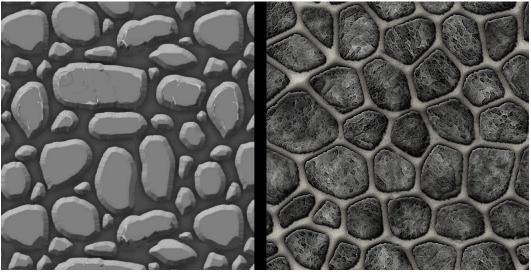
Chapter 1: Pseudo Random Numbers



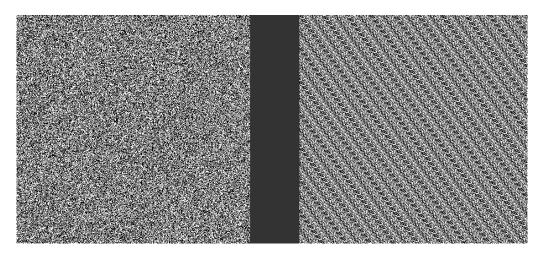
On the left is a hand-drawn texture, and on the right is a Procedurally Generated texture



A player-created building in the popular game Minecraft



Some of Gearbox Software's Borderlands procedurally generated weapons each generated from asset modules



Random number noise signals – on the left is a random number pattern that does not repeat and on the right is a PRN pattern that repeats

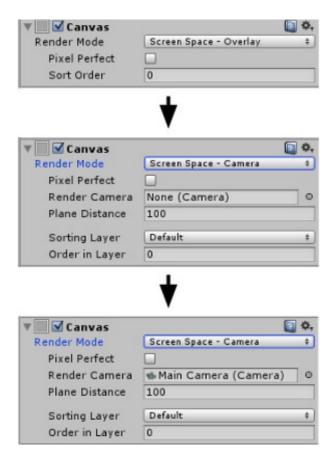


A forest scene created with Unity Terrain Engine which uses PRNs

🚯 Unity 5.0.1f1		
Projects Get sta	rted	
	Hello World Project name*	
	D:\Unity Projects Location* 3D 2D Asset packages	Create project
Community Documentation TL	torials	

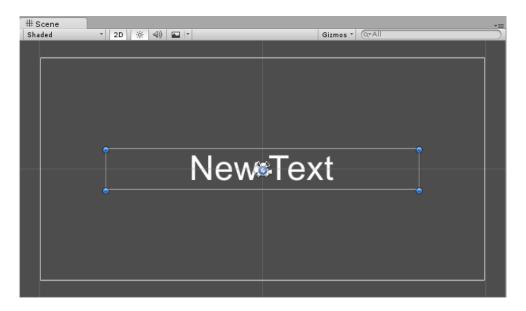
Unity launch screen

🚭 Unity Personal (64	lbit) - Untitled - Hello_World - PC	, Mac & Linux Standalo	one* <dx11 dx10="" gpu="" on=""></dx11>
File Edit Assets	GameObject Component Wi	ndow Help	
🖑 💠 😘	Create Empty	Ctrl+Shift+N	
# Scene	Create Empty Child	Alt+Shift+N	
Shaded	3D Object	· · · · ·	Gizmos * Q*All
	2D Object	• • •	
	Light	• •	
	Audio	• •	
	UI	•	Panel
	Particle System		Buttom
	Camera	(Text
	Center On Children		Image
	Make Parent		Raw Image Slider
	Clear Parent		Scrollbar
	Apply Changes To Prefab		Toggle
	Break Prefab Instance		Input Field
	Set as first sibling	Ctrl+=	Canvas
	Set as last sibling	Ctrl+-	Event System
	Move To View	Ctrl+Alt+F	
	Align With View	Ctrl+Shift+F	
	Align View to Selected		
C Game	Toggle Active State	Alt+Shift+A	
Free Aspect	•		Maximize on Play Mu

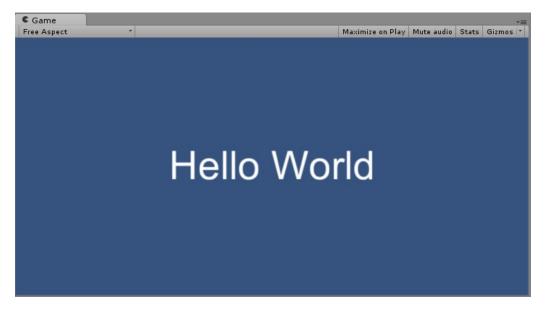


Workflow to get the Canvas in Main Camera view

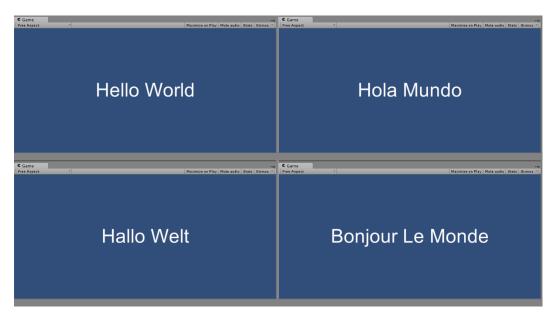




Finished canvas and text formatting



Hello World program's result



Hello World with PRNs Program Result

Chapter 2: Roguelike Games

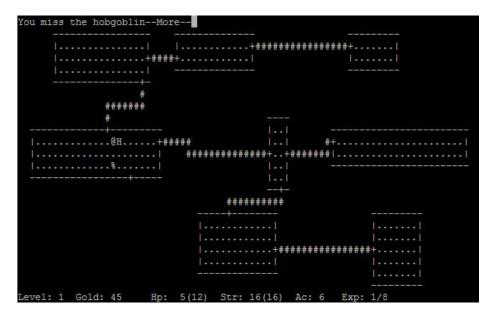
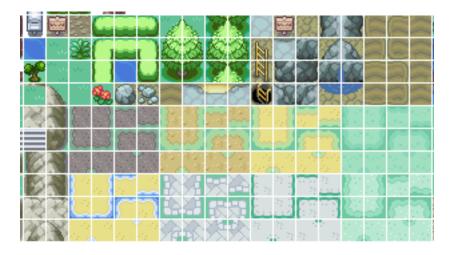


Image of Rogue (1980) by Michael Toy and Glenn Wichman



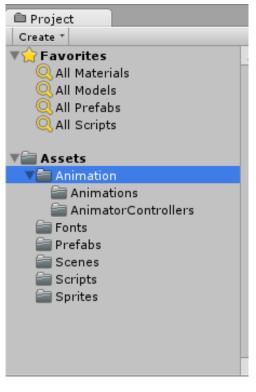
Tile sprite sheet from the popular game, *Pokemon*, developed by Game Freak



Unity Technologies' 2D Roguelike-courtesy of Unity Technologies

() + S X II	🕫 Pivot 🛛 🛱 Local				
Teate * Q*All	→= # Scene	C Game 28 Animator			Maximize on Play Mute audio Stats Gizmos *
Main Camera					manine on ay mate asso stary stands
Player ⊫ Canvas					
EventSystem GameManager(Clone					
			1		
			Health:	100	

Results of importing the package and clicking on play

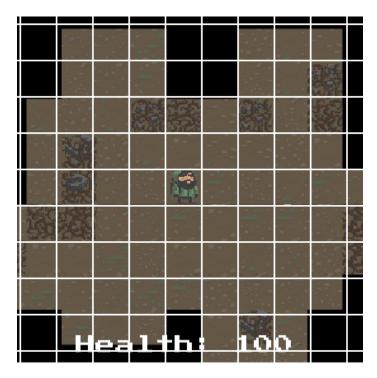


Folder structure for the Roguelike project

Chapter 3: Generating an Endless World



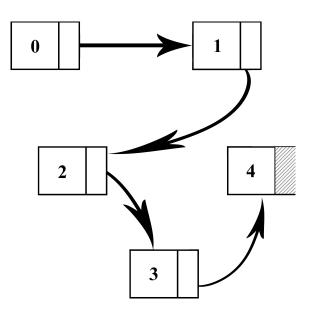
This is what our Roguelike endless PCG Game Board will look like



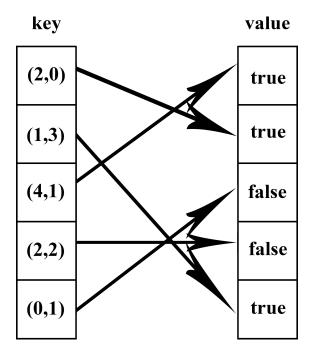
Imagine the Game Board within a grid

X	0	1	2	3	4
	\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
Y	0	0	0	0	0
	1	1	1	1	1
	2	2	2	2	2
	3	3	3	3	3
	4	4	4	4	4

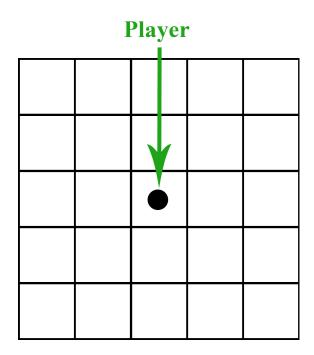
Visualization of a 2D array



Visualization of a linked list



Visualization of a dictionary/map

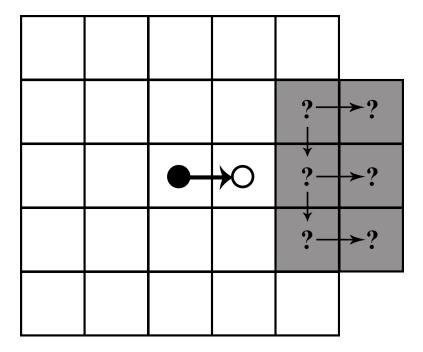


The initial Game Board grid with the player

The line of sight grid squares are shaded

	•	Ŷ	

Revealing more tiles as the player moves right



The tiles are iterated over to check whether they have already been discovered

		(4,4)
	• (2,2)	
(0,0)		

The grid will correspond with the x-y plane



All our sprites are 32 x 32, which is 1 unit of measure

		e
2D		
_	UnisionSider.pretab	
	🜍 CratePink .prefab	NEW
	🜍 ExtentsLeft.prefab	NEW
	🔰 ExtentsRight.prefab	THEM
	🔰 Killzone.prefab	THEM
	🔰 Platform04x01.prefab	NEW
	🔰 Platform08x01.prefab	THEM
	🔰 Platform12x01.prefab	THEM
	🔰 Platform16x01.prefab	THEM
	🔰 Platform36x01.prefab	TEN
	😺 PlatformRamp.prefab	INEW
	V 🔤 Scripts	
/	Camera2DFollow.cs	
	Platformer2DUserControl.cs	TEN
	PlatformerCharacter2D.cs	NEX.
	Restarter.cs	NEW
	🐨 🕋 Sprites	DEN
	BackgroundGreyGridSprite.png	NEN
	🔤 BackgroundNavyGridSprite.png	NEW
	🔤 CratePinkGridSprite.png	NEW
	📕 Platform White Sprite.png	NEW
	RobotBoyCrouchSprite.png	INEN
	🔤 RobotBoyDeathSprite.png	THEM
	🔤 RobotBoyIdleSprite.png	THEM
	📠 RobotBoyJumpSprite.png	INEN
	🔤 RobotBoyRollSprite.png	INEN
	🔜 RobotBoyRunSprite.png	INEN
	🔤 RobotBoy Walk Sprite.png	THEM
	V CrossPlatformInput	INEN
	📰 CrossPlatformInputGuidelines.txt	INEN
	V 🕋 Prefabs	INEN
	🥁 CarTiltControls.prefab	NEW
-	All None	Cancel Import

Import settings

🔻 🕼 🗹 Camera 2D F	ollow (Script) 🛛 🔯	\$,
Script	💽 Camera2DFollow	0
Target	,↓Player (Transform)	0
Damping	1	
Look Ahead Factor	1	
Look Ahead Return S	0.5	
Look Ahead Move Th	0.1	

The Camera 2D Follow settings screen



No Game Board

€	🖸 Inspector 🔒 🔒								
ą	🏹 Tags & Laye	ers	i 🗊 🌣,						
×	Tags Sorting Layers								
	— Layer		Default						
	😑 Layer		Floor						
	— Layer		Units						
•	Layers		+ -						
	Builtin Layer 0	D	efault						
	Builtin Layer 1	_	ansparentFX						
	Builtin Layer 2	-	nore Raycast						
	Builtin Layer 3								
	Builtin Layer 4	W	ater						
	Builtin Layer 5	U							
	Builtin Layer 6								
	Builtin Layer 7								
	User Layer 8	Ы	ockingLayer						
	User Layer 9	Fl	oor						
	User Layer 10	U	nits						
	User Layer 11								
	User Layer 12								
	User Layer 13								
	User Layer 14								
	User Layer 15								
	User Layer 16								
	User Layer 17								
	User Layer 18								
	User Layer 19								

The Layer settings



Initial Game Board



PCG Game Board



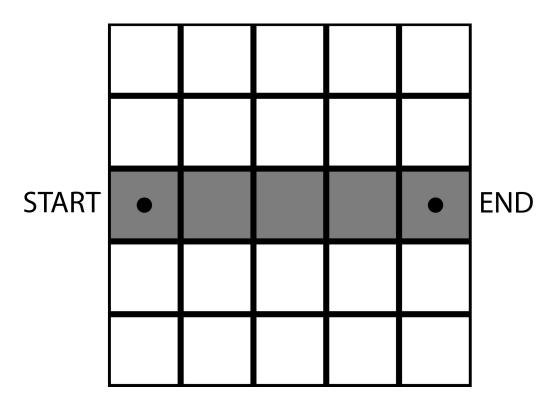
PCG Game Board plus wall tiles

Chapter 4: Generating Random Dungeons

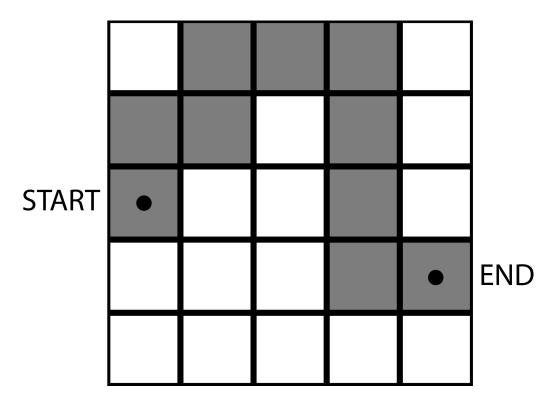


Image of final result of dungeon generator

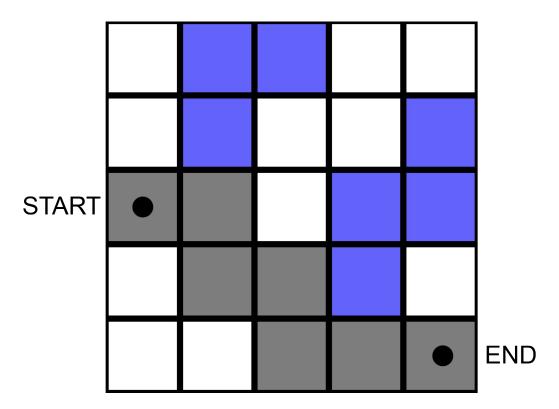
A diagram of the simple grid



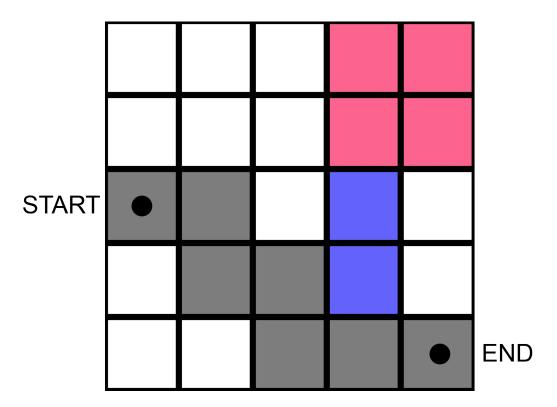
A diagram of the simplest essential path



A diagram of the winding essential path



A diagram of random paths in blue



A diagram of the chamber in red

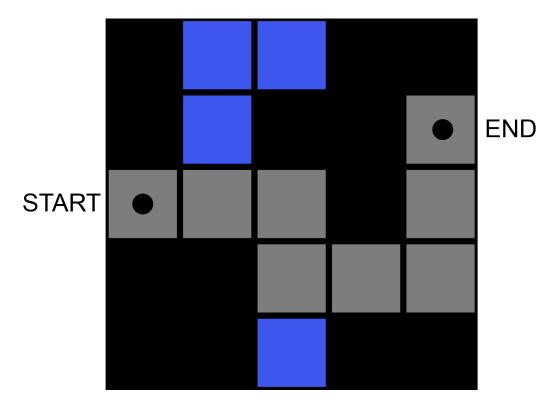
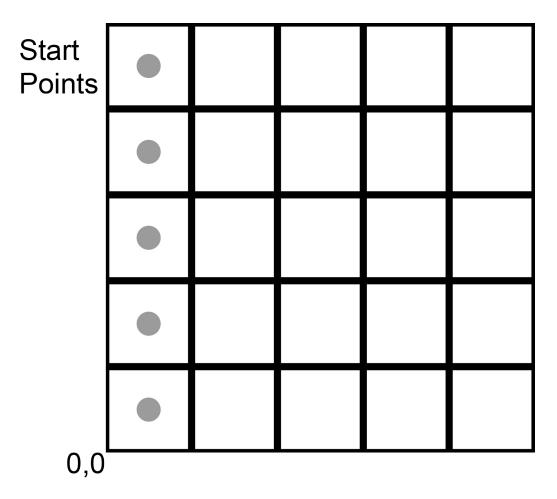
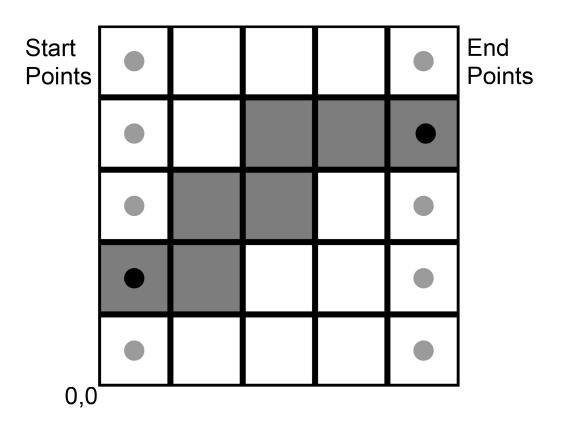


Diagram of outer wall tiles in black

A diagram of the outer wall tiles enclosing the dungeon in black

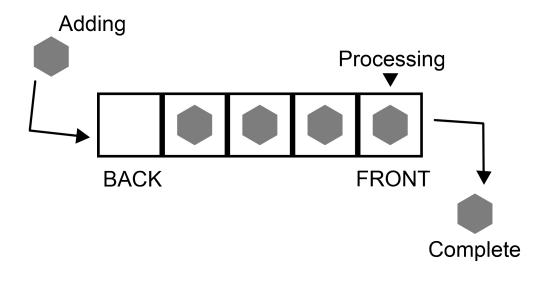


A diagram of possible starting points



A diagram of the placement of exit based on the path

A diagram of a path cycling back



A diagram of a queue

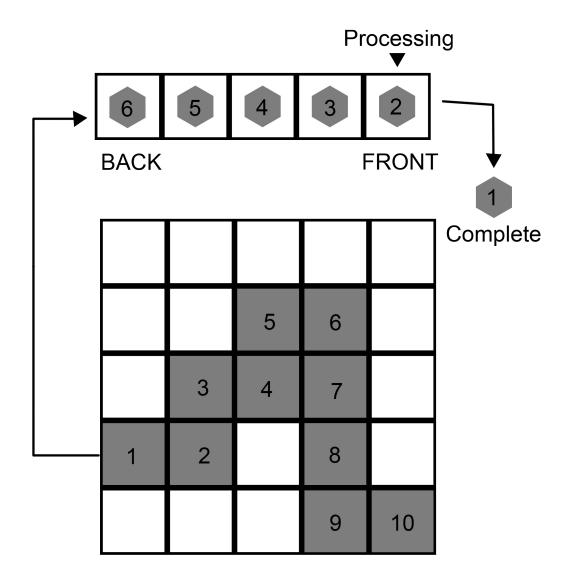


Diagram of essential path in queue



Image of exit tile sprite

🔻 💽 🗹 Sprite Renderer				\$,
Sprite	Scavengers_SpriteSheet_20			0
Color				Þ
Material	Sprites-Default			0
Sorting Layer	Items			ŧ
Order in Layer		Default		
🔻 🔲 🗹 Box Collider 20		Floor		\$,
Material		Items		0
Is Trigger	Ľ			
Used By Effector		Units		
Offset		Add Sorting Layer		
Size				

An image of sorting layer order

▼ Outer Wall Tiles		
Size	3	
Element 0	🜍 OuterWall1	0
Element 1	🜍 OuterWall2	0
Element 2	🜍 Outer Wall 3	0
🔻 🕒 🛛 Dungeon Manage	r (Script) 🛛 🗐	\$,
Dungeon Manage Script	r (Script) 🔯	≎, ⊙
		≎, ⊙
Script	🕞 DungeonManager	≎, ⊙

New options in the GameManager prefab

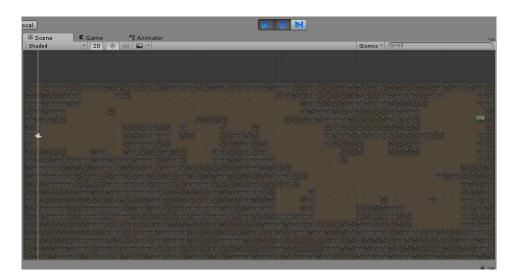


Image of dungeon overview

Chapter 5: Randomized Items

Inspector		<u></u>
😭 🗹 Food		Static 👻
Tag Food	‡ Layer Items	\$
🔻 🙏 🛛 Transform		💽 🌣,
Position	X 5 Y 5 Z 0	
Rotation	X 0 Y 0 Z 0	
Scale	X 1 Y 1 Z 1	
🔻 💽 🗹 Sprite Rendere	er	🔯 🌣,
Sprite	Scavengers_SpriteSheet_19	0
Color		P
Material	Sprites-Default	0
Sorting Layer	Items	\$
Order in Layer	0	
🔻 🔲 🗹 Вож Collider 2	D	💽 🌣,
Material	None (Physics Material 2D)	0
Is Trigger	\checkmark	
Used By Effector		
Offset	X 0 Y 0	
Size	X 1 Y 1	

Food item setting



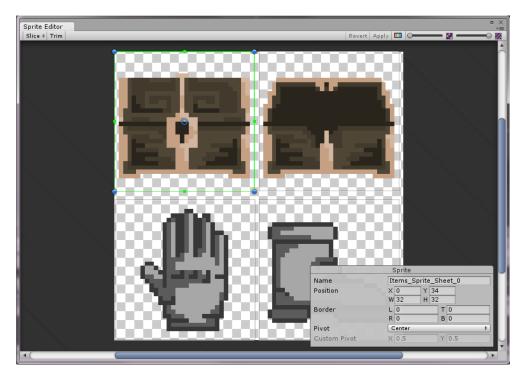
Health item appears when a wall is destroyed

🔻 📴 🗹 Game Manager (Script) 🛛 🔯			
Script	GameManager		
Turn Delay	0.1		
Health Points	1		

Where to find and set health point

Inspector	<u></u> =
🌆 🚮 Items_Sprite_S	heet Import Settings 🛛 🛛 🔯
4 E.	Open
Texture Type	Sprite (2D and UI) \$
Sprite Mode	Multiple \$
Packing Tag	
Pixels Per Unit	32
	Sprite Editor
Generate Mip Maps	
Filter Mode	Point \$
Default	
Max Size	1024 \$
Format	Truecolor +
	Revert Apply

Imported sprite sheet settings



Sprite Editor



A randomly spawned chest

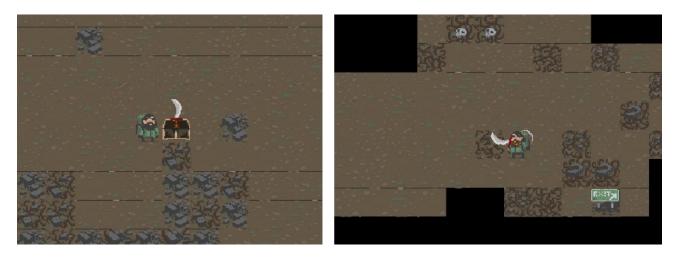


chest and item but no visible inventory



Picked up item shows in inventory

Chapter 6: Generating Modular Weapons



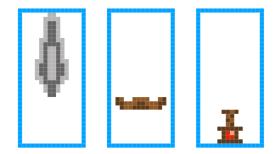
The final result of the modular weapon implementation



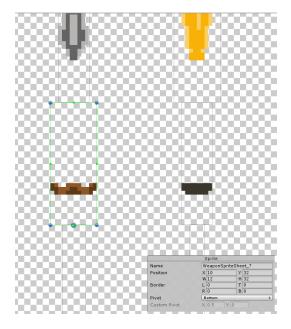
Weapon module sprites

$$4*4*4 = 4^3 = 64$$

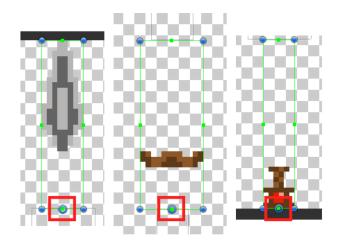
 $5*5*5 = 5^3 = 125$



Weapon modules in their respective bounding boxes



Measurements of a module



Pivot points for each type of module

👕 🗹 Weapon Com	ponents1	🗌 Static 👻	😭 🗹 Weapon Com	1ponents2	Static 🔻	👕 🗹 Weapon Com	ponents3	🗌 Static 👻
Tag Untagged	‡ Layer Units	\$	Tag Untagged	‡ Layer Units	\$	Tag Untagged	‡ Layer Units	\$
🔻 🙏 🛛 Transform		🔯 🌣,	▼ 🙏 Transform		🔯 🌣,	▼ 🙏 Transform		🔯 🌣,
Position	X 0 Y 0	Z 0	Position	X 0 Y 0	Z 0	Position	X 0 Y 0	Z 0
Rotation	X 0 Y 0	Z 0	Rotation	X 0 Y 0	Z 0	Rotation	X 0 Y 0	Z 0
Scale	X 1 Y 1	Z 1	Scale	X 1 Y 1	Z 1	Scale	X 1 Y 1	Z 1
🔻 💽 🗹 Sprite Rende	rer	🔯 🌣,	🔻 💽 🗹 Sprite Rende	erer	🔯 🌣,	🔻 頋 🗹 Sprite Rende	rer	🔯 🌣,
Sprite	None (Sprite)	0	Sprite	None (Sprite)	0	Sprite	None (Sprite)	0
Color		J.	Color		J.	Color		J.
Material	Sprites-Default	0	Material	Sprites-Default	0	Material	Sprites-Default	0
Sorting Layer	Units	\$	Sorting Layer	Units	\$	Sorting Layer	Units	\$
Order in Layer	0		Order in Layer	0		Order in Layer	0	
🔻 健 🗹 Weapon Com	ponents (Script)	🔯 🌣,	🔻 🕼 🗹 Weapon Con	nponents (Script)	[🖉 🎝 🙀	🔻 健 🗹 Weapon Com	ponents (Script)	🔟 🌣,
Script	💽 WeaponComponents	0	Script	WeaponComponents	0	Script	💽 WeaponComponents	0
▼ Modules			▼ Modules			▼ Modules		
Size	4		Size	4		Size	4	
Element 0	WeaponSpriteSheet_) 0	Element 0	WeaponSpriteSheet_	7 0	Element 0	WeaponSpriteSheet_3	0
Element 1	WeaponSpriteSheet_	1 0	Element 1	WeaponSpriteSheet_1	8 0	Element 1	WeaponSpriteSheet_4	0
Element 2	[▼] WeaponSpriteSheet_	2 0	Element 2	WeaponSpriteSheet_	9 0	Element 2	WeaponSpriteSheet_5	0
Element 3	○ WeaponSpriteSheet_	5 0	Element 3	WeaponSpriteSheet_:	10 0	Element 3	WeaponSpriteSheet_1	1 0

Weapon Component's settings



The expanded Weapon prefab



Chest spawning a weapon



The weapon is unhidden and follows the player, while there is a blank image to the right



The sword is hidden and the icon to the right appears



Weapon animation



The player faces to the right and the sword swings to the right as well, while the wall on the left is damaged



The player can now face the left



The Player can swing the sword toward the left

Chapter 7: Adaptive Difficulty



Player among enemies!



Enemy Sprite



Enemy walking on black space



Enemies on world board



Enemies on Dungeon Board



Attacking an enemy

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	•	财			
X .				S .	

Diagram of simple enemy movement

8	фÂ

Enemy stuck on wall

1	

Player is 1 space away horizontally and 2 away vertically so enemy moves vertically

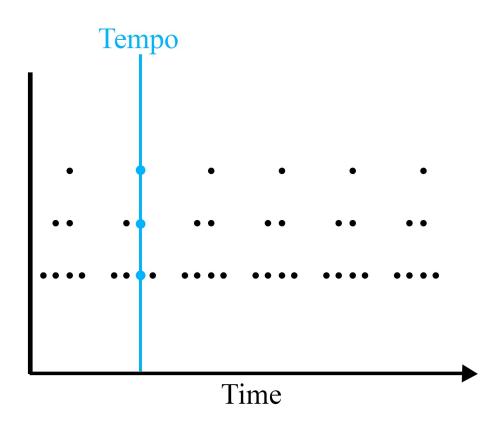
S .		
•	þý h	

Enemy going around wall

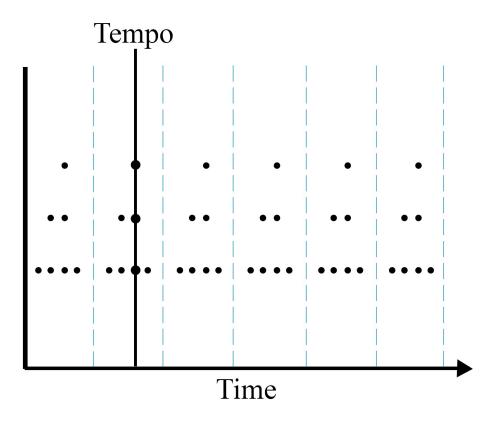
þý þ	

Smarter enemy getting stuck on a wall after two attempts of picking the best path

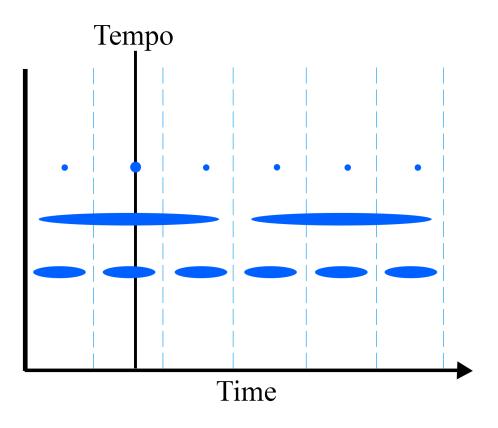
Chapter 8: Generating Music



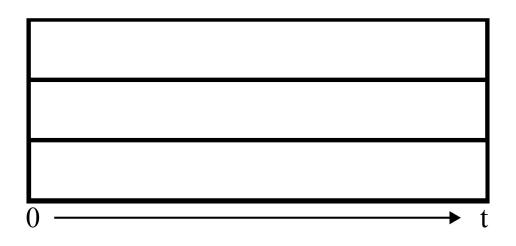
Visualization of tempo



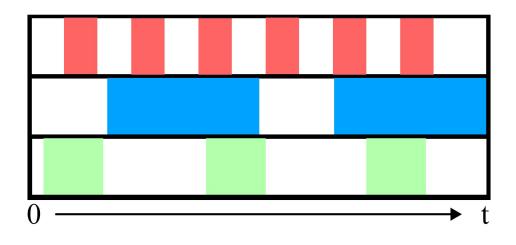
Visualization of tempo divisions



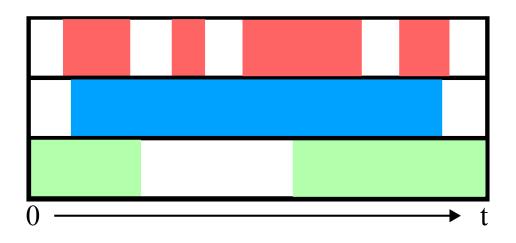
Visualization of sound length variations



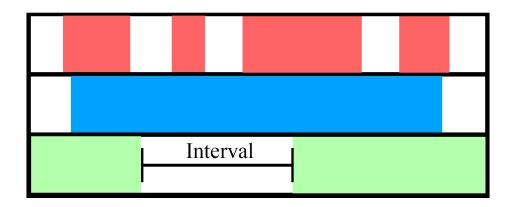
Visualization of the measure with sounds



Measure with sound division

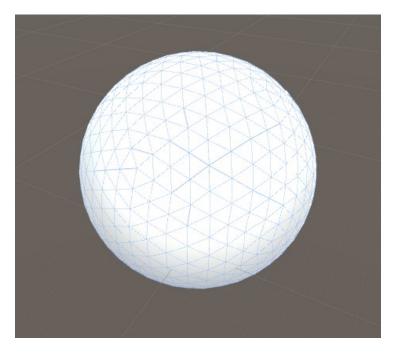


Measure with random sound lengths

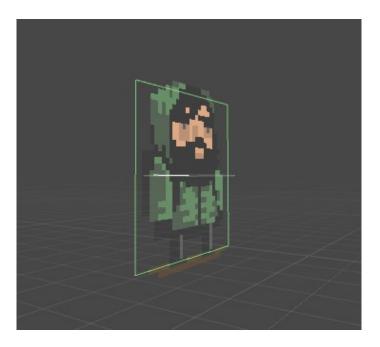


The interval in which sound is not played

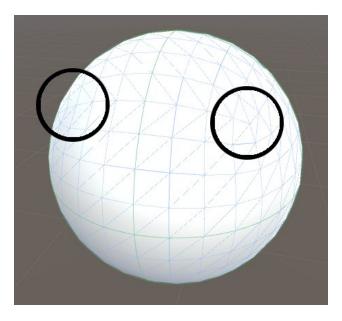




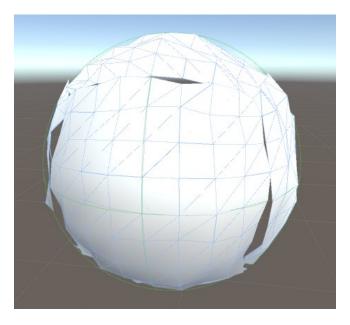
A procedurally generated sphere



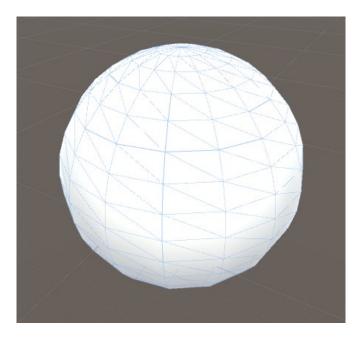
The 2D quad a sprite is drawn on to



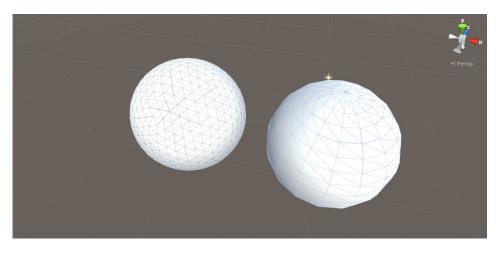
3D cube made into a sphere



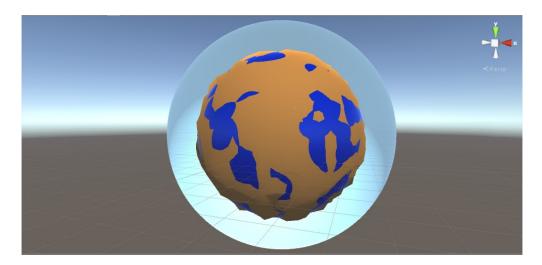
Sphere triangles splitting when moved



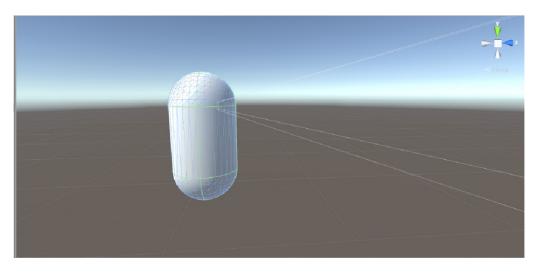
Procedurally generated sphere



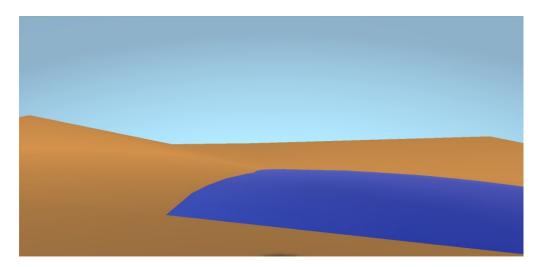
Icosahedron sphere on the left and polar sphere on the right



Procedurally generated planet



The first-person camera placement



The first-person view of the planet

Chapter 10:







