COMP4002/G54GAM Lab Exercise 07 – Racing and Menus

19/03/19

This exercise involves creating a game setup commonly seen in arcades – split screen racing.

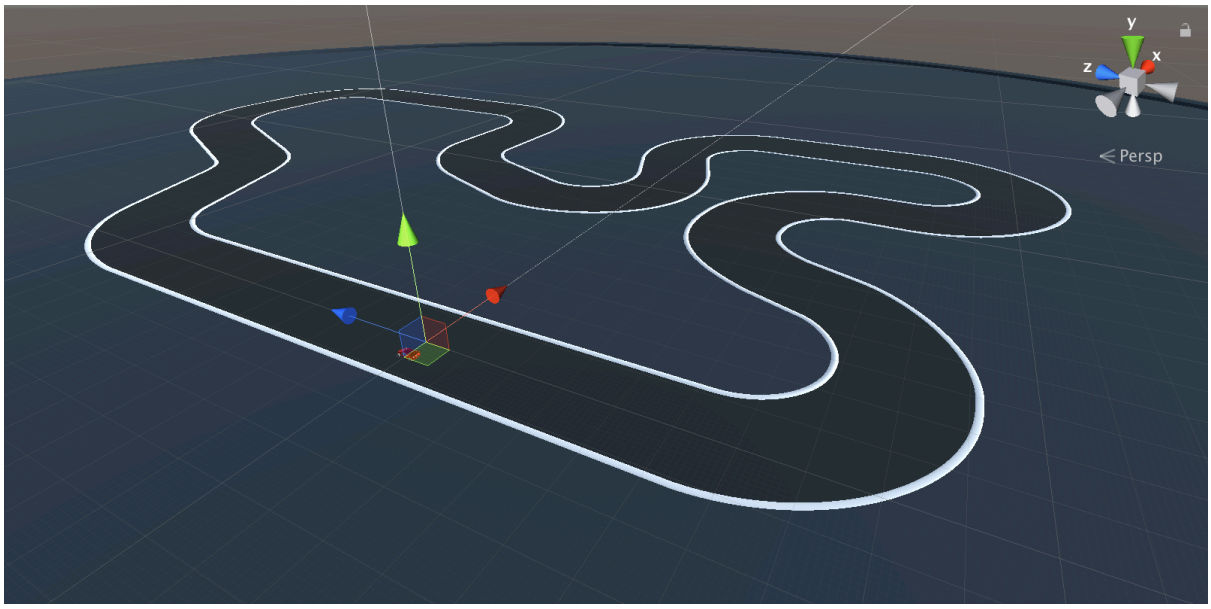
The game will have the following features

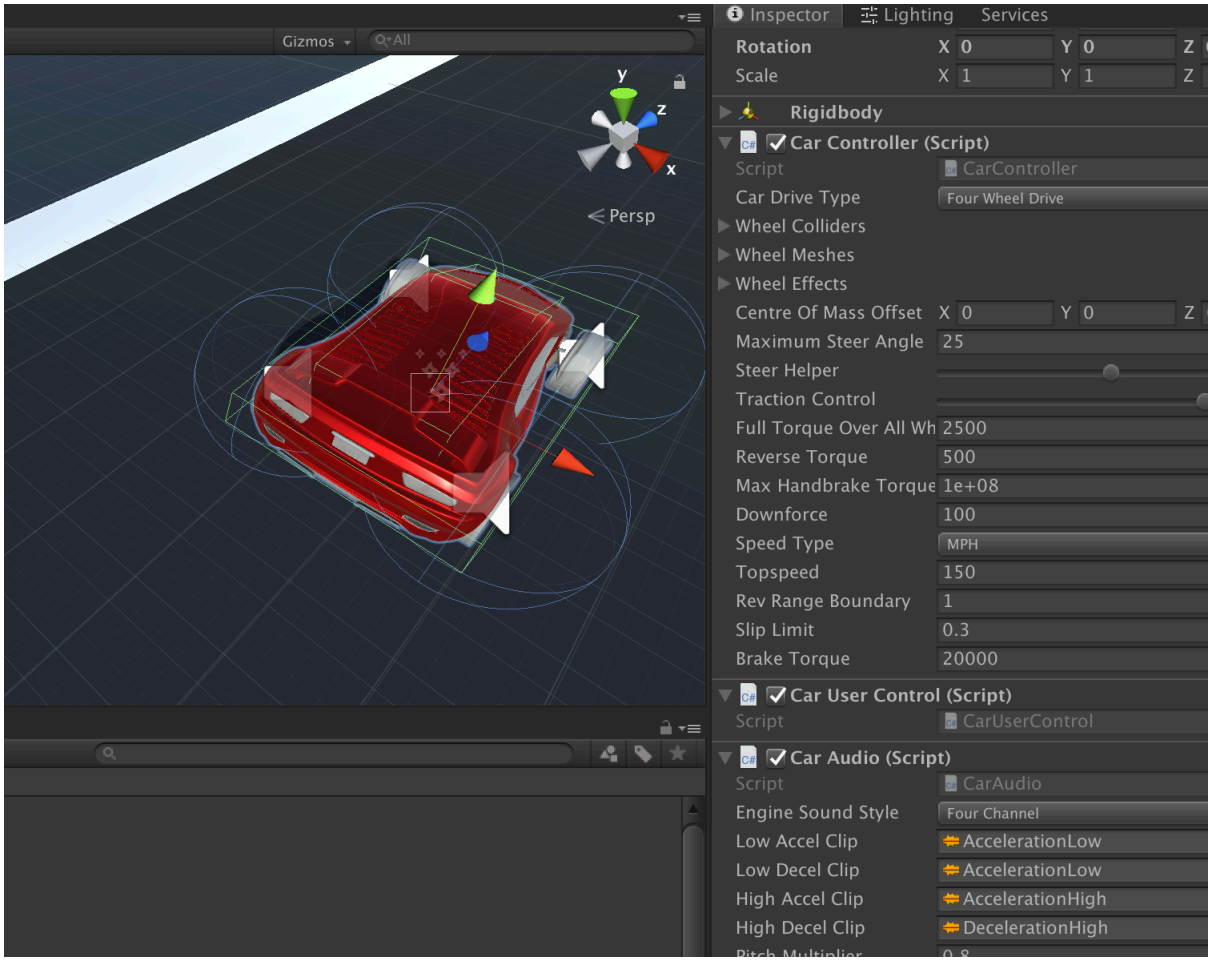
- A car that can be driven around a simple terrain or race track
- Split-screen multiplayer
- An AI opponent
- A simple menu system

Driving

Create a new project and include the *Standard Assets* content from the asset store as in lab 04. This exercise is going to reuse several components from the assets to implement the racing mechanic that will be extended into a more significant game.

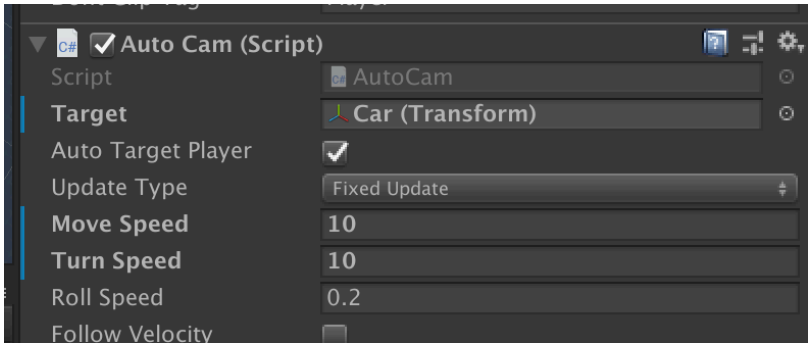
From the standard assets add the Assets->SampleScenes->GroundTrack prefab to your scene, or alternatively create whatever terrain you think might be appropriate for in initial race track (perhaps try out the *Terrain* tools having added a GameObject->3D Object->Terrain object) The GroundTrack prefab consists of a large ground mesh, an example race track layout and kerbs, however none of these objects include a mesh collider and so are not solid. Add a *Mesh Collider* component to the three objects to resolve this.



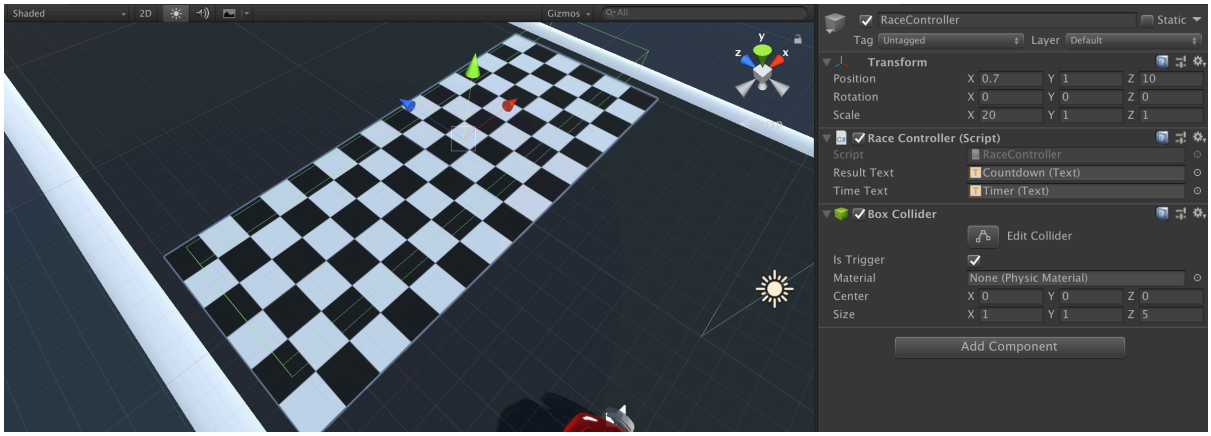


Building a realistic car character controller is a non-trivial task, so for this exercise we will make use of one provided in the standard asset pack. Add the Assets->Standard Assets->Vehicles->Car->Prefabs->*Car* prefab to the scene. This also provides a reasonable amount of configurability to the car.

As with the third-person and first-person character controllers from previous exercises we can also attach the *MainCamera* object as a child of the Car object. Here you have several options – is this a first-person perspective, or is the camera set back and above the car? An alternative is to use a more sophisticated camera rig that is less tightly coupled to the car but attempts to follow it.



Add the Assets->Standard Assets->Cameras->Prefabs->MultipurposeCameraRig prefab to the scene, and set the target of its AutoCam script component to be your Car object.



The game should have a simple start countdown before the race starts, then the player will be timed driving around the track, stopping the clock when they cross the finish line. Add an object to serve as a race controller, with a *Box Collider* trigger to register when the car crosses the line. In the screenshot above a textured quad provides the visual representation of the line.

The code fragment below gives an example of how a countdown might be created. Extend and add this to the race controller. Note that *resultText* and *timeText* are GUI components that should be added to a canvas as in the HUD in lab 03.

```
RaceState raceState;

enum RaceState
{
    START,
    RACING,
    FINISHED
};
```

```
void Start()
{
    StartCoroutine(startCountdown());
    raceState = RaceState.START;
}

IEnumerator startCountdown()
{
    int count = 3;

    while (count > 0)
    {
        resultText.text = "" + count;
        count--;
        yield return new WaitForSeconds(1);
    }
    raceState = RaceState.RACING;
    startTime = Time.time;
    resultText.text = "GO";

    yield return new WaitForSeconds(1);
    resultText.enabled = false;
}

void Update()
{
    if(raceState == RaceState.RACING)
    {
        timeText.text = "" + (Time.time - startTime);
    }
}
```

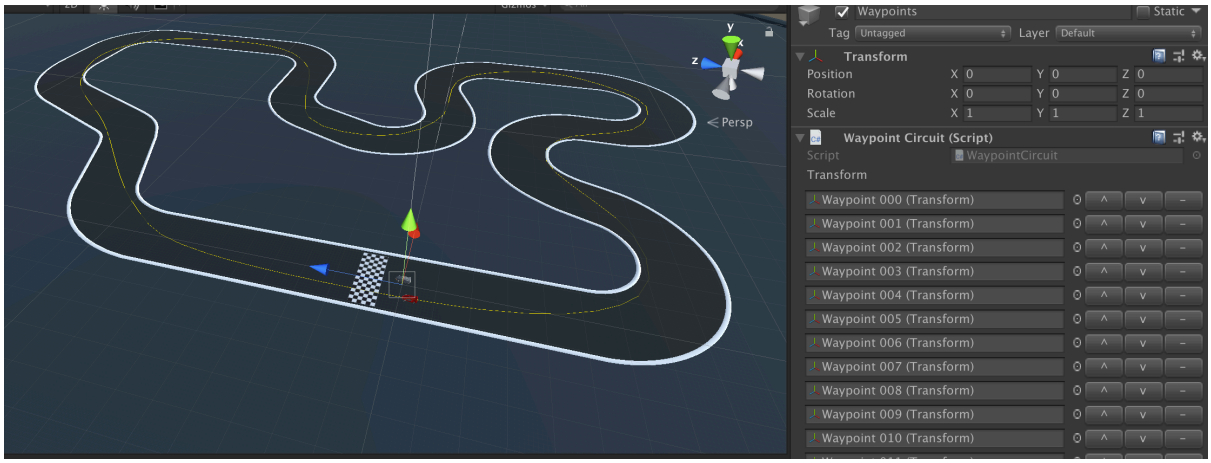
AI

A racing game with only a single car does not present much of a challenge for the player, so the next step is to add more cars and opponents. Here we will add one single AI player however it should be apparent how by modifying the *CarUserControl* script attached to a second controllable car object, a second human player using a different set of keys could be introduced. Either way, the game will have a classic “split-screen” multiplayer view as seen in games such as Mario Kart.

To create the AI car add the Assets->Standard Assets->Vehicles->Car->Prefabs-> CarWaypointBased prefab to the scene. This is a variant of the player controlled car but one that attempts to drive between a series of waypoints. This is similar to the construction used in lab 05 for controlling the AI, but unlike the NavMesh agent, a script will calculate a *spline* (a smooth curve) between the waypoints and then the car will attempt to follow it as best it can. However, the realistic physics of the car will mean that the curve will not be followed exactly.

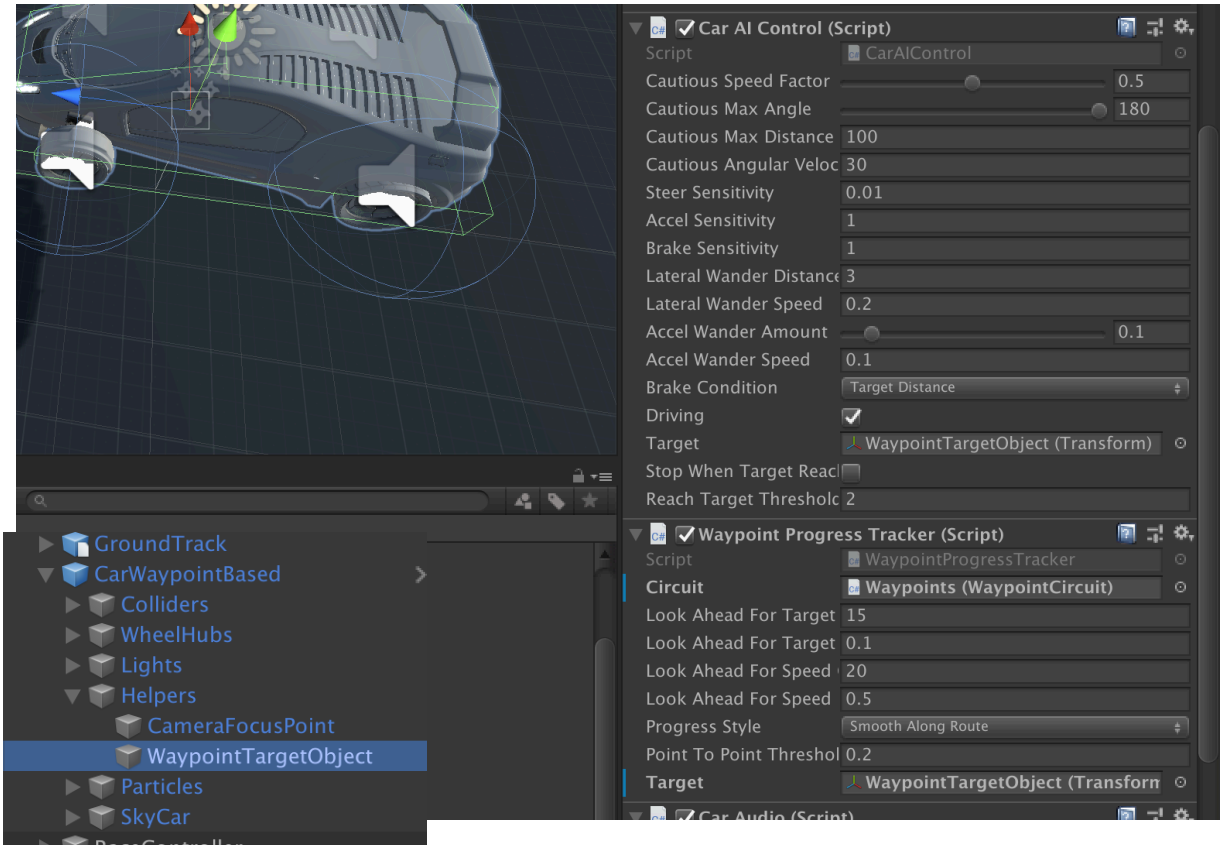
Here you may find it useful to look at the example *CarAIWaypointBased* scene in the SampleScenes folder of the standard assets to see a functioning setup in case of any issues.

Create an empty game object to serve as a parent for the waypoints. Create a series of empty game objects as children of this object around the track. Adding the script *WaypointCircuit* to the parent object and clicking *Assign using all child objects* will construct a smooth route between the waypoints for the AI car to attempt to drive.



Finally, the AI car must be configured to follow this new circuit. In the WaypointProgressTracker component of the car, set the *Circuit* property to be your waypoint parent object. Set the *Target* property of both the CarAIControl script and the WaypointProgressTracker script to reference the *WaypointTargetObject* that is a child of the AI car.

The upshot of this setup is that the WaypointProgressTracker will identify a point on the circuit some way ahead of the car, and continually update this, and the car will attempt to drive towards it.



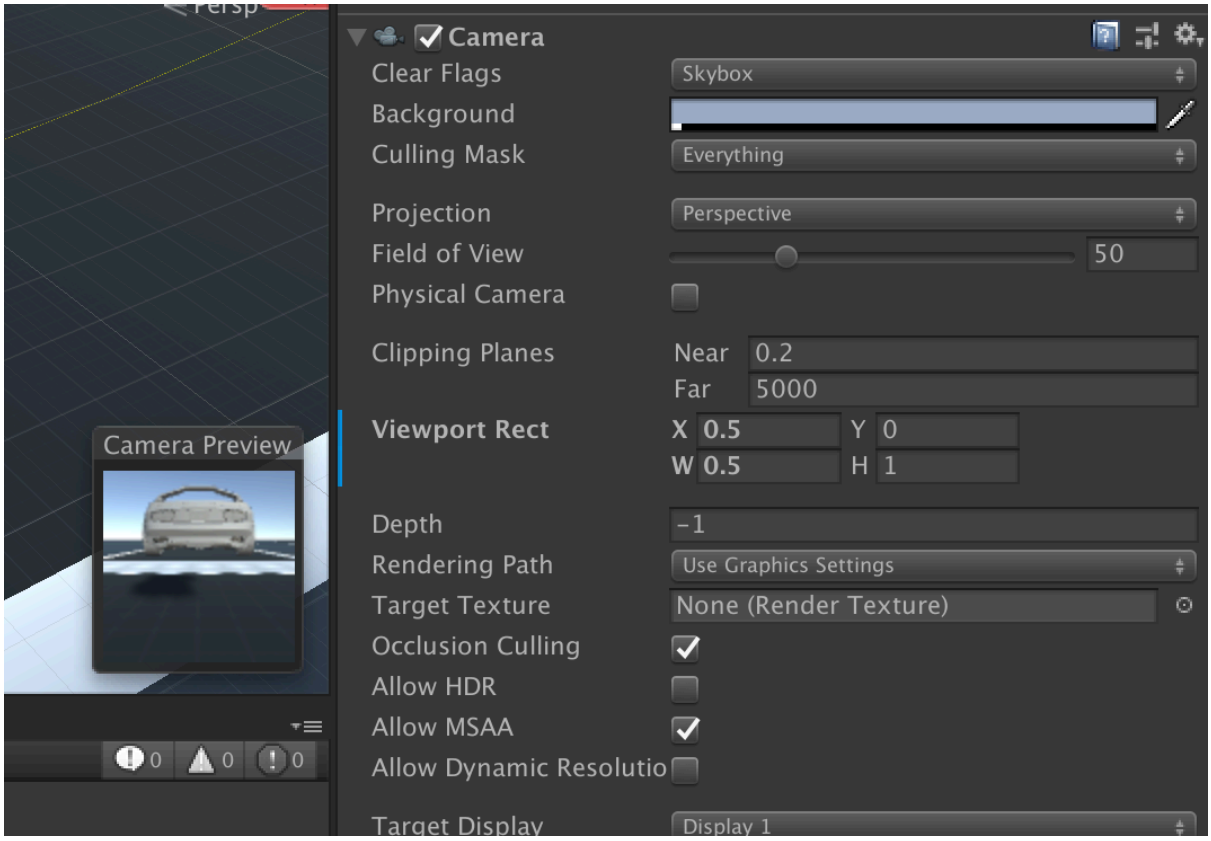
The AI car will set off when the scene is loaded. To control its behaviour, disable the CarAIControl script component, but then programmatically enable it via your RaceController script, by tagging the car appropriately.

```
using UnityStandardAssets.Vehicles.Car;
...
    GameObject[] AICars = GameObject.FindGameObjectsWithTag("AICar");

    foreach(GameObject car in AICars)
    {
        car.GetComponent<CarAIControl>().enabled = true;
    }
```

Split Screen Multiplayer

Giving each "player" their own screen is quite straightforward. Each car will have its own camera, and be allocated part of the screen to display that camera.

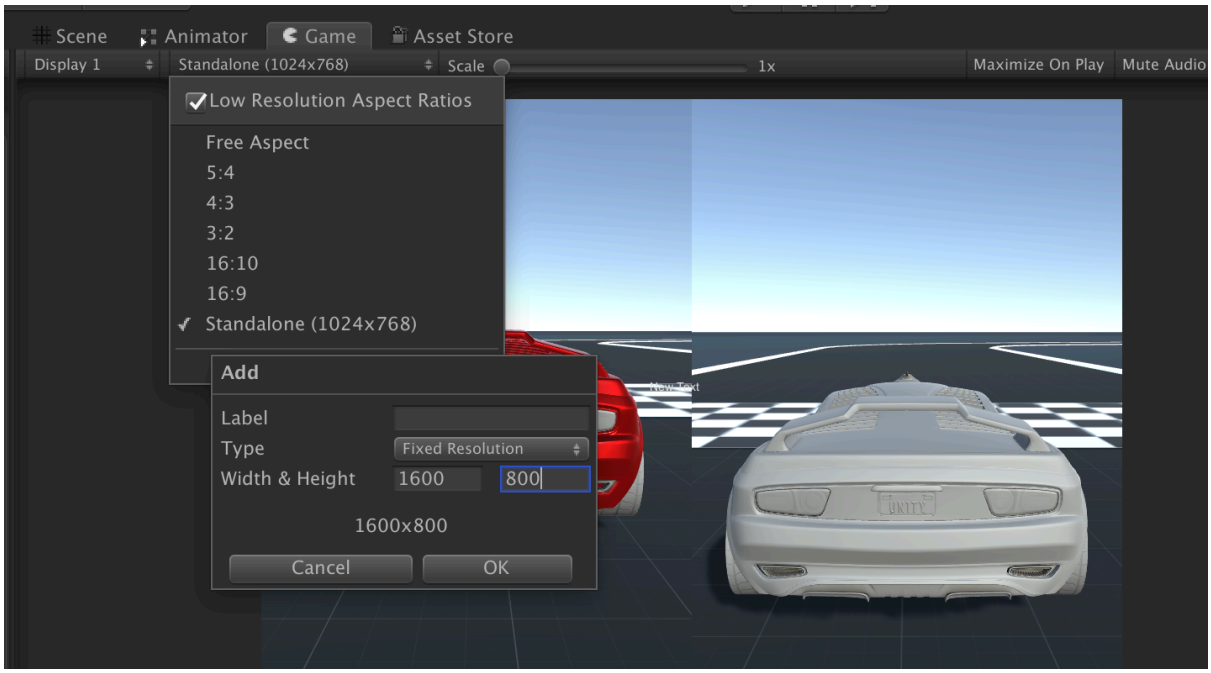


Add a second MultipurposeCameraRig to the scene, but have this one target the AI car. In both rigs disable the *Auto Track Player* flag. The grandchild of the camera rig is the *Camera* object itself, and here we will configure the split-screen effect.

Pick one of the car and rig combinations to take the left side of the screen. In the *Camera* set its *Viewport Rect* – this is the space on the screen the view from this camera will occupy – and set its width to 0.5 (i.e. half of the screen) and its X coordinate to 0 (i.e. the left of the screen).

Repeat this process for the other car and rig combination, but this time also set the X coordinate of the *Viewport Rect* to be 0.5 (i.e. specifying that this view will take up the right of the screen).

Finally, in the game view, set the resolution of the screen to be of an aspect ratio that allows the two views to sit side by side, for example a 2:1 ratio such as 1600 by 800.



Menus and Multiple Scenes

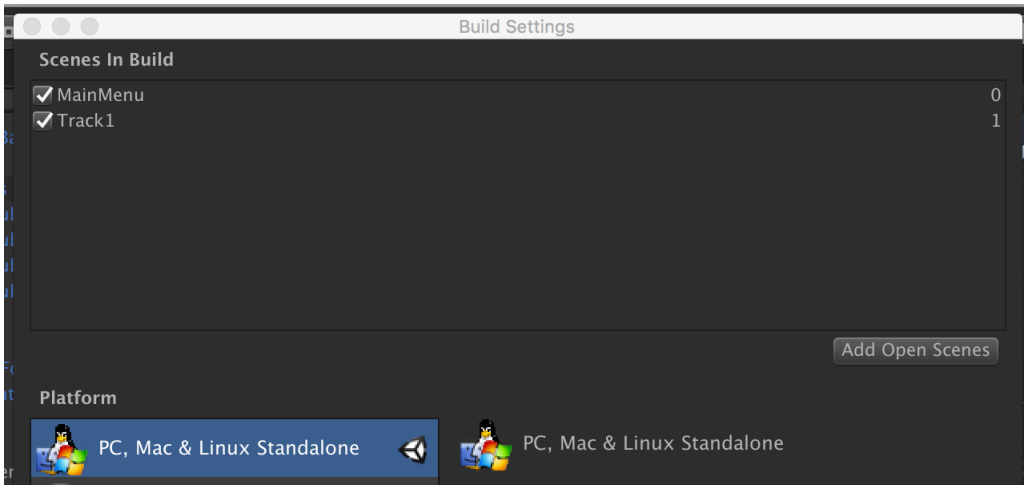
So far, the games that have been made have been demonstrations of various principles and core mechanics that take place in a single *scene*, rather than things that would arguably be complete, albeit very simple, games. Next, we will consider how the game can be further structured to address this.

Dividing the game into multiple levels, with each in an individual scene gives distinct advantages. The game can be segmented into, for example, easy, medium and hard difficulties. More commonly, however, multiple levels allow for the game to be structured into manageable chunks, for example requiring each to be completed before the next is unlocked or to give an indication of progress. A full game is likely to be far too large to be loaded at once, and so only loading the subset of the game that will be immediately interacted with is a significant efficiency step.

In Unity, the *scene* – the structure that is used to encapsulate a level – can be used to also scaffold large elements of interaction with the game, for example to host interfaces to allow the player to start the game, or select a level, to show credits, or to return to on failure rather than just quitting the game or automatically restarting the same level. Here we need to consider how to move from one scene to the next – i.e. from the menu to the level, or from the level to the credits – and also how data can persist between scenes, given that to date all objects have been added to the hierarchy for a particular scene, and are reset when that scene is restarted.

Create a new *Scene* asset. This will be the first screen that the user sees, and they will return to it between races.

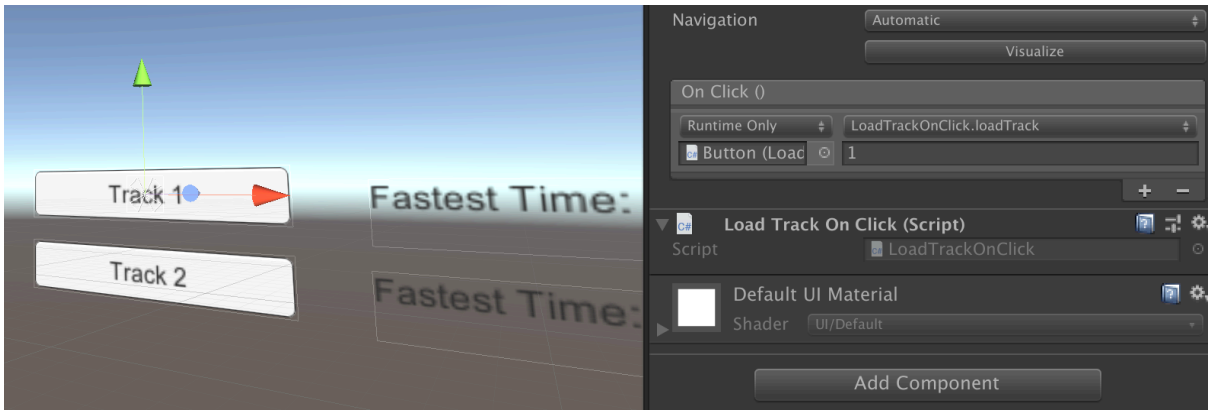
The first task is to decide which scenes should be in the game, and to be able to identify each one appropriately. Open the File->Build Settings menu, which displays the scenes currently in the build (note this menu is also where you can configure and build an executable package for the game that can be distributed). By either dragging scenes into this list or removing superfluous scenes, ensure that your new “menu” scene is at index 0, and your race track scene is at index 1.



Add a *Button* to the scene, that when clicked calls an attached script (as in lab 06) to load the scene at the specified index. Note that when the loadTrack method is selected in the drop down the ability to specify the argument for this method appears. This means that this script can be added to multiple buttons, to provide an appropriate button for scenes at different indices.

```
using UnityEngine.SceneManagement;

public class LoadTrackOnClick : MonoBehaviour
{
    public void loadTrack(int trackIndex)
    {
        SceneManager.LoadScene(trackIndex);
    }
}
```



- Modify your RaceController class so that, when the player crosses the finish line, the Menu scene is reloaded – i.e. scene index 0 is loaded as above.

A detailed tutorial on creating a similar menu is available here:

https://unity3d.com/learn/tutorials/topics/user-interface-ui/creating-main-menu

The final piece of the game is to add a persistent object that exists in all scenes to maintain the “best time” for the race track.

Create an empty object to act as a manager for this cross-scene data, with a new script attached. The following implements something like a *singleton* pattern – meaning that there will only be one instance of the ScoreManager object regardless of how many times the object is itself instantiated. The *DontDestroyOnLoad* call means the object will continue to exist when we move from the menu scene to the race track scene, and the singleton pattern will ensure it is not duplicated when we move from the race track back to the menu.

Further detail is available here:

https://unity3d.com/learn/tutorials/projects/2d-roguelike-tutorial/writing-game-manager
https://en.wikipedia.org/wiki/Singleton_pattern

```
public class ScoreManager : MonoBehaviour
{
    static ScoreManager instance = null;

    void Awake()
    {
        //Check if instance already exists
        if (instance == null)
            //if not, set instance to this
            instance = this;

        //If instance already exists and it's not this:
        else if (instance != this)
            // Then destroy this. This enforces the singleton pattern,
            // meaning there can only ever be one instance of a ScoreManager.
            Destroy(gameObject);

        //Sets this to not be destroyed when reloading scene
        DontDestroyOnLoad(gameObject);
    }
```

```
    public float bestTime = 100.0f;

    public void setTime(float newTime, int trackNumber)
    {
        if(bestTime > newTime)
            bestTime = newTime;
    }

}
```

When the race ends, the RaceController can save the lap time to this object:

```
    ScoreManager.instance.setTime((Time.time - startTime),
        SceneManager.GetActiveScene().buildIndex);
```

However, the other objects in the menu scene – the various text and button elements – no longer exist, so when the menu scene is loaded these elements should retrieve the values they need to display from the ScoreManager object on start.

Obviously the best time will not persist between launches of the game, as the ScoreManager object only survives between *scenes*. To save the player's times for future games the ScoreManager could make use of the *PlayerPrefs* storage functionality, which provides key-value pair persistence (disk based).

https://docs.unity3d.com/ScriptReference/PlayerPrefs.html

https://unity3d.com/learn/tutorials/topics/scripting/high-score-playerprefs

Exercises

Create a second track – copy your initial race track scene but add more obstacles to it to make it more complicated. There are ramps and a loop in the Sample Scene assets.

Add a second button to the menu that loads the new scene, but restrict access to this (i.e. disable the button) until the player has achieved a certain time in the first track, essentially "unlocking" the new track.