

Laboratory Teaching Manual 2

SCIE 1005 Integrated Science Laboratory

**Hong Kong Baptist University
Faculty of Science**

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Hong Kong Baptist University
Faculty of Science
Department of Computer Science

SCIE 1005
Integrated Science Laboratory

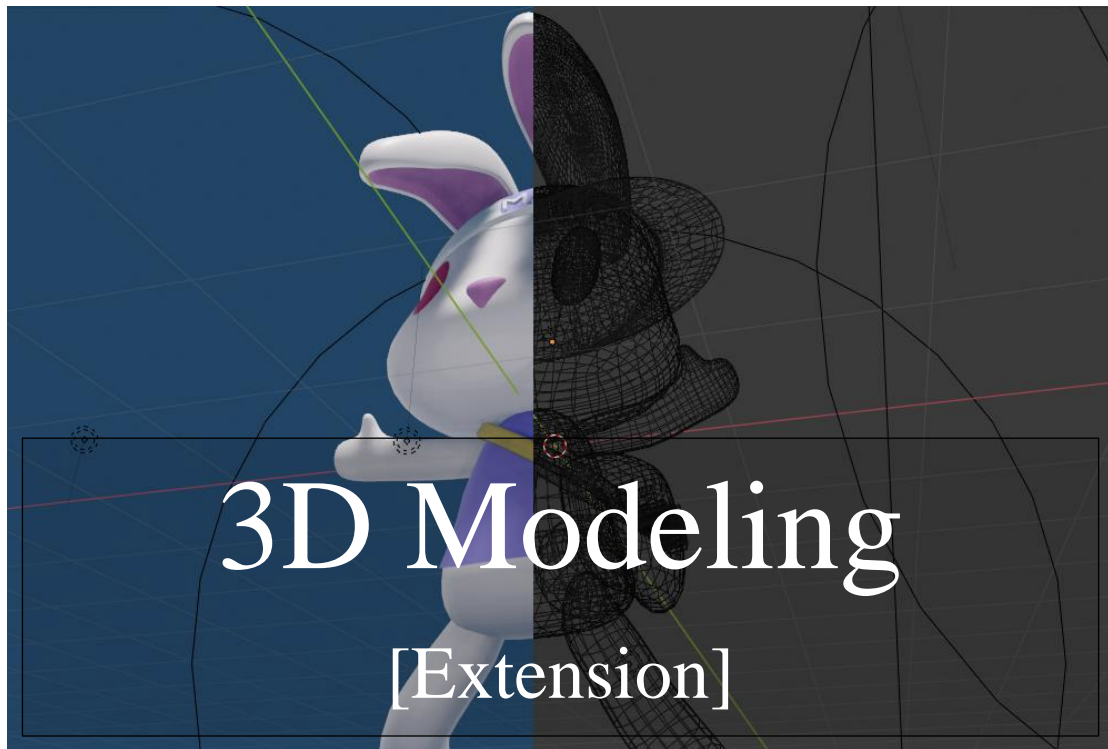
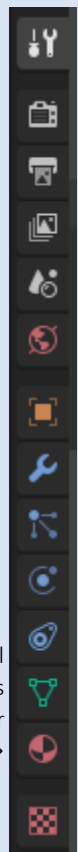
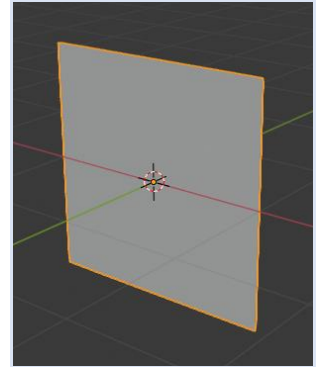
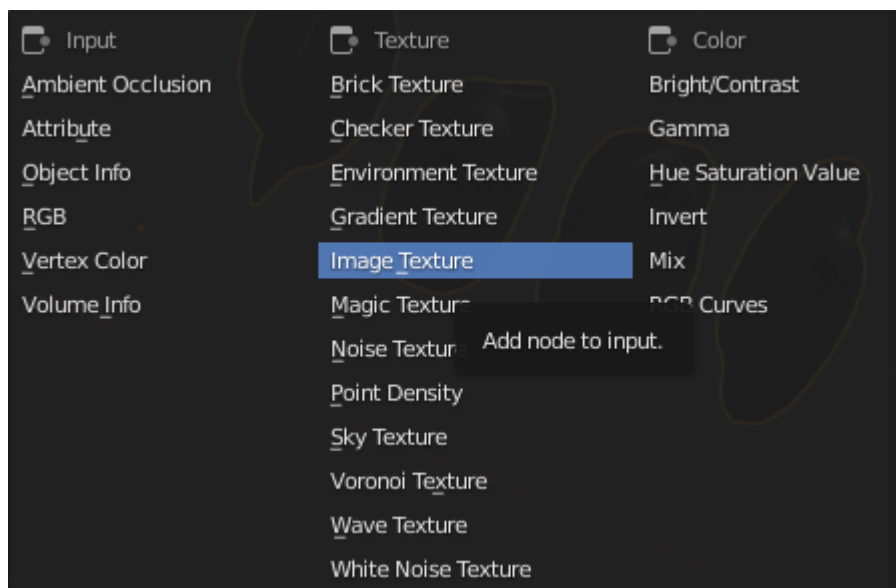
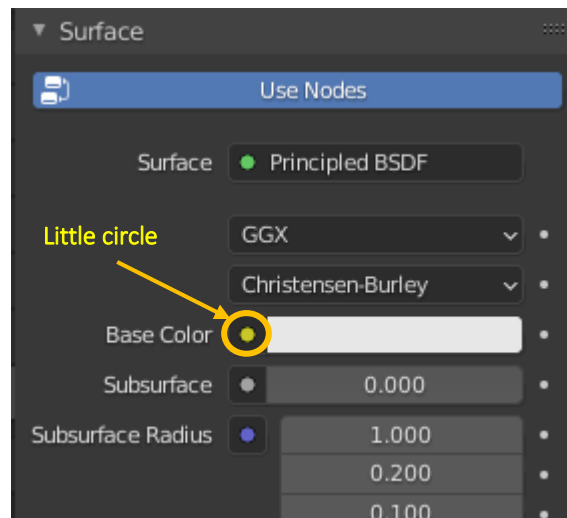


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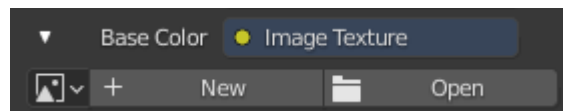
Adding Background

1. Download “jungle.jpg” from Moodle.
2. Go back to Blender, add a plane (menu “Add” > “Mesh” > “Plane”).
3. Rotate it 90° along X-axis. Then, switch to “Edit Mode”.
4. Change the Model Shading Mode to rendered by Pressing Z > “Rendered”.
5. Go to the “Material Properties” editor, add new material and change its name to “background”.
6. Expand “Surface” and enable “Use Nodes”.
7. Click the little circle of “Base Color” and select “Image Texture” showed on the “Texture” column.

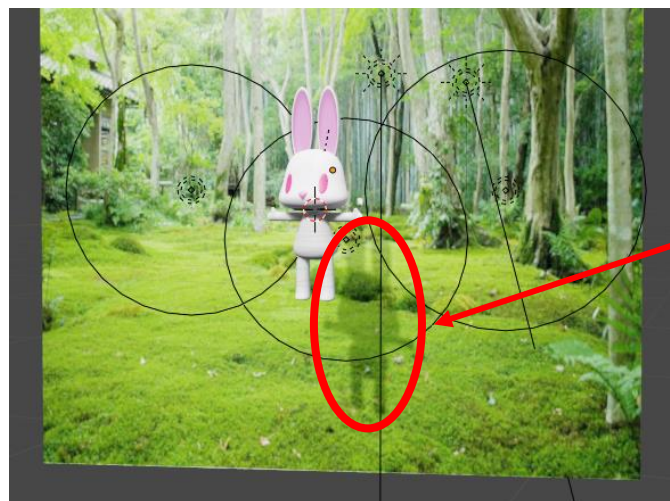


Material
Properties
editor
→

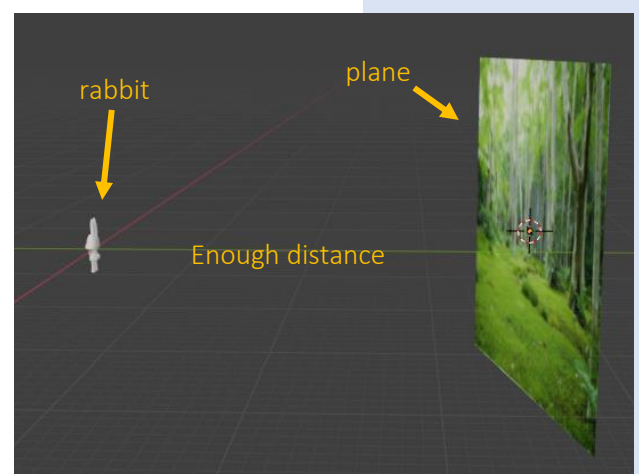
8. Click “Open” just below “Base Color” and select the downloaded image.



9. Go to the “Material Properties” editor again, change “Specular” of the current material to 0.
10. Now, the plane will not react to the light anymore and the color becomes shaper.
11. Enlarge the plane using scale function. Put the plane behind the rabbit with enough distance. Let the rabbit stands in front of the plane but the shadow of the rabbit will not be placed on the plane. You may adjust the position and angle of the plane too.
12. Press CTRL+S to save.



strange shadow



Poses

We will not directly rotate the rabbit's arms, legs, neck, and so on to set a pose. We will add some bones to the rabbit and rotate the bones instead. With the bones, we can set different poses easier. Besides, Blender provides a convenient way to build animation using the bones. We are going to discuss the pose and animation. But, before that, we need to learn how to add bones to our models.

Using Premade Armature

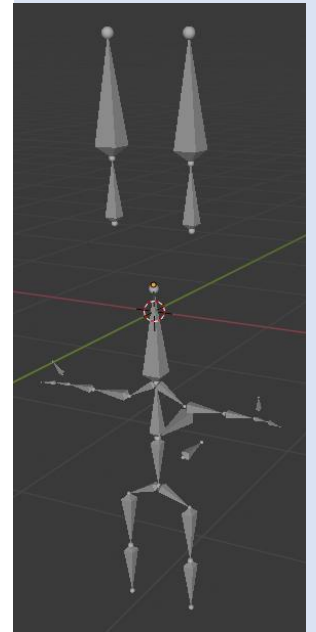
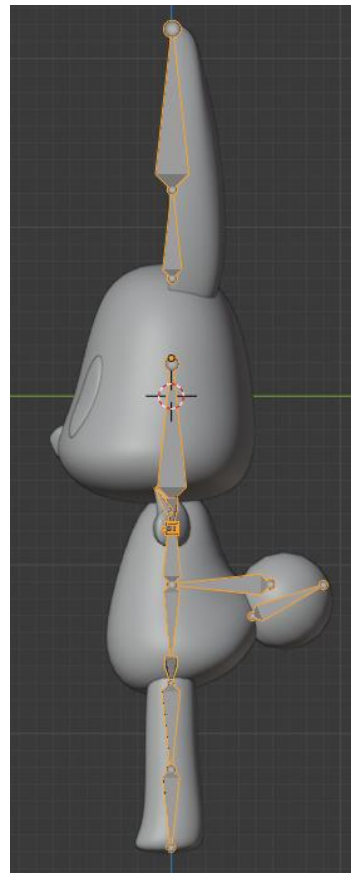
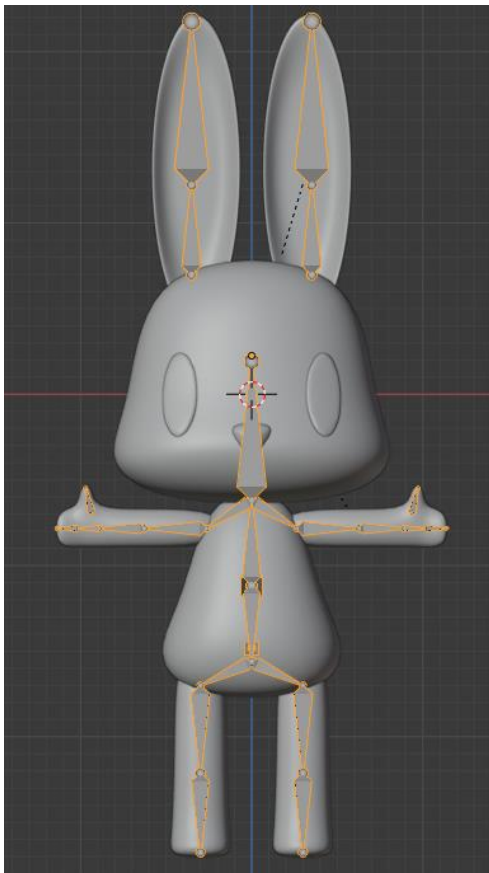
In this section, we are going to use the premade armature for our models. If you tried the procedure mentioned in the previous section, you need to delete the armature first. Then, follow the procedure below:

1. Download “armature.blend” and save it on the desktop.
2. Click the menu “File” > “Append...”. Locate and double-click “armature.blend”.
3. Open “Object” and select “Armature”. Then, click “Append”.
4. Select the armature and go to the “Object Data Properties” editor.
5. Expand “Viewport Display” and enable “In Front”. Now, you can see the bones always.
6. Move the newly added armature to the rabbit.
7. Select the armature and switch to “Edit Mode”.
8. Select the individual bones and adjust the length and position.

Object Data
Properties
editor
→



9. Switch back to “Object Mode”.



Mapping Model to the Armature

You can see that the imported armature has many bones. Now, we map the rabbit to the bones. After mapping the rabbit (meshes) to the bones, we can then rotate the bones to strike a pose.

We will use two kinds of mapping for different parts. For the head and tail, we use **single bone mapping**. For other parts, we use the **armature deform with automatic weights**. After finishing the following instruction, you will find the difference between these mapping methods.

Before Mapping

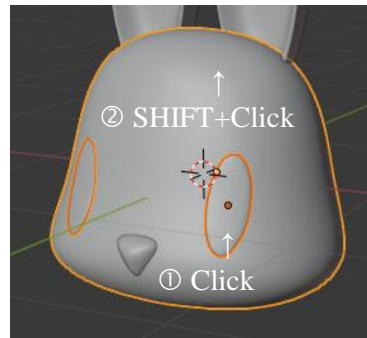
We know that the rabbit head consists of the head core, eyes, ears, and nose. The armature has the head bone and ear bones but no bones for eyes and nose. It is because the design is that the eyes and nose will move following the head core. Therefore, there are no individual bones for eyes and nose.

Now, we need to take an action to “paste” the eyes and nose on the head core. So that the eyes and nose will move following the head core.

Bones include:

root
chest
shoulder.R, shoulder.L
upper_arm.R, upper_arm.L
lower_arm.R, lower_arm.L
palm.R, palm.L
fingers.R, fingers.L
thumb.R, thumb.L
head
ear_base.R, ear_base.L
ear.R, ear.L
spine
tail
hip.R, hip.L
upper_leg.R, upper_leg.L
lower_leg.R, lower_leg.L

1. Switch to “Object Mode”.
2. Select the eyes and the head core.
(*you must click the eyes first and then SHIFT+click the head core*)



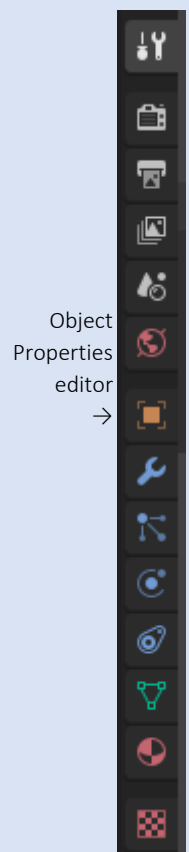
3. Click menu "Object" > "Parent" > "Object" to set the head core as the parent of the eyes.
4. Select the nose and the head core.
(*you must click the nose first and then SHIFT+click the head core*)
5. Click menu "Object" > "Parent" > "Object" to set the head core as the parent of the nose.

Now the eyes and nose will move following the head core, you may test it by moving the head core. Press CTRL+Z to undo and put the head core back to the original position after the test.

Head to Head Bone Mapping (Single Bone Mapping)

We map the head of the rabbit to the head bone by following the steps below:

1. Switch to “Object Mode” and select the head.
2. Go to “Object Properties” editor, expand the “Relations” section.
3. Change the **Parent** to “Armature”.
4. Change the **Parent Type** to “Bone”.
5. Change the **Parent Bone** to “head”.
6. Adjust the position and rotation of the head if it moved after setting the parent.

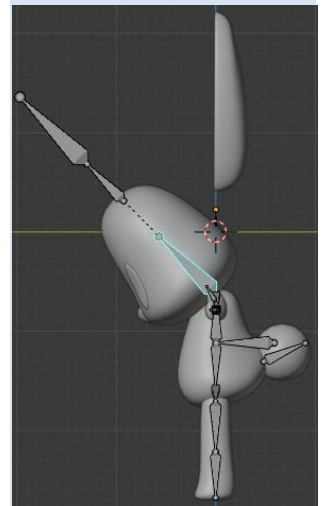
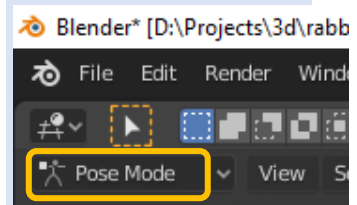


Verifying the Head-to-Head Bone Mapping

Then, we can verify the mapping by following the steps below:

1. Select the armature only and then switch to “Pose Mode”.
2. Select the head bone and rotate it.
3. The mapping is completed successfully if the head of your model moves following the head bone.
4. If it does not follow the head bone (bone name: head), check whether you follow the mapping steps correctly or not.

Note that the ears will not move following the ear bones because we finished the mapping for the head only.



Arm-to-Arm Bones Mapping (Armature Deform w/ Automatic Weights)

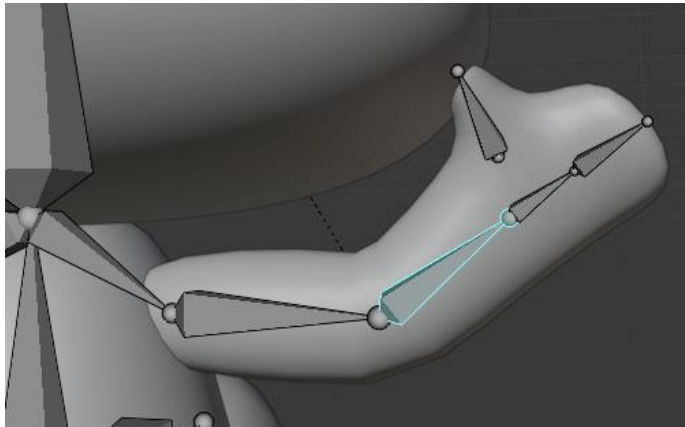
An arm can be separated into several parts – upper arm, lower arm, palm, thumb, and fingers. We can see that it involves multiple bones. To do the mapping, we need to map the specific vertices to the individual bones. That is a very difficult task because we need to work on the vertex level. Fortunately, Blender provides a convenient way to complete this task – *Armature Deform with Automatic Weights*. Let's see how to do so.

1. Switch to “Object Mode”.
2. Select the arms and select the armature.
(*you must click the arms first and then SHIFT+click the armature*)
3. Click menu “Object” > “Parent” > “With Automatic Weights”.
4. As two arms are joined, we only need to do the procedure once and the mapping of both arms is done.

Verifying the Arm-Bones Mapping

Then, verify the mapping by following the steps below:

1. Deselect all and switch to “Pose Mode”.
2. Select the left lower arm bone (bone name: lower_arm.L) and rotate it.
3. The mapping is completed successfully if the lower arm and hand of your model move following the bone.



Mapping for Other Parts

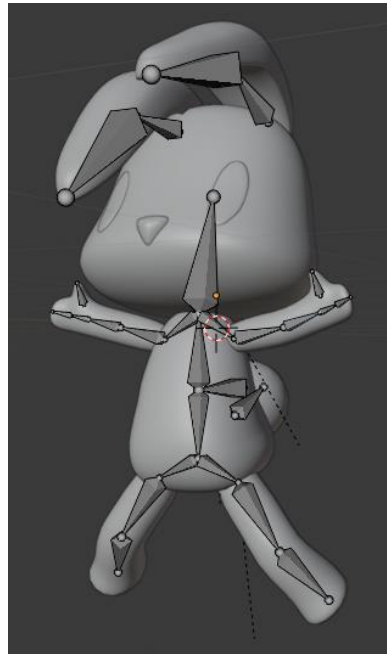
Now, we know how to map the head and arms using single bone mapping and armature deform with automatic weights respectively. Next, you need to do the mappings for the remaining parts.

Remaining part	Mapping method
Tail	Single bone
Body	Armature deform with automatic weights
Legs	
Ears	

Striking Pose

After completing all mapping, the model can now strike a pose. Let's make it strike a pose by rotating the bones.

Press CTRL+S to save your changes before playing with the pose.



If you want to reset the pose back to the original, you only need to select the armature, switch to “Pose Mode”, select all bones and click the menu “Pose” > “Clear Transform” > “All”.

Believe that you helped your model to strike an awesome pose. Let's switch to “Pose Mode”, select all bones, and then press CTRL+C to copy the pose. The pose information now is stored in the system memory, We will use it later.

Animation

Blender has an animation function that allows us to create animations in a simple way. We only need to set some keyframes in different timeslots. Then, Blender will generate other frames based on the keyframes.

A “Timeline” editor is shown at the bottom of the main window. It has some buttons for playing, pausing, and rewinding the animation. If you now click the Play button, your model will move immediately, Rabbit Dance... It is because the imported armature includes the animation keyframes I added before.

To pause the animation, you may press the Pause button shown or press SPACEBAR. Note that SPACEBAR is used for starting or pausing the animation.

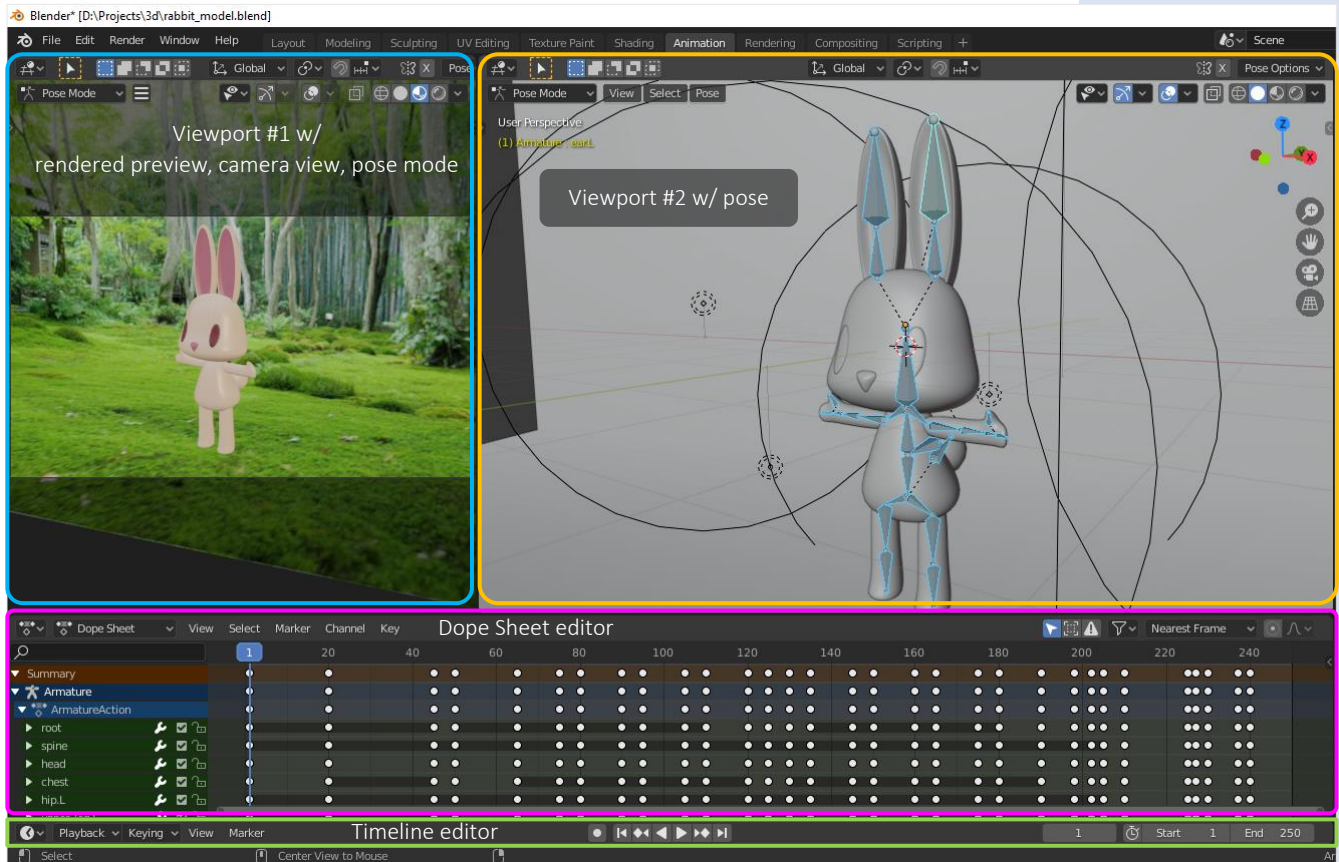


↑
Play



↑
Pause

Next, we learn how to edit the keyframes. Click menu “Animation”, then you will see that all animation related editors are opened.



The “Dope Sheet” editor is used for managing keyframes. We are going to use it.

Adding Keyframe

Adding a new keyframe is very simple, you only need to:

1. Go to the “Dope Sheet” editor, drag the **current frame marker** to your target position, for example, frame 1.
2. Go to the viewport #2, strike a pose or you may press CTRL+V to paste the buffered pose.
(Do you remember we pressed CTRL+C to copy the pose previously?)
3. Select all bones.
4. Click the “Dope Sheet” editor’s menu “Key” > “Insert Keyframes” and then select “All Channels”. To put the pose information to the current frame.
(Note than the original information will be overwritten if frame 1 is not empty)

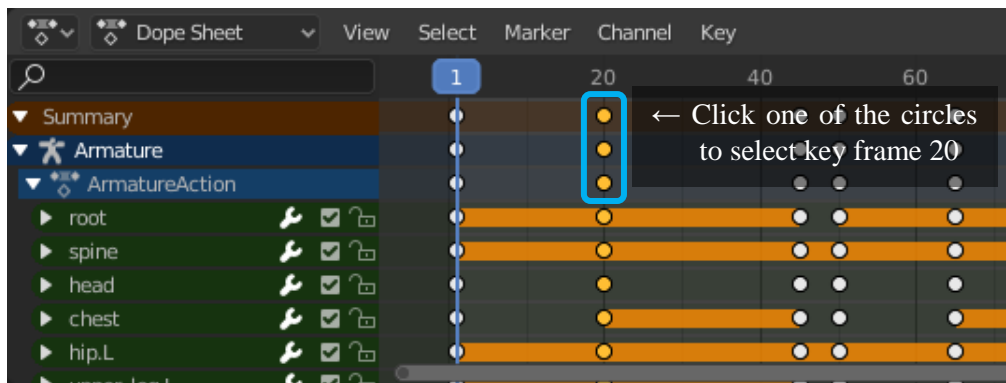
Current frame marker



Selecting Keyframe

To select an existing keyframe, you need to click the little circle shown on the “Summary” / “Armature” / “ArmatureAction” row.

After selecting a keyframe, all circles in the same frame will change to orange.



Deleting Keyframe

If you want to delete a keyframe, you only need to:

1. Go to the viewport #2, select all bones.
2. Go to the “Dope Sheet” editor, select the frame you want to delete. Then, click the “Dope Sheet” editor’s menu “Key” > “Delete keyframes”.

Moving Keyframe

To move a keyframe (e.g., move from frame 20 to frame 30), you only need to:

1. Select all bones in viewport #2.
2. Go to the “Dope Sheet” editor and select the frame (e.g., frame 20).
3. Drag the circles to the target position (e.g., frame 30).

Changing the Length of the Animation

There are two text boxes on the top-right corner of the “Timeline” editor. These two text boxes are used for changing the first frame and the last frame respectively. By default, the first frame is frame 1 but you may change it to a larger number for skipping some frames.



After editing the keyframes, you may change Blender back to the default layout by clicking the menu “Layout”.

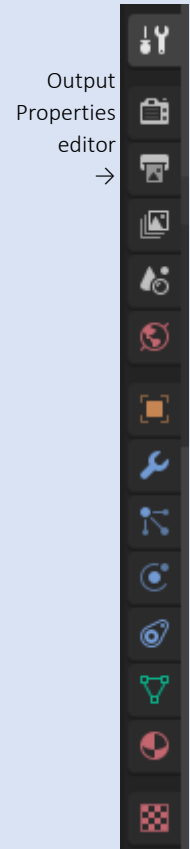
Rendering Image with Pose

Assume that you add a keyframe of your awesome pose (e.g., frame 1). So, you can drag the current frame marker to the frame and press F12 to render an image. You may try other frames to get images of different poses.



Producing a Video

1. Go to the “Output Properties” editor, expand the “Output” section and select “FFmpeg video” for “File Format”.
2. Expand the “Encoding” section and select “MPEG-4” for “Container”.
3. Click the menu “Render” > “Render Animation”.
4. It will take several **10** minutes to finish. The rendering time depends on the performance of your computer. Rendering a video for an animation of **250** frames (video length: **10** seconds) in the medium quality may take 25 minutes.
5. You can find the output video file in C:\tmp (Windows) or /tmp (Macintosh). Typically, the file name is 0001-0250.mp4.
6. Rename the file to animation_xxxxxxx.mp4. Double-click it to watch the video.



Adding Characteristics



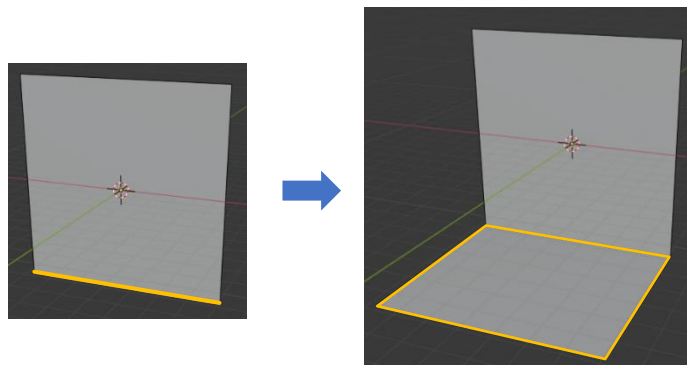
You learned many techniques in creating the 3D model. It is time to have your own idea to add the characteristics to your model.

Adding Background with Ground

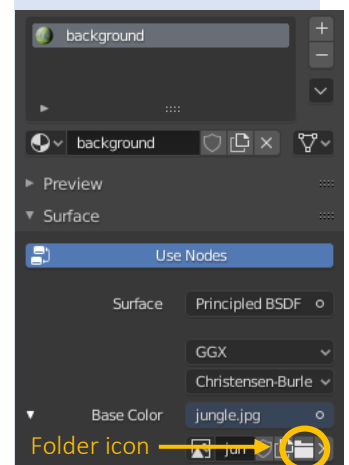
In the previous parts, a simple background and premade armature are used. If you want to make the background a bit details and you are interested in the creating the armature, you may follow the following procedures:

- **Adding Background with Ground:** make the ground (expanded from the background plane).
- **Adding Bones (Armature):** create new armature by adding bones one-by-one.

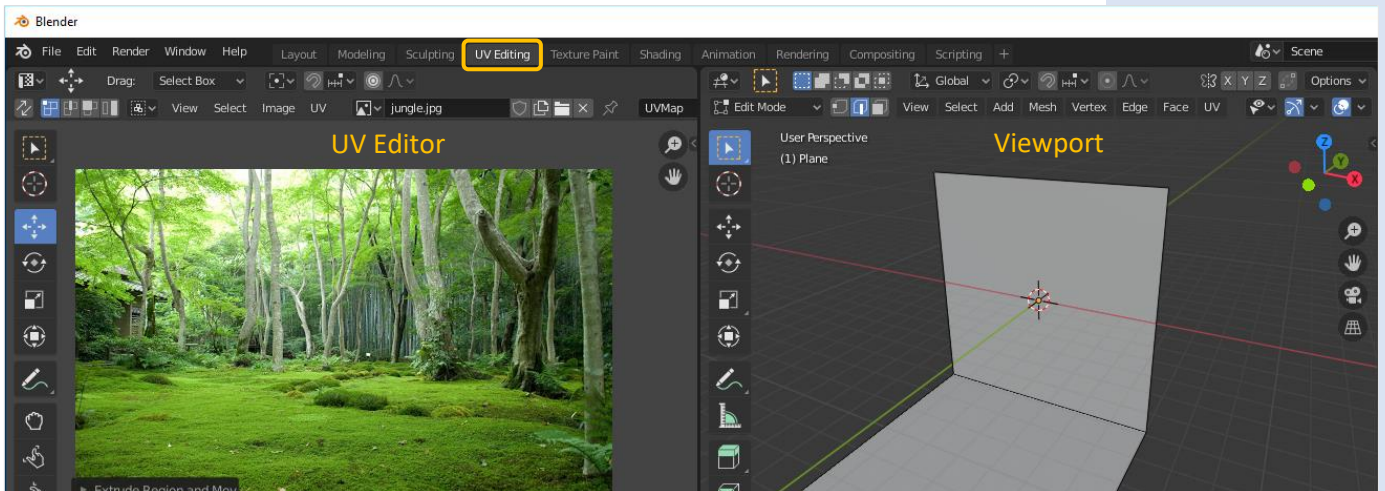
1. Download “jungle.jpg” from Moodle.
2. Go back to Blender, add a plane (menu “Add” > “Mesh” > “Plane”).
3. Rotate it 90° along X-axis. Then, switch to “Edit Mode”.
4. Select the bottom edge.
5. Click menu “Edge” > “Extrude Edges”, Press Y and move the mouse to make a new face.



6. Go to the “Material Properties” editor, add new material and change its name to “background”.
7. Expand “Surface” and enable “Use Nodes”.
8. Click the little circle on the rightmost of “Base Color” and select “Image Texture”.
9. Click the “Folder” icon just below “Base Color” and select the downloaded image.



10. Click menu “UV Editing” to open the UV Editor

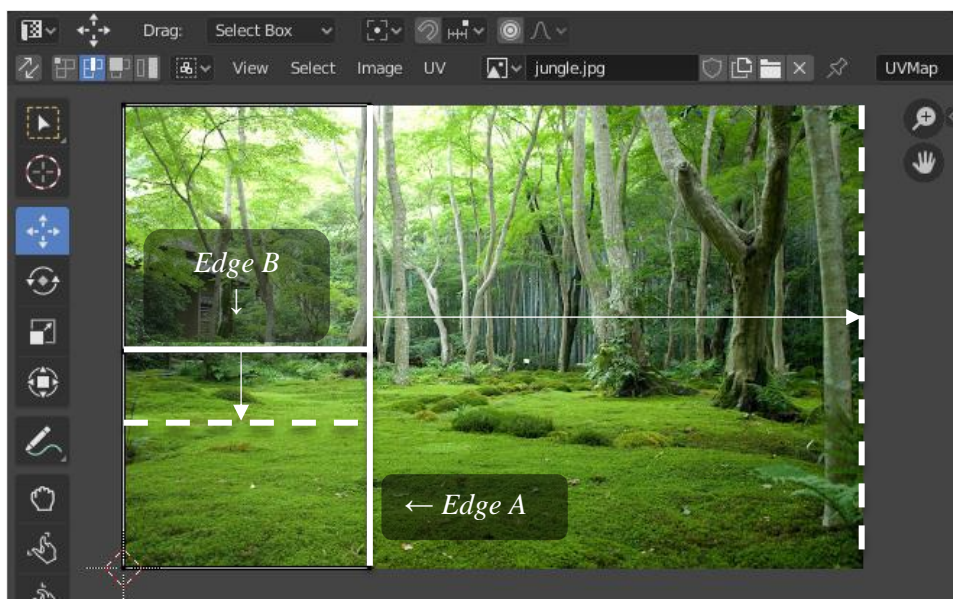


11. Select all edges in the viewport. Then, click the menu “UV” > “Unwrap”.
(The selected edges will be shown in the UV editor)

12. Go to the UV editor, switch to “Edge select”.

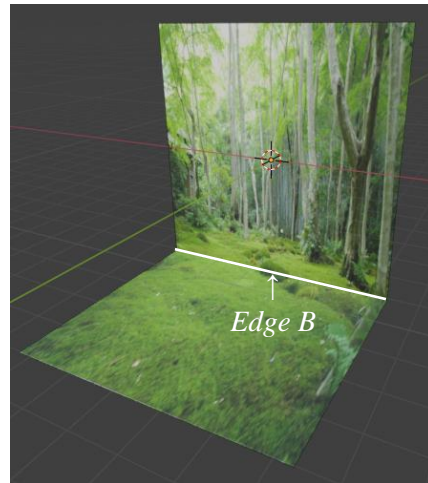
13. Move Edge A to the right boundary of the image texture.

14. Move Edge B downward a bit.



15. Go to the viewport, switch the viewport shading to “Material Preview” by pressing Z > “Material Preview”. Now, the plane is colored by using the image. (Note that the texture will be shown in “Material Preview” or “Rendered Preview” only)

16. Edge B works as the horizon. Adjust Edge B in the UV editor to have a more natural ground.



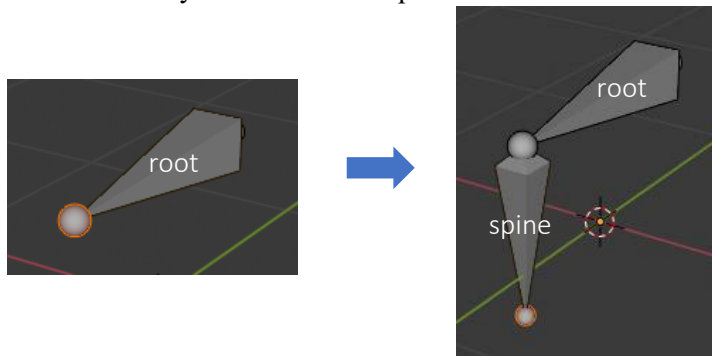
17. Click the menu "Layout" to close the UV editor.
18. Select all edges and click the menu "Face" > "Shade Smooth".
19. Go to the "Material Properties" editor again, change "Specular" of the current material to 0.
20. Now, the plane will not react to the light anymore and the color becomes shaper.
21. Put the plane behind the rabbit. Let the rabbit stand on the ground properly. You may scale the plane to make it large enough and adjust its position and angle.



Adding Bones (Armature)

The following shows you the procedure to create bones one-by-one. You may use it as a reference for your future use. In this lab, we will use the premade armature instead.

1. Click menu "Add" > "Armature".
2. Switch to "Edit Mode".
3. Go to the "Active Tool and Workspace Settings" editor, expand "Options" and enable "X-Axis Mirror".
4. Select the bone (click its body)
5. Go to the "Bone Properties" editor and rename it to "root".
6. Rotate it 90° along X-axis.
7. Click menu "Armature" > "Extrude", press Z and move the mouse downward to add a new bone. Then, press LMB to confirm.
8. Rename the newly added bone to "spine".



9. Select "spine", click the menu "Armature" > "Extrude Forked", press X and move the mouse to right to add two new bones. Then, press LMB to confirm.
10. Rename the left one to "hip.R" and the right one to "hip.L".
11. Select the tail of "hip.R", move it downward.
12. Use the techniques above to add other bones.

