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Big shout out to Ryan Heath for researching and implementing all of the awesome tech that makes all of this Lua integration into our engine possible. None of this would be possible without all of Ryan's hard work, and I would have never learned all of this without his help. Thank you, Ryan!

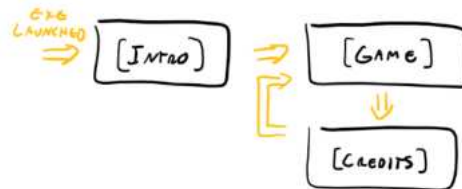
## Terminology

**Scene** – A collection of objects saved as a .json file using the Grool Editor

**State** – A set of functions in a script that determines what happens from the start of the state, during the state, and at the end of the state.

## Scenes Overview

Currently our game is broken up into 3 scenes. The Intro scene, the Credits scene, and the Game scene. The Intro scene is the first scene to be loaded when launching the game. At the end of the intro animation, the Game scene is loaded. From the pause menu in the Game scene, the Credits scene can be loaded. The Credits scene then goes back to the Game scene.



### Intro Scene

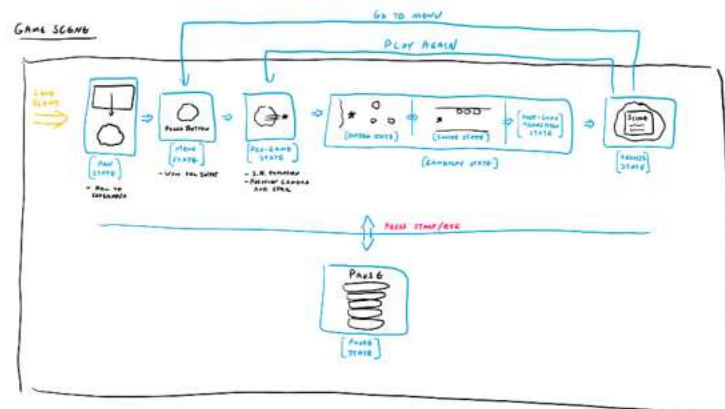
The Intro scene cycles through the logos for DigiPen, FMOD, and team Critical Orbit

### Credits Scene

The Credits scene is the credits scene. That's it.

### Game Scene

The Game scene contains the bulk of the actual game. It is broken up into multiple states which can be seen in the following image. This will be explained in more detail in the following section.



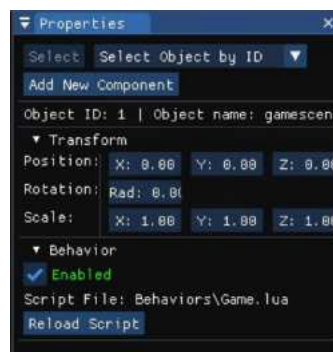
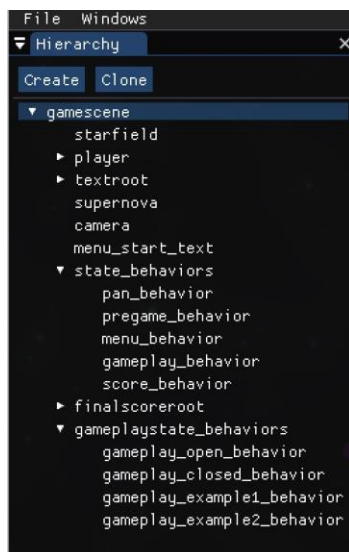
## The Game Scene

A scene is just a collection of objects placed in the editor, and saved to a .json file. The Game scene contains all of the objects that will be needed to run the various states that make up the main flow of the game.

When the scene is first loaded, the camera pans down to where the main menu state takes place. We then switch to the Menu state which awaits input from the user to start the game. When input is detected, we switch to the PreGame state that plays the animation of the supernova exploding, launching the player star into position for gameplay. We then switch to the Gameplay state, which is comprised of sub states that represent different sections of gameplay (like the open and closed sections of Infinite Supernova). When the gameplay ends, the state switches to the results screen. At this point the user can switch the state back to the menu, or back to the PreGame state to start the game over again. At any point during these states, the pause menu can be brought up.

### The Current State of the Game Scene

Currently these are the objects that the Game scene contains. The root object of the scene contains a behavior component that has the file Game.lua attached to it. This file contains the state machine and essentially runs the entire game state through its Update loop.



```

1  --[[
2      File: Game.lua
3      Authors: Christian Licona
4      Course: GAM250
5      Team: Critical Orbit
6      Project: Fetch Engine
7      Date: 03/28/20
8
9      Brief: This file contains the core game state for the game scene.
10
11      Copyright © 2020 DigiPen - All Rights Reserved
12  --]]
13
14  -- called when the behavior component is first created
15  function Init()
16  -- called every frame
17  end
18
19  function Update(dt)
20  -- sets the next state to use by storing which shutdown and update functions to use
21  -- from the given environment and calling the new environments state init function
22  end
23
24  function SetState(env)
25  -- necessary so that we are sure all behavior components have been created
26  end
27
28  function LoadFirstState()

```

### The State Machine Preview

The state machine is nothing more than a simple function, SetState(), that changes a few variables pointing to which Init, Update, and Shutdown functions to call. This will be explained in more detail in section: The State Machine.

## Behavior Functions

---

As a refresher and reminder, these are two of the main functions that you have access to as part of a Lua script being attached to a behavior component.

```
1 function Init()  
2     -- initialize stuff  
3 end  
4  
5 function Update(dt)  
6     -- update stuff  
7 end  
8
```

### Init()

The init function gets called when the behavior component for an object is first created. This means that when the Game scene is first loaded from either the Intro scene or the Credits scene, the init function will be called for all of the objects in the Game scene containing behaviors with Lua scripts attached to them. This also means that any “scene” that is instanced in during gameplay with InstanceScene() will have the init function called for any objects containing behavior components from that instanced scene.

### Update()

For any behavior component in the scene, the Update() function will be called every frame.

## GetEnvironment()

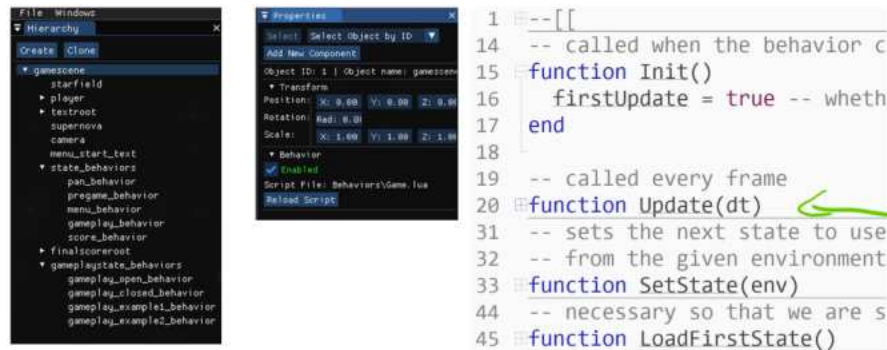
This function retrieves the Lua environment from the behavior component at the given ID. This is similar to getting the Transform component from an object at a given ID.

```
1 function Init()
2
3   env = GetEnvironment(ID)
4
5 end
6
```

### So what?

This means that you can have the Lua script attached to a certain behavior component in game, access the variables and functions from a Lua script attached to another behavior component in game.

Remember that the gamescene root object has a behavior component with the Game.lua script attached to it?



Well by getting the ID of the gamescene object, you can then get the lua environment from that behavior component, which will give you access to the functions and variables you have created in the lua file script.

Imagine I have attached this script to one of the other objects in the hierarchy list above.

```
1 function Init()
2
3   env = GetEnvironment(GetObjectName("gamescene"))
4
5 end
6
7 function Update(dt)
8
9   -- I can call the update function from another file!
10  env.Update(dt)
11  -- I can get/set variables!
12  env.firstUpdate = false
13
14 end
15
```

## The State Machine

The state machine handles switching the state of the Game scene between all of the different states: PanState, MenuState, PreGameState, GameplayState, and ScoreState.

### Game.lua

This script is attached to the “gamescene” root object of the Game scene. It is through this script that most of the rest of the Game scene is ran. The Update() function in this file is called as being part of a behavior component. Inside the Update() function, it calls the StateUpdate() function of whatever state is the current state.

```

19 -- called every frame
20 function Update(dt)
21
22     -- if this is the first time the update function has been called
23     if (firstUpdate) then
24         LoadFirstState()
25     end
26
27     StateUpdate(dt) --update the current state
28
29 end
30
31 -- sets the next state to use by storing which shutdown and update functions to use
32 -- from the given environment and calling the new environments state init function
33 function SetState(env)
34     -- if there is a current shutdown state
35     if StateShutdown then
36         StateShutdown()
37     end
38
39     StateShutdown = env.StateShutdown
40     StateUpdate = env.StateUpdate
41     env.StateInit()
42 end

```

If you are new to Lua, it might not be obvious at first glance, but StateShutdown and StateUpdate are global variables declared in this file. We are using them to store which functions to call.

### Basic State Functions

When you create a Lua file that is going to be used as a state that is part of the game scene, it must declare these three functions:

```

1 function StateInit()
2
3 end
4
5 function StateUpdate(dt)
6
7 end
8
9 function StateShutdown()
10
11 end

```

## SetState()

```

31 -- sets the next state to use by storing which shutdown and update functions to use
32 -- from the given environment and calling the new environments state init function
33 function SetState(env)
34     -- if there is a current shutdown state
35     if StateShutdown then
36         StateShutdown()
37     end
38
39     StateShutdown = env.StateShutdown
40     StateUpdate = env.StateUpdate
41     env.StateInit()
42 end

```

This function is the heart of the state machine. When you call this function, you must pass in the Lua environment of a behavior that has a Lua script attached to it with the proper State functions declared. If any of the state functions, StateInit(), StateUpdate(), and StateShutdown(), are missing, you will certainly get an error.

The function first checks if the StateShutdown variable has been set and given a shutdown function to call in another state. If it has, it calls that shutdown function. The shutdown and update function from the passed in environment are then stored in the variables: StateShutdown and StateUpdate. We don't need to store the init function, so we just call it directly from here.

## Calling SetState()

We want to be able to call the SetState() function from within our states so that we can tell the state machine to switch to the next state. To do this we will make use of GetEnvironment(). We will use the Gameplay state as an example.

```

39 --[[
40     The init function that gets called when this state is first switched to.
41 --]]
42 function StateInit()
43     -- get the game environment so we can change its state later
44     gameEnv = GetEnvironment(GetObjectByName("gameScene"))
45     -- get the next environment so we can switch to its state at the end of this state
46     nextEnv = GetEnvironment(GetObjectByName("score_behavior"))

```

One of the first things you should do when your state initializes is to store a reference to the environment of the Game scene root which contains the state machine, and the environment of the next state you want to switch to after this state. (you don't HAVE to determine which scene to switch to now, you can do that later. In this case we know we want to switch to the scoreboard state after the gameplay state).

When its time to switch states, we'll call SetState() on gameEnv and pass in the environment of the next state.

```

64 -- for testing purposes, change to next state when space is pressed
65 if (Input:IsAction3Released()) then
66     gameEnv.SetState(nextEnv)
67 end

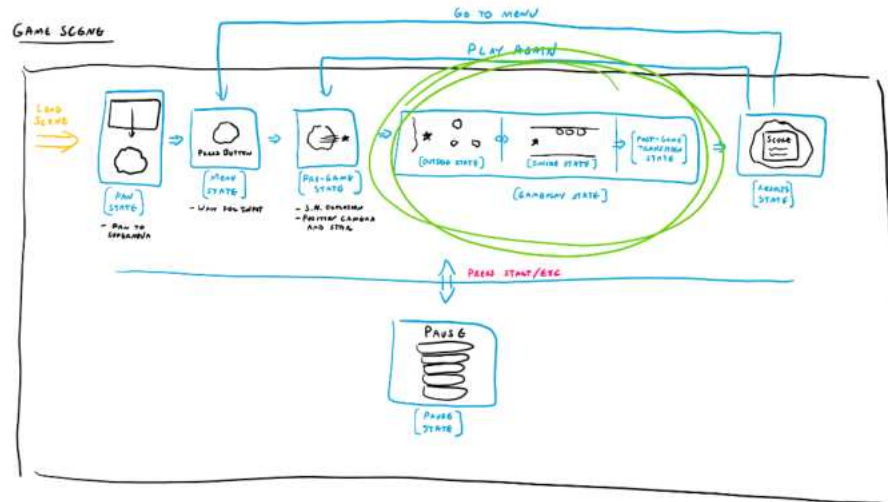
```

For example, here I am switching states when I press the space bar.



## The Gameplay State

As we have seen, the Gameplay state is one of the states as part of the Game scene. However, we plan on having different sections of gameplay as part of the Gameplay state. So the Gameplay state itself has been broken up into separate smaller gameplay states, and thus has its own state machine to handle switching between these sections.



## GameState.lua

Remember that the Gameplay state is part of the Game state machine. Thus this file has the functions `StateInit()`, `StateUpdate()`, and `StateShutdown()`, which will be called by the state machine in `Game.lua`.

```

1  --[[
2      File: GameState.lua
3      Author: Christian Licona
4      Course: GAM250
5      Team: Critical Orbit
6      Project: Fetch Engine
7      Date: 03/28/20
8
9      Brief: The state that executes and holds gameplay information
10
11     Copyright © 2020 DigiPen - All Rights Reserved
12 --]]
13
14 -- load the gameplay state that we should start in when this game state is first switched to
15 function LoadFirstGameplayState()
16     -- called when the behavior component is first created
17 end
18
19 function Init()
20     --[[
21         The init function that gets called when this state is first switched to.
22     --]]
23 end
24
25 function StateInit()
26     --[[
27         The update function for this state that gets called every frame from the state machine in the Game behavior.
28         Note: This is NOT the same as the regular Update(dt) function that gets called every frame for the specific
29         behavior component this script is attached to.
30     --]]
31 end
32
33 function StateUpdate(dt)
34     --[[
35         This function will be called from the state machine when SetState is called to switch states.
36     --]]
37 end
38
39 function StateShutdown()
40     -- sets the next state to use by storing which shutdown and update functions to use
41     -- from the given environment and calling the new environments state init function
42 end
43
44 function SetGameplayState(env)
45     -- call the shutdown function for the current gameplay state and switch to the score state
46 end
47
48 function EndGameplayState()

```



## Functions

The Gameplay state has one notable function other than SetGameplayState() that may be useful to call from within a gameplay section.

```

100 -- call the shutdown function for the current gameplay state and switch to the score state
101 function EndGameplayState()
102     GameplayStateShutdown()
103     gameEnv.SetState(nextEnv)
104 end

```

EndGameplayState() will call the shutdown function for the current gameplay section. It will then tell the Game state machine to move on to whatever state “nextEnv” is.

## SetGameplayState()

```

87 -- sets the next state to use by storing which shutdown and update functions to use
88 -- from the given environment and calling the new environments state init function
89 function SetGameplayState(env)
90     -- if there is a current shutdown state
91     if GameplayStateShutdown then
92         GameplayStateShutdown()
93     end
94
95     GameplayStateShutdown = env.GameplayStateShutdown
96     GameplayStateUpdate = env.GameplayStateUpdate
97     env.GameplayStateInit()
98 end

```

As you can see, the Gameplay state has a state machine nearly identical to the Game state machine. The only difference being that the functions it calls are prepended with GameplayState instead of just State. This of course means that any gameplay states that should be considered a part of the Gameplay state machine should have these functions:

```

1 function GameplayStateInit()
2
3 end
4
5 function GameplayStateUpdate(dt)
6
7 end
8
9 function GameplayStateShutdown()
10
11 end

```

## Calling SetGameplayState()

This process will be similar to calling SetState() for the Game scene.

We’ll use GameplayState\_Example1.lua as an example. In this example we will store a reference to the Gameplay state environment.

```

19 --[[
20     The init function that gets called when this game play state is first switched to.
21 --]]
22 function GameplayStateInit()
23
24     -- get the gameplay state environment managing this state so we can change its state later
25     gameplayEnv = GetEnvironment(GetObjectByName("gameplay_behavior"))

```

Then, when its time to switch to another gameplay section, we'll tell the Gameplay state to switch to the section we want.

```

38 -- if 10 seconds have passed, switch back to example2 gameplay
39 if timer >= 5 then
40     local env = GetEnvironment(GetObjectByName("gameplay_example2_behavior"))
41     gameplayEnv.SetGameState(env)
42 end

```

Or maybe we want to end the Gameplay state instead.

```

15 if OverlappingPlayer() then
16     -- get the gameplay state
17     local env = GetEnvironment(GetObjectByName("gameplay_behavior"))
18     env.EndGameState() -- end the gameplay state and show score
19 end

```

This is a snippet from Example1Enemy.lua. When the enemy overlaps the player, it tells the Gameplay state to end. The Gameplay state is handling which Game state it will switch to, which in our case is the Scoreboard. (however you could make the Game state switch to whatever state you wanted yourself. Do that at your own risk though)

## GameState\_STATENAME.lua

If you want to create a new gameplay section for the Gameplay state, you will need to follow these steps:

1. Make a copy of the GameState\_TEMPLATE.lua file. Rename it to whatever your sections is called.
2. Create a new object in the Game scene with a behavior component. Please parent it to the gameplaystate\_behaviors object for organization purposes.
3. Attach your state script to the object.

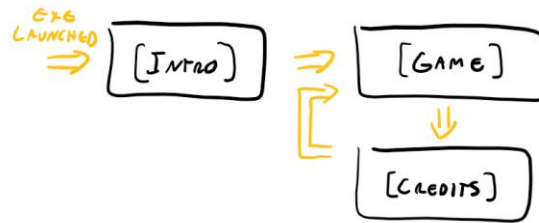


## GameState\_TEMPLATE.lua

This file already contains the state functions it should contain, as well as a premade header. The init function also already stores a reference to the Gamestate's environment so you can tell the gameplay state to switch sections from your section.

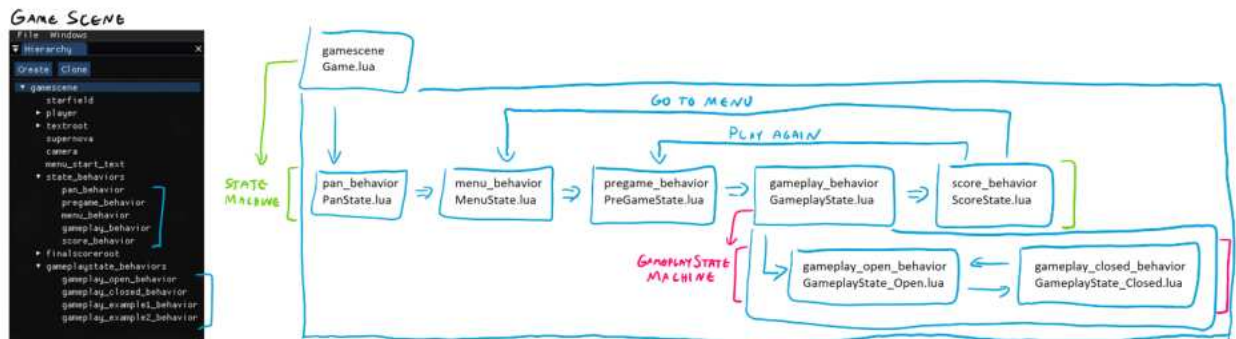
## TLDR

Game Scenes Diagram

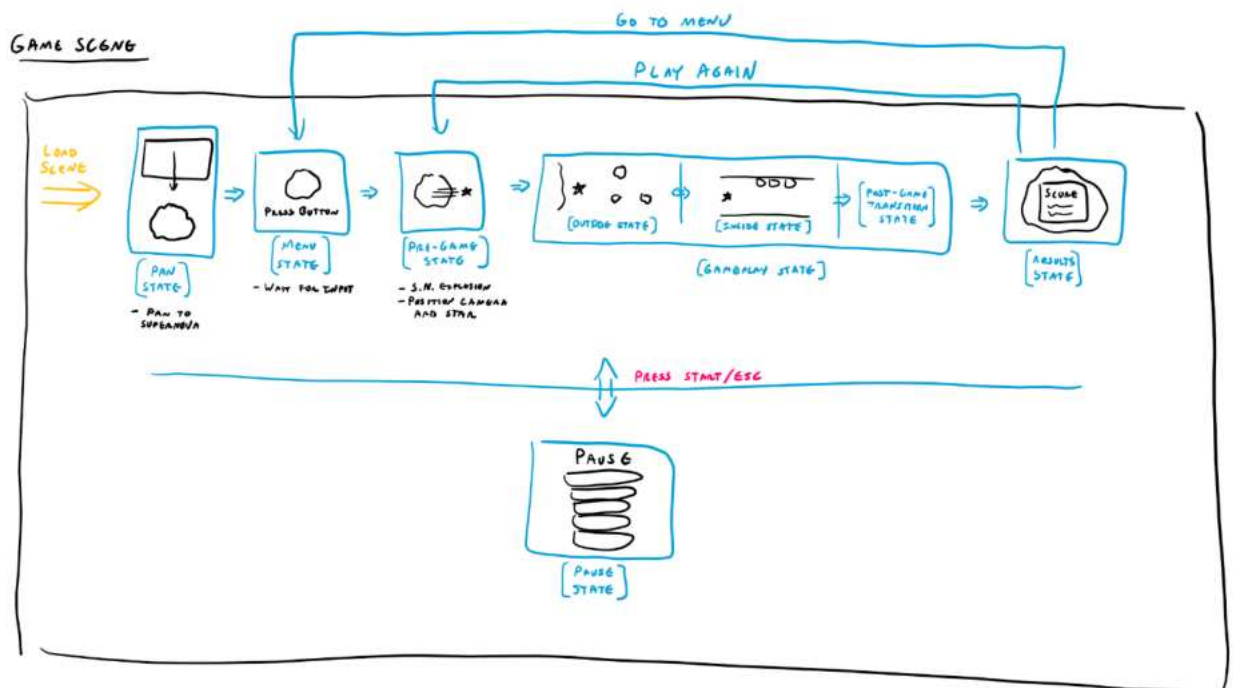


Game Scene Diagram

This is a view of the game scene with object names and the lua files that represent the states for each of those objects.



Game State Diagram



## Behavior Functions

```

1 function Init()
2     -- initialize stuff
3 end
4
5 function Update(dt)
6     -- update stuff
7 end
8

```

## GetEnvironment()

```

1 function Init()
2
3     env = GetEnvironment(ID)
4
5 end
6
39 --[[
40     The init function that gets called when this state is first switched to.
41 --]]
42 function StateInit()
43     -- get the game environment so we can change its state later
44     gameEnv = GetEnvironment(GetObjectName("gamescene"))
45     -- get the next environment so we can switch to its state at the end of this state
46     nextEnv = GetEnvironment(GetObjectName("score_behavior"))
47
19 --[[
20     The init function that gets called when this game play state is first switched to.
21 --]]
22 function GameplayStateInit()
23
24     -- get the gameplay state environment managing this state so we can change its state later
25     gameplayEnv = GetEnvironment(GetObjectName("gameplay_behavior"))
26

```

## State Functions / Gameplay State Functions

1 function StateInit()	1 function GameplayStateInit()
2	2
3 end	3 end
4	4
5 function StateUpdate(dt)	5 function GameplayStateUpdate(dt)
6	6
7 end	7 end
8	8
9 function StateShutdown()	9 function GameplayStateShutdown()
10	10
11 end	11 end