CS-452 Computer Graphics
Blender, Unity 5, Unreal Engine 4

LUMS
A Not-for-Profit University

CS452 Computer Graphics Project

Release Date: 19th October 2020

Overview

For this project, you will be going over the entire game / animation development pipeline using Blender and a game engine of your choice from Unity / Unreal! Both of their constraints and advantages will be considered when grading relatively just like the project type. Generally, you will be designing textured model props and animating a character in Blender **(Phase 1)** then importing your own assets into Unity / Unreal (as well as using free assets) in creating a simple custom game / animation **(Phase 2)**.

	Phase-1A	Phase-1B	Phase-2A	Phase-2B	Phase-2C
Name	**Modelling**	**Animation**	**Setup & Assets**	**Logic**	**Visuals**
Tool	*Blender*	*Blender*	*Unity/Unreal*	*Unity/Unreal*	*Unity/Unreal*
Details	Model 3 static scene props in Blender and add materials to them.	MOCAP Animation of online Humanoid player asset	Install tools, setup IDE, learn the basics by doing tutorials, import models, test player animation etc.	GUI if any and programming/no-coding logic for the game loop/animation	More assets, post-processing, decor, particle systems, animations and final polishing, video & tutorial etc.
Duration / Time required	1 week	1 week	1 week	1 week	1 week
Submission		[Submission of latest progress]	[Evaluation Meeting]	[Submission of latest progress]	**[Final Submit]** [Evaluation Meeting]
Deadline / End	**6th Nov (Friday)**	**14th Nov (Saturday)**	**22nd Nov (Sunday)**	**10th Dec (Thursday)**	**20th Dec (Sunday)**

Final Project Deadline: **15th December 2020**

Project Weightage: **Blender: 35%, Unity/Unreal: 65%**

Submissions will be bi-weekly, **but you are required to send us an update of your progress on Slack after every phase/week (150 words max)**. The submission formats will be communicated every time, but may include a *short report, images and a contribution statement*. *A video submission is required for the final submission*. The lab/HW deadlines will be shuffled according to the project deadline for convenience. There will be two evaluation meetings as mentioned with the Instructor and your primary Supervisor/TA assigned, one mid-way through the project and one at the end.

More detailed descriptions will be released in the objectives section that will be updated weekly! More links and resources may be added over time, so this document will be your main source of reference for the project and deliverables based on weekly objectives will have to be submitted on LMS.

Sample Projects

We have referenced some sample projects as well but do not restrict yourself to them! Check out all of these different genres before you decide on an idea.

Sample animation projects:

- Entertainment for kids / nursery rhyme: https://youtu.be/HLm9IJRqW-U
- Dramatic / cinematic: https://youtu.be/5NU95YMmzAc
- Comedy short: https://youtu.be/dbjIm3Upy7A
- Educational short stories for kids: https://youtu.be/wZq2tyLNPRU

Sample game projects:

- Obstacle run: https://youtu.be/6MQqjKbhLkE
- Interactive horror: https://youtu.be/X6S0asGD2oc
- Fighting: https://youtu.be/yQhQDI_TOKo
- Endless runner: https://youtu.be/d4Qrq-NOlO4
- FPS: https://youtu.be/NvzpOCkw-eA
- Adventure, hack and slash: https://js13kgames.com/games/minipunk/index.html
- Top-down, RTS: https://globalgamejam.org/2020/games/technician-1

Week 1 - Objectives

1. Go over all the tools listed here, their descriptions and understand their context.
2. Start by installing these tools and trying out the initial tutorials for each of them, you can later watch them at your own pace. We will specify which videos are mandatory for every phase.
3. Decide your project partner and fill in the **project proposal** as a group if you have not already.

Week 2 - Objectives

1. Attend the guest and project session on Saturday - 31st October, 2020
2. Install Blender if you have not already! Start watching tutorials relevant to this task as specified. (Refer to the Tools and Tutorials section. Watch Tutorials 1, 2, 3.)
3. Read Phase 1-A instructions carefully and divide work. Start executing!

Phase 1-A - Modelling

Requirements:

- ➔ Design ***at least*** 2 static scene objects (prefer quality over quantity, the rest can be for your own use but you can showcase them). These objects may be tables, chairs, houses or map decorations or weapons depending on the nature of your idea. These are just objects that do not need to be animated. (See examples at the end) (2)

- ➔ Each object MUST have ***at least*** 3 different materials. (3+3)

- ➔ The objects cannot be entirely composed of primitives. There must be intersections, exclusions, curves and reshaping etc. (1+1)

- ➔ **BONUS:** Apply textures to your objects. (Texture painting, custom textures, online assets) (See sample 2) (1)

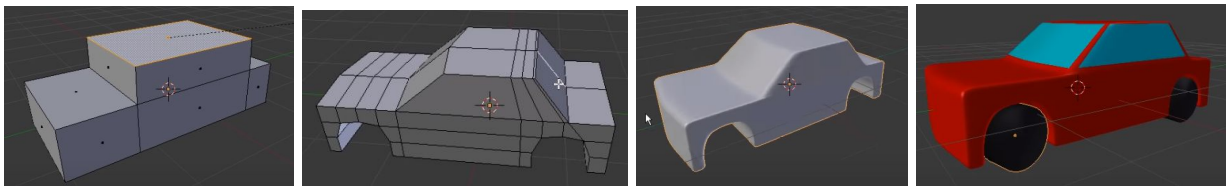
Submissions:

- ➔ You are to save 4-5 screenshots of your progress for every prop at different points of development (See Sample 1), the TA's will request these progress screenshots later. The screenshots are not graded, they are merely to check what you have done, your prop's development and see if any corrections are necessary.

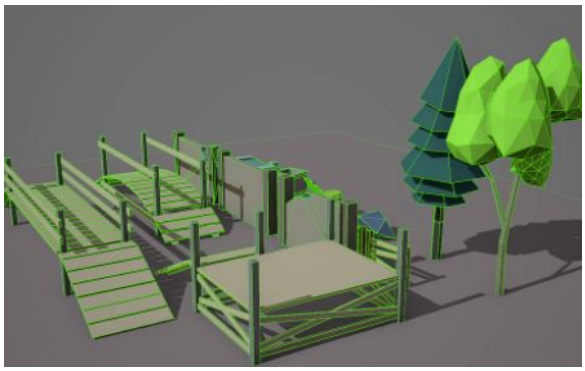
- ➔ The submission for this phase has to be done with the next one. For now, create folders for each prop with the folder names being the prop names and add all screenshots (numbered 1,2,3,4...), the Blender project file and the model FBX file inside each folder.

- ➔ You have to send the final screenshots of your prop models on Slack, how they will be used in the project and explain how you developed them, what exact tools/techniques you used and any hurdles you faced in the procedure. We will recommend any edits as required and you can improve them later on an ungraded basis if you want to.

Sample 1 (Screenshots):



Sample 2 (Texturing):



Phase 1-B - Linking Motion Capture Data

Requirements:

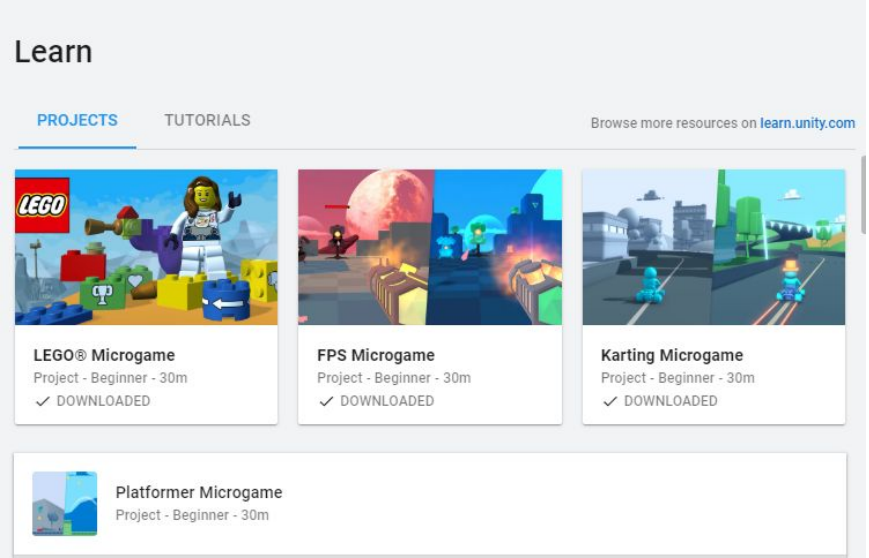
- ➔ Import ***at least*** 1 fully textured ***humanoid*** model. There are no restrictions on how you obtain this model, feel free to download it from the store or make your own. This requirement will make sense when you watch the tutorial that will be released. Kindly keep checking the *tutorials* section of this document (1)
- ➔ Link ***at least*** 4 animations to that model. One possible way this could be done is using the CMU Motion capture dataset that is publicly available here. A tutorial guiding you on how to do this will be released shortly. (4)

Submissions:

- ➔ Along with your phase 1A submission files and your humanoid model with animations mapped (from phase 1B) as .FBX files.
- ➔ Compress and ZIP these FBX files and upload it to the LMS submission tab for the blender phase.
- ➔ **Update:** In case materials and textures are not exporting with the .FBX file, submit the .blend file as well.

Week 3 - Objectives

1. Install Unity / Unreal if you have not already!
   In the case of Unity: Refer to complete installation instructions in the Tools and Tutorials section. However, there has been an *update*. You must install version **2019.4.14f1 (LTS)** to get access to most of the tutorials. But those planning to use the latest AR features should additionally install version **2020.1.13f1** (for AR Foundation). Get comfortable with the documentation as well! For people using *Cinemachine* for animations in Unity, additionally do this 10 min tutorial to get an overview then refer to other resources mentioned. Moreover, get used to working with either Unity Collab (recommended - follow these steps) or just use *Git* to work together in a group. Check out Bolt if you are interested in visual scripting but understand its constraints.
2. For Unity, do 2-3 of the 30 min tutorials on Unity Hub (they point and you just follow along step by step interactively, and even if you are working on an animation they will be semi-programmed so you will partially have to code as well.) For Unreal, just watch the tutorial that has been up on LMS.



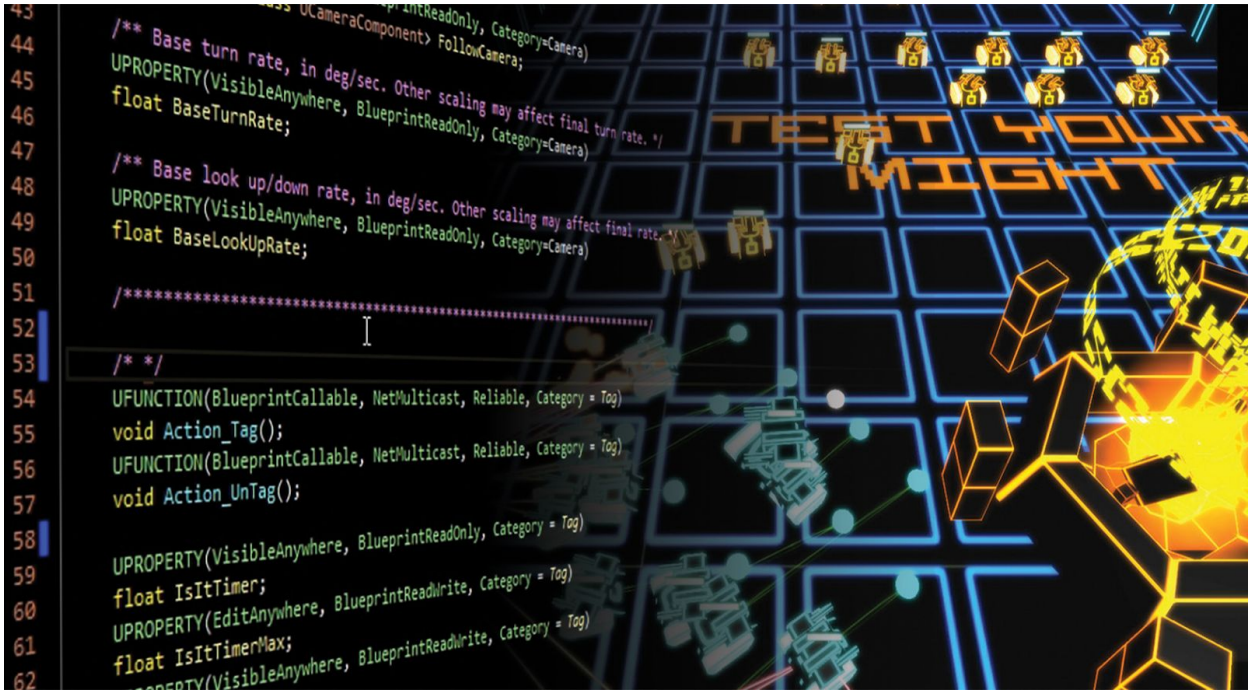
3. Finally, import all of the assets you created in Phase 1 - A and B and play around with them, especially test out the animations for your humanoid character using the animation editors in your relevant tools. Look around for more assets online and also character builders like Mixamo to polish your asset library for your game/animation.
4. Optionally, go through all of the resources available in the tools sections (tutorials) and watch what you like accordingly. There are no hard deadlines.
   Just relax and learn for this week!

Week 4 - Objectives

Phase 2B - Logic

This is one of the most crucial phases, focused on the *core functionality* of your game/animation, that is all the *logic* involved without any focus on the visual appeal.

Utilize event-driven, visual programming mainly and where necessary, object-oriented scripting offered by your development tool (Unity/Unreal). Refer to official documentation for all API.



For **games** dominantly, focus on the following features:

1. **Game Loop:** A complete functional game loop is to be implemented for one level/mode at least for your game.
2. **Player Movement & Interactions:** Mapping keyboard/touch controls to the movement of the main character. The required interactions mentioned in the project description that the player can perform with the environment (or other assets) should also be incorporated.
3. **UI elements:** Core basic GUI to toggle or initiate certain behaviors e.g. to play/restart/exit the game, select mode/level, toggle game effects or user controls, customize assets etc.

4. **Miscellaneous:** Automated generation, randomization, AI, NPCs, enemies etc.

For those working on **animations**, some of these contextually apply as well (apart from 2). For example, 2D UI elements can also be incorporated as in some of the sample animations given. Your animation loop should be replayable from the project file as they will be executed programmatically (using event triggers for the modification of object properties and playing specific animations from the assets). Other factors to consider are:

1. **Camera Motion:** Create certain camera behaviors for your animation cutscenes for cinematic effects as required using the procedural camera systems given from your tool.
2. **Sounds:** For animations it is recommended to focus on the sounds during this phase and trigger them along as well as the overall experience matters more for them.

Although this submission will not be assessed for its visual appeal, it is recommended to set up character assets and animations at least to save time for further polishing in the next phase. Any camera overlay effects, particle effects, sounds (for games), help/tutorial and enhanced UI graphics will be part of the next phase. Do not be afraid to leave minor bugs also, just ensure that you have attempted to cover most of the functional product. Make sure you add comments to your scripts also!

Submission:

Deadline: **8th December, Tuesday**

You are required to submit a Google Drive link as before containing a zip file **groupX_rollnumber1_rollnumber2_phase2b.zip** including a simple **PDF containing all controls and instructions** that you would like us to test with and the **final project folder**.

Phase 2C - Final Submission

Focus on the following deliverables:

1. **Project:**
    - **Fix previous logical issues** - include all bugs, ensure you have decent complexity for your animation/game prototype. You are allowed to use asset scripts and blueprints for this phase for minor functionality. Just ensure you program the main game loop and framework yourself.
    - **Add visuals** - ***particle effects, complex assets and map scenery, graphics, animations, sounds, interactive GUI, lighting, tutorial/help***

2. **Video (3 minutes max):** Just a fun demo showcasing your game. For animations, your final composed and edited animation video with an explanation of the individual scenes at the end. (length of the animation itself - **2 minutes max**)

3. **Report:** A document (Word and PDF) *ideally* containing the following headings with any formatting and length:

    - **Short Pitch** (2-3 lines)

    - **Final Idea Complete Description and Highlights** (Screenshots)

- **Instructions** (and Controls if applicable)

- **Features/Scenes and Process** (how they were created or made functional, highlight any scripts and assets you used from online sources)

- **Bugs and Improvements Required**

- **Contribution Statement**

Submission:

Deadline: **20th December, Sunday**

You are required to submit a Google Drive link as before containing a zip file **groupX_rollnumber1_rollnumber2_final.zip** including the **video** (mp4/mpeg/mkv/avi), the **report** (Word and PDF) and the **final project folder**.

Tools and Tutorials

1. Blender

Introduction

Blender is a free and open-source 3D modelling and animation tool that rivals industry competitors such as AutoDesk Maya and ZBrush. Historically Blender has been classified more as a hobbyist tool than an actual industry grade software. However, with the new Blender 2.8 release that happened back in 2019, has now proven itself to be more than capable of being used in industry grade projects. If you want to get a feel for just what is possible with the free tool, check out this sample short film created completely with Blender!

Installation

Download Blender from your specific OS from here (the latest version or any version >= 2.8 works). [190 MB max]

Objective

This phase of the project you will have a total of two tasks:

1. Model, texture and export **inanimate objects** (e.g. a sword or a chair)
2. Create/Find a **humanoid 3D model** and animate it with **motion capture data**.

This document provides selected videos from a really high quality YouTube tutorial series by Andrew Price (Blender Guru). You are encouraged to watch the full series if you are interested and find the time to do so.

Finally, this document is to help you get started with blender asap. More details about every phase of the project (Criteria, marking, deliverables etc.) will be released later.

Tutorials

Note: These tutorials are for Blender 2.8, but you may use Blender 2.9 since there is not much difference. Do not use anything earlier than 2.8!

1. **Intro:**
    a. [**link**] A longer and better introduction to Blender 2.8 by the Guru himself.
    b. [**link**] Introduction to the UI and how to get around. Common keys and shortcuts.
2. **Sculpting and design:**
    a. [**link**] Introduction to modelling in Blender 2.8
3. **Materials:**
    a. [**link**] Changing colors and the *feel* of the material.
4. **Animation with Motion Capture:**
    a. [**link**] Using the CMU motion capture data with Blender 2.9

Resources

1. [**link**] In general, anything you find on the Blender Guru channel is really high quality. Andrew Price (the host) is an industry professional who uploads most of his content for free.
2. [**link**] CMU Motion Capture Data.

2. Unreal Engine 4

Introduction

Continuously evolving to serve not only its original purpose as a state-of-the-art game engine from Epic Games, today it gives creators across industries the freedom and control to deliver cutting-edge content, interactive experiences, and immersive virtual worlds. It features photorealistic rendering, dynamic physics and effects, life like animation, robust data translation. Take a look at its features in depth here some of them including blueprint visual scripting, animation blueprints, sequencer, realtime ray-tracing, clothing tools and the chaos destruction system.

Installation

1. Create an Epic Games Account (if you don't already have one).
2. Download and run the installer (Epic Games Launcher Set-Up Program) [~42 MB], pick the Creator's License when asked.
3. Sign into the Epic Games Launcher.
4. Install Unreal Engine 4 using the launcher. [~11GB]

Objectives

The first 3 tutorials are mandatory to watch and will be sufficient to complete your project. The next few are for those who want to take the extra step and explore the true potential of UE4.

1. **Intro:** This tutorial will have 2 segments, the first being a discussion on what a game engine is, what popular game engines are in the market right now, what makes Unreal Engine 4 special and is UE4 the right choice for you? The second segment will be a quick demo of the software's interface, from the layout and placement of some basic tools to important shortcuts. [Available on LMS]
2. **Level Design:** This tutorial will get you started on level designing in UE4; from setting up a level and importing assets to materials and textures. The tutorial will also discuss some basic techniques of adding realism to the scene (foliage and lighting etc.).
3. **Game Programming 1 - Blueprints:** An introduction to the popular blueprint system in UE4 that enables you to create games without writing a single line of code. All essential concepts from character movement and object interactions to Artificial Intelligence will be covered.
4. **Game Programming 2 - C++:** Everything mentioned in the last part except using C++ rather than blueprints.
5. **Advanced Photorealism:** This tutorial will introduce you to photogrammetry, a modern technique that can be used to enhance photorealism. This will include an introduction to Quixel Megascans and will also help setup Quixel Bridge and Quixel Mixer. Finally, we'll take a look into post-processing our scene.
6. **Game Design:** This will be a rather casual session discussing best practices in game design.

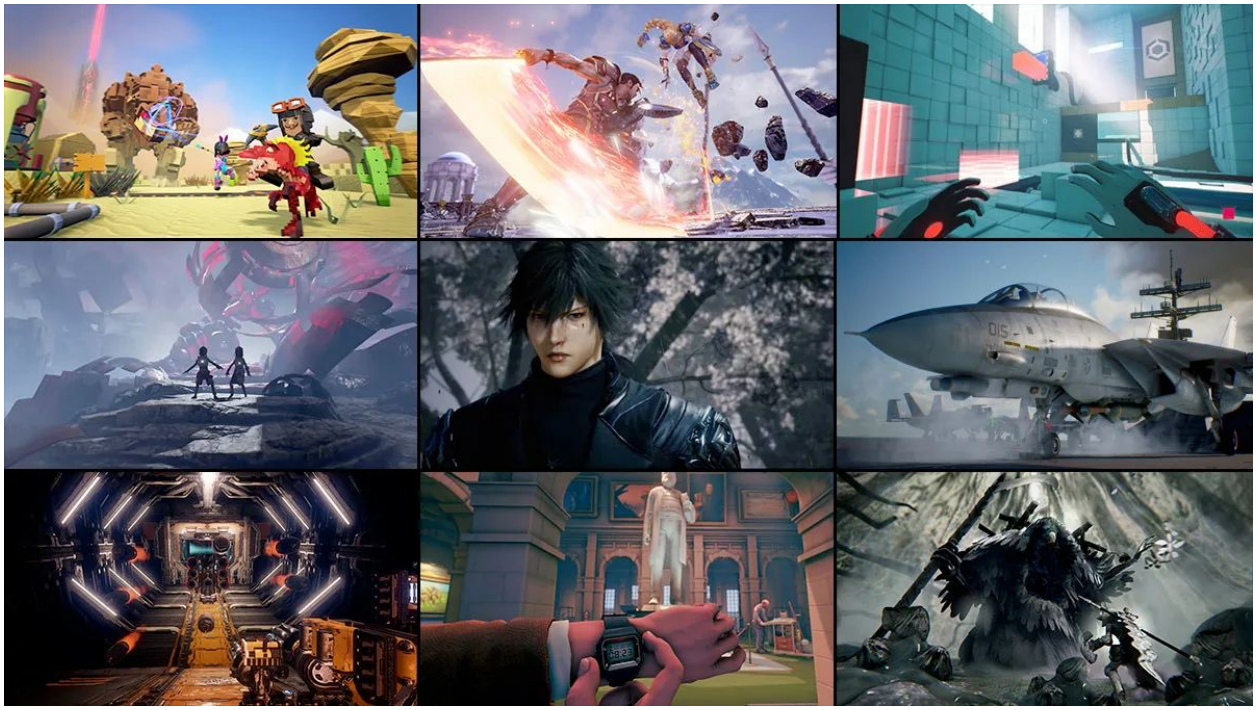
Resources

1. Rebirth: a glance into how powerful the engine is & making of Rebirth.
2. A guide to UE4 Terminology.
3. The UE4 Editor Manual and the official documentation for Rendering and Graphics in UE4.
4. A few awesome level design examples: Overgrown Ruins, Country Road, Rainy Night.

3. Unity 5

Introduction

Unity is a cross-platform game engine developed by Unity Technologies to create three-dimensional, two-dimensional, virtual reality, and augmented reality games, as well as simulations and other experiences. As of 2018, the engine had been extended to support more than 25 platforms. It has been adopted by other industries as well such as film, automotive, architecture, engineering and construction. You can check out the latest version 2020.1 updates here.



Installation

1. Download Unity Hub (a management tool used to manage Unity Projects and installations). [~150 MB]
2. Create a Unity ID from here as it downloads, then sign in to the Unity Hub when done.

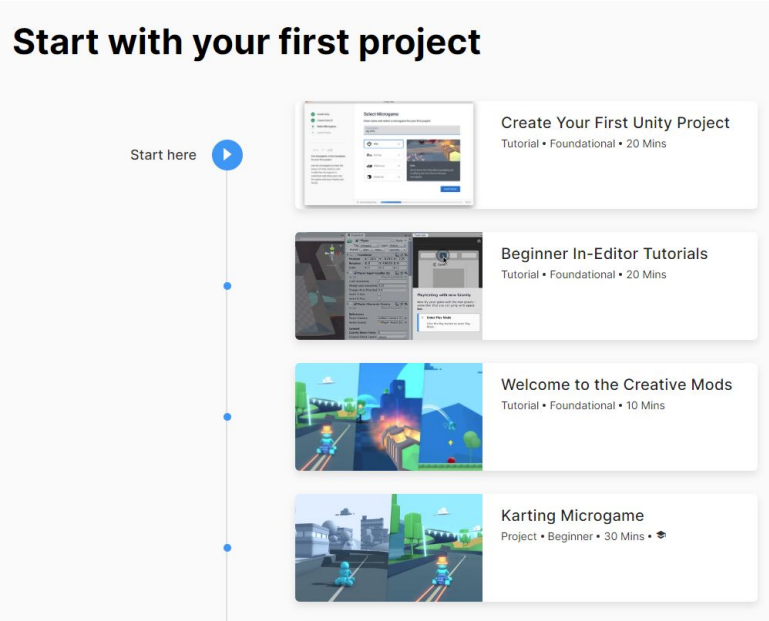
3. Finally, install version **2019.4.14f1 (LTS)** where LTS is for long-term support, to get access to most of the tutorials. However, for those planning to use the latest AR features should additionally install version **2020.1.13f1**. [~3GB] You can learn more about the new features of Unity 5 here. Make sure all of you have this same Unity version for easier project collaboration.
4. In case you aim to make a mobile game, download the Android and iOS Build Support when installing. You do not need to install Visual Studio also, just link up the engine with VS Code (better integration) or Sublime as your IDE if you prefer. Just change the "External Script Editor" in Preferences (menu: Unity > Preferences > External Tools > External Script Editor) to your desired IDE. Try out a sample tutorial on the Unity Hub to get started!

Objectives

1. **Intro:** The game/animation development life-cycle and basic components of each. Introduction to Unity interface and basic functions as well as game physics. Introduction to 3D game systems and coordinates. Objects and their transformations that is rotation, scaling, translation and combinations. 3D and 2D vectors and their use. Scenes and cameras, perspective and different types of games with respect to angles. [link]
2. **Physics and Coding:** Introduction to engine physics, velocity, acceleration, collusion, momentum and how Unity handles it, along with a C# primer. Also an introduction to 3D game kit to program gameplay without any coding.
3. **Assets:** Importing your Blender model into Unity3D. Acquiring assets from online sources, websites, Unity Store and more.
4. **Level design and decor**: Textures, materials, bounciness, elasticity, chains, ropes and hinges etc. Handling lights, particle systems, fire, smoke, water and more. Using Terrains, mountains and landscapes, placing objects like trees, stones and texturing them to create custom worlds.
5. **Cinemachine:** A package providing dynamic, smart, codeless cameras used based on scene composition and interaction, allowing you to tune, iterate, experiment and create camera behaviors in real-time, for short films / cutscenes. [intro]
6. **Augmented Reality:** Using Unity's AR foundation system for photorealistic and interactive AR applications. [intro]

Resources

1. Unity has its own amazing set of [interactive tutorials].



2. The [Brackeys youtube channel] has some of the best guides out there for Unity 3D. We will be referring to him more often.

3. Importing Blender models: [unity-docs] [yt].
4. Unity for Film/Animation [yt-unity] [unity-docs]
5. Cinemachine [yt-brackeys] [yt-unity]

Free 3D Graphical Assets

For those looking for free 3D assets, here is a non-exhaustive list:

- **Unity Asset Store / UE Marketplace**
- **free3d.com**
- **3dexport.com**
- **Mixamo** for custom animated character assets
- **https://itch.io/game-assets/free/tag-low-poly** for lowpoly voxel sets
- **https://221b-asset-street.com/free-3d-models.html**
- **https://smoothie-3d.com/** for going from images to 3D models
- **Blendswap**
- **http://www.3dsmodels.com/**
- **http://archive3d.net/**
- **http://www.blender-models.com/**
- **http://www.3dxtras.com/3dxtras-free-3d-models-list.asp?catid=-1**
- **http://artist-3d.com/**
- **http://tf3dm.com/3d-models/all**
- **https://craftpix.net/freebies/**
- **https://www.gamedevmarket.net/category/3d/?type=free**
- **https://sketchfab.com/tags/free**
- **https://www.cgtrader.com/free-3d-models**

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