

Editor's Interface

Scene view	Build the game world, interact with game objects
Game view	Preview and play game (pressing Play in Toolbar)
Inspector	Show and modify game objects' components' properties
Hierarchy	Game objects in game
Project	Assets available
Toolbar	Bar with buttons at the top. Contains transform tools, play controls, layers and layout
Assets	Files (scripts, textures, models, prefabs)
Console	Contains debug logs and errors
Tags, Layers, Sorting Layers	Open from Edit > Project Settings > Tags and Layers. Tags are identifiers for Game Objects. Game Objects can belong to Layers. Objects in last Layers are rendered above the others. SpriteRender Components can belong to Sorting Layers, which define the rendering order for sprites. Camera Components can see or not Sorting Layers by setting the Culling Mask

Game Objects and Components

Game Object	Basic entity in Unity. Can be a 3D or 2D object, a particle or audio or video source, a UI element, or an empty object. Game Objects are just containers for Components. Scripts can be attached to Game Objects, to define their behavior and properties. Game Objects in your scene are represented in the Hierarchy
Component	Basic entities that implement functionalities inside Game Objects
Component in the Inspector	Each Component has a small header bar with: Turn down arrow, Icon, (De)activate checkbox, Reference book (opens online manual), Preset button, Options gear (allows to copy and paste Components). Under the bar are all the Component's properties

Game Objects and Components (cont)

Prefab	Blueprint for Game Objects. You can make a Prefab out of a Game Object. The Prefab will be like a "model" from which you can instantiate new identical copies of that object in your game. Modifying the Prefab properties will modify all Game Objects instantiated from it
Parent/Child	Any Game Object can have other Game Objects as children. The Transform of a child Game Object will be relative to the parent's Transform. If you make a Prefab out of a Game Object with children, all the hierarchy will be copied. You can see parent/child relationships in the Hierarchy
Usage	
Create new Game Object	Right click on the Hierarchy > select the Game Object type

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Game Objects and Components (cont)

Game Objects' name Set the name from the Inspector (upper part), or from slow double click on the object in the Hierarchy

Tag Assign custom Tags to Game Objects from the Inspector (upper part)

Add a child In the Hierarchy, drag a Game Object over another

Add Component Inspector > Add Component

Create Prefab Drag the Game Object from the Hierarchy to the Project window

Create Game Object from Prefab Drag the Prefab from the Project to the Scene view or the Hierarchy

Modify a Prefab If you select a Prefab from the Project, and you modify its properties/components, all objects of that type will be modified. On the contrary, if you modify a single Game Object, you can then, from the Inspector (upper part) click on Prefab: Apply button to modify the Prefab

Game Objects and Components (cont)

Deactivate Game Object Click the tickbox in the upper part of the Inspector

Reference Game Object in the Inspector If you define public `GameObject` or Component (ex: `Transform`) variables in a script, they will be visible as properties in the Inspector (under the Script Component). You can assign Game Objects to these variables by dragging a Game Object from the Hierarchy to the field in the Inspector. If the variable is of type `GameObject`, you reference the whole Game Object. If it is of some Component type, instead, you will reference that Game Object's Component directly instead

Game Objects and Components (cont)

Reference Prefab in the Inspector The same way you reference a Game Object or a Component in a Script variable from the Inspector, you can drag a Prefab from the Project window to reference it. This is useful for instantiating copies of the Prefab later on

Instantiate Prefab To instantiate a Prefab from a Script: define a variable of type `GameObject` or of some Component type. Reference the Prefab from the Inspector. You can now use the `Instantiate()` function (see API section)

Basic Game Objects and Components

Basic Game Objects

Sprite 2D graphic Game Object. Contains `SpriteRenderer` component, that manages the rendering of the texture. If you add 2D Colliders and/or 2D `Rigidbody` Components, the Sprite will behave like a physical object



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Basic Game Objects and Components (cont)

Camera Contains a Camera component and an Audio Listener. Gives the window through which you can experience your game's world. In a new scene, there is always a Main Camera already present. You can parent a Camera to a Game Object to follow it (or setup a script that continually sets the Camera's position to the Game Object's position)

Basic Components

Transform Determines position, rotation and scale. It is always present

SpriteRenderer Display an image (Sprite property). You can create and set a Sorting Layer to define which sprite is rendered above and which below when two sprites overlap

Camera Capture and display the world. Has several options, such as background default color, field of view. In Culling Mask you can set what layers to render and what to ignore. Game Objects belonging to ignored layers won't be seen

Script Defines custom properties and behavior of a Game Object

2D Physics

Physics Components

Rigidbody 2D Places an object under control of the physics engine, giving it a Body Type (see below), a mass, a new position (overriding the Transform's one), a velocity, an angular velocity, a Material (defining drag and bounce), and allowing it to be affected by forces (gravity, drag, impulse). Attaching a Rigidbody to a Sprite makes it behave in a physically convincing way

Collider 2D Defines the shape for the purpose of collisions. Can be edited by clicking "Edit Collider". Can be set to "Trigger" to emit events

Body types

Dynamic Body designed to move. Collides with any body type. Can be affected by forces

Static Doesn't move (infinite mass). Collides with Dynamic bodies. Gives back forces when colliding

Kinematic Designed to move (only via function calls). It moves accordingly to its velocity, but it's not affected by forces. Collides only with Dynamic bodies

Mechanics

2D Physics (cont)

Spatial coordinate s The position of a body is identified by a point (Vector3 with 3 coordinates in 3D space, Vector2 in 2D space). In games, the X axis grows from left to right, while the Y grows from top to bottom (it's reversed)

$S = V * T$ A body with velocity V moves by S in a timestep T

$V = A * T$ A body with an acceleration A increases its velocity by V in a timestep T

$F = m * A$ Applying a force F to a body with mass m causes an acceleration A on it

Static drag If there is a static drag D on a surface, a body cannot move unless you apply a force $F > D$ to it

Dynamic drag If there is dynamic drag D on a surface, a body moving on it will constantly have a force D *opposed* to where it's moving

Gravity If there is a gravitational acceleration g, a body will have a downwards acceleration of g

Trajectory Curve on which a body moves. A projectile (Angry Bird) with just an initial velocity and in a gravitational field will "draw" a parabola shape. The projectile lands farther if the initial velocity vector was at 45°

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2D Physics (cont)

Angular mechanics When dealing with rotations, simply substitute: position with angle, velocity with angular velocity, acceleration with angular acceleration, force with torque, drag with angular drag. The laws stay the same

Scripting

What is a script A script is a file containing code (usually C#) that defines the properties and the behavior of a Game Object

Adding a script Add a Script to a Game Object from Inspector > Add Component > New script

Editing a script Double click on the script in the Inspector. It will be open with your default external editor (Visual Studio, Monodevelop). Then change the script and save it

Script contents A script usually has import statements in the upper part, and then the code of a class (with the same name of the file), that contains variables and methods

Scripting (cont)

Set variable from Inspector From the Inspector you can set values for public variables defined in Scripts. For numbers and strings, type directly in. For `GameObject` or any Component types, drag Game Objects or Prefabs from the editor to the field

Compiling Once a script is saved, Unity automatically (re)compiles it. It may take some time (wait for the loading gif in the bar below to disappear)

Debugging Compile-time errors and debug logs (outputs of `Debug.Log()`) are shown in the Console

Accessing classes from other scripts If a Script defines a `public` class, you can use that class as a reference in any other Script. Ex: the script `Enemy` contains a reference to the class `Player` because it needs to chase it

Documentation From the text editor, select a term and press `Ctrl + '`

C#

Syntax

`statement ;` End every statement with a semicolon

`using namespace` Include namespace, making new classes available

`class name : father { }` Define class (inheriting from `father` class). A class is a blueprint that you can use to instantiate an object: a special variable that contains its own variables (members) and functions (methods)

`public field` Make a member or method visible in the Inspector and accessible from other scripts

`private field` Deny access from other scripts

`// comment` One-line comment

`/* multiline comment */` Multiple line comment

Types

`bool` true or false

`int` Integer number

`float` Decimal number. Floats always end in `f`. Ex: `4.5f`

`string` Text

`someType[]` Array containing objects of type `someType`

Variables



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C# (cont)

`int a;` Declaring a variable

`a = 5;` Assigning a value

`ClassName` Declaring a reference (variable that can contain an object)

`ComponentClass` For every Component, there exist a class with the same name that you can use to refer to it (ex: Transform)

`b = new` Instantiating an object

`ClassName`
`me();`

`object.variable` Accessing an object's member variable

`null` Value for null reference (a variable referring to no object)

`int[]` Create and assign empty array of 5 integers.
`myList`
`= new`
`int[5]`
`;`

`myList` Assign a value to an index of an array (indexing starts from 0)
`t[0]`
`= 9;`

Methods

`retType` Method definition. Can take one or more arguments in. You must specify the type of the returned object/variable. Use `void` if there is no return statement

`...` {
`body`
`return`
`x;` }

`object.` Calling a method
`method(`
`)`

Control flow

C# (cont)

`if(condition){` Conditional statement
`code`
`} else if`
`(condition) {`
`code`
`} else {`
`code}`

`while(condition)` While loop. Executes `code` until `condition` is false
{
`code`}

`for(int i=X;` For loop. Initializes `i` to `X` and executes `code` as long as `i<N`
`i++; i<N){`
`code}`

`foreach(type x` Executes `code` looping over `myList`. `x` is the current element of the list
`in myList){`
`code}`

Operators

`+ - * / % ? ! ++ --` Operators (4 operations, modulus, ternary conditional, not, increase, decrease)

`< > == != <= >=` Relational operators (lesser, greater, equal, different, less or equal, greater or equal)

`cond1 && cond2` 'and' operator. True only if both conditions are true

`cond1 || cond2` 'or' operator. False only if both conditions are false

In *italics* generic or sample terms

Code Flow and Events

Code Flow Scripts do not run in the traditional manner, looping until they complete a task. Instead, Unity runs the main Game Loop (think of it as a `while` loop where continuously the following things happen: external input is taken, the game state is updated, objects may be created and destroyed, physics and graphics computations are run, and a new frame is rendered on the screen). When events of a certain type happen, Unity passes control to Scripts by calling the corresponding function. These are called Event Functions

Event Functions Callback functions that are called by Unity when certain events occur. Event Functions are provided as methods of the `MonoBehaviour` class, from which the classes in every Script inherit

Code Flow and Events (cont)

Trigger Checkbox you can tick in a Collider

Collider Collider Component. If active, the object will emit a *trigger event* when in contact with something. Triggers are used for non-physical collisions (e.g. detecting when someone enters)

MonoBehaviour Event Functions

Awake () Called once before everything else

Start () Called once after all Awakes, before any Update

Update () Code that changes the position, state, behavior of objects in game. It is called before each frame is rendered. Updates happen at every iteration of the Game Loop, therefore each update may take a different time. The variable `Time.deltaTime` always contains the duration of the last update iteration

Code Flow and Events (cont)

FixedUpdate Called before each physics update.

physicsUpdate () The physics engine updates in time steps of fixed duration, therefore you don't have to correct for deltaTimes when moving things inside FixedUpdate. Place physics calls inside this

OnMouseDown () Called when there is a mouse event. *** can be: Down, Enter, Exit, Over, Up, UpAsButton

OnCollision-*2D** Called when the object is involved in a collision. *** can be: Enter, Stay, Exit (contact is made, held, or broken). The parameter contains info about the collision

Collision

OnTrigger*2D(Collider other)** Called when the object is involved in a collision, only if the object's collider is configured as a Trigger. *** can be: Enter, Stay, Exit. The parameter is the other object's collider

Unity game loop:
https://docs.unity3d.com/uploads/Main/monobehaviour_flowchart.svg

Input

Input Manager Access in the editor by Edit > Project Settings > Input. Contains the properties of the Axes

Axes Axes are virtual directions ("Horizontal", "Vertical", "Jump", "Fire1",...) that represent possible inputs. Each Axis has a name, and one or two buttons that are mapped onto the *Positive direction* and the *Negative direction* (e.g. "Fire1" only has a button for the Positive input, since there is no concept of *firing backwards*)

Getting Input When a player presses an axis button, Unity will set the axis state to a value between -1 and 1 (-1 negative, 1 positive, 0 when there is no input). Get the input by querying Axes. Alternatively, you can query using button names (Keys)

```
value = Input.GetAxis("Horizontal");
```

Input (cont)

```
value = Input.GetKey( "a" );
```

Returns true if the user is holding down the key "a"

API

MonoBehaviour

MonoBehaviour Each class inherits from MonoBehaviour, inheriting members and methods that should be used for most functionalities in the Scripts

gameObject This Game Object (the Game Object to which the Script is attached)

tag This Game Object's Tag

transform This Game Object's Transform

GetComponent<Type>() Returns the component of type *Type* contained in this Game Object

GetComponent<Type>() Returns all components of type *Type*

Destroy(gameObject, t) Removes something (after *t* seconds). **Destroy(gameObject)** destroys the Game Object attached to the Script. **Destroy(this)** destroys the Script Component itself. **Destroy(GetComponent<...>())** destroys another Component

API (cont)

Instantiate(Component, position, original) Clones a GameObject or Component and returns the clone. If you clone a Component, the whole GameObject it is attached to will also be cloned

GameObject

GameObject Base class for all entities in Unity Scenes

tag Tag of this Game Object

transform Transform of this Game Object

SetActive(bool value) Activate/deactivate this Game Object

GameObject.FindWithTag("Tag") Static method that finds and returns the first Game Object with tag *Tag*

Component

Component Base class for everything attached to GameObjects. For every specific component there is a class (with the same name as the Component), inheriting from this. Ex: Transform

Transform

position Position as a *Vector3*

rotation Rotation as a *Quaternion*

API (cont)

Rotate(float xAngle, float yAngle, float zAngle) Rotate around X, Y, Z axis

Translate(Vector3 translation) Moves position. Ex: `transform.Translate(Vector3.forward*Time.deltaTime)`

Vector

new Vector2(x, y) Create new 2D vector

new Vector3(x, y, z) Create new 3D vector. Transform's positions are always *Vector3*, even in 2D! (But you shouldn't set positions directly to move objects)

v + u, v - u Sum/subtract two vectors

v * 5, v / 5 Multiply/divide a vector by a number

target.position - player.position Vector representing the distance between the two objects's Transforms

v.magnitude Vector's length

v.normalized Vector with the same direction, but magnitude of 1

v.x Access X component (same for Y and Z)

Debugging

Debug.Log("message"); Prints a message to the Console

Rigidbody2D

API (cont)

`mass` The body's mass. You can access all the other properties that you see from the Inspector as well

`AddForce` Apply a force to the Rigidbody. Use this inside `Update()` (Vector2- for a constantly applied force
`force`)

`AddTorque` Add a torque (gives an angular acceleration)
`e(float`
`torque)`

`MovePosition(Vector2 position)` Quickly thrust towards a new position (tries to get there in the time of a physics update, but collisions or long distances may impair it). Use this in `FixedUpdate()` rather than in `Update()`

Full scripting API: <https://docs.unity3d.com/ScriptReference/index.html>

Manual: <https://docs.unity3d.com/Manual/index.html>

2D guides: <https://unity3d.com/learn/tutorials/s/2d-game-creation>

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