

Final Project Overview

Housekeeping

- Guest speakers!!
 - 7/23: Catherine Hicks
 - 7/30: Matthew Larsen
 - 8/4: Lvmin Zhang and Connor Ding
 - 8/11: Matthew Yu
- Nicole project review session on 8/3
 - No lecture on 8/6

Housekeeping

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- Nicole project review session on 8/3
 - No lecture on 8/6
- HW4 released!
- Project proposal released
 - Make sure to include a reference sketch/image
- Post your creations + how you achieved them on Ed!

Lecture Outline

- The focus: What we expect for your final project!
- The straightforward “quantitative” project requirements
- The less straightforward “qualitative” raytracing requirement
- Grading rubric & curve
 - Reminder: the final project is worth 45% of your final grade!
- Evaluating past student projects

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Basics

- You DO NOT
 - need to do any coding if you don't want to. You can simply use Blender Cycles to ray trace your render.
 - need to make everything in your image from scratch.

Basics

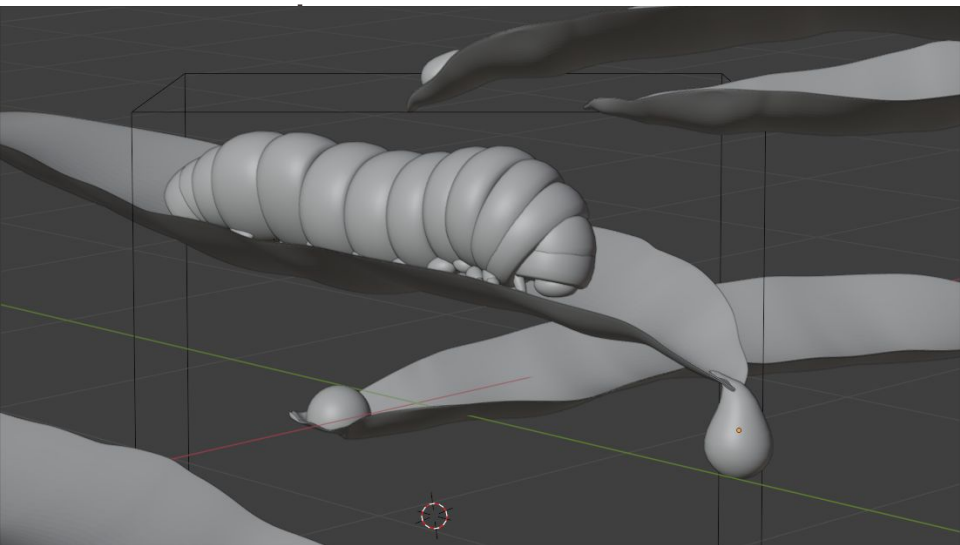
- You DO NOT
 - need to do any coding if you don't want to. You can simply use Blender Cycles to ray trace your render.
 - need to make everything in your image from scratch.
- You CAN
 - import geometry and textures you find online. You MUST cite your sources in your report.

Basics

- You DO NOT
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 - need to make everything in your image from scratch.
- You CAN
 - import geometry and textures you find online. You MUST cite your sources in your report.
- You CANNOT
 - do any post processing on your image. Your submitted image must be the result of a Blender Cycles render.

Straightforward Requirements

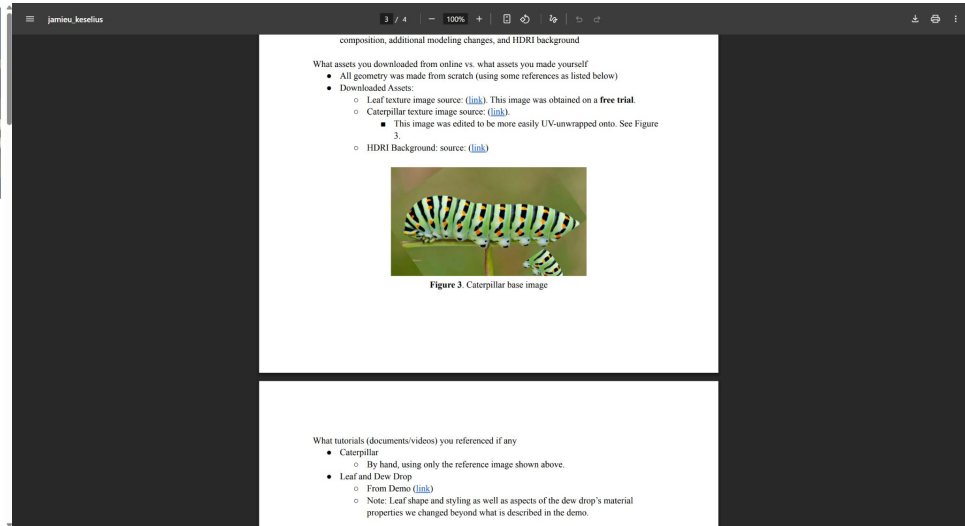
- The main geometry (the focus) of your image must be your own
- Half of the geometry that make up the image must be your own
- At least one object must be UV mapped and textured (HW4) from



Kate Eselius and Jamie Ullman, Fall 2022

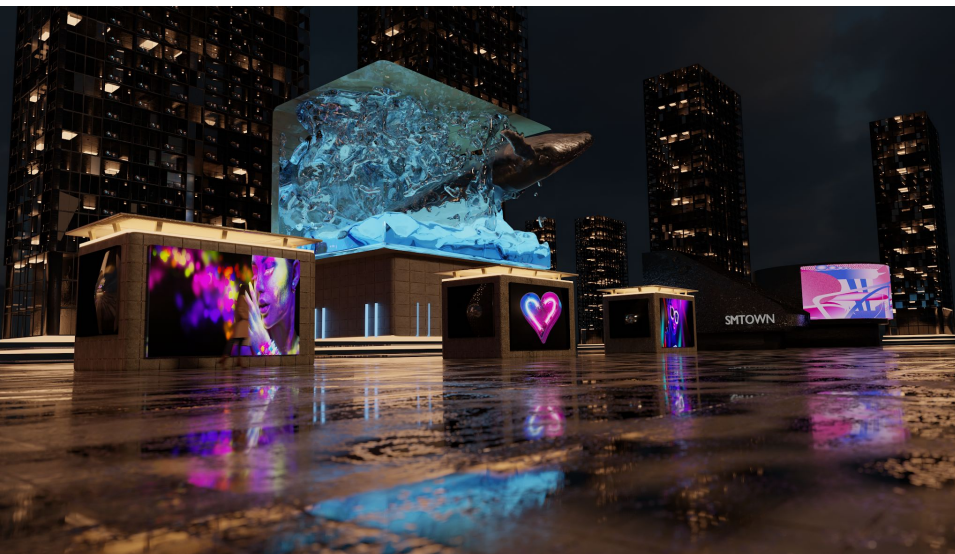
Straightforward Requirements

- You MUST cite your sources in your report
- In the “showcase” tab, click on each showcase image to see the reports (some are more detailed than others)

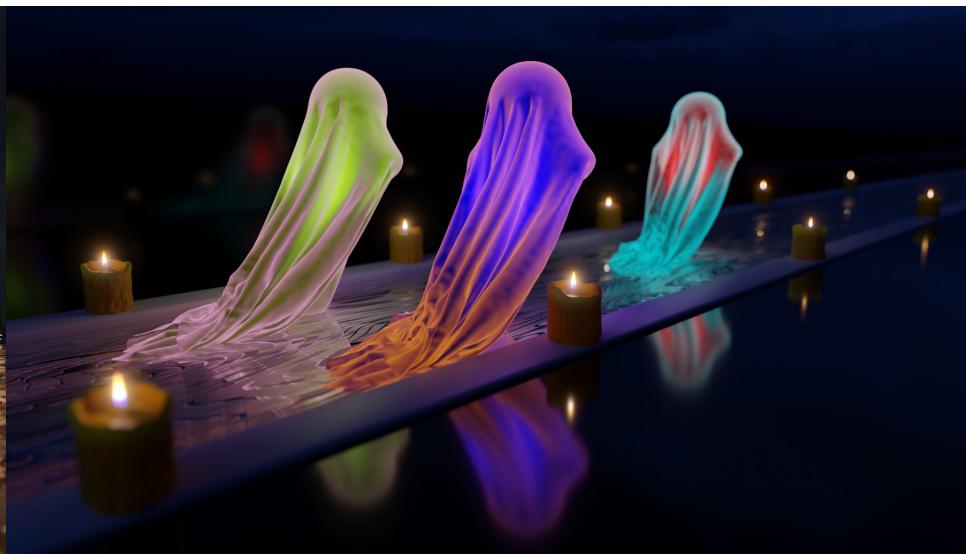


Aside: Simulating Geometry in HW5

- We are done talking about geometric modeling except for doing so via simulation (e.g. simulating cloth folds or splashing water)
- We suggest Youtube tutorials for more complex modeling!



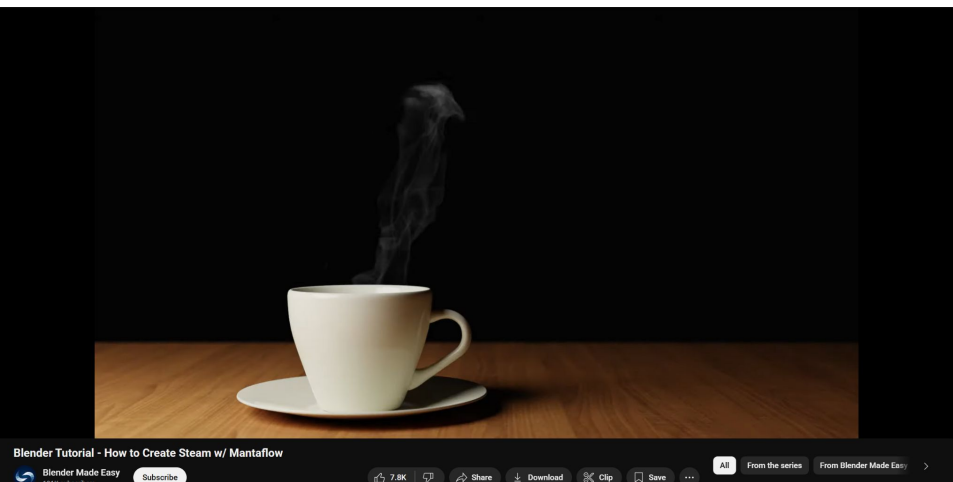
Kelly He and Yiyun Liang, Fall 2020



Bogdan Burlacu, Fall 2021

Straightforward Requirements

- At least one **Blender Cycles advanced feature**: depth of field, motion blur, volumetrics (e.g. fog/steam), etc. (HW 5)



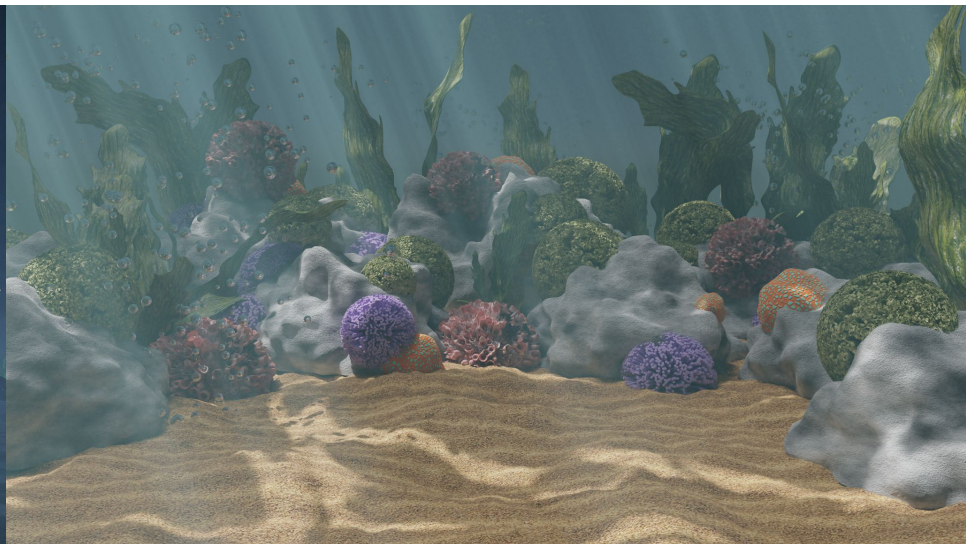
Luna Yang and Xuelin Yang, Fall 2021

Aside: Emissive Materials & God Rays

- We suggest Youtube tutorials for more complex phenomena!
- **Emissive materials:** making your objects glow / bloom
- **God rays:** show the shape of your light (e.g. light through stained glass)



Tassica Lim and Tatiana Wu, Fall 2020



Aditya Mundada, Fall 2021

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Ray Tracing Requirements

- This is MORE than just Blender Cycles
- **Lighting** is key! Otherwise, ray tracing will not really have an effect...



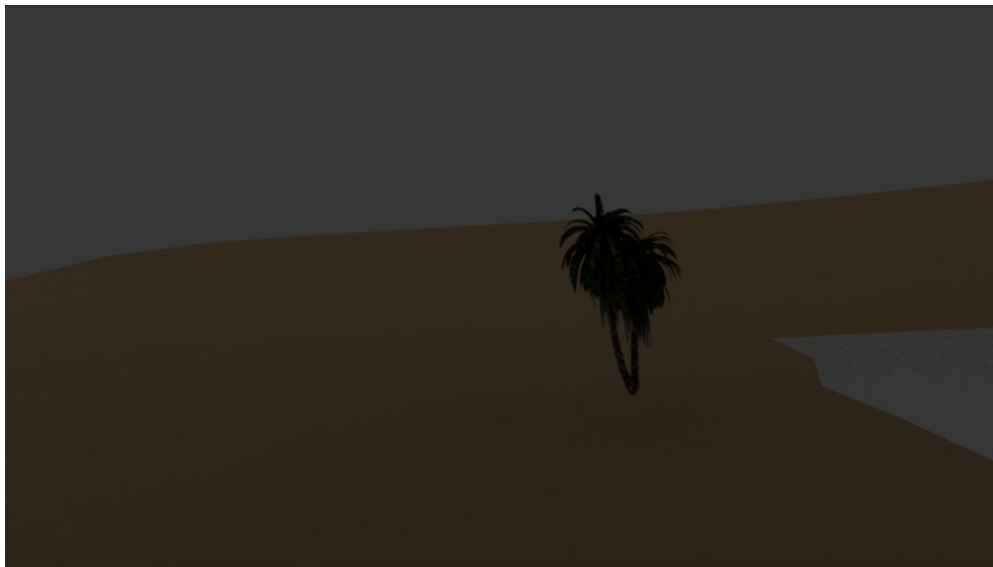
Scanline Render (Blender Eevee)



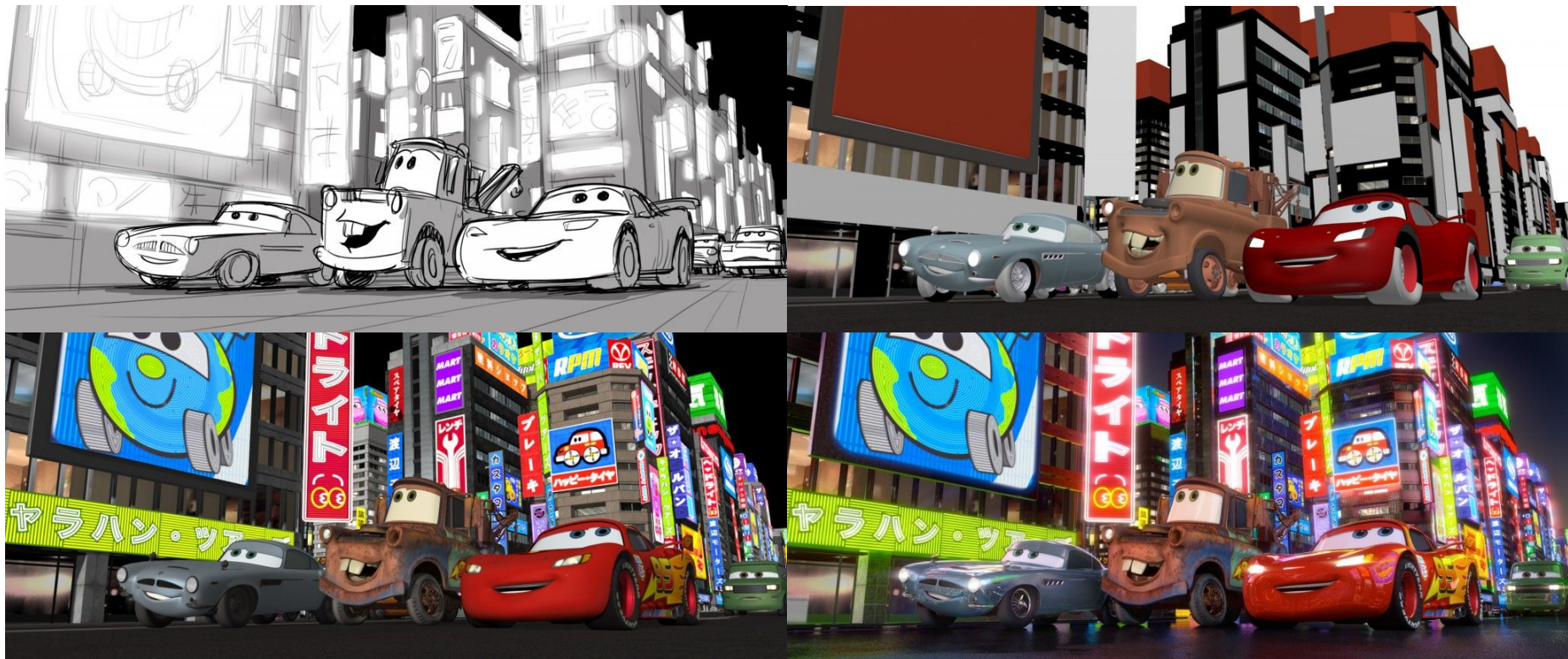
Ray Traced (Blender Cycles)

Ray Tracing Requirements

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Photorealistic lighting is key!



(1) Sketch - (2) Geometry - (3) Materials & Textures - **(4) Lighting & Ray Tracing**

Photorealistic lighting is key!

- Goal: Your scene, when rendered in Blender Cycles, has most if not all the components of ray tracing for a photorealistic image
- Even stylized scenes need photorealistic lighting to look good



Yifan Wang
Fall 2020

Photorealistic lighting is key!

- Goal: Your scene, when rendered in Blender Cycles, has most if not all the components of ray tracing for a photorealistic image
- Even stylized scenes need photorealistic lighting to look good



Mai Hoang, Fall 2023

Photorealistic lighting is key!

- Left: a reference scene from a Japanese animation (2D)
 - Even though it is a 2D hand drawn scene, it still has photorealism

Weathering with You (Tenki no Ko) (2019)



Cameron Mohne and Nicholas Vo, Fall 2021



Photorealistic lighting is key!

- Left: sometimes the reference scene might not lend well to ray tracing
- Right: the students got creative in modifying the scene for a project
 - When in doubt, add glass/water for reflections

Xi Yan and Siyun Li, Fall 2021



Photorealistic lighting is key!

- Iterate with us in OH! Ask friends, family, coworkers too for opinions!
- Most people can tell you whether an image looks “good” or “bad”

Justin Jasper, Fall 2023 - Initial Version



Justin Jasper, Fall 2023 - Final Version



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You'll be Presenting!

- See Ed post for more information

Grading & Curve

- Each project will be given a score out of 10 based on how well it compares to other images in the class (see handout for details)
- Buckets:
 - 10 → featured on showcase
 - 9-10 → usually A+
 - 7-8 → usually A
 - 5-6 → usually A-
 - 4 → usually B+
 - And so on

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Good or Needs Improvement?



Good or Needs Improvement?

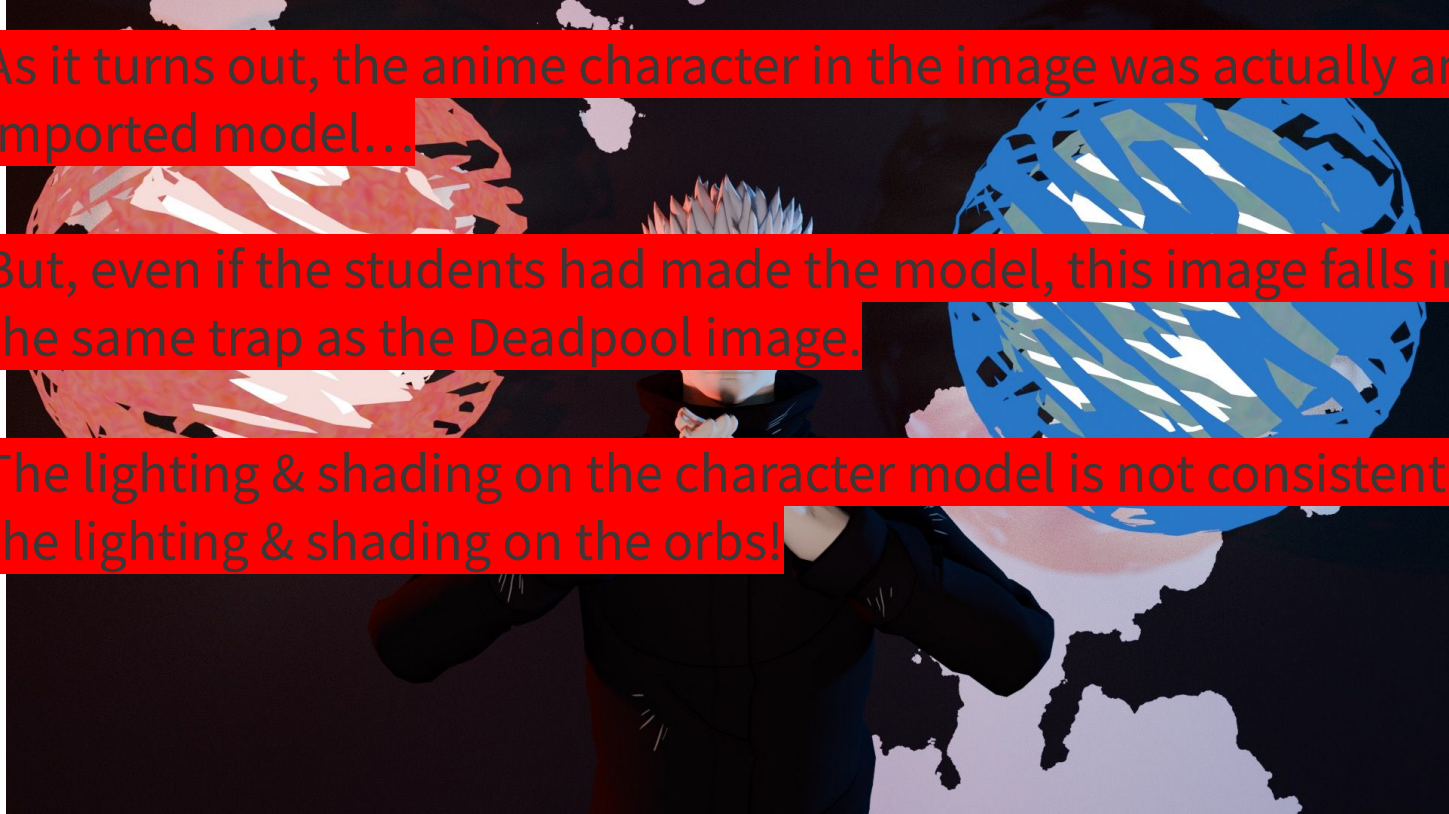
- The student made an impressive model of Marvel's Deadpool, but the lighting has a lot to be desired...
- Common trap: Getting caught up in modeling something you find cool and losing sight of the goal of the class!

Good or Needs Improvement?



Good or Needs Improvement?

- As it turns out, the anime character in the image was actually an imported model...
- But, even if the students had made the model, this image falls into the same trap as the Deadpool image.
- The lighting & shading on the character model is not consistent with the lighting & shading on the orbs!



Good or Needs Improvement?



Good or Needs Improvement?

- Has consistent lighting and shading across all objects in the image
- Improvises by adding water for easier interactions with light

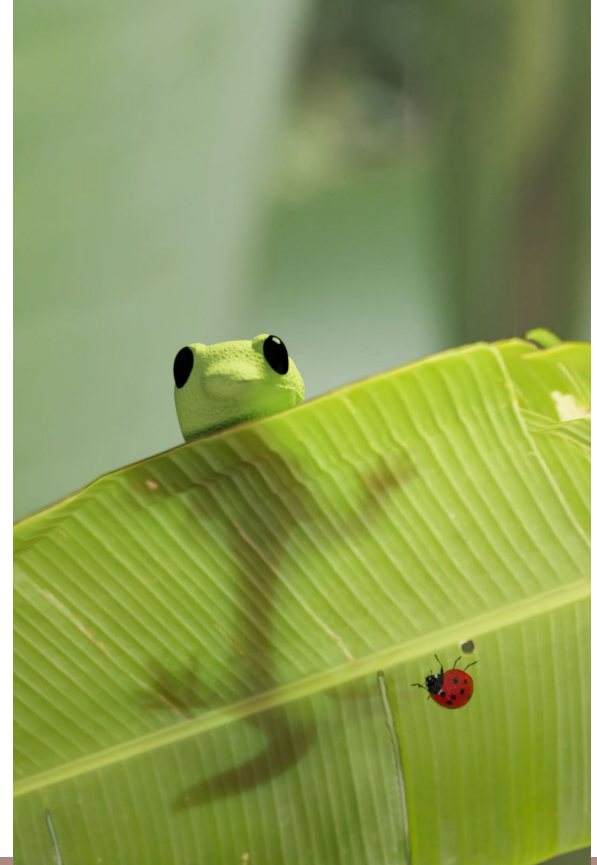


Elden Ring (2022)



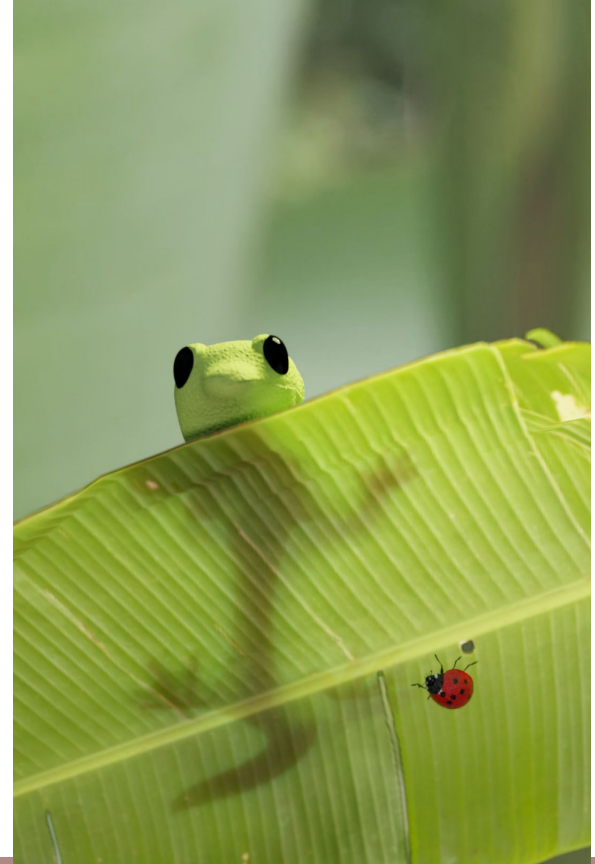
Zuyi Liz Zhao, Fall 2023

Good or Needs Improvement?



Good or Needs Improvement?

- Very simple scene composition & geometry, but that's fine!
- Has consistent lighting & shading across all parts of the image, plus nice depth of field!
- Includes both soft shadows & transparency through clever placement of the gecko and material design on the leaf.
- Tip: it's fine to not be able to model your entire creature/object if you can find a creative way to hide the missing parts!

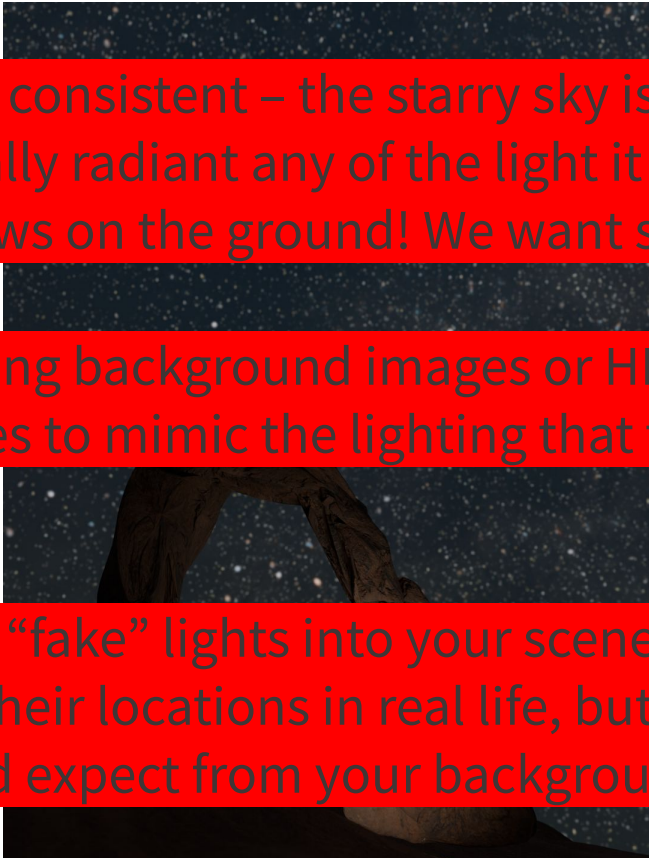


Nova Halavins,
Summer 2022

Good or Needs Improvement?



Good or Needs Improvement?

- 
- The lighting is not consistent – the starry sky is a background photo that doesn't actually radiate any of the light it captures. Also: harsh shadows on the ground! We want soft shadowing!
 - Common trap: Using background images or HDRIs without including actual light sources to mimic the lighting that the background would create in real life.

One solution: add “fake” lights into your scene that normally wouldn't exist in their locations in real life, but help produce the lighting you would expect from your background!

Good or Needs Improvement?

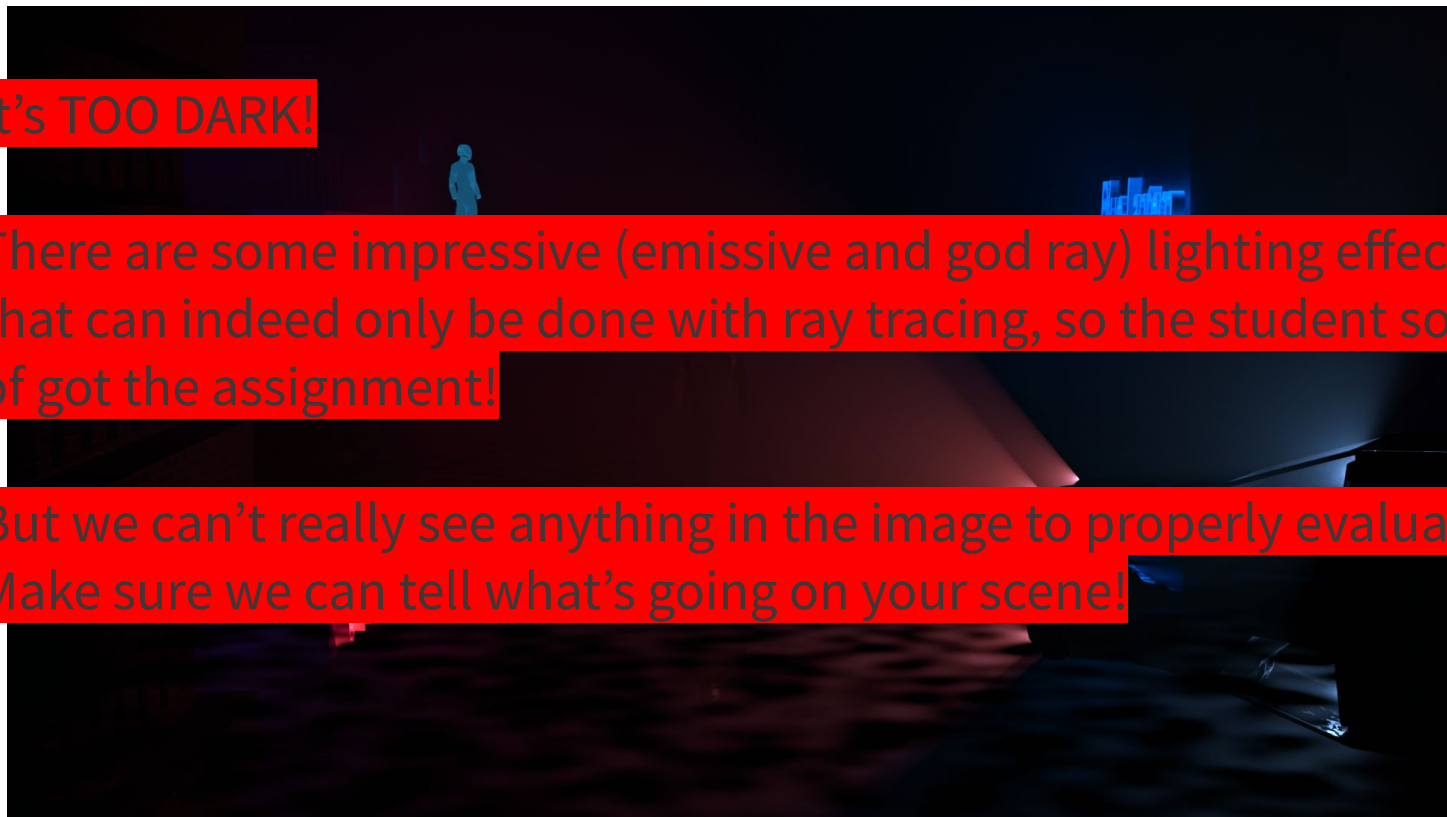


Good or Needs Improvement?

- It's TOO DARK!

- There are some impressive (emissive and god ray) lighting effects that can indeed only be done with ray tracing, so the student sort of got the assignment!

- But we can't really see anything in the image to properly evaluate it! Make sure we can tell what's going on your scene!



Good or Needs Improvement?



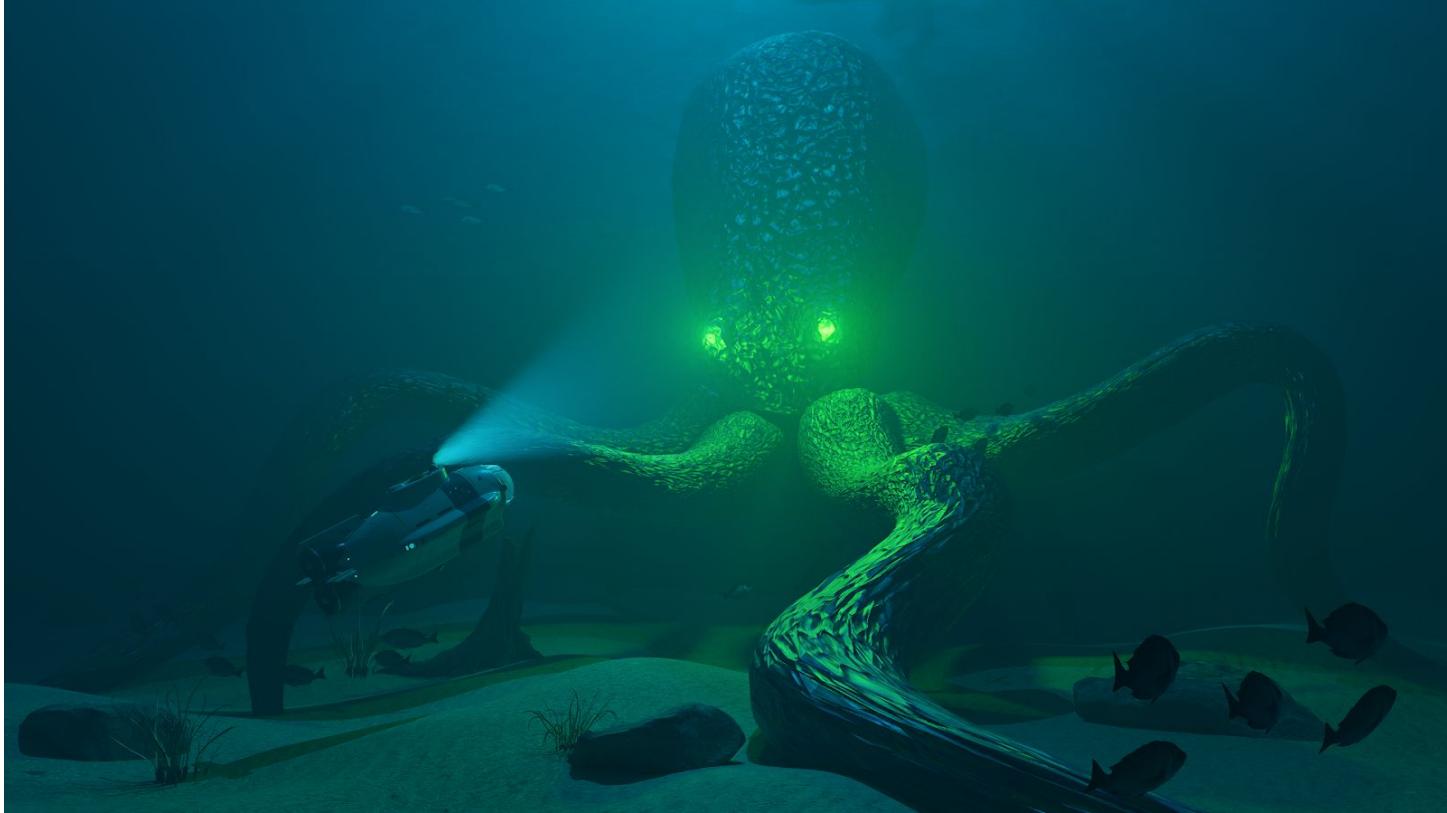
Good or Needs Improvement?

- We can clearly tell what the objects in shadows are meant to be!
- Moral of the story: dark scenes are fine, but you need to be purposeful with what you let the viewer see vs not see!



Hannah Norman,
Fall 2023

Good or Needs Improvement?



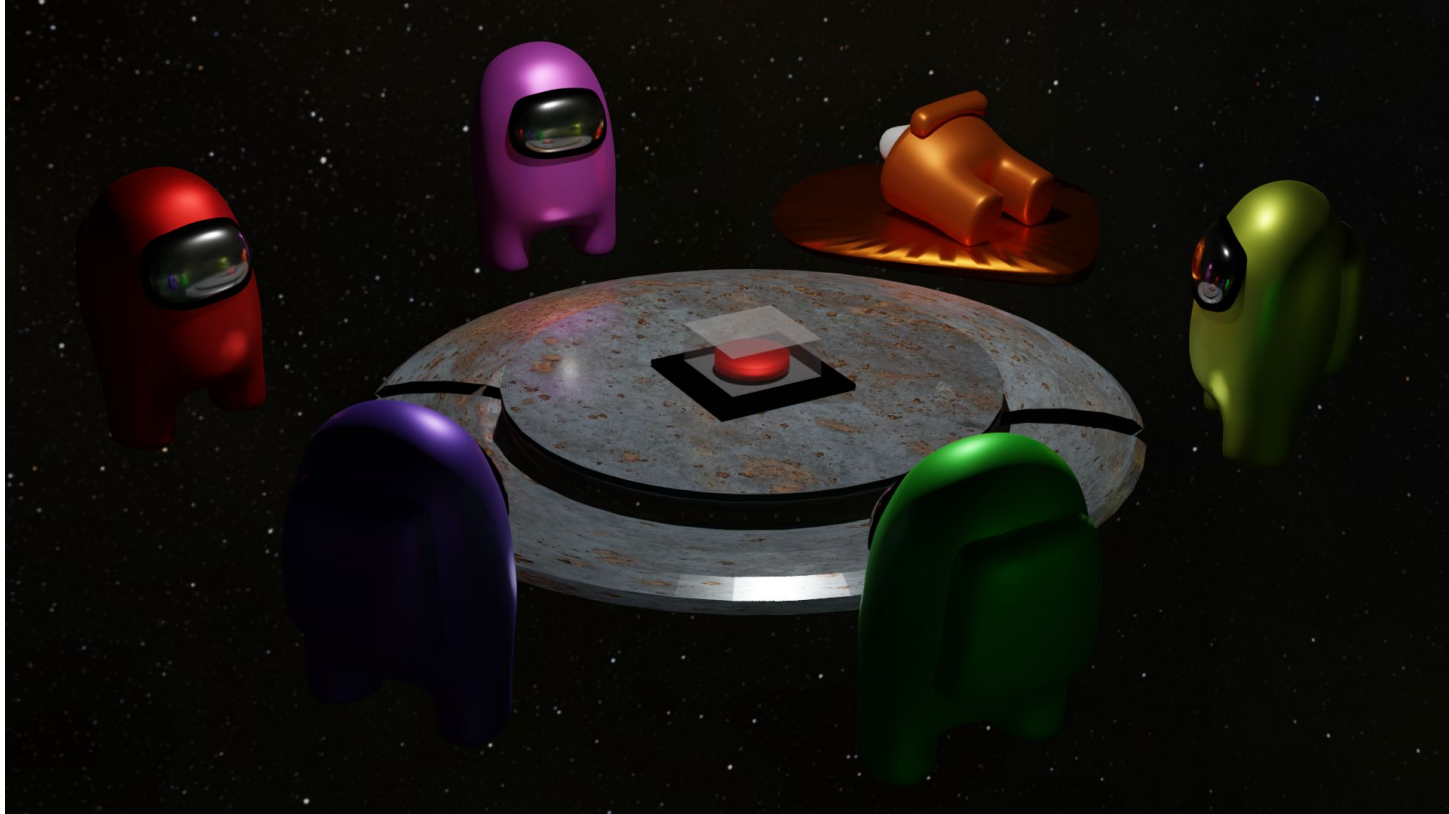
Good or Needs Improvement?

- Good use of emissive materials (on the eyes of octopus) and a combination of a spotlight + volume rendering!
- Those two simple lighting choices add enough light to this dark scene!



Bradford Lin and
Wilson Liang,
Fall 2021

Good or Needs Improvement?



Good or Needs Improvement?

- Left: Similar issues to the images with Deadpool and the starry night
- A project on “Among Us” might seem easy given the simplicity of the characters, but it might take effort to make a dynamic enough scene!



Olivia Loh and Xin-Yi Pan, Fall 2022

Good or Needs Improvement?

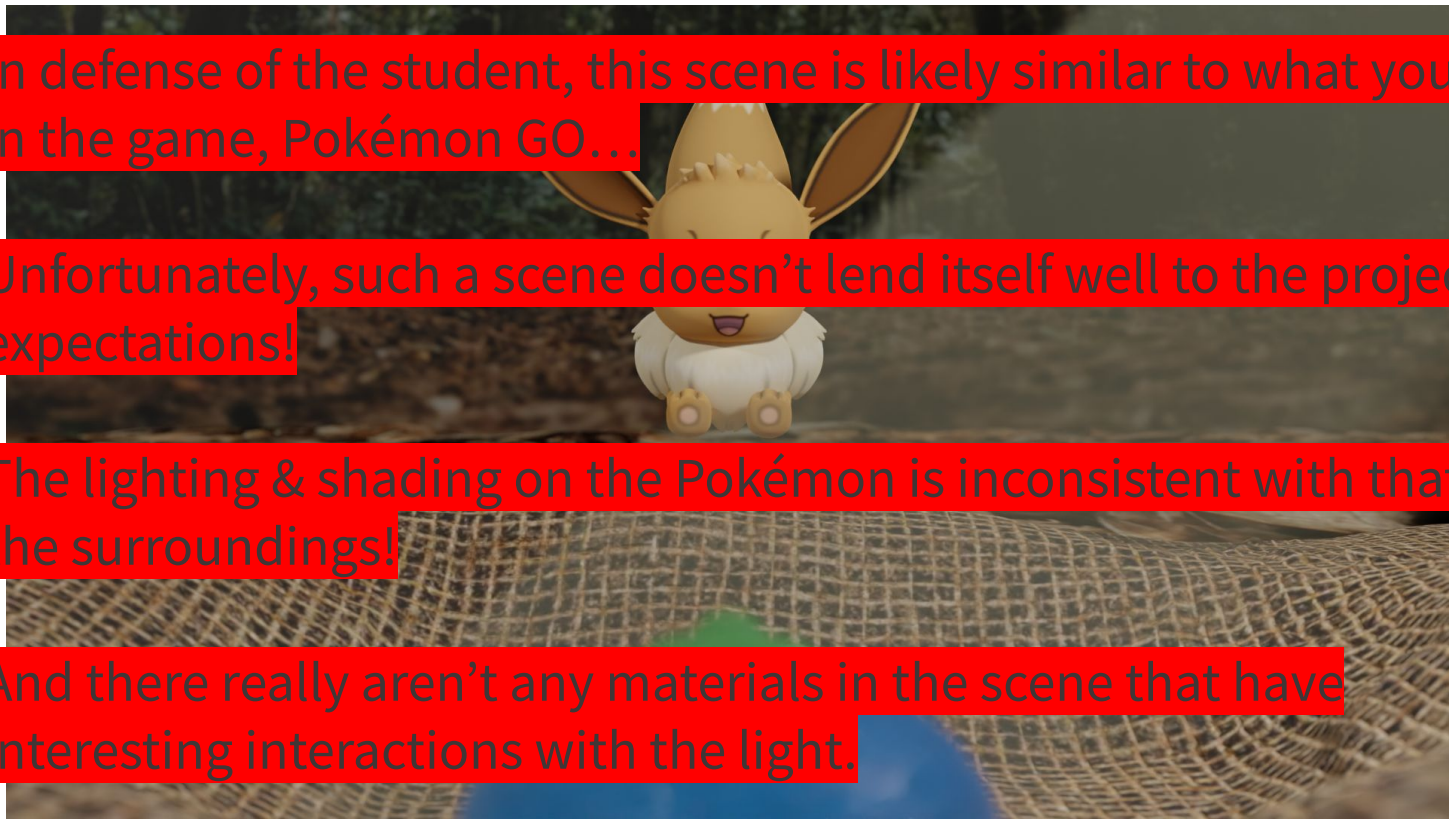


Good or Needs Improvement?

- In defense of the student, this scene is likely similar to what you see in the game, Pokémon GO...
- Unfortunately, such a scene doesn't lend itself well to the project expectations!

The lighting & shading on the Pokémon is inconsistent with that of the surroundings!

And there really aren't any materials in the scene that have interesting interactions with the light.



Good or Needs Improvement?

- In comparison, the following scene does the Pokémon theme better with consistent lighting & shading across the image.
- Moral of the story: be careful when choosing your reference scene!



Aliya Alsafa and
Sophie Wu,
Fall 2024

Good or Needs Improvement?

- Minecraft is another popular theme amongst students, but once again, **the simplicity of its models can lead to a deceptively tough project!**
- Moral of the story: be careful when choosing your reference scene!



Defne Genc and
Elena Recaldini,
Fall 2024

Good or Needs Improvement?

- On the other hand, be careful choosing a reference scene that might be too challenging (you only have 3 weeks!)

Tangled (2010)



Walker Stewart and Will Coors, Fall 2022



Good or Needs Improvement?

- If you can't recreate the full scene, then get creative!

Tangled (2010)



Romrawin (Jin) Chumpu, Summer 2023



Good or Needs Improvement?



Good or Needs Improvement?

- Scene can be simple as long as the power of ray tracing is clear!
- If you're stuck on coming up with a scene for your project, then going simple is fine – we won't judge!



Tracy Cai and
Xiaohai Lu,
Fall 2021

Good or Needs Improvement?

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Alex Oseguera and
Jay Saleh,
Fall 2021

Good or Needs Improvement?

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Ang Li,
Fall 2024

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**Michael Rybalkin,
Summer 2023**

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Catherine Huang and
Yara Sevilla,
Fall 2021

Good or Needs Improvement?

- Easy way to appeal to ray tracing: add reflective & transmissive materials like glass/water!
- Careful placement of glasses or bodies of water might be all it takes!



Danielle Tang,
Fall 2021

Good or Needs Improvement?

- Easy way to appeal to ray tracing: add reflective & transmissive materials like glass/water!
- Careful placement of glasses or bodies of water might be all it takes!



Kathleen Cheng,
Summer 2023

Good or Needs Improvement?

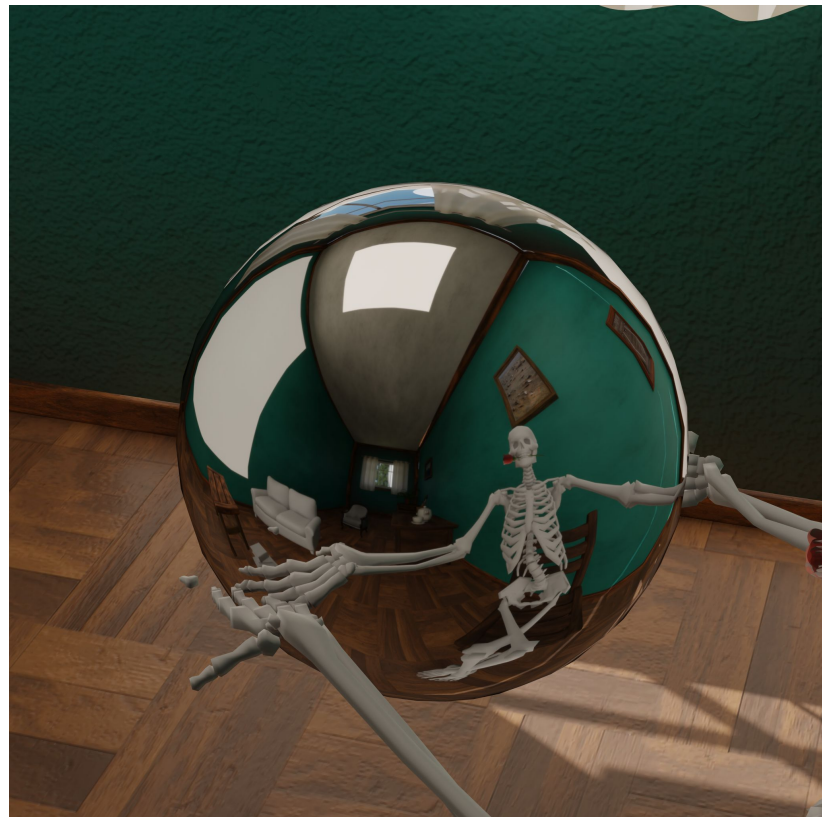
- Easy way to appeal to ray tracing: add reflective & transmissive materials like glass/water!
- Can also work for low-poly scenes!



Kevin Phan,
Fall 2022

Good or Needs Improvement?

- Easy way to appeal to ray tracing: add reflective & transmissive materials like glass/water!
- **Can get creative with how to use the reflections**
- This student was having trouble tuning the lighting in the scene, but they came up with the idea of mirroring the entire scene on a glass ball!



Eliza Huang, Summer 2023

Good or Needs Improvement?



Good or Needs Improvement?



Good or Needs Improvement?

- Left: Too much motion blur can lead to unrealistic effects!
- When adding motion blur, make it even across the entire scene, or it can look unnatural for e.g. only one object/part to be in motion



Mhar Tenorio, Fall 2023

Animation

Lecture Outline

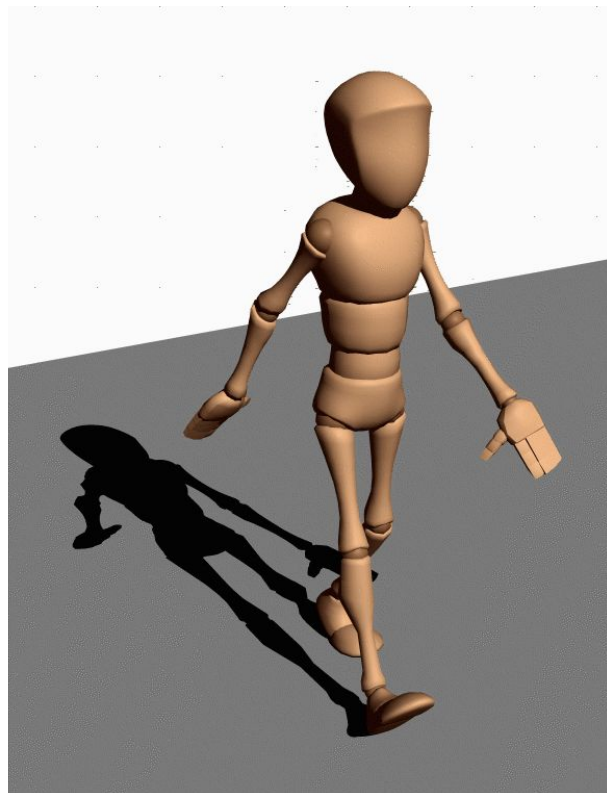
- Animation cycles + kinematics
- Keyframe animation
- Animation splines + motion blur

Lecture Outline

- Animation cycles + kinematics
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- Animation splines + motion blur

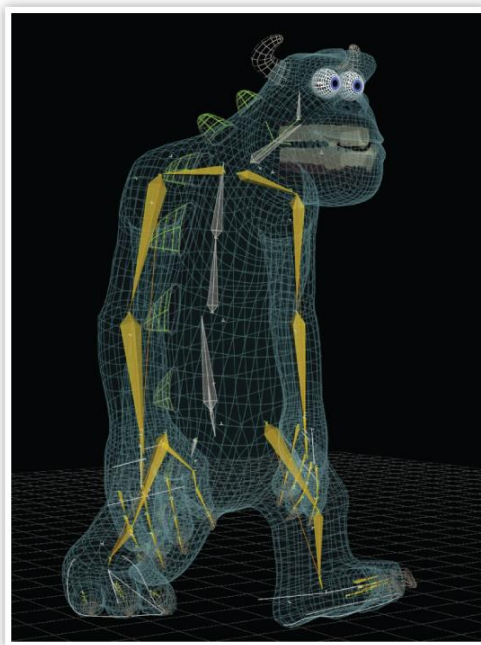
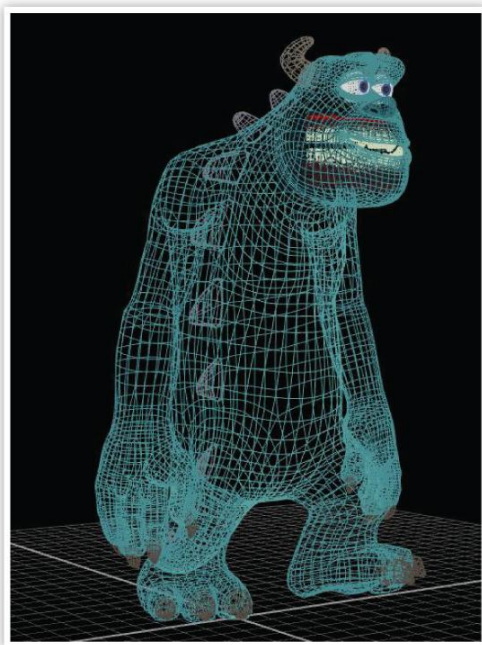
Animation Cycles

- Consider object space and world space
- One beat that's looped



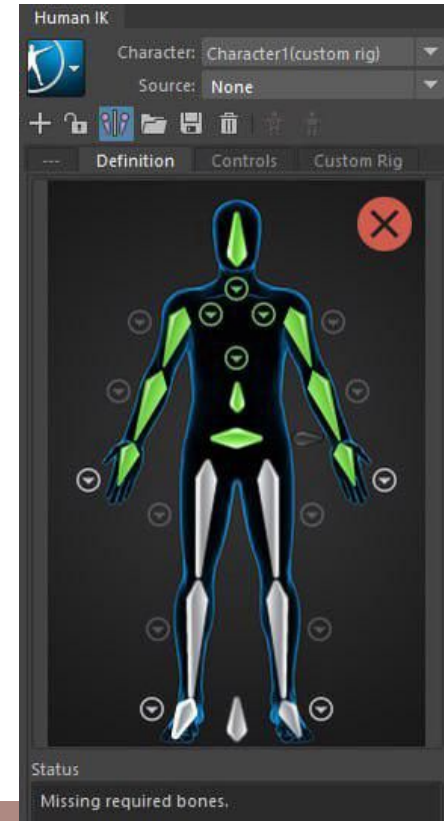
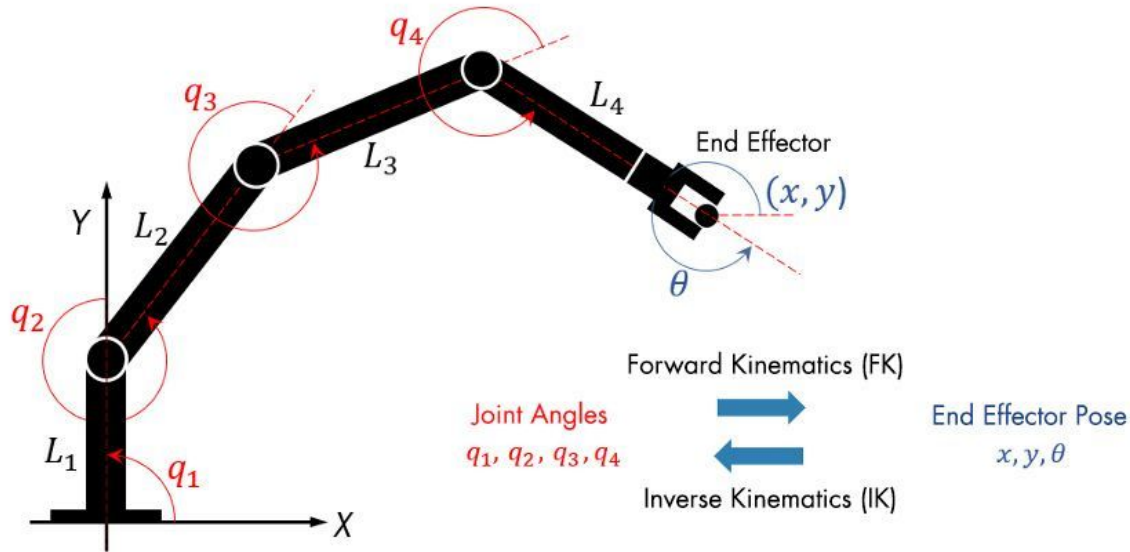
Character Animation + Rigging

- Move the bones, then project onto the mesh



Rigging + Inverse Kinematics

- Essentially calculating everything backwards



Rigging + Inverse Kinematics



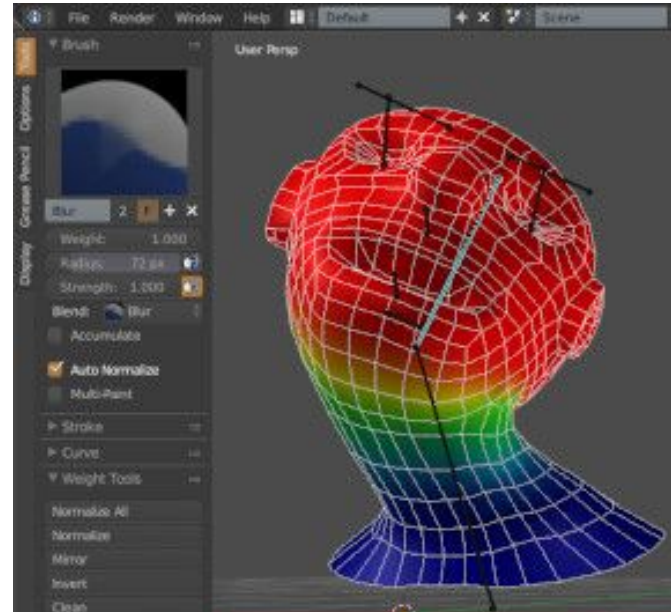
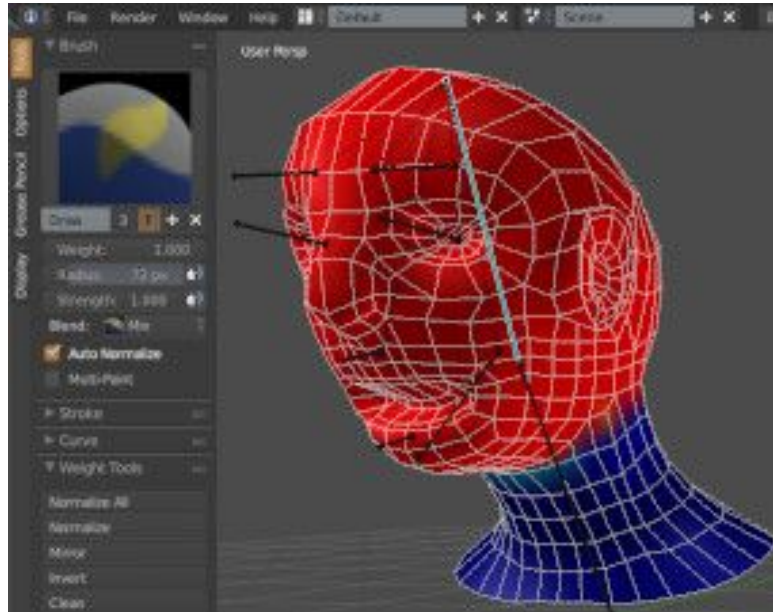
Forward Kinematics



Inverse Kinematics

Mesh Weights

- How to move the mesh along with the bones
 - While keeping things looking fluid and smooth

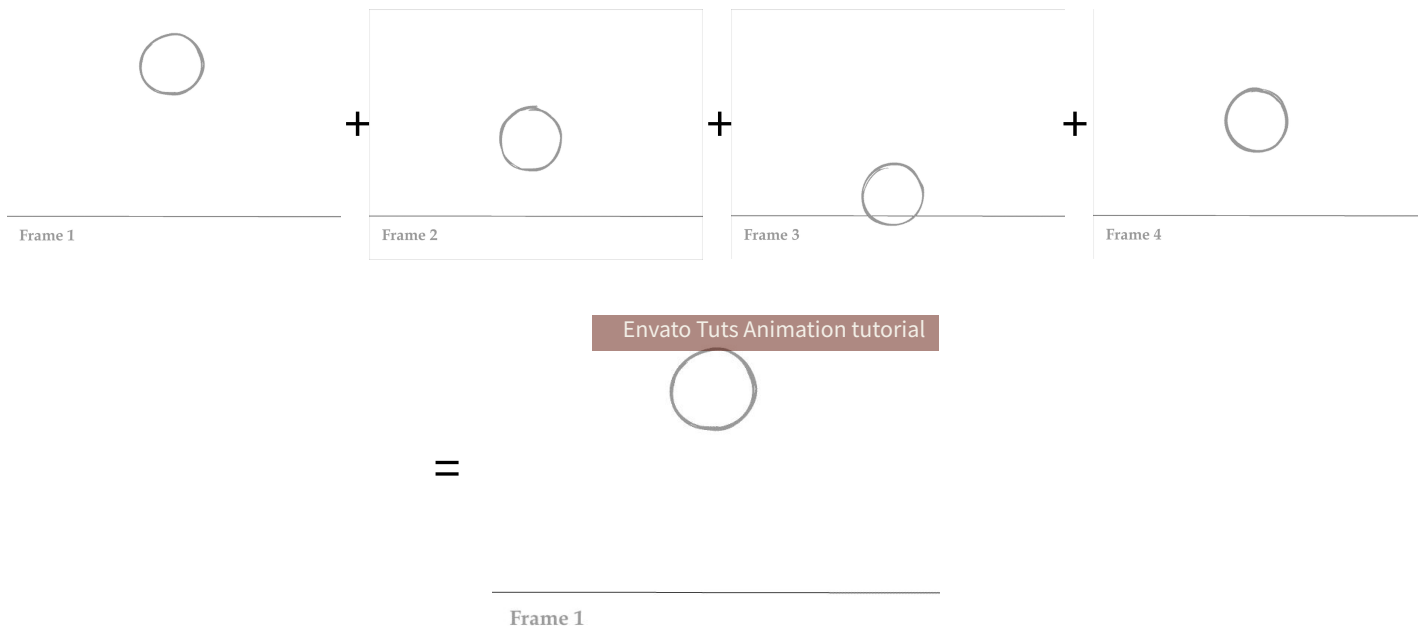


Lecture Outline

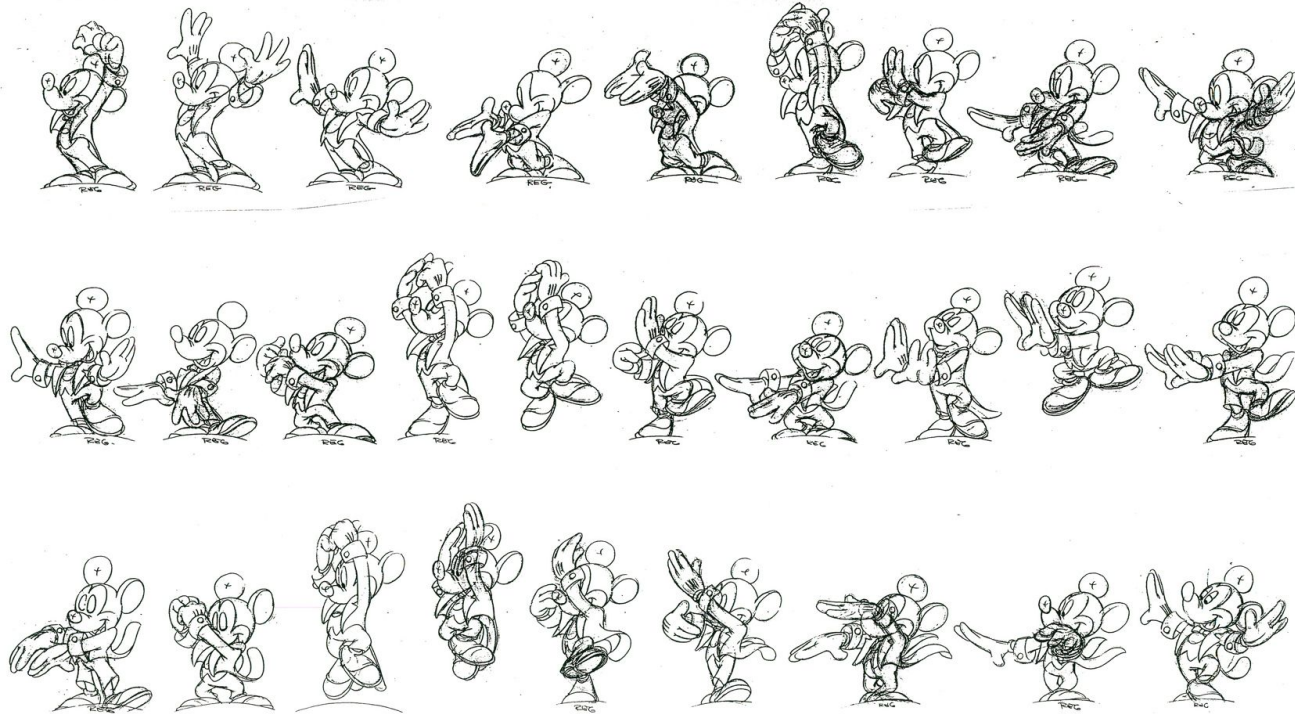
- Animation cycles + kinematics
- Keyframe animation
- Animation splines + motion blur

Virtual Time

- Animation takes place over time
- Frames in fast succession make an animation

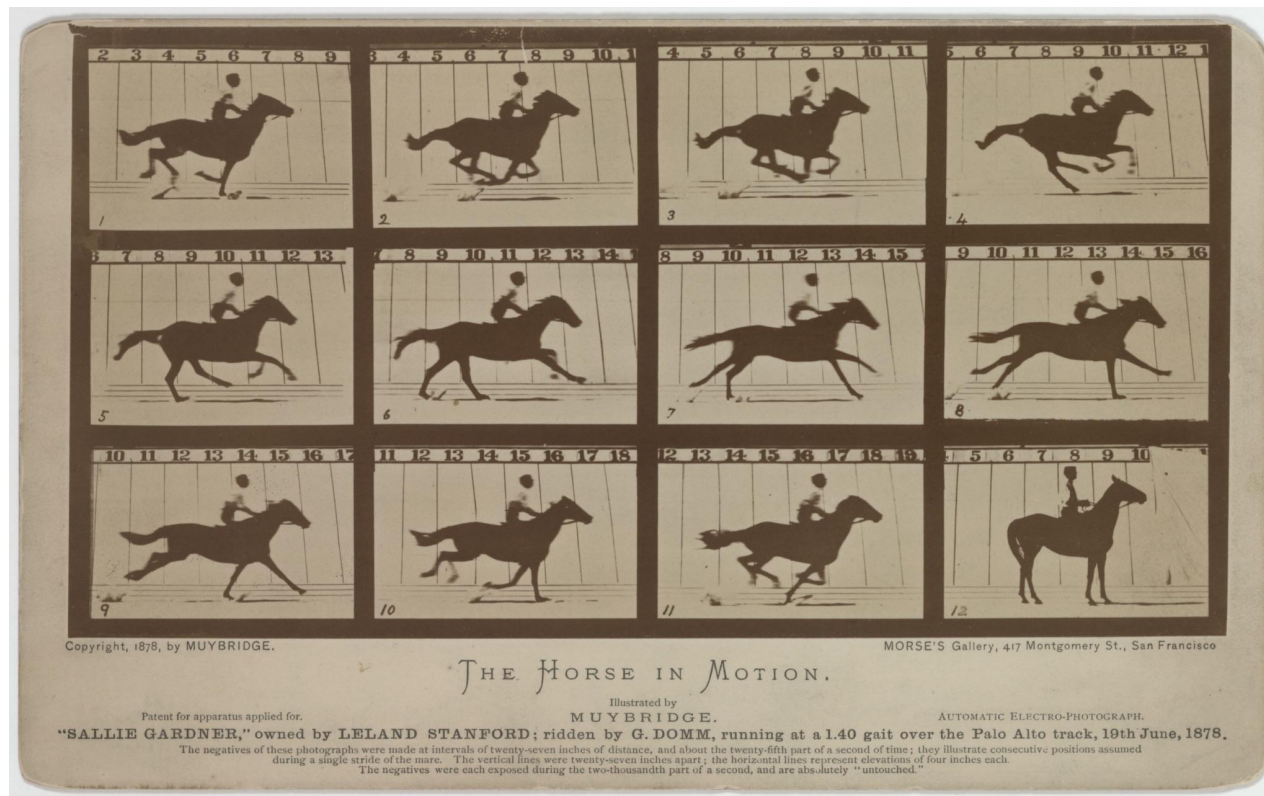


Hand Drawn Animation



SYMPHONY HOUR # 2272 SCENE 13

Horse Drawn (haha) Animation

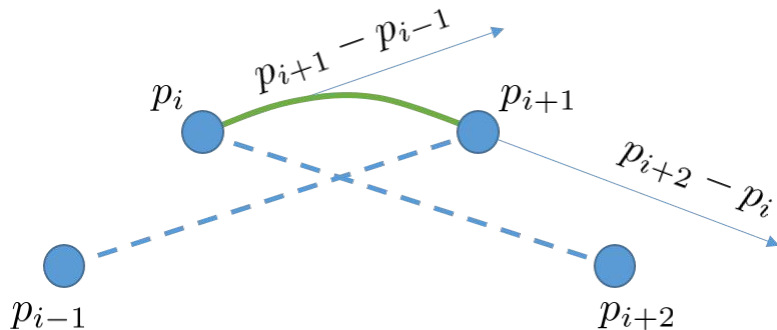


Horse Drawn (haha) Animation



Animating with Keyframes

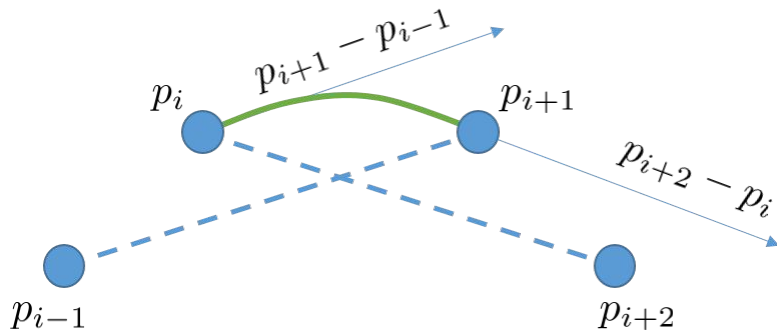
- Recall cubic splines from the geometry lecture:



- We can use them to **smoothly interpolate any two points**, not just vertices in geometry!
- Can use cubic splines to **interpolate between position values or scaling factors** from one keyframe to another

Animating with Keyframes

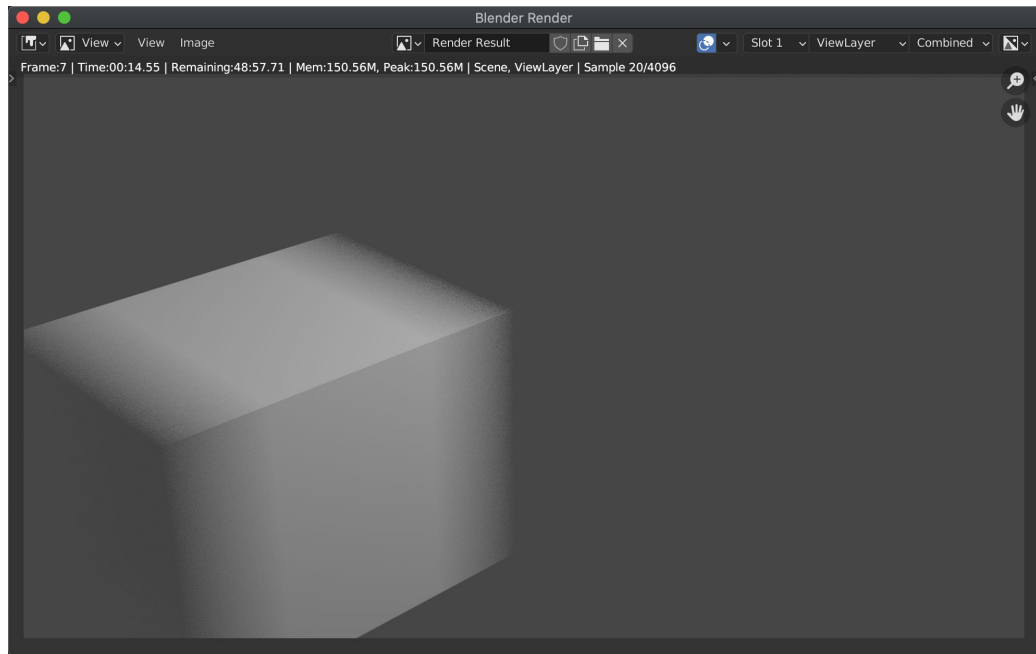
- Recall cubic splines from the geometry lecture:



- The cubic spline gives you a curve between the two points
- Remember this curve is parameterized by a variable **u between $[0, 1]$**
- If you want e.g. 9 frames between two consecutive keyframes, then simply evaluate your cubic spline at $u = 0.1, 0.2, 0.3, \dots 0.7, 0.8, 0.9$

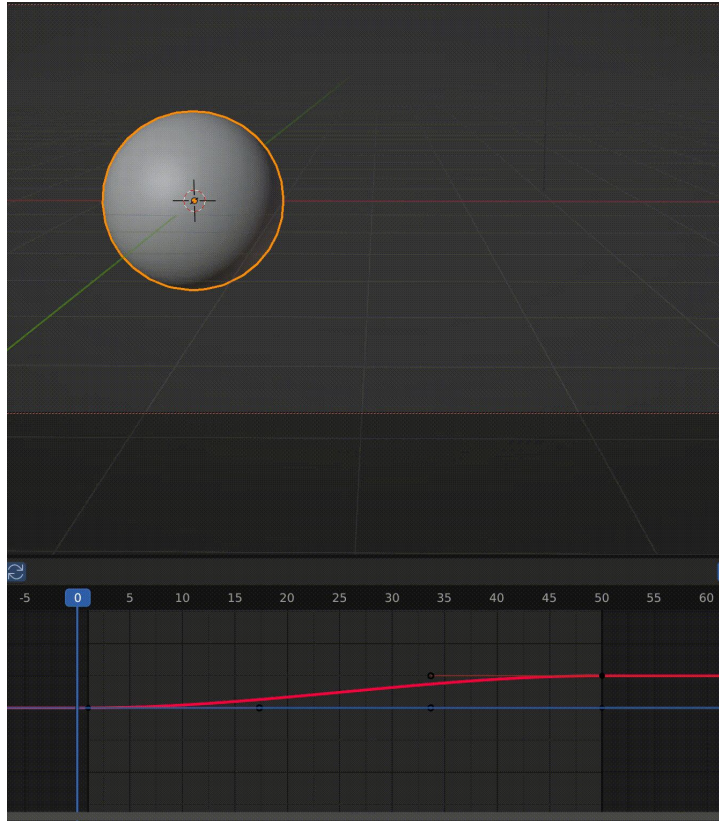
Aside: Ray Tracing Motion Blur

- Motion blur occurs when the object is moving faster than the aperture can shut
- Example: for a 10 frame animation, save all 10 scenes
- For **each ray, randomly pick a frame** to trace



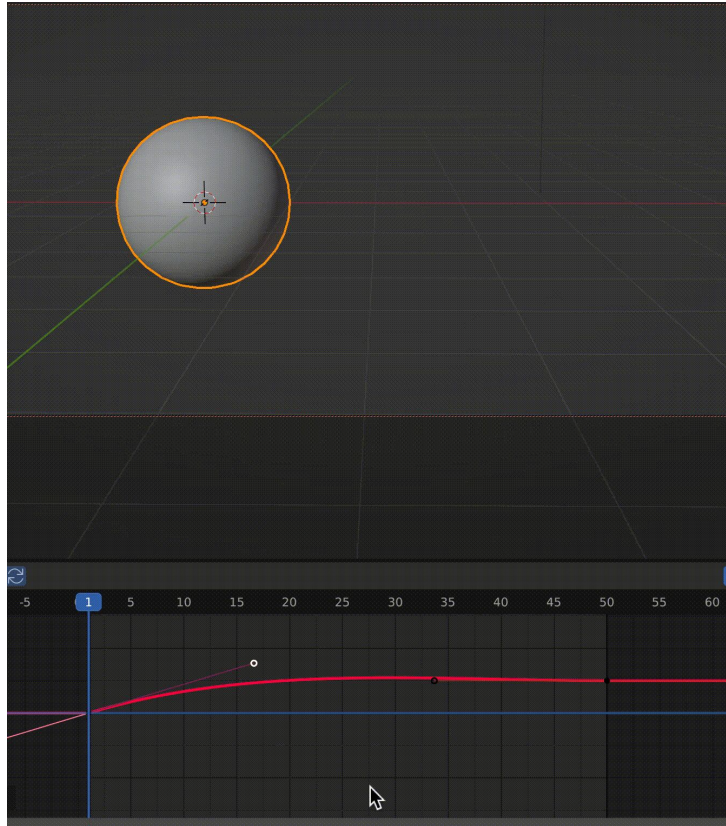
Animation Spline

- The slope determines the speed of movement



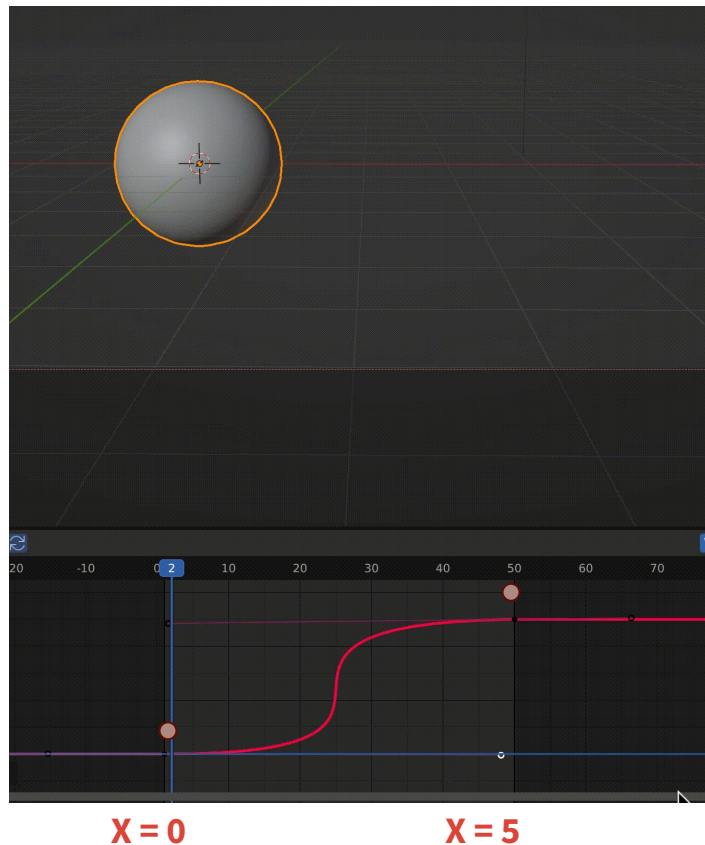
Animation Spline

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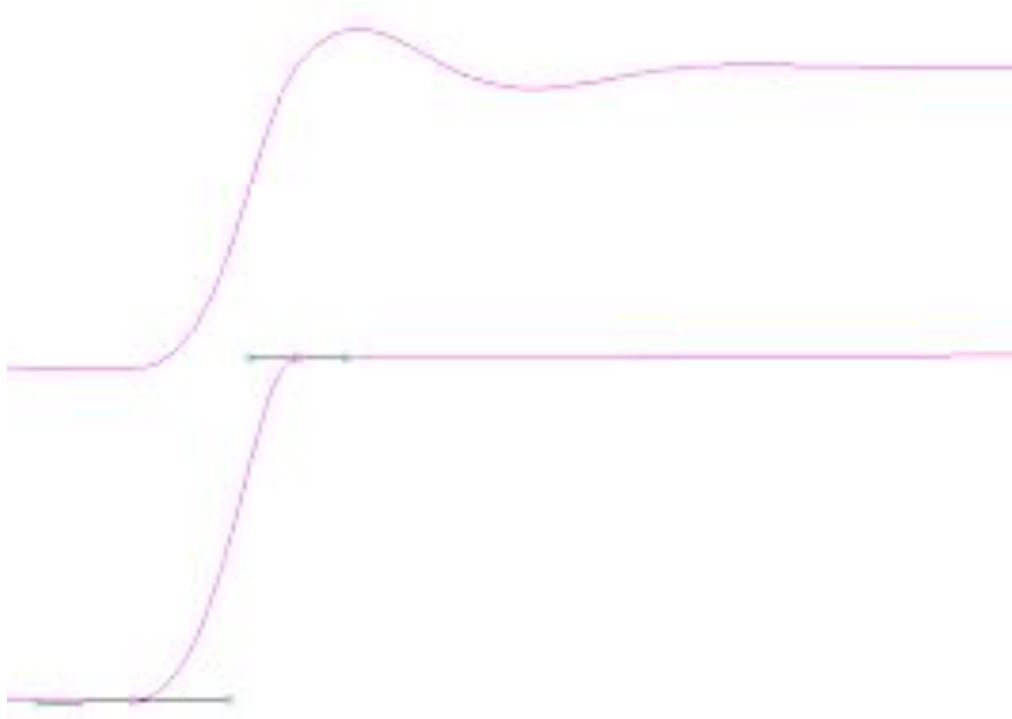
Animation Spline

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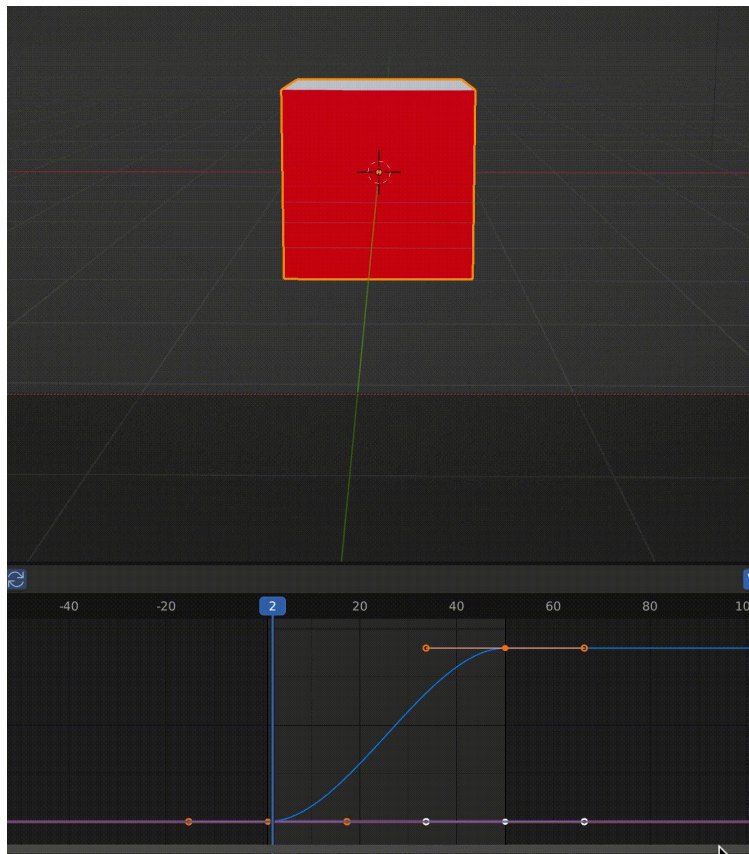


Animation Spline

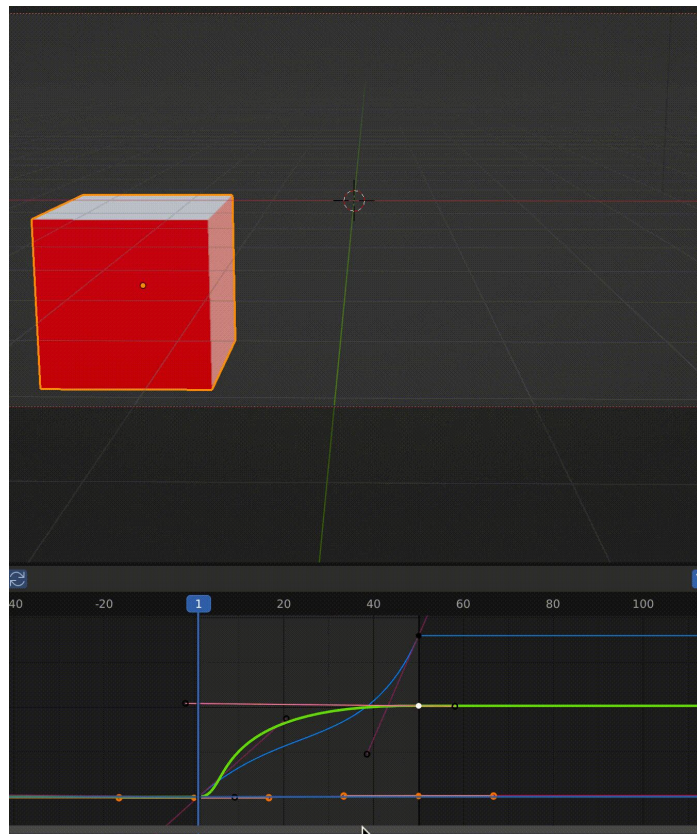
- What do these do?

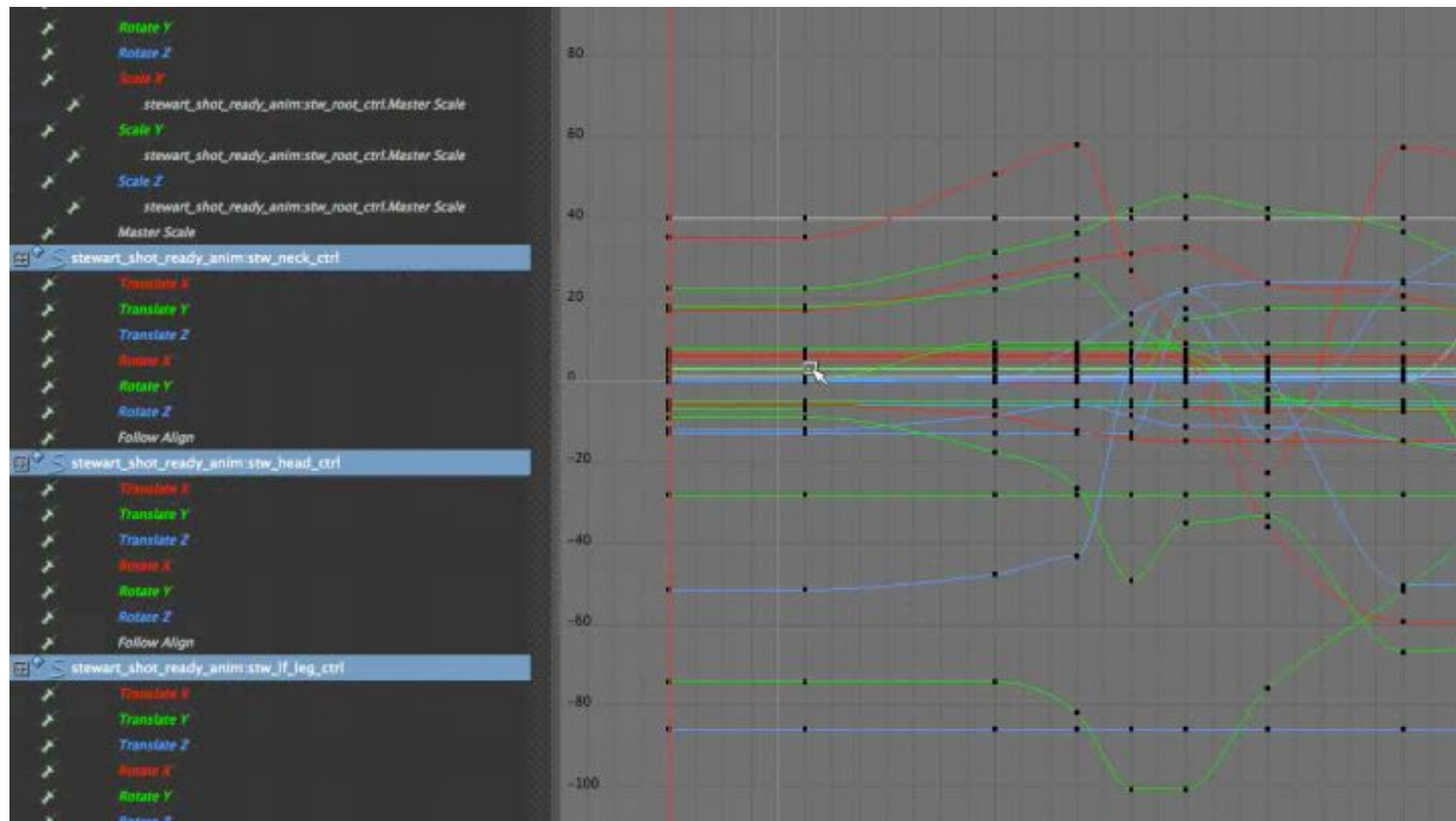


Animation Spline



Animation Spline







PIXAR'S PIPELINE

GIULIA FROM LUCA

Additional Resources + Exploring!

- REMINDER: **CAT HICKS** ON THURSDAY!
- [Blender Spline IK Constraint](#)
- [Eadweard Muybridge Collection Stanford](#)
- [Inverse Kinematics + Libraries](#)



- Fundamentals of Computer Graphics, Steve Marschner and Peter Shirley
 - [Preview, Book](#)