CS148 Homework 1 - Blender Setup

Grading on Monday, Sep 30th

1 Assignment Outline

This first assignment is primarily setup and installation to ensure that you have the proper Blender environment for the class. The policies for this assignment differ from the usual course policies, so please read through everything carefully. **Instructions for what to submit and how to do so are at the end of this document.**

Note that a common theme for these assignments is the heavy use of blue hyperlinks to embed outside resources and references. For instance, the following blue link should send you to the class Ed page.

2 Collaboration Policy

You must be able to produce all the deliverables for this first assignment on your own. For future assignments, you may work with one partner to produce and submit the same deliverables together. But for this first week, we want everyone to make sure that they have their own Blender environment set up properly.

You are of course still encouraged to consult other students if you are having trouble with the installation. In fact, we encourage you to consult with as many people for this as necessary to get everything working.

Discussion of the quiz questions is allowed as long as the answers are not explicitly posted anywhere public (like e.g. Ed).

3 Office Hours

Office Hours will start Week 2 with the release of the second assignment, and the logistics will be posted on Canvas. For this first installation assignment, please post any questions that you may have on the class Ed. We will also primarily post announcements (e.g. homework releases, office hour rescheduling, etc) on Ed.

4 Blender Basics

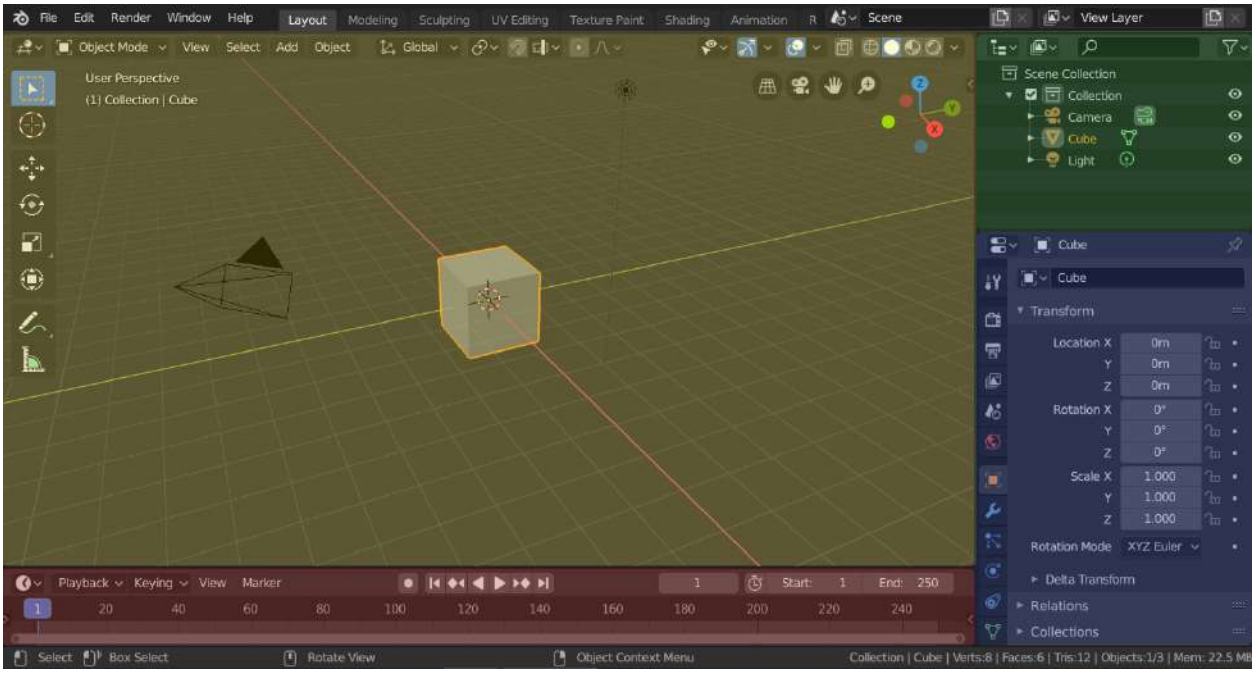
What is Blender? Blender is a free and open-source 3D creation suite. It supports the entirety of the 3D pipeline – modeling, rigging, animation, simulation, rendering, and compositing, and even supports motion tracking, video editing, and game creation. See the official Blender website if you're interested in looking more into any of these features.

For this course, we will use Blender as a way to learn the basics of modeling, lighting, shading, texturing, and rendering. We will also use Blender's Python scripting API for a hands-on experience in coding various algorithms as well as our own, custom raytracer.

4.1 Installing Blender

Download and install the latest version of Blender from the official website. If you already have Blender installed, then make sure it's at least version 3.0 or higher. Note that the screenshots in these assignments are from an earlier version of Blender and may have slight text or graphical user interface (GUI) differences from the latest version. These differences should be minor enough that they won't affect any of the assignments, but if a major difference does come up, then don't be afraid to post on Ed!

When you run Blender, you should see a default scene with a cube, a light, and a camera. Alternatively, you can also get the default scene by creating a new project via **File → New → General** on the upper left of the screen.



This is the default workspace for Blender (more in the Blender documentation), with the:

- 3D Viewport on the top left (yellow)
- Outliner on the top right (green)
- Properties editor on the bottom right (blue)
- Timeline on the bottom left (red)

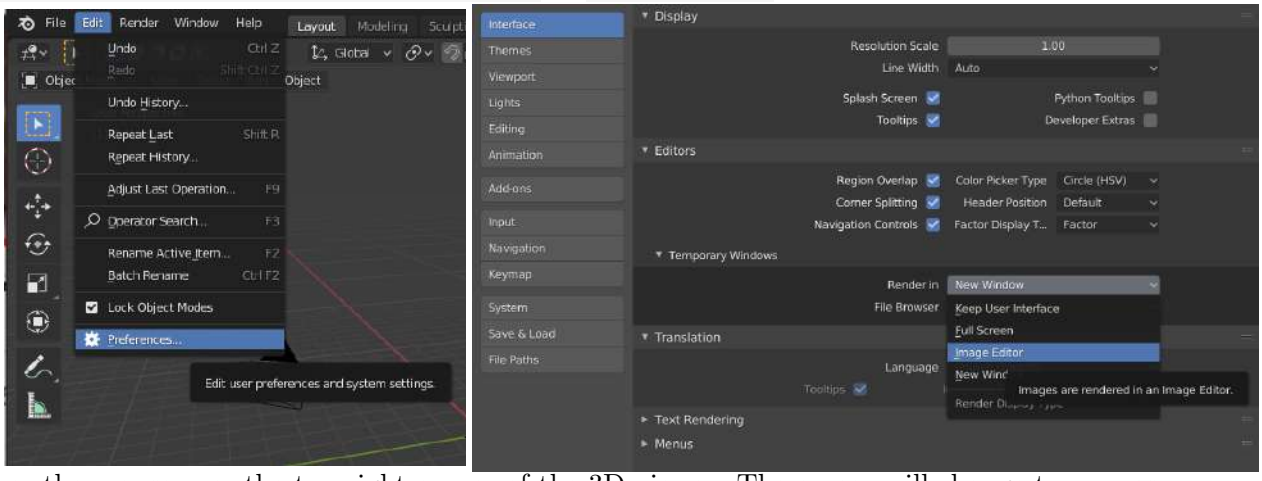
Blender has a nice official introduction playlist for versions 2.8 and higher on their Youtube channel. These should still be applicable for the newer versions as well. If you haven't used Blender before, then we suggest watching the first two videos to learn the basics.

4.2 Editor Setup

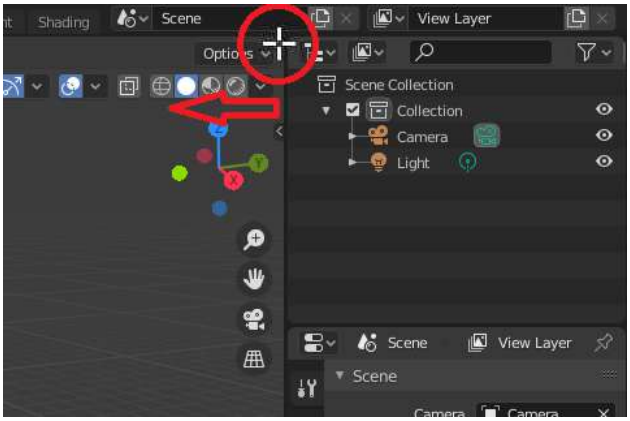
We will first add an Image Editor to our workspace. This will be where we see our rendered results inside Blender. It will be more convenient than (as you may try later) saving your image each time you make changes to the scene, going to your file explorer, and then opening the rendered image.

Setting up the editor will keep the render in the same window without popping out a new window every time.

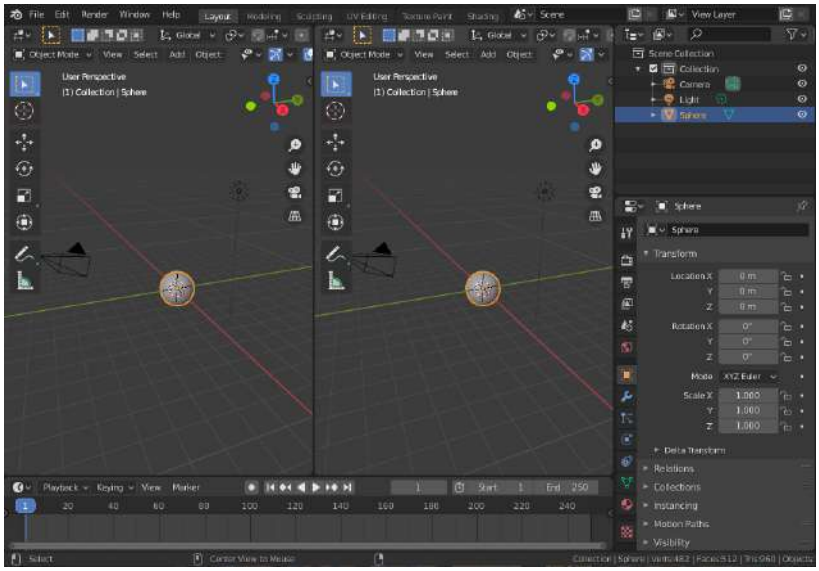
Go to the top bar, and click on **Edit → Preferences**. A new window should pop up. On the sidebar of this window, select **Interface**, then change the option for **Editors → Temporary Editors → Render in** to **Image Editor**.



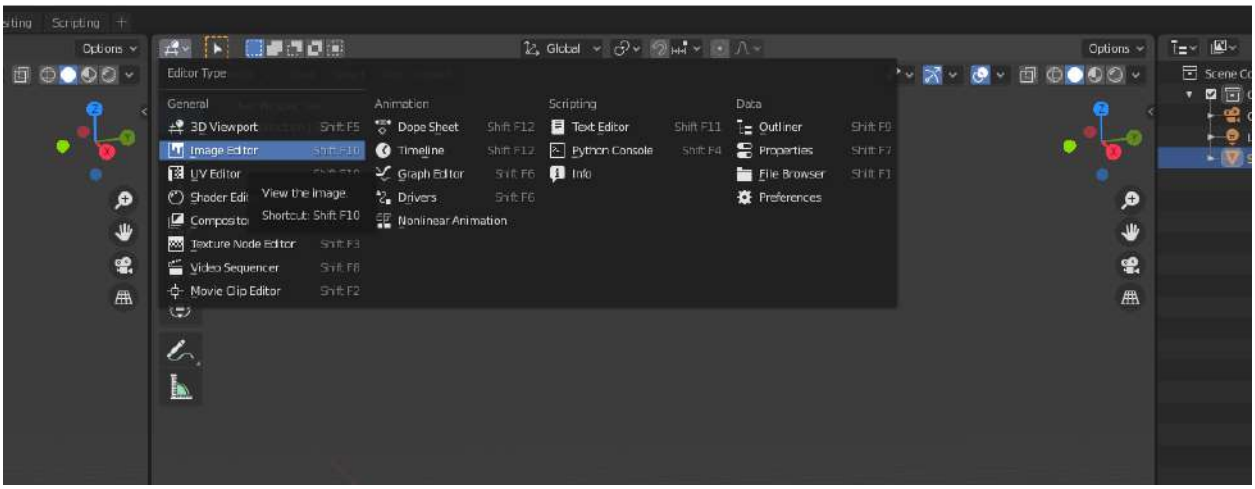
Hover the mouse over the top right corner of the 3D viewer. The cursor will change to a cross.



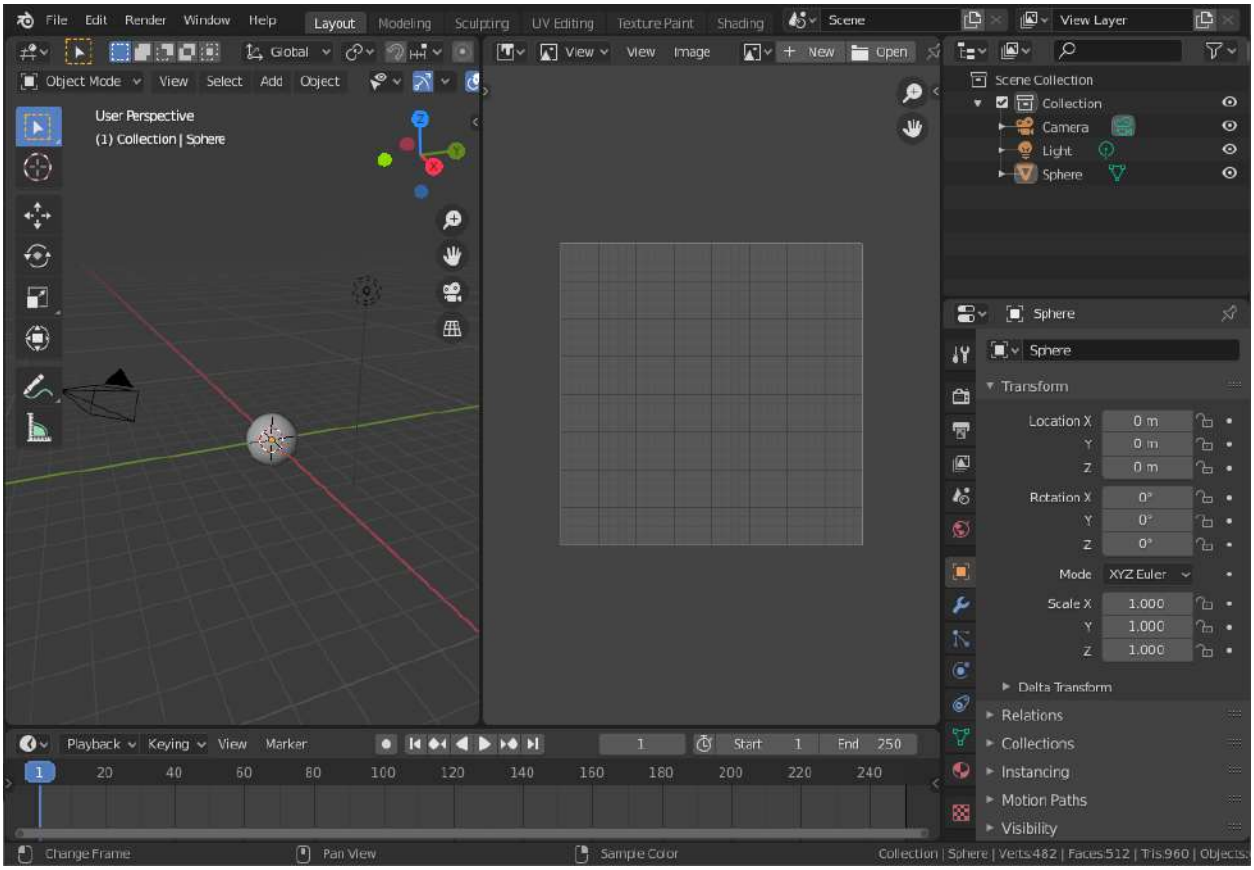
Drag left to create a new area.



In the top left of the new area, change the editor type to Image Editor.



Your screen should now look like this:

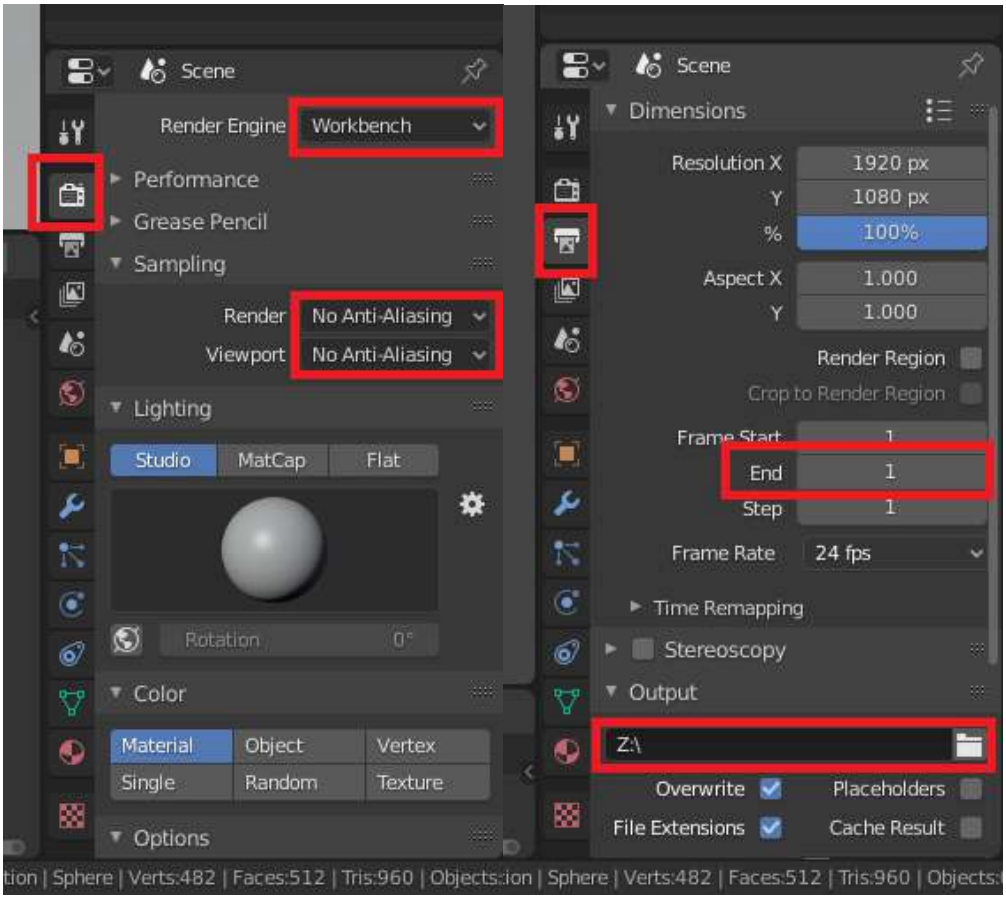


For more detail about areas and how to manipulate them, we optionally recommend the tutorial video.

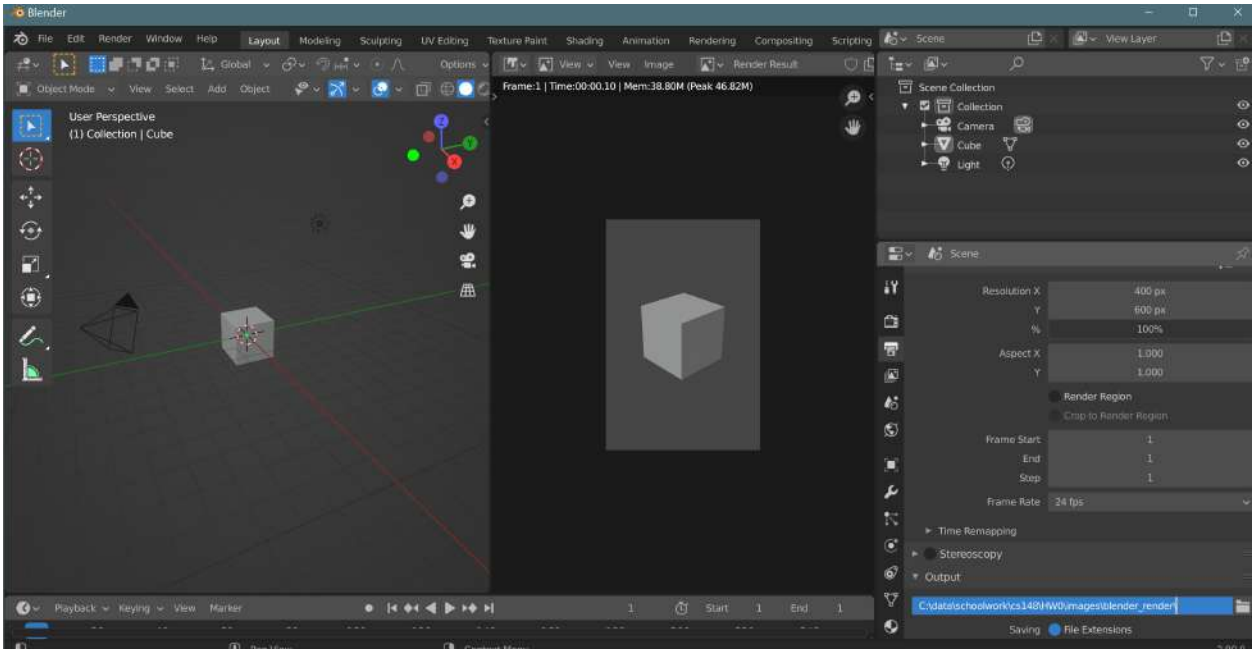
4.3 Render and Save Image

We can now change the render settings and render the image. By default Blender only saves animations, so here we change the length of the animation to 1. Also, we are playing with the viewport scanline renderer for this homework, so we will use the Workbench render engine.

Go to the Properties Editor (bottom right) and select the camera icon (Render Properties) on the sidebar. Change the **Render Engine** to **Workbench**, and the **Sampling** for Render and Viewport to **No Anti-Aliasing**. (We will talk about about what this all means later!) Then click on the printer icon (Output Properties) on the sidebar. Change **Frame End** to **1**, the Output Path to where you want to save the image (e.g. **$MY_CS148_DIR/hw1/**), and the resolution to **X=480px,Y=640px**.



Now render the image by going to **Render → Render Animation** on the top bar (or shortcut Ctrl/Cmd F12), and it should save to the specified path automatically. (You can verify this yourself by going to the directory where you told Blender to save the image.) The rendered image will also show up as "Render Result" in the Image Editor we created in the previous step.



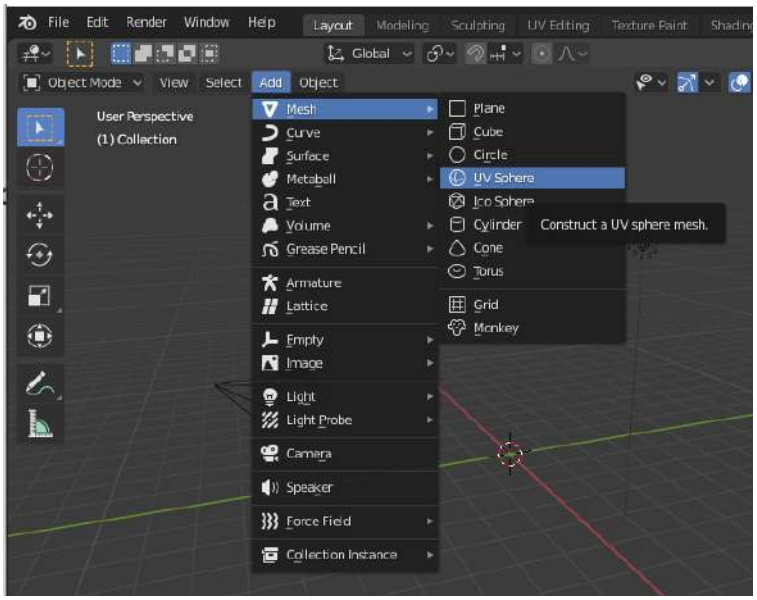
Now you have rendered your first image in Blender! Note that this image is rendered from the default camera's perspective.

4.4 Scene manipulation

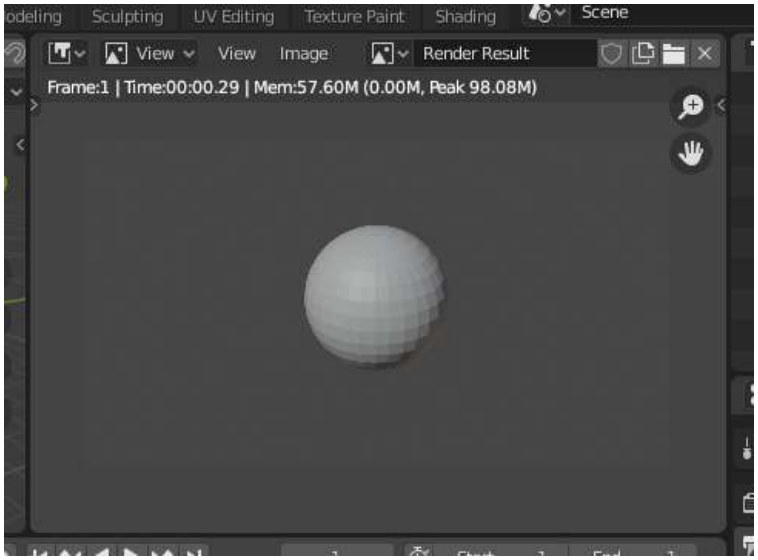
The default scene comes with a cube. We can add/delete objects in the scene. Blender stores some basic objects that we can directly add to the scene without constructing them from scratch. Here we will delete the cube and add a UV sphere.

Move your mouse over the cube, left click to select. An orange outline will appear around the cube, indicating it's being selected. Hit the Delete key to delete the cube.

Then go to the menu bar on top, and navigate to **Add → Mesh → UV sphere**. A sphere should appear in the center of the scene.



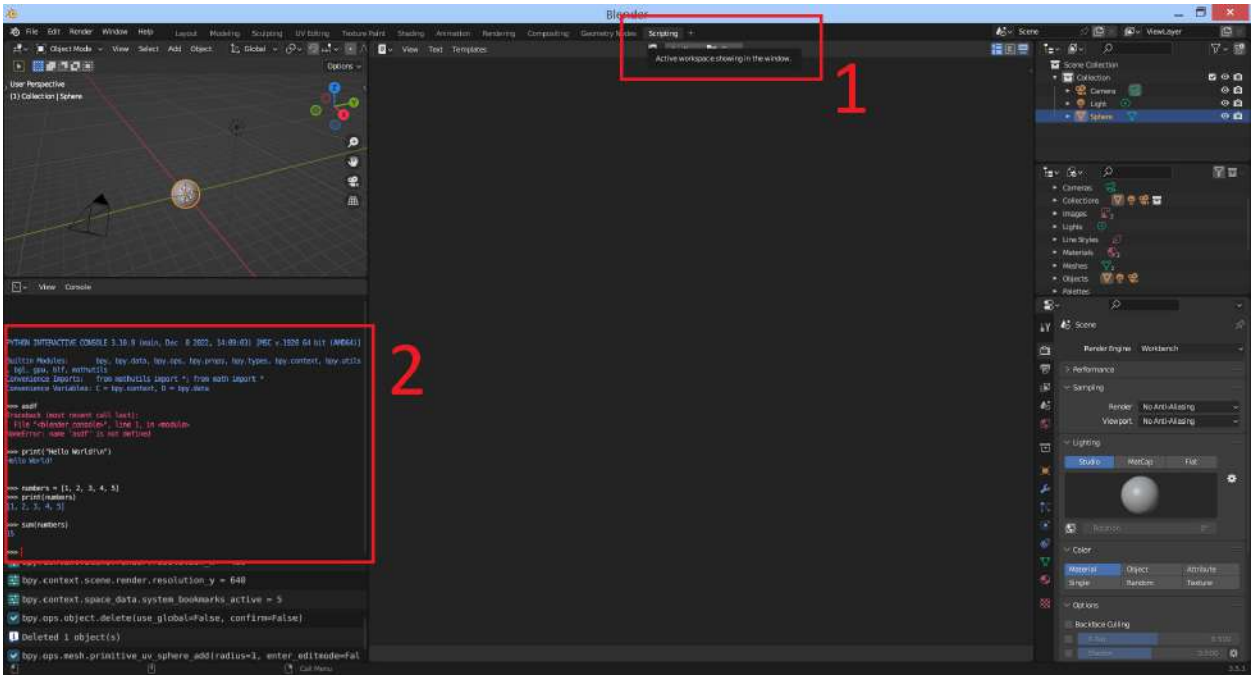
Press Ctrl/Cmd F12 (or **Render → Render Animation**) again to update the render. You should see a sphere instead of a cube now. Check that the rendered image of the sphere is saved correctly to your directory, having overwritten the render of the cube.



4.5 Scripting

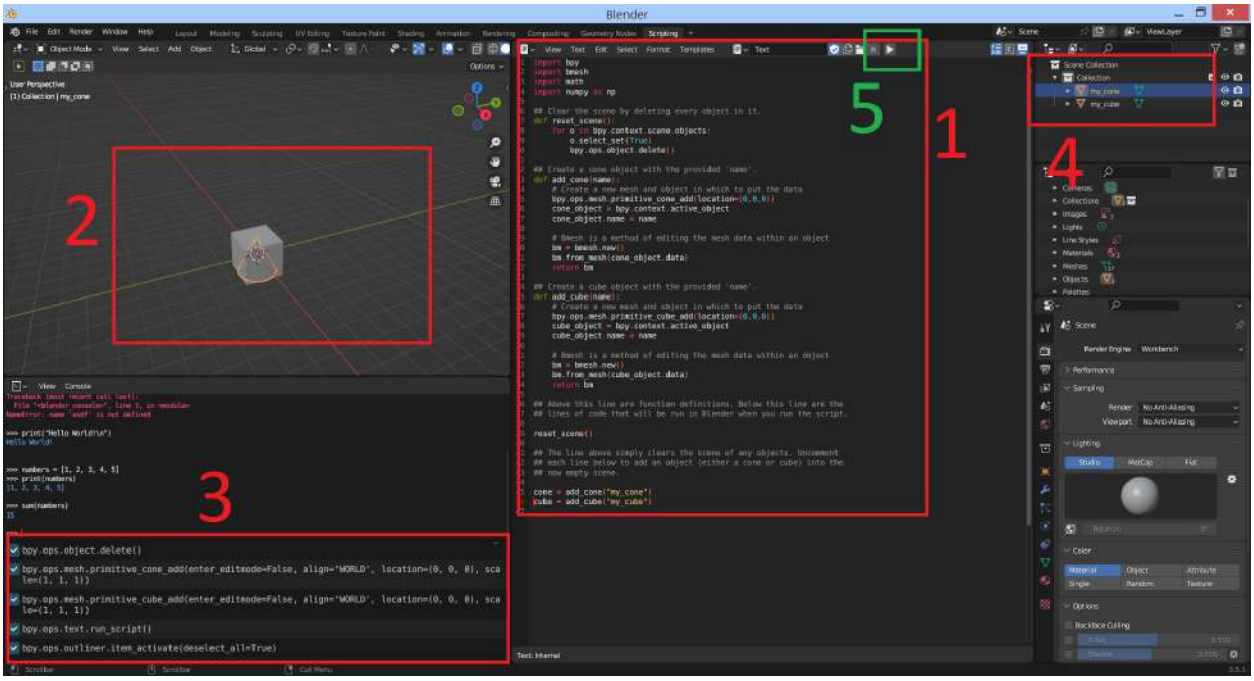
Blender provides a scripting environment that allows us to develop using Python in addition to using the GUI. By default, the Blender installation should have included a Python installation. You can check by locating your Blender installation folder and finding a Python folder within (e.g. on Windows, it may be located in **Program Files** → **Blender Foundation** → **Blender 4.2** → **4.2** → **Python**).

To access the scripting environment, click **Scripting** on the top bar (labeled **1** below). Depending on the size of your window or monitor, the **Scripting** tab might be cut off from view. If this is the case, then you can hover your mouse over the top bar and use the scroll wheel on your mouse to horizontally scroll through the top bar. Once you find the **Scripting** tab and click on it, the GUI should then resemble the following.



In the boxed area labeled **2** in the above image, you have the Python interactive console. Similar to other Python shells that you may have used in the past, this console provides you a space to experiment with snippets of Python code. You can see the documentation here. If you find the default layout not to your liking, then you can always move your mouse to the borders of each window and drag to resize them.

To write an actual Python script, press the **New** button that should be under the top bar, likely under **Scripting** if you haven't changed the default layout. You should now have an area in which you can type (labeled **1** in the picture below).



To try it out, copy and paste the code in this test script into the text editor. If you try to mess with the code in the text editor, then you might notice that it feels a lot more restrictive than your typical Python editor. Blender has a very friendly development environment compared to other 3D software, but it is still not on par with professional Python IDEs or professional text editors. **If you already have a preferred Python environment in which you write your code, then we recommend doing any code writing and edits in that first, THEN copy and paste the final code over to Blender to run.**

If you do decide to use the Blender text editor, then here are some handy shortcuts that can help with formatting:

- `Tab` for indent
- `Shift` + `Tab` for unindent
- `Ctrl` + `/` or `Cmd` + `/` to toggle comments

For more shortcuts in the text editor, please see the Blender documentation.

Press the run button (labeled `5` in green above) to run the script. Alternatively, if you do not see the button, then you can still run the script from the menu bar above the text editor with `Text` → `Run Script`. Without any changes, the script will simply delete every object in the scene displayed in the upper-left "3D Viewport" window (`2` in the image above). The log and any warnings and bug messages that may occur will be displayed in the Info Editor in the lower-left (`3`).

Try uncommenting the lines at the bottom of the script to add a cone and/or cube object to the scene after clearing it. You should then see the object(s) being added to the scene in the upper-left 3D Viewport as well as being listed in the upper-right "Scene Collection" (`4`). We'll discuss these parts of the GUI in more detail in later assignments.

5 How to Submit / How to get Graded

Please read these instructions carefully!

As alluded to on the website, CS148 has live grading, unlike most other classes. To get live graded, you will need a STANFORD Zoom account.

On **Monday, September 30**:

- If your **last name** begins with a letter between **A - F**, then join this Zoom call (passcode 589534 if needed) from **4 - 5:30 PM PST**.
- If your **last name** begins with a letter between **G - L**, then join this Zoom call (passcode 589534 if needed) from **5:30 - 7 PM PST**.
- If your **last name** begins with a letter between **M - R**, then join this Zoom call (passcode 985790 if needed) from **4 - 5:30 PM PST**.
- If your **last name** begins with a letter between **S - Z**, then join this Zoom call (passcode 985790 if needed) from **5:30 - 7 PM PST**.

If you can not attend your assigned time block, then make a post on Ed about your circumstances, and we will try to accommodate with a different time.

Upon entering the Zoom call, you will be placed in a waiting room. The CAs will let students into the main session from the waiting room to get graded in the order they enter the call. Since there are over 100 students per grading block, it is possible for there to be up to an hour delay if all 100+ students show up at the beginning of their session. We recommend doing other work in parallel while waiting to get graded just in case. The actual grading per assignment should only take about 5-8 minutes max.

In future weeks, when you are allowed to work with a partner, you may both show up at the same time to either one of your grading blocks to get graded together.

6 Quiz Questions

During the grading session, the CA will choose one of the following questions at random to ask. Please be prepared to give a brief (1-3 min) answer based on the lecture material.

- Explain what it means for light to be absorbed or reflected. If an object absorbs all incoming colors of light except red, then how does that affect the way we perceive the object with our human eyes? What if an object absorbs all incoming light? How would we perceive that? What about an object that reflects all incoming light?
- Explain the RGB color space in terms of trichromatic theory. Why is it sufficient to represent colors with just 3 numbers? What do the numbers mean, e.g. what color would be represented by the vector $(1, 0, 1)$ (aka $(255, 0, 255)$) and why? What would halving the numbers do to the color, e.g. $(1, 0, 1) \rightarrow (0.5, 0, 0.5)$?
- What is the difference between a black and white (gray scale) image vs an RGB (colored) image? Think about the Y-component (aka the luminance channel) of the YUV color space, or alternatively think about the concept of luminance in general. Why do you think a single "Y" is enough to represent a gray scale image when a fully-colored image needs an "R", "G", AND "B"?

7 What to Demo / Submit

During the grading session, please screenshare with your CA and:

- (1 pt) Run Blender or have it open already over screenshare to show that you've successfully installed Blender and set up your Image Editor UI to your liking.
- (1 pt) Upon creating a new Blender project, replace the default cube in the Blender UI with a UV sphere.
- (1 pt) Show a saved image of a UV sphere rendered using Blender's `Workbench` render engine. (You can pre-render this ahead of time before the grading session and simply show the image.)
- (1 pt) Show the result of running a script through the `Scripting` tab of the Blender UI. (You can use the provided test script from the tutorial above.)
- (1 pt) Answer the quiz question given by the CA correctly.

If you suspect that your internet connection may not be stable enough to live demonstrate everything over screenshare, then you may take screenshots of your Blender UI ahead of time and present those instead.