Find your name/group and sit at that table
Administrivia

• Really do group rosters

• Get started on Unity

• Review project 1
  • Variation on Roll-A-Ball tutorial

• Today – take moments to work on Unity
Today’s question

What do you need to know to use Unity?
Today: Unity Blitzkrieg

• Lighting war
  • Cover ground quickly
  • Go around enemy strongholds
  • Handle those later

• In Unity
  • Get an overview
  • Leave hard concepts for later
    • Geometry, navmesh, animations

• Work along
  • Experiment with Unity
Two steps

1. Build
   • Assemble resources
   • Combine and layout in Unity GUI
   • Create your world

2. Script
   • Add behaviors
   • Tie game objects together

• Project 1
Unity game structure
Unity game objects: elements of scene

- Project
  - Scene
    - Game Obj
      - Component
    - Game Obj
      - Component
    - Game Obj
      - Component
  - Scene
    - Game Obj
      - Component
  - Scene
    - Game Obj
      - Component

- Agents
  - Player
  - NPC
  - Traps

- Environment
  - Terrain
  - Skybox
  - Obstacles

- Collectables
  - Weapons
  - Potions

- View
  - Cameras
  - Lights

- Audio
  - SndPlayer
Unity game components

Project

Scene

Scene

Scene

Game Obj

Game Obj

Game Obj

Component

Component

Component

Player object has

Shape (mesh)

Appearance (material, color, texture)

Physics (rigid body)

Extent (Collider)

Behavior (scripts)
Unity project: game + resources
Resources: Asset Store

• Free and paid
• Can use in projects
• (Animations in particular)
• But, cite your sources
Unity runtime: game + system elements

- Sources of events
  - Input Manager
  - Network Manager
  - Physics engine/Collider

- Services
  - Audio
  - Visual rendering
  - Access to assets
  - etc.
Interface

• Scene/game view
  • Build scene
  • Play scene

• Hierarchy
  • Manage scene

• Inspector
  • Manage game objects and components

• Project window
  • Manage resources
Editing assets externally

• Use external editors to
  • Create/edit scripts
  • Create/edit images, meshes, shaders
  • Create character animations

• Unity does have internal editors
  • Terrain
  • Trees

• For C# scripts: Monodevelop or Visual Studio
Blank game

All scenes start with Camera
   Light

Add Game object

All objects have Transform Position/orientation

Add components
Editing objects

• Add
  • Shape – Mesh filter
  • Collider
  • Renderer – color, reflection, etc

• Edit
  • Set position, orientation, scale
  • Set collider offset (if needed)
  • Set color, other properties
Unity coordinate system: left handed

**World space:**
left handed

**Screen space:**
Origin bottom left, positive z away

Many graphics systems right handed -> depth negative
Transforms

- Translate along axes
- Rotate around axes
- Scale along axes
Object hierarchy and transforms

• Root objects
  • Transform relative to World

• Child objects
  • Transform relative to Parent

• Move Parent
  • Move Child

• Scale Parent
  • Scale Child
Camera following object

• Camera as child object

• Can also attach camera to follow in script (lookAt)
Multiple coordinate systems

• World
• Scene
• Camera (3d), Screen (2d)
• Object
  • Object hierarchy

• Move left in which?
Materials

• Standard, default material
  • Tricky - starts greyed out
  • Can't edit directly

• Instead
  • Create new Material in Project
  • Drag onto Object to replace Standard material
  • Edit

• Can code with Shaders
Material properties

• Albedo (RGB color)
• Metallic (mirror-ness)
• Smoothness (shininess)

• Try yourself with sphere
Texture mapping

- **Albedo map** – color
- **Normal map** – local orientation
- **Height map** – local displacement
Unity stage one (build) summary

- **Structure of game**
  - Project-scene-object-component
  - Resources-packages-prefabs-assets

- **Interface**
  - Project(assets)-Hierarchy(objects)-Inspector(components)
  - Scene view(build)
  - Game view(play)
  - External editors

- **Key components**
  - Shape, transform, material
Stage 2: With scripts you can

- Create and destroy objects
- Initialize objects
- Activate and inactivate objects
- Move objects
- Activate animations
- Change object appearance
- Keep score
- And more

Topics
1. Events
2. Life of an object
3. Event loop
4. Accessing data
5. Key Unity data types
Scripting: UnityEvents

```csharp
using UnityEngine;  // basic objects
using System.Collections;  // basic structures

public class MyGameObject : MonoBehaviour {
    void Start () {
        // ... initializations
    }

    void Update () {
        // ... code repeated each frame tick
    }
}
```
public class MyGameObject : MonoBehaviour {

    void Start () {
        transform.rotation = Quaternion.Euler(0,0,0);
    }

    void Update () {
        transform.Rotate (new Vector3 (0, 45, 0) * Time.deltaTime);
    }
}

// This shows: accessing component, use of delta time, Quaternions
Comparing: event program in Processing

```java
void setup() {
    size(400, 400);
}

draw() {
}

void mousePressed() {
    ellipse(mouseX, mouseY, 20, 20);
}

void keyPressed() {
    save("pic.jpg");
}
```

- **setup** – called once on program start
- **draw** – called every frame (rate adjustable)
- **mousePressed** – called once when mouse is pressed
- **keyPressed** – called once when key is pressed
using UnityEngine; // basic objects
using System.Collections; // basic structures

public class MyGameObject : MonoBehaviour {
    void Start () {  // ... LIKE SETUP
    }
    void Update () {  // ... LIKE DRAW (but, no draw cmds)
    }
    void OnMouseDown() {  // ... LIKE MOUSEPRESSED
    }
}
Tracking events through console log
Types of events

A. Object initialization and state
B. Object updates
C. Physics events including collisions and trigger
D. User input events
2. Lifetime of objects

• Some objects persist throughout the game – player, etc

• Some objects only need be enabled when their room is entered
  • Avoid spending time calling their update, etc, when not used or viewed

• Some objects only needed to be rendered when viewable
  • Don't try to render things behind you, or too far away

• Some objects have short lifetime – create and destroy quickly
  • Projectiles, spell animations, and so on
A. Object initialization and state events

- void Awake - when object is initialized (set up all objects)

- void Start - when object is enabled (eg, when room is entered) 
  (enough for now)

- object.enable - turns off update, rendering, but not all physics

- object.active - turns off all components/events

- Tricky! Can't re-enable in Update if that's turned off
Create new object from prefab

• Load Missile prefab

```csharp
public class RocketShipController : MonoBehaviour {
    public GameObject mPrefab;
    void Start () {
        GameObject mPrefab = Resources.Load("Missile") as GameObject;
    }
}
```

• Instantiate

```csharp
void ShootMissile () {
    GameObject m = Instantiate(mPrefab , transform.position ,
                              transform.rotation);
    m.velocity = transform.TransformDirection(Vector3.forward*10);
}
```
B. Object updates

- void Update - called at frame rate
  - intervals not constant

- void FixedUpdate - called at fixed interval
  - Time.deltaTime
  - for accurate physics

- void LateUpdate - called after Update calls are done
  - for objects that react to all others
C. Physics: collisions and triggers

- Events when objects overlap

- For colliders:
  - void OnCollisionEnter()
  - void OnCollisionStay()
  - void OnCollisionExit()

- For triggers:
  - void OnTriggerEnter()
  - void OnTriggerStay()
  - void OnTriggerExit()

When two objects collide!

Put invisible objects in doors, pads
D. User input events

• Event handlers

  void OnMouseDown()
  void OnMouseUp()
  void OnMouseOver()

  void OnMouseDrag()
  { print("dragging");
  }

• Polling

  public void Update() {
  if(Input.GetButtonDown("Fire1")) {
    Debug.Log(Input.mousePosition);
  }
  }

• Choice: efficiency, code complexity
3. Unity game loop

Initialize game
do
  Physics (+collision)
  Input
  *Game logic(new)*
  Rendering
  GUI rendering
loop
Clean up

- Events handled in order during loop
- [https://docs.unity3d.com/Manual/ExecutionOrder.html](https://docs.unity3d.com/Manual/ExecutionOrder.html)
Review: Time!

• Frame time (not constant)
  • Things executed every frame
  • Most important is rendering of scene

• Physics time
  • Steps in physics simulation
  • May run faster than frame time to get physics right (avoid big steps)

• Real time
  • System clock
  • For syncing music, video, other things that need real time
Event loops and time: 45 degrees/second

• Frame time (not constant)

```csharp
void Update () {
    transform.Rotate (new Vector3 (0, 45, 0) * Time.deltaTime);
}
```

• Physics time

```csharp
void FixedUpdate () {
    transform.Rotate (new Vector3 (0, 45, 0) * Time.fixedDeltaTime);
}
```

// 0.02 typically
Going slower than frame rate?

• Coroutines
• Yield control each loop with "yield" command
• Call in Update, resumed with each new Update

IEnumerator Fade() { // gradually fade from opaque to transparent
    for (float f = 1f; f >= 0; f -= 0.1f) {
        Color c = renderer.material.color;
        c.a = f;
        renderer.material.color = c;
        yield return null; // return to Unity to redraw the scene
    }
}
4. Key Unity components and data types

• **Transform** - Position and orientation
  • Vector3: \( \text{Vector3 } u = \text{new Vector3}(1, 2, -3); \)
  • Ray: \( \text{Ray ray = new Ray(FromVector, ToVector)}; \)
  •Quaternion: \( \text{Quaternion q1 = Quaternion.Euler}(0,30,0); \)

• **Rigid body** - Physical properties
  • \( \text{rb.mass} = 10f; // \text{change this body’s mass} \)
  • \( \text{rb.AddForce(Vector3.up * 10f);} //\text{up force} \)

• **Collider** - Extent of game object

• **Material** - Color and surface properties
Motion options

- Rigid body: Has mass, extent, other properties
  - Nudge by forces

- Kinematic object: Set position and velocity directly

- Static object: Doesn’t move
  - So don't do static/static collision detection
5. Accessing data in a script

• Access public script variables
  
  ```csharp
  public float floatSpeed = 10.0f; // how fast ball floats up
  public float jumpForce = 4.0f; // force applied when ball jumps
  ```

• Access object components of your object
  
  ```csharp
  Rigidbody rb = GetComponent <Rigidbody> ();
  ```

• Access other game objects by game or tag
  
  ```csharp
  GameObject camera = GameObject.Find ("Main Camera");
  GameObject player = GameObject.FindWithTag("Player");
  GameObject[] enemies =
      GameObject.FindGameObjectsWithTag("Enemy");
  ```
C# vs Java

• Similar
  • OOP, garbage collection, bytecode, data types, control structures

• Differences that matter in Unity
  • yield statement allows coroutines in Unity
  • inheritance system different- can packages up objects more completely

• Will leave it to you to learn the details of C#
Summary

• After today you should be able:

Have a better handle on Unity tutorials
1) Explain the hierarchical structure of a Unity game
2) List the usual components of a game object
3) Use the Unity interface to create and edit Unity projects and elements
4) Explain and use the Unity left handed coordinate system
5) Use transform component to move and orient an object
6) Explain how the parent child relationship effects object position
7) Explain some basic properties of the material component
8) Start on writing Unity C# scripts with an understanding of events, object life, event loop, accessing data inside and outside objects, key data types
Readings

• David Mount's lecture
• "Intro to Unity"
• Roll-A-Ball tutorial
• Project 1 assignment
• Unity Manual (browse as you need)
• Find other tutorials, use the manual as you wish
• https://www.raywenderlich.com/980-introduction-to-unity-scripting
Activity 4a: Design a computer game

• At each table plan out a game for your team. Answer these questions (quickly!)

• What type of game? (platformer, FPS, RPG, etc. Multi-player?)
• What design choices?
  • Story
  • Environment
  • Characters
  • Gameplay
  • Visual look and feel
Activity 4b: Build a computer game

• At each table plan out a game for your team. Answer these questions (quickly!)

• What platform(s)?
• Any special hardware or peripherals needed?
• What software elements needed?
• Build from scratch or use engine? Which language or engine?
• What assets will you need? How will you make or get them?