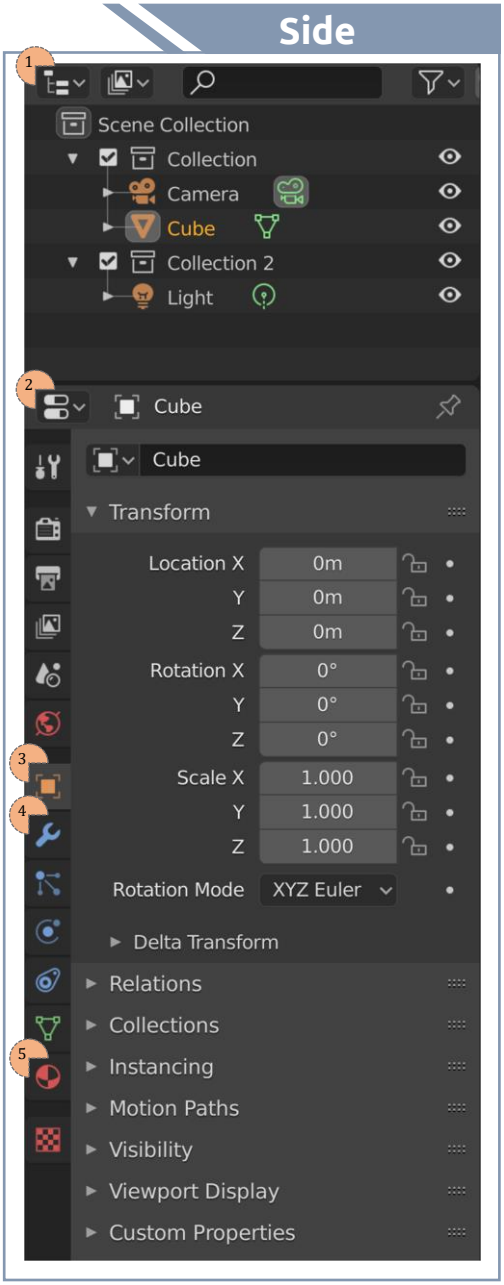
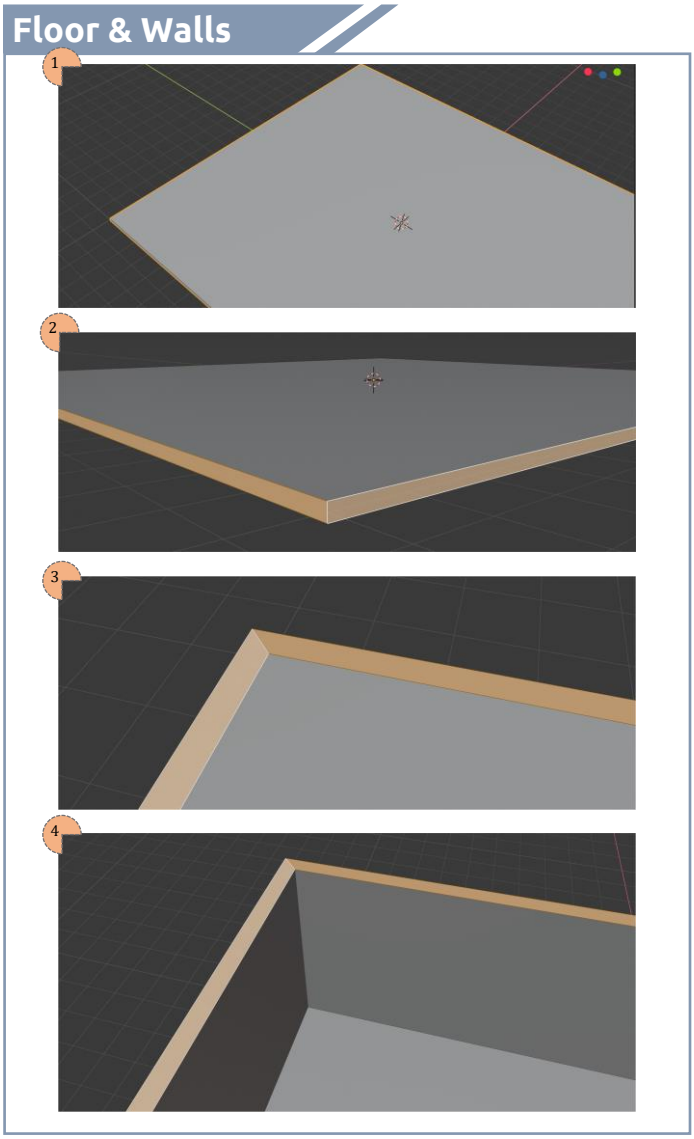


Figure 6

Simple Room Tutorial

Now that the most fundamental controls have been discussed, we will begin with a simple demonstration of how to create a basic scene in Blender. This will give you some practice while learning the controls. After this section you should be able to create multiple objects and position them around the scene. Then, you can apply materials and textures and create a basic room.

First, you can remove all the default camera and light source from the scene. We can add those back later. Starting with the default cube, we can reduce the scaling along the Z-axis and scale the X and Y-axis to your desired size (we used 5m x 5m) to create a floor, as seen in **[Figure 7, #1]**. Alternatively, you can use a plane object to create your floor too, but we wanted to give the floor some thickness.



Creating a room (floor & walls) in four steps. Figure 7

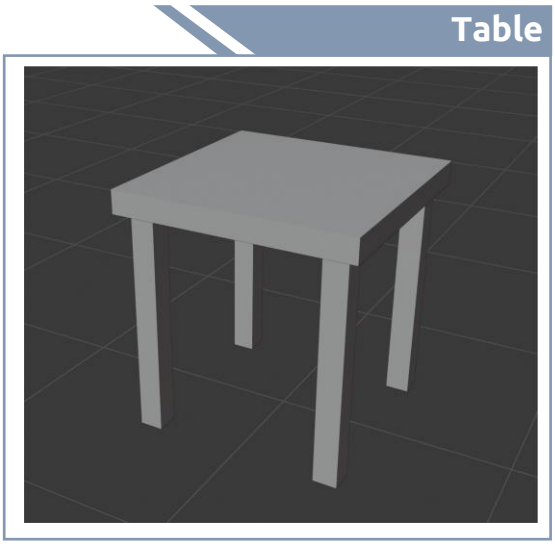
Now that the floor is in place, we will create two walls so to form the corner of a room. To do so, we will go into edit mode and extrude the walls.

Once you are in edit mode, select two side faces that form a corner **[Figure 7, #2]**. Once you have selected them, find the orbit gizmo and click on the circle labeled "Z". This will snap the view into a top down view of the floor.

Then, you can either right-click and select "Extrude" or simply press the E key. The mesh will drag out along with your cursor. Notice that there is a guideline that fixates the direction the extrusion goes in. You can either manually move it to a size you are happy with or type in a number directly. Then, left click or press enter to apply the changes.

For this wall, we do not want it too thick, so we will extrude it out by 0.5m. Rotate the viewport camera out of the top down view and select the top faces of the newly extruded mesh **[Figure 7, #3]** and extrude those upward.

And just like that, you have created a corner of a room **[Figure 7, #4]**! Again, you can use planes if you prefer. You can now decorate the room with furniture. Let's make a table and a chair.



Creating a simple table. Figure 8

When you want to add a new object, you must first go back to Object mode. Adding objects while in edit mode will parent the meshes together (which we do not want in this case).

Add a cube by going into Add>Mesh or pressing Shift+A. We want to create the top of a table, so we will scale it like we did for the floor, but at a smaller scale since it's going to be a small table.

You can then add legs to the table by scaling another cube into a long rectangle and duplicate it for all four legs. This is a very basic table and you can certainly add a lot more detail to it. Let's try adding a bevel to the edges of the table.

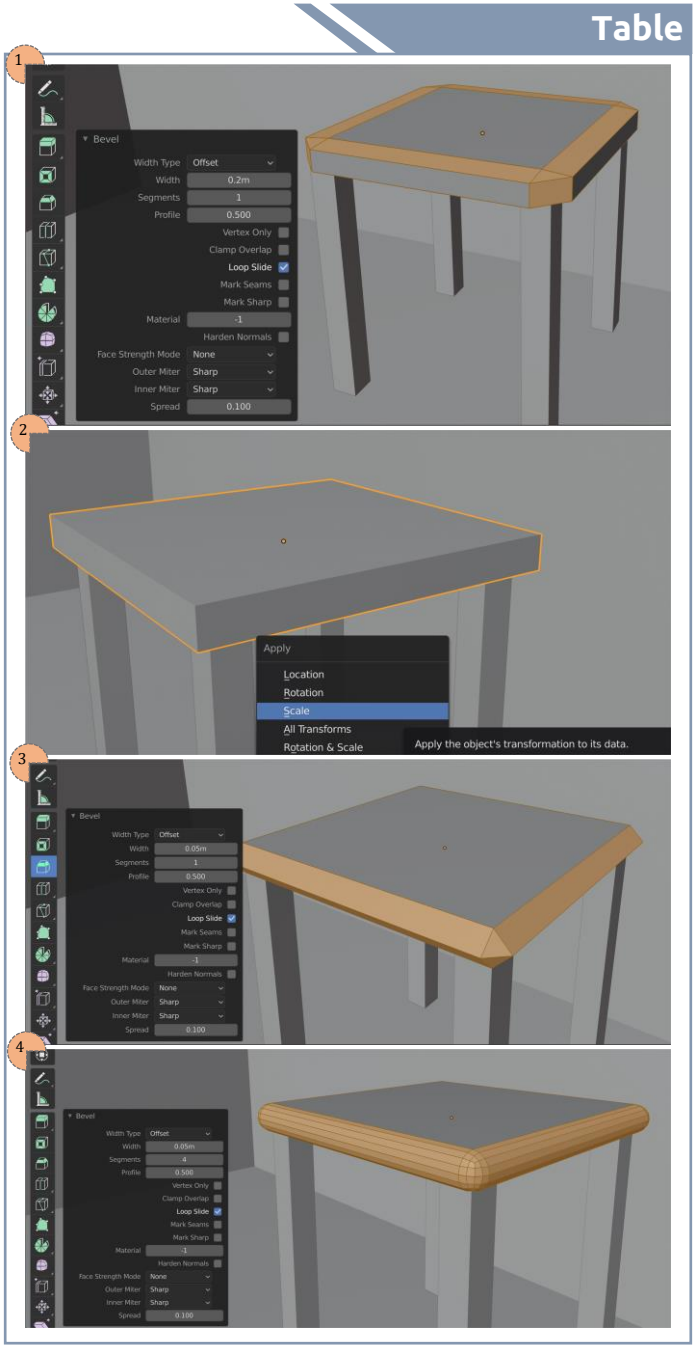
A bevel tool can be used by going to Edit mode once the top of the table had been selected. First, you need to select the faces on the edge sides of the table. Then, select the bevel tool and click and drag anywhere in the viewport. You can also use the keyboard shortcut (Ctrl+B) for this. This will create the bevel on the 4 selected faces.

A "Bevel" menu will pop up (if not it may be minimized) **[Figure 9, #1]**. Refer to the manual for what each value or option does.

However, there is a slight problem with this. The bevel tool (in fact most tools) behaves differently than expected when the object is scaled. When scaling up, the bevel becomes a lot shallower and does not behave how we want it (unless you purposefully want it to look that way).

Say we want the entire edge of the table to be rounded but cannot achieve this no matter how large the width value is set at. To solve this problem, we must first apply the scaling. First, undo the bevel you just applied. Then, go into object mode and press Ctrl+A to bring up the Apply menu. Select "Scale" (this will apply the current scaling) **[Figure 9, #2]**. Notice in the transform properties that the scale value is now all 1's, but the shape is the same. Now apply the bevel again **[Figure 9, #3]**.

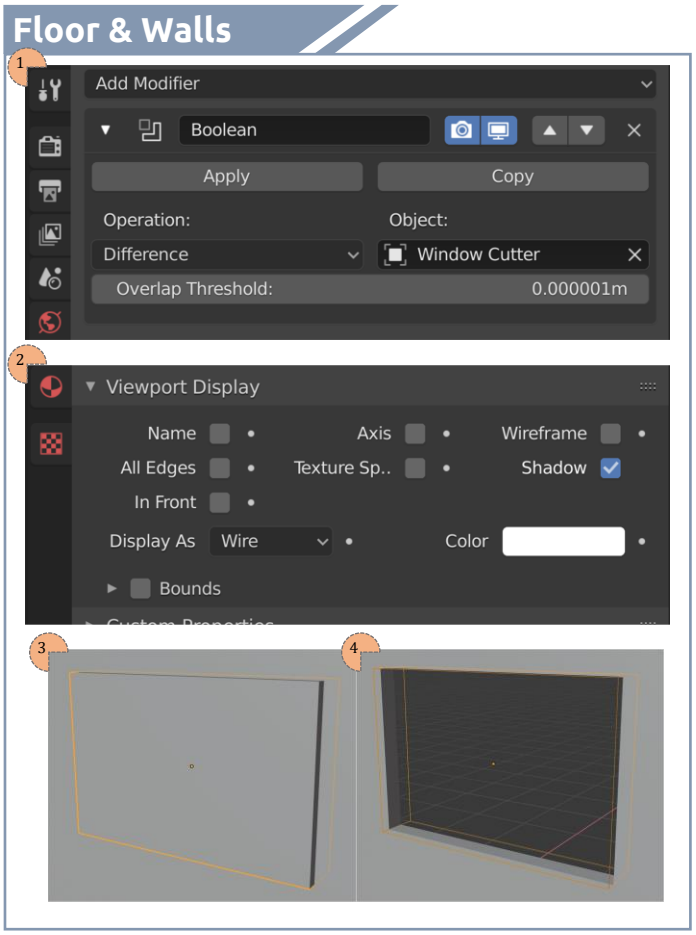
Next, you will want to increase the number of segments which will increase the resolution of the bevel **[Figure 9, #4]**. Don't worry if it's a bit blocky/flat, you can set the shading to smooth it out. Right click on the table and select "Shade Smooth."



Adding a bevel to the edge of the table. Figure 9

Now you have a simple table that you can use or add more detail to! You can also make more furniture like chairs, lamps, shelves, etc. Try out sculping your own shapes using the sculpting workspace.

Next, let's look at what we can use Modifiers for. We will create a window that goes through the wall we had made earlier. First, add a cube and scale it so that it is the size you want for the window. Make sure the thickness of this cube is a bit thicker than that of the wall. We will use this to cut a rectangular hole through the wall.



Creating a hole in the wall for a window. Figure 10

Select the floor & walls object and go into the Modifiers tab within the properties editor.

Select the "Add Modifier" drop-down menu and select "Boolean." This will add the Boolean modifier ❓ to the list of modifiers **[Figure 10, #1]**. Under "Object:", use the eyedropper tool (or type in its name) to select the window sized cube you made. The default setting is difference so it will remove the volume that cube occupies.

To see what is going on, you want to set this cube to wireframe. Going into the Object tab of the properties editor, find "Viewport Display" and change "Display As" to "Wire" **[Figure 10, #2]**.

Now, move the cube into the wall where you want your window to be. You can hide this cube, so you don't see the wireframe **[Figure 10, #4]**.

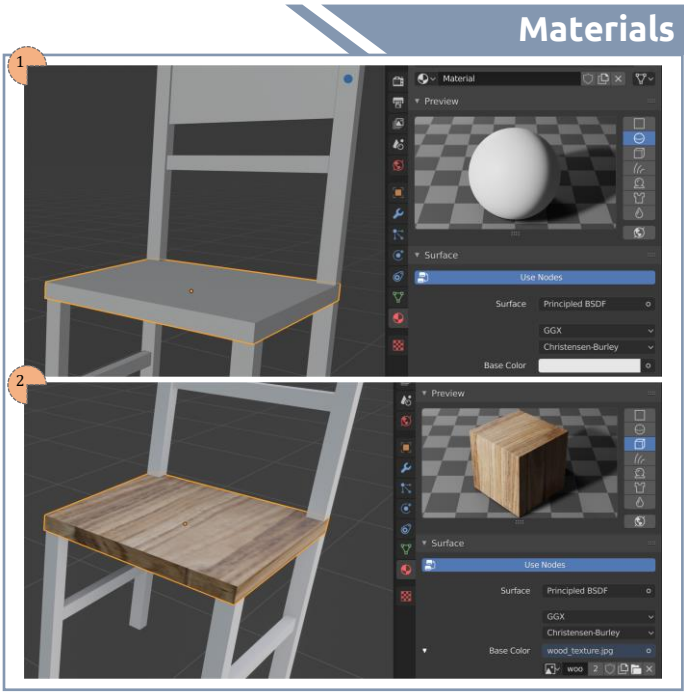
You can now create the window frame using a technique of your choice: adding cubes, using extrusion, or adding Boolean modifiers.

Now that we have some models made, lets add textures.

Adding materials to objects within Blender will also allow you to export them into Unity. To begin, you want to select the object you want to add a material to. Then, go to the "Material" tab in the properties editor. Since this is the first material being applied to the object, you will need to create a new material. Once it is created you should see an interface that looks like **[Figure 11, #1]**.

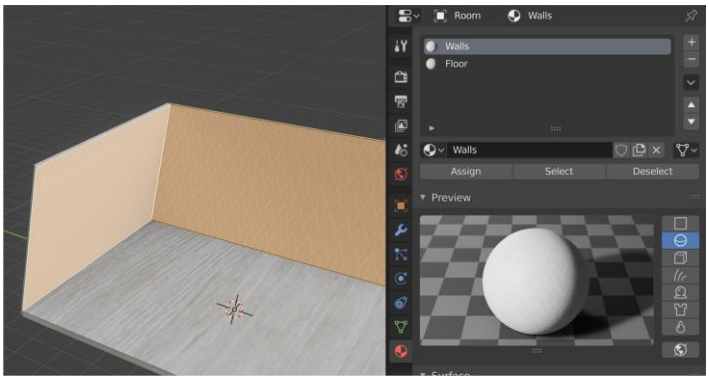
You can change the shader, color, and other different settings, in a similar way to Unity. For this chair, we will use a wooden texture.

To input a texture, select the circle to the right of "Base Color". Select the "Image Texture" option. You should be able to click "Open" and find a texture that is saved on your hard drive. Then, select the "Look Dev" viewport shading (top right of the 3D viewport) to see the material **[Figure 11, #2]**.



Adding wood texture to a simple chair. Figure 11

Multi Materials



Setting the walls as one material and the floor as another. Figure 12

Materials can be reused for different objects, so you do not need to make a new material for every single mesh.

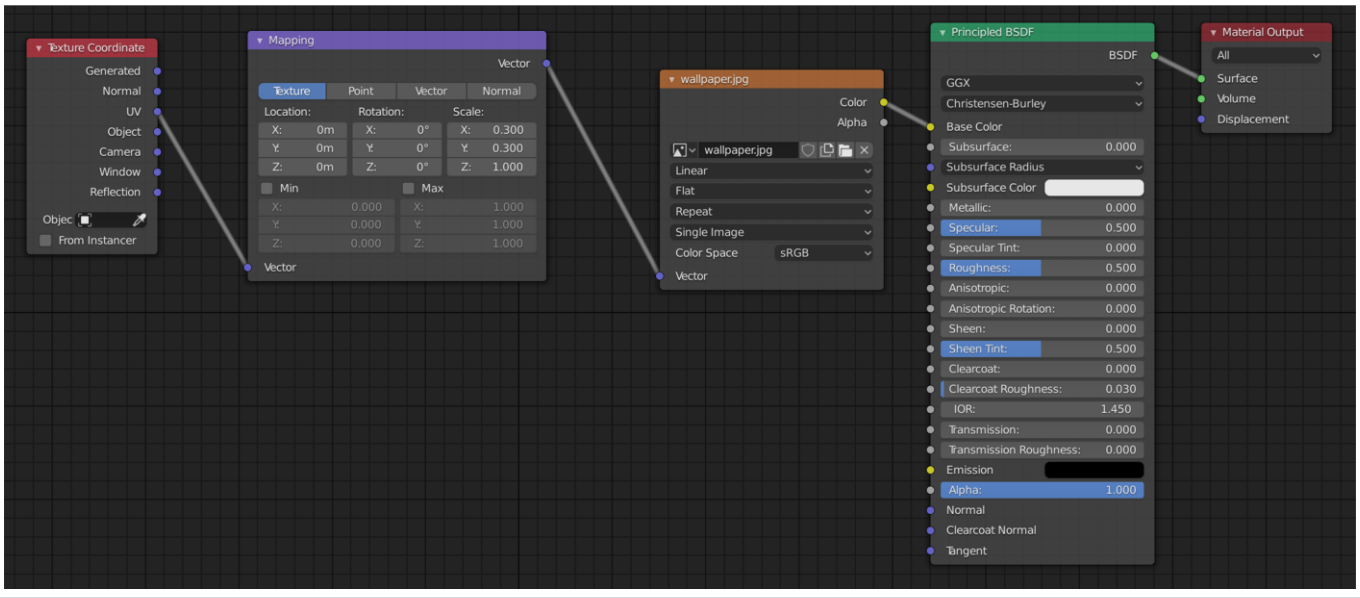
Materials can be accessed by clicking the  icon in the materials tab. There you can browse or search for other existing materials.

It is also possible to have different textures on different parts of the same mesh. Start by adding another material with the plus button on the top right. Then, going into edit mode, select the faces you want the texture to be applied to. Finally select the material and select "Assign" to assign the material to those faces. You can repeat for all materials you want by selecting different faces and then assigning the desired material to them.

Furthermore, you may want to tile a texture. To do so, you must use shader nodes. Select the object you want to edit and go into the "Shading" workspace. Once you are there, you will see a node editor at the bottom. Add and connect the following nodes as shown in **Figure 13**. Then, change the scale on the "Mapping" node to tile the texture to your liking.

Once you have added all your textures, feel free to experiment with other objects and features Blender has to offer such as lighting, reflections, shader nodes, texture painting, rendering, and other tools. **Figure 21** shows our example scene, fully rendered with a few pieces of furniture and lighting. You will not need to render an image, but if you decide that you want to, simply add a camera object and go to Render>Render Image from the top bar.

Tiling with Nodes



Nodes for tiling textures. The node "wallpaper.jpg" is the texture node and will change depending on the file name. Figure 13

Advanced Section

Basic Animations

Besides modeling and rendering, Blender is also capable of rigging and animations. These animations can be exported and used in Unity to supplement its native animation tool (more in a different Lab).

To begin, select your object and go into the "Animation" workspace. Here you will be able to see a dope sheet **[Figure 14, #1]** as well as two 3D viewports at the top.

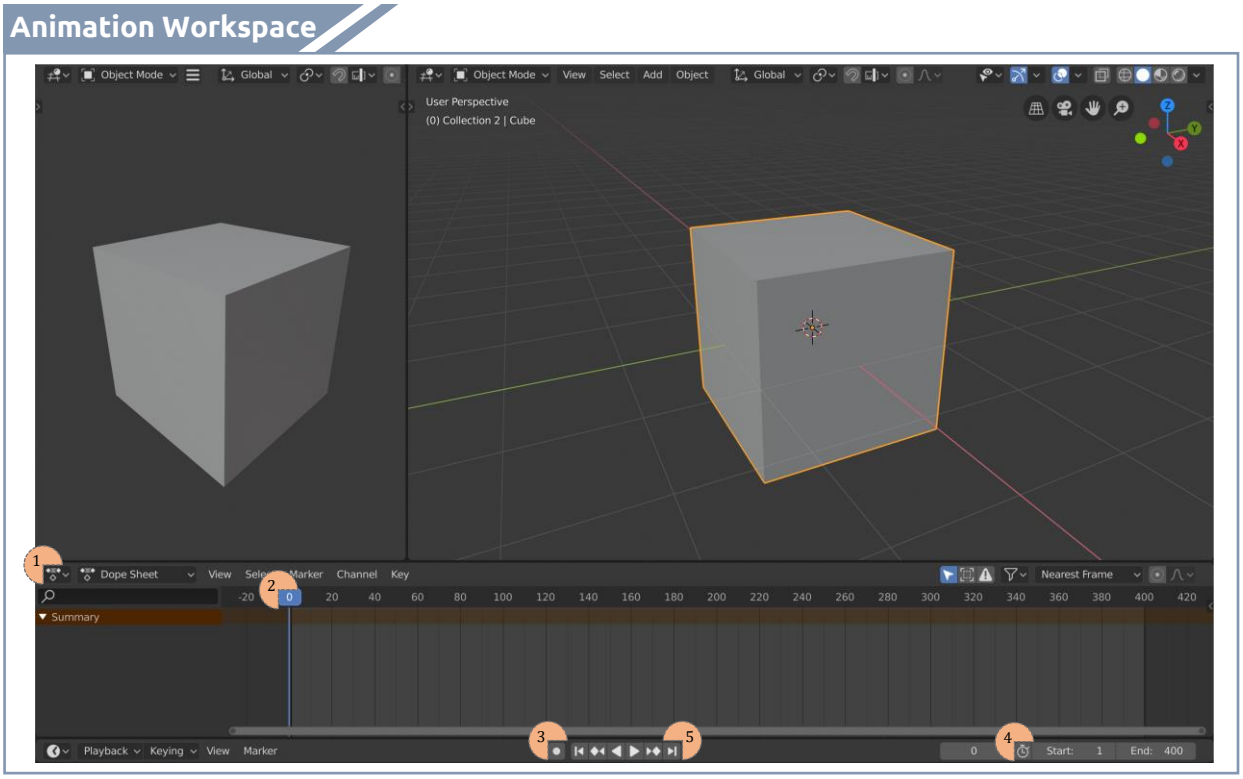


Figure 14

The dope sheet displays the keyframes inside a scene and allows you to manipulate and change the location and timing of these keyframes. Keyframes are frames that you can define and the animation in between them will be interpolated by Blender. In classical hand drawn animation, every frame would have to be done manually!

Let's try animating this cube. First, you want to insert the first keyframe as the starting position of the cube. You can do this by right-clicking and selecting "Insert Keyframe" or pressing the "I" key. A menu will come up showing you what data will be saved into the keyframe. Select "LocRotScale" for location, rotation, and scale.

A few dots will appear on the dope sheet timeline indicating the keyframes. You can scrub the timeline (in units of frames), or click on the numbers to move the blue line **[Figure 14, #2]** over to where you want to place your next keyframe. You can also use "auto keying" which will place a

keyframe where the current timeline position is whenever the object is changed. This can be toggled by the record button **[Figure 14, #3]**.

Let's try to animate something simple, such as rolling over the default cube. First, put the blue line at frame 60. Next, change the cube's X rotation to 90° and shift the cube's position over by -1m. Insert the keyframe manually, or have auto keying on.

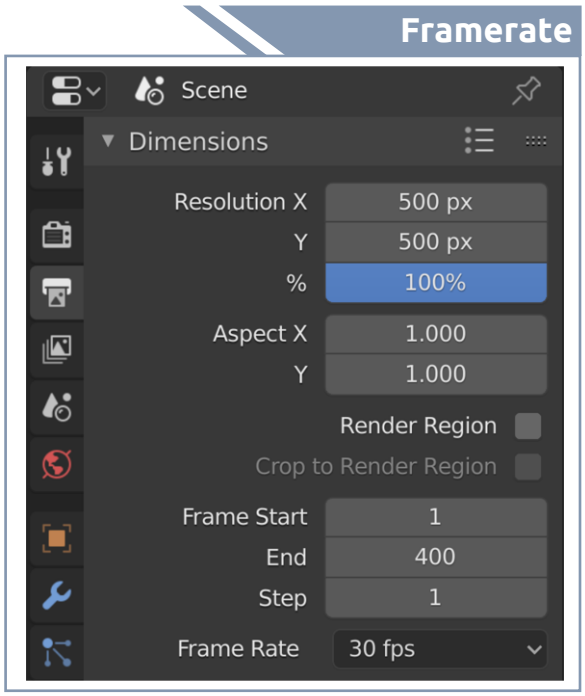
Now you can try playing the animation! Change the end frame value to 60 at the bottom right of the dope sheet **[Figure 14, #4]** so the animation will end at frame 60 and loop. Then, using the playback controls **[Figure 14, #5]**, press the play button. The animation will play back at the current output framerate. You can change the framerate by going to the properties editor and selecting the "Output" settings tab as seen in **Figure 15**. Then, you can change the framerate (frames per second or fps) to one of the preset values or set a custom rate.

It is also important to note when animating and playing back large, complex meshes, if your computer cannot handle the computation, it will be forced to play back at a much lower framerate.

You can see when it loops, it will snap back into the original keyframe. To stop this, we will add another keyframe which will rotate the cube back to the original position for a seamless loop.

Put the blue line at frame 120 and change the cube's rotation and position back to the original values. Alternatively, you can duplicate the first keyframe by selecting it (selected keyframes turn yellow) and moving the duplicate keyframe over to frame 120. The shortcuts are the same in the dope sheet as the 3D viewport (Shift+D for duplicate, G to move).

Now you have a seamless loop and a basic understanding of Blender animation!



Scene settings in output tab. Figure 15

Continue experimenting with animating the cube or other shapes by changing position, rotation, and scale more dramatically.

Armature Animations

In more advanced animations, we will be using armatures for animating meshes. Armatures allow you to manipulate and deform the mesh like bones in a body. In fact, the armature is made of object called bones.

This is a type of rigging which controls the object like a puppet. There is a special mode called "Pose Mode" which allows you to move and pose the bones, which in turn move and deform the mesh.

Let's begin by creating a basic mesh that we will try to deform and animate. We will start by adding a cylinder, rotating it to its side, and thinning and elongating it as seen in **[Figure 16, #1]**.

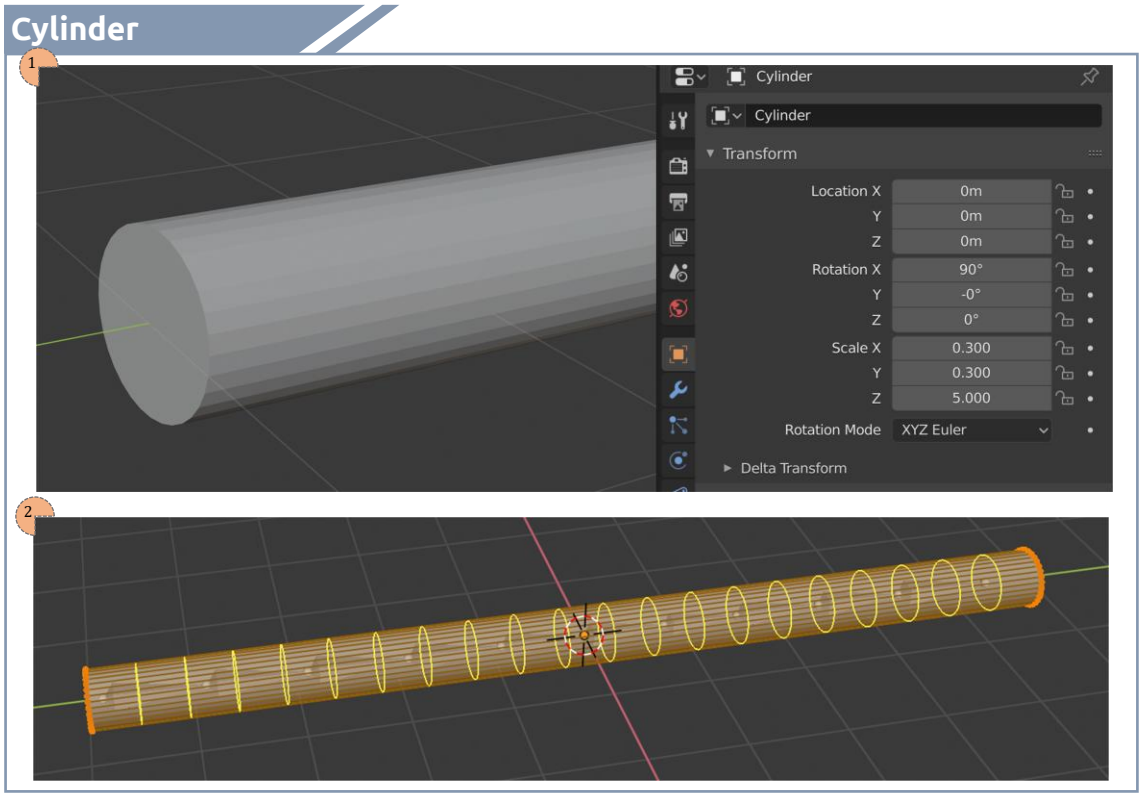


Figure 16

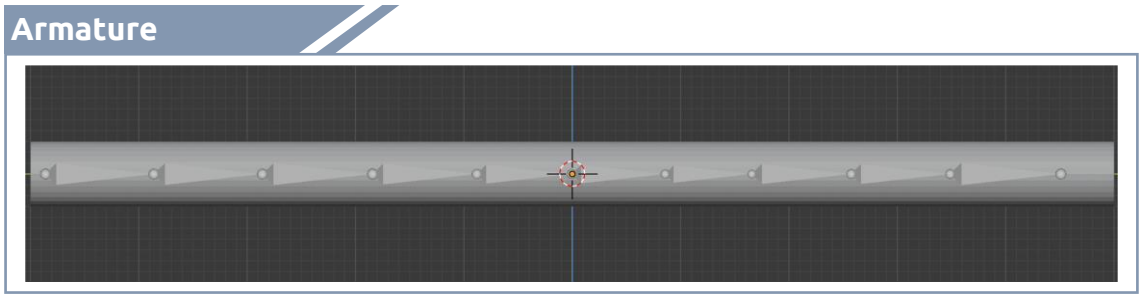
Then, we want to add edge loops around the length of the cylinder so it can bend. If you do not have these edge loops, when you parent the armature to the mesh, the automatic edge weights will not work properly.

To add edge loops, select the cylinder and then go to edit mode. Press Ctrl+R to activate the edge loop tool. Hover over the cylinder and use the scroll wheel to increase the number of loops (you can see the number on the bottom left of your window). We added around 20 edge loops for this example. Press enter twice to add the edge loops **[Figure 16, #2]**.

> **TIP:** You can use edge loops for other applications as well! They can be useful for adding edges to where you need them. After you press Enter (or click) once, you can shift the edge loop to where you want it. Press Enter (or click) again to apply.

Then, Add>Armature to add the first bone in your armature. The bone will be inside the mesh, so in order to see it better you can enable transparency for the viewport shaders. Another option is to enable the "In Front" option in the "Viewport Display" settings in the object tab.

We will create a long section of bone segments along the cylinder in order to bend it. It will be easier to view this facing directly at the side of the cylinder. So, snap into side view by clicking the X or Y circle (depending on which way your cylinder is oriented). Move the first bone to the left end of the cylinder and rotate the bone 90° so the smaller end point towards the other side. Then, go into edit mode with the bone still selected and select the smaller tip of the bone. The controls here are the same for editing a mesh. Extrude another bone by pressing "E". Continue making similar sized bones until you reach the end. It should look something like in **Figure 17**.

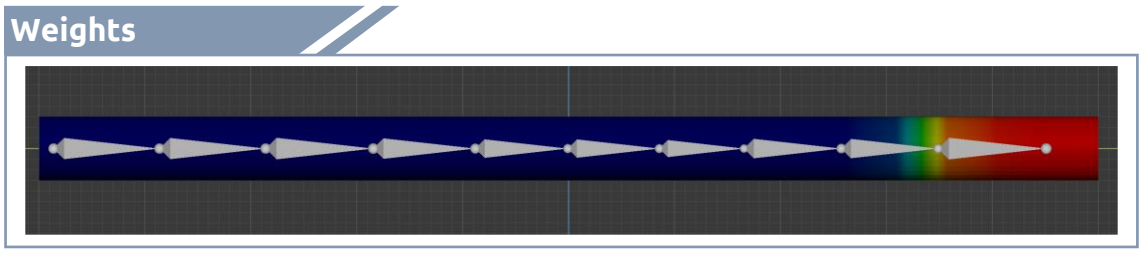


Cylinder and armature. Figure 17

When you extrude bones like this, the bones are attached to each other. You can add separated bones within edit mode to add more bones to the same armature. If you create a new bone, it will not be attached. However, you can parent bones together if you want them to move together. To do this, select the two bones you want to attach and press Ctrl+P and select either "Connected" (meaning the bones will connect by the joints) or "Keep Offset" (meaning the bones will stay where they are.

Now that the armature is created, we need to attach the armature to the mesh so that it can control it. In object mode, select the cylinder first, then the armature. The one selected last will be the parent and we want the armature to be the parent. Press Ctrl+P and select "Armature Deform: With Automatic Weights". Once you do this, the armature is ready to be posed and animated.

You can visually see what the automatic weights did to the mesh by selecting the cylinder and go into weight paint mode. In this mode, you can see the area of influence of the last bone you added to the armature, as seen in **Figure 18**.

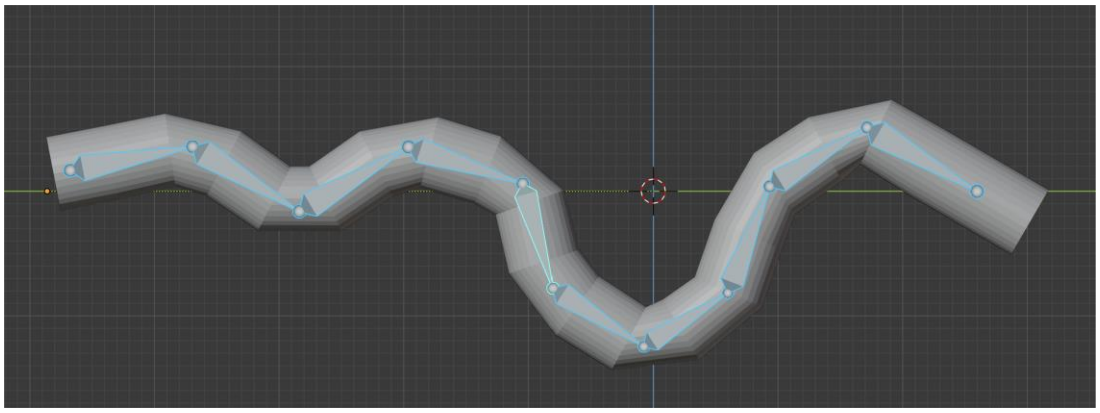


Weight paint mode on cylinder with armature. Figure 18

You can now select the armature and go into pose mode. Try moving the bones around and experimenting with moving the mesh with the bones. You can rotate the individual bones and the

corresponding areas that those bones effect will rotate with it. It may look blocky due to the small number of surface polygons, but this example is just to teach you the basics of how to set up an armature.

Bendy Cylinder

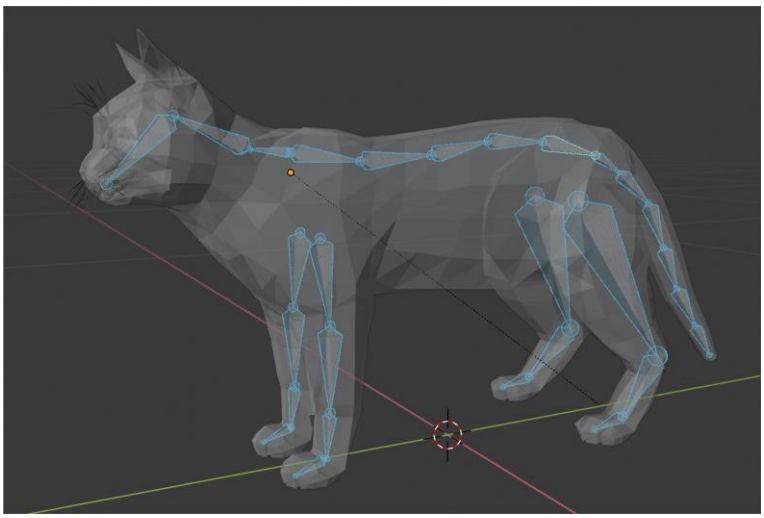


Cylinder mesh with armature. Figure 19

Now that your armature and mesh are set up, you can animate it like before. However, unlike before, instead of animating the object, you will animate the bones in the armature! In the Animating workspace, you can select the armature and go into the pose mode. Try making the tube move like a snake. It may even be useful looking up how snakes move to get a better idea of animating natural movement.

You can expand this concept into more complex meshes such as humans or animals bodies. Take for example the cat in **Figure 20**.

Cat Armature



Cat mesh with armature. Figure 20

You can look at a picture of a cat skeleton and create an armature approximation of the direction and connection of the bones.

In this way, you can do the cat's animations more realistically, as the bones restrict how the cat body and its appendages are supposed to move.

You can find this model at the link provided in the Additional Resources section if you want to try it out for yourself!

Example Renders

Render of simple room during the daytime and nighttime respectively. Figure 21

Post Lab Homework Assignment – Option A

[BASIC] (Undergraduate Students)

Now that you have learned how to use Blender, you will create a scene within it. This scene must be confined to a room. You can use what you have created in the tutorial as a starting point. You must create and use your own models from scratch.

Your room must have all of the following deliverables:

- One room with at least two walls
- At least one window
- At least 10 distinct pieces of furniture
  - You are free to duplicate and reuse the same furniture to decorate your room
  - Hint: Look around your room or rooms online for inspiration.
- Everything must have a material/texture.
- Lighting (Optional)
  - Note: To view lighting use the "Render" shading within the viewport. Use "Look Dev" shading if you are not adding lights.

What to submit for your Assignment:

- Blender project file (*.blend);
- Rendered Image(s);
- Lab Report (Explanation & Images)

[ADVANCED] (Graduate Students)

In addition to the basic assignment above, the advanced assignment will have you animate objects in the scene.

Additional deliverables:

- At least 3 non armature-controlled animations;
- One basic armature-controlled animation (doesn't need to do much).

Post Lab Homework Assignment – Option B

[BASIC] (Undergraduate Students)

Now that you have learned how to use Blender, you will create a full 3D model within Blender. You must create an original model of a robot. The robot needs to be decently complex with different parts. You must create your own robot from scratch.

Your robot must have all the following deliverables:

- At least two appendages (i.e. arms and/or legs);
- A head with at least one eye;
- Multiple components on the outside of the robot;
- Hint: Use photos for reference.

What to turn in:

- Blender project file (*.blend).
- Rendered Image
- Lab Report (Explanation & Images)

[ADVANCED] (Graduate Students)

In addition to the basic assignment above, the advanced assignment will have you animate objects in the scene as well.

Additional deliverables: (CHOOSE ONE)

- Animate the robot you created (complex)
    - Ideas:
        - Walking around
        - Dancing
        - Emotive gestures
        - Etc.
- OR, animate a cat walking across a room (use cat model in additional resources)
    - Walks from one end to another.
    - Stops to curl under the table.
    - Yawns or wags tail.

What to additionally turn in:

- Rendered animation (video format)

References & Additional Resources

1. Blender Manual
    a. https://docs.blender.org/manual/en/latest/

2. Interface Navigation
    a. https://docs.blender.org/manual/en/latest/interface/window_system/introduction.html
    b. https://docs.blender.org/manual/en/latest/interface/window_system/topbar.html
    c. https://docs.blender.org/manual/en/latest/editors/index.html
    d. https://docs.blender.org/manual/en/latest/editors/3dview/index.html
    e. https://docs.blender.org/manual/en/latest/editors/3dview/modes.html
    f. https://docs.blender.org/manual/en/latest/modeling/meshes/editing/index.html
    g. https://docs.blender.org/manual/en/latest/editors/index.html
    h. https://docs.blender.org/manual/en/latest/editors/outliner.html
    i. https://docs.blender.org/manual/en/latest/editors/properties_editor.html
    j. https://docs.blender.org/manual/en/latest/scene_layout/object/properties/relations/index.html
    k. https://docs.blender.org/manual/en/latest/modeling/modifiers/index.html
    l. https://docs.blender.org/manual/en/latest/render/materials/index.html

3. Tools & Modifiers
    a. https://docs.blender.org/manual/en/latest/modeling/meshes/editing/subdividing/bevel.html
    b. https://docs.blender.org/manual/en/latest/modeling/modifiers/generate/booleans.html
    c. https://docs.blender.org/manual/en/latest/modeling/meshes/editing/edges.html

4. Animation & Armatures
    a. https://docs.blender.org/manual/en/latest/animation/index.html
    b. https://docs.blender.org/manual/en/latest/editors/dope_sheet/index.html
    c. https://docs.blender.org/manual/en/latest/animation/armatures/index.html

5. Cat Model
    a. https://www.turbosquid.com/FullPreview/Index.cfm/ID/1266312