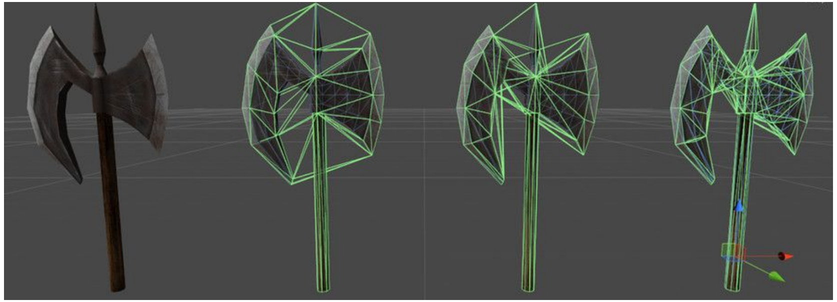
Lab 4 - Game Design

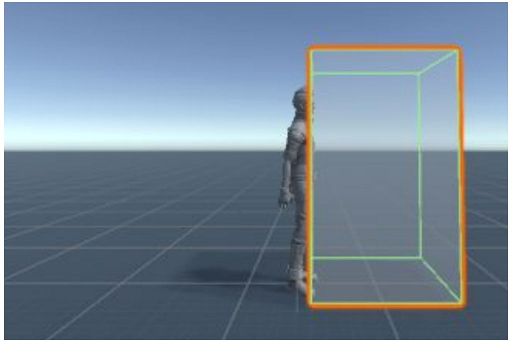
Midterm Demo

Unity Collision and Trigger

Most game events are triggered by collision



- **Colliders**
  - Colliders with physics, shapes and mass.
    - Provide realistic interaction to the game.
    - Hitting monsters with weapons, moving objects, walls that can’t walk through.



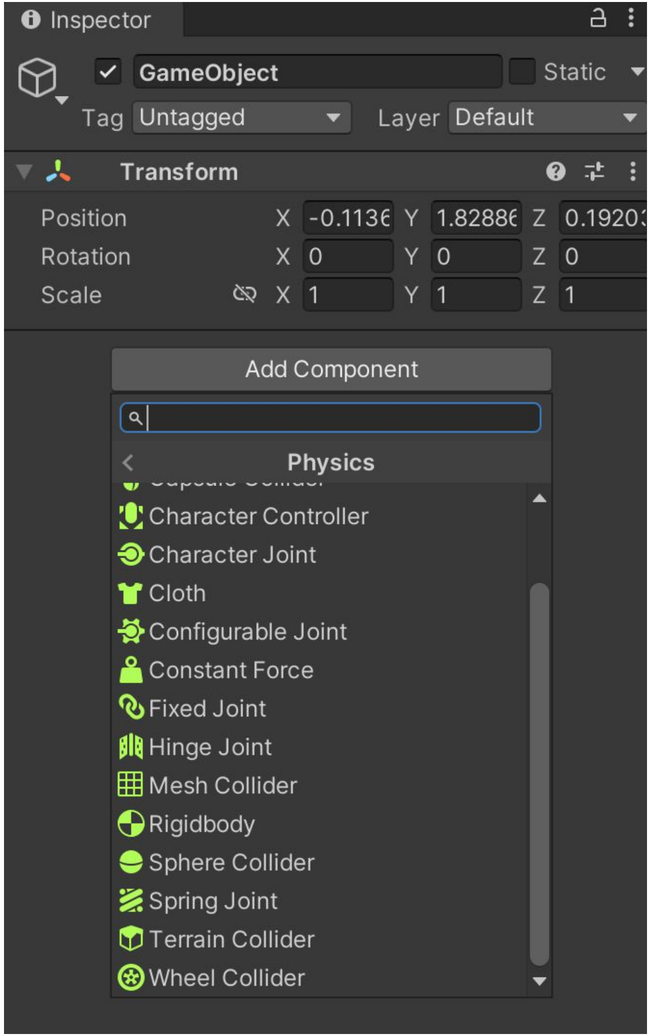
- **Triggers**
  - Colliders without physics that other objects can pass through, usually without visual representation (invisible).
    - Detect if game objects enter a certain place.
    - Checkpoints in kart games, trigger boss fight when enter certain area.

Collider

- A 3D boundary to detect collision.
- Only collisions between colliders will trigger collision.
- Collisions between parts without colliders will not be detected.

Add Collider to GameObject

- Select collider for your 3D gameobject
- For complex shapes,
  need to create multiple colliders.
  (or use Mesh collider)



Inspector

☑ GameObject □ Static

Tag Untagged Layer Default

Transform

Position X -0.1136 Y 1.82886 Z 0.1920

Rotation X 0 Y 0 Z 0

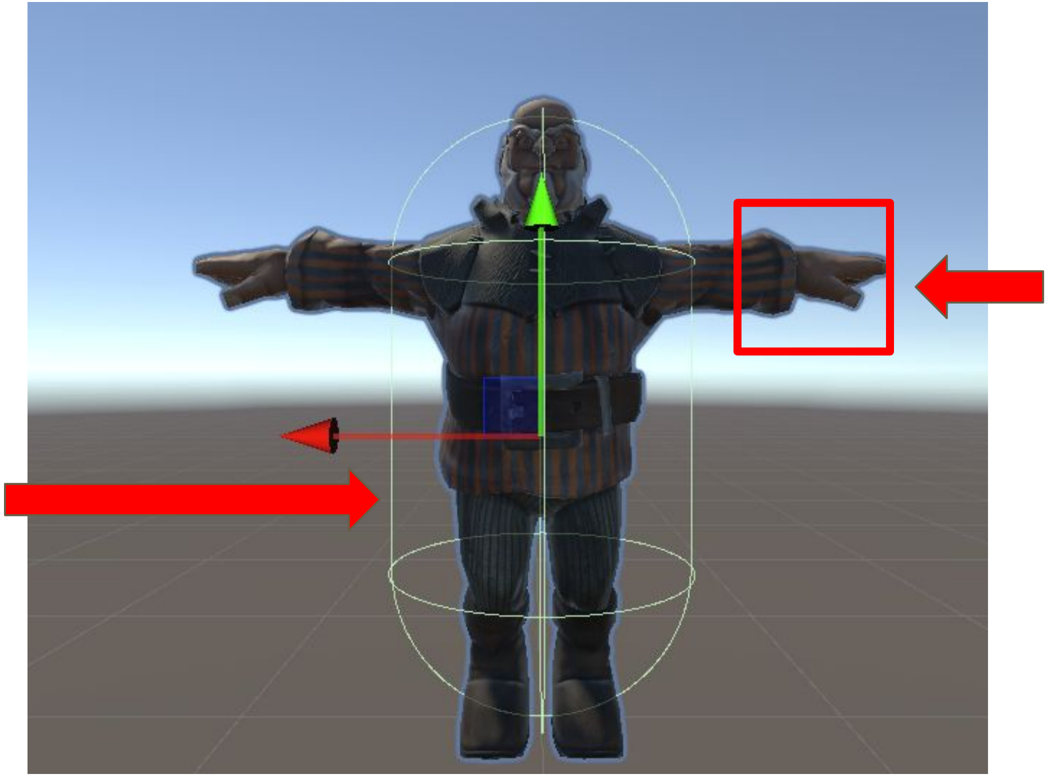
Scale X 1 Y 1 Z 1

Add Component

Physics

- Character Controller
- Character Joint
- Cloth
- Configurable Joint
- Constant Force
- Fixed Joint
- Hinge Joint
- Mesh Collider
- Rigidbody
- Sphere Collider
- Spring Joint
- Terrain Collider
- Wheel Collider

Only collisions with the collider will be triggered



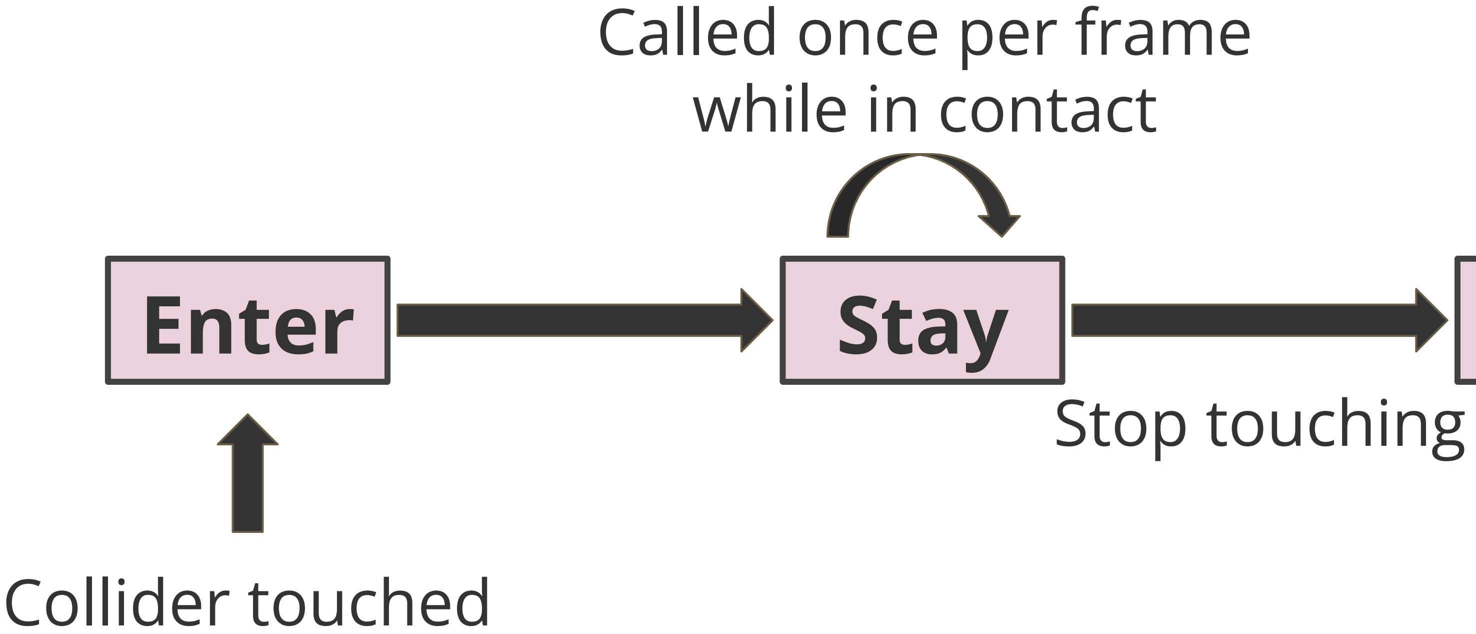
Inside collider (green capsule)

Collision triggered.

Out of collider.

No collision triggered.

Collision States



Called once per frame while in contact

Enter

Stay

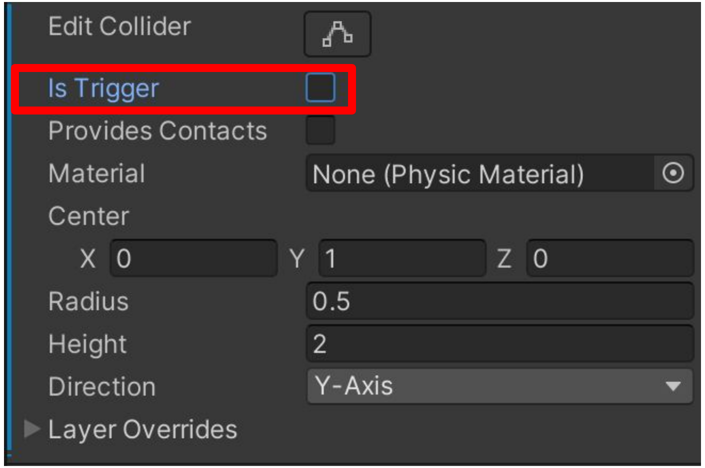
Exit

Stop touching

Collider touched

Collision

- Physics applied
- Use OnCollision functions



Edit Collider

Is Trigger ☐

Provides Contacts ☐

Material: None (Physic Material)

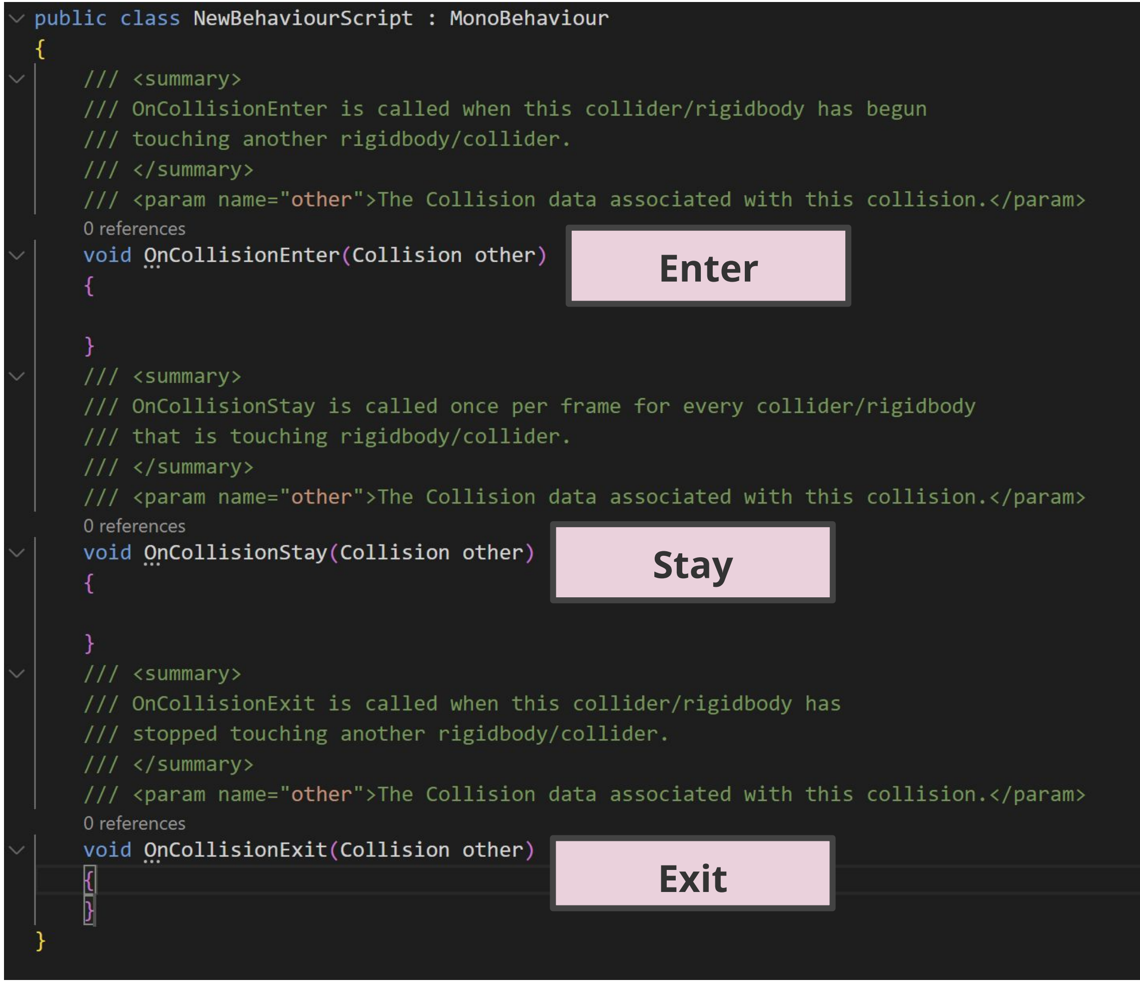
Center: X 0 Y 1 Z 0

Radius: 0.5

Height: 2

Direction: Y-Axis

Layer Overrides



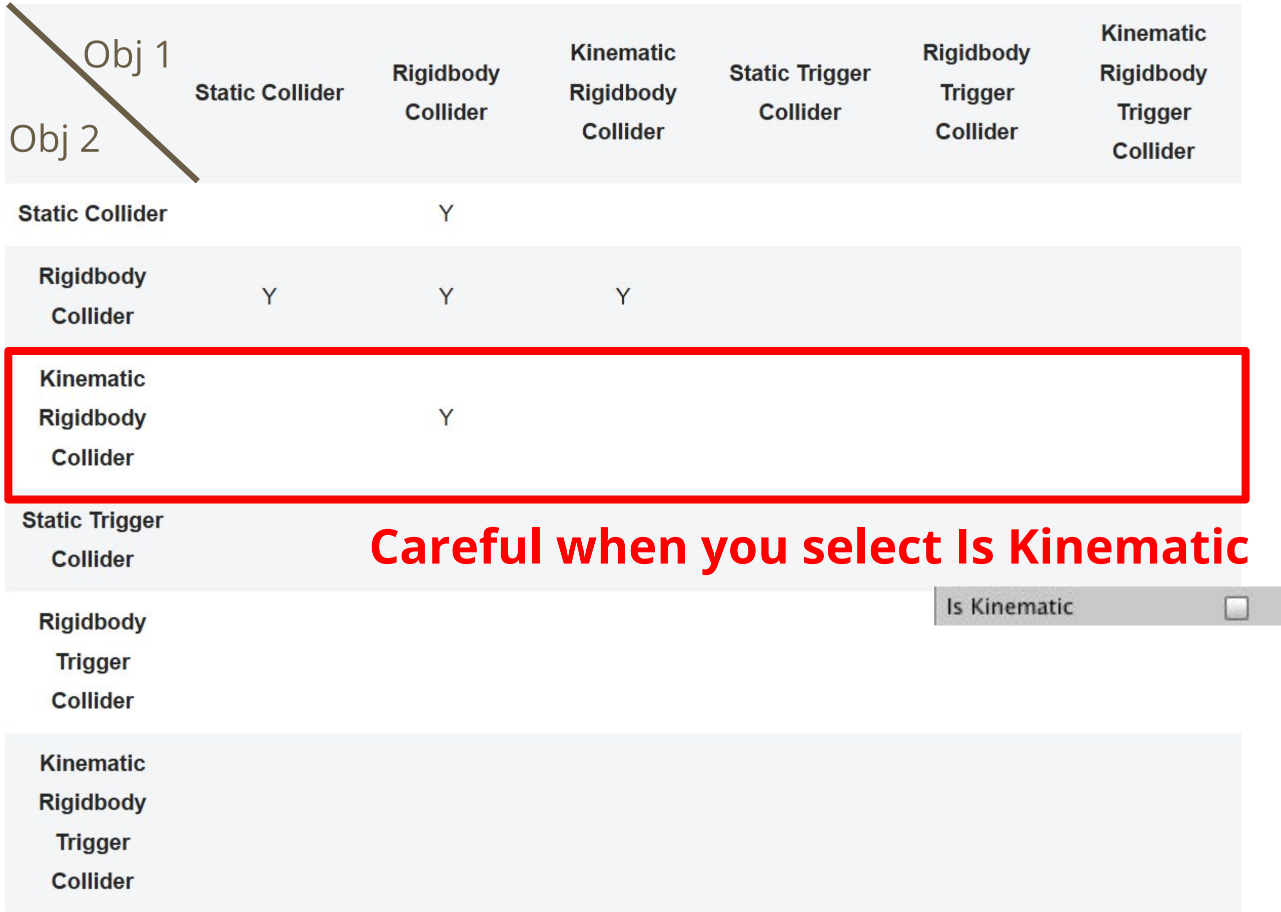
```
public class NewBehaviourScript : MonoBehaviour
{
    /// <summary>
    /// OnCollisionEnter is called when this collider/rigidbody has begun
    /// touching another rigidbody/collider.
    /// </summary>
    /// <param name="other">The Collision data associated with this collision.</param>
    0 references
    void OnCollisionEnter(Collision other)
    {

    }
    /// <summary>
    /// OnCollisionStay is called once per frame for every collider/rigidbody
    /// that is touching rigidbody/collider.
    /// </summary>
    /// <param name="other">The Collision data associated with this collision.</param>
    0 references
    void OnCollisionStay(Collision other)
    {

    }
    /// <summary>
    /// OnCollisionExit is called when this collider/rigidbody has
    /// stopped touching another rigidbody/collider.
    /// </summary>
    /// <param name="other">The Collision data associated with this collision.</param>
    0 references
    void OnCollisionExit(Collision other)
    {
    }
}
```

Enter

Stay

Exit

Collision messages are sent upon collision



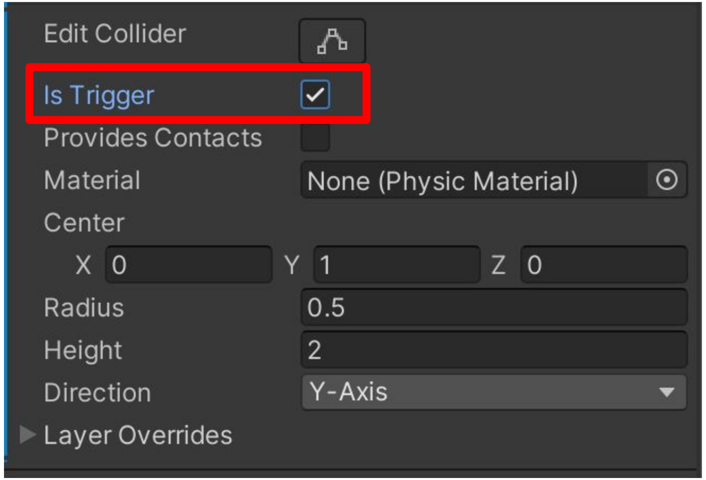
Obj 1 Obj 2	Static Collider	Rigidbody Collider	Kinematic Rigidbody Collider	Static Trigger Collider	Rigidbody Trigger Collider	Kinematic Rigidbody Trigger Collider
Static Collider		Y				
Rigidbody Collider	Y	Y	Y			
Kinematic Rigidbody Collider		Y				
Static Trigger Collider						
Rigidbody Trigger Collider						
Kinematic Rigidbody Trigger Collider						

Careful when you select Is Kinematic

Is Kinematic ☐

Trigger

- **No physics applied**
- Use OnTrigger Functions



Edit Collider

Is Trigger ☑

Provides Contacts □

Material None (Physic Material)

Center

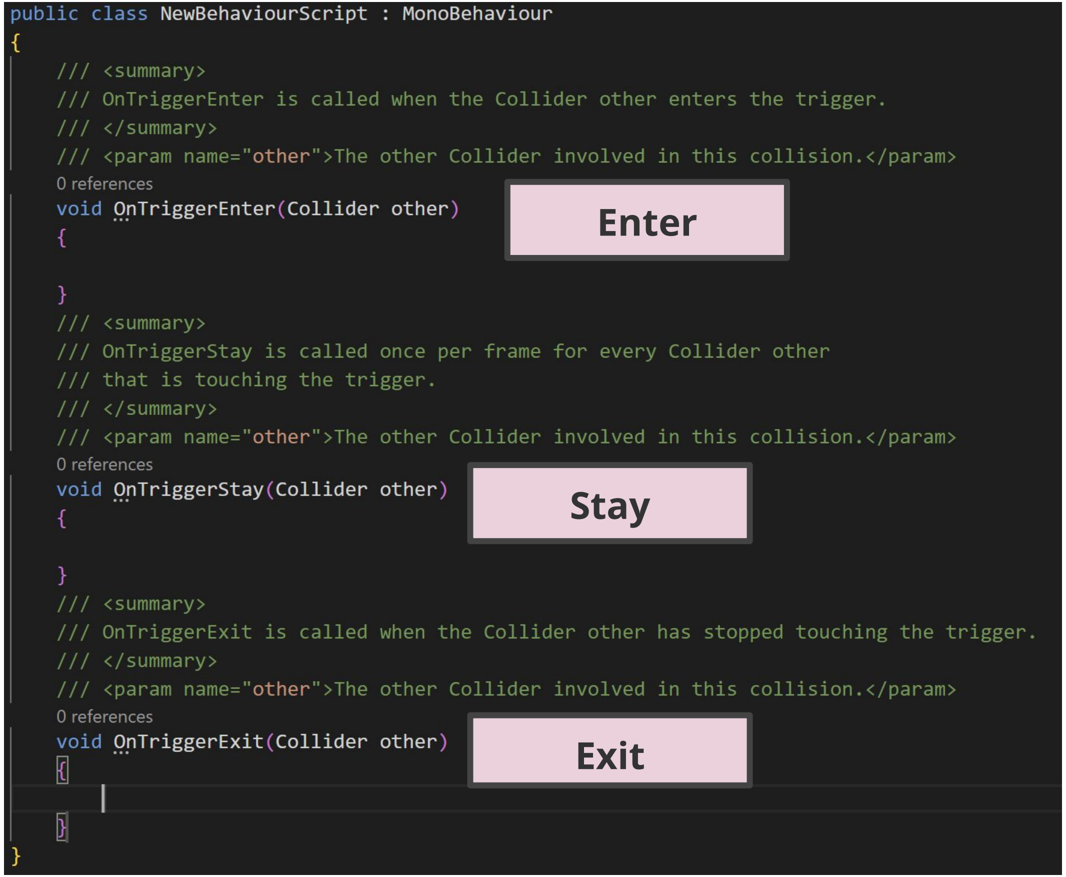
X 0 Y 1 Z 0

Radius 0.5

Height 2

Direction Y-Axis

Layer Overrides



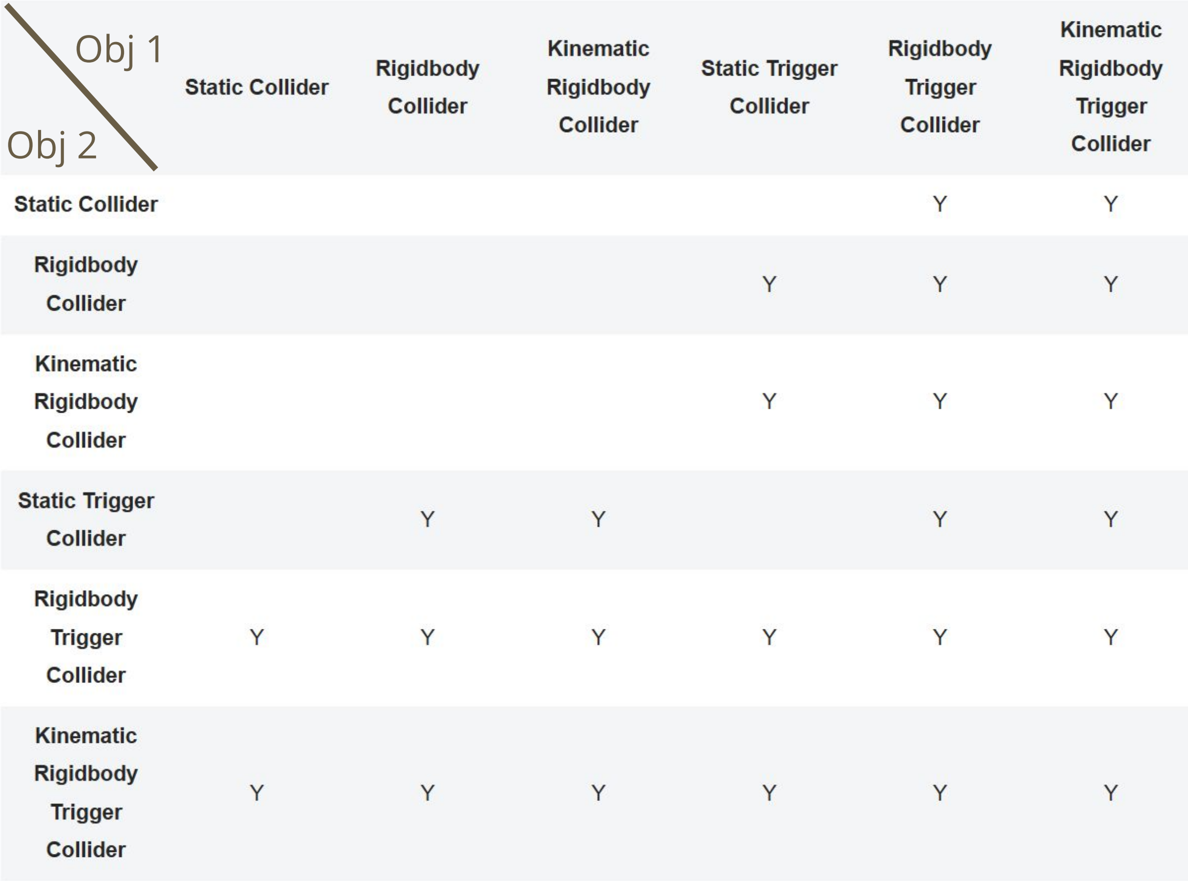
```
public class NewBehaviourScript : MonoBehaviour
{
    /// <summary>
    /// OnTriggerEnter is called when the Collider other enters the trigger.
    /// </summary>
    /// <param name="other">The other Collider involved in this collision.</param>
    0 references
    void OnTriggerEnter(Collider other)
    {

    }
    /// <summary>
    /// OnTriggerStay is called once per frame for every Collider other
    /// that is touching the trigger.
    /// </summary>
    /// <param name="other">The other Collider involved in this collision.</param>
    0 references
    void OnTriggerStay(Collider other)
    {

    }
    /// <summary>
    /// OnTriggerExit is called when the Collider other has stopped touching the trigger.
    /// </summary>
    /// <param name="other">The other Collider involved in this collision.</param>
    0 references
    void OnTriggerExit(Collider other)
    {

    }
}
```

Enter

Stay

Exit

Trigger messages are sent upon collision

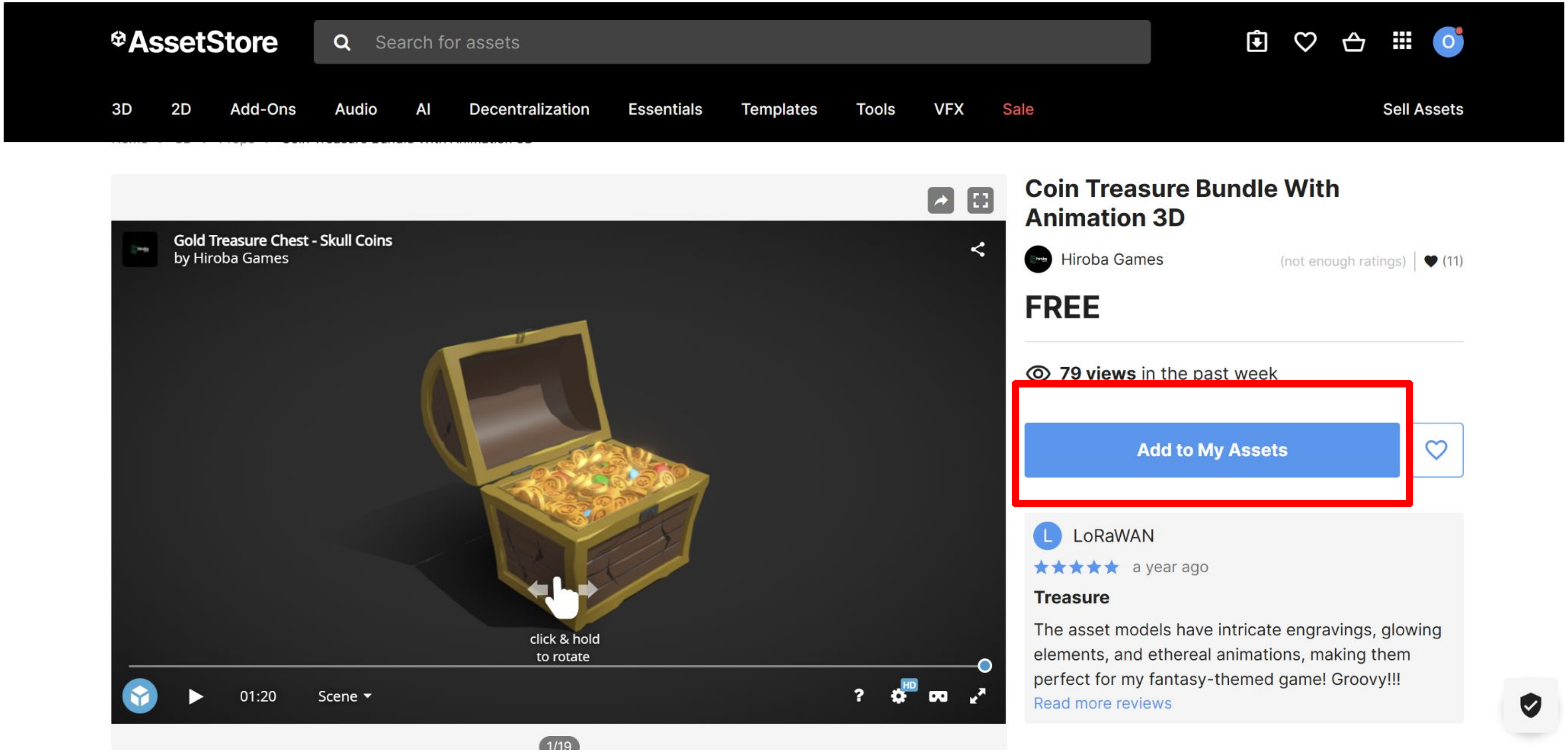


Obj 1 Obj 2	Static Collider	Rigidbody Collider	Kinematic Rigidbody Collider	Static Trigger Collider	Rigidbody Trigger Collider	Kinematic Rigidbody Trigger Collider
Static Collider					Y	Y
Rigidbody Collider				Y	Y	Y
Kinematic Rigidbody Collider				Y	Y	Y
Static Trigger Collider		Y	Y		Y	Y
Rigidbody Trigger Collider	Y	Y	Y	Y	Y	Y
Kinematic Rigidbody Trigger Collider	Y	Y	Y	Y	Y	Y

Unity Asset Store

Unity Asset Store

- Full of free textures, models and animations, whole project examples, tutorials and Extension Assets



Coin Treasure Bundle With Animation 3D

Hiroba Games (not enough ratings) | ♥ (11)

FREE

79 views in the past week

Add to My Assets ♡

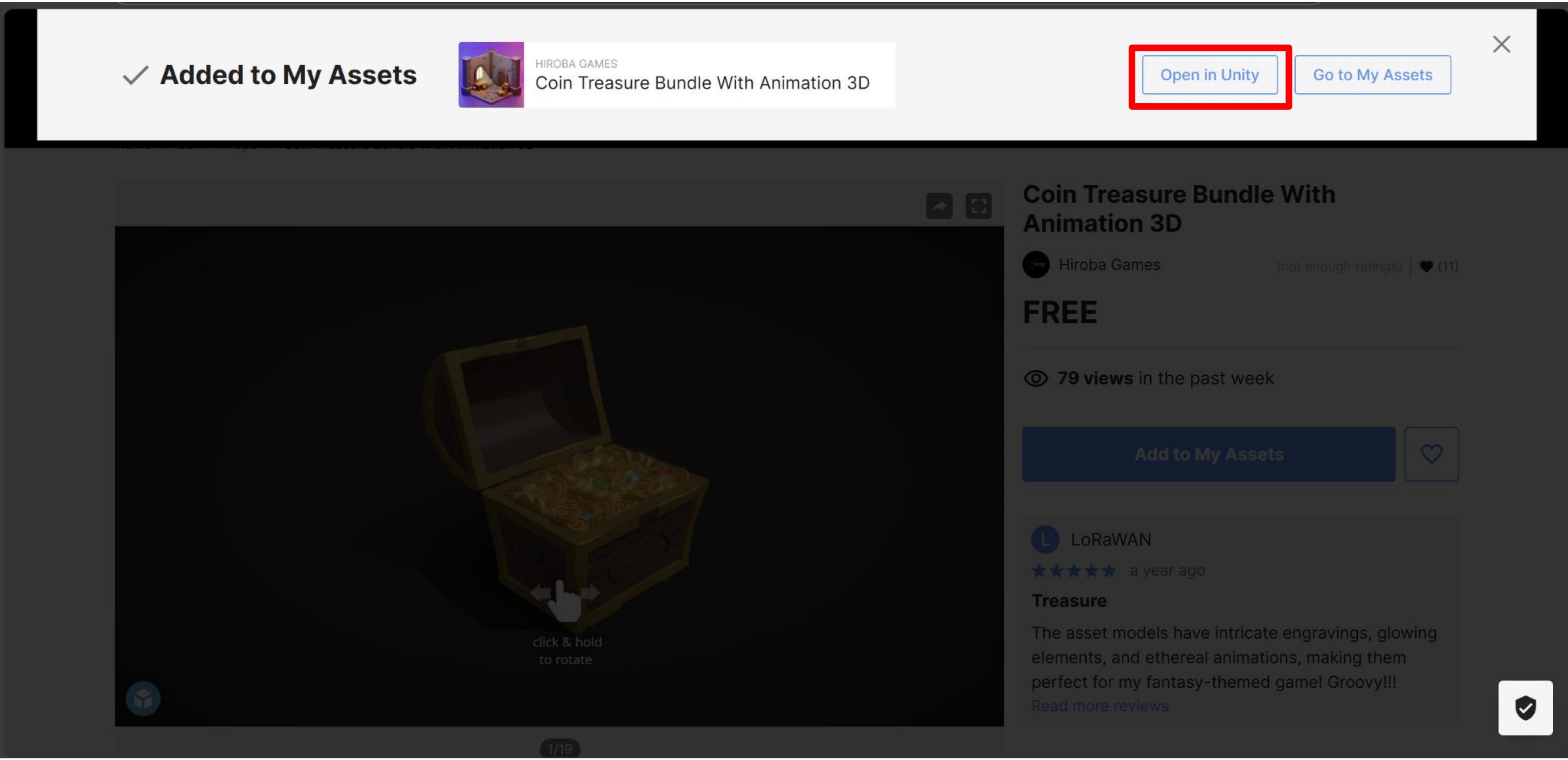
L LoRaWAN

★★★★★ a year ago

Treasure

The asset models have intricate engravings, glowing elements, and ethereal animations, making them perfect for my fantasy-themed game! Groovy!!!

Read more reviews



✓ Added to My Assets

HIROBA GAMES
Coin Treasure Bundle With Animation 3D

Coin Treasure Bundle With Animation 3D

Hiroba Games (not enough ratings) (11)

FREE

79 views in the past week

LoRaWAN
★★★★★ a year ago

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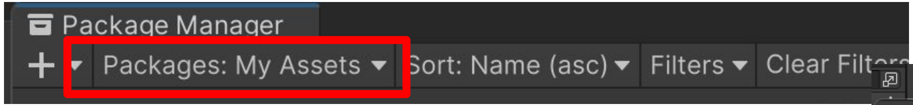
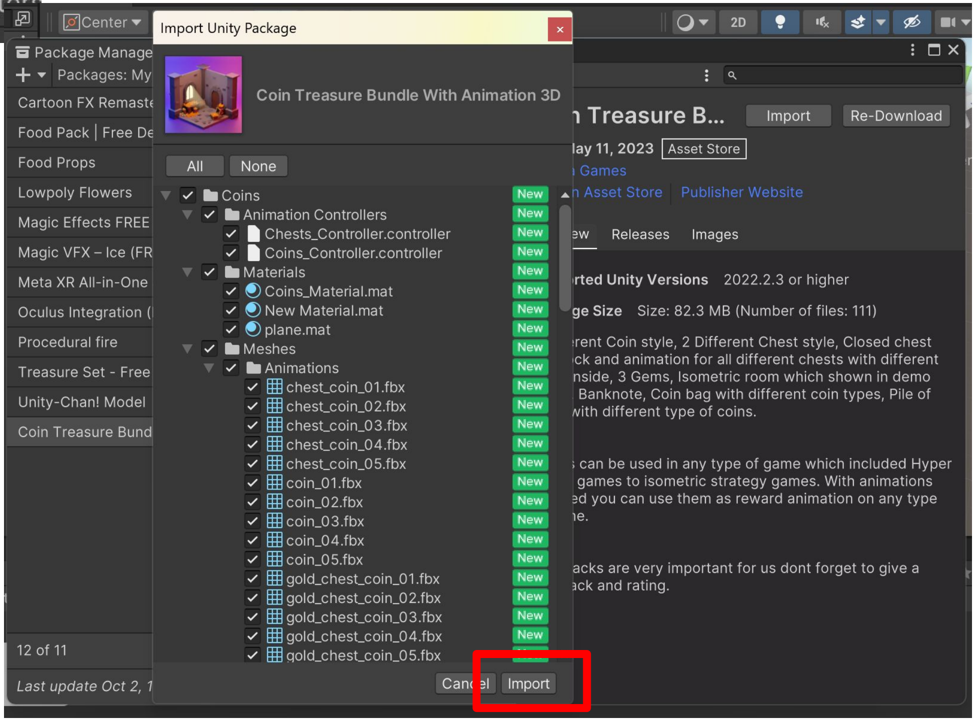
The asset models have intricate engravings, glowing elements, and ethereal animations, making them perfect for my fantasy-themed game! Groovy!!!

Go to Package Manager in your Unity project



1. Select My Asset

2. Select asset you want.
Then download and import.



Cartoon FX Remaste
Food Pack | Free De
Food Props
Lowpoly Flowers
Magic Effects FREE
Magic VFX – Ice (FR
Meta XR All-in-One
Oculus Integration (
Procedural fire
Treasure Set - Free
Unity-Chan! Model
Coin Treasure Bund

12 of 11

Last update Oct 2, 1

Coin Treasure Bundle With Animation 3D

```
☑ Coins                                  New
  ☑ Animation Controllers                New
    ☑ Chests_Controller.controller       New
    ☑ Coins_Controller.controller        New
  ☑ Materials                            New
    ☑ Coins_Material.mat                 New
    ☑ New Material.mat                   New
    ☑ plane.mat                          New
  ☑ Meshes                               New
    ☑ Animations                         New
      ☑ chest_coin_01.fbx                New
      ☑ chest_coin_02.fbx                New
      ☑ chest_coin_03.fbx                New
      ☑ chest_coin_04.fbx                New
      ☑ chest_coin_05.fbx                New
      ☑ coin_01.fbx                      New
      ☑ coin_02.fbx                      New
      ☑ coin_03.fbx                      New
      ☑ coin_04.fbx                      New
      ☑ coin_05.fbx                      New
      ☑ gold_chest_coin_01.fbx           New
      ☑ gold_chest_coin_02.fbx           New
      ☑ gold_chest_coin_03.fbx           New
      ☑ gold_chest_coin_04.fbx           New
      ☑ gold_chest_coin_05.fbx
```

ı Treasure B...

lay 11, 2023 Asset Store

ı Games

ı Asset Store Publisher Website

ew Releases Images

rted Unity Versions 2022.2.3 or higher

ge Size Size: 82.3 MB (Number of files: 111)

erent Coin style, 2 Different Chest style, Closed chest
ck and animation for all different chests with different
nside, 3 Gems, Isometric room which shown in demo
Banknote, Coin bag with different coin types, Pile of
with different type of coins.

; can be used in any type of game which included Hyper
games to isometric strategy games. With animations
ed you can use them as reward animation on any type
ne.

acks are very important for us dont forget to give a
ack and rating.

Import 3D objects from web

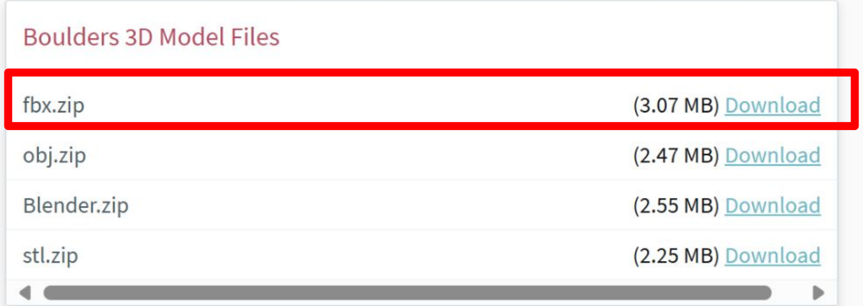
Find any FBX, OBJ, and 3DS you like

- CGTrader
- SketchFab
- TurboSquid
- ModelsResource
- Free3D.com

Add FBX, OBJ, and 3DS to Unity

1. In the Unity Editor window, click on “Assets” in the Project window.
2. Click on “Import New Asset” and select the 3D model file from your computer, or just drag the file to the Assets folder.
3. Unity will import the model and create a new asset in the project. You can drag and drop the asset from the Project window into the Scene view to see the model in the scene.

Download 3D models

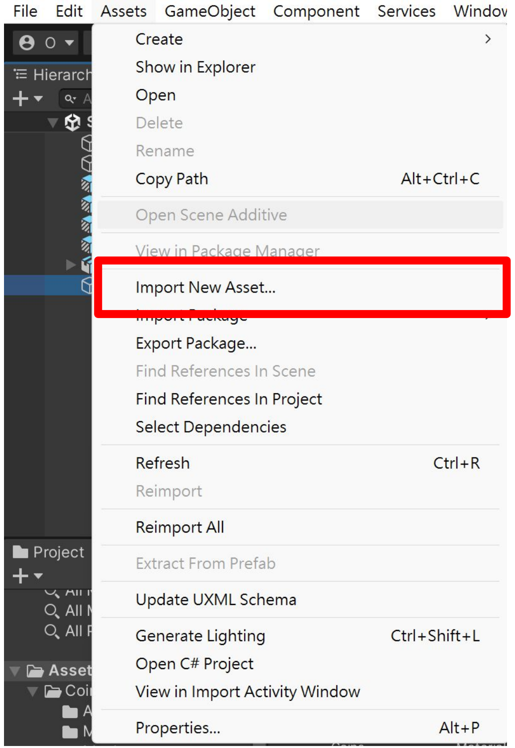


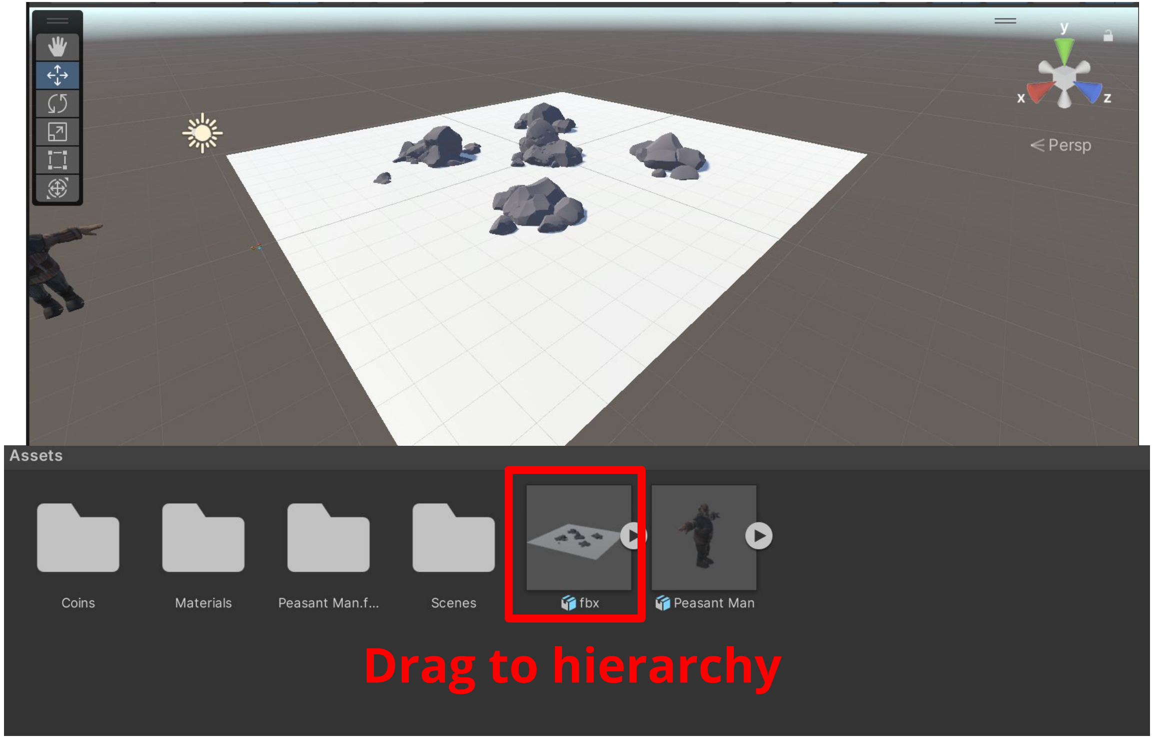
Boulders 3D Model Files

fbx.zip	(3.07 MB) Download
obj.zip	(2.47 MB) Download
Blender.zip	(2.55 MB) Download
stl.zip	(2.25 MB) Download

Download this example

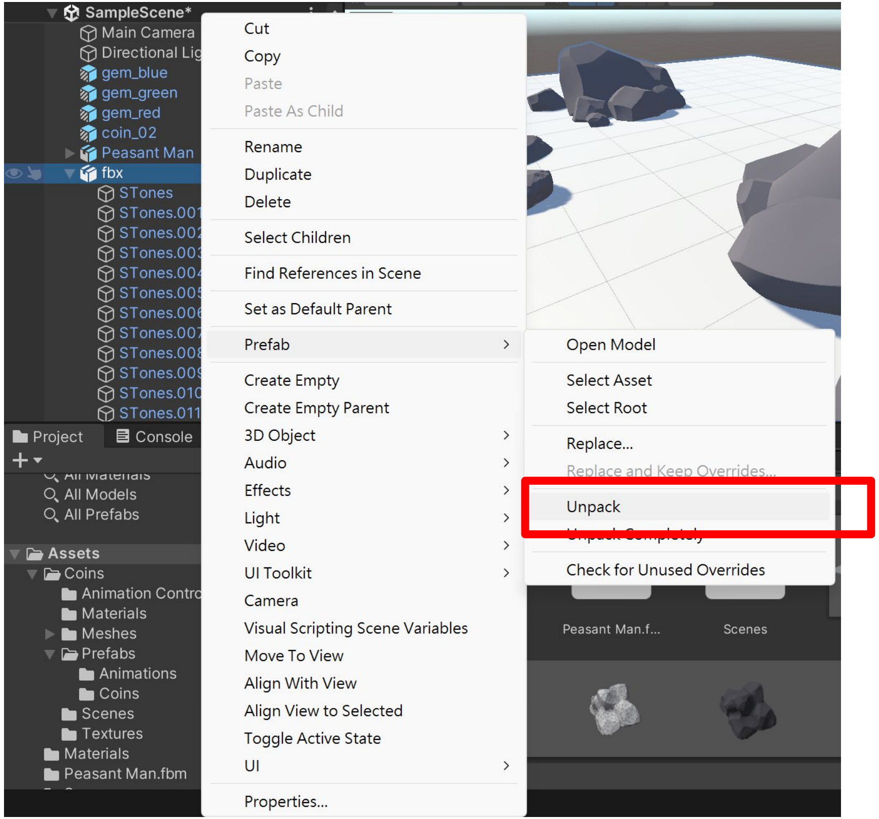
Import Asset

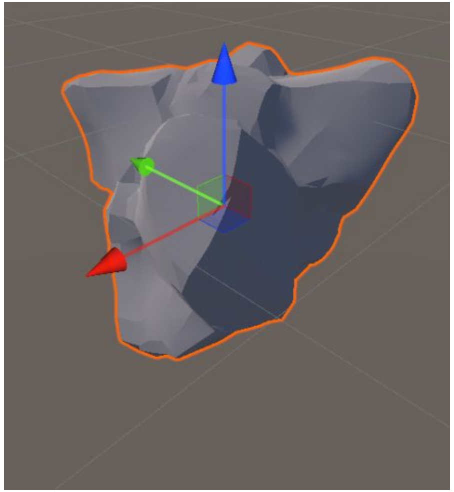




Drag to hierarchy

Unpack Prefab to transform a prefab into a regular game object





Midterm Demo

Midterm Demo - Implement an XR game

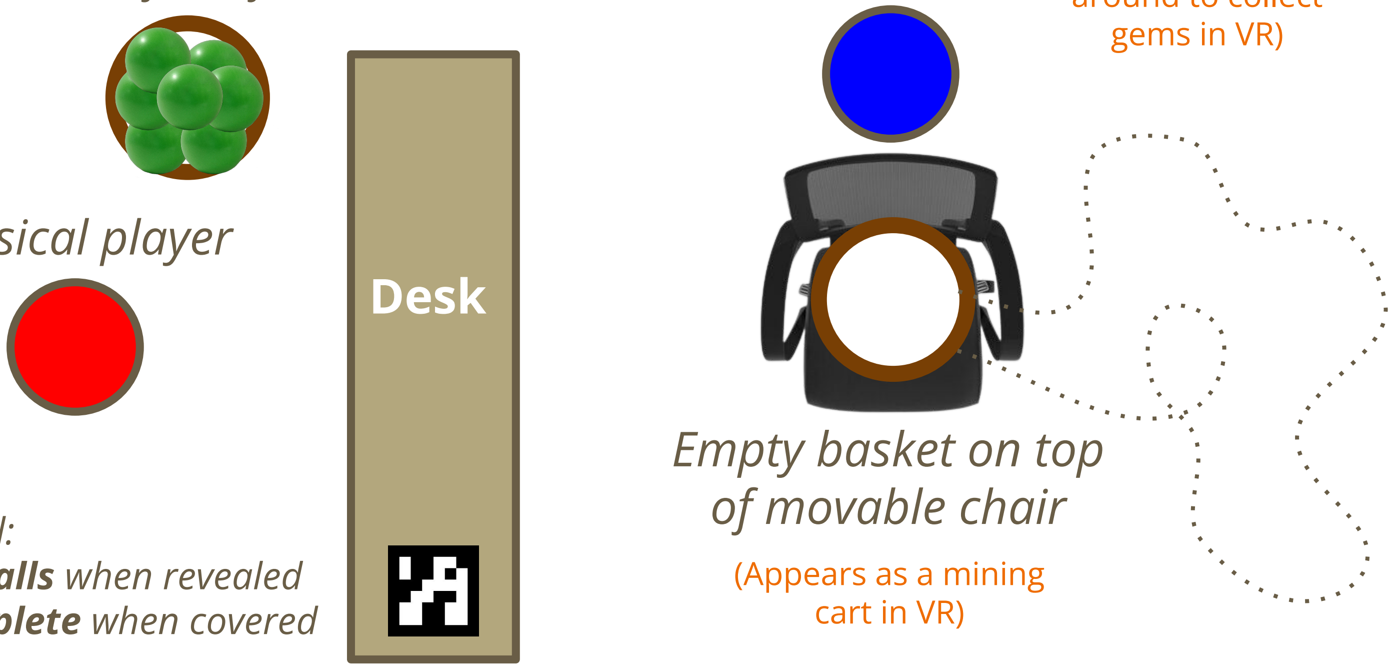
- A game consist of **two players**:
  - One physical player (**without** VR)
  - One virtual player (**with** VR)
- Objective:
  - **Physical player** will try to throw balls into a moving basket pushed around by virtual player.
  - **Virtual player** will try to collect gems for a NPC using a cart in an underground mine.
- Physical player is invisible in the VR world and can only interact with the virtual world through the **ArUco** and control the NPC with **body tracking**.

Physical Scene

Basket full of balls

Virtual player

(Moves the chair around to collect gems in VR)



(Tries to throw balls into the empty basket)

Physical player

Empty basket on top of movable chair

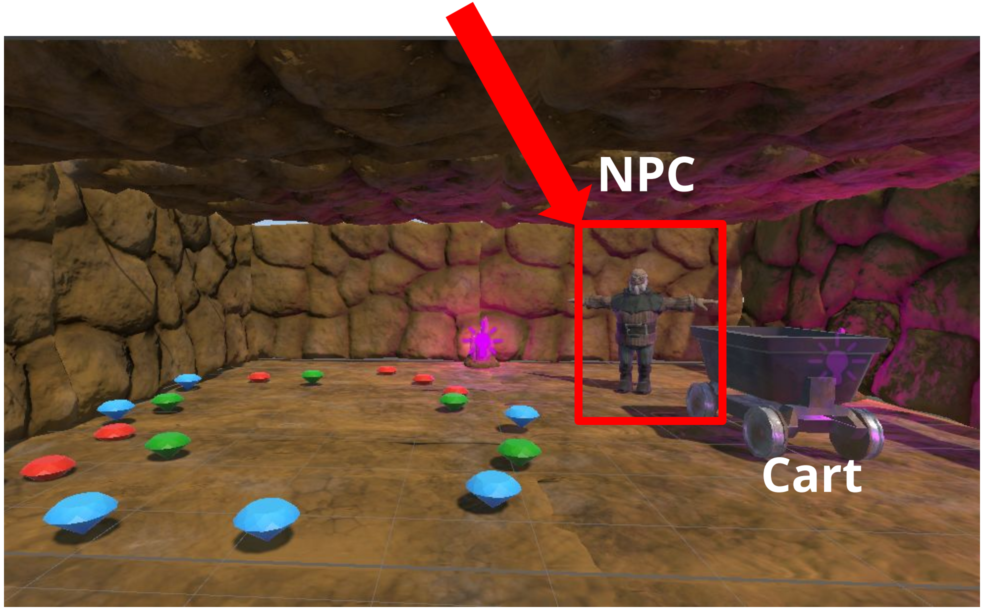
(Appears as a mining cart in VR)

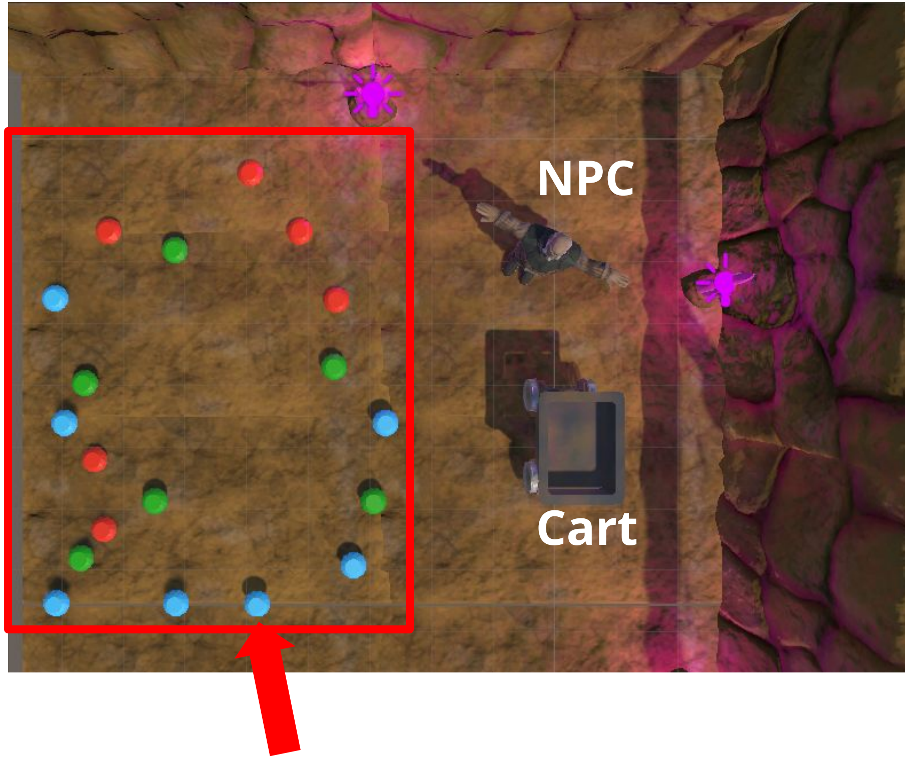
An ArUco code to signal:

- ***I need to refill balls** when revealed*
- ***The refill is complete** when covered*

Virtual Scene

NPC stays in place but its animation is linked to physical player.
Once all gems are collected, move cart to the NPC and give gems to him





Virtual player pushes the cart to follow the path created by gems to collect them

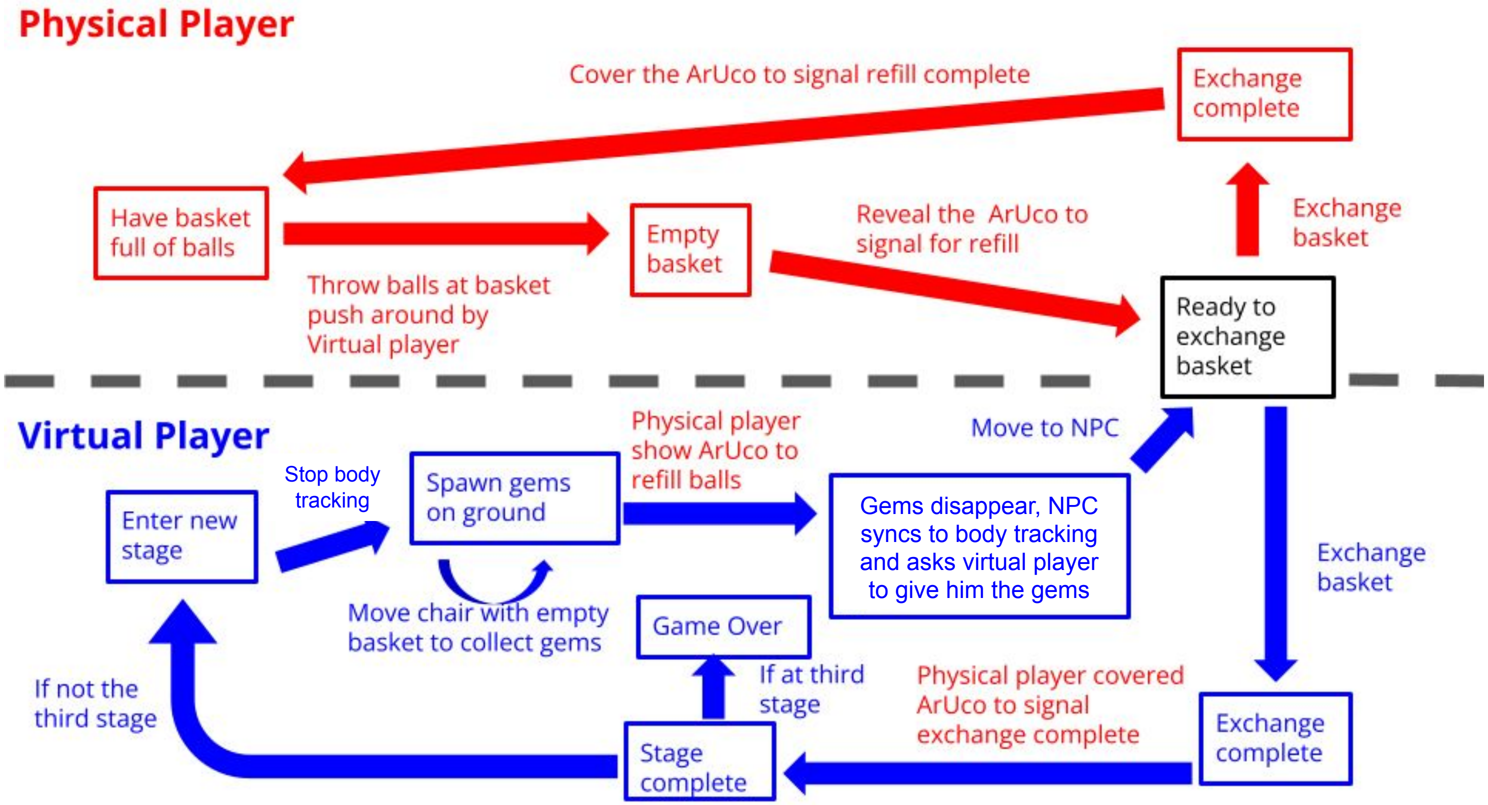
Physical World

1. Physical player tries to throw balls into a moving basket pushed around by virtual player
2. When the physical player needs to refill the balls, he will reveal the ArUco code to signal the system
3. Virtual player pushes the basket (now full of balls) to in front of the ArUco code so that the physical player can reach it
4. Once the physical player exchanges the baskets, he will cover the ArUco again to signal the system
5. Virtual player starts moving the chair again and physical player starts throwing balls again
6. Start again from step 1 unless game is over

Virtual World

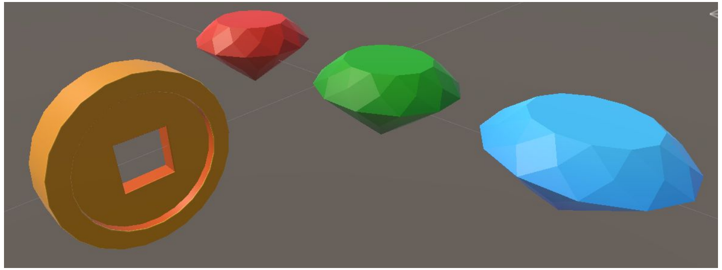
1. An NPC asks virtual player to collect gems on the floor by moving a mining cart over them (using UI text/images)
2. Start pushing the cart around (a chair with an empty basket in the real world) to collect gems. Gems will continue to spawn until the physical player signals to refill
3. When physical player signals to refill, gems disappear and NPC syncs to body tracking and asks virtual player to move the cart to him
4. When physical player signals that refill is complete, NPC stops syncing to body tracking or switches to another animation.
5. If this is the third loop:
    a. End game and tell physical player the game is over.
    b. Else: start again from step 1 with a different location of gems on the ground

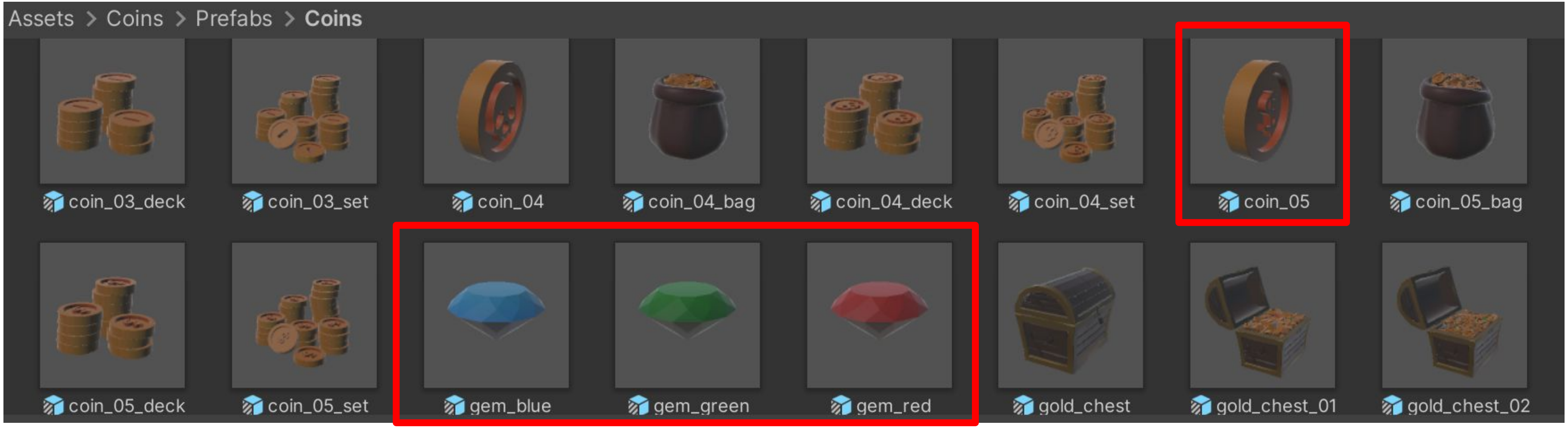
State Machine


Physical Player
Cover the ArUco to signal refill complete
Exchange complete
Have basket full of balls
Empty basket
Reveal the ArUco to signal for refill
Exchange basket
Throw balls at basket push around by Virtual player
Ready to exchange basket
Virtual Player
Stop body tracking
Spawn gems on ground
Physical player show ArUco to refill balls
Move to NPC
Enter new stage
Gems disappear, NPC syncs to body tracking and asks virtual player to give him the gems
Exchange basket
Move chair with empty basket to collect gems
Game Over
If at third stage
Physical player covered ArUco to signal exchange complete
If not the third stage
Stage complete
Exchange complete

Example Prefabs: Coin Treasure Bundle With Animation 3D

- Example prefab for coins and gems



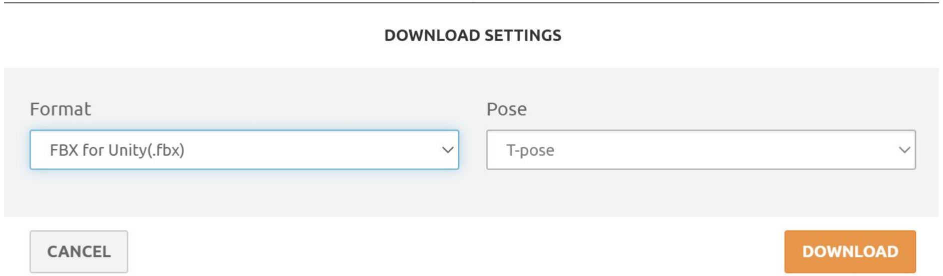


Assets > Coins > Prefabs > Coins

coin_03_deck
coin_03_set
coin_04
coin_04_bag
coin_04_deck
coin_04_set
coin_05
coin_05_bag
coin_05_deck
coin_05_set
gem_blue
gem_green
gem_red
gold_chest
gold_chest_01
gold_chest_02

Example Prefabs: Peasant Man

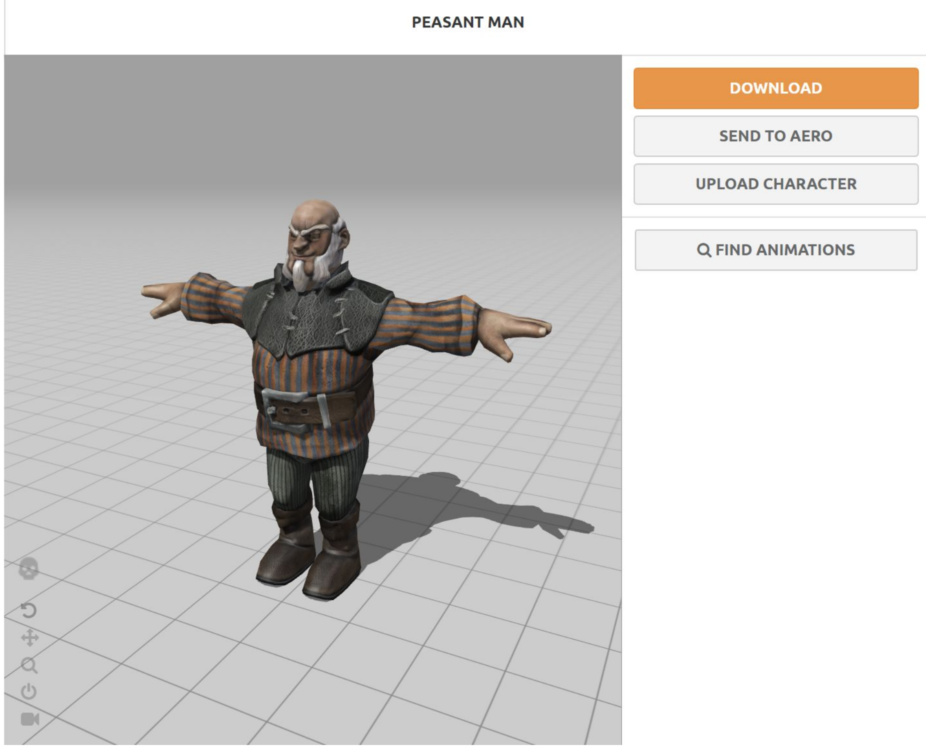
- NPC action linked to **physical player**
  - Use body tracking from Lab 3
- NPC represents the physical player in VR and instructs the **virtual player**
  - What animations do we need?



DOWNLOAD SETTINGS

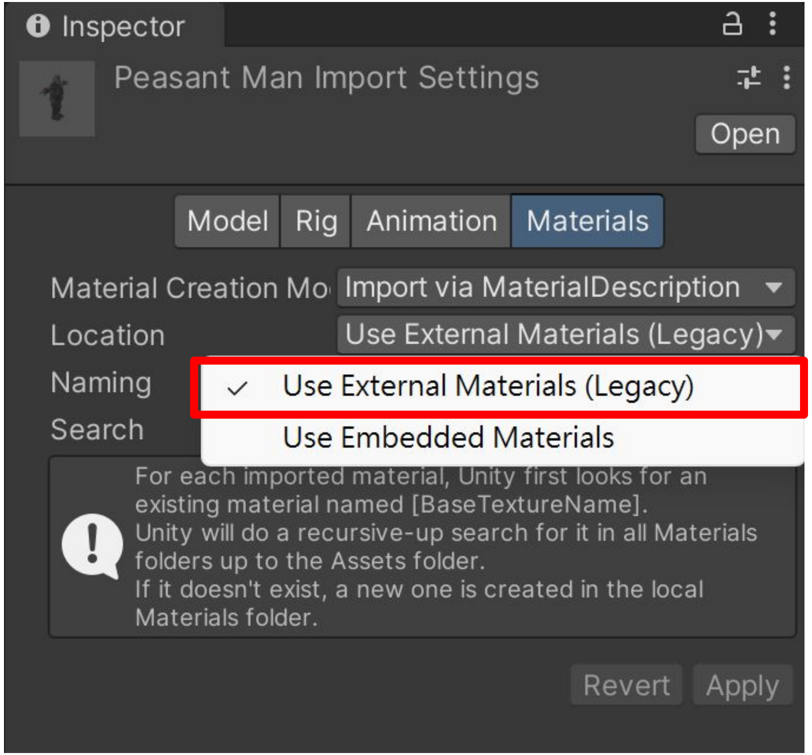
Format: FBX for Unity(.fbx)

Pose: T-pose



PEASANT MAN

Select External Materials if the avatar texture is broken



Material Creation Mo Import via MaterialDescription

Location Use External Materials (Legacy)

Naming

Search

✓ Use External Materials (Legacy)

Use Embedded Materials

For each imported material, Unity first looks for an existing material named [BaseTextureName].
Unity will do a recursive-up search for it in all Materials folders up to the Assets folder.
If it doesn't exist, a new one is created in the local Materials folder.

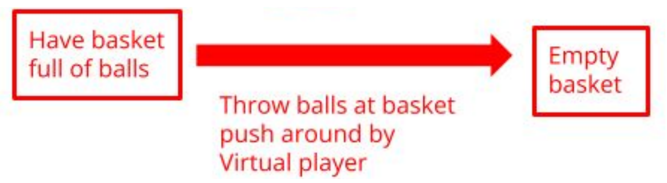
Midterm Demo - Basic

Implement the game according to the state machine

- The system should be calibrated.
  - e.g. test if the chair is correctly mapped to the mine cart in VR
- The state machine should be implemented
  - Test if we can move from state to state smoothly according to our graph
- The physical player’s action should mapped to the virtual NPC, at least when exchanging baskets
  - The mapping should have at least three points (head and hands), like the body tracking implementation in Lab 3
- No bugs
  - The game won’t crash, no flying carts, NPC inside walls, etc.

Midterm Demo - Bonus

- Expand the state machine and add extra interaction


Have basket full of balls
Throw balls at basket push around by Virtual player
Empty basket

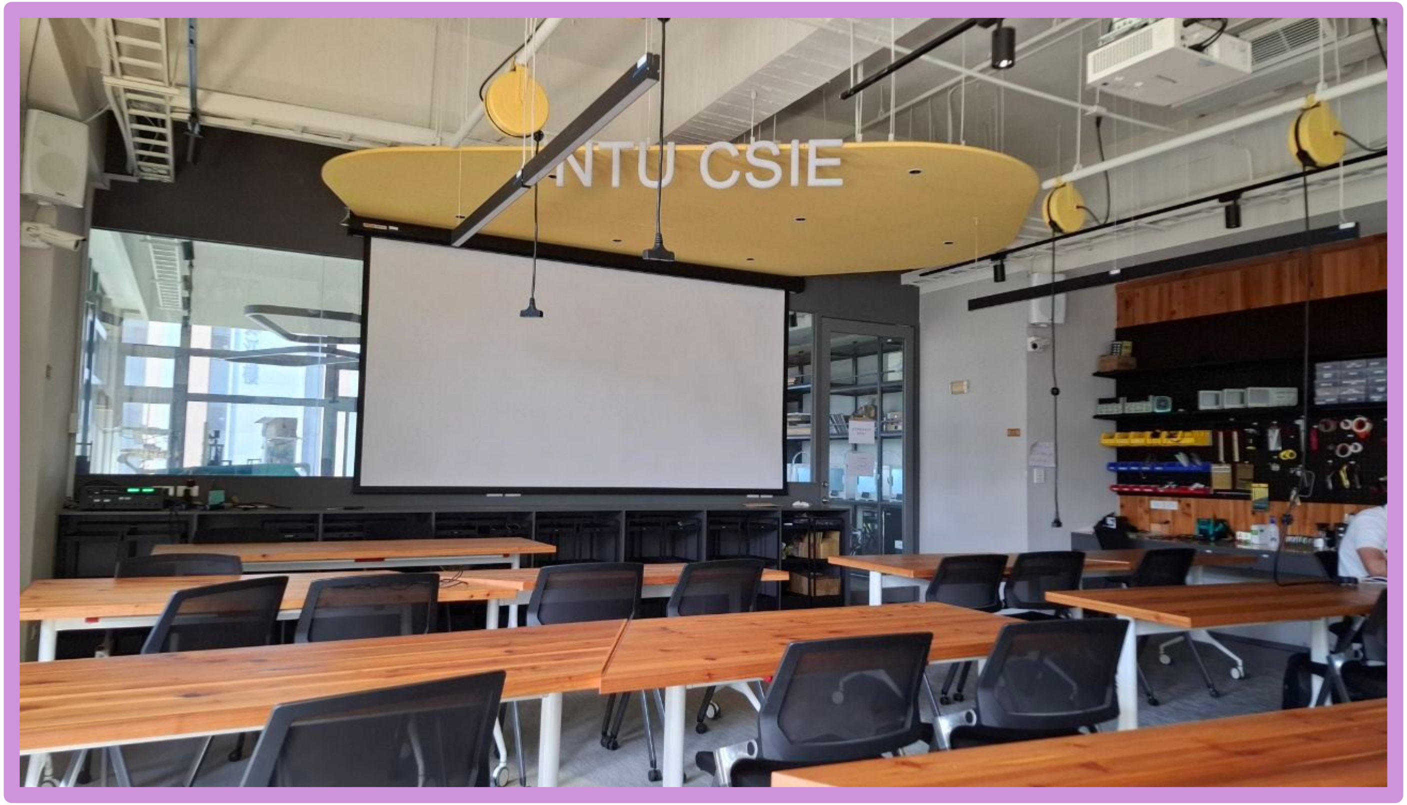
What happens if the physical player misses and some balls fall to the ground?

This case is actually not represented in the current state machine

- Improve player experience (both physical and virtual)
- Add sound effect, VFX, animation, etc.
- Bonuses from previous labs:
  - Track object position without ArUco (Lab 1 bonus)
  - Improvement of the calibration process (Lab 2 bonus)
  - Improve the quality of action mapping to NPC (Lab 3 bonus)

Report

- Summarize what you did in this lab.
  - Show the basic and bonus you implemented.
  - Use screenshots & video demos to show your results.
- What you did to improve this device. Or how you can improve this device.
- Anything related to this lab.



We will do an in-person demo in class on 10/23