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COESC AI+AR/VR

Spring 2025

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https://docs.google.com/presentation/d/1utVYhSMCL8EviY2QNkuyc3JoUDwlz9j4vyebENd_kko/edit?usp=sharing

Luke Miller

Course Summary

- Week 1: Foundations of Unity and ML Integration - Jan 25, 2025
  - Session 1: Setting Up and Unity Basics
  - Session 2: ML Basics and Unity Integration
- Week 2: Building the Final AR Project - Feb 1, 2025
  - Session 1: AR Development with Meta Oculuses
  - Session 2: Finalizing and Presenting the AR Project

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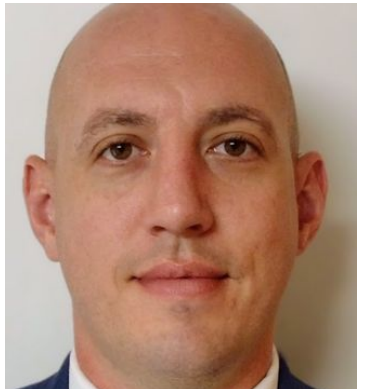

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Logistics and Materials

- **Prerequisites:**
  - Basic programming knowledge (Python and/or C# preferred).
- **Tools and Setup:**
  - Python (with TensorFlow /PyTorch) for ML sessions.
  - Unity (with Oculus SDK) for AR/VR sessions.
  - Meta Oculuses provided for hands-on activities.
- **Team Size:**
  - Small groups (2–3 participants) to encourage collaboration.
- **Resources Provided:**
  - Presentation Materials
  - Pre-configured Software
  - Sample Datasets.
  - Tutorials

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Objective:

- **By the end of the course, participants will:**
  - Understand the basics of ML and its applications in AR/VR.
  - Be familiar with using Meta Oculuses for AR development.
  - Create a simple, functional AR/VR application enhanced with an ML feature.

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- Week 1: Foundations of Unity and ML Integration - Jan 25, 2025
  - Session 1: Setting Up and Unity Basics
  - Session 2: ML Basics and Unity Integration
  - Session 3: Tutorial/Hands-on Assignment

Session 1: Setting Up and Unity Basics

- Getting Started with Unity
  - What is Unity
  - Overview of the Unity interface
- Building the First Scene
  - Adding objects (3D models, UI elements) and adjusting transforms.
  - Adding physics components: Rigidbodies and colliders.
- Basic Interactions with Unity
  - Adding scripts (in C#) to objects for interactivity.

Introduction to Unity

- What is Unity?
- Why is it used in AR/VR development?
- Installing and Configuring Unity

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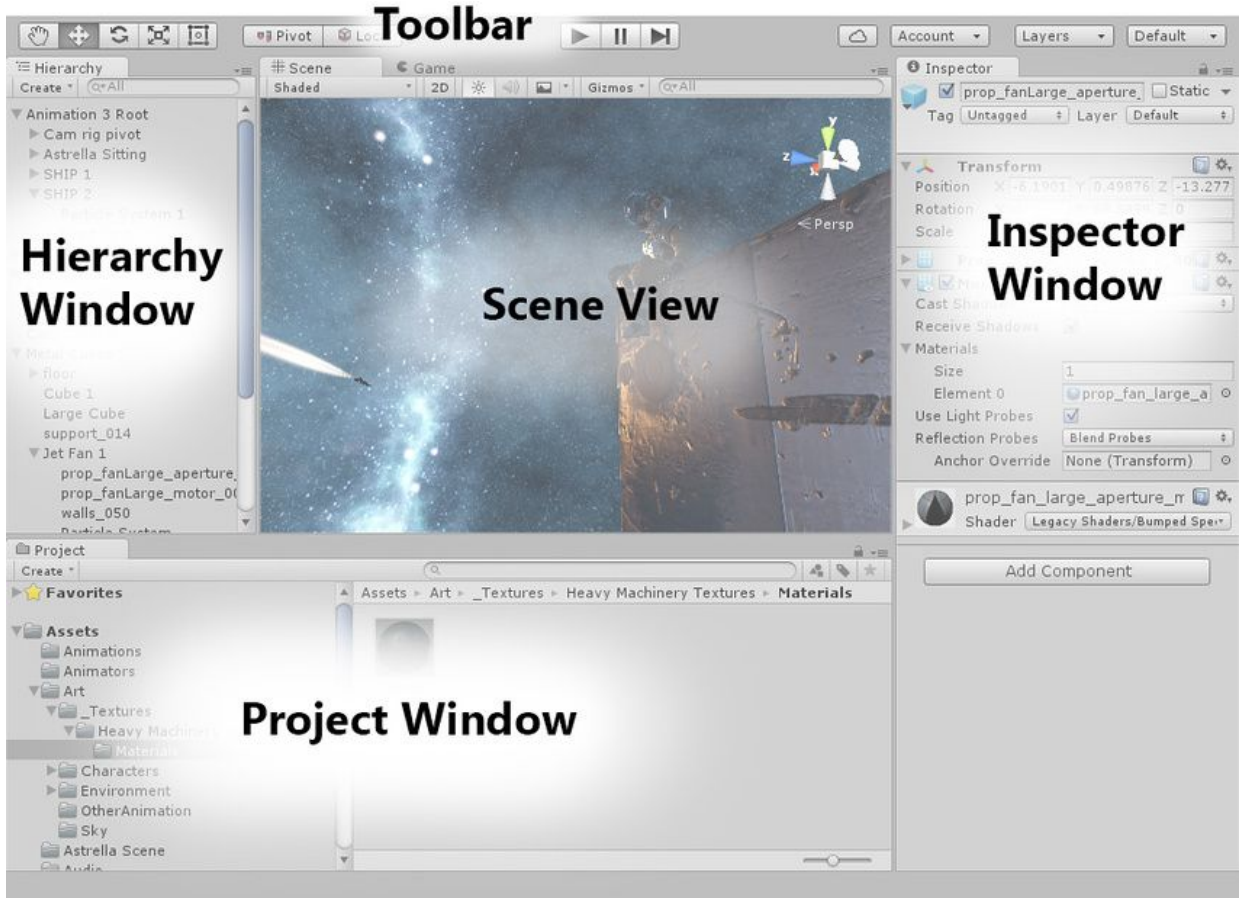
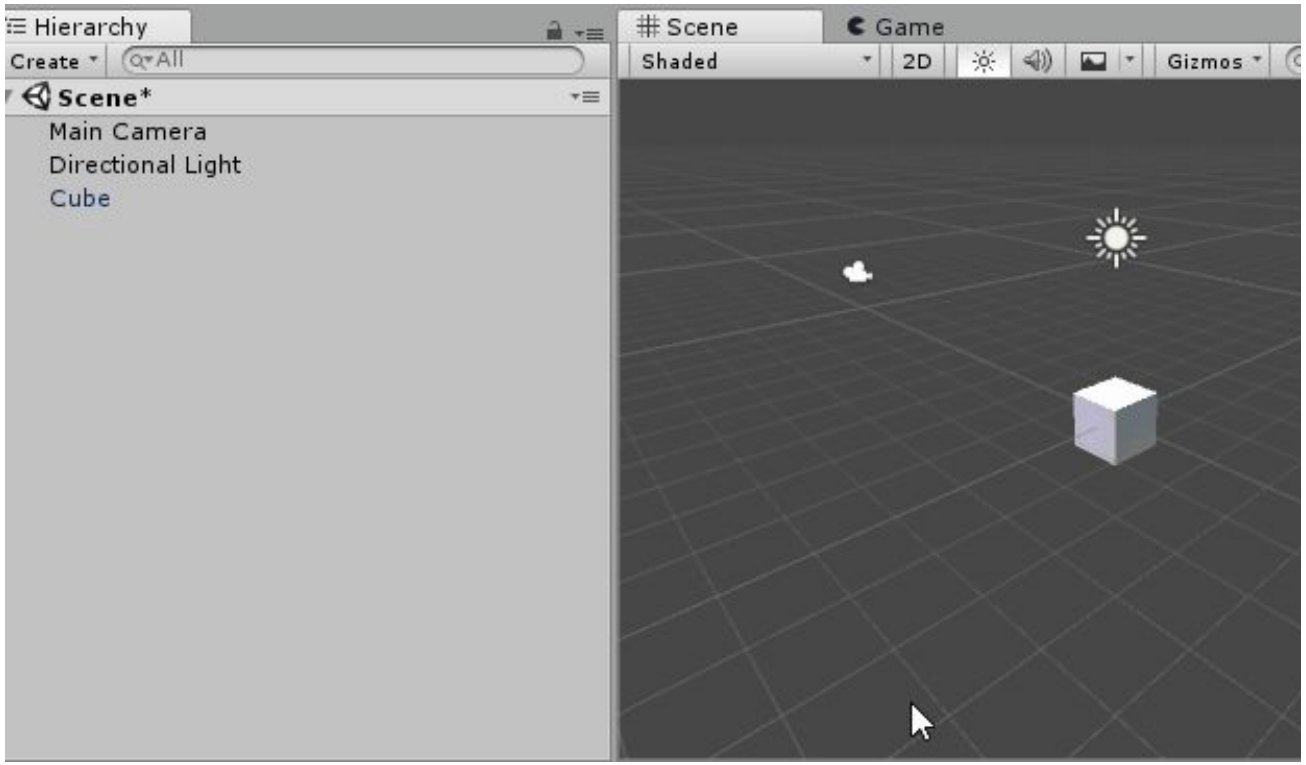
Unity Interface Overview

- Key components:
  - Hierarchy: List of all objects in the scene.
  - Scene View: Visual representation of the scene.
  - Inspector: Object properties and adjustments.
  - Toolbar: Provides options to the user
  - Project Window: Asset management.



Unity Interface: Hierarchy



- The Hierarchy window displays every GameObject in a Scene
- You can use the Hierarchy window to sort and group the GameObjects you use in a Scene.
- When you add or remove GameObjects in the Scene view, you also add or remove them from the Hierarchy window.

Learn more: https://docs.unity3d.com/Manual/Hierarchy.html

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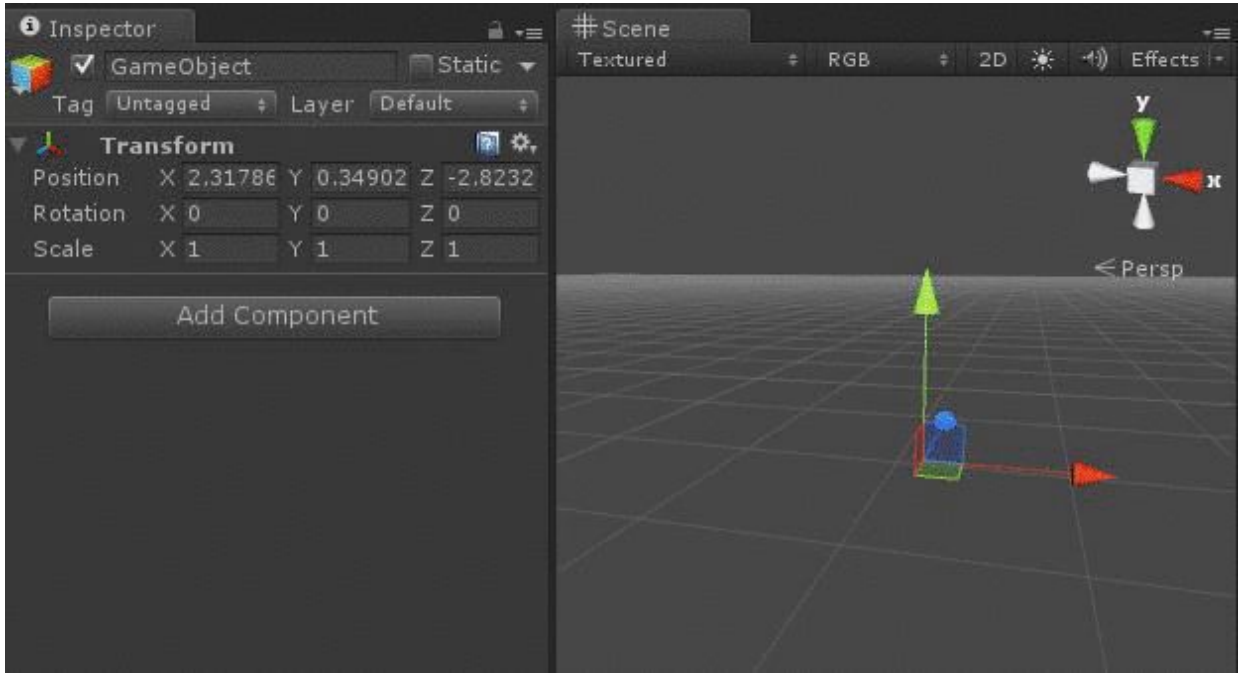
Unity Interface: Scene View

- The Scene view is where you visualize and interact with the world you create in the Editor.
- In the Scene view, you can select, manipulate, and modify GameObjects: scenery, characters, cameras, lights, and more.



https://docs.unity3d.com/Manual/UsingTheSceneView.html

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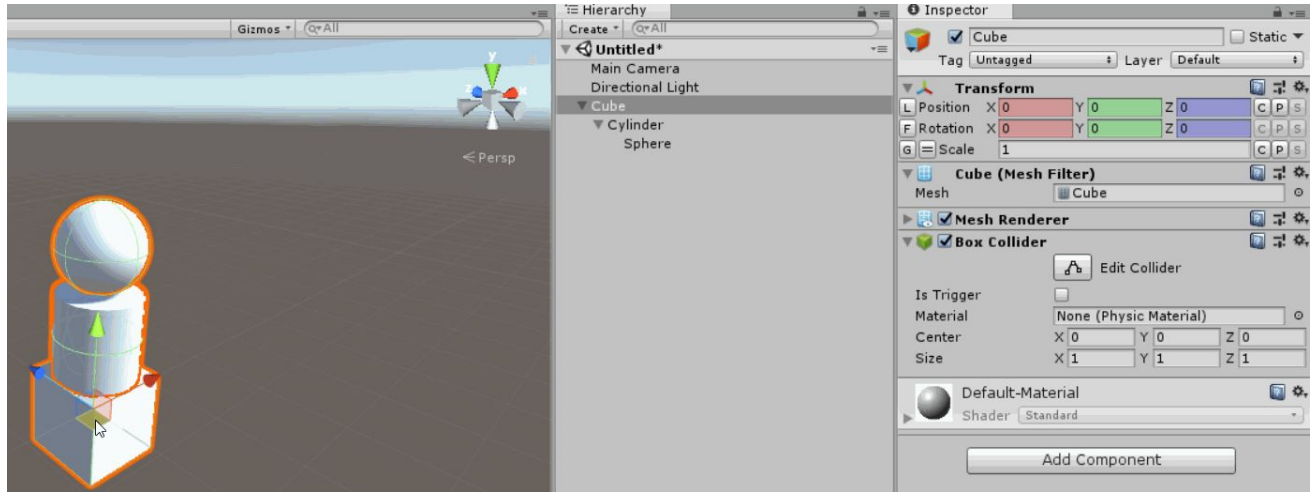
Unity Interface: Inspector



- Use the Inspector window to view and edit properties and settings for almost everything in the Unity Editor:
  - GameObjects
  - Unity components
  - Assets
  - Materials
  - In-Editor settings and preferences

https://docs.unity3d.com/Manual/UsingTheInspector.html

Unity Interface: Game View

- The Game view is rendered from the Cameras in your application.
- The Game view displays how your final, built application looks.
- You need to use one or more Cameras to control what the player sees when they're using your application.

https://docs.unity3d.com/Manual/GameView.html

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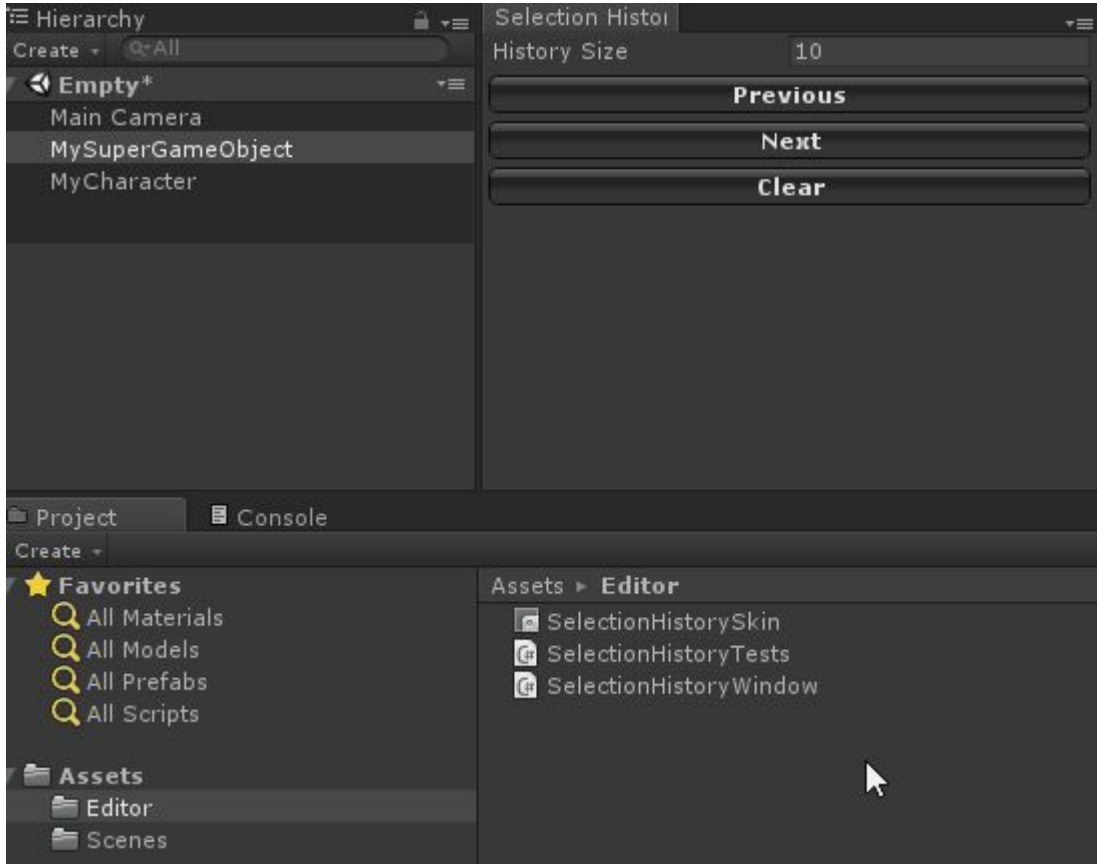
Unity Interface: Project Tab

- The Project window displays all of the files related to your Project
- The main way you can navigate and find Assets and other Project files in your application.
- When you start a new Project by default this window is open.



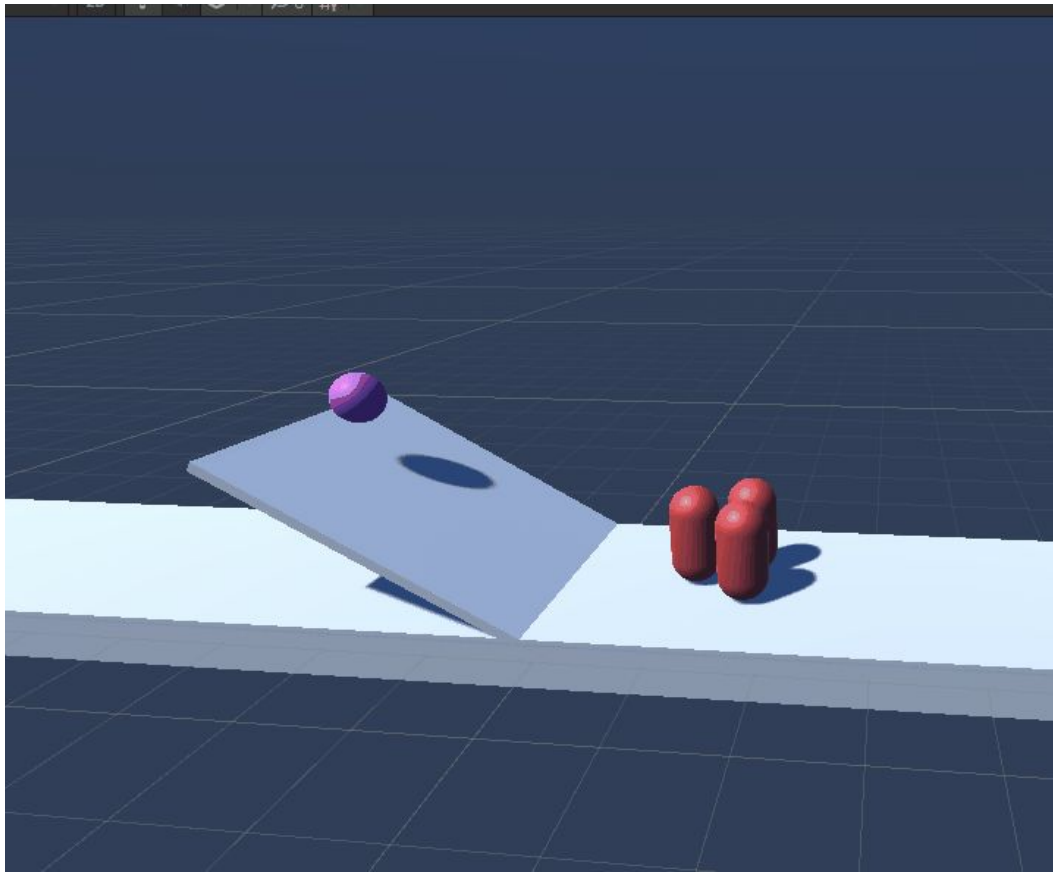
Building the First Scene

- Add 3D objects (cube, sphere, plane).
- Move, Rotate, and Scale tools.
  - Hand Tool. Pans around.
  - Move tool 
  - Rotate Tool 
  - Scale Tool 
-

Building the First Scene: Objects

- Add 3D objects (cube, sphere, plane).
- Move, Rotate, and Scale tools.
  - Hand Tool. Pans around.
  - Move tool 
  - Rotate Tool 
  - Scale Tool 

Building the First Scene: Physics



- Rigidbodies
  - Adding a Rigidbody component to an object will put its motion under the control of Unity's physics engine.
  - Even without adding any code, a Rigidbody object will be pulled downward by gravity and will react to collisions.
- Colliders
  - Collider components define the shape of an object for the purposes of physical collisions.
  - A collider is invisible
  - A rough approximation of the visual shape is often more efficient and indistinguishable in gameplay.

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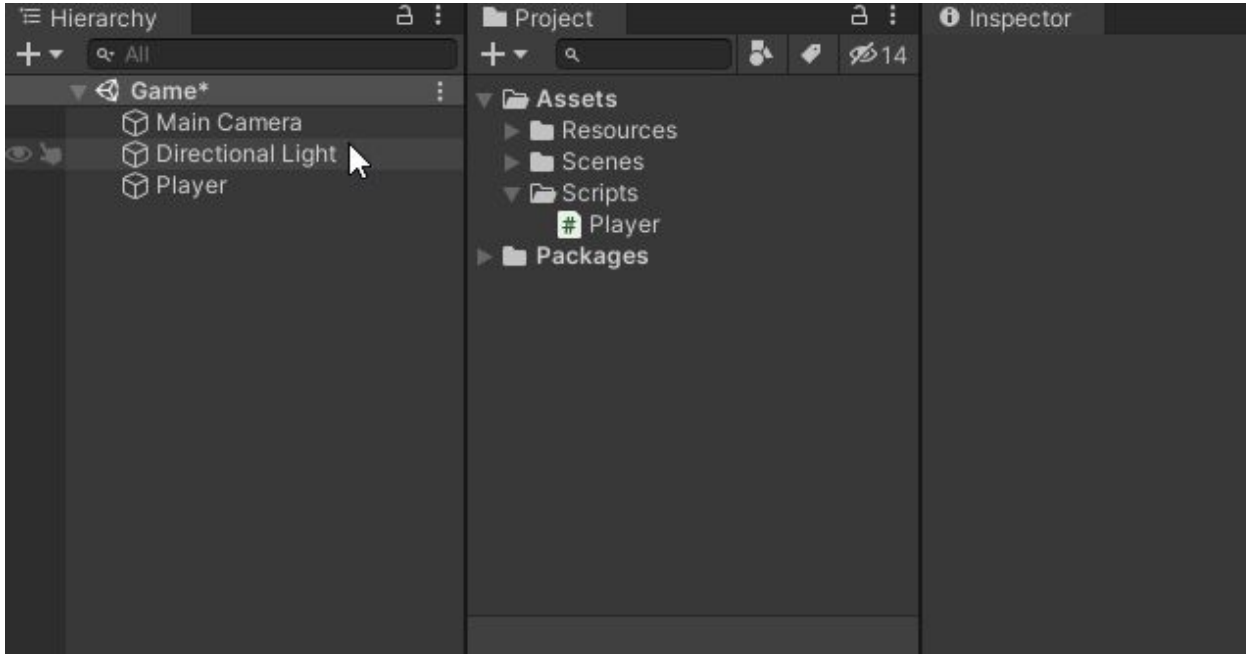
Basic Interactions with Unity



- What are Scripts
  - Scripts allow you to customize and extend the capabilities of your applicaton with C# code.
  - Unlike most other assets, scripts are usually created within Unity directly.
- Adding Scripts to Entities
  - From the main menu: go to **Assets > Create > Scripting** and select the type of script you want to create. *OR*
  - From the Create menu (plus sign) in the Project window toolbar: go to Scripting and select the type of script you want to create.

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Session 2: ML Basics/Unity Integration

- Introduction to ML
  - What is Machine Learning
  - ML applications in AR/VR
- Pre-Trained ML Models
  - Why use pre-trained models?
  - Examples of pre-trained models
  - How models process images
- Integrating ML into Unity
  - Tools for integration
  - Real-time object detection in Unity

Introduction to Machine Learning

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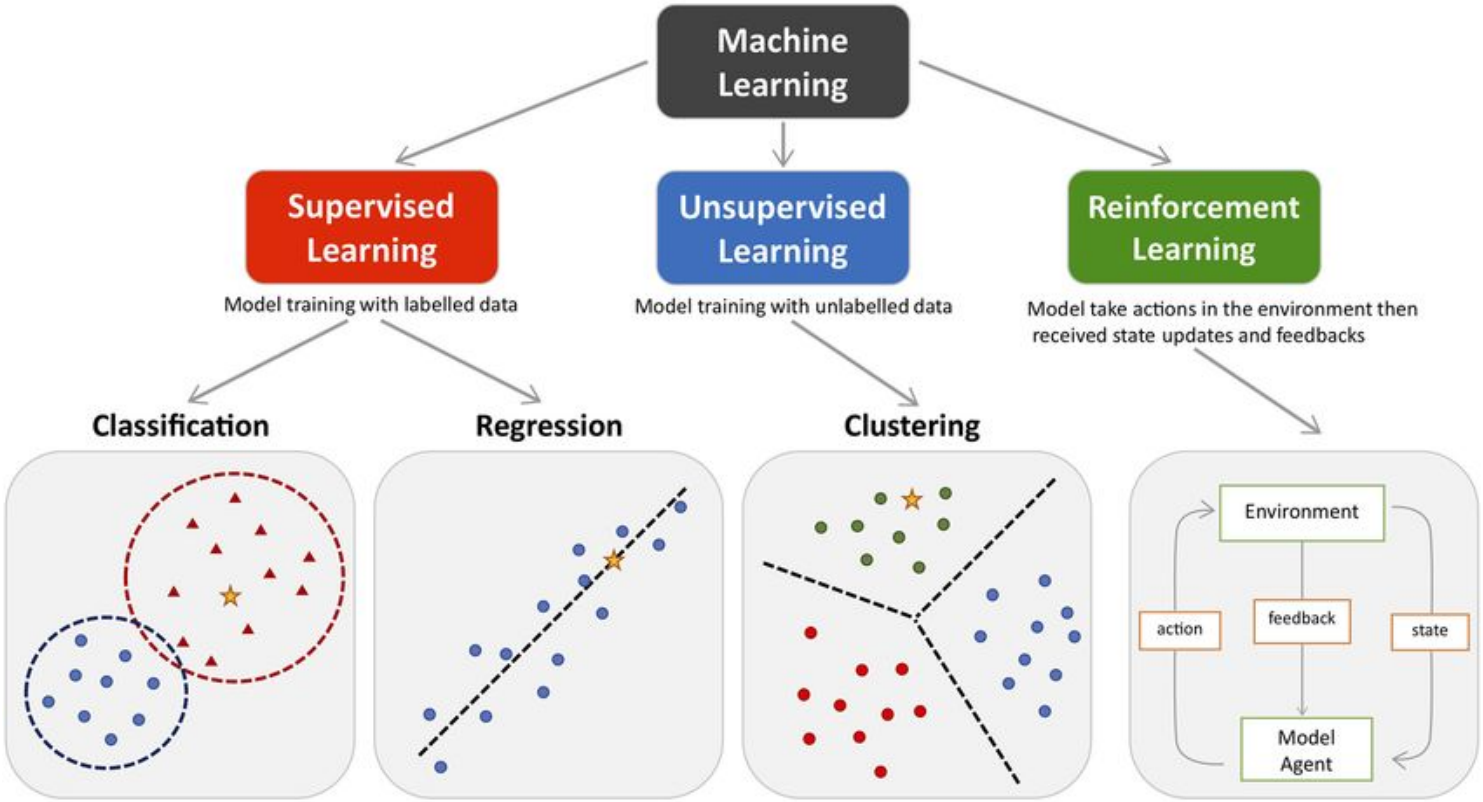
Introduction to Machine Learning



- Key concepts:
  - Definition
  - training data
  - models
  - predictions.
- Types of ML:
  - supervised
  - unsupervised
  - reinforcement learning.

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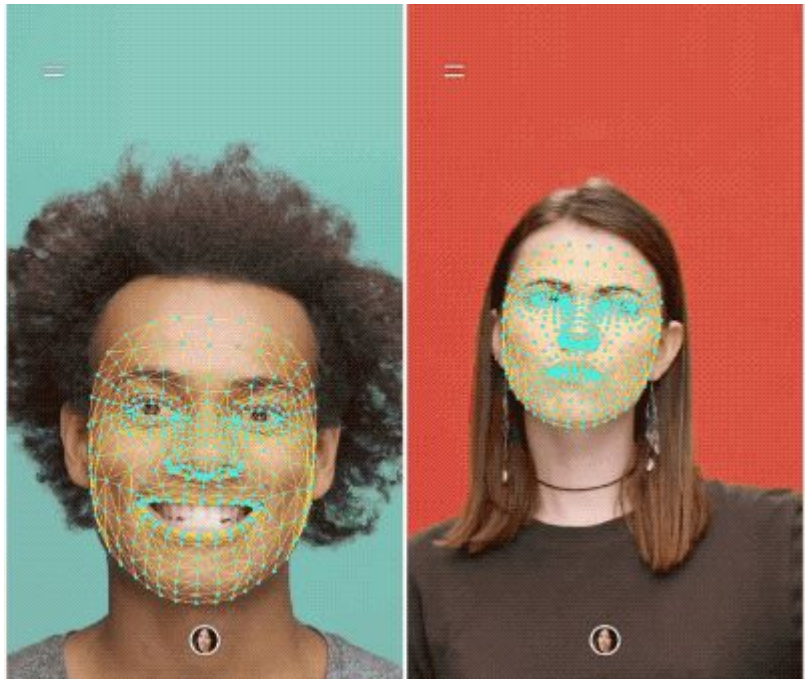
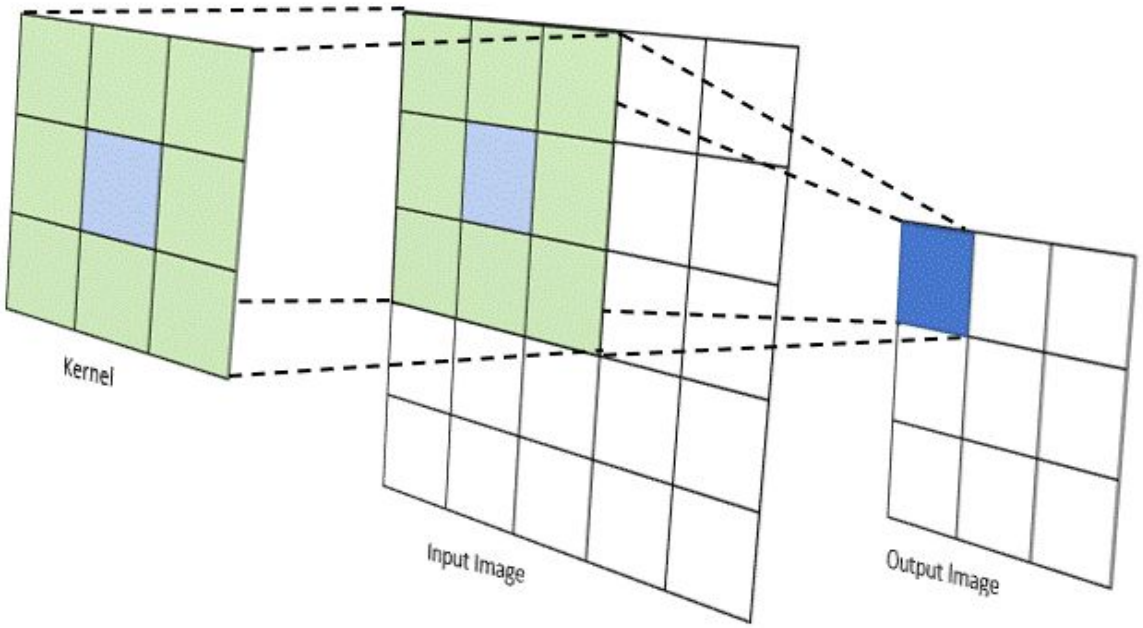
ML Applications in AR/VR

- Object Detection
  - Identifying and locating objects within an image or video.
  - Commonly used for interacting with real-world objects in real time.
- Gesture Recognition
  - Enables systems to identify and interpret hand gestures or body movements
  - Creates intuitive controls: pinch-to-zoom or swipe gestures
- Scene Understanding
  - Analyzes an environment to identify its structure and the objects within it.
  - Maps walls, floors, and furniture in a room
  - Recognizes outdoor features like roads and trees.
  - Anchors virtual elements to real-world surfaces or adjust the experience based on the environment.



Pre-Trained ML Models



- Why use pre-trained models?
  - Ease of use
  - Saves training time
- Examples of pre-trained models:
  - MobileNet (lightweight image classification).
  - YOLO (real-time object detection).
- How models process images:
  - Convert input (images) to numerical data.
  - Perform predictions based on trained weights.

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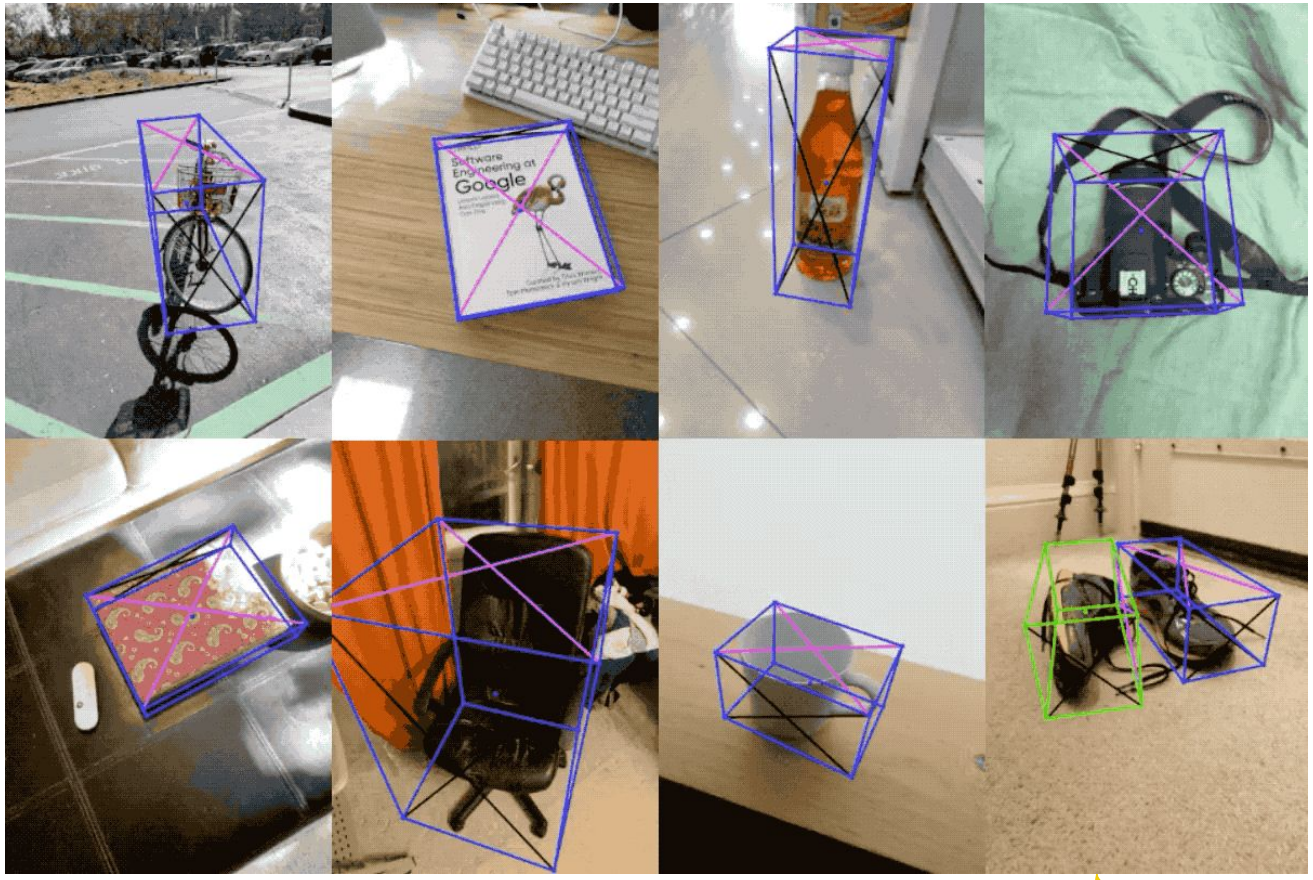
Integrating ML into Unity

- Tools for integration:
  - Unity Barracuda:
    - Lightweight and Unity-native.
  - TensorFlow for Unity:
    - Flexible and widely used.
- Real-time object detection in Unity:
  - Example workflow:
    - Feed live camera input to an ML model →
    - Process predictions →
    - Highlight detected objects.



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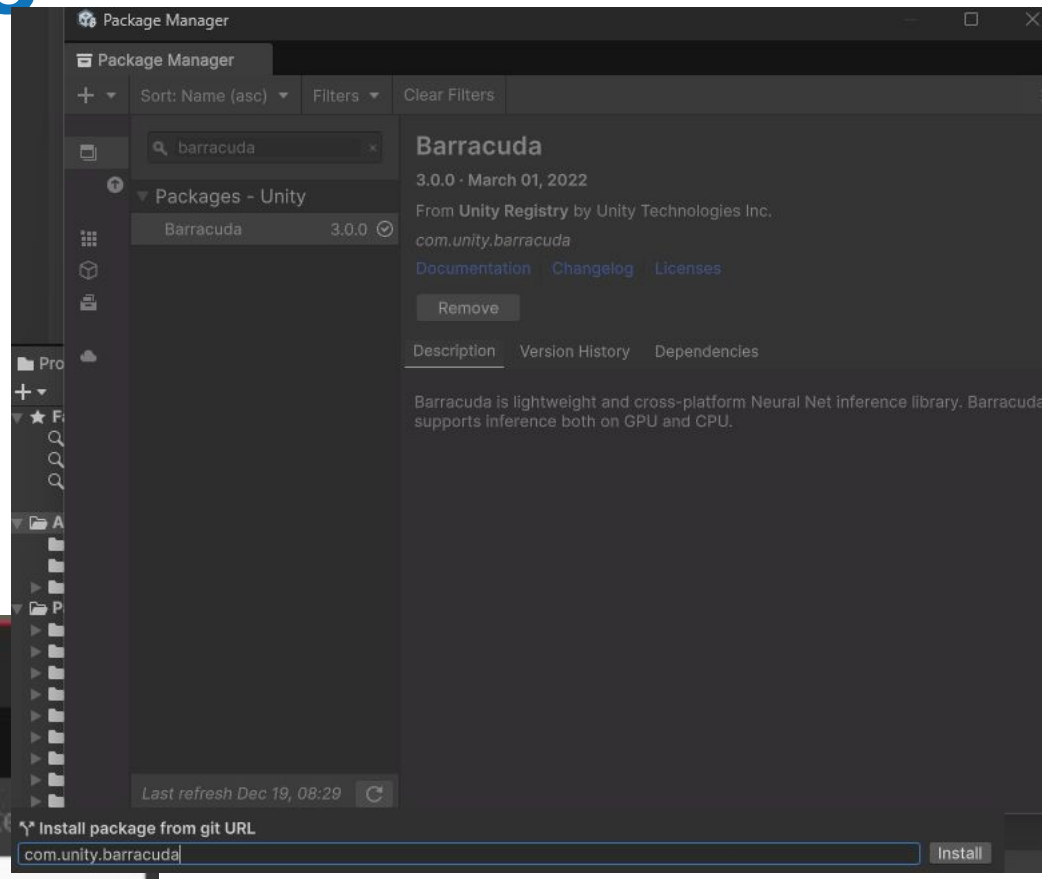
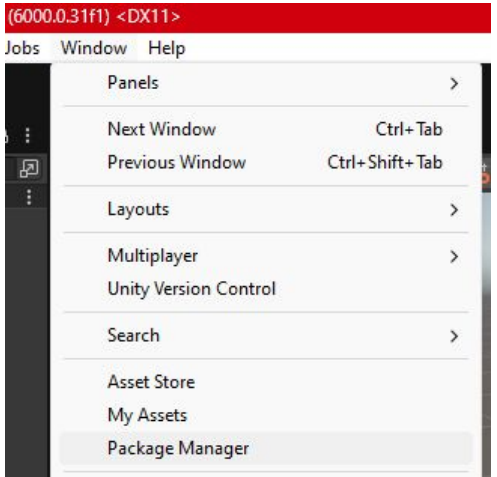
Session 3: Tutorial/Hands-on Assignment

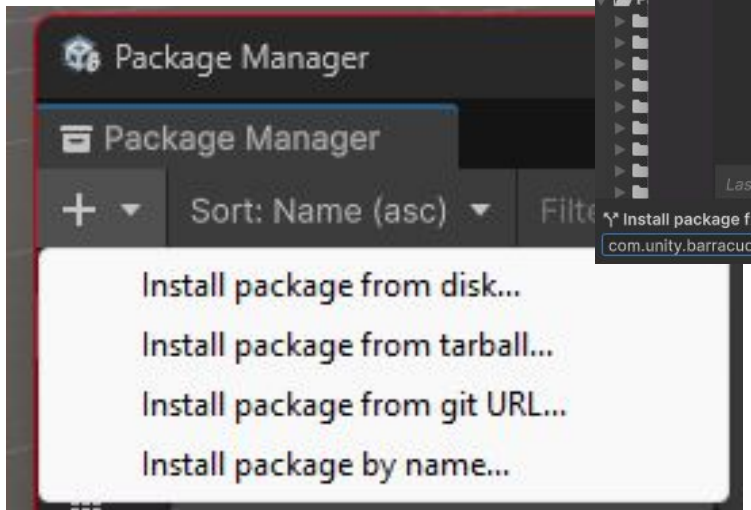
- Setup Unity for ML Integration
- Create the Scene
- Integrate the ML Model
- Display Object Detection Results

Setup Unity for ML Integration-Barracuda

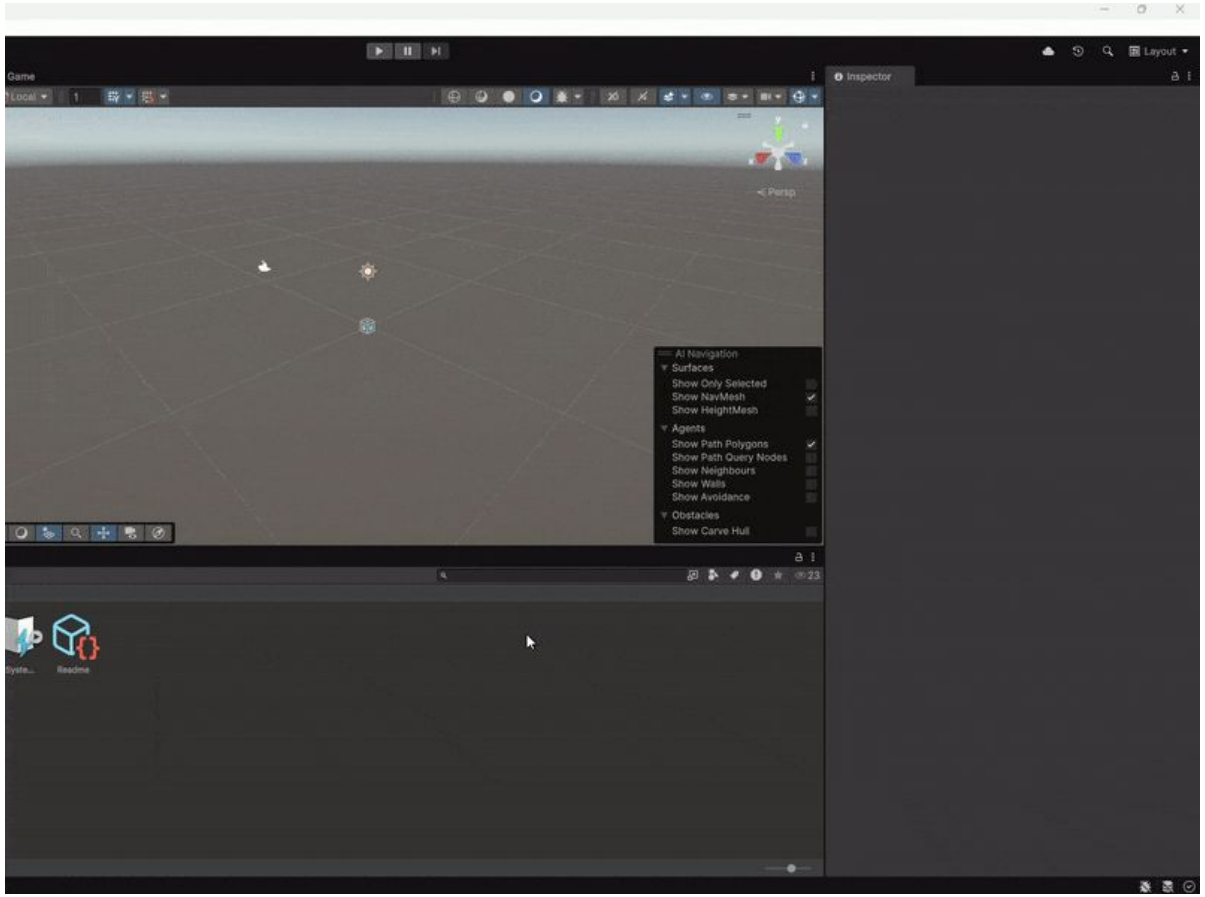
- Install Unity Barracuda
  - Open your Unity project.
  - Go to Window → Package Manager.
  - Click the Plus Sign
  - Select "Add package from git url
  - Type "com.unity.barracuda"
  - Click Install







Setup Unity for ML Integration-Models



- Download and Import a Pre-Trained Model
  - Download a pre-trained MobileNet model in ONNX format from TensorFlow Hub. We've done this for you, and it is available on the GitHub.
  - Drag and drop the .onnx file into Unity's Assets folder.
  - In real life, you would need to convert the keras, tf2, or HD5 model to the onnx format (Tutorial). We have already done this, and it is on the Github.

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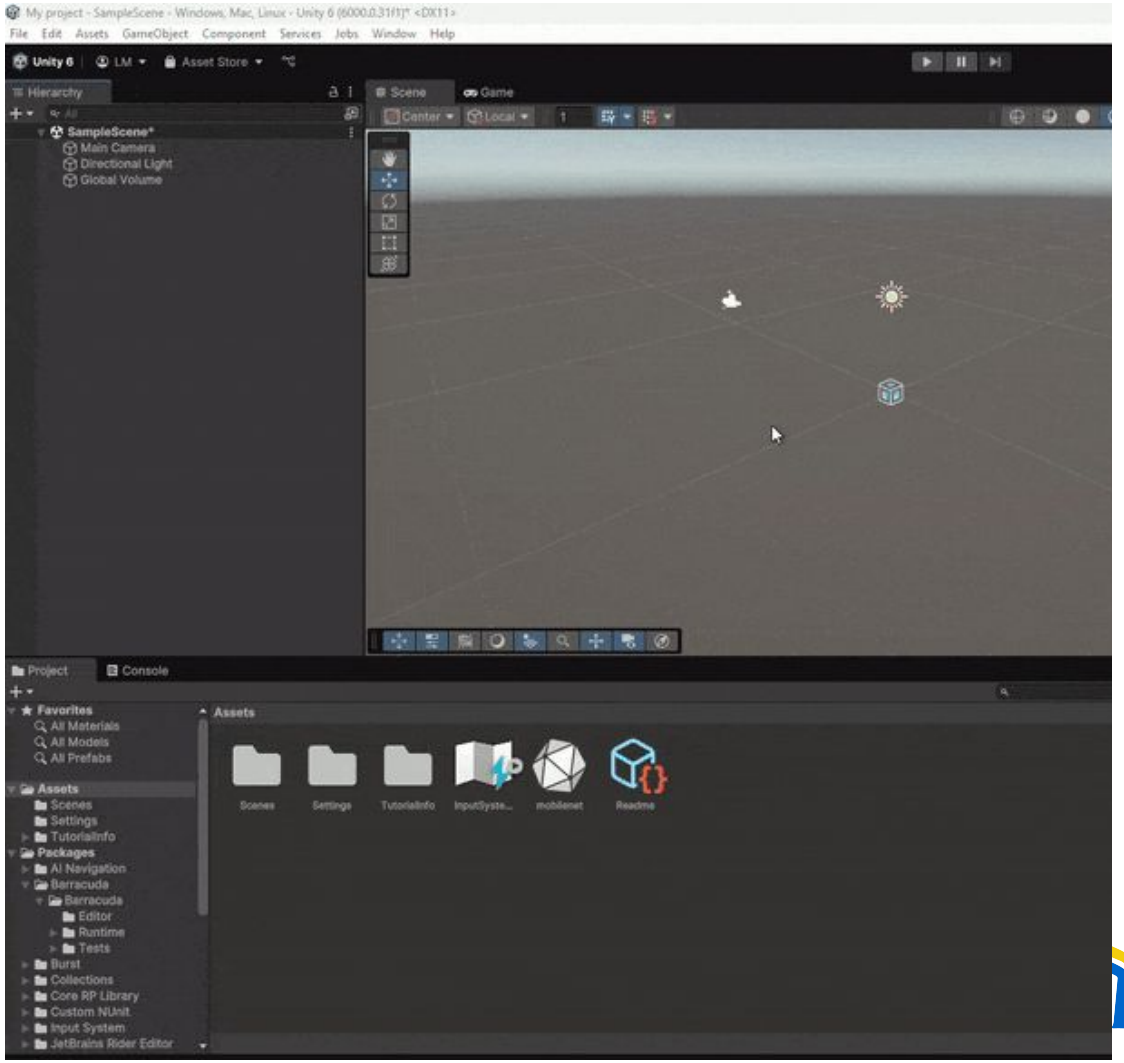
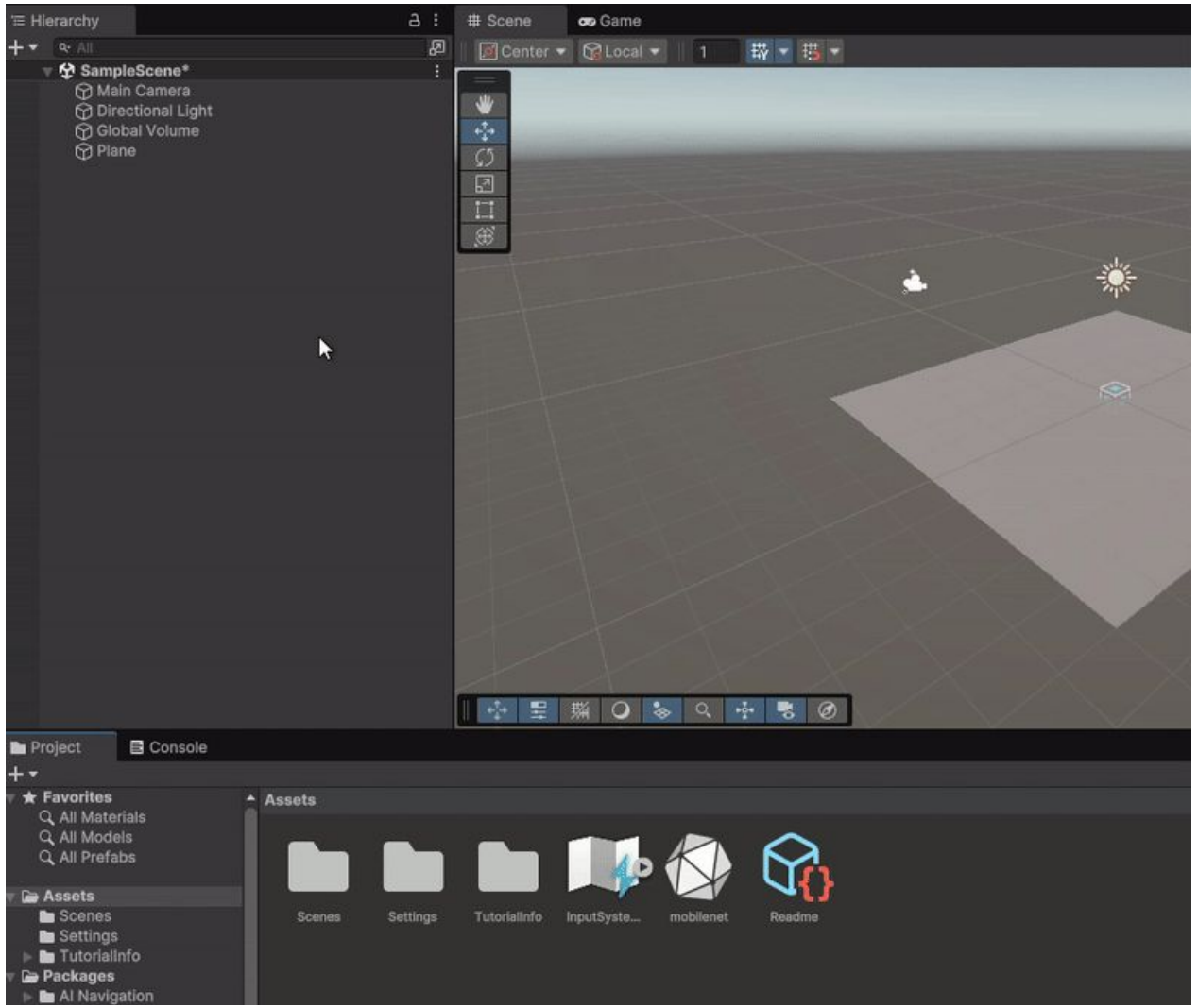
Create the Scene - Add a Plane

- Add a Plane for the Camera Feed
- In the Hierarchy window:
  - Right-click
  - 3D Object
  - Plane.
- Position the plane so it’s visible to the main camera.



Create the Scene - Configure Camera



- Select the Main Camera in the Hierarchy.
- Create a material for displaying the live webcam feed:
  - Right-click in Assets
  - Create
  - Material.
- Name it 'webcamMaterial'.

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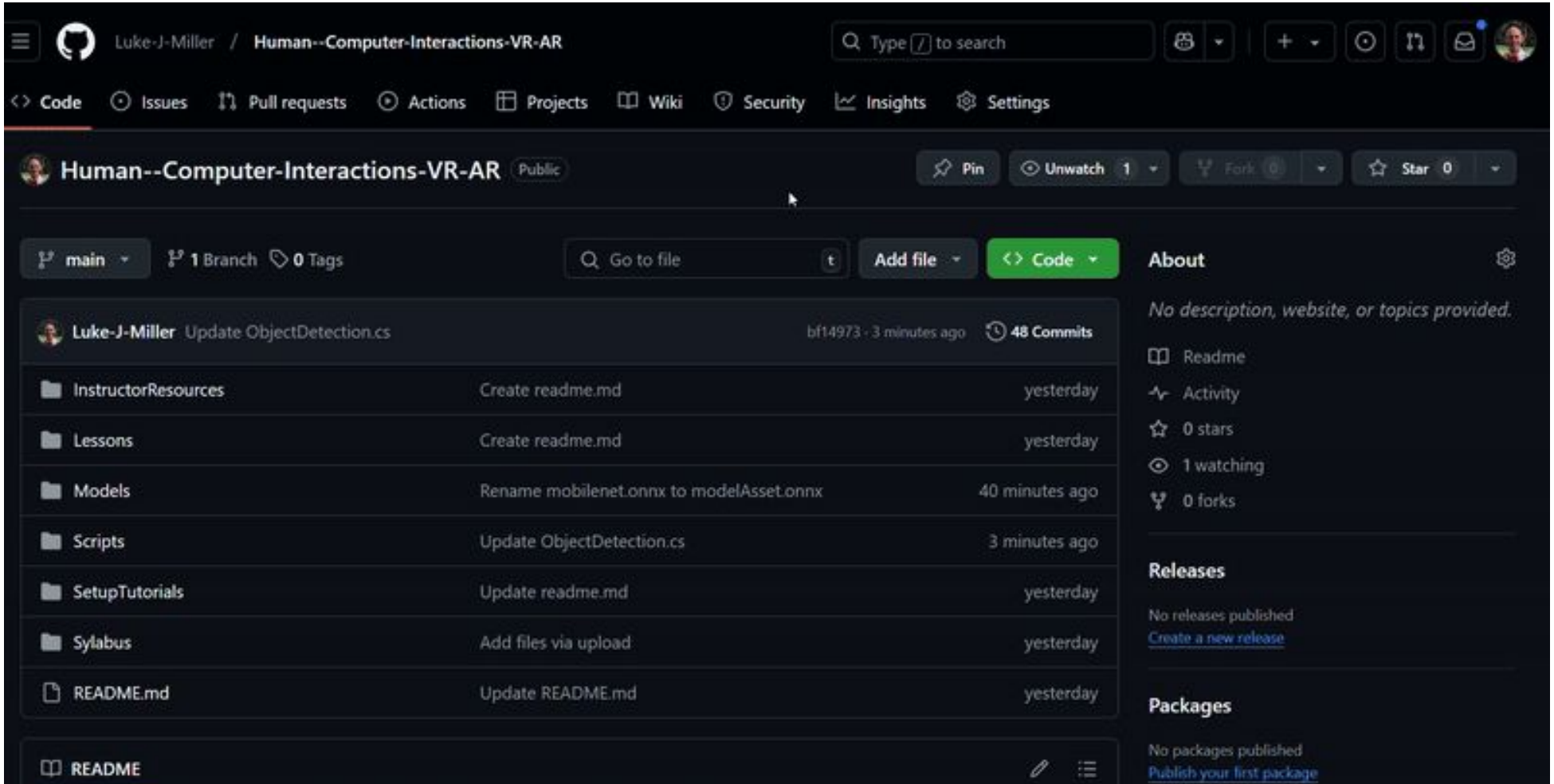
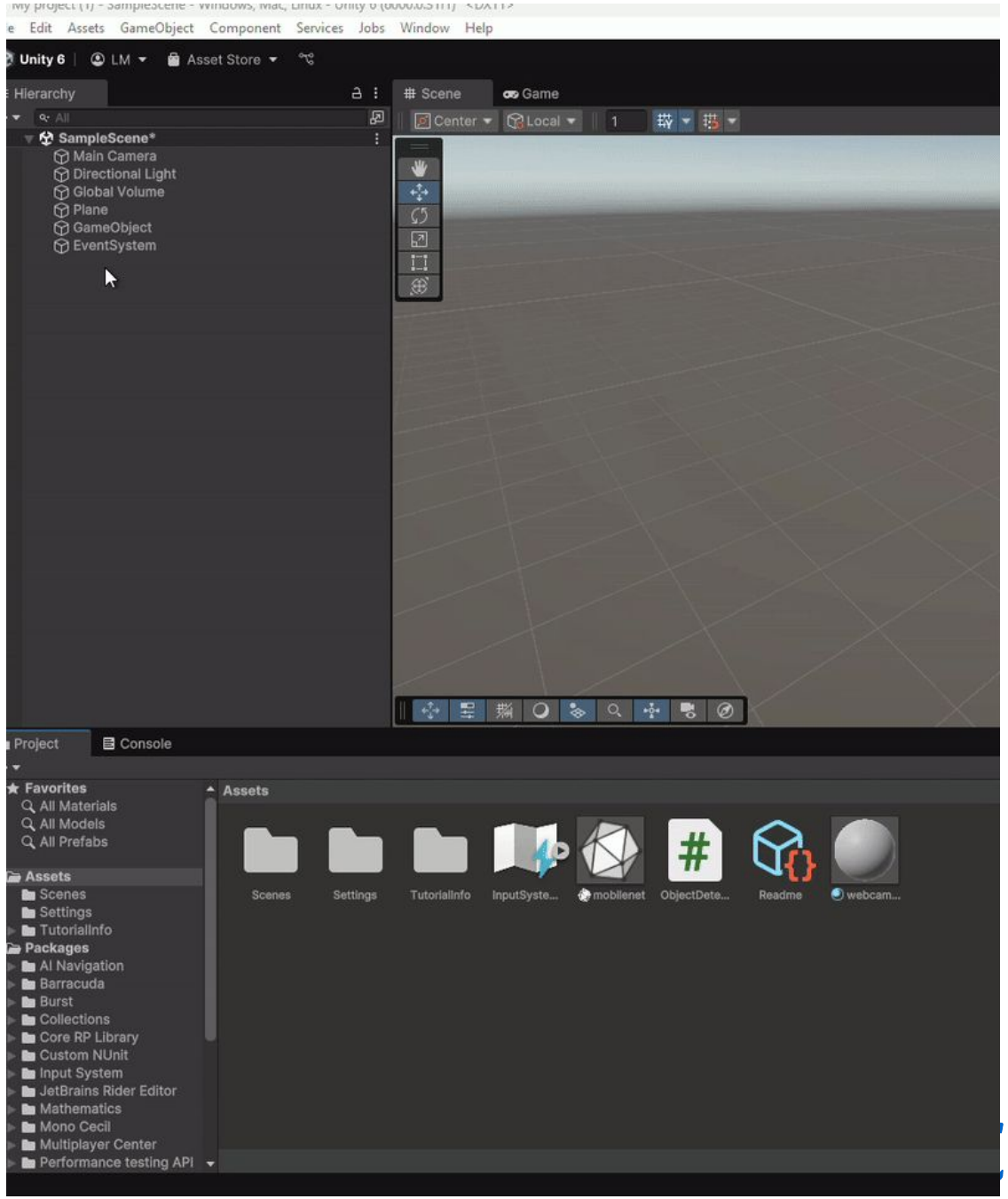
Integrate the ML Model - Model Processor Script

- Create a new script called ObjectDetection.cs and attach it to an empty GameObject. Code available on the [Github]



Display Object Detection Results

- Add a Canvas to the scene:
  - Right-click in the Hierarchy
  - UI
  - Canvas.
- Set the Render Mode of the Canvas to:
  Screen Space - Overlay.
- Add a placeholder for bounding boxes:
  - Right-click the Canvas
  - Create Empty
  - Rename to "BoundingBoxesContainer".



Create a UI Prefab for Bounding Boxes

- Create a new Panel:
  - Right-click in the Canvas
  - UI
  - Panel.
- Resize the panel to a small rectangle (this will represent a bounding box).
- Add a Text element as a child of the Panel:
  - Right-click the Panel
  - UI
  - Text.
  - Style the text to show labels and confidence scores (adjust font size and color).
- Convert the Panel to a Prefab:
  - Drag it from the Hierarchy to the Assets folder.
- Delete the original Panel from the scene.

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