

Section 5 Slides - Testing Grounds

[<< Back To Section 4](#)

These are the slides that accompany the [Complete Unreal Developer Course](#).

See me develop the slides as I write the course...

- Right click or Insert > Comment to comment, especially if you see a typo
- The slides will update immediately as I change things.

Enjoy your stay!

Ben Tristem



4.12.5^z

Testing Grounds Introduction

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In This Video...

- Welcome, fresh start, new energy
- Did you go back and modify Building Escape?
- Most ambitious section yet
- Bookmark the live Google Slides
- Comment on the slides, especially typos
- Come say hi at community.gamedev.tv



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Testing Grounds GDD

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In This Video...

- The concept of the game
- The rules of the game
- Some of the asset requirements for the game
- Identify possible technical challenges.

Concept

- You're a contestant in an entertainment game
- Survive as many testing grounds as possible
- Can you reach the end? Is there even an end?
- You can use force or stealth to pass the grounds.

Rules

- You can pass a testing ground undetected
- If detected you must clear the area
- You're scored on how many areas you pass.

Requirements

- Testing ground scenery
- Props and textures
- A rigged humanoid character we can modify
- Gun and projectile meshes
- Various SFX, samples from Gamemaster Audio
- Other stuff I haven't thought of yet!



Potential Technical Challenges

- Procedural generation of testing grounds.
- Controlling skeletal animations.
- AI behaviour and awareness.
- Tracking large assets in Git.

How the Grounds Spawn



AI alert event
Last AI dead



Share your GDD

- Write a post on the forum
- Use the link in resources
- Start a new topic
- Write your GDD
- Use markdown to format
- Include sketches if you wish.

4.12.5^z

Using Git LFS (Large File Support)

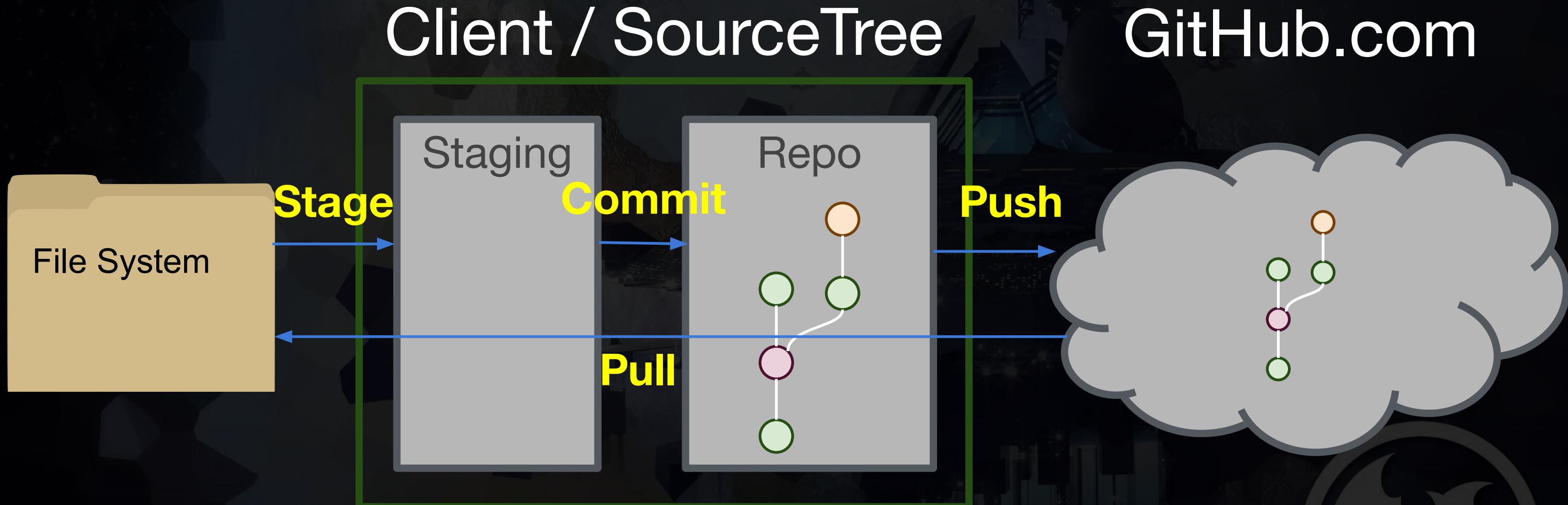
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In This Video...

- The distinction between Git vs GitHub
- Use Unreal's toolbar & SourceTree
- Enable Git Large File Support (LFS)
- Setup on GitHub (no readme.md or initial commit)
- Push to GitHub and share*
- Warning: may take a while on slow broadband.

Git & SourceTree



Setup your Project with Git LFS

- Create using Epic Games Launcher
- Connect to Source Control in Unreal
- “Add Working Copy” to SourceTree
- Enable LFS & track `.uasset` and `.umap` files
- Setup a plain repository on www.GitHub.com
- Connect SourceTree to GitHub & push.

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Markdown & Marketing

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In This Video...

- Limitations of Unreal's connection to GitHub
- How to reset to previous commit to combine
- Presenting your public GitHub page well
- Using Markdown to enrich formatting.

Decorate & Share your Repo

- Use Organisations / Teams as needed
- Add a `readme.md` file and use MarkDown
- Check visibility in an anonymous browser
- NOTE: This all assumes you're OK with it public!
- Share using link in Resources for feedback
- How else can you get feedback on your game?



Use **git clean** to Revert Project

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In This Video...

- Preview our work with AI characters
- A way of renaming the last git commit
- Revert to a previous state using Stash
- Automatically clearing derived files with...
- `git clean -x -d -i`
- Use `git clean -help` for details



Git Comfortable

- Make some changes to your project
- For example move a cube, add a class, whatever
- Close Unreal and commit using SourceTree
- Reset master to previous commit
- Run `git clean -x -d -i`
- Open your project and check it has reverted.

A collage of various game screenshots showing futuristic landscapes, structures, and vehicles. The images include a large industrial complex with a tall tower, a futuristic city at night, a vehicle driving through a desert-like environment, and a close-up of a mechanical arm. The overall theme is science fiction and advanced technology.

4.13.0^z

First Person Character Overview

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In This Video...

- Upgrading my project to Unreal 4.13
- An overview of the scene
- How the First Person Character is composed
- Adding a spiral staircase.



Add a Staircase

- Overview the scene
- Look at the First Person Character's components
- Add a curved staircase where indicated.

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The Third Person Character

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In This Video...

- Add a third person character to the scene
- Caution about tidying files at this stage
- Add a navmesh, and check it's continuous.

Add a Navmesh

- Ensure it covers “up the stairs”
- Preview with the P key
- Share on the community site.

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Introducing AI Behaviour Trees

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In This Video...

- Setup a Blueprint AI controller class
- Behaviour Trees control AI execution flow
- Blackboard holds AI instance data
- How to associate a behaviour tree with an AI
- Testing that our behavior tree is running.



Get NPC_AI_BP Class Working

- Create a new Blueprint class
- We can re-parent to C++ later if needed
- Make this the default class for placed AI
- On Begin Play test by printing.

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Introducing AI Blackboard Data

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In This Video...

- Blackboard data is like member variables in code
- Using blackboard data to set patrol points
- Practice setting blackboard values in Blueprint
- Test simple AI patrol behaviour.

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Target Points and Patrol Routes

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In This Video...

- Add a variable to the NPC's blueprint
- How to make a variable an array in blueprint
- Introducing Target Point actors
- Using target points to specify patrol routes.

Add Another Patrolling Soldier

- Add another AI character
- Add a new Target Point up the stairs
- Make the two actors share this point only
- Add a couple of new points just for the new guy.

4.13.0^z

Using Any Actor for Waypoints

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In This Video...

- Actors are more general than target points
- How to select an actor from another actor
- Getting the AI Controller to set Blackboard data
- Testing our characters go to a set waypoint.

Get AI Going to First Targets

- Find index 0 from the array
- Set the Waypoint Blackboard key
- Check both guards to go their first waypoint.

Options for Grouping Actors

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In This Video...

- Use layers (usually used for visibility)
- Use groups as a simple multi-select tool
- Use tags, can be flexible but easy to forget
- Use a parent Empty Actor, or a Folder
- Group on game object (e.g. array on NPC)
- The key is to know the pros and cons.



Explain a Grouping Choice

- Pick a grouping choice for patrol points
- Don't worry about how we're already doing things
- Click “Lecture Discussions” in Resources
- Share your thoughts with others
- I'll pick one and carry-on with that
- The purpose is to think about it.

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Blueprint Behaviour Tree Tasks

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In This Video...

- How to use Blackboard Key Selector variables
- Creating new Tasks in Behaviour Trees
- Pseudocode programming in Blueprint
- How to use the Execute AI node
- How to use the Finish Execute node.



Set Next Waypoint

- Get the functionality we had back
- Just go to the first waypoint
- You can assume the index initialises to 0.

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Modular Arithmetic & Cycles

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In This Video...

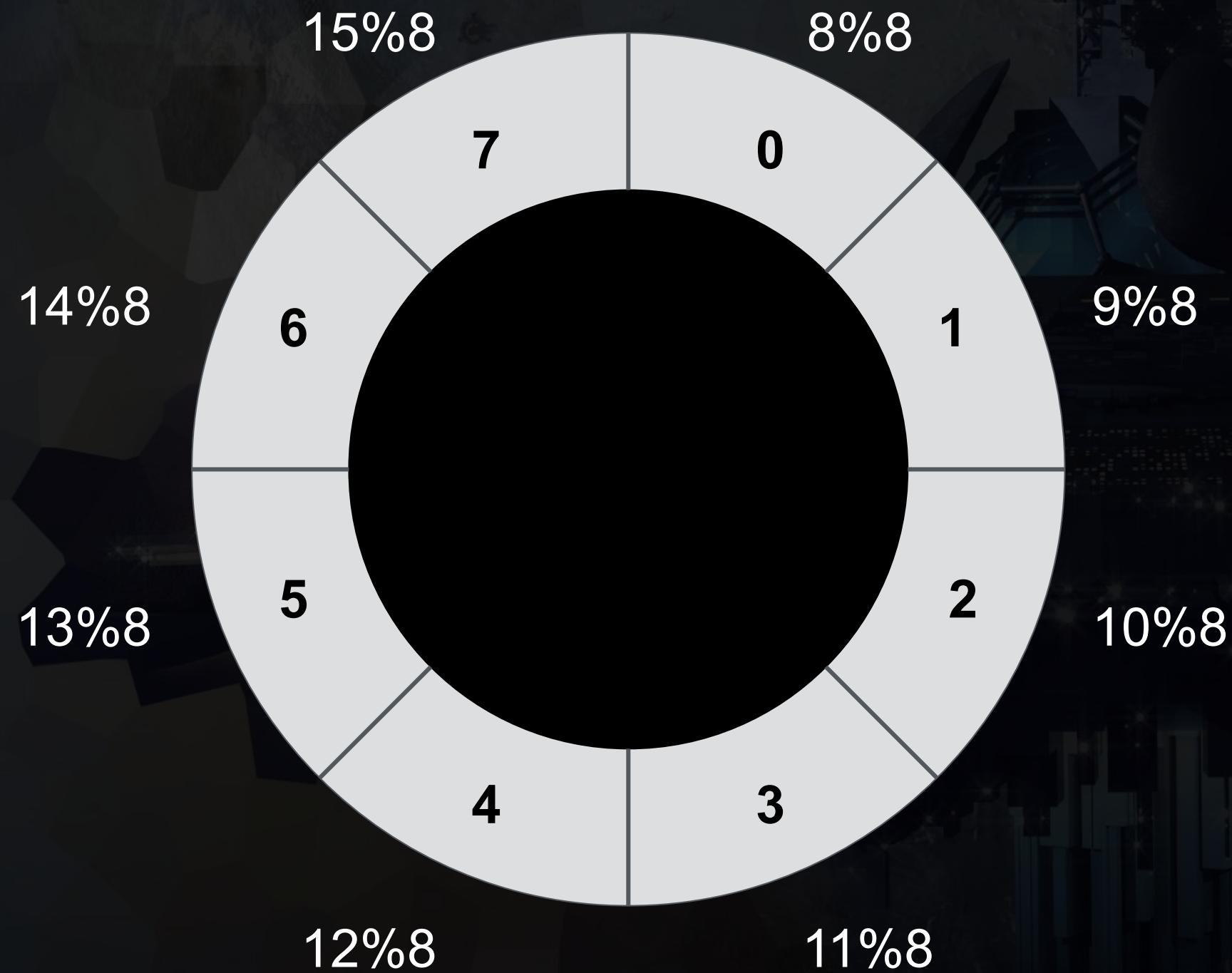
-

About the Modulus Operator

- The % operator is the **REMAINDER** of a division
- $1\%3 = 0 + 1/3$ so the modulus is 1
- $2\%3 = 0 + 2/3$ so the modulus is 2
- $3\%3 = 1 + 0/3$ so the modulus is 0
- $5\%3 = 1 + 2/3$ so the modulus is 2
- $7\%3 = 2 + 1/3$ so the modulus is 1



Using Modulus to Cycle



What's the bug in the closet?

- If we store the index value...
- Eventually it will go out of range (e.g at 2^{32})
- Usually this will cause the counter to “skip”
- Solution: just store the result.

Get the Cycling Working

- Write our final Blueprint function
- Use Set Blackboard Value as Int node
- Test the AI cycles between waypoints
- Celebrate, and share your solution.

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Performance Profiling 101

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In This Video...

- The first rule of performance: “profile first”
- Access profiler from Window > Developer Tools
- Choose Session Front End
- Select your running game session
- Choose Profiler tab, and hit Data Preview
- Search for your function and double-click.



Calculate Your Max Load

- Estimate max load **value** for each function
- Find the slowest of the 5 or 6 functions you find
- Share the **value** and your working on the forum
- Also include a screenshot of your profiler
- $\text{MaxLoad} = \text{Max}^* \text{ Calls \%}$.

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C++ AI Behaviour Tree Tasks

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How to Create C++ AI Tasks in Unreal

- Add “AI Module” and “GameplayTasks” to build
- Inherit C++ class from **UBTTaskNode**
- Override **ExecuteTask()**
- Return **EBTNodeResult::Succeeded;**
- Don’t try and extend in Blueprint
- Use Blueprint XOR C++ for a given task.



Reading Blackboard Data in C++

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In This Video...

- Expose a blackboard key selector in C++
- `#include`
`“BehaviorTree/BlackboardComponent.h”`
- `OwnerComp.GetBlackboardComponent()`
- Use `GetValueAsInt()` etc to get the value
- You can now access blackboard data in C++.

Get the Index

- Finish the line of code to get the index.

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The Consequences of Inheritance

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In This Video...

- We have coupled our AI ChooseNextWaypoint task to the Third Person Character.
- We have also specialised our Blueprint class with a variable, PatrolPoints.
- These dependencies are undesirable, but we will proceed with our conversion.



Create a PatrollingGuard Class

- Inherit from `TP_ThirdPersonCharacter`
- Add an array of Actor pointers variable
- Make it an appropriate `UPROPERTY`
- Re-parent your `ThirdPersonCharacter` Blueprint
- Check you can assign to this new C++ variable
- NOTE: This is bad practice, as we'll see later.

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Converting Blueprint to C++

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In This Video...

- `OwnerComp.GetAIOwner()` to get AI Controller
- If you're casting, you're probably coupling
- Use `.Num()` to get number of elements in `TArray`
- Use `TODO` for reminders, to help you FOCUS
- FOCUS = Follow One Course Until Successful.

Finish the C++ Patrolling

- Use `OwnerComp.GetAIOwner()` to get controller
- Use `#include` where necessary, but consciously
- Use the same algorithm as in Blueprint
- Test the patrolling works
- Clean-up unused Blueprint.

Composition over Inheritance

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In This Video...

- We created PatrollingGuard by inheritance
- How about if we want a patrolling tank?
- Another option is to use an actor component
- This is an age-old debate
- Let's get some real-world experience of the two
- Convert to a component model.



Create PatrolRoute Component

- Create an Actor Component
- Move the **PatrolPoints** array to the component
- Add the new component to the guard's BP
- Get the patrol points from the component
- Don't bother deleting the **PatrollingGuard** class.

How to Delete a C++ Class

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In This Video...

- Yes it should be easier than this, tell Epic!
- How to remove CPP files from browser in Unreal
- The process for deleting C++ classes.

Remove PatrollingGuard Class

- Close Unreal and Visual Studio
- Remove .cpp and .h files from your disk (not in VS)
- Clear derived files (`git -x -d -i` if committed)
- Generate the Visual Studio project files
- Re-open Unreal!

Instanced Materials

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In This Video...

- Also called Material Instances
- These allow modification with little overhead
- How to create an instanced material.

Colour the Other Guard

- Create another material instance
- Check the Reference Viewer
- Set it a different colour
- Apply to a 2nd guard
- Bonus: Add a new parameter and tweak
- Share your creations with us!



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Introducing AI Perception

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In This Video...

- Use AI Perception, it's newer than Pawn Sensing
- How to add AI Perception to your controller
- Use the apostrophe key ' to enable AI debug
- Remember Shift + F1, F8, F11 etc.



Tweak Your AI Perception Radius

- Practice visualising the AI
- Shift + F1 to get the mouse
- Use F11 for fullscreen
- Aim at AI with cross hair then...
- ...use apostrophe key ‘ for AI debug overlay.

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OnTargetPerceptionUpdated Event

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In This Video...

- Use the On Target Perception Updated event
- This reports the actor sensed
- And the class of the sense (e.g. sight, hearing)
- How to setup perception events.

Report Perception Events

- Wire the required blueprint
- Report in format “guard x <perception class> y”
- Crtl key makes hand icon, allows node dragging.

AI Hearing Perception in Unreal

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In This Video...

- Hearing is a sense that complements sight
- How to set up AI Perception hearing sense
- How to get hearing perception to trigger
- Making your actor create a noise.



Setup a Hearing Sense

- Add a 2nd sense to the AI controller
- Make this of type hearing
- Bonus: report hearing events*

**may require a web search, good practice.*

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The Animation Starter Pack

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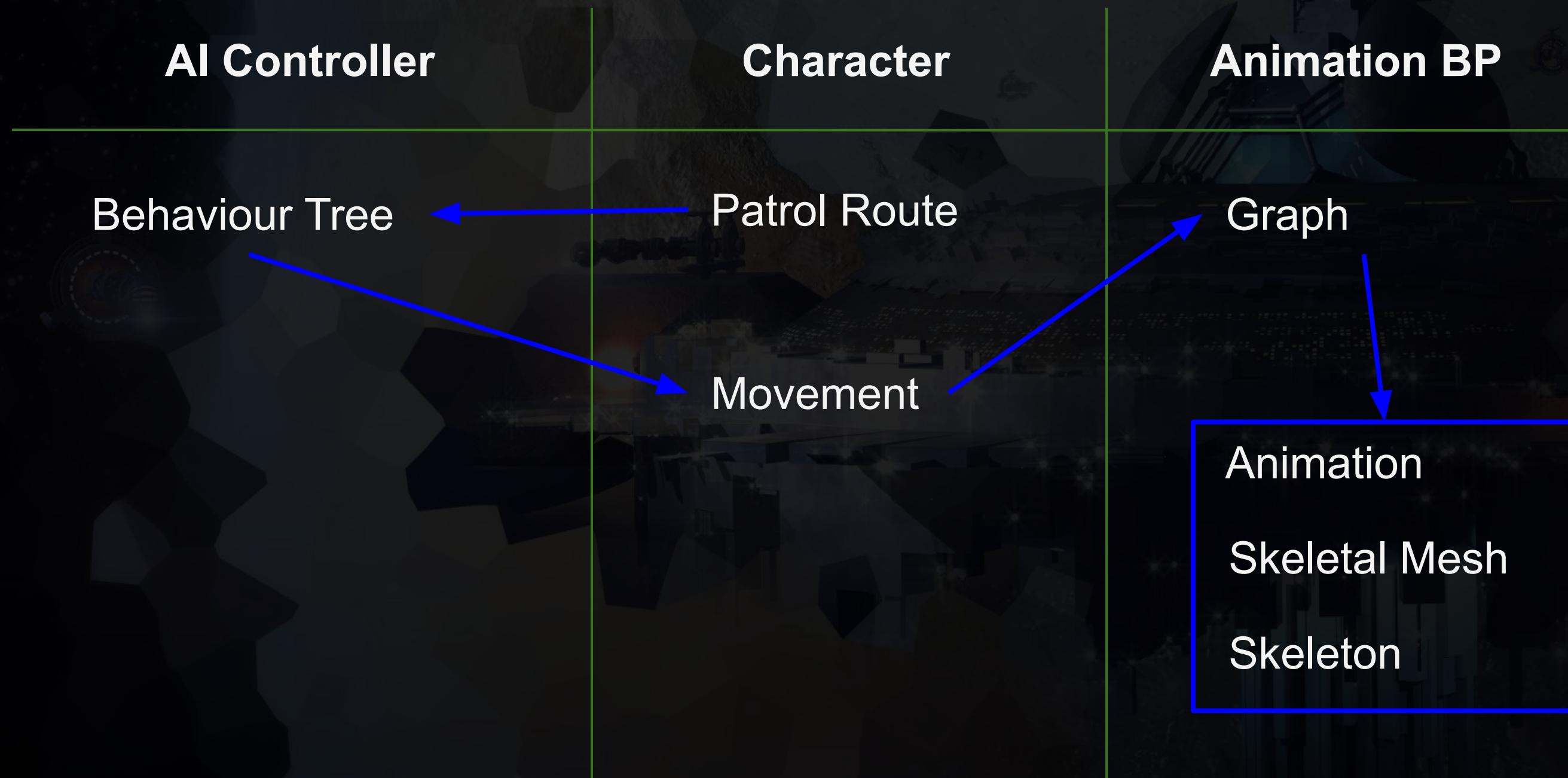


In This Video...

- The skeleton comprises the bones
- Over the skeleton lays a skeletal mesh
- Each vertex of the mesh connects to bone(s)
- The animation tells the bones how to move
- The bones tell the mesh how to move
- The Animation BP controls the animations.



Animation Sequence in Context



Import & Explore

- Claim Animation Starter Pack for free
- Add to Testing Grounds project
- Explore the Animation Sequences
- Commit and upload to Git LFS.

Changing a Character's Animation

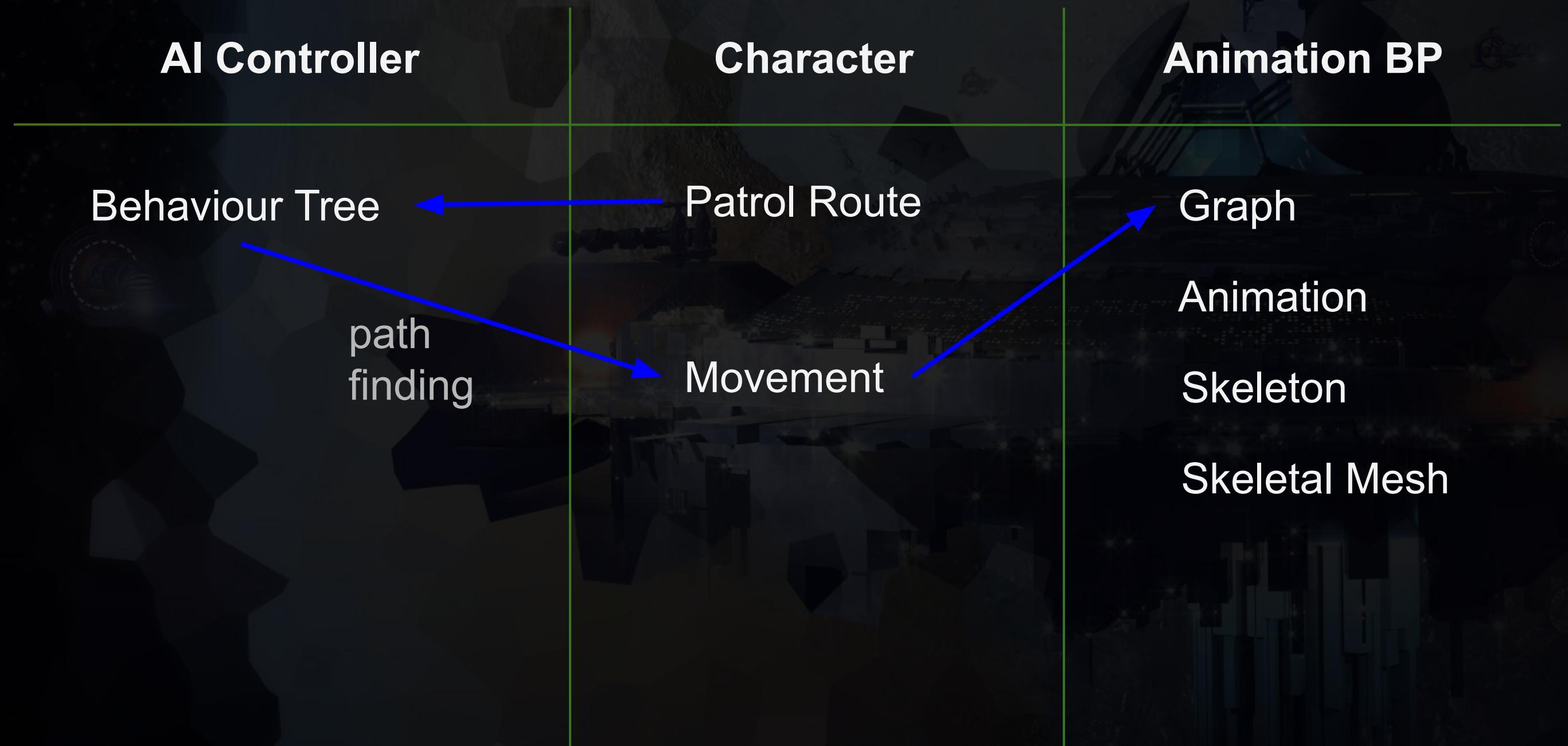
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In This Video...

- How to change a mesh's animation class
- Matching the animation's mesh to...
- ... the mesh selected on the character
- You can apply instance changes to blueprint
- However be careful what you take with you
- Solving “can't save... graph is linked” error.

Animation Sequence Revisited



Why isn't the character animating?

- Re-watch the previous video if required
- Think through the steps
- See if you can find the cause
- Test by making a small change (one setting)
- Let us know your thinking process
- Spend approx 20 mins on this I suggest.

Customising a Character Blueprint

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In This Video...

- You can start with a off-the-shelf blueprint
- We can then add our reusable components
- Another way of getting our desired character.

Create your new Blueprint

- Ensure your ASP based guard works
- Make sure you feel happy with why
- Save your & close your project.

Sub Behaviour Trees

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In This Video...

- Behaviour trees can get complex
- We want to keep a consistent level of abstraction
- Behaviour trees can run “sub” trees
- This helps us organise our project.



Make some Interesting Behaviour

- Play with sub-behaviour trees
- Share your top-level, and one or two next level
- Optionally share a short video or animated GIF
- Have fun, get creative.

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Talking Head - Introducing Sam

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In This Video...

- Congratulations on getting this far in the course.
- Recapping the AI work we have done so far.
- Introducing the new instructor for the section:
Sam.



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Refactoring Superpowers

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In This Video...

- Why refactoring is so important.
- Refactor skills give you the edge.
- What's coming up in the next lectures.

Target Structure

- Levels
 - Level_1...
- NPC
 - Animations
 - Character
 - AI
- Player
- Geometry
- Weapons



Clean-up Your Folders

- Check references, or delete and read warning
- “Fix-up redirectors” if you’re having issues
- Create a folder structure that makes sense to you
- Remember you can filter by type
- So you may as well add some other value
- I suggest something similar to Epic’s structure.

Changes Sam Made - Part 1

Remember you can show redirectors with Content Browser > Filters > Other Filters > Show Redirectors.

1. Make new **Levels** folder in Unreal (in this case it overlaps with the filter options)
2. Move **FirstPersonExampleMap** from **FirstPersonCPP/Maps** to **Levels**
3. Delete any other maps from the **FirstPersonCPP/Maps** folder
4. Delete the **FirstPersonCPP/Maps** folder in Unreal & your file system
5. Create **Trash** folder in **Unreal**
6. Move **ThirdPersonCPP/Blueprints/PatrollingGuard** to **Trash** folder
7. Fix-up redirectors and delete **ThirdPersonCPP** folder, & in your file system
8. Move all meshes from **ThirdPerson/Meshes** to **Geometry/Meshes**
9. Delete **ThirdPerson** folder in Unreal, and in file system
10. Move **Mannequin** folder into **Trash** folder
11. Create **FirstPerson/Behaviour** folder

Continued on next slide...



Changes Sam Made - Part 2

12. Move blueprints from **FirstPersonCPP/Blueprints** to **FirstPerson/Behaviour**
13. Fix-up redirectors & delete **FirstPersonCPP** in Unreal and file system
14. Rename **FirstPerson** folder to Player
15. Delete **FirstPerson** folder in file system
16. Create new **NPC** folder, and **NPC/AI** sub-folder
17. Move all files from **Blueprints** to **NPC/AI** (remember to fix-up redirectors)
18. Delete **Blueprints** folder in Unreal and on disc
19. Create **NPC/Animations** folder
20. Move all *animations* from **AnimStarterPack** to **NPC/Animations****
21. **Create NPC/Character** folder and move **AnimStarterPack/Ue4ASP_Character** into it
22. Move the **Showcase** level to **Trash**

* if you have a problem with this stage, try quitting all Unreal Engine tasks in your OS, or rebooting

** leave the *Ue4ASP_Character* and the *Showcase* level (if you still have it)

Continued on next slide...

Changes Sam Made - Part 3

23. Move all three folders in **AnimStarterPack/UE4_Mannequin** to **NPC/Character**
24. Fix-up redirectors and delete **AnimStarterPack** in Unreal, and on disc
25. Create **Weapons** folder, and move **Player>FPWeapon** into it
26. Delete **Player/FPWeapon** in file system
27. Also in the file system delete the following in Content: Mannequin, Collections, Developers

Renaming & Moving CPP

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In This Video...

- Renaming CPP files.
- How to deal with renaming blueprint parents.
- Refactor class names in CPP.
- Updating **.generated.h** files.



CPP Refactor Process

1. Are any blueprints based of this?
2. If so, copy outside our directory while renaming.
3. Rename/move the file.
4. Find and replace the file path.
5. Find and replace the class name.
6. Copy back, reparent, delete.



Reorganise Your CPP

- Make the structure match your contents.
- Watch out for dependencies in blueprint.
- Make sure you regenerate your project files.
- Try to debug your own error messages.

Solution: Renaming & Moving CPP

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In This Video...

- Repeating the renaming process.
- Finishing our refactor.
- Fixing CDO Constructor errors.

The background of the slide features a futuristic space station with a large satellite dish and a smaller ship docked at a port. The station is set against a dark, star-filled background with a hexagonal grid pattern.

Holding a Gun with Skeletal Sockets

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In This Video...

- Reading existing source code for hints.
- Creating a socket on a skeletal mesh.
- Parenting a gun to that socket.
- Removing unused assets.



Copy The FirstPersonCharacter

- Read the constructor and BeginPlay.
- Can you see how the gun is set up?
- What does this tell us about the skeleton?
- Can you replicate the setup on the 3rd person?



Understanding Animation Blueprints

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In This Video...

- The major components.
- How to preview animations.
- Definition of an animation and pose.
- Understanding the AnimGraph.
- Playing a custom animation.



Dance Monkey Dance!

- Play an animation in the preview.
- Use only the AnimGraph to achieve this.
- HINT: Try dragging from the animation pane.



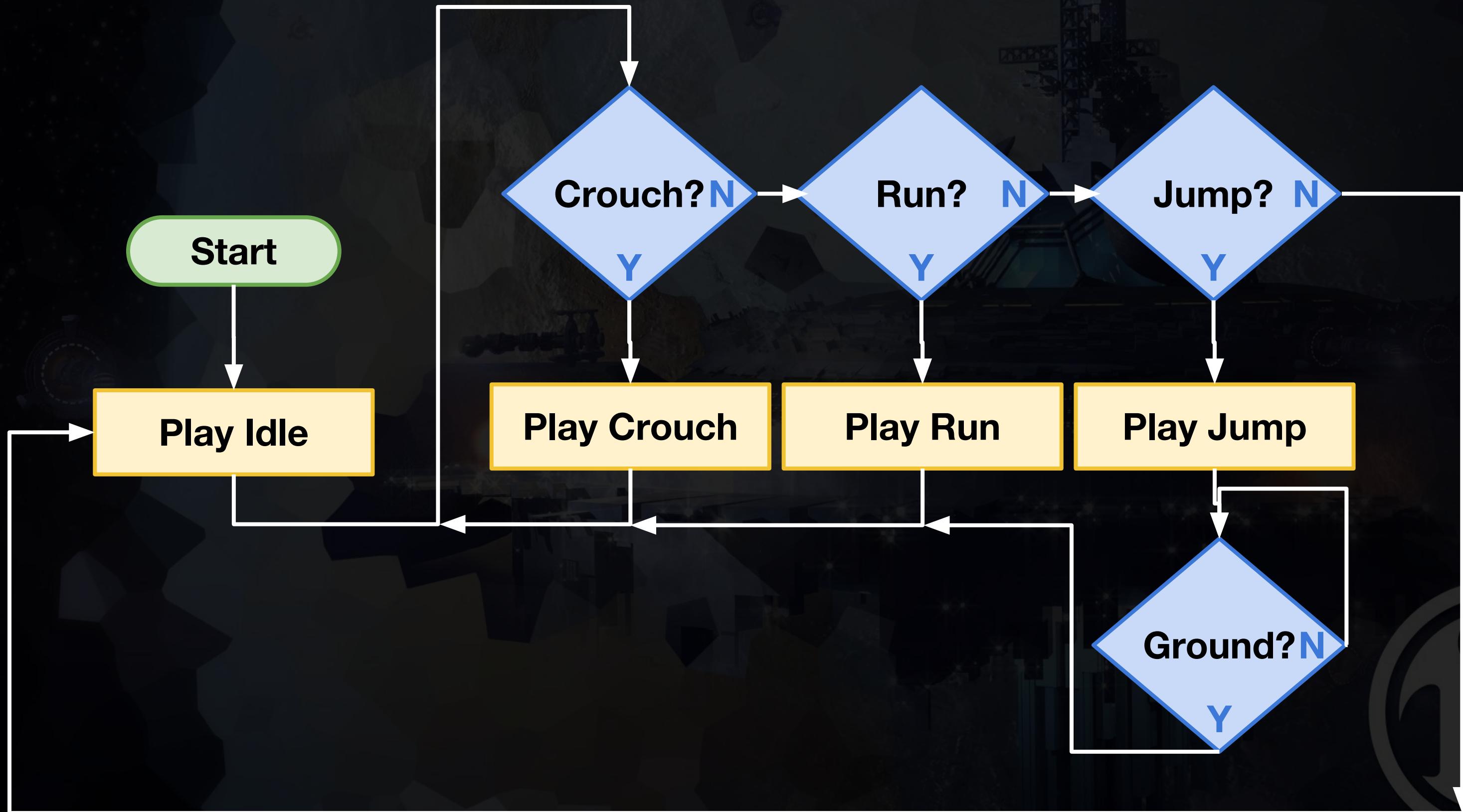
Creating Animation State Machines

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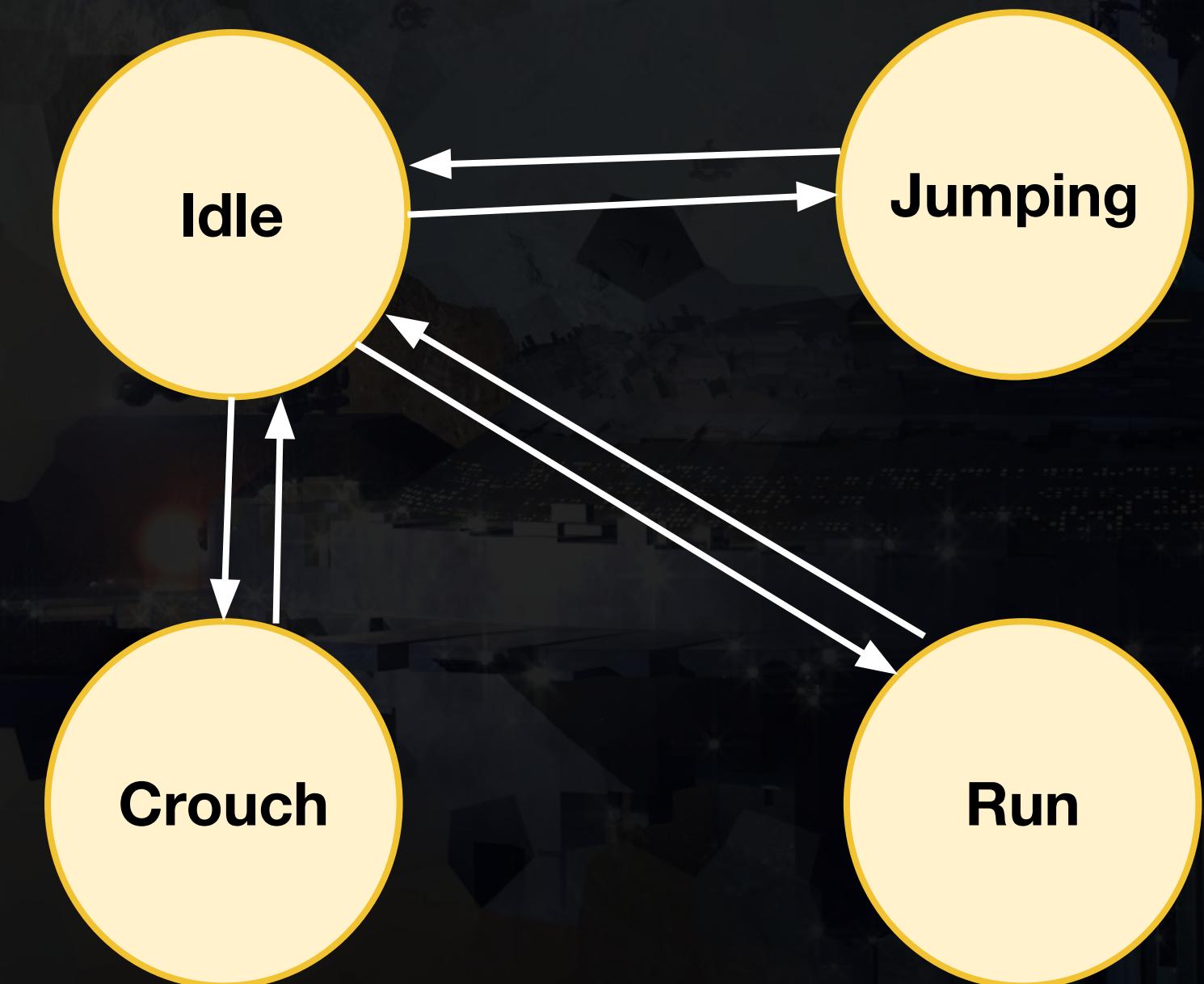


In This Video...

- Why state machines?
- What are state machines?
- What's inside a UE4 state?
- How to add transitions.
- Adding a shooting state.



A State Machine



Add a shooting state

- Use the iron-sight shooting animation.
- Create a new state from idle.
- Add a boolean to trigger shooting.
- Set the transition conditions.
- Does it work?

Movement Blend Spaces

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In This Video...

- What is a blend space?
- How to create a movement blend space.
- Examining the existing Jog blend space.
- Replicating for Ironsights.



Replicate the Jog Blend Space

- What are the axes?
- Position the animations correctly.
- Test in the scene.
- Does it look right in all directions.

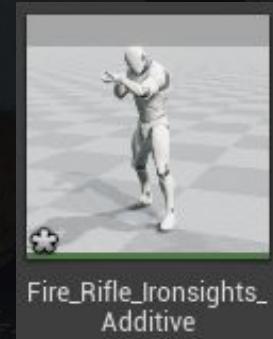
Offset Animations

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In This Video...

- Creating an offset animation.
- Applying an offset to a base.
- Conditional blend nodes.



Base



Mesh-space



Bone-local



Create Other Offsets

- Make a down and centre offset.
- Use a conditional node to choose.
- Make the variable that controls it a float.
- When float < -45 should look down.
- When > 45 should look up.
- Otherwise look in the middle.

Aiming Blend Spaces Offsets

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In This Video...

- Aim offset assets.
- 1D vs 2D Aim offsets.
- Editing an existing animation sequence.

Create the Aim Offset

- Add the offsets into the aim graph.
- Check the preview.
- Try to add to the animation blueprint.
- Can you figure out how?

Rotating with `SetFocalPoint()`

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In This Video...

- Revising Behaviour Tree tasks.
- Making our character face us.
- Using **AIController's SetFocalPoint()**

Create a FocusAtPoint Task

- Any sensible name.
- Public blackboard key for point.
- Should set the AI focus.
- Then action should finish.
- Test it by setting a location in the blackboard.

Character Movement vs Rotation

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In This Video...

- More code reading.
- Jumping between files in Visual Studio.
- Difference between movement and rotation.
- Mapping out complex systems.



Character Rotation

Behaviour Tree

AIController

Input

Focus on
point

Move mouse

Controller

PlayerCtrlr

FPCharacter

Update
rotation

Add yaw
(via Pawn)

Update
rotation

Get desired rotation

UCharMC

Get control
rotation

Animation BP

Map out the Character Movement

- Start from **Behaviour** tree.
- Where does it lead?
- Also try working back from the **Animation BP**
- Can you find where they meet?
- What about starting from **Input**?

Character Movement

Behaviour Tree

AIController

Input

Forward key pressed

FPCCharacter

Move to point

Move to point

UCharMC

UPawnMC

UNavMC

Set Velocity

Run in direction

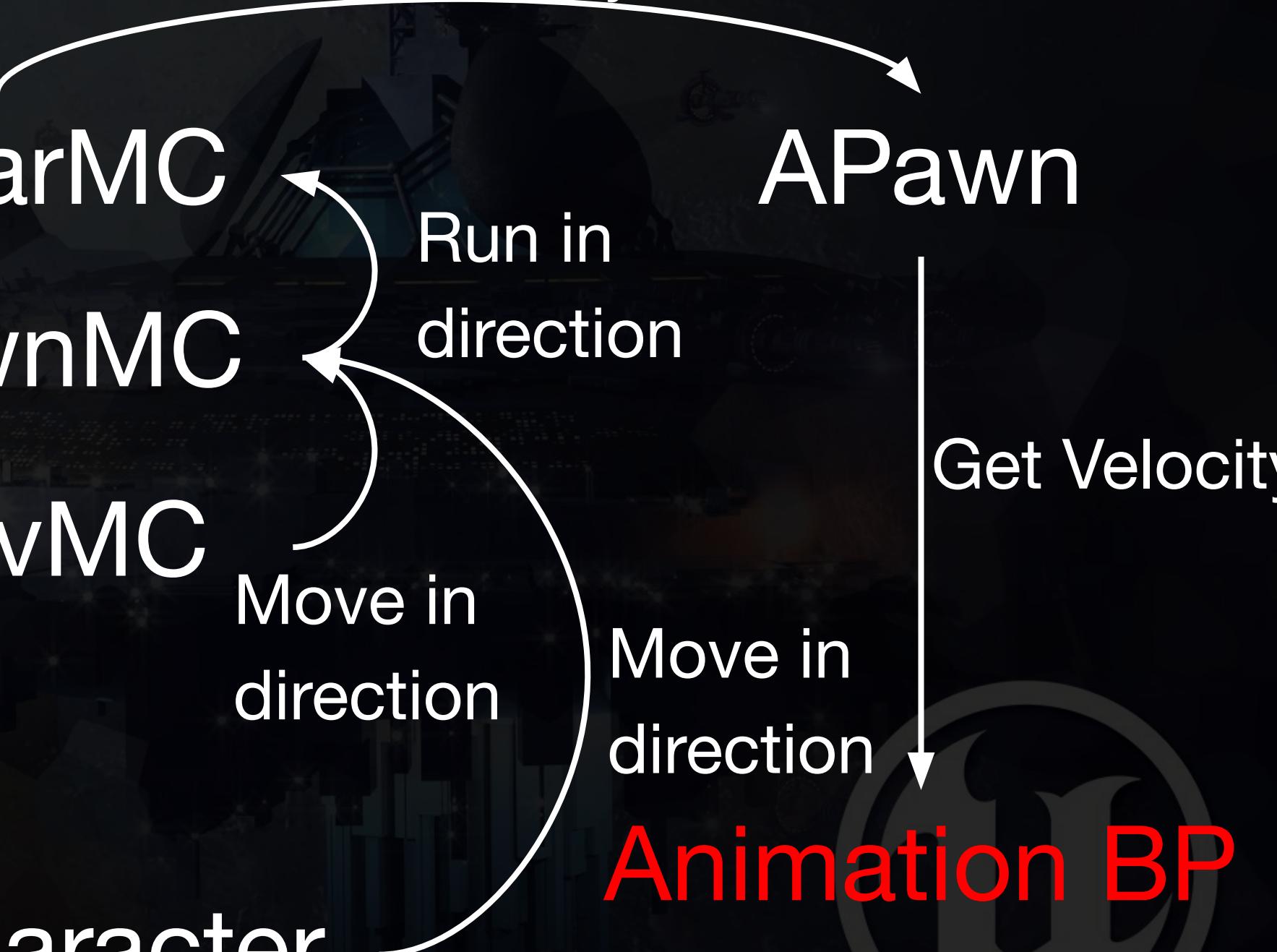
Move in direction

APawn

Get Velocity

Animation BP

Move in direction



4.13.1

Control Rotation for Aim

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In This Video...

- Getting the control rotation.
- Focus Actor vs Focal Point
- Splitting rotators and setting pitch.
- Controlling Animation BP properties.



Focus on Actor Instead of Point

- Get the correct type in FocusAtActor.
- Change the blackboard property.
- Set the correct type in AIController.
- Why do we need to focus on actor?

Behaviour Tree Decorators

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In This Video...

- Creating a decorator.
- Sequence vs Select nodes.
- Aborting decorators early.
- Clearing blackboard keys from blueprint.
- Patrolling, agro and following.

Set and Clear Enemy

- Update the AI Blueprint.
- When enemy sensed, set Enemy.
- When enemy lost, clear Enemy.
- Try splitting the stimulus to help.
- Are there any problems with the behaviour?

Behaviour Tree Services

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In This Video...

- Using decorators vs services.
- Creating a service.
- Deeper into behaviour tree states.
- How to implement suspicion.
- Giving our character breathing space.
- Comparing BP Validity and NULL.



Create a Suspicion Behaviour

- Use a new blackboard variable.
- E.g. `LastSeenLocation`.
- Set with a service.
- Then set move to that location.
- Unset when visited.
- Any tweaks to make it more natural?

Tweaking AI Behaviour

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In This Video...

- Preventing Behaviour Tree flicker.
- Creating mutually exclusive states.

Make All States Mutually Exclusive

- Enemy should give us breathing space.
- Shouldn't be suspicious if can chase.
- Shouldn't chase if we are already close.

Debugging AI Behaviour

Twitter @GameDevTV :: Web community.GameDev.tv



In This Video...

- Viewing behaviour while playing.
- Using tags on Actors.
- Revising interrupting tasks.
- Adding in multiple actors.

Debug Two Enemies

- Put two enemies in the scene.
- Observe the behaviour.
- What happens?
- Can you think of a fix?

Refactoring to a Gun Actor

Twitter @GameDevTV :: Web community.GameDev.tv



In This Video...

- Create a Gun actor.
- Move the firing code over.
- Revising refactoring.

Do the Refactor

- Create an new C++ class.
- Move the default sub objects over.
- Move the `OnFire()` code.
- What else needs to move for this to work?
- It won't work but make it compile.

Attaching Actors to Components

Twitter @GameDevTV :: Web community.GameDev.tv



In This Video...

- Revise spawning child actors.
- Attaching actors to sub-components.
- Attachment rule to sockets.

Spawn and Attach

- Create a variable for the gun blueprint.
- Spawn an instance of this.
- Attach the instance to the grip socket.
- What else needs connecting?

Configuring the Gun

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In This Video...

- Playing montage animations.
- Connecting to actors in code.
- Finishing our refactor.

Finish Connecting

- Can you make the gun fire again?
- Do they fire in the right direction?
- Make the projectiles smaller.



Moving Files from LFS to Git

Twitter @GameDevTV :: Web community.GameDev.tv



In This Video...

- The pros and cons of LFS.
- How to move files from LFS.
- Tracking folder instead of extensions.
- Where tracking happens.

How to Remove from LFS

- Edit tracked files.
- `git rm --cached -r .`
- `git add .`

Re-track Your Files

- Move everything into a static folder.
- Leave one blueprint out.
- Edit tracking.
- `git lfs track Content/Static`
- `git rm --cached -r .`
- `git add .`

To LFS or Not to LFS?

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In This Video...

- The pros and cons of LFS.
- Organising your project for clarity.
- How to deal with **.umap** assets.

Re-organise Your Project

- Investigate each sub folder.
- Which assets are you likely to change?
- Are they an acceptable size?
- Move them into the two folders.
- Ensure you clean up on disk too.
- Update the git index.

Child Actor Components

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In This Video...

- Previewing the gun with the skeleton.
- Positioning the gun.
- Child actors with Blueprint.
- Using Child Actor Components.

Add a Gun to the AI

- Use a Child Actor component.
- Make sure it's visible in game.
- Position the gun correctly.

Introduction to Inverse Kinematics

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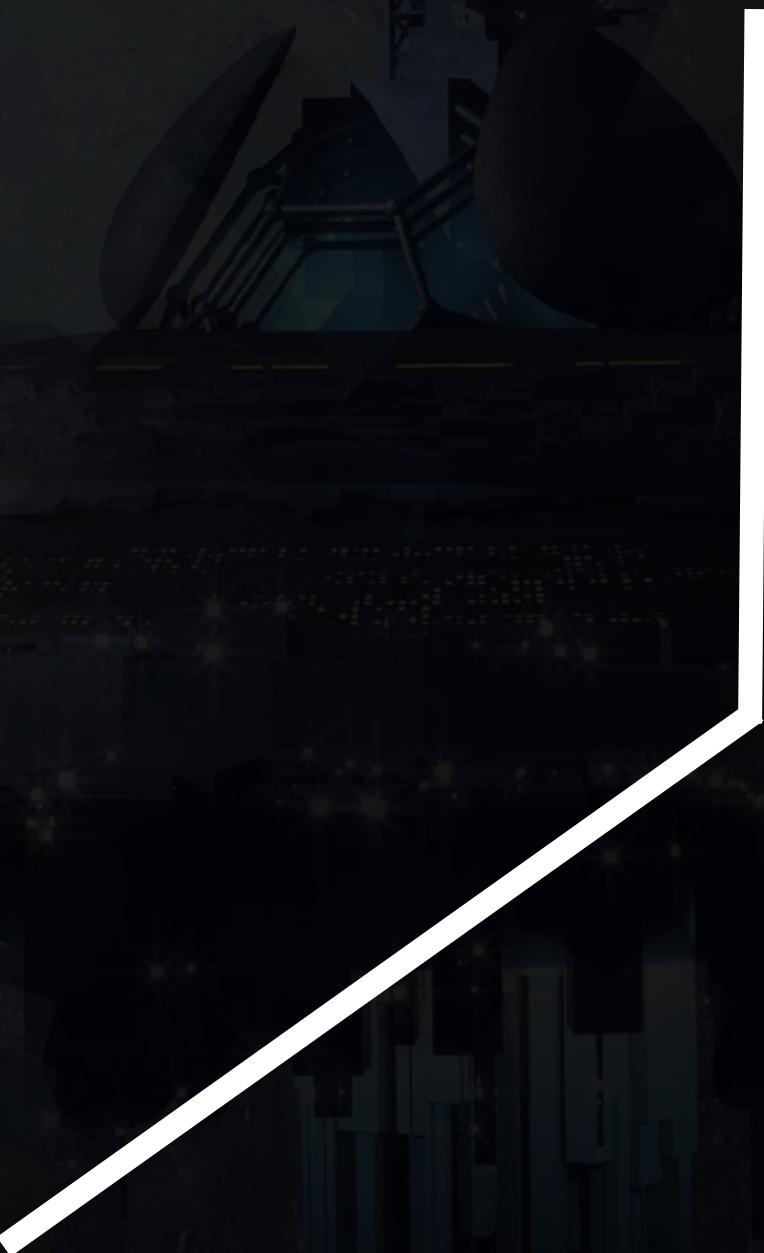
In This Video...

- Local vs component-space poses.
- Understanding bone-space.
- The principles of IK.
- End effectors and Joint targets.
- Mapping to the Two Bone IK node.



IK Fundamentals

X



IK Fundamentals

X

End Effector

IK Fundamentals



Joint Target



How Does It Map?

- Create a Two Bone IK node
- Take a look at the properties.
- Can you guess which properties map to which?



Inverse Kinematics with Animations

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In This Video...

- Using the Two Bone IK node.
- Effectors vs Joint targets

Set-up the AI IK

- Create the Two Bone IK.
- Link the main bone.
- Set up the relative effector and joint.

4.13.2^z

Comparing Blueprints with Diffs

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In This Video...

- Using UE4 built-in version control.
- Diffing blueprints.
- LFS vs Git assets in editor.

What Changes Can You Find?

- Dig through the commits.
- What cool looking diffs can you find?
- Share with the community.
- What happens to LFS assets?
- How could you diff them?



4.13.2^z

Boolean Blending for Aim States

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In This Video...

- Boolean blending in Unreal.
- Setting variables in animation BP.
- Making the AI aim.

Connect to Focus

- Complete the **Jogging** state.
- Set a variable in the character.
- Pull that in the animation.
- Set when focus is set.

Adding Firing Animations

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In This Video...

- When to use additive identities.
- Blending additive animations.
- Creating an additive firing animation.
- Controlling firing from the AI.



Make an Additive Fire

- Make a copy of the fire animation.
- Change it to being additive.
- Plug in to the conditional.
- Connect up to the AI.

A collage of various video game screenshots, including a city at night, a futuristic station, and a space station.

4.13.2^z

Animation Notify Events

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In This Video...

- Synchronising sound and animation.
- Creating custom notify events.
- Hooking up our gun trigger to AI.

Hook up the Event

- Create a fire notify.
- Expose the gun function to BP.
- Create a Fire function in the character.

4.13.2^z

Taking Damage in Blueprint

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In This Video...

- Applying damage from a projectile.
- Taking damage in a BP character.
- Detaching a controller from a Pawn.

Create the Damage System

- Apply damage on hit.
- Update health in the character BP.
- When dead, detach from the controller.

4.13.2^z

Death Animations and Refactors

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In This Video...

- Revision of BP refactoring.
- Making our Animation BP clean.
- Death animations on the AI.

Refactor the Animation BP!

- Replicate the death animation.
- Sort out our event graph.
- Abstract into functions.
- Abstract repeated or shared code.

4.13.2^z

Switching 1st and 3rd Person

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In This Video...

- Swapping out a 1st to 3rd person character.
- Wrapping rotations.

Debug and Fix Rotation

- Use some print statement.
- What's happening?
- Can you create an elegant fix?

A collage of various video game screenshots showing futuristic landscapes, structures, and vehicles. The images include a large industrial complex with a tall tower, a futuristic city at night, a massive satellite dish, and several small flying vehicles. The overall theme is a blend of science fiction and advanced technology.

4.13.2^z

Owner Invisible Meshes

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In This Video...

- Own See vs Owner no see meshes.
- Why 1st person Meshes.
- Hooking up Fire input in TPCharacter.

Enable Firing

- Handle the fire input in TPCharacter.
- What should this do?
- Make sure the animation works too.

A collage of various video game scenes, including a city at night, a futuristic station, and a space station, set against a dark background with geometric shapes.

4.13.2^z

Separating Firing from Gun Meshes

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In This Video...

- Why we need two gun meshes.
- Creating Blueprint components.
- Scene components vs Actor components.
- Camera rotation with control rotation.

Create a Firing BP Component

- Use a scene component to have a transform.
- Just a fire method.
- Use it to spawn a projectile.
- Set the transform from the components location.
- Position and test.

4.13.2^z

Aiming Our 1st Person Camera

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In This Video...

- Local vs Global rotation.
- UE4 optimizations for unpossessed characters.

Make The Camera Rotate On Tick

- Update the camera pitch.
- Should you use local or global?

4.13.2^z

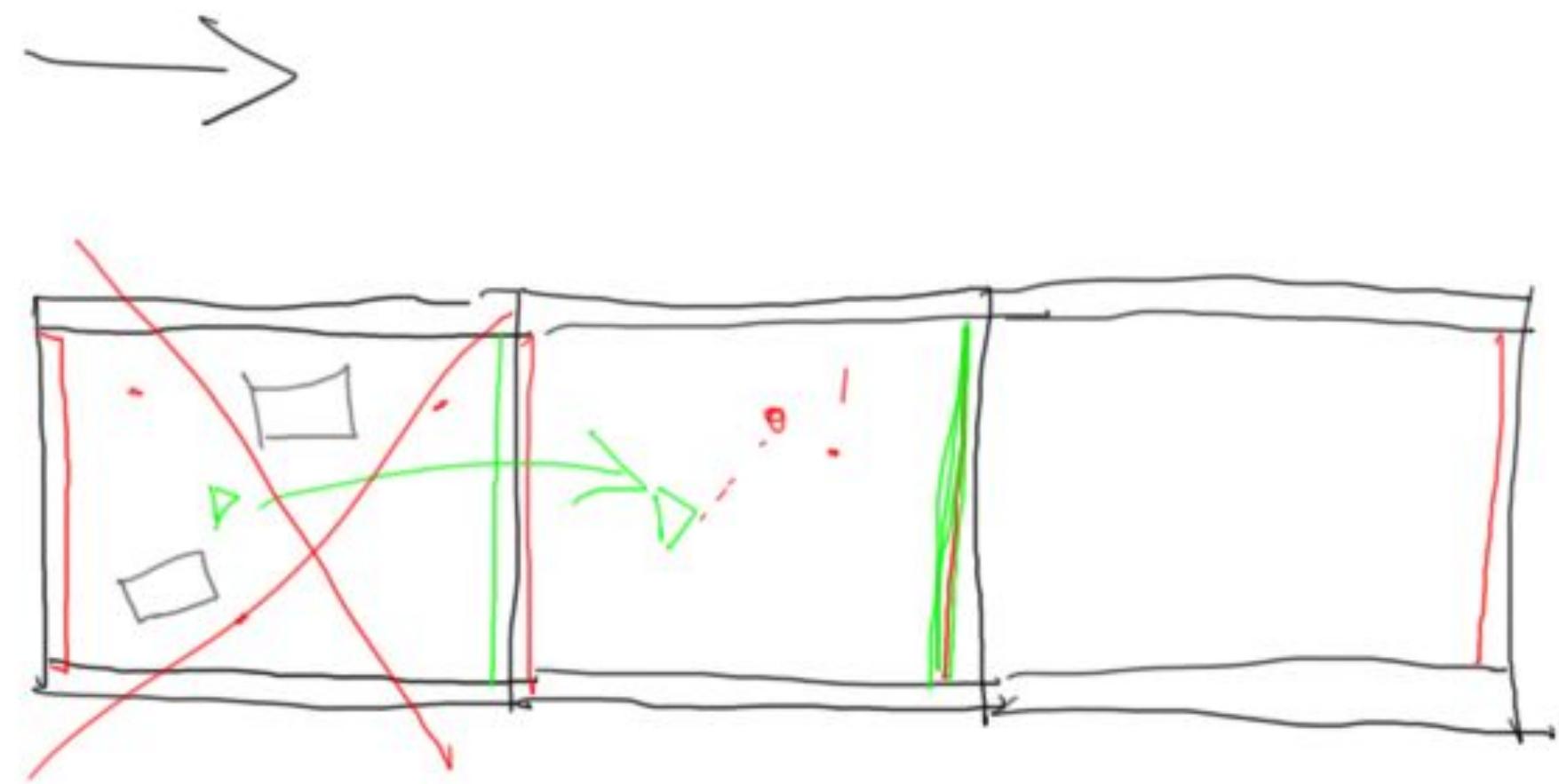
Architecture of Infinite Runners

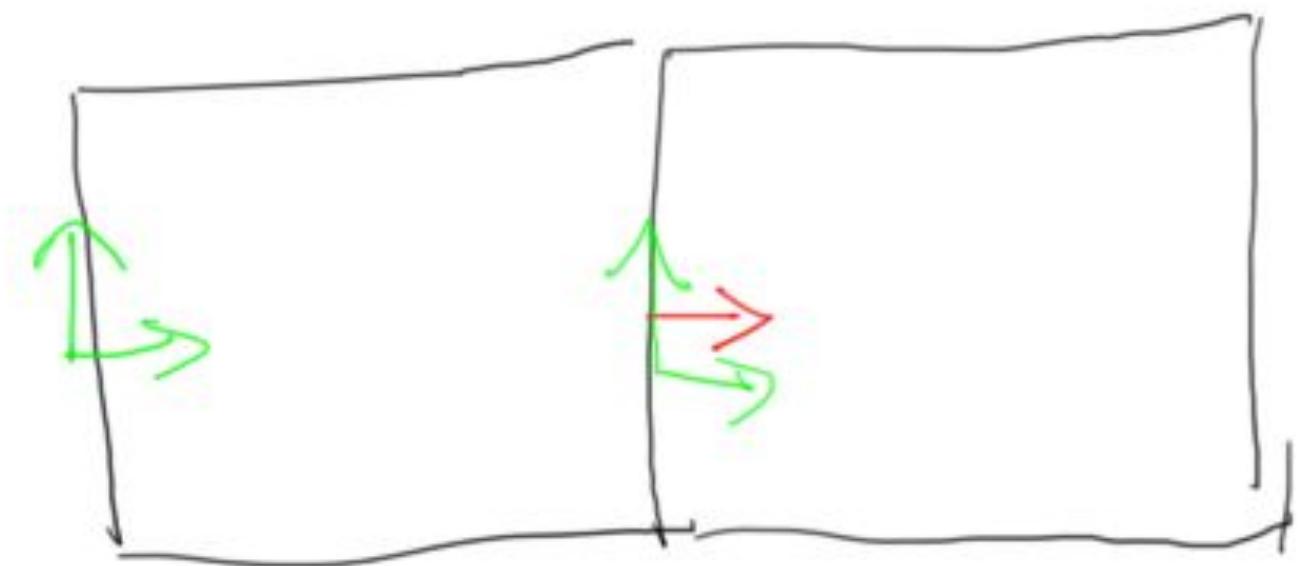
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In This Video...

- Using the Arrow component.
- How to architect an infinite runner.
- Overview of how we want our levels to work.





Hile RP

Create the Tile BP

- Use the existing terrain to start.
- Add an arrow for the attach point.
- Add a function for getting the attach location.
- Ensure the centre of the tile is at the left edge.

4.13.2^z

Spawning Terrain in the GameMode

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In This Video...

- GameMode BP vs Level BP
- Creating a blueprint GameMode
- How to spawn tiled terrain.
- Using a blueprint for-loop.

Spawn a Series of Tiles

- Create a variable for the transform.
- Set an initial transform.
- Update the transform after spawning.
- Refactor your code.

4.13.2^z

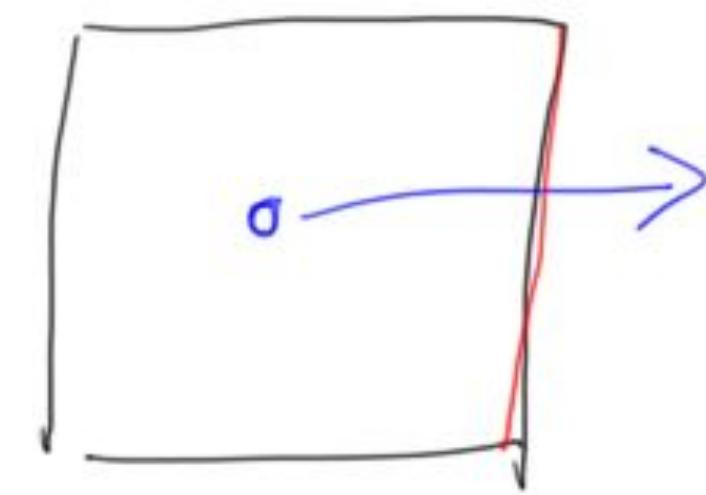
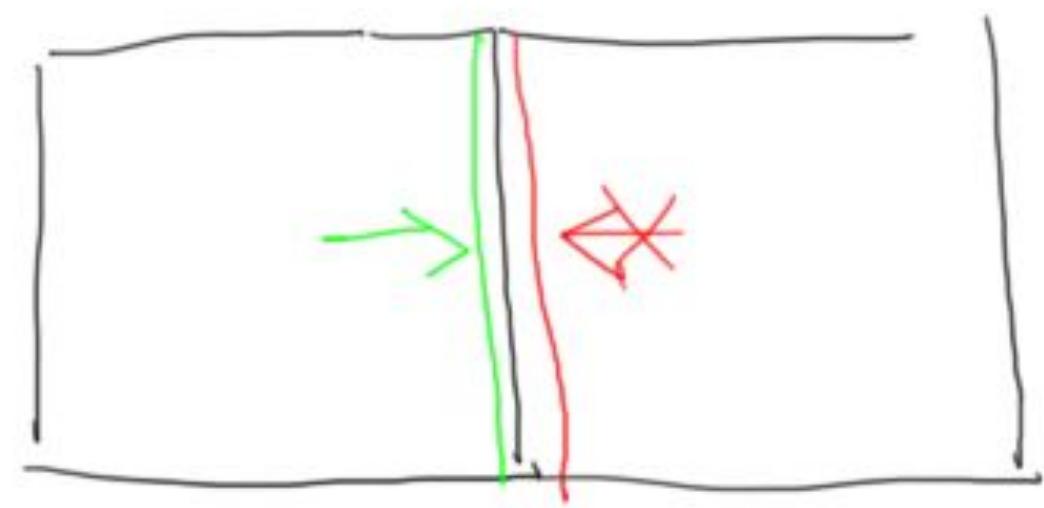
Level Gating for Testing Grounds

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In This Video...

- Why we need level gating.
- Our approach to gating.
- Enabling/disabling collisions.



Lock on Exit

- Create a new locking function.
- Create a collision box component.
- When leaving box, lock the level.

Swapping Materials in Blueprint

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In This Video...

- Creating material instances.
- Exposing material parameters.
- Swapping materials in blueprint.
- Adding affordance to our barriers.

Red and Green Barriers

- Create two material instances.
- Setup the correct opacity and colour.
- Replace the materials on lock and unlock.

4.13.2^z

Garbage Collecting Previous Tiles

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In This Video...

- When to delete previous tiles.
- How to get hold of the Game Mode.
- Spawning new tiles when needed.
- Keeping the minimal tiles in memory.



Garbage Collect Old Tiles

- Create a new collision volume.
- Position it appropriately.
- Destroy when entered.

Merging Our TP and FP Files

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In This Video...

- Fix camera glitch while strafing.
- Merge the NPC and Player folders.
- Revise redirectors.
- Revise folder movement and deletion.

Merge the Hierarchies

- Try deleting Player folder.
- Move the dependencies into the NPC hierarchy.
- Repeat.
- Rename TP_ names in NPC.
- Rename NPC folder.

4.13.2^z

Hit vs Overlap Events

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In This Video...

- Debug a projectile spawn issue.
- Overview the collision system.
- Understand hit and overlap notifications.
- Review different Collision Presets



What is Destroying Projectiles?

- Put more logging.
- Which actor is causing the hit?
- Why?
- Can you fix it?

4.13.2^z

Dynamically Calculating NavMesh

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In This Video...

- NavMesh and procedural terrain.
- Dynamic NavMesh generation.
- When LFS shouldn't be used.

Enable Dynamic NavMesh

- Edit > Project Settings > Engine >
- Navigation Mesh > Runtime > Runtime Generation
- Put a tile in the world for reference.
- Align everything else to it.

4.13.2^z



Keep It Simple, Stupid!

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In This Video...

- Make the player tough for testing.
- Deeply understand the AI system.
- When is code too complex to debug?
- Write high level pseudo code.

Write Self-explanatory Pseudocode

1. Read through the current NPC_AI.
2. Get an understanding of what's happening.
3. Re-write it as you would explain it.
4. Does the blueprint read like this?

Parallel Behaviour Tree Tasks

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In This Video...

- Parallel actions in Behaviour Trees.
- Pseudocode-lead refactoring.
- Aborting lower priority with decorators.
- Organising conditional Behaviour Trees.

Refactor to Pseudocode

- Reorganise the tree.
- Create decorators, services and tasks.
- Don't worry about implementation.
- Repeat until it reads like pseudocode.

Custom BT Tasks and Decorators

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In This Video...

- Implementing a conditional decorator
- Custom task nodes
- **Implement the Task and Decorator**
- Clean up when task node is aborted.

Implement the Task and Decorator

- Implement Receive Execute AI.
- Move the code over from NPC_AI_BP.
- Also Receive Abort AI.
- Make a decorator for distance checking.

4.15.0^z

External Build Data in 4.14+

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In This Video...

- Updating to 4.15.0
- Storing build data outside of .umaps.

Upgrade Your Own Project

- Commit after the upgrade.
- Playtest your game.
- Report any changes you find.

A collage of various video game scenes, including a city at night, a futuristic station, and a space station, set against a dark background with geometric shapes.

4.15.0^z

Physical Gun Architecture

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In This Video...

- Renaming to style guide
- Problems of our existing architecture
- Improved gun-centric architecture
- Challenge: reinstating the gun actor.

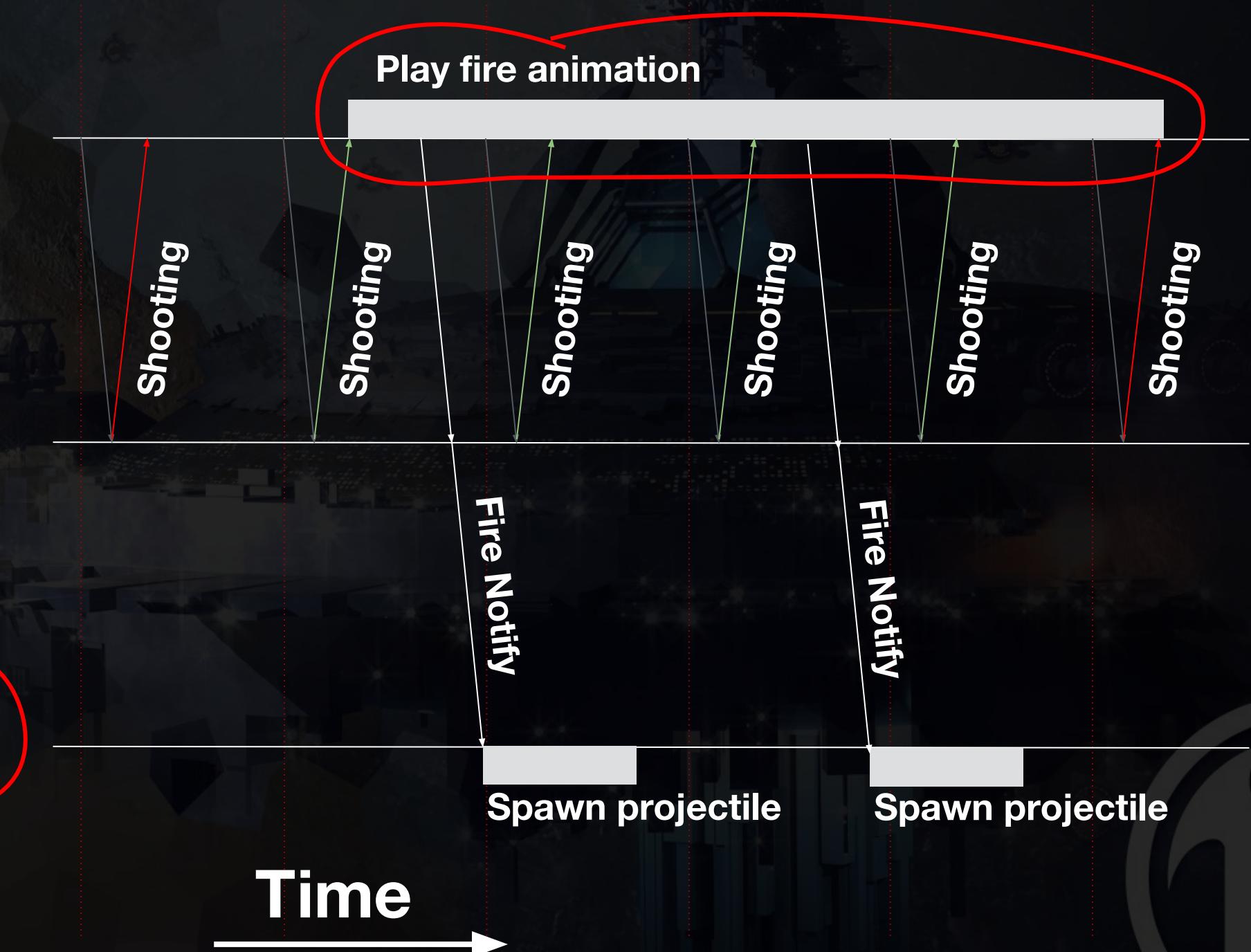


Gun Animation Architecture

ABP_TP

BP_Character

BP_FireComponent

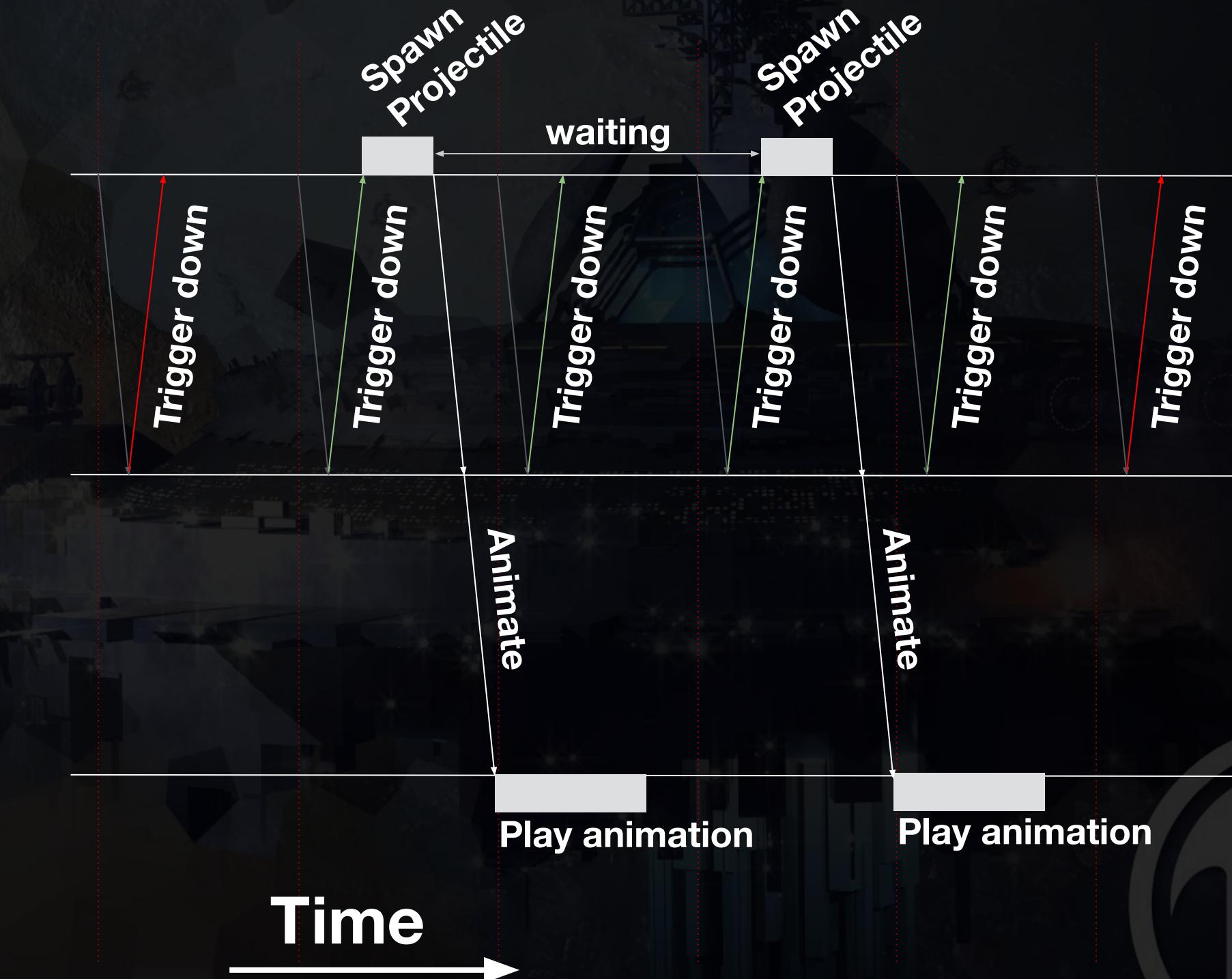


Improved Architecture

BP_Gun

BP_Character

Mesh



Reinstate the Gun Actor

- Only needs to be childed to FP_Arms
- FireComponent should be removed
- Both AI and Player should be able to shoot.

4.15.0^z

Converting a Character BP to C++

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In This Video...

- Creating and reparenting a character
- Challenge: Converting the component hierarchy
- Reviewing my **Mannequin.cpp**

Converting the Component Hierarchy

- Both mesh and cameras should be “inherited”.
- Only need the FP camera.
- All components in correct places.
- No Fire method in Blueprint.
- Weapon firing should work.

A collage of various video game screenshots, including a city at night, a futuristic tower, and a space station.

4.15.0^z

Who's Pulled the Trigger?

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In This Video...

- Reviewing the architecture
- Revision: binding input in C++
- Challenge
- Remove firing from Animation BP
- Control trigger from AI



Improved Architecture

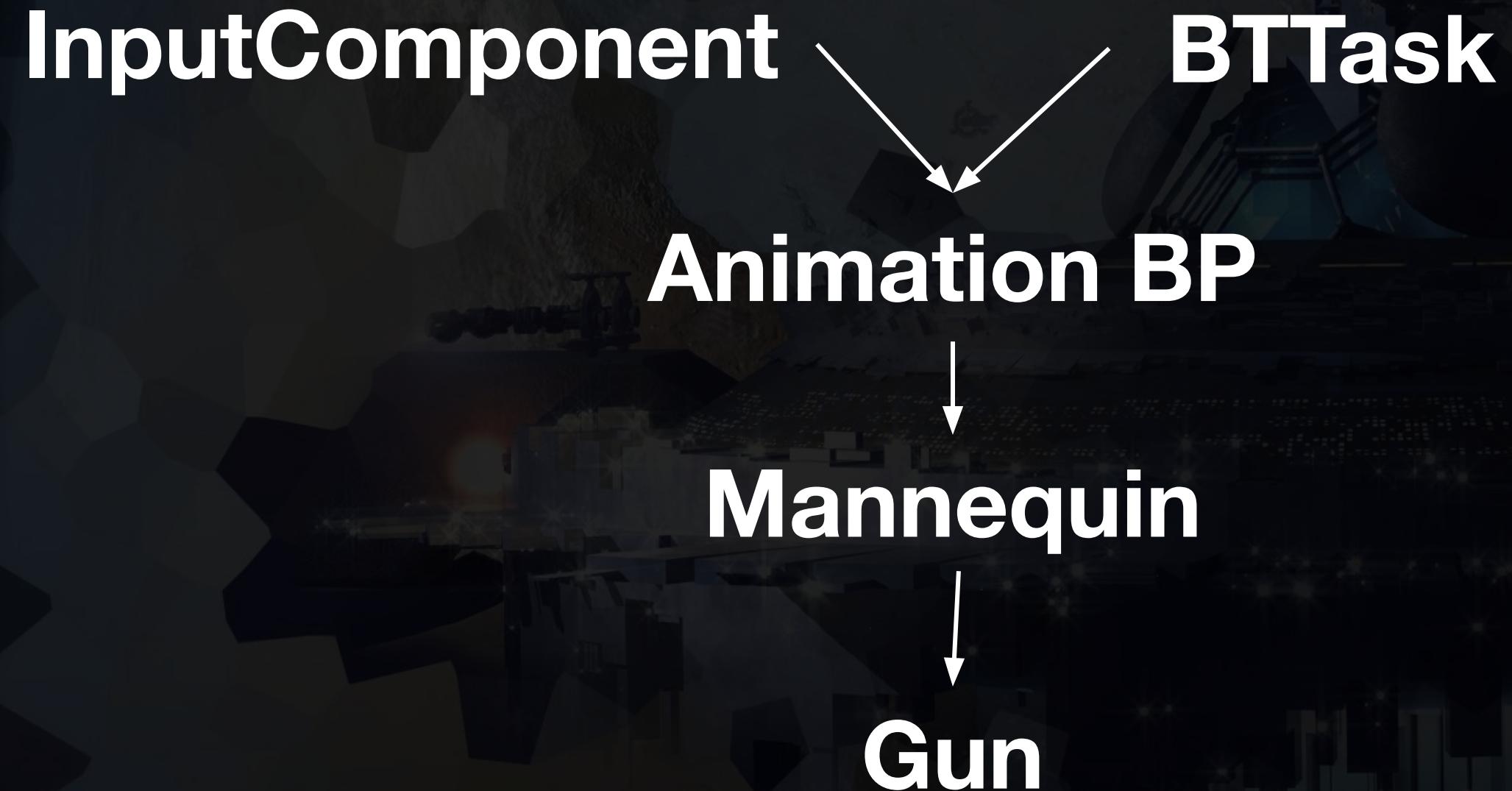
BP_Gun

BP_Character

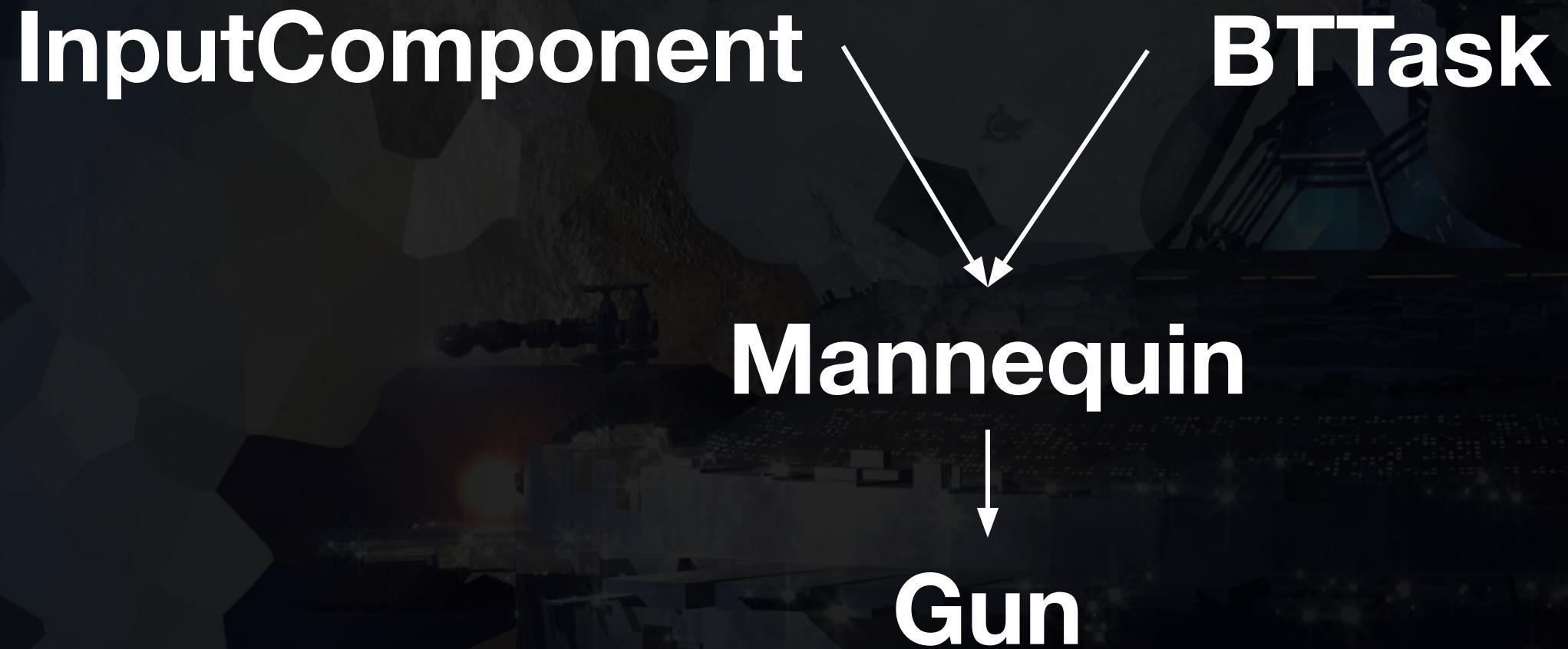
Mesh



Who Pulls the Old Trigger?



Who Pulls the New Trigger?



Direct Firing Control

- Rename the **Fire** function to **PullTrigger**.
- Should not be called from the Animation layer.
- Strip out all shooting animations.
- Shoot BTTask should fire once.
- Doesn't matter if this leads to rapid firing.

4.15.0^z

Cooldown Nodes & Gameplay Tags

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In This Video...

- How cooldown nodes work.
- Adding gameplay tags.
- Challenge: Let the AI Cooldown
- Randomised burst of fire.
- Separated into sub-behaviour trees.

Let the AI Cooldown

- The AI should pause between gunshots.
- Ensure this works both moving and stationary.
- Keep duplication to a minimum.
- **BONUS:** implement bursts of fire.

A collage of various video game scenes, including a futuristic city at night, a space station with multiple modules and solar panels, and a rocky, mountainous landscape with small structures. The overall aesthetic is dark and futuristic.

4.15.0^z

Animation Montages and Slots

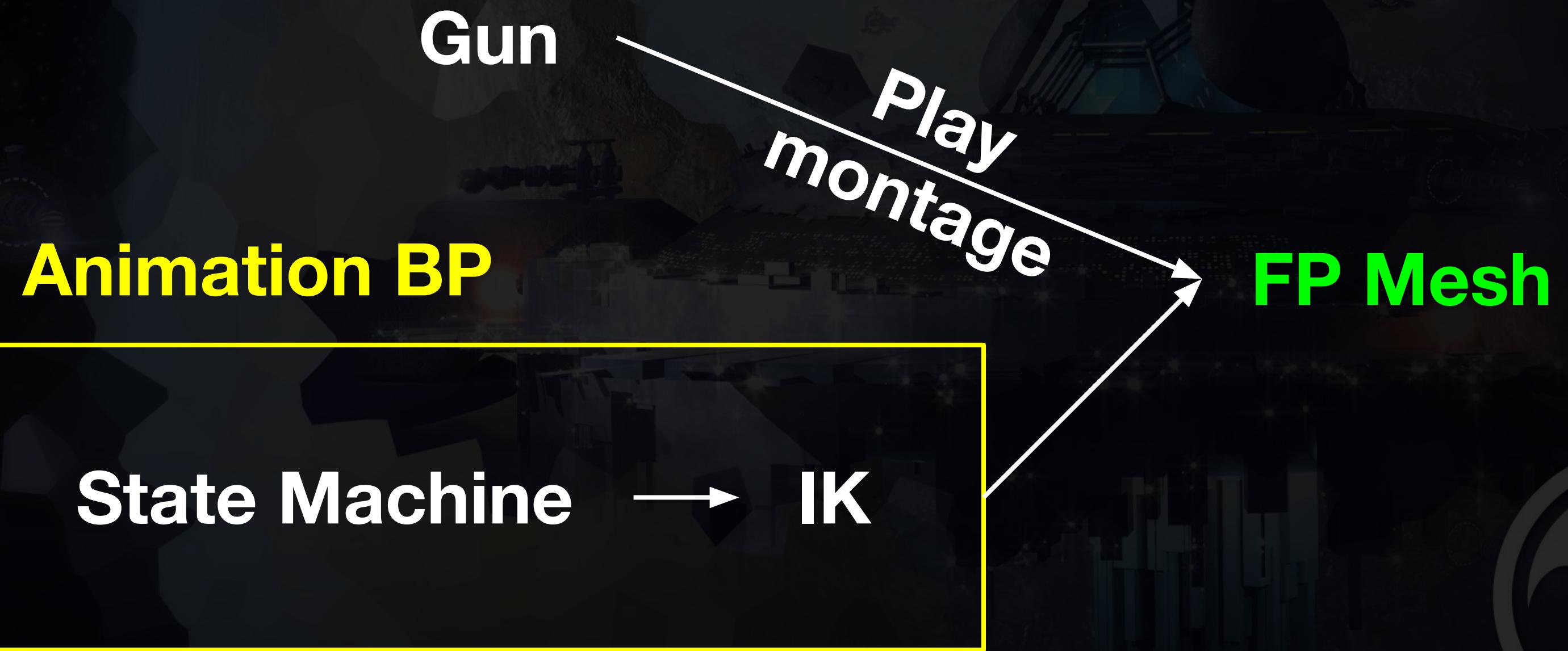
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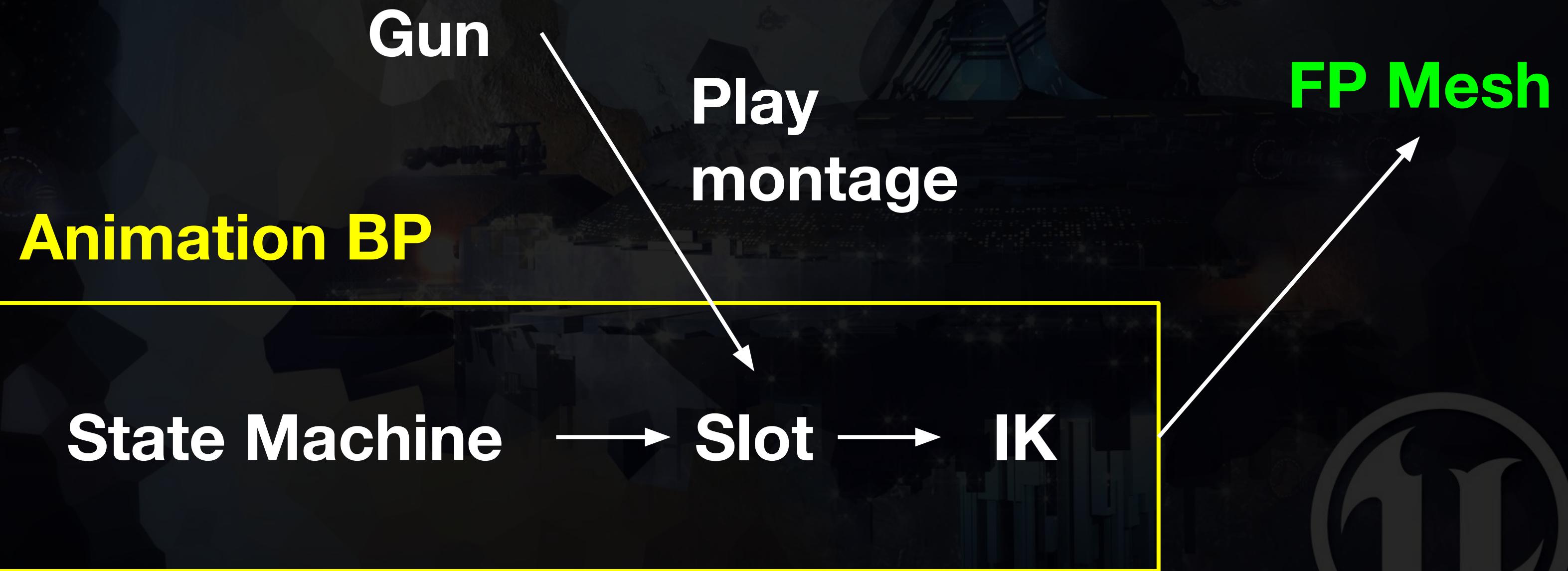
In This Video...

- What is an animation slot?
- How to blend by root bone.
- "Caching" a pose.
- Challenge: Create and Play Firing Montage

Who's Animating the FP Arms?



Who's Animating the FP Arms?



Create and Play Fire Montage

- ABP_TP should have an “Arms” slot.
- The TP montage plays in the “Arms” slot.
- It only affects the upper body.
- Aim offsets still affect the fire animation.
- **BEWARE** of the ease in time.

4.15.0^z

Reattaching the Gun

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In This Video...

- Attach gun to correct mesh if player
- Reattach gun when player dies
- Challenge: Play Two Montages

When to change attachment?

1. Possessed by a player.
2. Player died.

Play Two Montages

- BP Gun should take two montages.
- FP and TP should play fire montage.
- **HINT:** configure two **AnimInstances**

4.15.0^z

Procedural Level Generation

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In This Video...

- Importing asset pack.
- Introduction to procedural terrain.
- Creating ground mesh from BSP.
- Challenge: creating spawnable props.



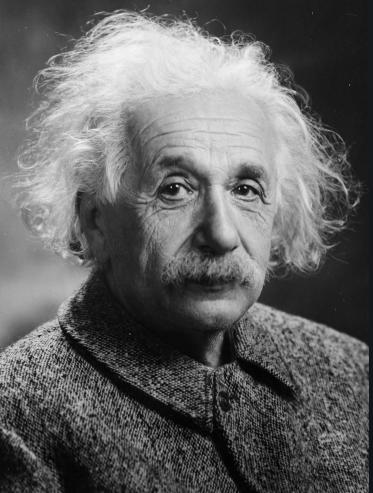
Generate

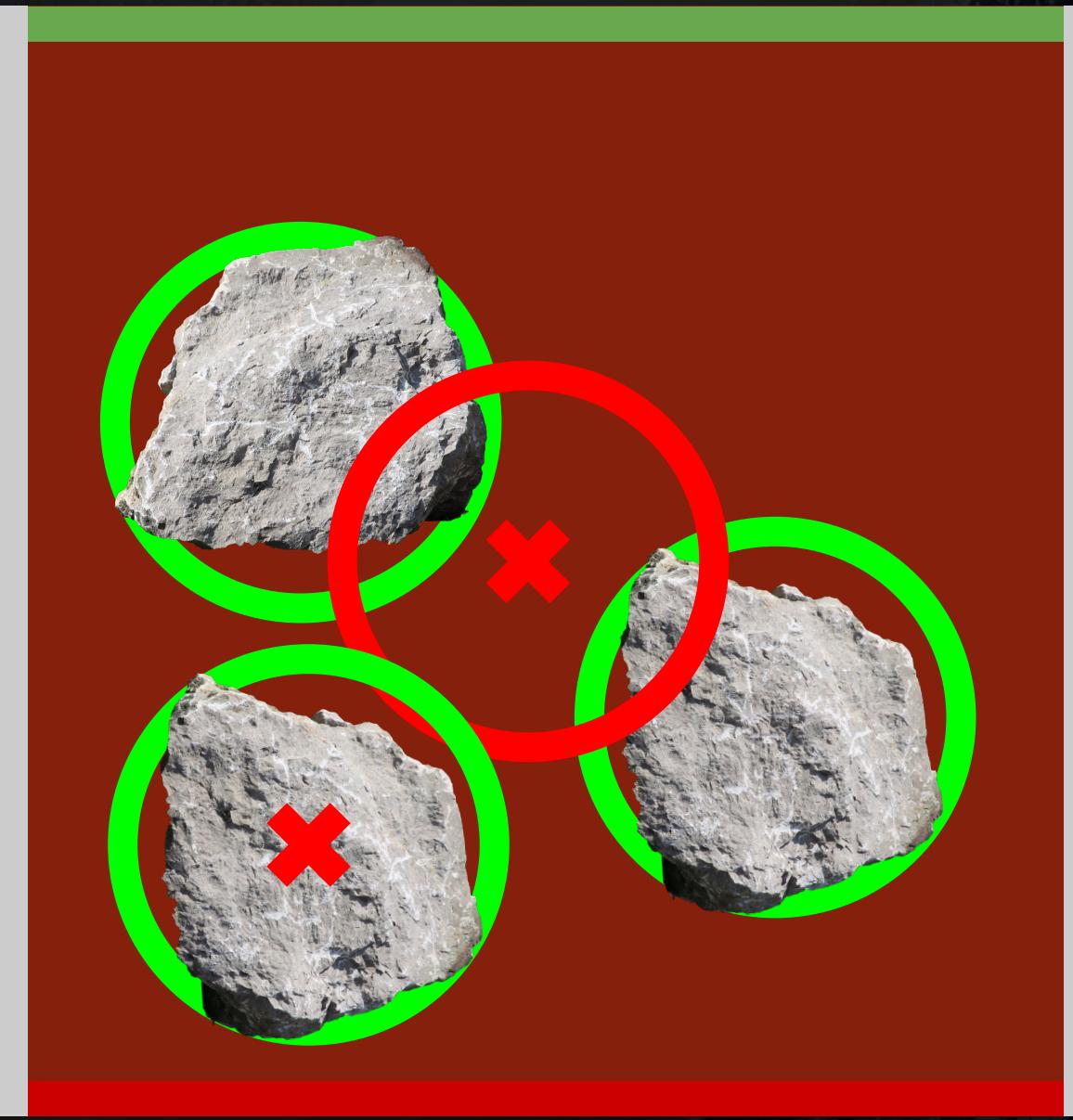
Perlin noise,
Fractal terrain

vs

Test

Fitness function





Create Prop Blueprints

- Use the asset pack or your own assets.
- Put together some actors out of meshes.
- Ensure ground centred.

4.15.0^z

Generating Random Numbers

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In This Video...

- Create a Tile C++ class.
- Expose a **UFunction** to spawn actors.
- Functions to generate random data.
- Challenge: generate a random spawn point.



Generate Random Spawn Points

- Calculate the min and max points of your box.
- Generate a random location.
- Print and check the points look sane.
- HINT: generate more than one point per call.

4.15.0^z

Spawning Actors in the Tile

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In This Video...

- Spawn an actor.
- Randomise the number of actors.
- Challenge: place the actors correctly.

Position the Actors

- Put the actors at the correct position.
- Attach the actors to the Tile.
- Ensure that they are on the floor.
- Spawn all your Blueprints.

4.15.0^z

Sphere Casting in C++

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In This Video...

- What is a Sweep?
- How to Sphere Cast in C++.
- Challenge: visualise the cast.

Visualise the Cast

- Use a `DrawDebug` method.
- Don't forget to include.
- Green for nothing hit.
- Red for something hit.

4.15.0^z

Configure Custom Trace Channels

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In This Video...

- Creating a Trace Channel.
- Where to configure presets.
- Challenge: make it trace green.

Make it Trace Green

- Walls and barriers should block.
- Other objects should block.
- Floor and Triggers should not block.

4.15.0^z

Spawning into Free Space

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In This Video...

- Writing an actor spawning algorithm.
- Challenge: generate empty space.
- Converting from local to global positions.

Generate Empty Spaces

- Don't allow it to loop forever.
- It's okay to fail.
- Change the original pseudo code if you must.

4.15.0^z

Randomising Rotation & Scale

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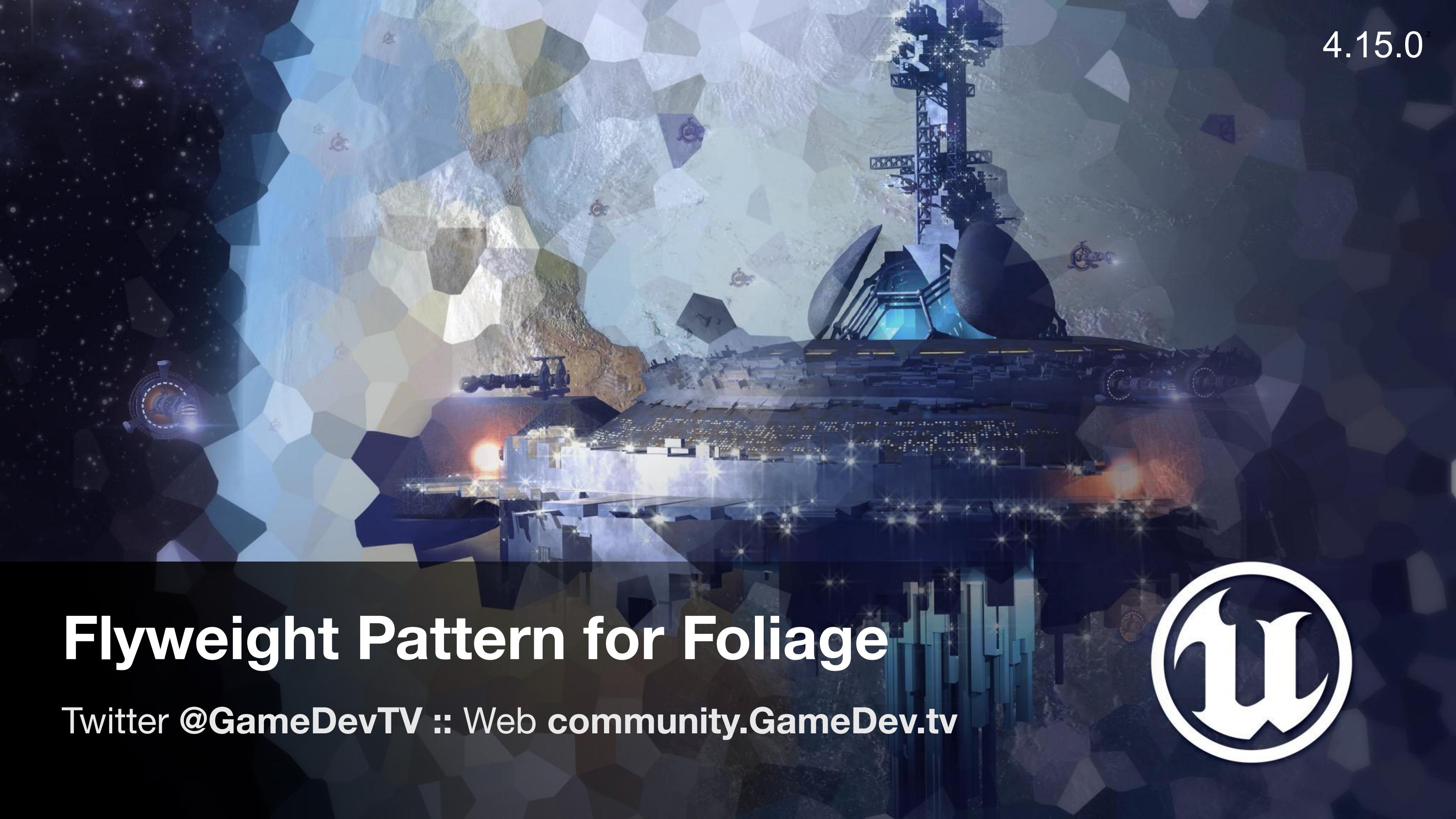


In This Video...

- Adding randomised rotation.
- Challenge: add randomised scale.
- Tweaking the spawn radii.

Add Randomised Scale

- Expose to the designer.
- Use a sensible default.
- Ensure scaled objects still don't overlap.
- Set sensible radii.

4.15.0^z

Flyweight Pattern for Foliage

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In This Video...

- Flyweight pattern for rendering
- Adding LOD for foliage.
- Challenge: spawn grass instances.
- Reviewing my code.
- Configuring my component.



Spawn Grass Instances

- Make use of the HISMC.
- Allow configuration of the spawn count.
- Randomise the spawn across the terrain.
- Check your LOD.

4.15.0^z

Choosing Waypoint with EQS

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In This Video...

- Outline of EQS.
- Enabling EQS.
- Creating and testing queries.
- CHALLENGE: Create a Waypoint Query.



What is EQS?

Generate → Filter → Test →



Create a Waypoint Query

- Choose sensible waypoints.
- Must be able to navigate there.
- Run your query.
- Replace current waypoint.

4.15.0^z

Find Actors of Type from C++

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In This Video...

- Overviewing the navigation issue.
- Getting hold of existing objects.
- CHALLENGE: Finding **NavMeshBoundsVolumes**

Finding NavMeshBoundsVolumes

- Create an `InfiniteTerrainGameMode` C++
- Use a stub `AddToPool()` method.
- It should print the actor name.
- Create `PopulateBoundsVolumePool`
- Should print all Volumes in scene

4.15.0^z

Plumbing an Actor Pool Setup

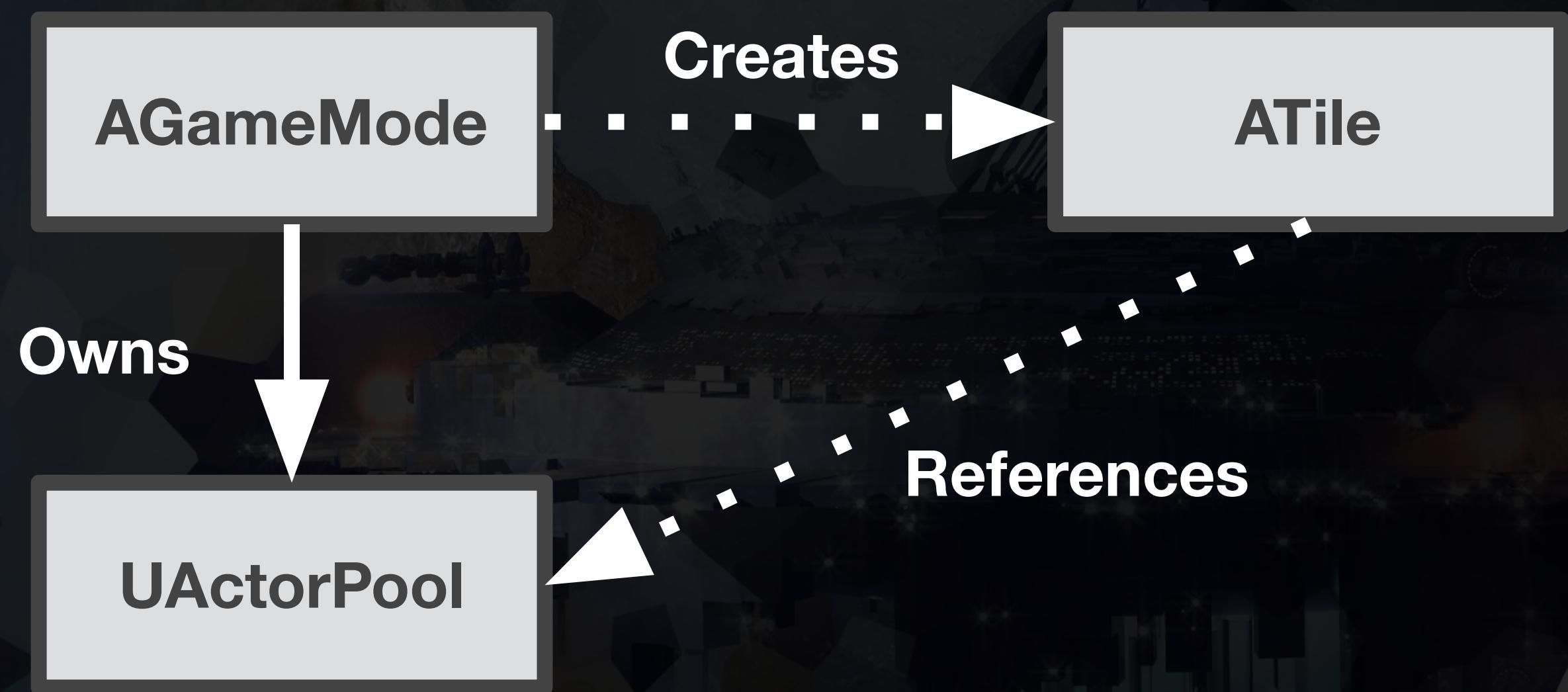
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In This Video...

- Actor Pool architecture.
- Creating the Actor Pool Component.
- CHALLENGE: Plumb the Pool.

Pool Architecture



Plumb the Pool

- Create the component in the GameMode.
- Keep a reference in the Tile.
- Set the Tile reference from the GameMode.

4.15.0^z

Using the Pool API

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In This Video...

- Using the Checkout API
- Overview of object lifecycle
- CHALLENGE: Return to Pool
- Populate the initial pool.

Avoid Your Late Fees

- Make sure you return.
- It should be same you checked out.
- Also populate the initial pool.

4.15.0^z

Using TArray for Pools

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In This Video...

- Implementing checkout.
- Challenge: Implement return and add.

Implement Return and Add

- Both should add to array.
- Add logging to Tile.
- Check expected values.

4.15.0^z

Rebuilding Navigation Meshes

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In This Video...

- Rebuilding the Navigation.
- Offset the NavMeshBoundsVolumes.
- CHALLENGE: Spawn on destroy.

Spawn on Destroy

- Should always have the same number in scene.
- Create more bounds volumes.
- Check your AI can navigate.

4.15.0^z

Structs to Simplify Function Args

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In This Video...

- The AI spawning problem.
- Combining parameters as structs.
- CHALLENGE: SpawnPosition Generator Function.

SpawnPosition Generator Function

- Create a function to generate **SpawnPositions**.
- It should return a **TArray**.
- It should take the random arguments.
- Loop over **TArray** to **PositionActors**.

4.15.0^z

Spawning AI from C++

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In This Video...

- How to spawn AI.
- PlaceAI Pawns definition.
- CHALLENGE: spawn AI in the world.

Spawn AI into the World

- Define the `PlaceAIPawns` method.
- Call it in Blueprint.
- Ensure actors are AI controlled.
- Ensure they don't attack each other.

4.15.0^z

Understanding Function Templates

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In This Video...

- What is a template.
- When would you use one?
- What is the syntax for functions.

4.15.0^z

Template Specialization

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In This Video...

- When copy and paste isn't enough.
- How to handle tricky types.

4.15.0^z

Fixing Double Spawning

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In This Video...

- Fixing out spawn issue.
- When static polymorphism isn't enough.
- How to use templates in classes.
- Caveats to using templates in C++



Complete the Functions

- Implement `RandomlyPlaceActors`
- Call `PlaceActor` from there
- Call `RandomlyPlaceActors` from `PlaceActors`
- Call `RandomlyPlaceActors` from `PlaceAIPawns`
- Fix any other errors.

4.15.0^z

Keeping Score

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In This Video...

- Adding a GameMode Score.
- CHALLENGE: Notify on Tile Conquered

Notify on Tile Conquered

- Notify on entering new tile.
- Don't notify more than once.
- No need for UI yet.

4.15.0^z

Using the HUD Class

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In This Video...

- Extending the HUD class
- Why use the HUD class
- CHALLENGE: Create the scoring UI

Create the Scoring UI

- Create a new widget.
- Add a score text label.
- Bind to the GameMode score.
- Attach the display the widget.

4.15.1^z

Post Processing for Tunnel Vision

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In This Video...

- Adding PostProcessing Effects
- CHALLENGE: Ease in on Damage

Ease in On Damage

- Make the blend weight increase on damage.
- Then slowly decrease again.
- Effect should fade in then out again.
- Play with other effects.

4.15.1

Recruiting Play Testers

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In This Video...

- Sharing your game
- CHALLENGE: Recruit Some Testers
- Changing the lighting
- Firing lasers
- Improving score UI
- Shorter blackout effect



Recruit Some Play Testers

- Share with your gamer friends.
- Share on **community.gamedev.tv**.
- Don't forget to sell you game.
- Implement the feedback.
- Repeat.

4.15.1^z

Smooth Blending the Camera

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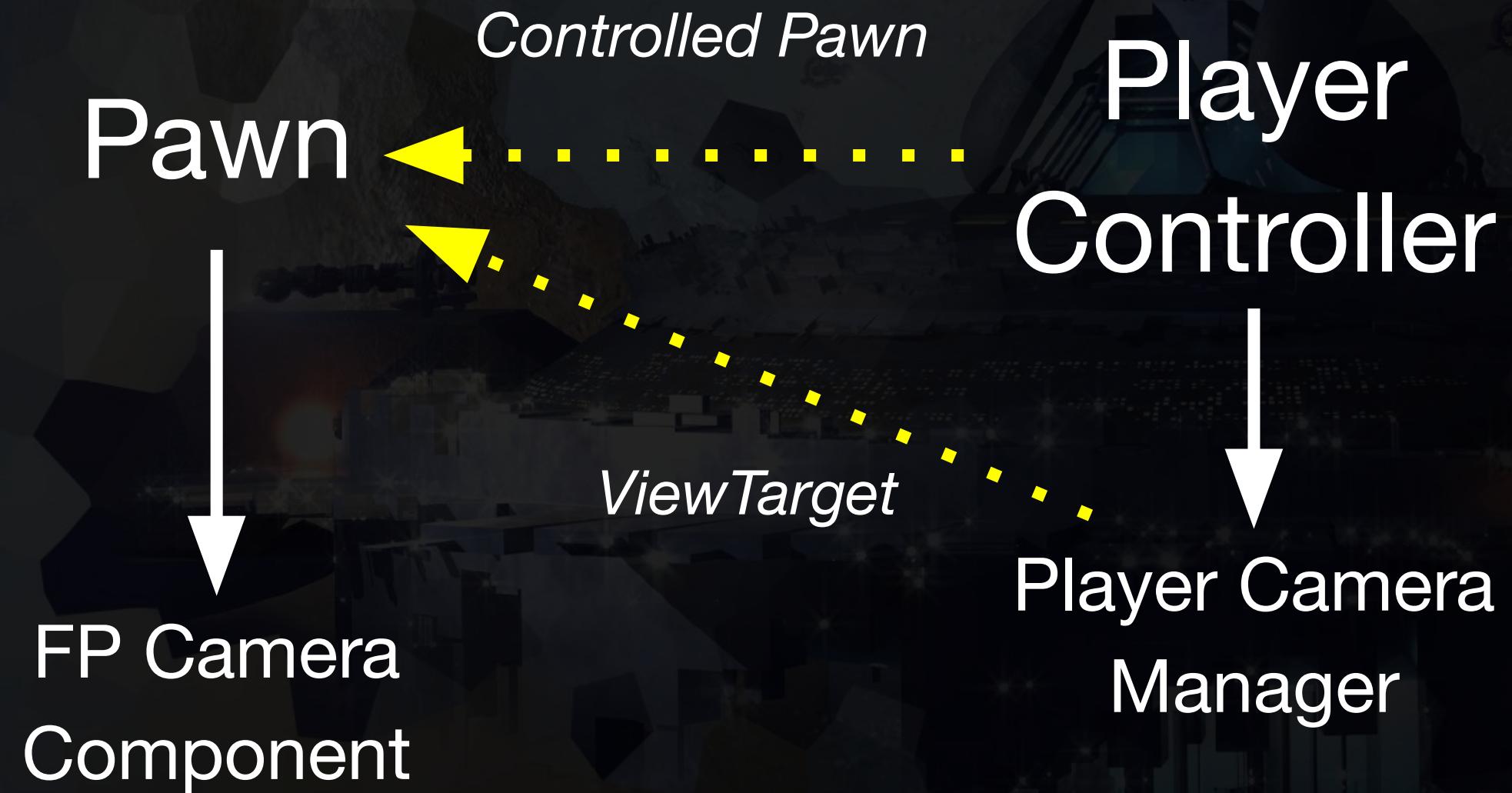


In This Video...

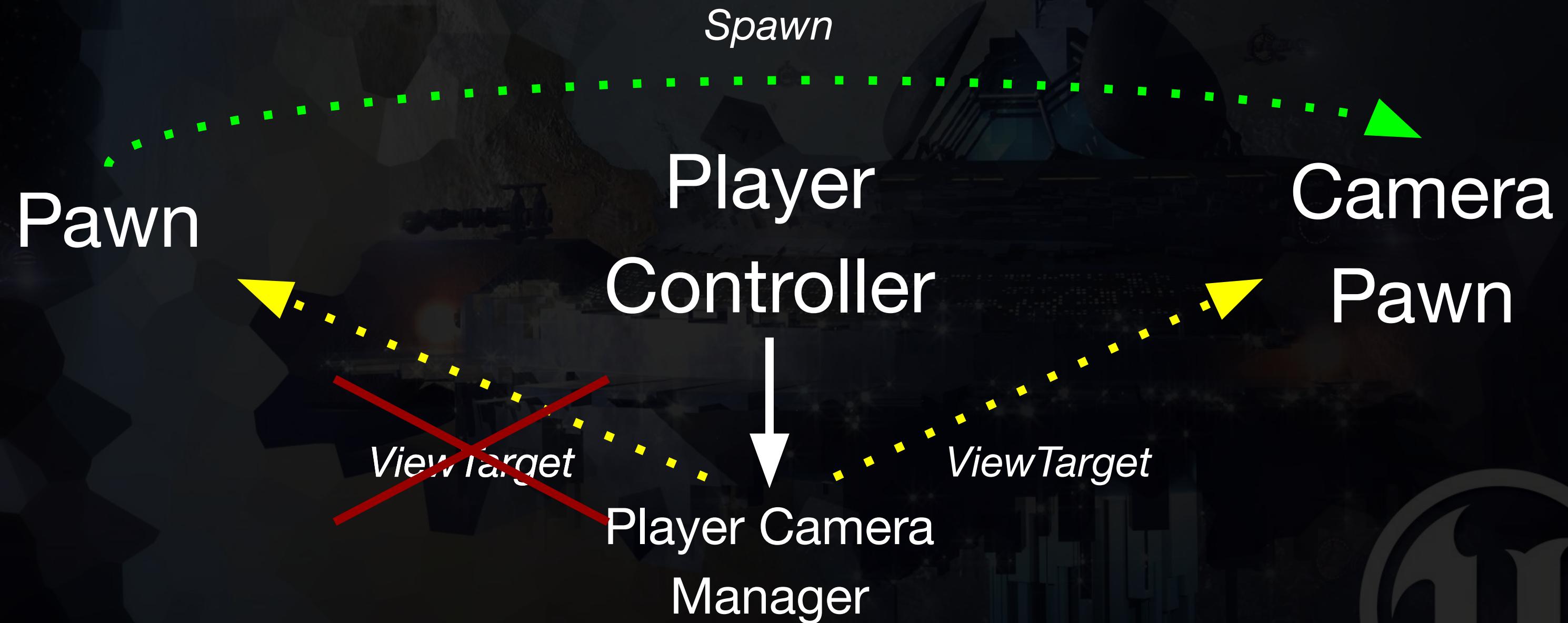
- Making death easier
- How the camera works
- Overview of SetViewTargetWithBlend
- CHALLENGE: Smooth Blend the Camera



How the Camera is Selected



Camera Pawn ViewTarget



Smooth Blend the Camera

- On death:
- Spawn a camera pawn
- Set it as the ViewTarget
- DON'T unpossess right now

Possessing and the View Target

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In This Video...

- Unpossing with View Targets
- Auto managed View Targets
- CHALLENGE: Manually Manage the View Target

Manually Manage the View Target

- Ensure the BP_PlayerController is used.
- What happens when you spawn?
- Does it work?
- What if Unpossess happens afterwards?

4.15.1^z

The Calm Before The Storm

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In This Video...

- Peace before the storm
- CHALLENGE 1: Fix the crashing issue
- CHALLENGE 2: Make the Actors spawn
- Parametrise the enemy count
- BONUS: Fixing multiple camera transitions

