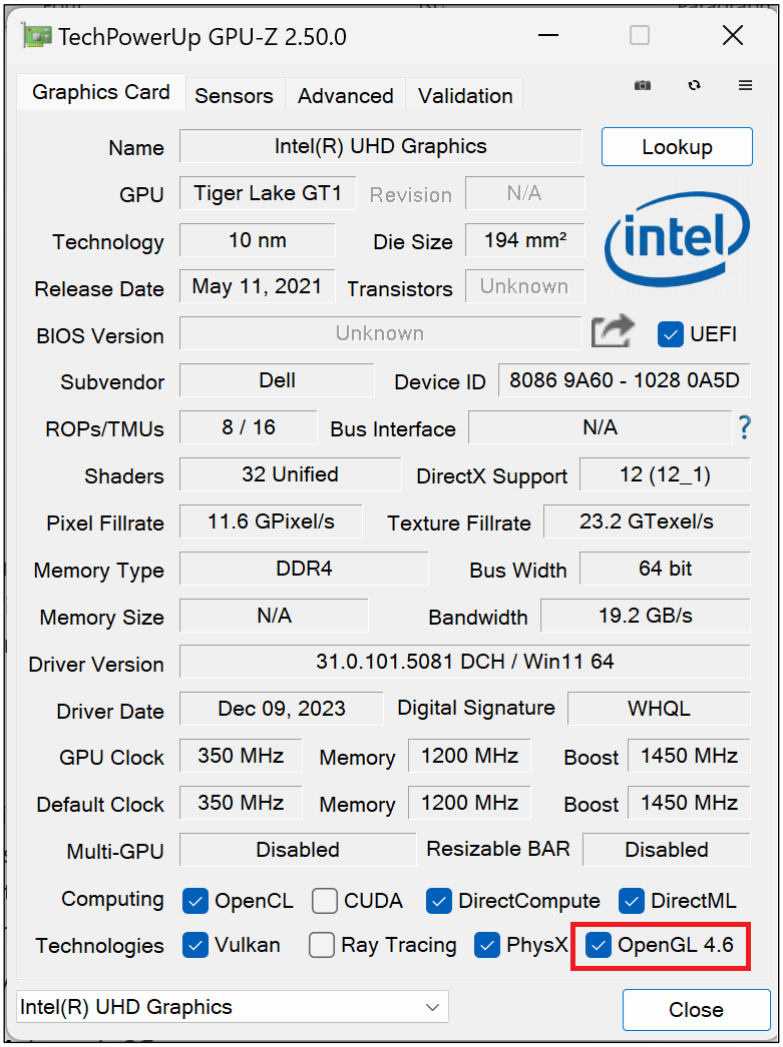
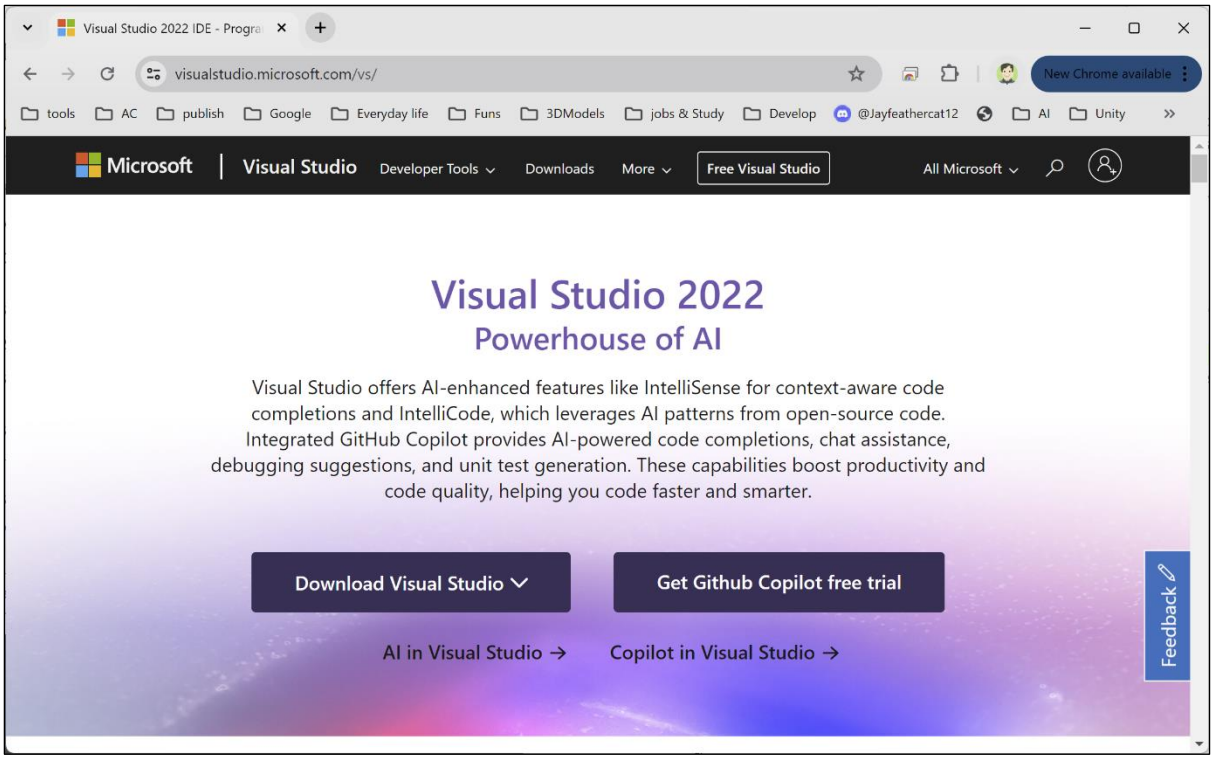
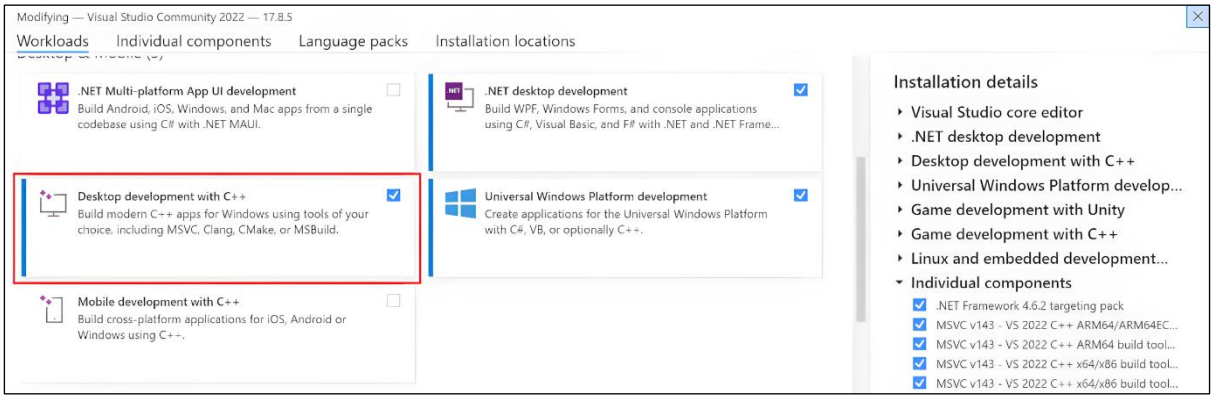
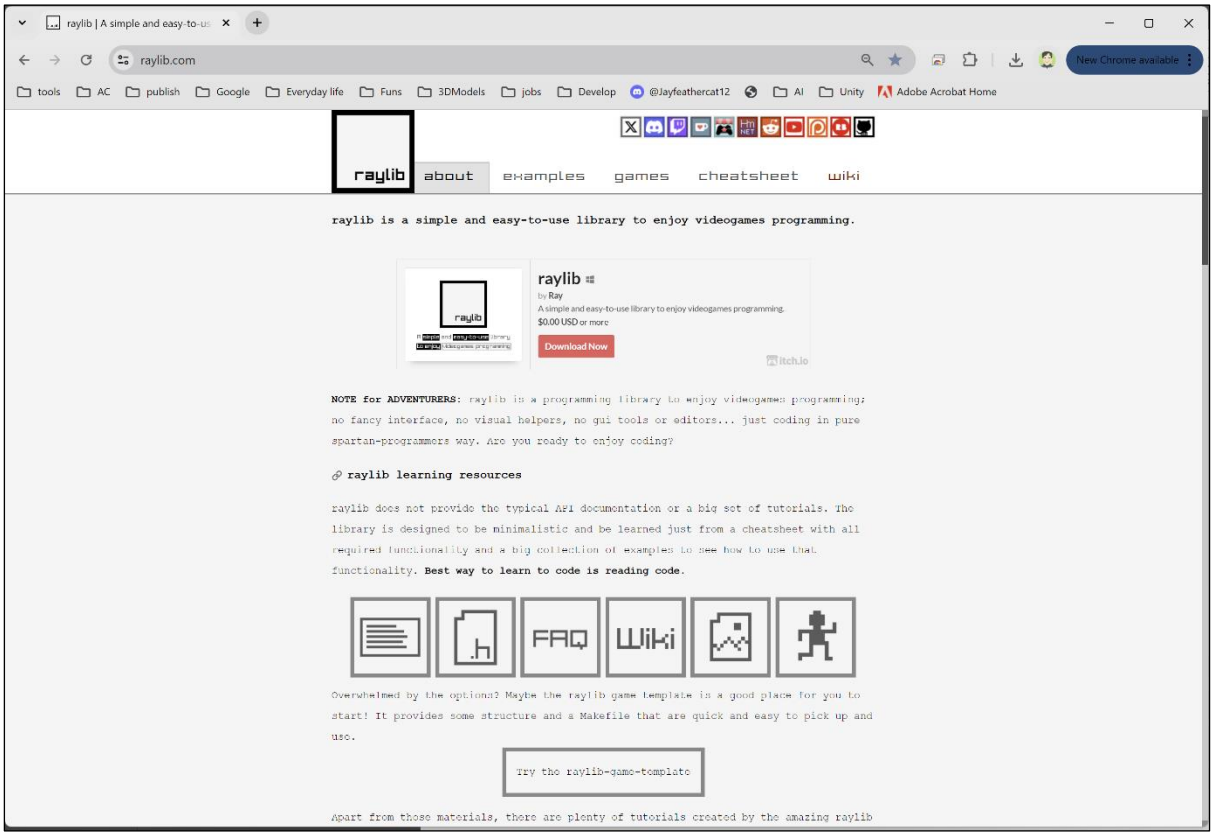
Chapter 1: Gearing Up: C++ for Game Development

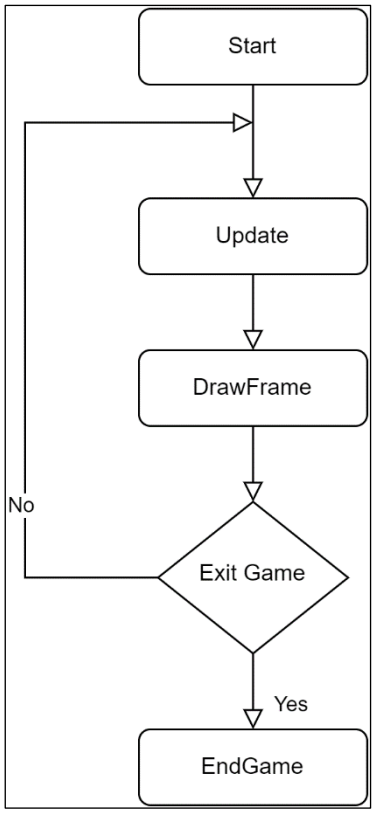


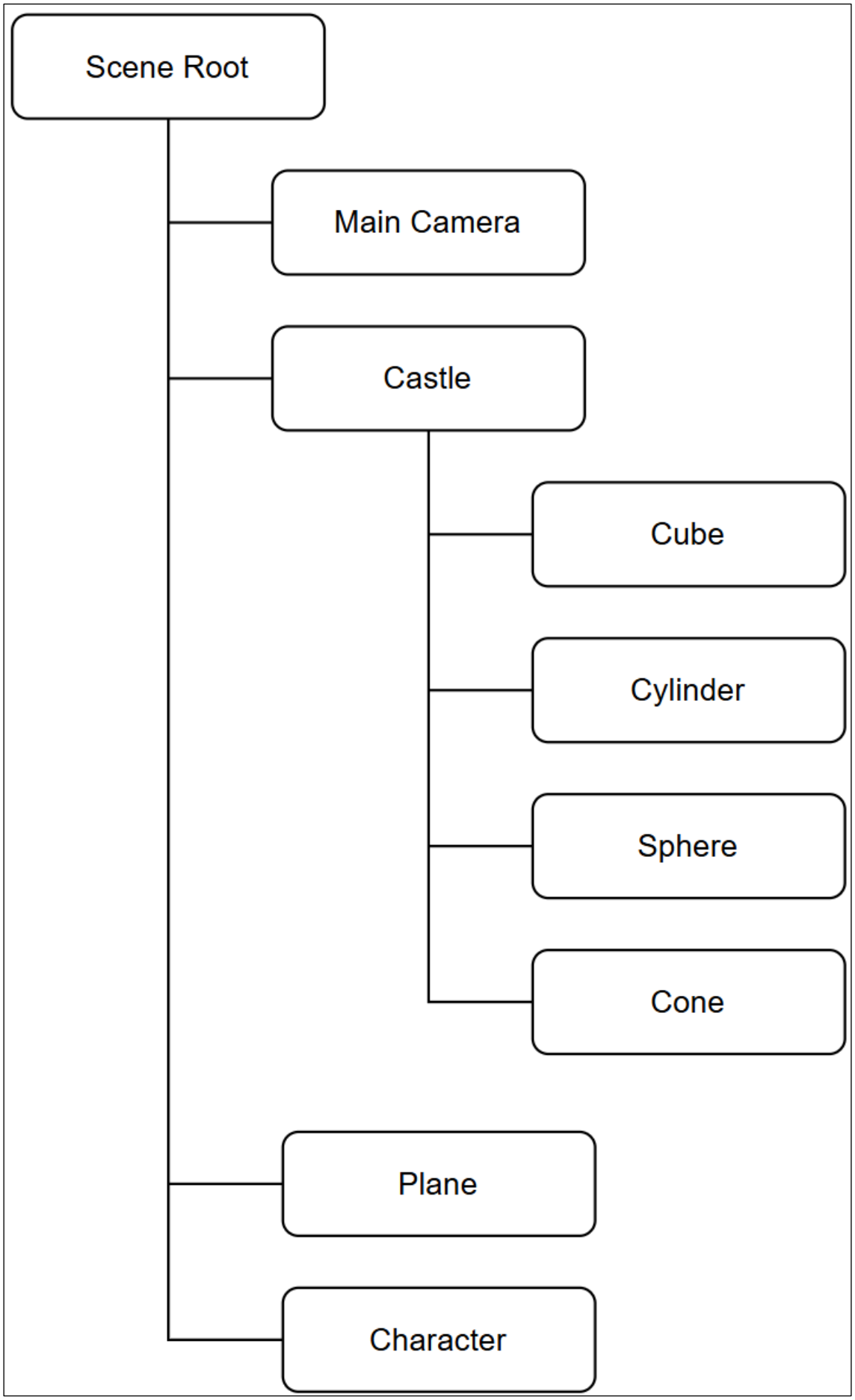

Visual Studio 2022 IDE - Progra
visualstudio.microsoft.com/vs/
New Chrome available
tools
AC
publish
Google
Everyday life
Funs
3DModels
jobs & Study
Develop
@Jayfeathercat12
AI
Unity
Microsoft
Visual Studio
Developer Tools
Downloads
More
Free Visual Studio
All Microsoft
Visual Studio 2022
Powerhouse of AI
Visual Studio offers AI-enhanced features like IntelliSense for context-aware code completions and IntelliCode, which leverages AI patterns from open-source code. Integrated GitHub Copilot provides AI-powered code completions, chat assistance, debugging suggestions, and unit test generation. These capabilities boost productivity and code quality, helping you code faster and smarter.
Download Visual Studio
Get Github Copilot free trial
AI in Visual Studio →
Copilot in Visual Studio →
Feedback

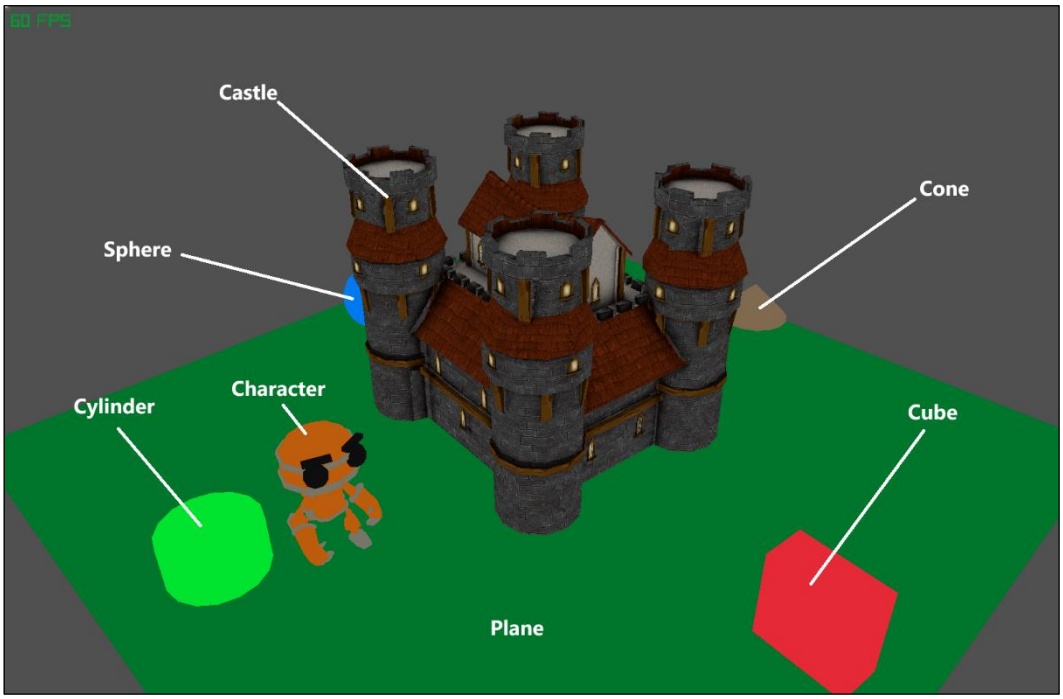

Modifying — Visual Studio Community 2022 — 17.8.5
Workloads
Individual components
Language packs
Installation locations
.NET Multi-platform App UI development
Build Android, iOS, Windows, and Mac apps from a single codebase using C# with .NET MAUI.
.NET desktop development
Build WPF, Windows Forms, and console applications using C#, Visual Basic, and F# with .NET and .NET Frame...
Desktop development with C++
Build modern C++ apps for Windows using tools of your choice, including MSVC, Clang, CMake, or MSBuild.
Universal Windows Platform development
Create applications for the Universal Windows Platform with C#, VB, or optionally C++.
Mobile development with C++
Build cross-platform applications for iOS, Android or Windows using C++.
Installation details
Visual Studio core editor
.NET desktop development
Desktop development with C++
Universal Windows Platform develop...
Game development with Unity
Game development with C++
Linux and embedded development...
Individual components
.NET Framework 4.6.2 targeting pack
MSVC v143 - VS 2022 C++ ARM64/ARM64EC...
MSVC v143 - VS 2022 C++ ARM64 build tool...
MSVC v143 - VS 2022 C++ x64/x86 build tool...
MSVC v143 - VS 2022 C++ x64/x86 build tool...


60 FPS


raylib | A simple and easy-to-us
raylib.com
New Chrome available
tools
AC
publish
Google
Everyday life
Funs
3DModels
jobs
Develop
@Jayfeathercat12
AI
Unity
Adobe Acrobat Home
raylib
about
examples
games
cheatsheet
wiki
raylib is a simple and easy-to-use library to enjoy videogames programming.
raylib
by Ray
A simple and easy-to-use library to enjoy videogames programming.
$0.00 USD or more
Download Now
itch.io
NOTE for ADVENTURERS: raylib is a programming library to enjoy videogames programming; no fancy interface, no visual helpers, no gui tools or editors... just coding in pure spartan-programmers way. Are you ready to enjoy coding?
raylib learning resources
raylib does not provide the typical API documentation or a big set of tutorials. The library is designed to be minimalistic and be learned just from a cheatsheet with all required functionality and a big collection of examples to see how to use that functionality. Best way to learn to code is reading code.
FAQ
Wiki
Overwhelmed by the options? Maybe the raylib game template is a good place for you to start! It provides some structure and a Makefile that are quick and easy to pick up and use.
Try the raylib-game-template
Apart from those materials, there are plenty of tutorials created by the amazing raylib

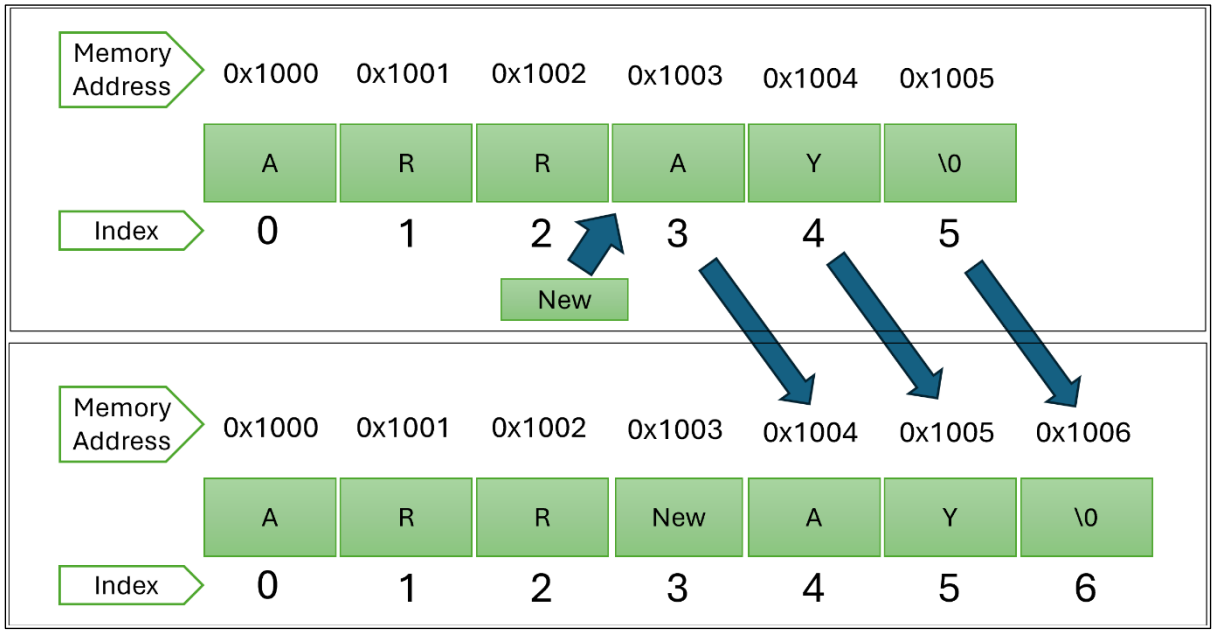

Start
Update
DrawFrame
Exit Game
No
Yes
EndGame

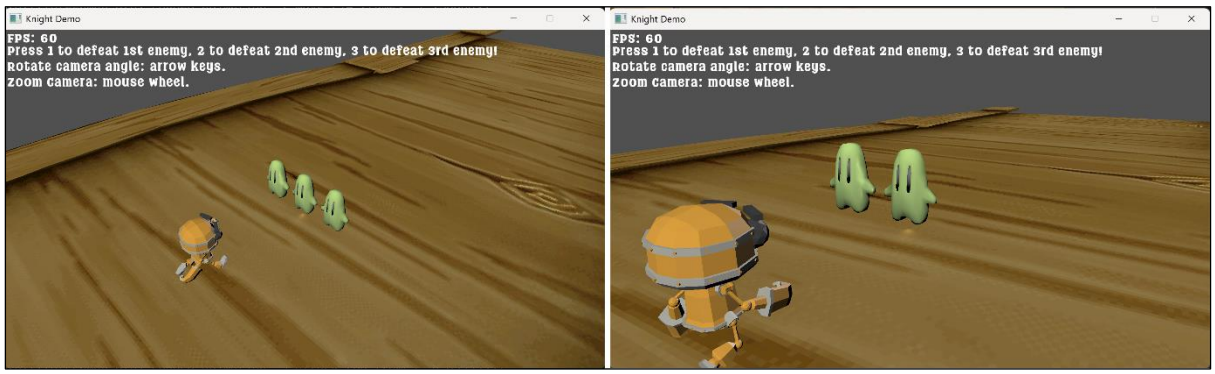

Scene Root
Main Camera
Castle
Cube
Cylinder
Sphere
Cone
Plane
Character

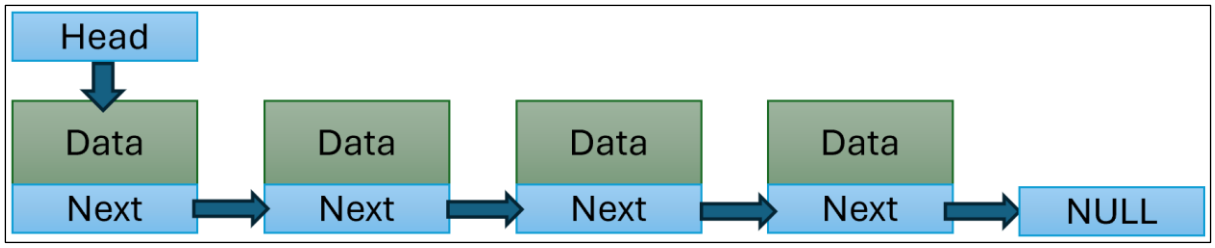

60 FPS
Castle
Cone
Sphere
Character
Cylinder
Cube
Plane

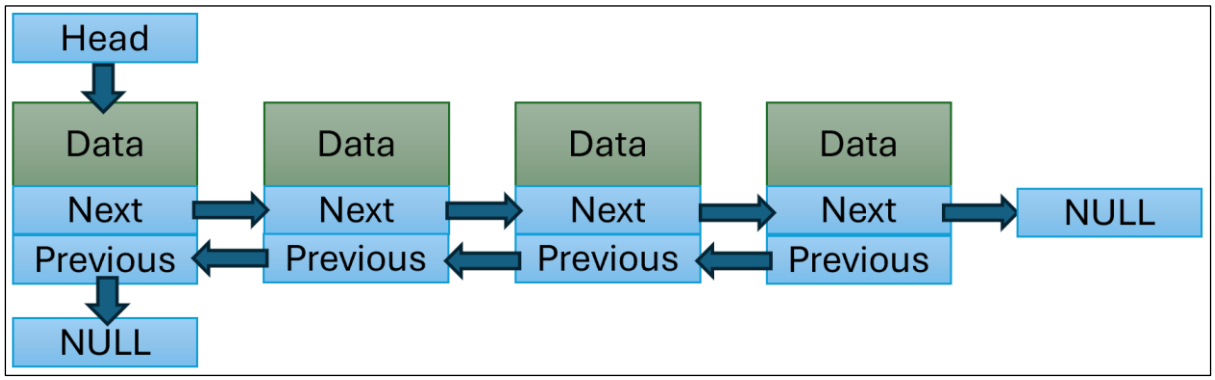
Chapter 2: Data Structures in Action: Building Game Functionality

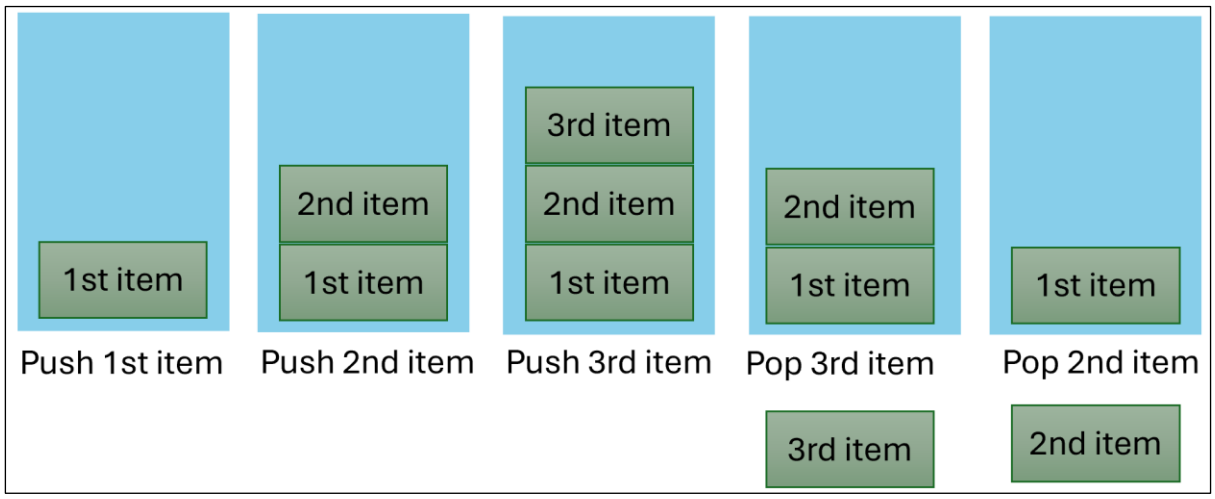


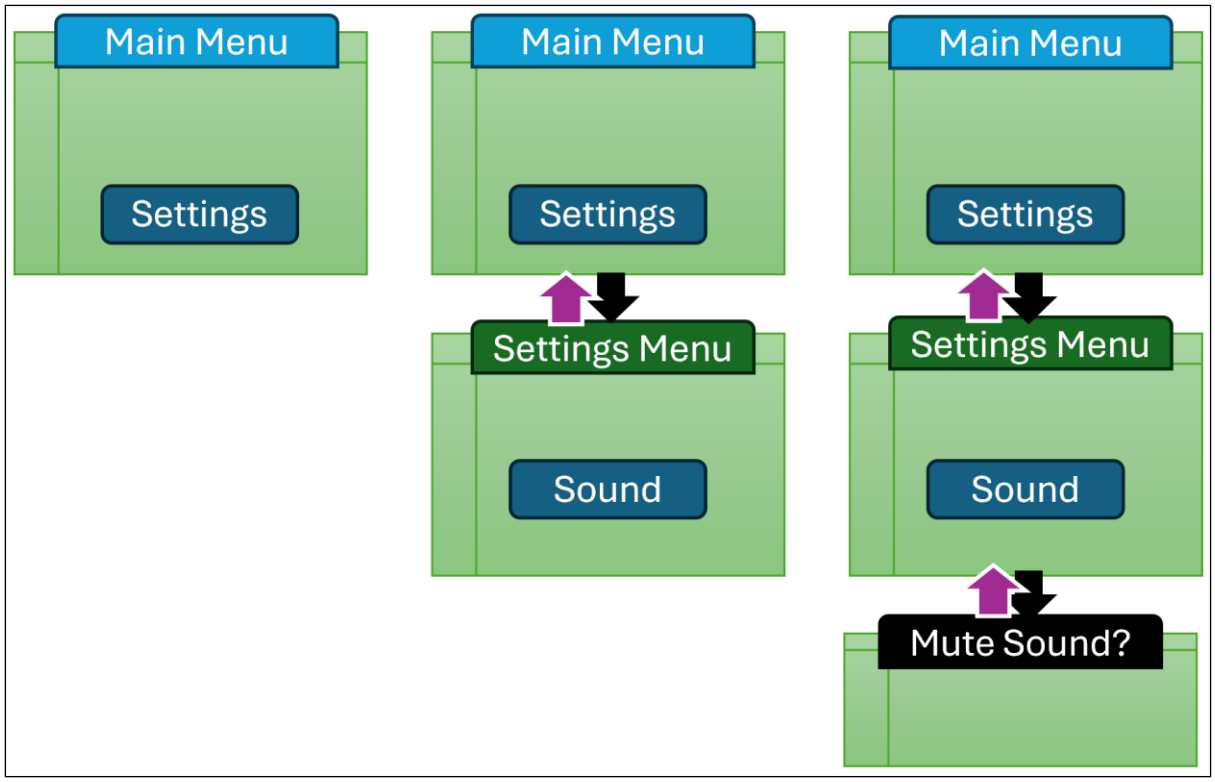


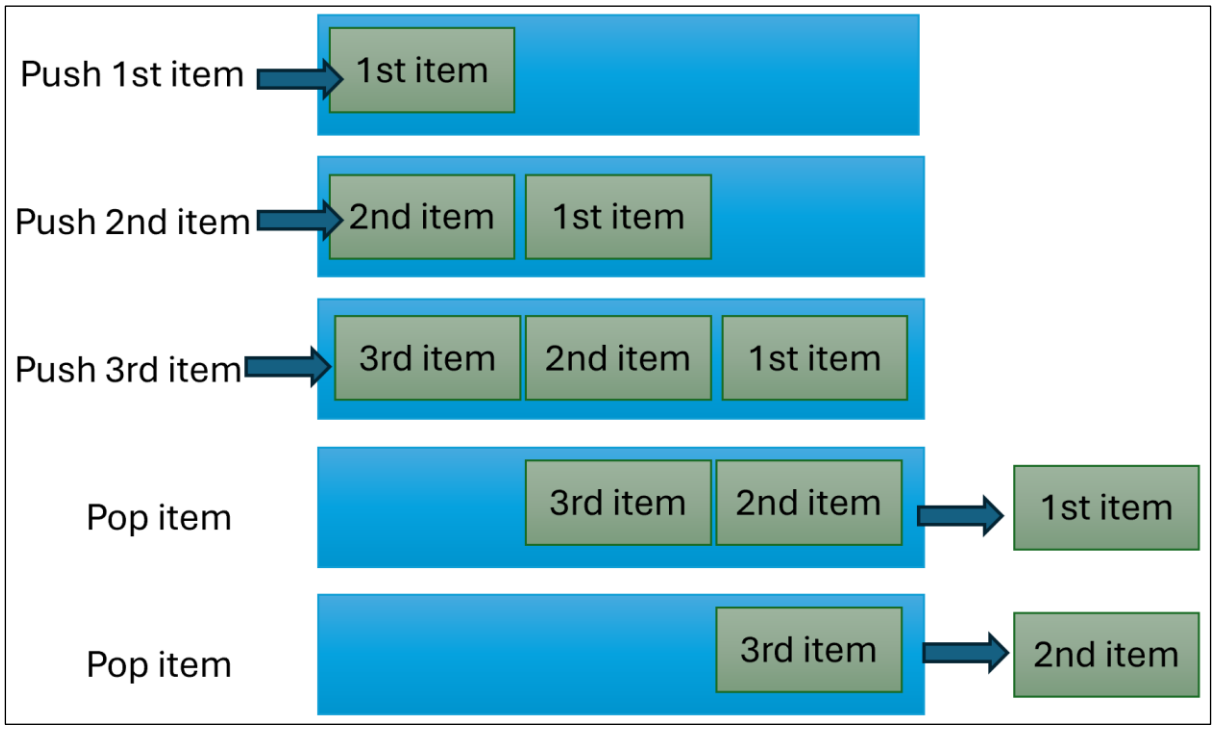



Head
Data
Next
Data
Next
Data
Next
Data
Next
NULL

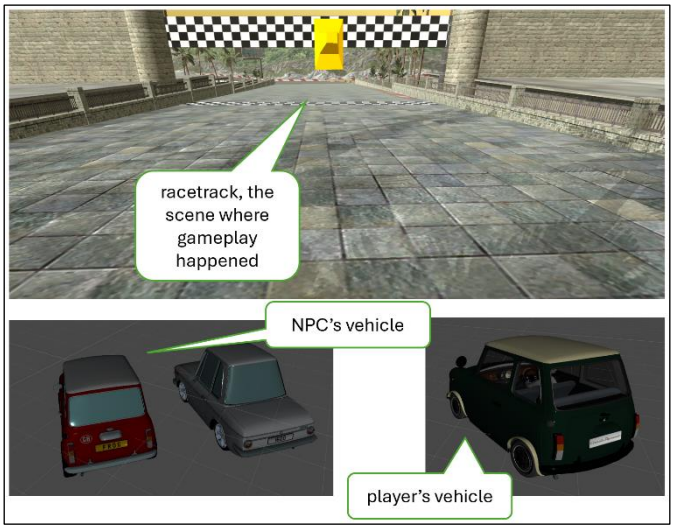

Head
Data
Next
Previous
NULL
Data
Next
Previous
Data
Next
Previous
Data
Next
Previous
NULL


1st item
Push 1st item
2nd item
1st item
Push 2nd item
3rd item
2nd item
1st item
Push 3rd item
2nd item
1st item
Pop 3rd item
3rd item
1st item
Pop 2nd item
2nd item

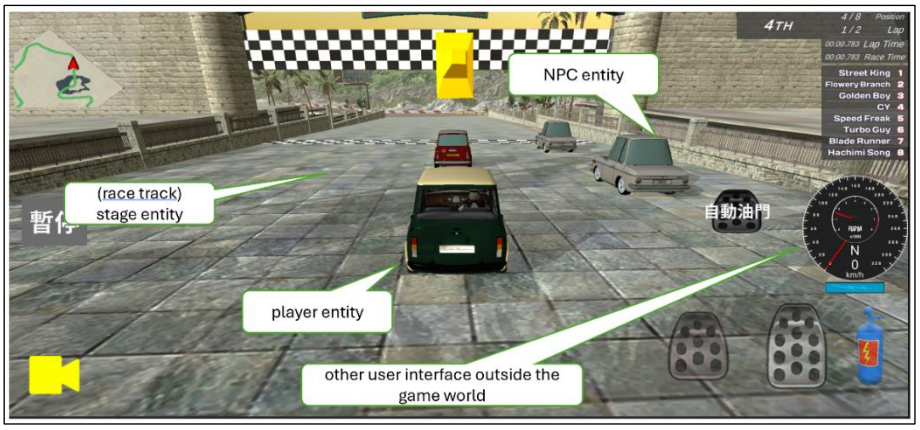

Main Menu
Settings
Main Menu
Settings
Settings Menu
Sound
Main Menu
Settings
Settings Menu
Sound
Mute Sound?

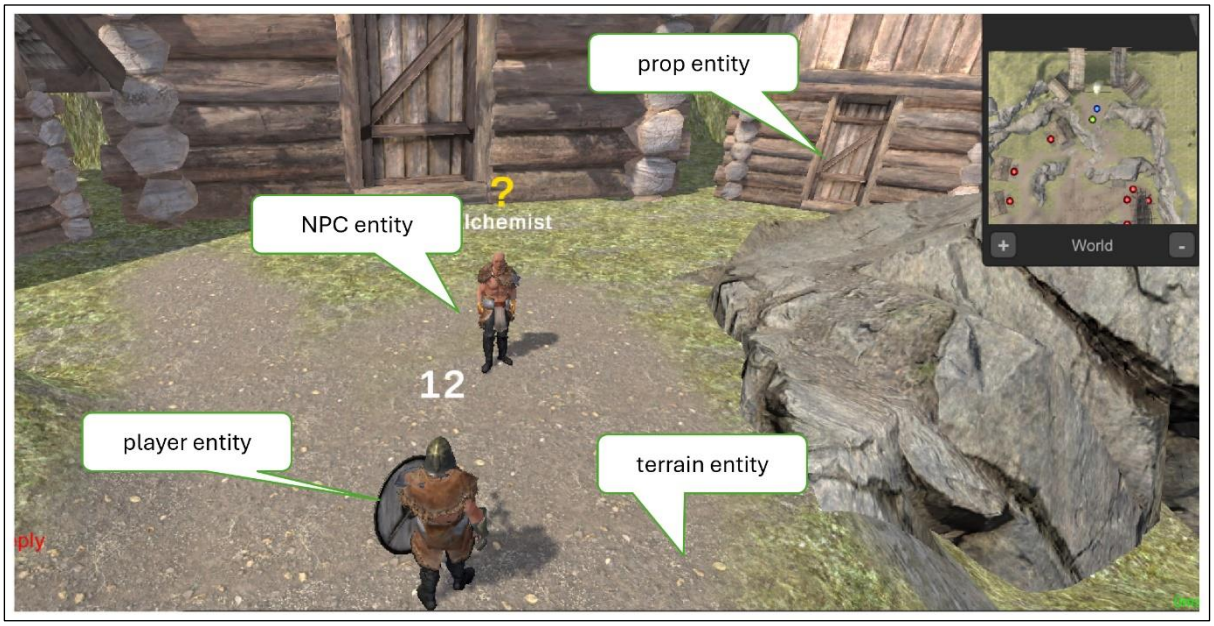

Push 1st item
1st item
Push 2nd item
2nd item
1st item
Push 3rd item
3rd item
2nd item
1st item
Pop item
3rd item
2nd item
1st item
Pop item
3rd item
2nd item

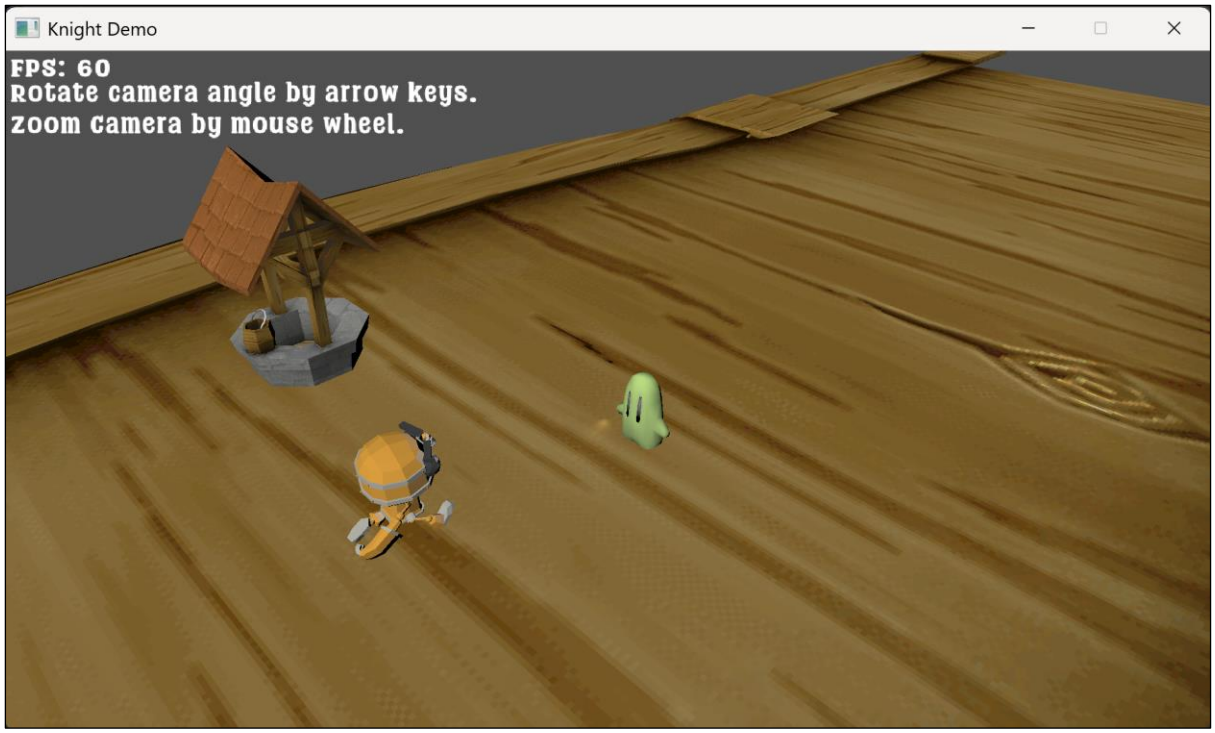

Knight Demo
FPS: 60
Player
Ready
Enemy
Enemy heavy attack!
Player receive damage:20 HP:60
Player minor attack!
Enemy receive damage:10 HP:90
Enemy heavy attack!
Player receive damage:20 HP:40
Player heavy attack!
Enemy receive damage:20 HP:70
Enemy minor attack!
Player receive damage:13 HP:27

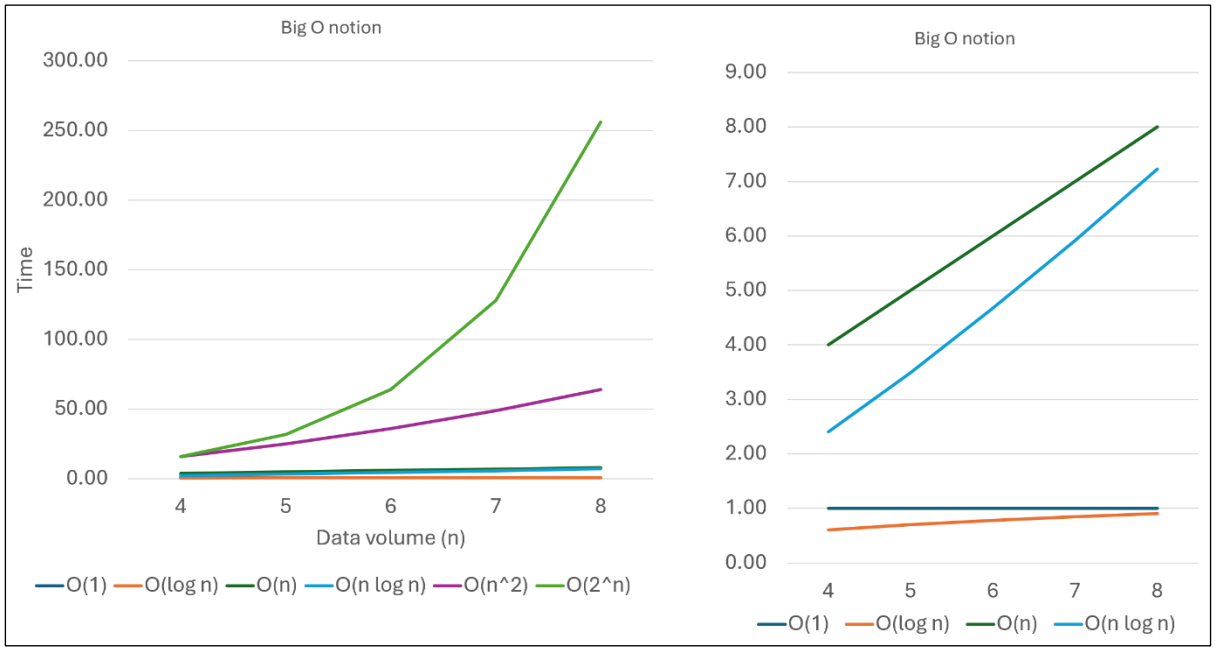

racetrack, the scene where gameplay happened
NPC's vehicle
player's vehicle

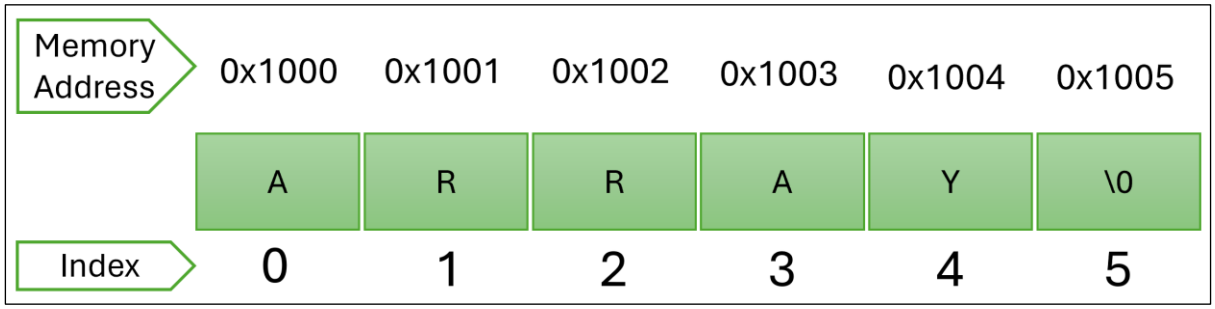

the game
enemy NPC
Battlefield, the terrain
player hero cards

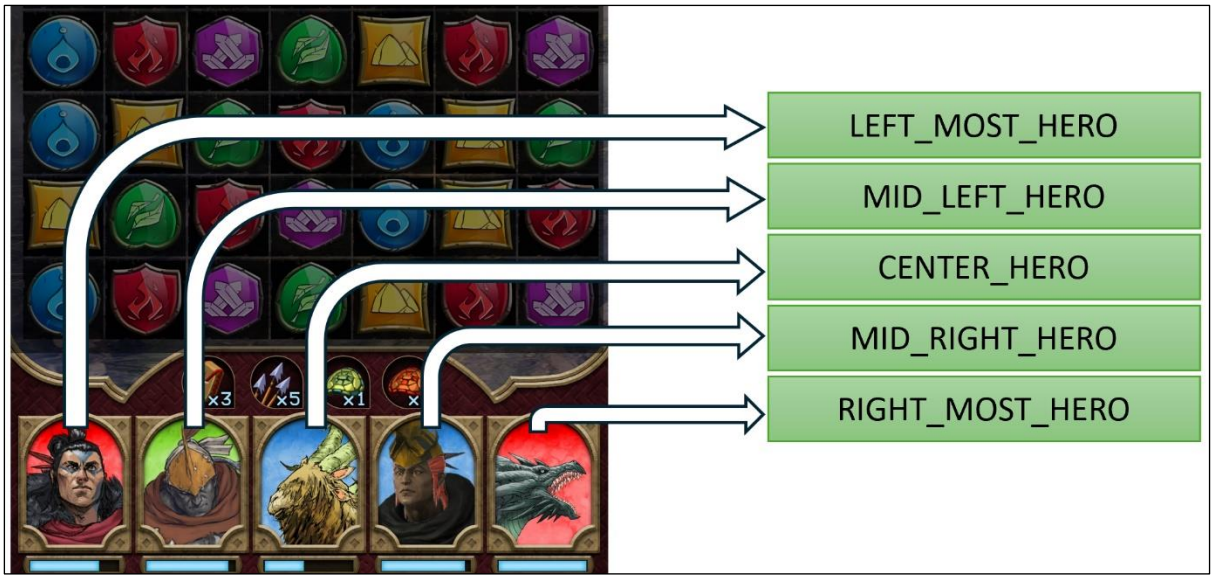

NPC entity
(race track)
stage entity
player entity
other user interface outside the
game world
4TH
自動油門


prop entity
NPC entity
12
player entity
terrain entity
World

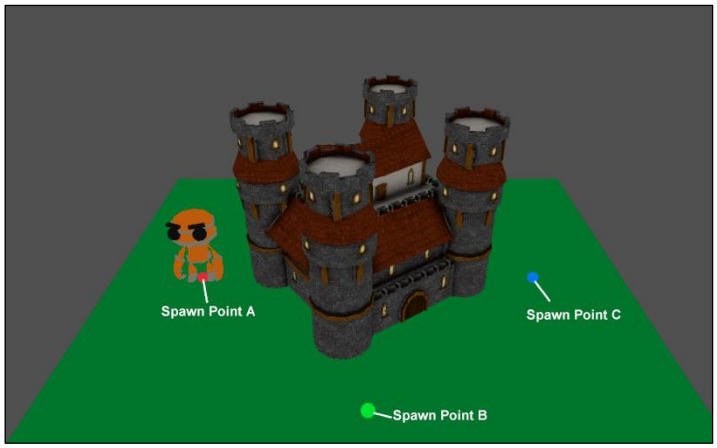

Knight Demo
FPS: 60
Rotate camera angle by arrow keys.
zoom camera by mouse wheel.

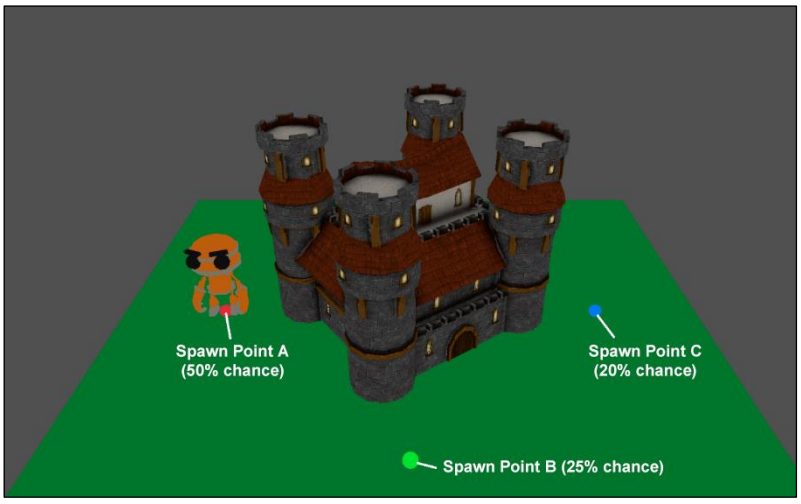

Big O notion
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Time
4
5
6
7
8
Data volume (n)
O(1)
O(log n)
O(n)
O(n log n)
O(n^2)
O(2^n)
Big O notion
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
4
5
6
7
8
O(1)
O(log n)
O(n)
O(n log n)

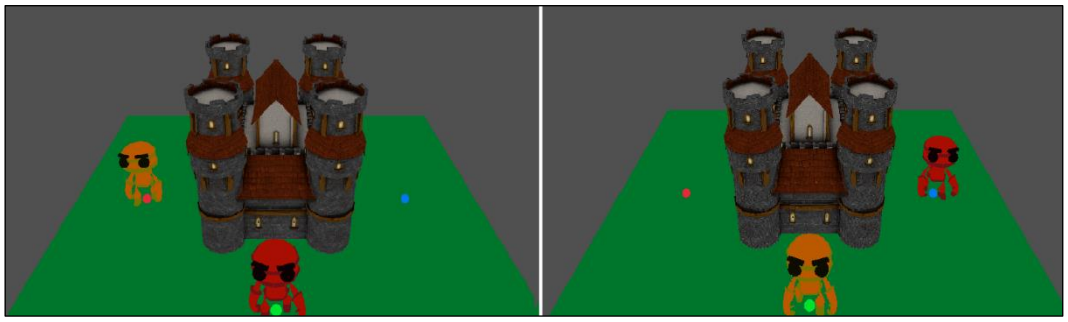

Memory Address
0x1000
0x1001
0x1002
0x1003
0x1004
0x1005
A
R
R
A
Y
\0
Index
0
1
2
3
4
5

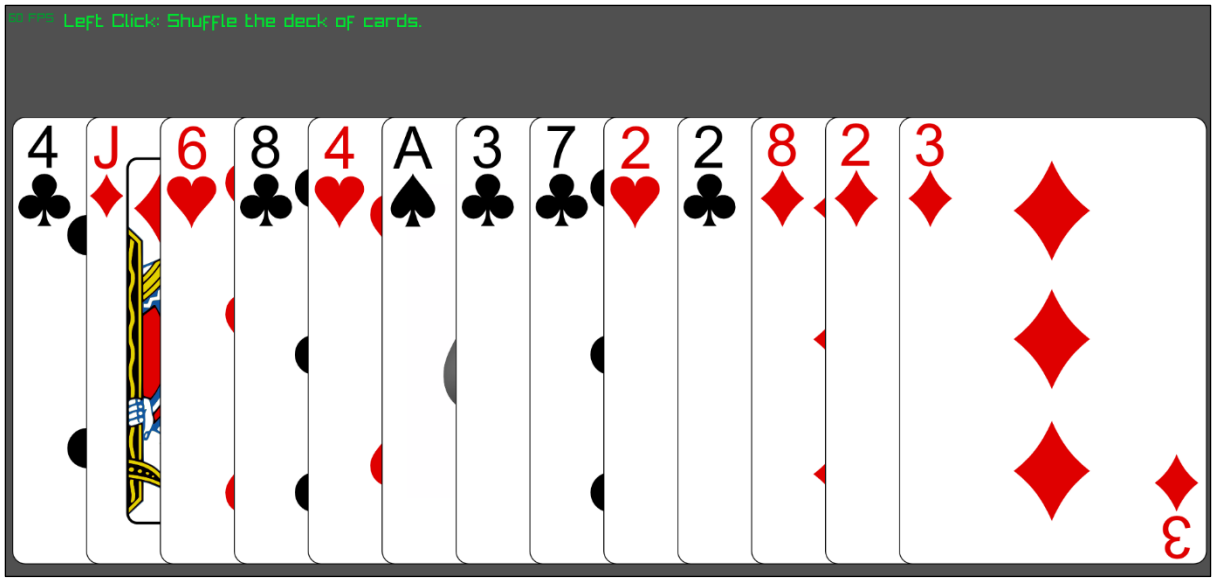

LEFT_MOST_HERO
MID_LEFT_HERO
CENTER_HERO
MID_RIGHT_HERO
RIGHT_MOST_HERO

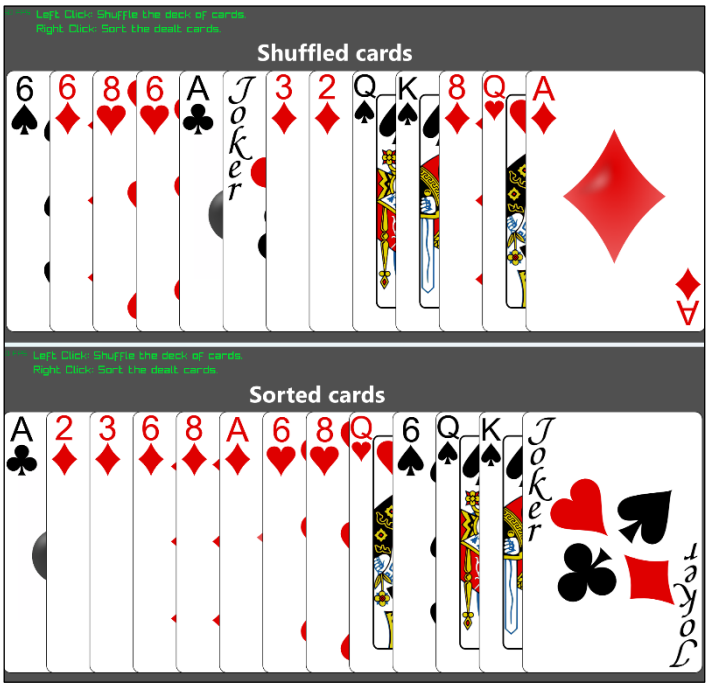
Chapter 3: Algorithms Commonly Utilized in Game Development

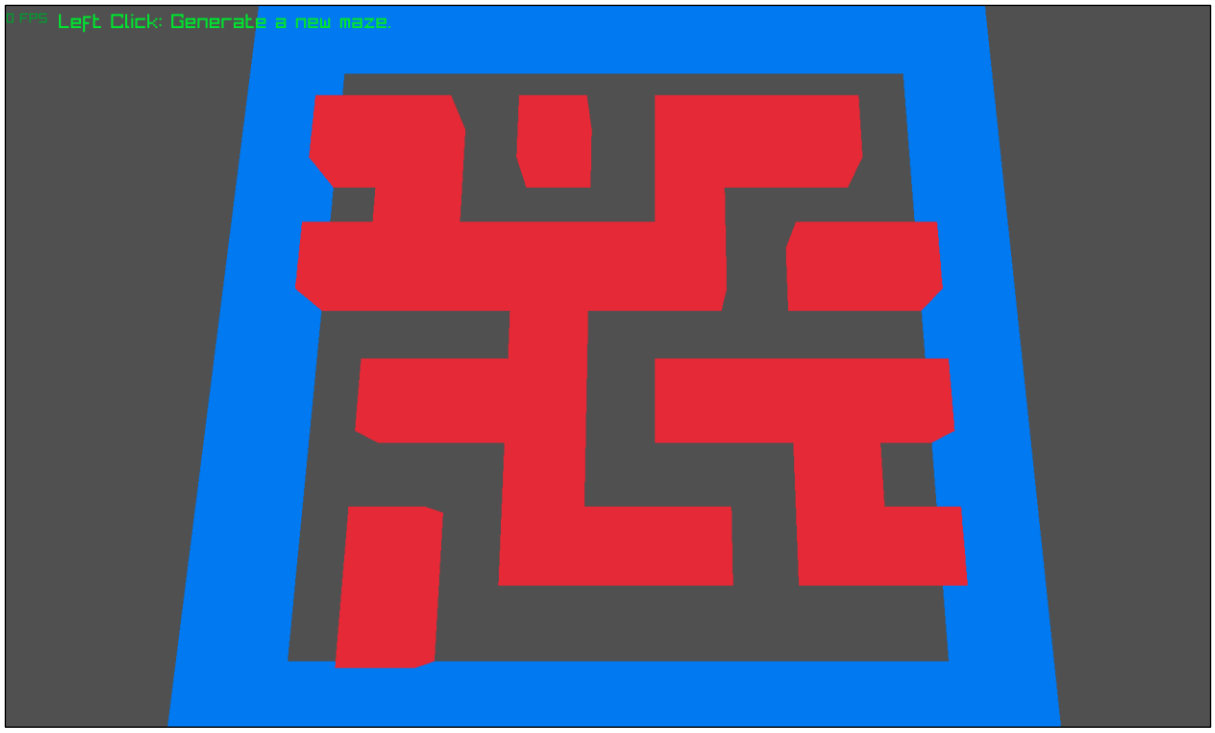


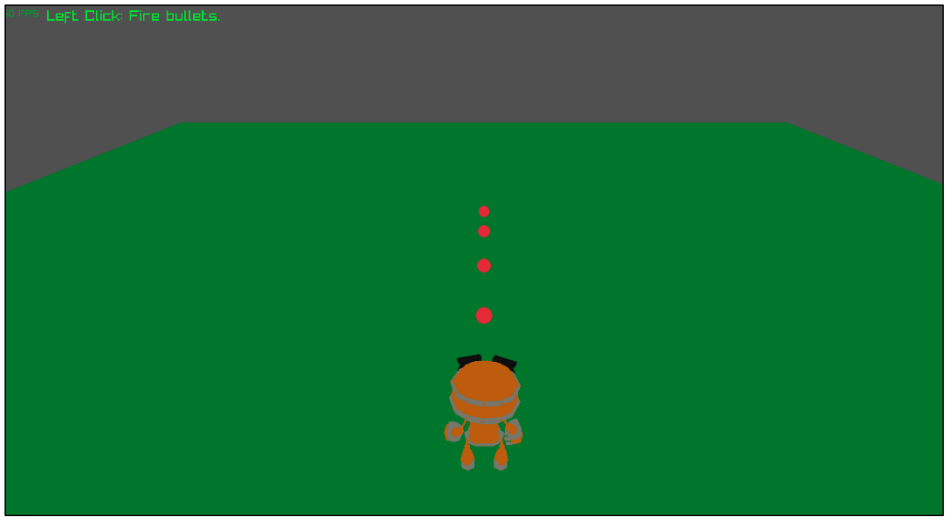




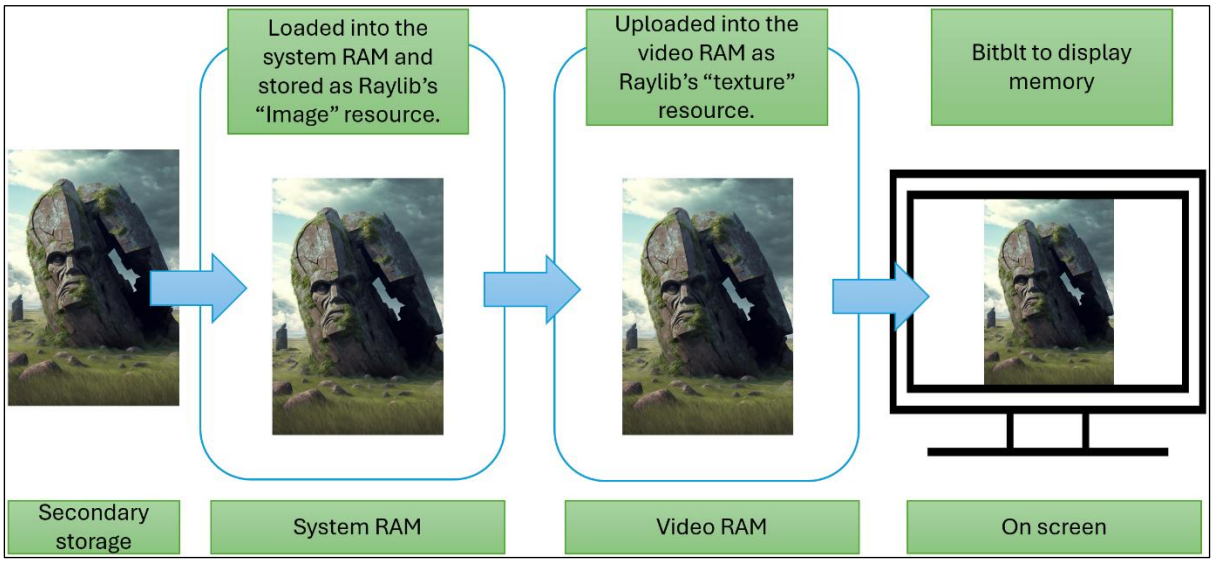

Left Click: Shuffle the deck of cards.

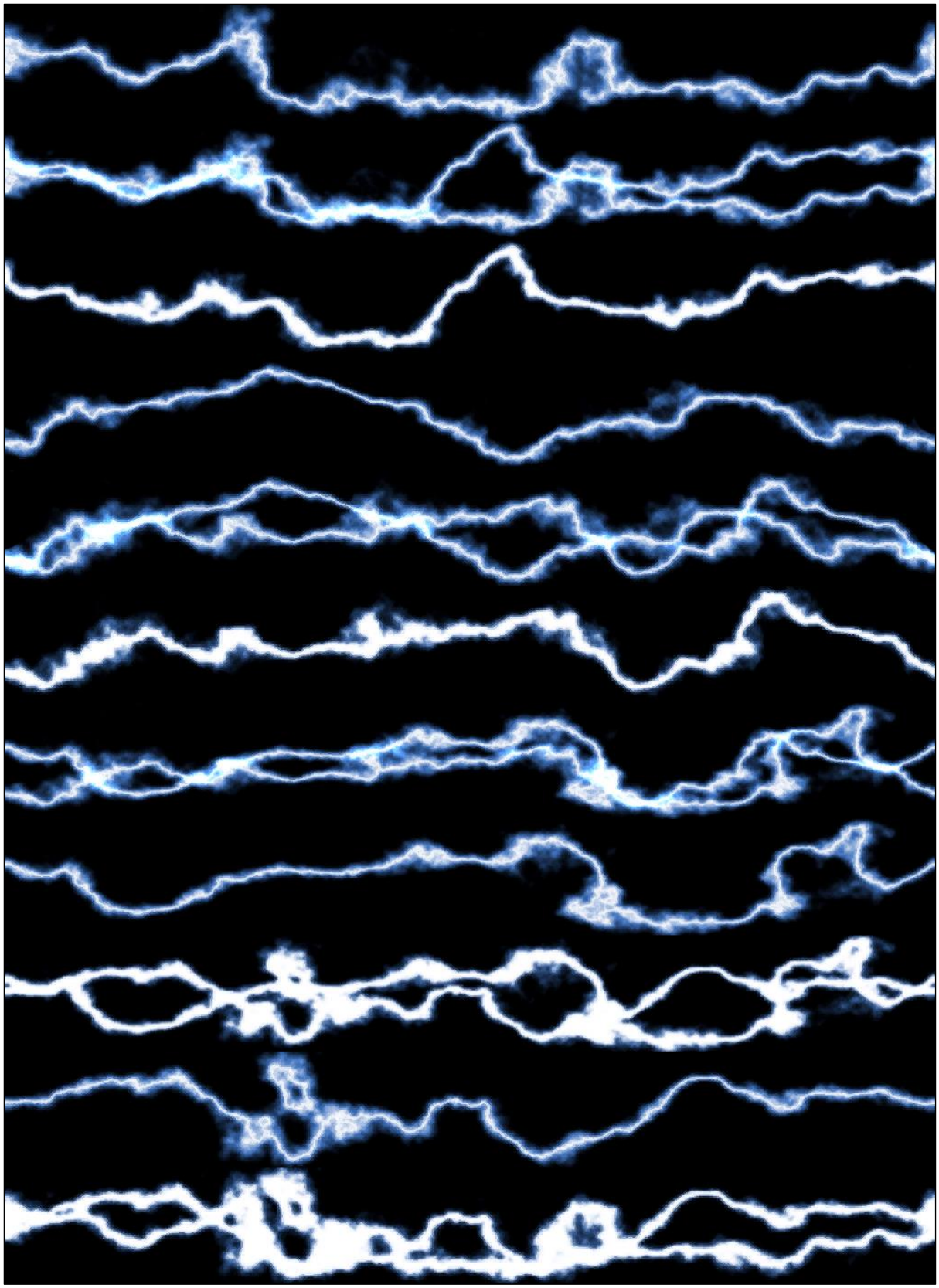

Left Click: Shuffle the deck of cards.
Right Click: Sort the dealt cards.
Shuffled cards
Left Click: Shuffle the deck of cards.
Right Click: Sort the dealt cards.
Sorted cards

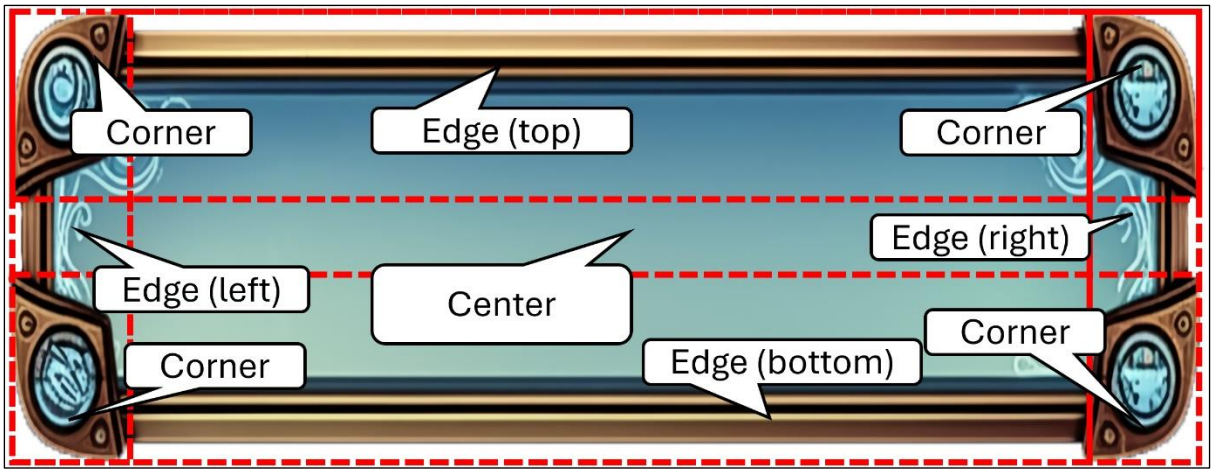

Left Click: Generate a new maze.

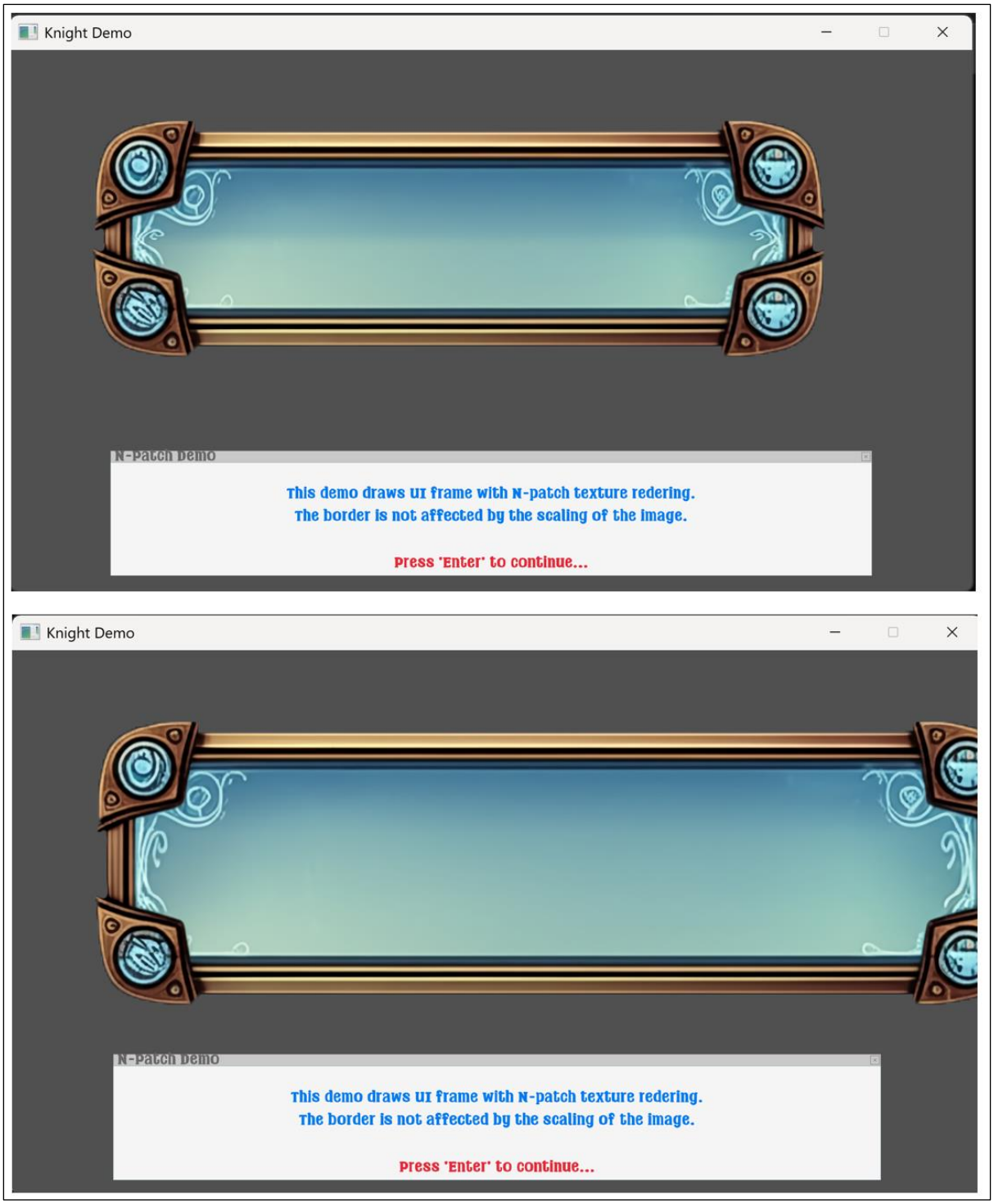

Left Click: Fire bullets.

Chapter 4: 2D Rendering and Effects

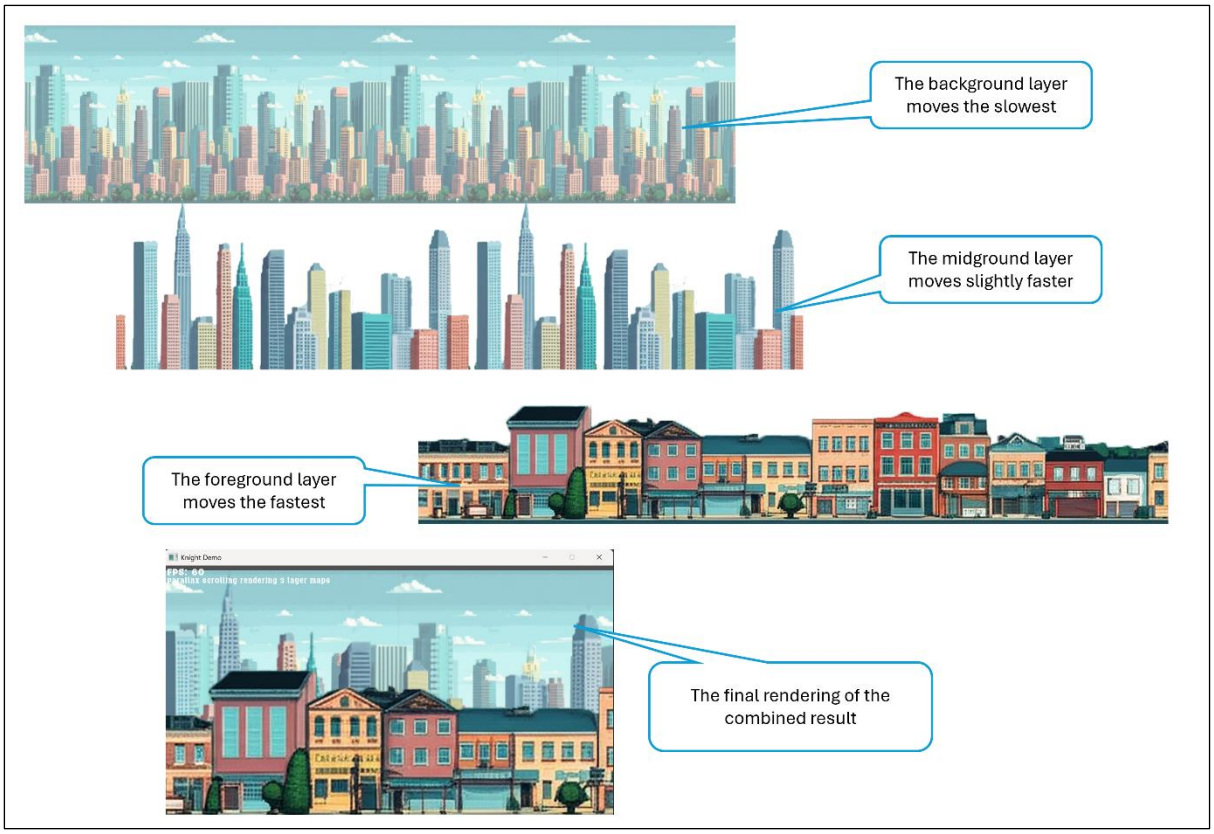




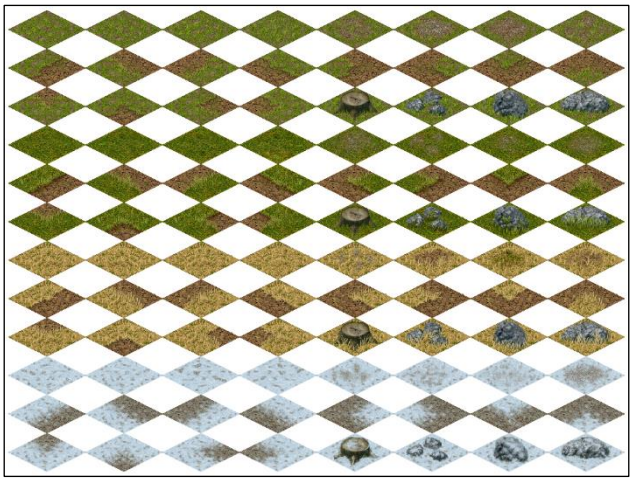

Corner
Edge (top)
Corner
Edge (right)
Edge (left)
Center
Corner
Edge (bottom)
Corner

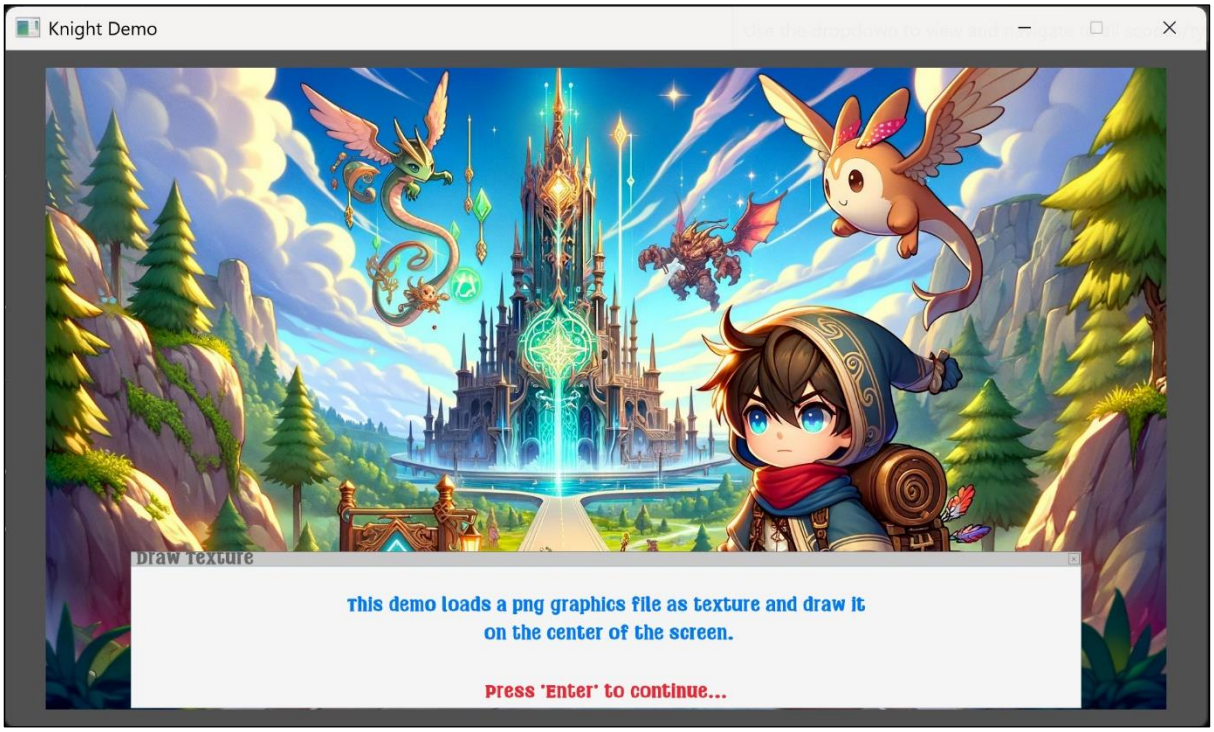

Knight Demo
N-Patch Demo
This demo draws UI frame with N-patch texture redering.
The border is not affected by the scaling of the image.
Press 'Enter' to continue...
Knight Demo
N-Patch Demo
This demo draws UI frame with N-patch texture redering.
The border is not affected by the scaling of the image.
Press 'Enter' to continue...


03M

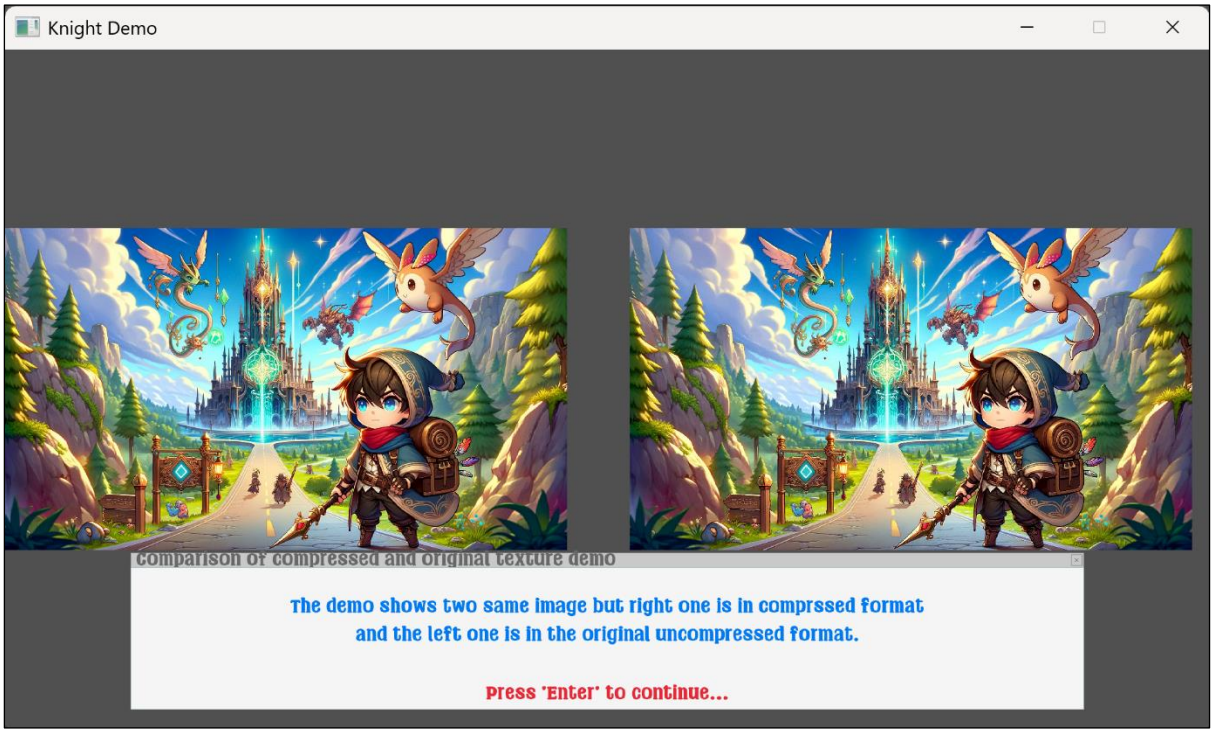

The background layer moves the slowest
The midground layer moves slightly faster
The foreground layer moves the fastest
Knight Demo
FPS: 60
Parallax scrolling rendering 5 layer maps
The final rendering of the combined result

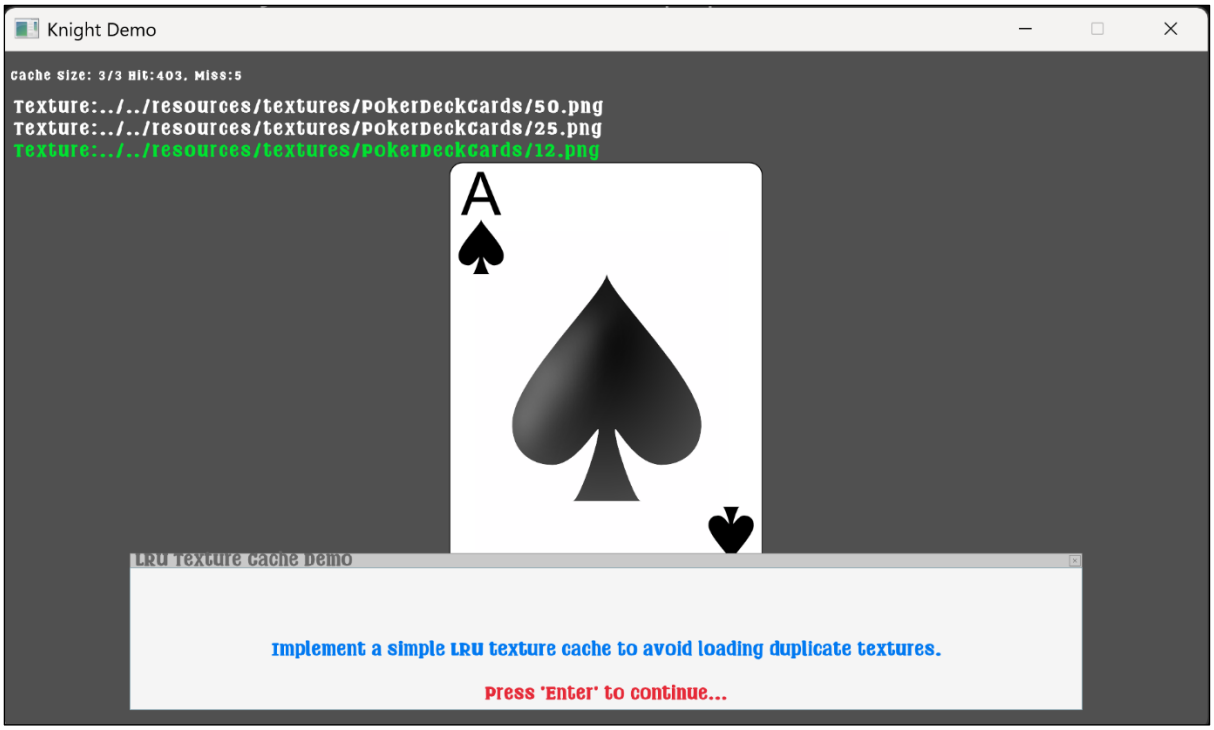

Knight Demo
Rendering isometric map

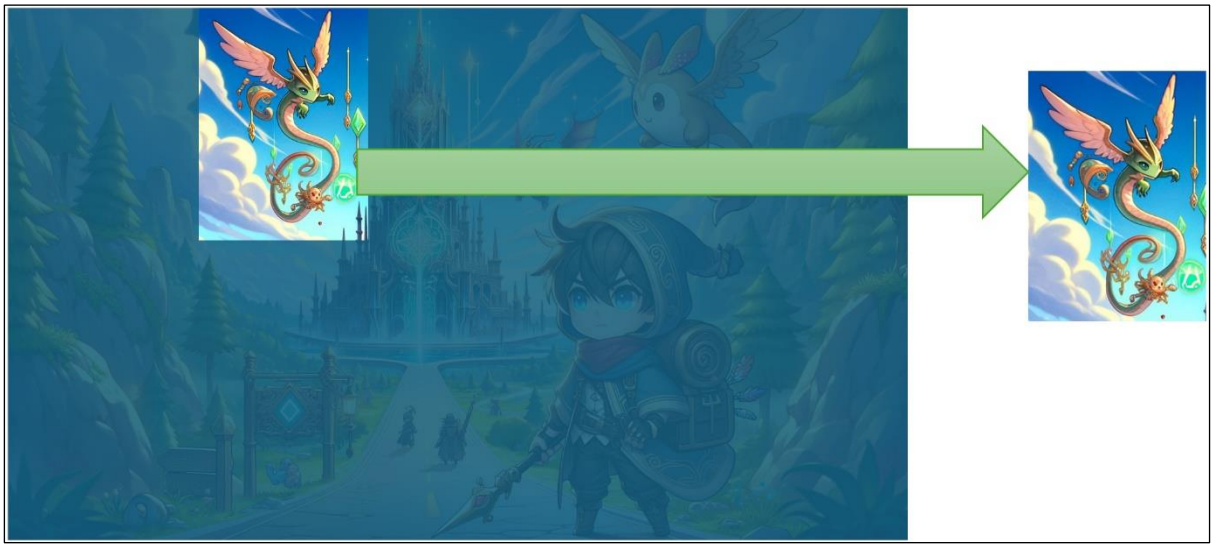



Knight Demo
Draw Texture
This demo loads a png graphics file as texture and draw it
on the center of the screen.
Press 'Enter' to continue...

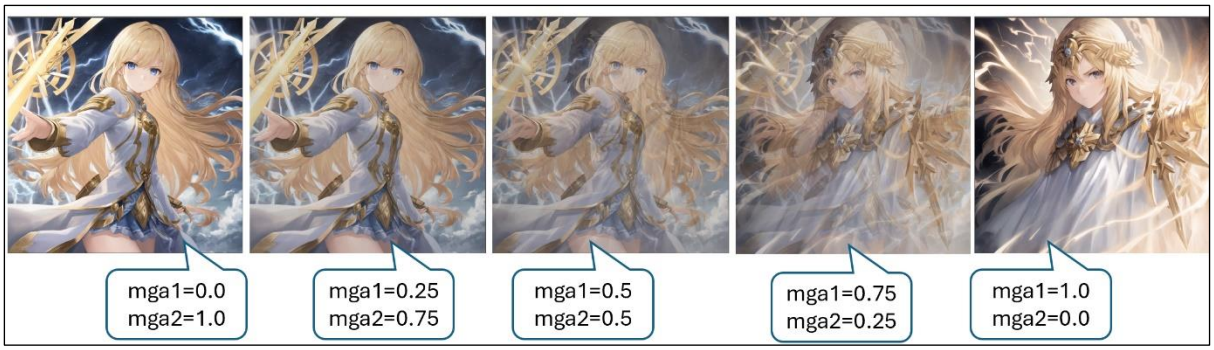

PIXELFORMAT_UNCOMPRESSED_R8G8B8A8
Each pixel 4 bytes long
PIXELFORMAT_UNCOMPRESSED_R5G5B5A1
Each pixel 2 bytes long
PIXELFORMAT_UNCOMPRESSED_R4G4B4A4
Each pixel 2 bytes long
PIXELFORMAT_UNCOMPRESSED_R5G6B5
Each pixel 2 bytes long, no alpha
PIXELFORMAT_UNCOMPRESSED_GRAYSCALE
Each pixel 1 bytes long

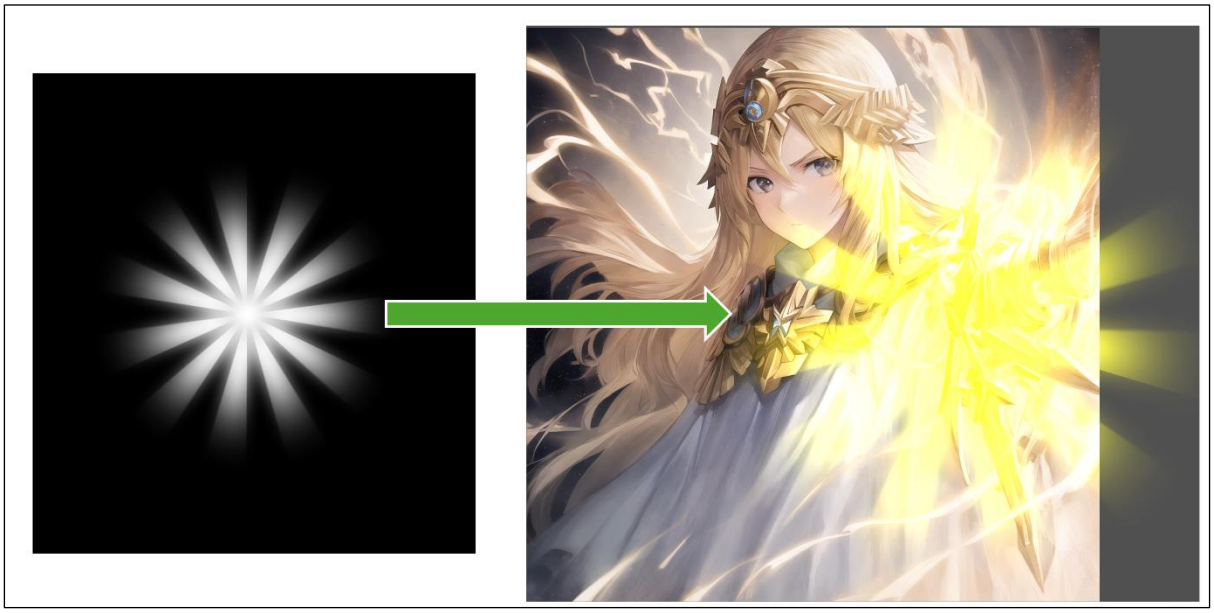

Knight Demo
comparison of compressed and original texture demo
The demo shows two same image but right one is in comprssed format
and the left one is in the original uncompressed format.
Press 'Enter' to continue...


Knight Demo
Cache Size: 3/3 Hit:403. Miss:5
Texture:../../resources/textures/PokerDeckCards/50.png
Texture:../../resources/textures/PokerDeckCards/25.png
Texture:../../resources/textures/PokerDeckCards/12.png
A
LRU Texture Cache Demo
Implement a simple LRU texture cache to avoid loading duplicate textures.
Press 'Enter' to continue...



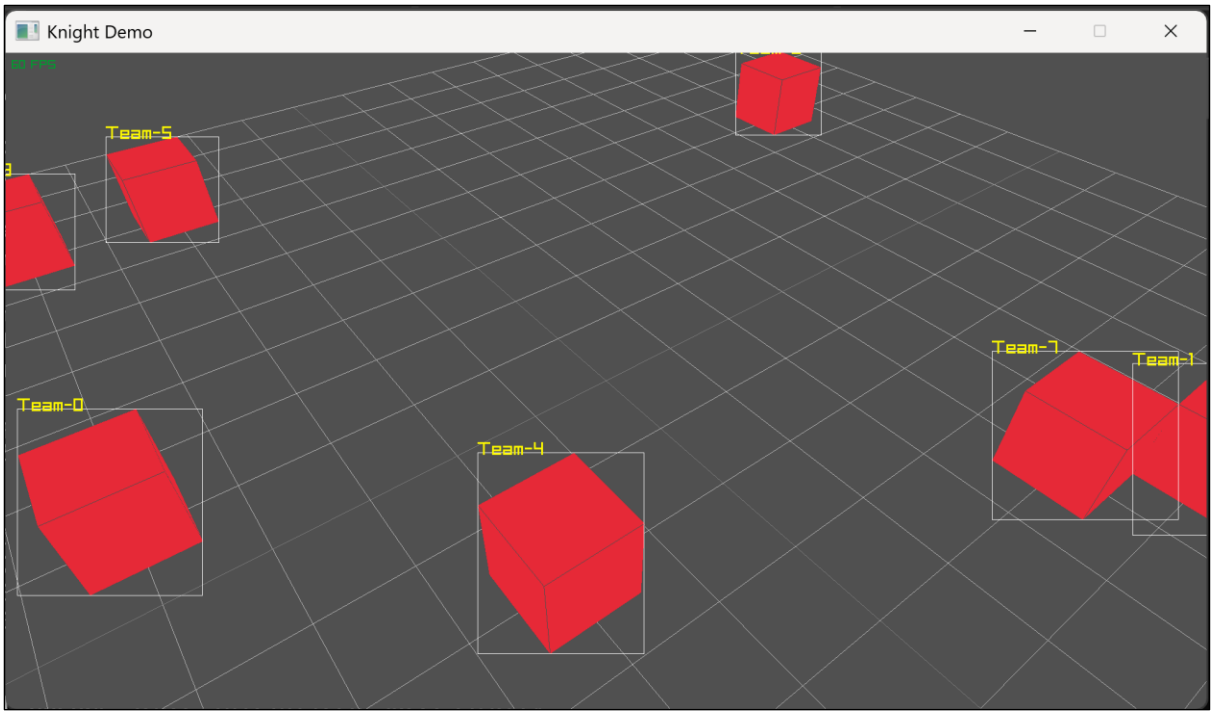


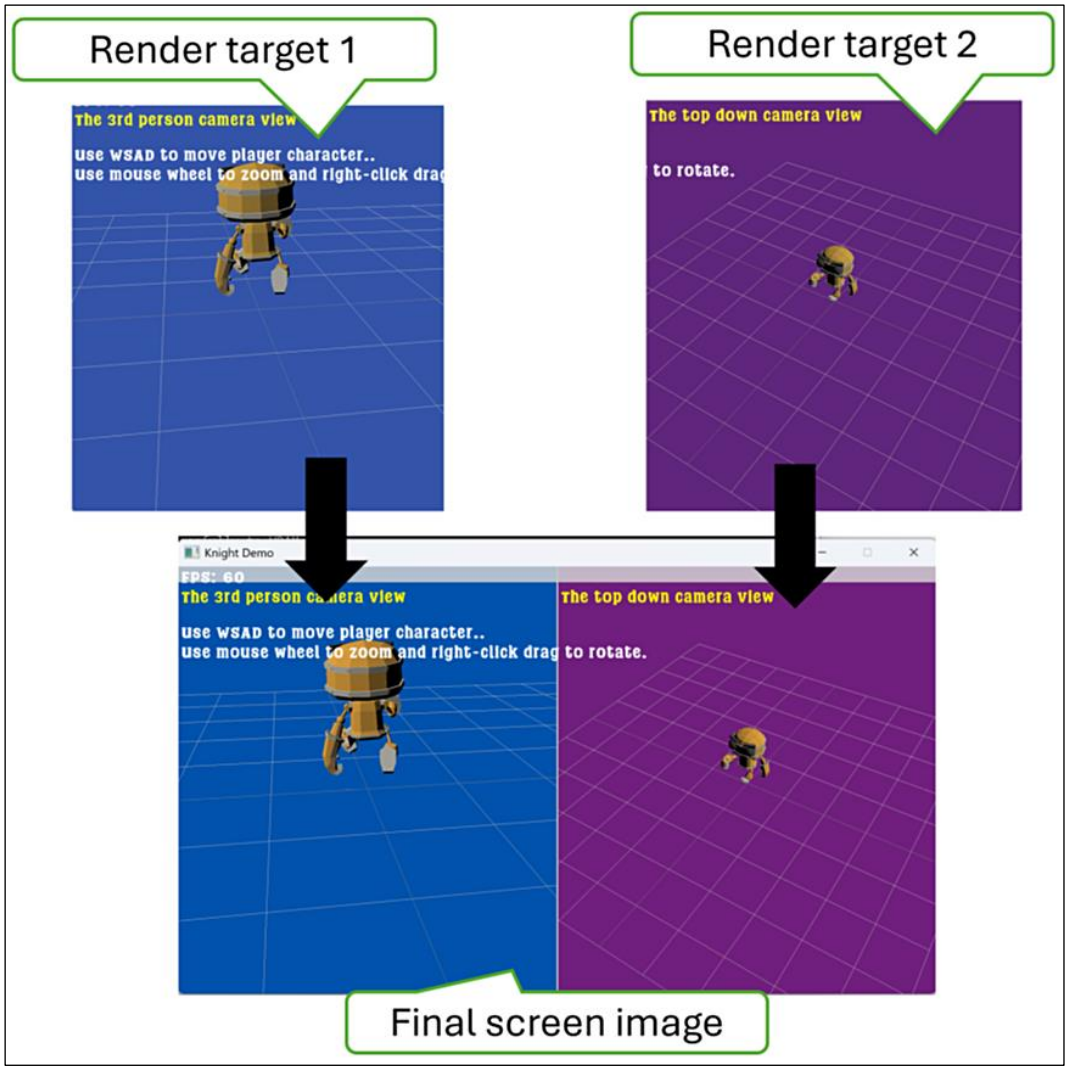

mga1=0.0
mga2=1.0
mga1=0.25
mga2=0.75
mga1=0.5
mga2=0.5
mga1=0.75
mga2=0.25
mga1=1.0
mga2=0.0



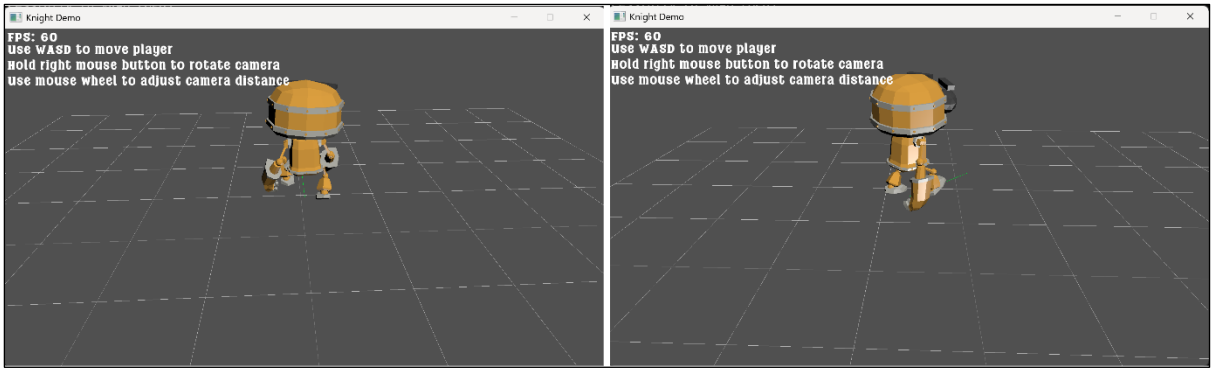
Chapter 5: The Camera and Camera Controls

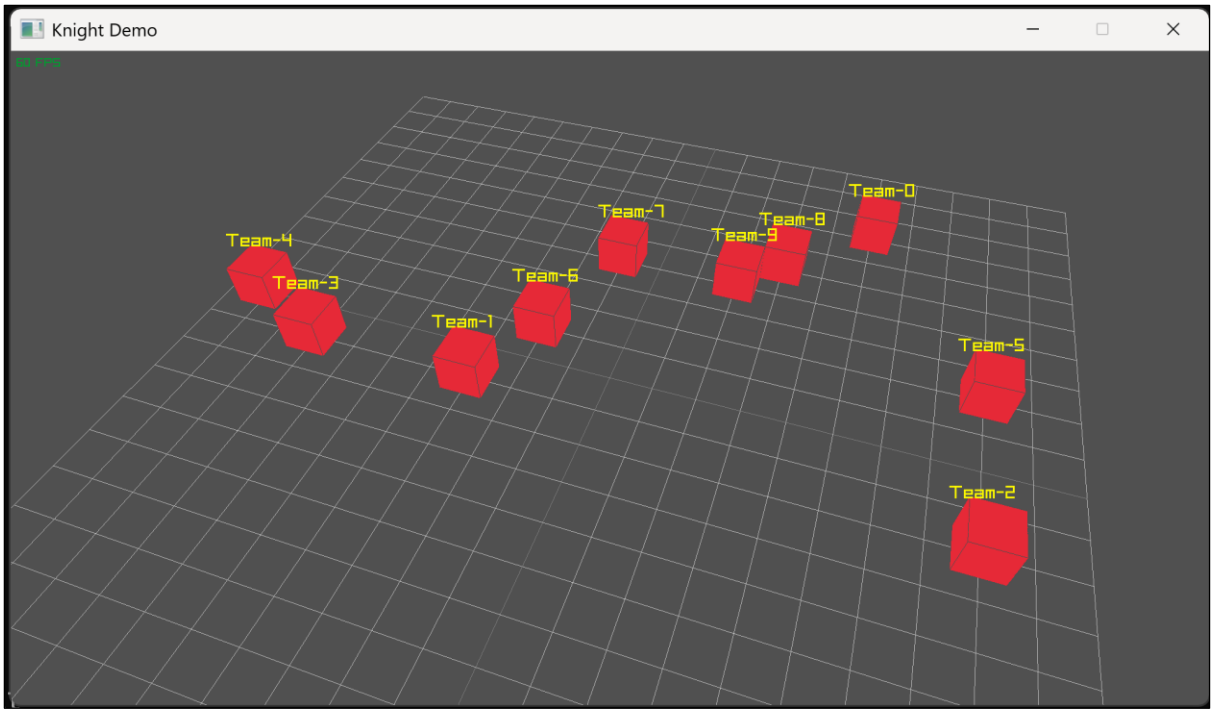


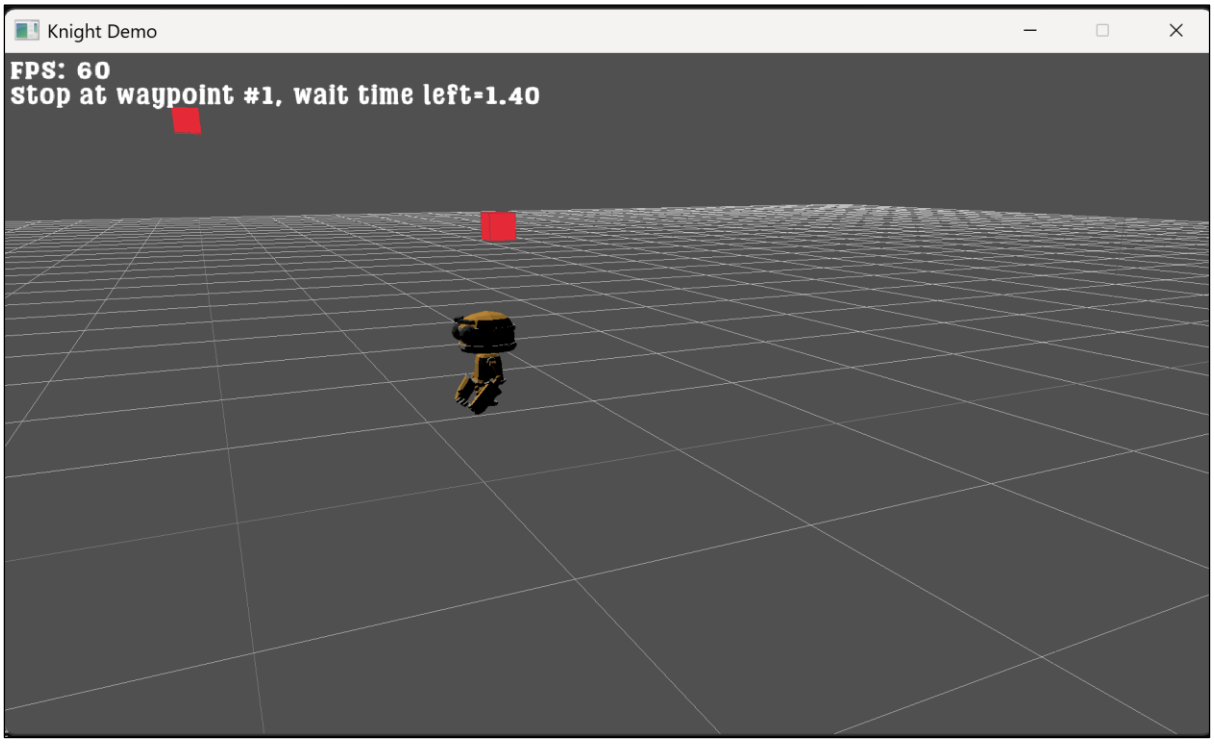

Knight Demo
Team-5
Team-0
Team-4
Team-7
Team-1

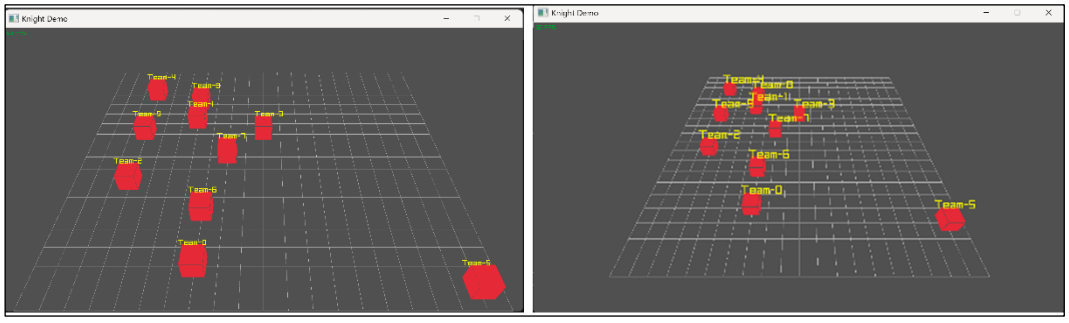

Render target 1
The 3rd person camera view
use WSAD to move player character..
Render target 2
The top down camera view
to rotate.
Knight Demo
FPS: 60
The top down camera view
use WSAD to move player character..
to rotate.
Final screen image

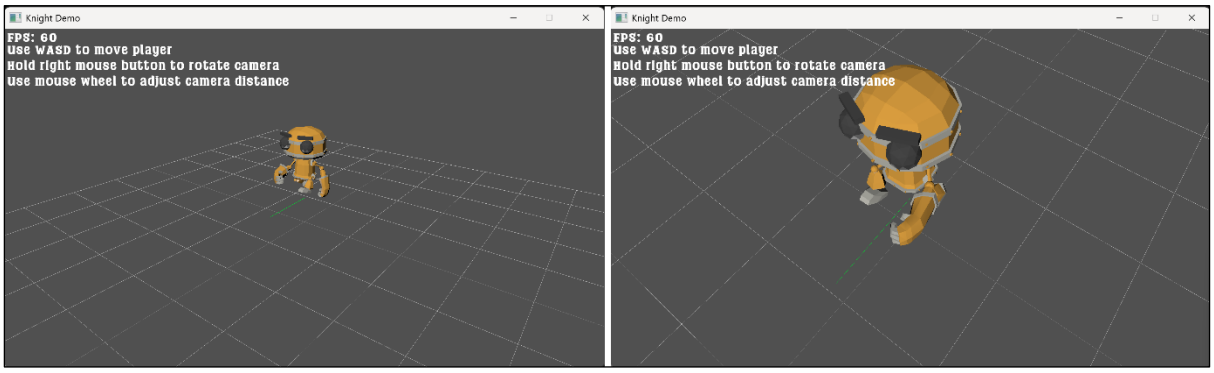

Knight Demo
FPS: 60
Rotate camera angle: move mouse.
Move camera: use W/S/A/D.

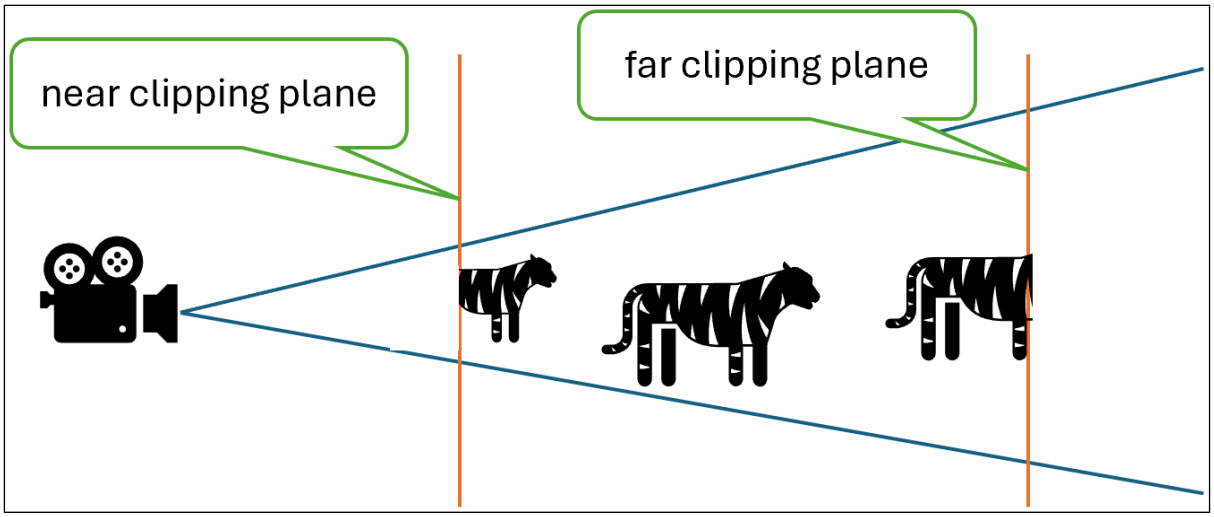

Knight Demo
FPS: 60
Use WASD to move player
Hold right mouse button to rotate camera
use mouse wheel to adjust camera distance
Knight Demo
FPS: 60
Use WASD to move player
Hold right mouse button to rotate camera
use mouse wheel to adjust camera distance

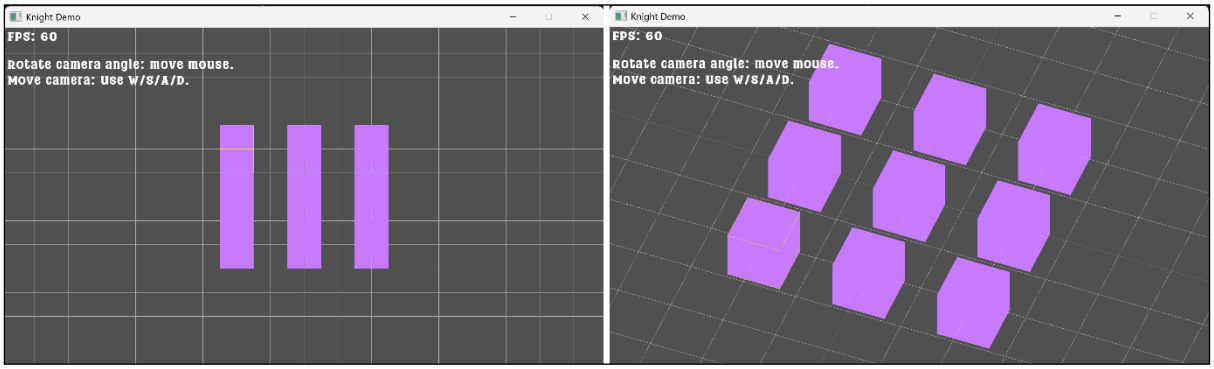

Knight Demo
Team-4
Team-3
Team-1
Team-6
Team-7
Team-9
Team-8
Team-0
Team-5
Team-2


Knight Demo
FPS: 60
Stop at waypoint #1, wait time left-1.40

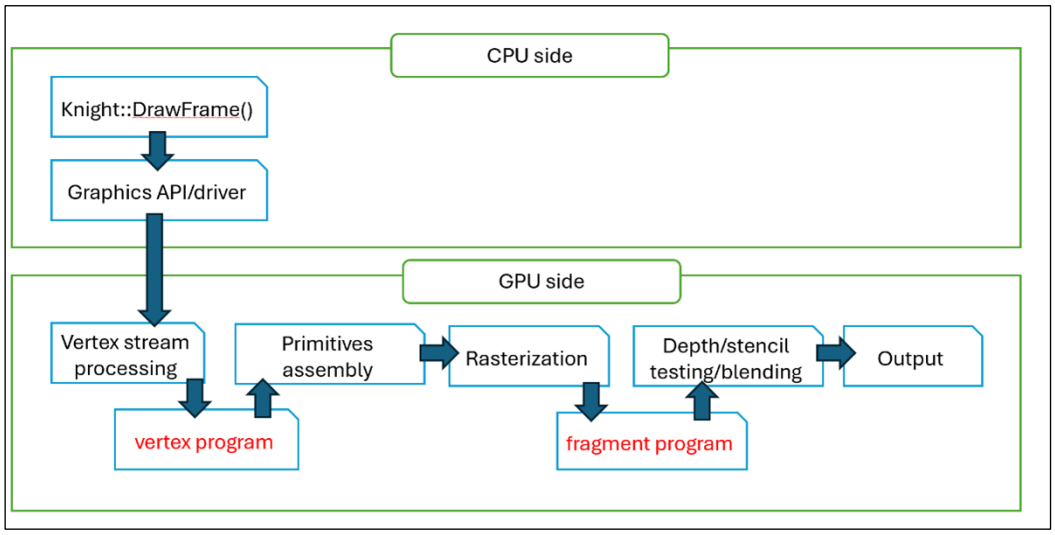

Knight Demo
Knight Demo

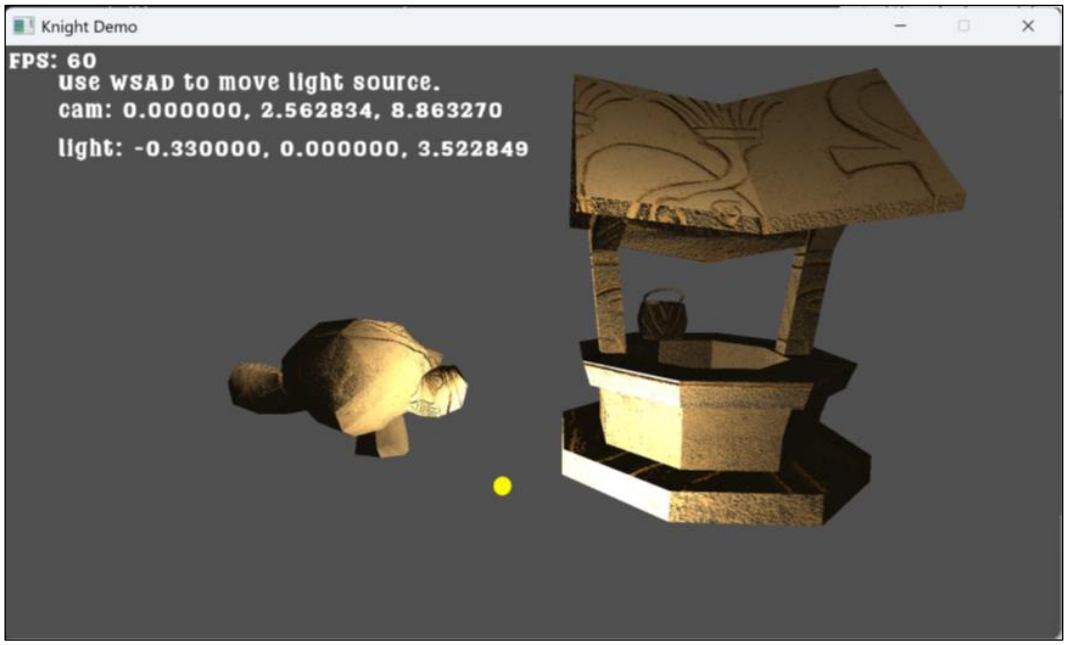

Knight Demo
FPS: 60
Use WASD to move player
Hold right mouse button to rotate camera
Use mouse wheel to adjust camera distance
Knight Demo
FPS: 60
Use WASD to move player
Hold right mouse button to rotate camera
Use mouse wheel to adjust camera distance

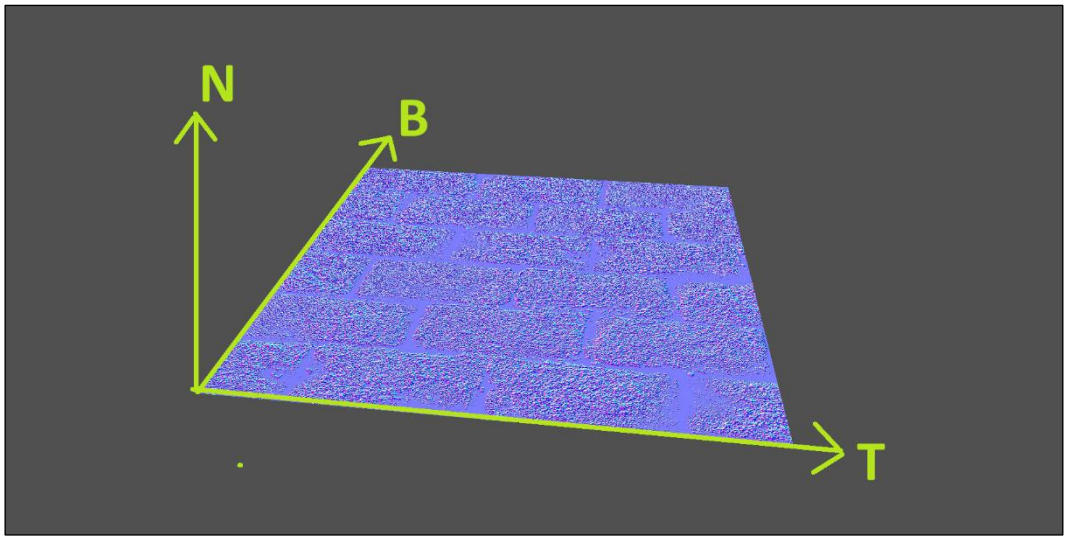

near clipping plane
far clipping plane

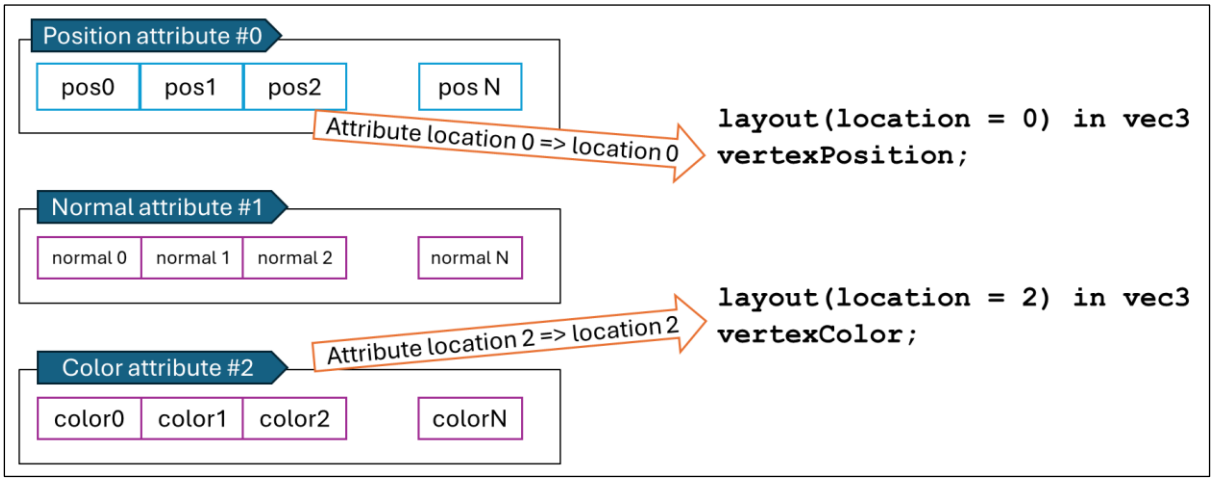

Knight Demo
FPS: 60
Rotate camera angle: move mouse.
Move camera: Use W/S/A/D.
Knight Demo
FPS: 60
Rotate camera angle: move mouse.
Move camera: Use W/S/A/D.

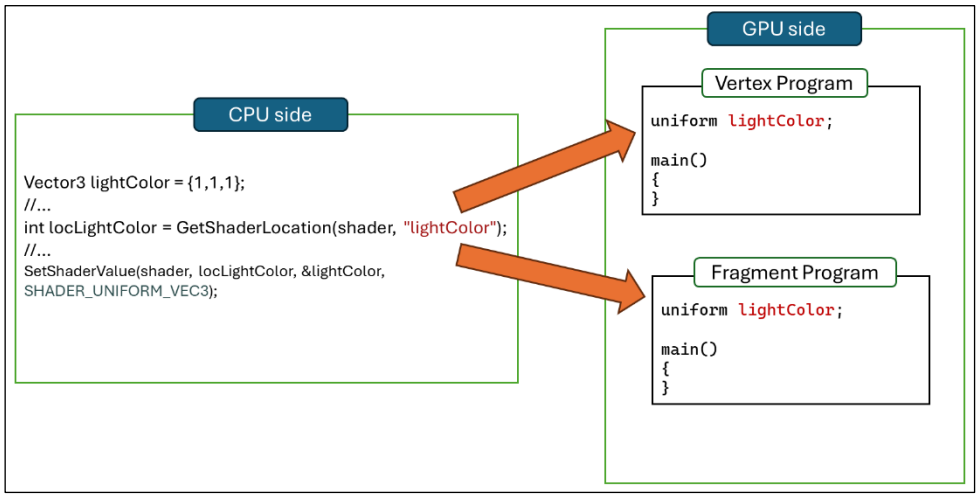
Chapter 6: 3D Graphics Rendering

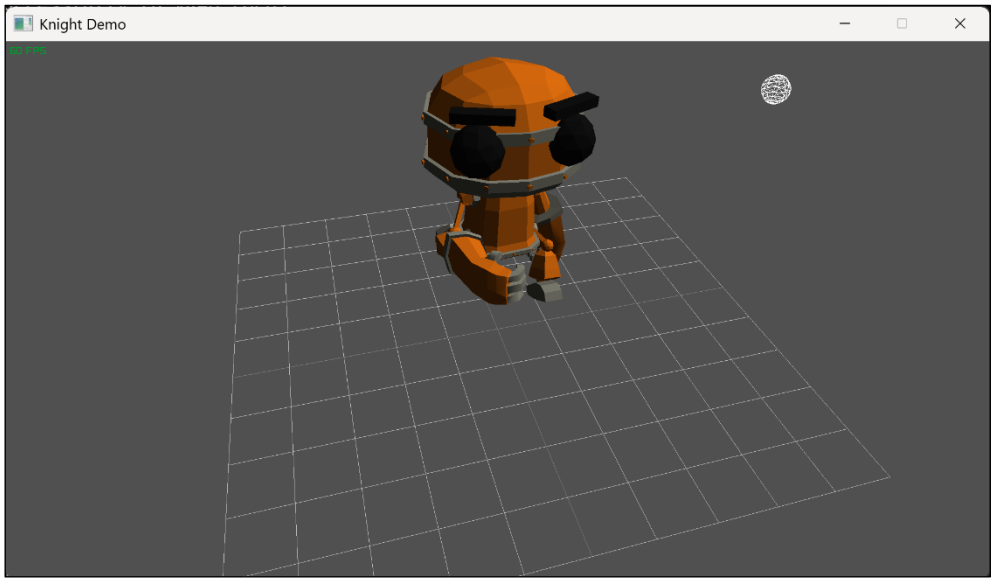


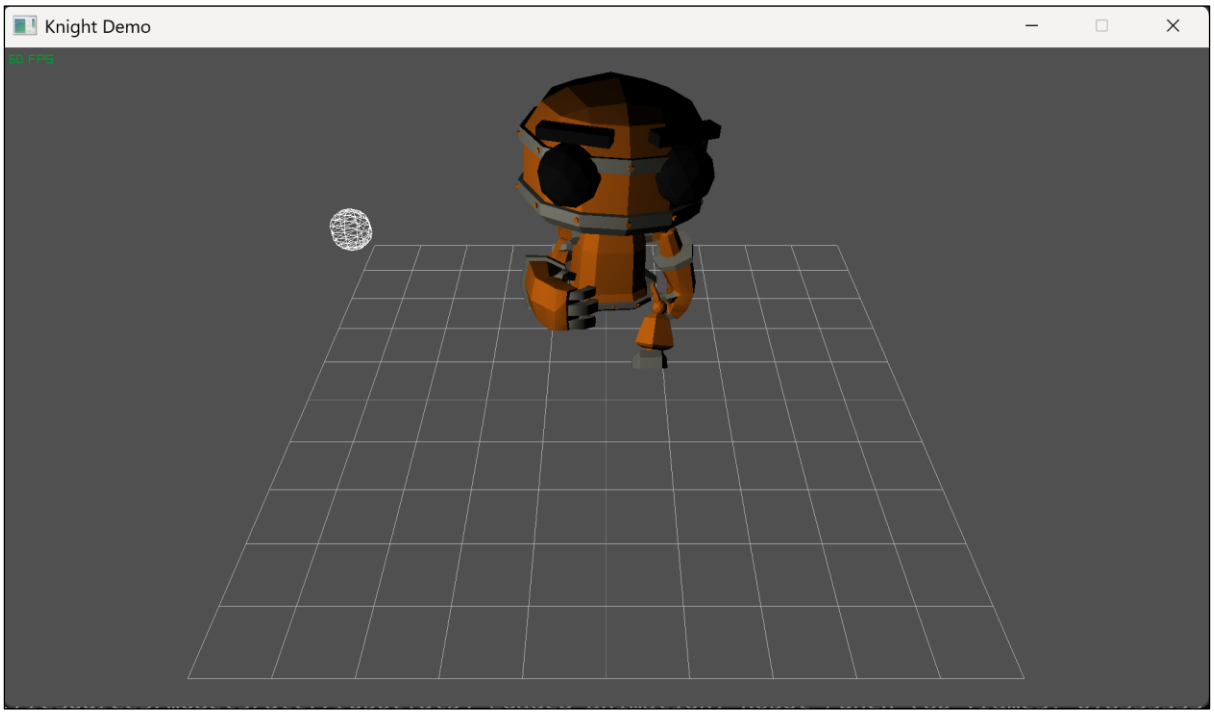


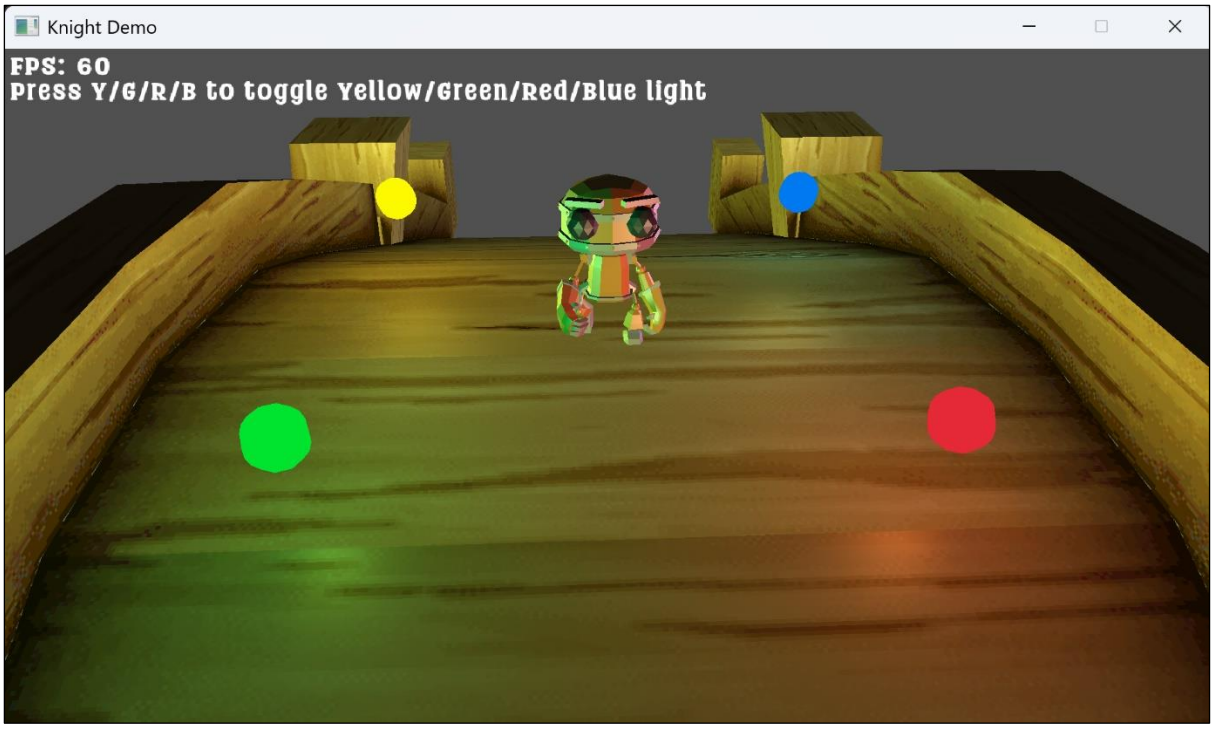

N
B
T

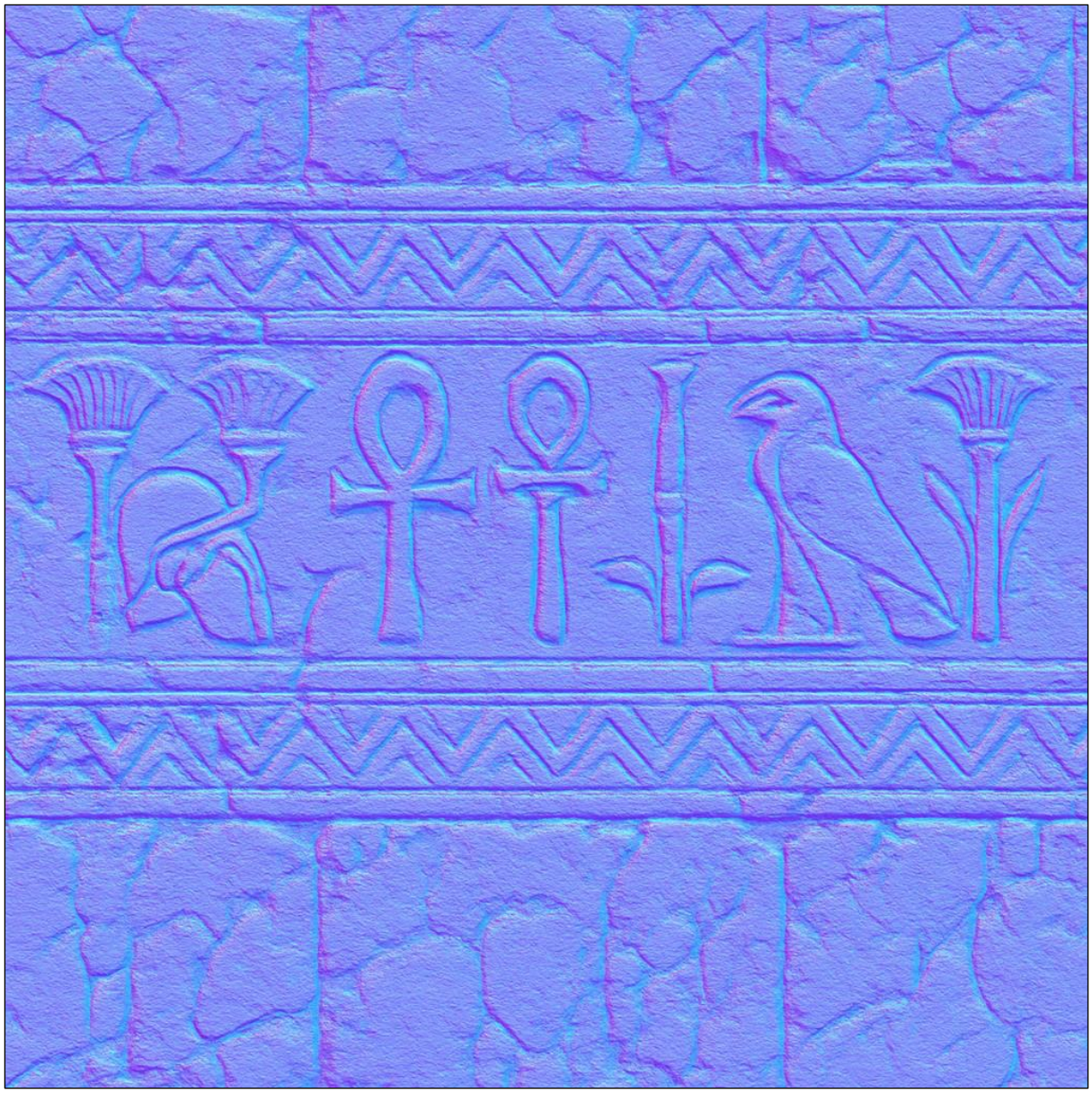

Position attribute #0
pos0
pos1
pos2
pos N
Attribute location 0 => location 0
layout(location = 0) in vec3 vertexPosition;
Normal attribute #1
normal 0
normal 1
normal 2
normal N
Attribute location 2 => location 2
layout(location = 2) in vec3 vertexColor;
Color attribute #2
color0
color1
color2
colorN

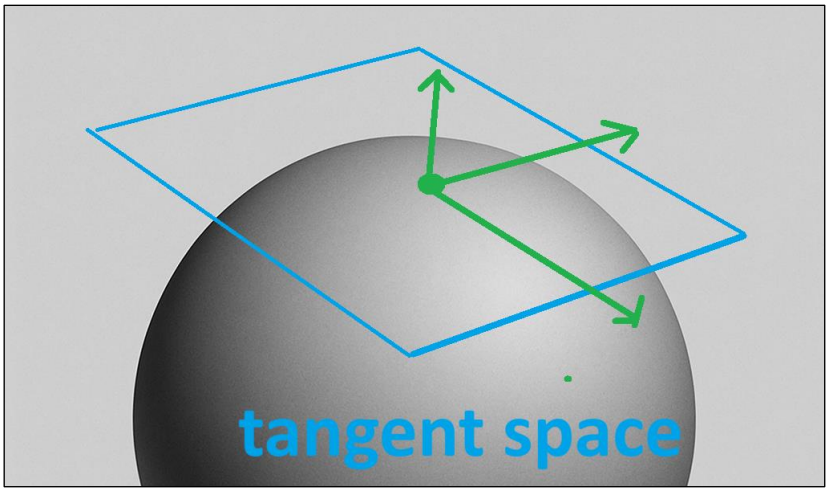

GPU side
Vertex Program
uniform lightColor;
main()
{
}
CPU side
Vector3 lightColor = {1,1,1};
//...
int locLightColor = GetShaderLocation(shader, "lightColor");
//...
SetShaderValue(shader, locLightColor, &lightColor, SHADER_UNIFORM_VEC3);
Fragment Program
uniform lightColor;
main()
{
}

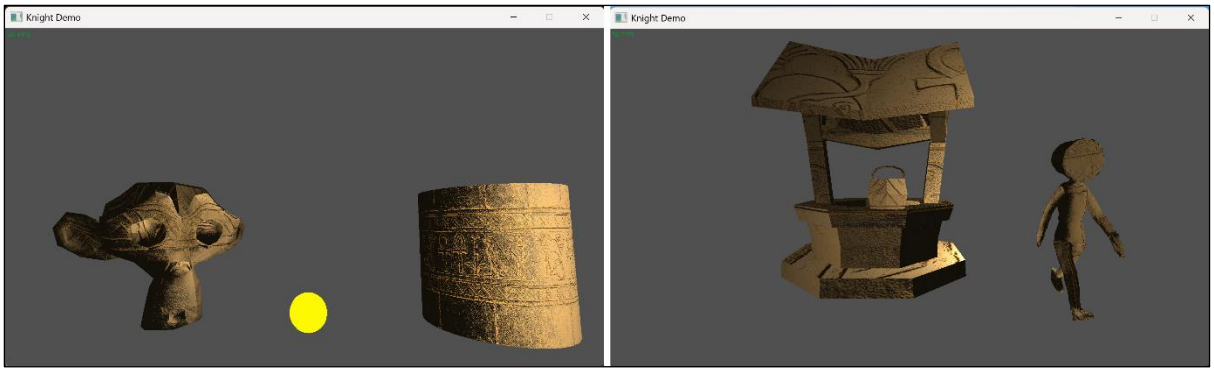

Knight Demo


Knight Demo

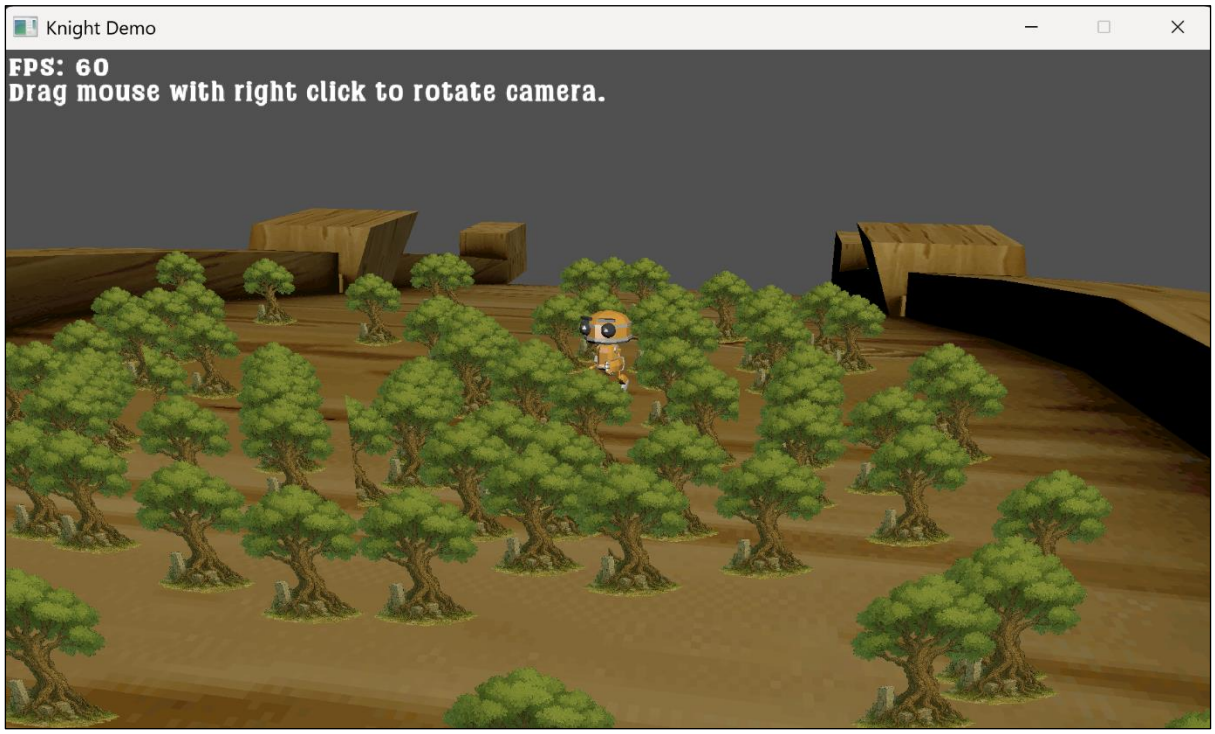

Knight Demo
FPS: 60
Press Y/G/R/B to toggle Yellow/Green/Red/Blue light



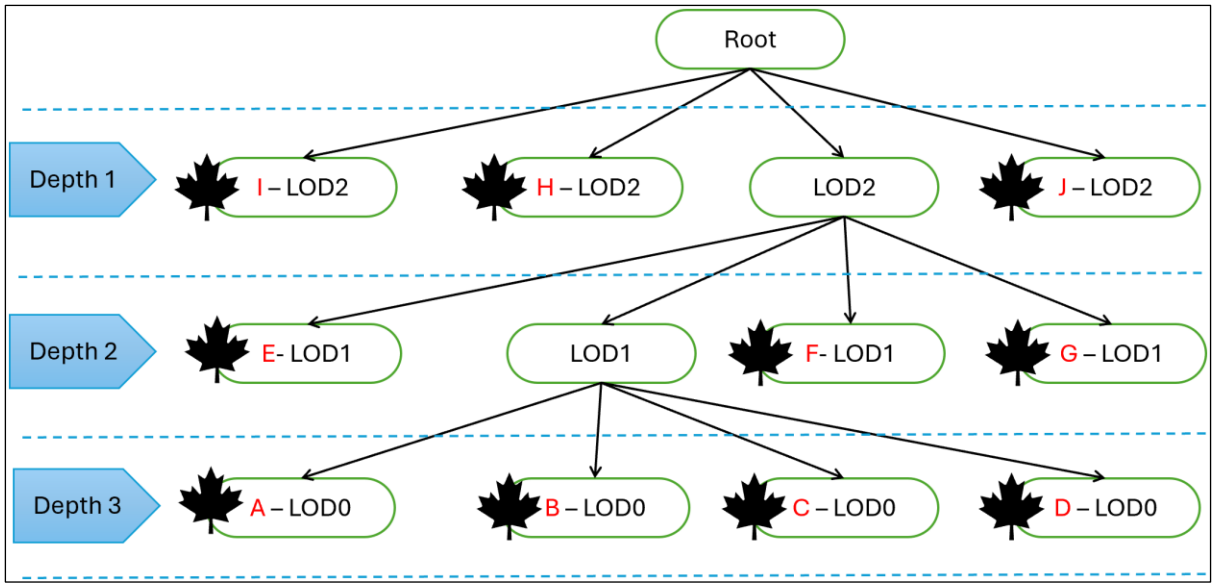

tangent space

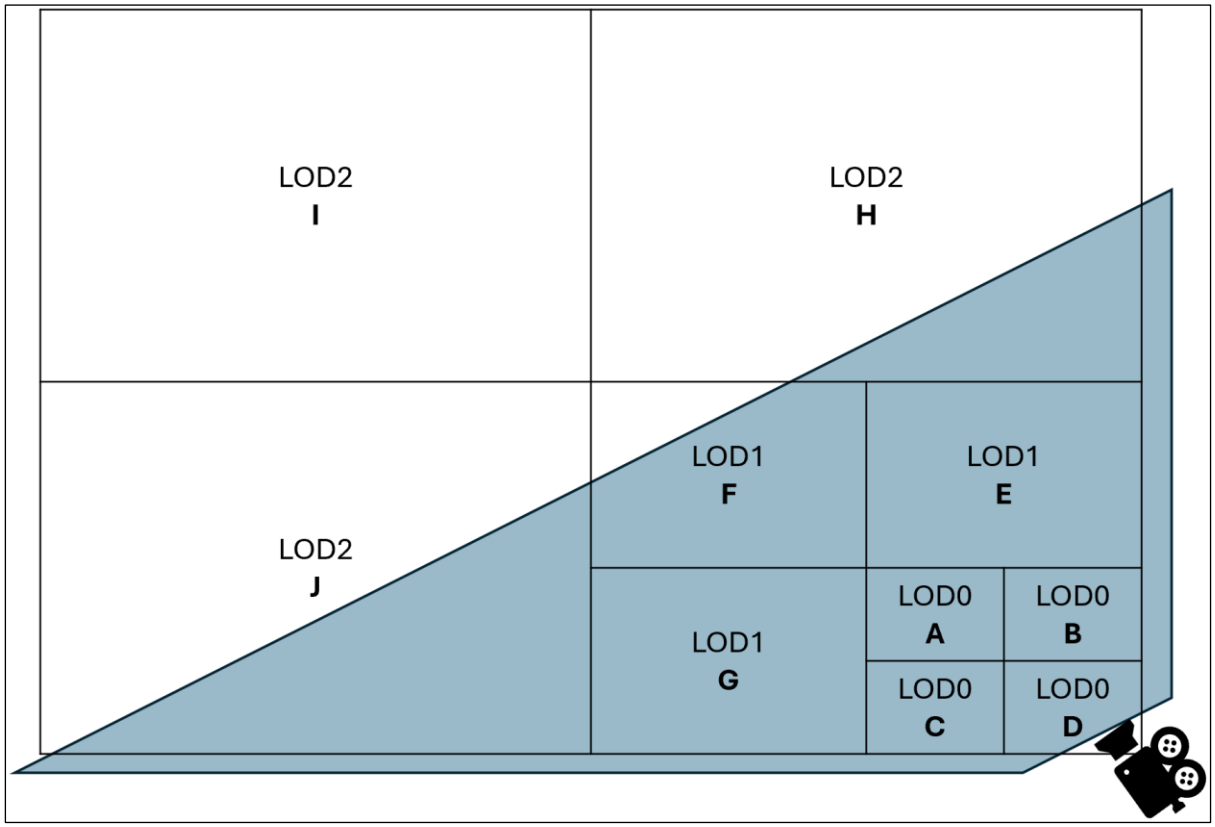

Knight Demo
Knight Demo

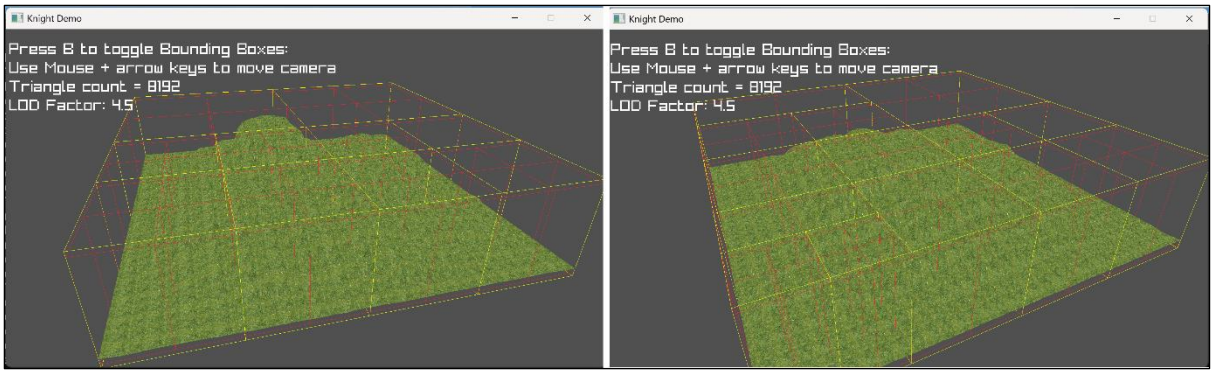
Chapter 7: Rendering a 3D Game World





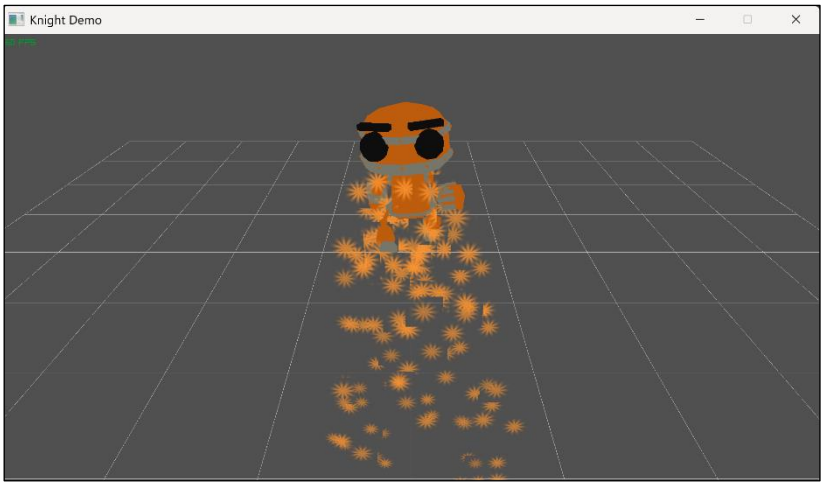

Root
Depth 1
I – LOD2
H – LOD2
LOD2
J – LOD2
Depth 2
E- LOD1
LOD1
F- LOD1
G – LOD1
Depth 3
A – LOD0
B – LOD0
C – LOD0
D – LOD0

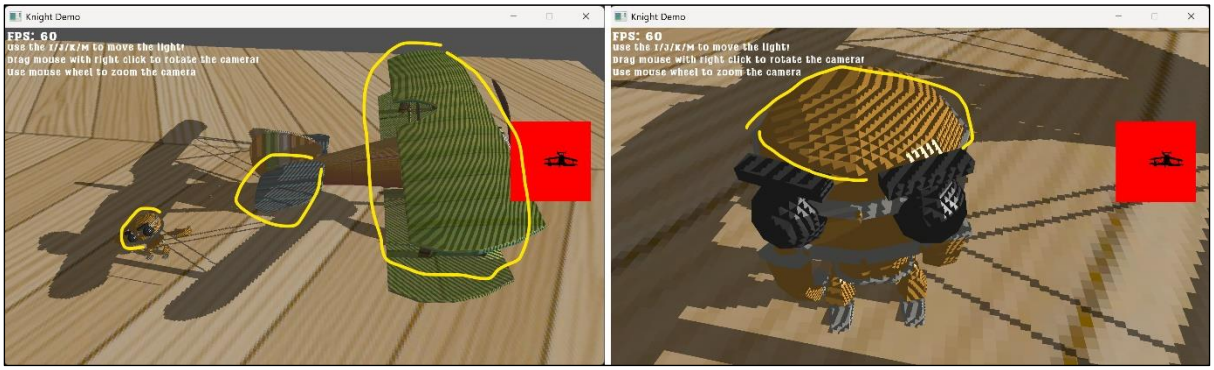

LOD2
I
LOD2
H
LOD2
J
LOD1
F
LOD1
E
LOD1
G
LOD0
A
LOD0
B
LOD0
C
LOD0
D

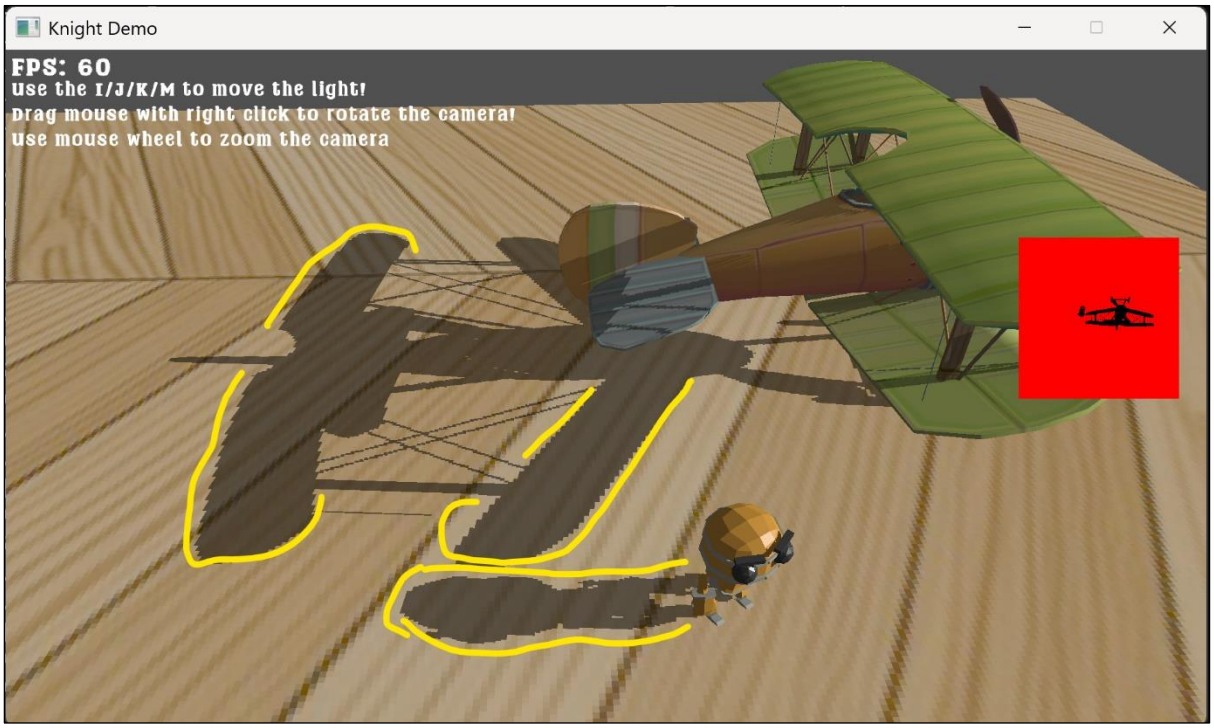

Knight Demo
Press B to toggle Bounding Boxes:
Use Mouse + arrow keys to move camera
Triangle count = 8192
LOD Factor: 4.5
Knight Demo
Press B to toggle Bounding Boxes:
Use Mouse + arrow keys to move camera
Triangle count = 8192
LOD Factor: 4.5

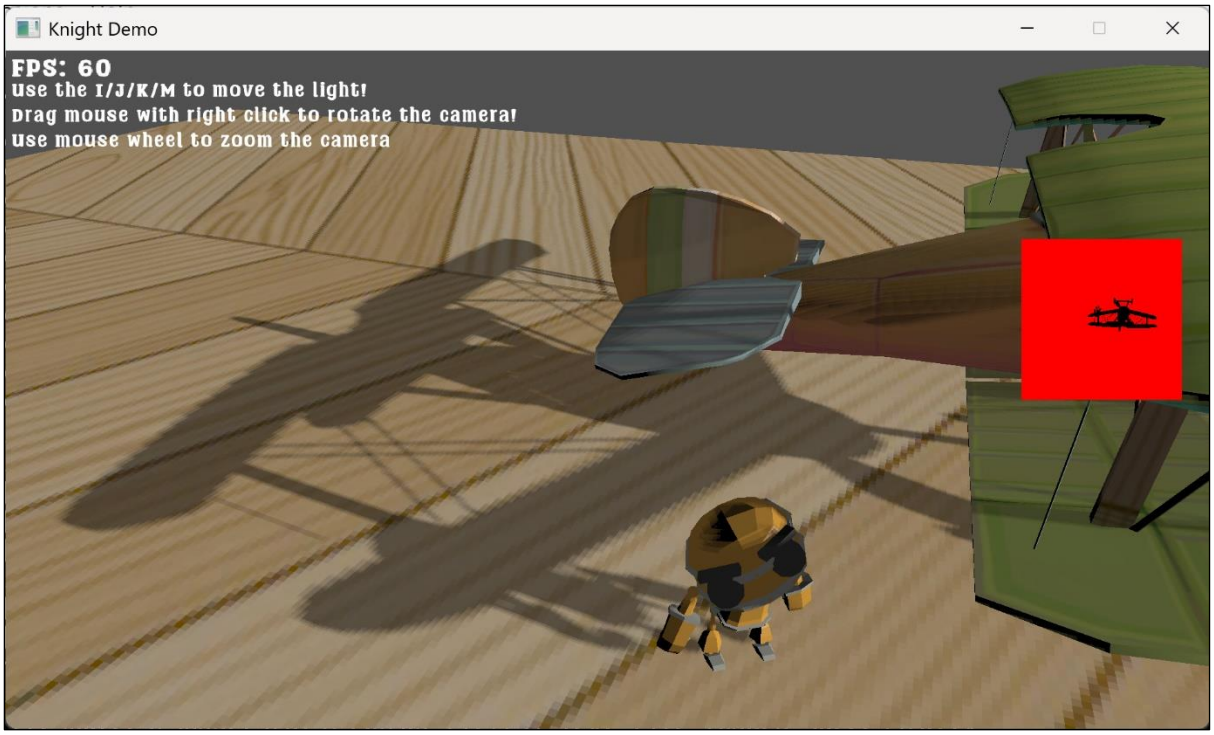

Knight Demo
FPS: 60
Move mouse to rotate the camera!

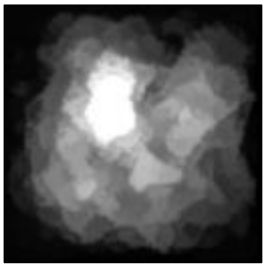

Knight Demo
FPS: 60
Drag mouse with right click to rotate camera.
Knight Demo
FPS: 60
Drag mouse with right click to rotate camera.

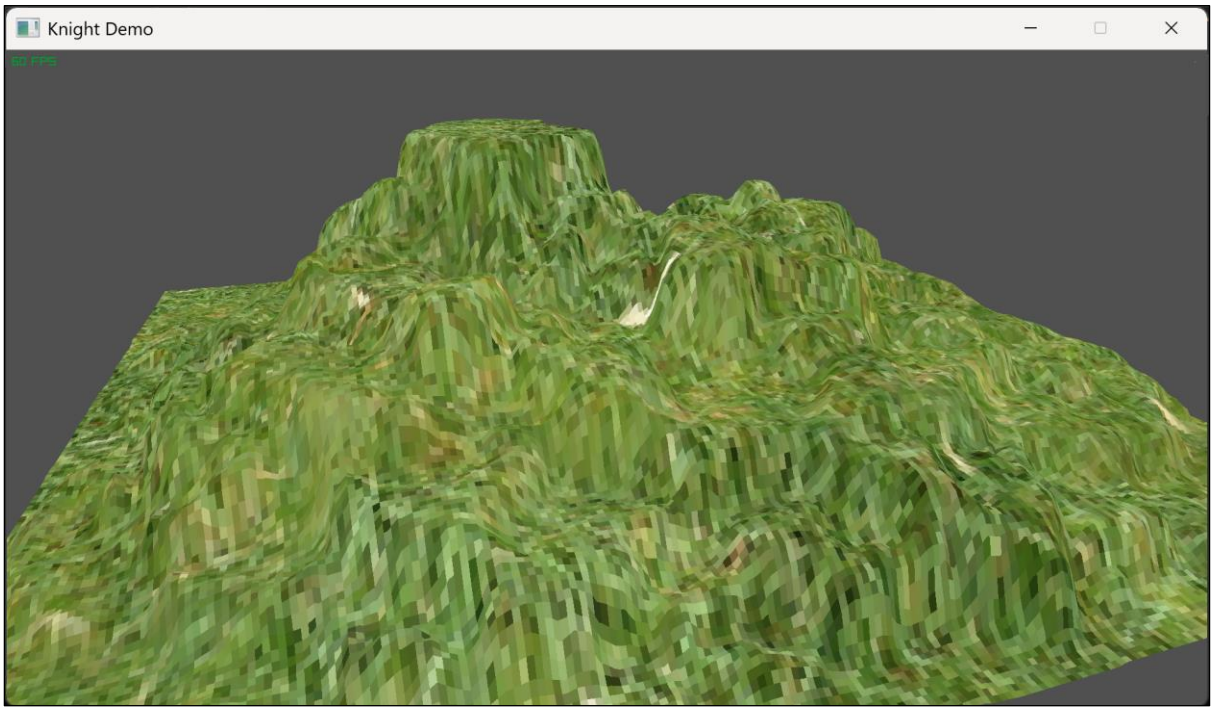

Knight Demo

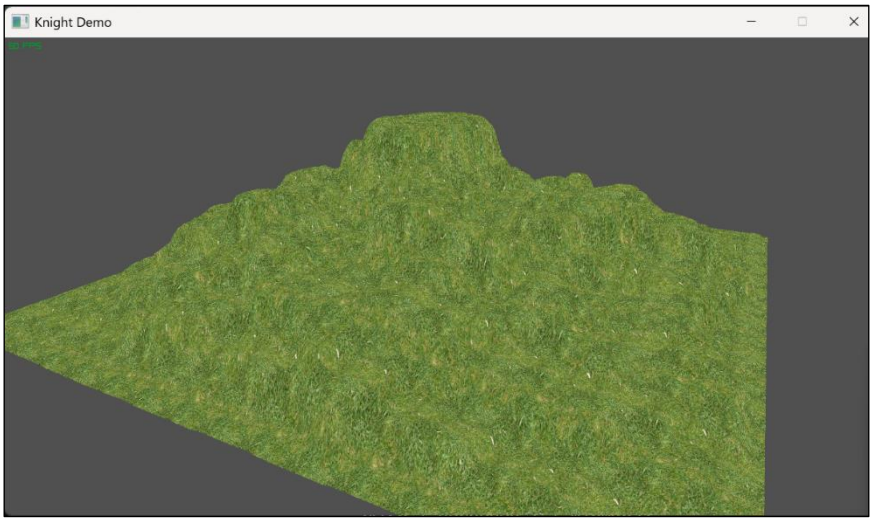

Knight Demo
FPS: 60
Use the I/J/K/M to move the light!
Drag mouse with right click to rotate the camera!
Use mouse wheel to zoom the camera
Knight Demo
FPS: 60
Use the I/J/K/M to move the light!
Drag mouse with right click to rotate the camera!
Use mouse wheel to zoom the camera


Knight Demo
FPS: 60
Use the I/J/K/M to move the light!
Drag mouse with right click to rotate the camera!
Use mouse wheel to zoom the camera

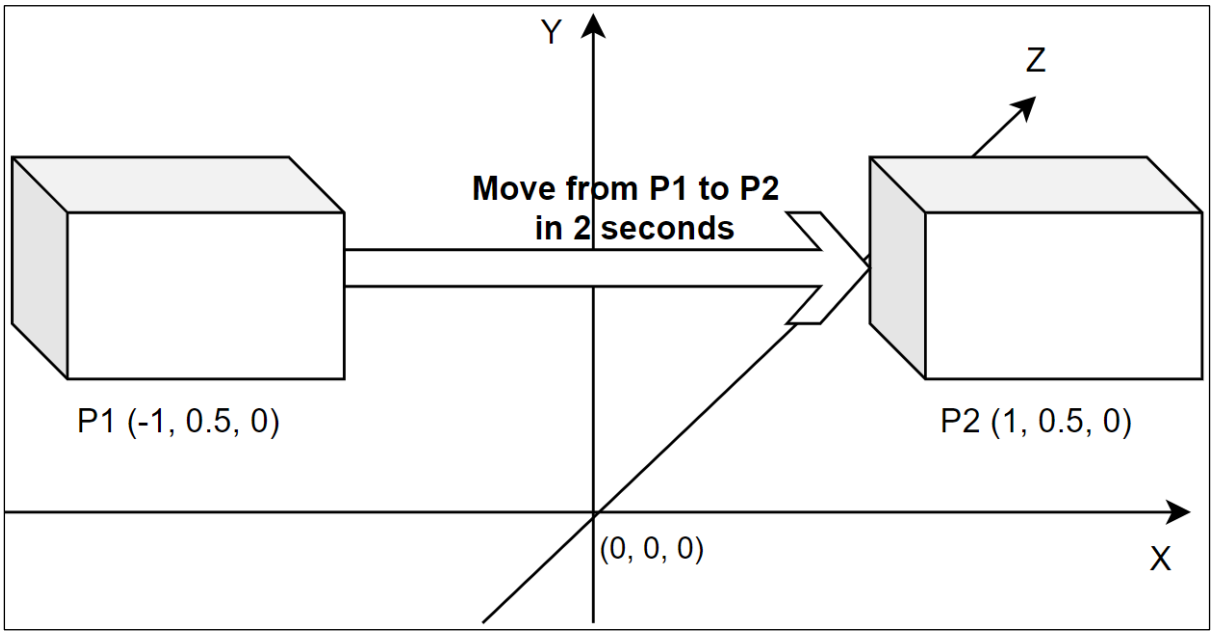

Knight Demo
FPS: 60
Use the I/J/K/M to move the light!
Drag mouse with right click to rotate the camera!
Use mouse wheel to zoom the camera

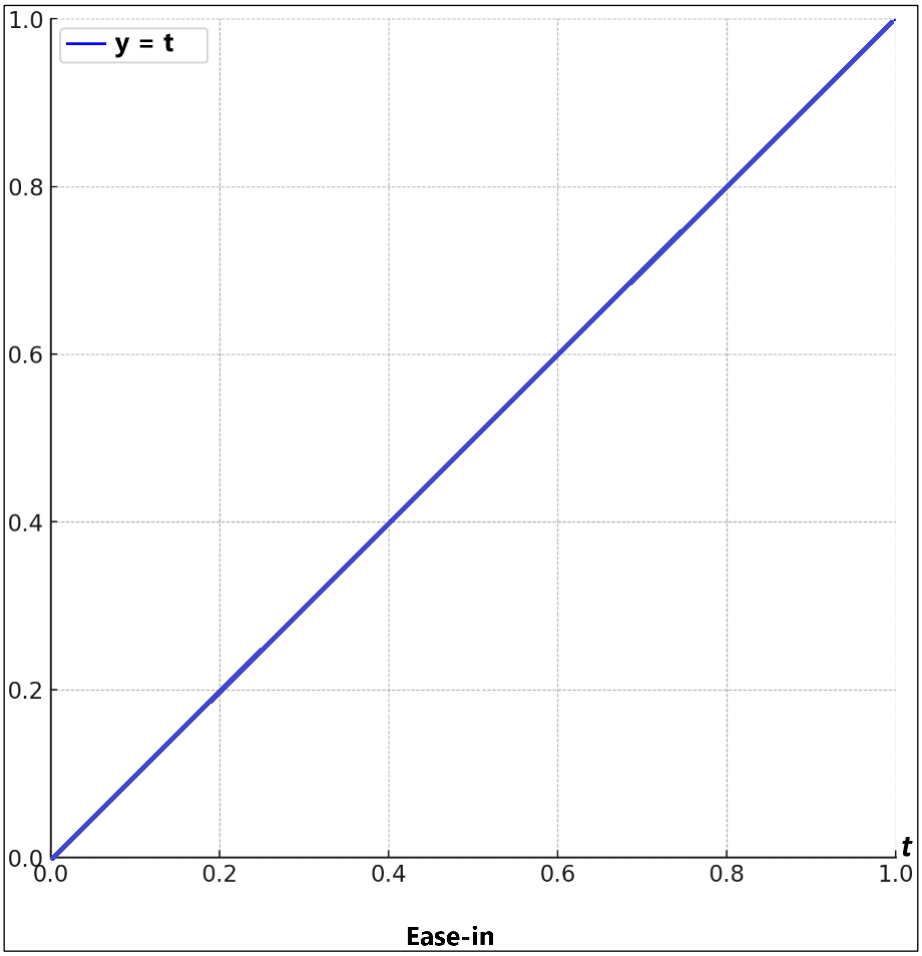


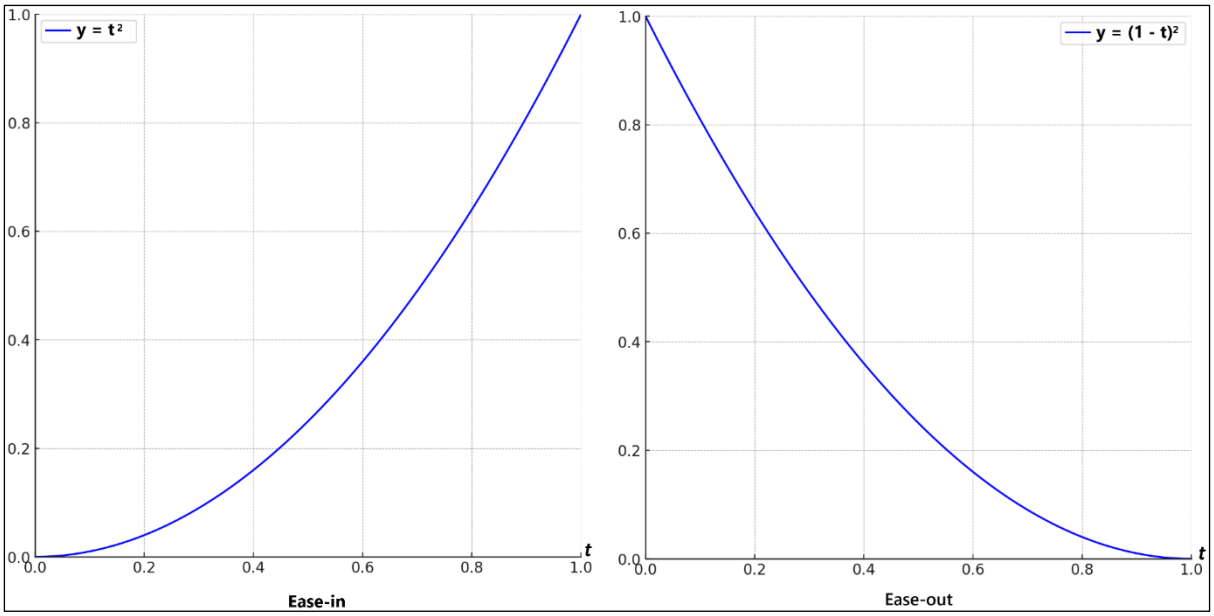

Knight Demo
60 FPS

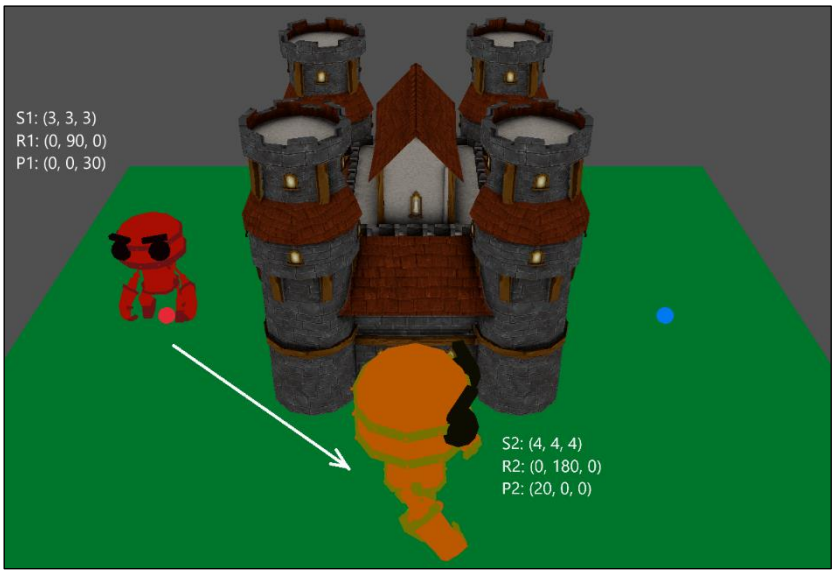

Knight Demo

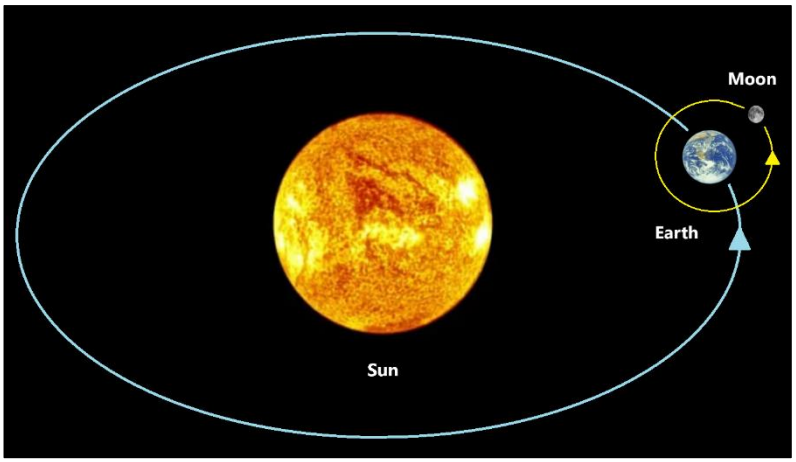
Chapter 8: Animating Your Characters

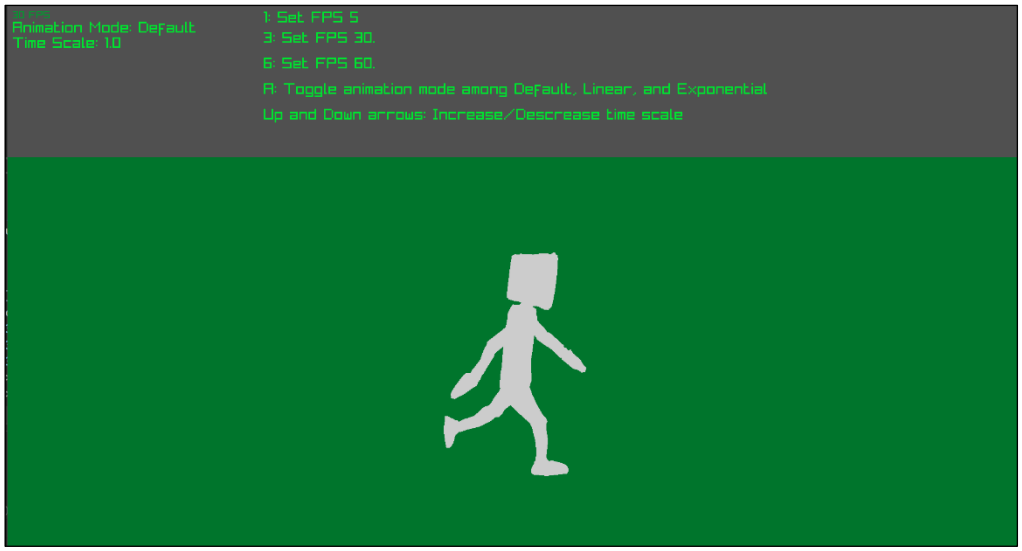


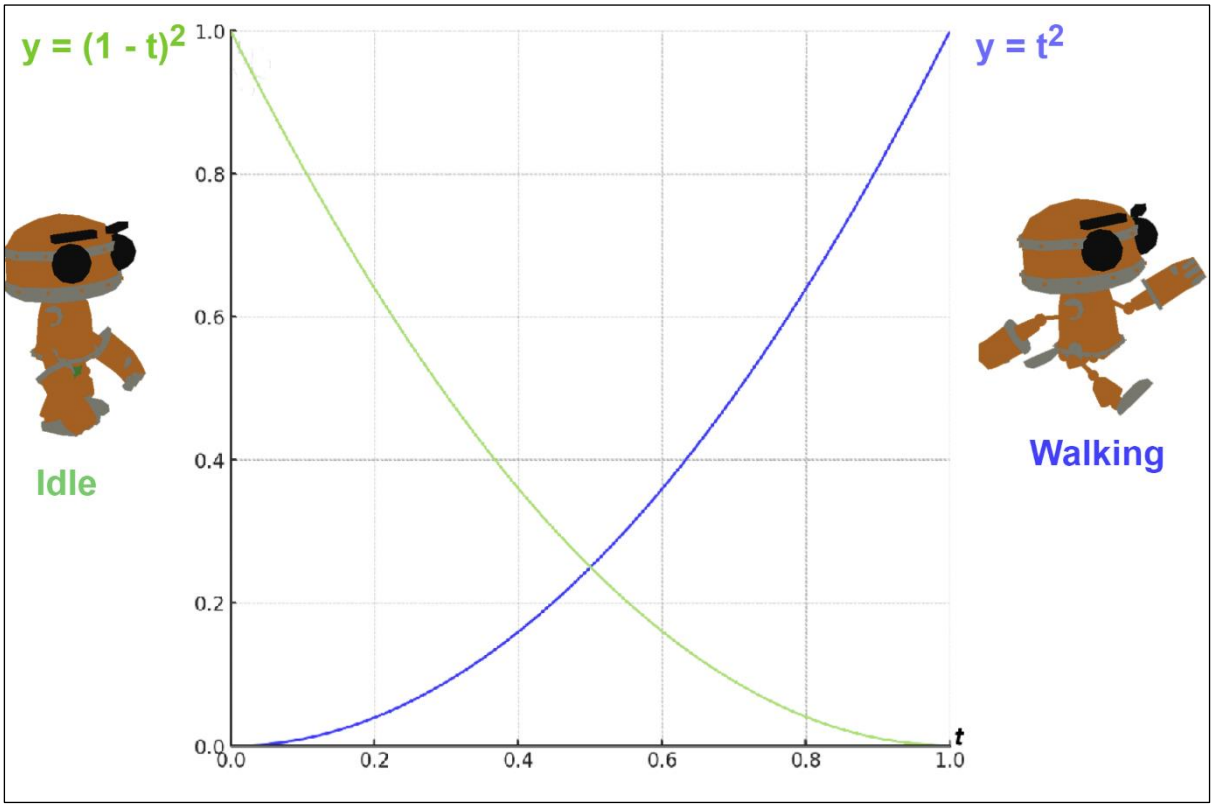



y = t²
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
t
Ease-in
y = (1 - t)²
Ease-out

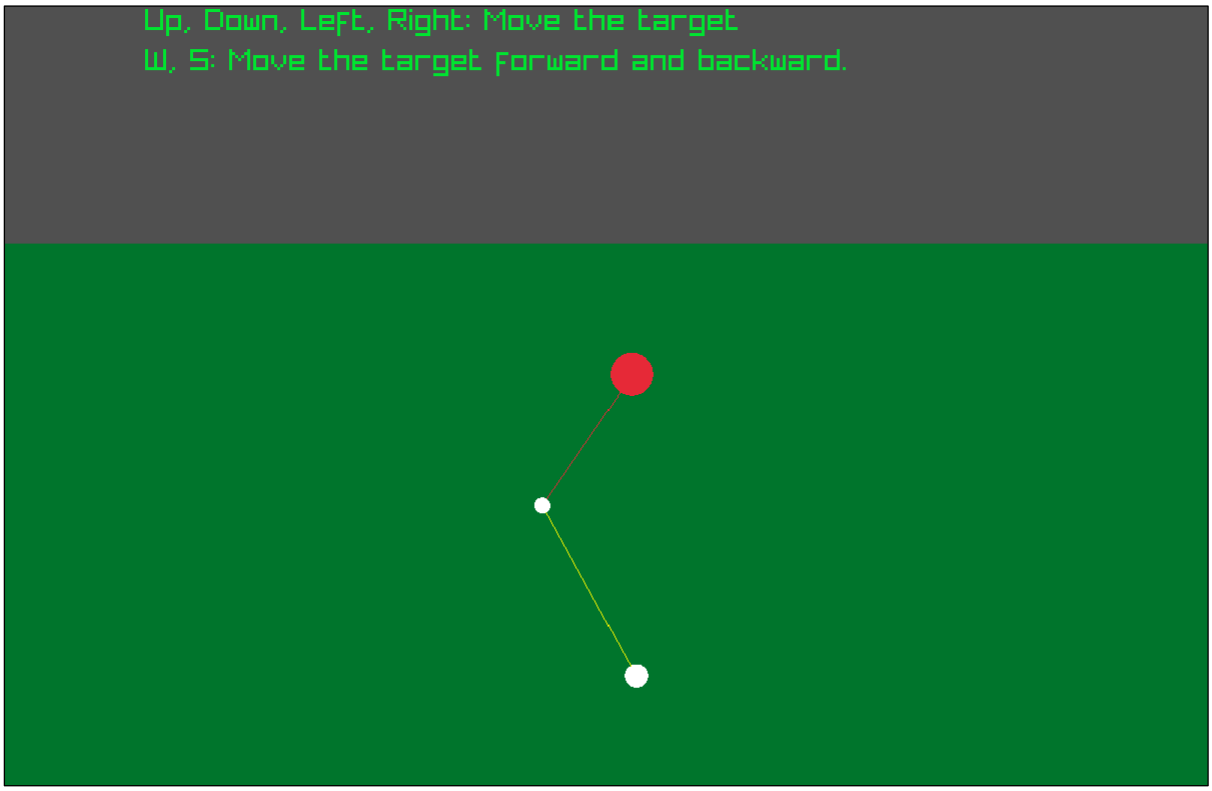

S1: (3, 3, 3)
R1: (0, 90, 0)
P1: (0, 0, 30)
S2: (4, 4, 4)
R2: (0, 180, 0)
P2: (20, 0, 0)


Moon
Earth
Sun

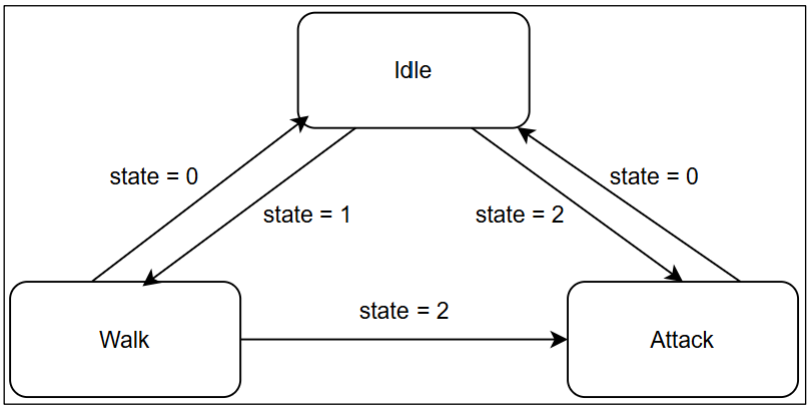

Animation Mode: Default
Time Scale: 1.0
1: Set FPS 5.
3: Set FPS 30.
6: Set FPS 60.
R: Toggle animation mode among Default, Linear, and Exponential
Up and Down arrows: Increase/Descrease time scale

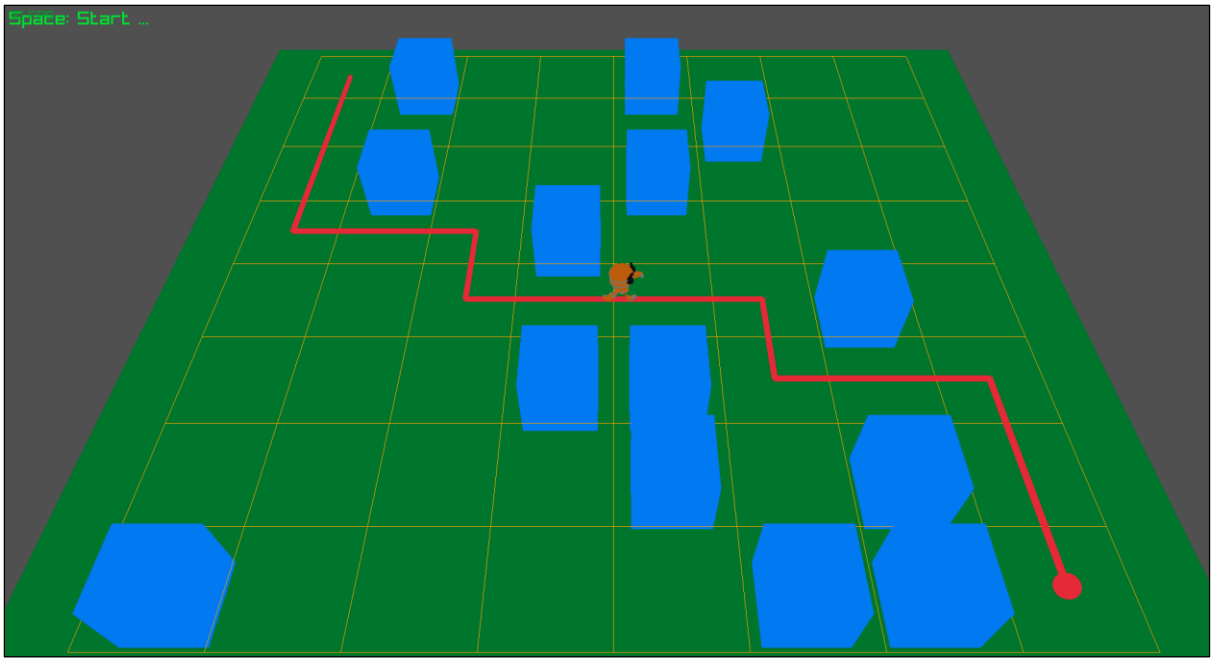

y = (1 - t)2
y = t2
Idle
Walking
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
t

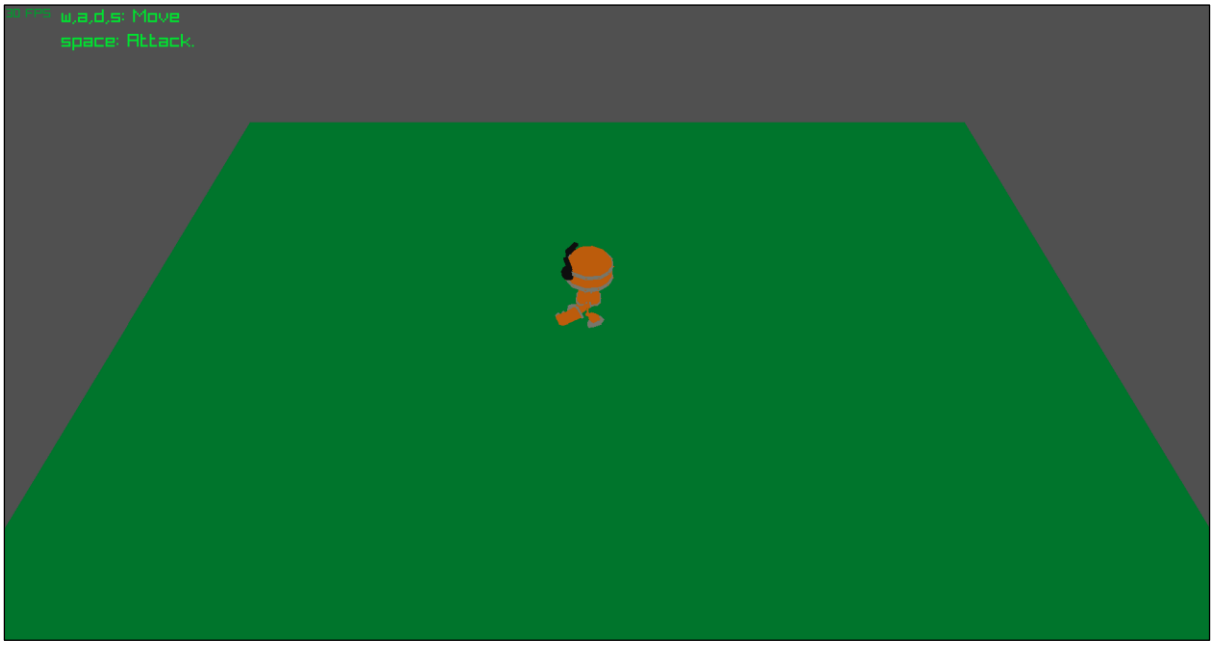

nimation Mode: Linear
ransition Mode: Immediate
ime Scale: 1.0
Left and Right arrows: Rotate
A: Toggle between the Idle and Run animations
T: Toggle between the Immediate, Linear, and EsayInEasyOut transition modes
+/-: Increase/Descrease time scale

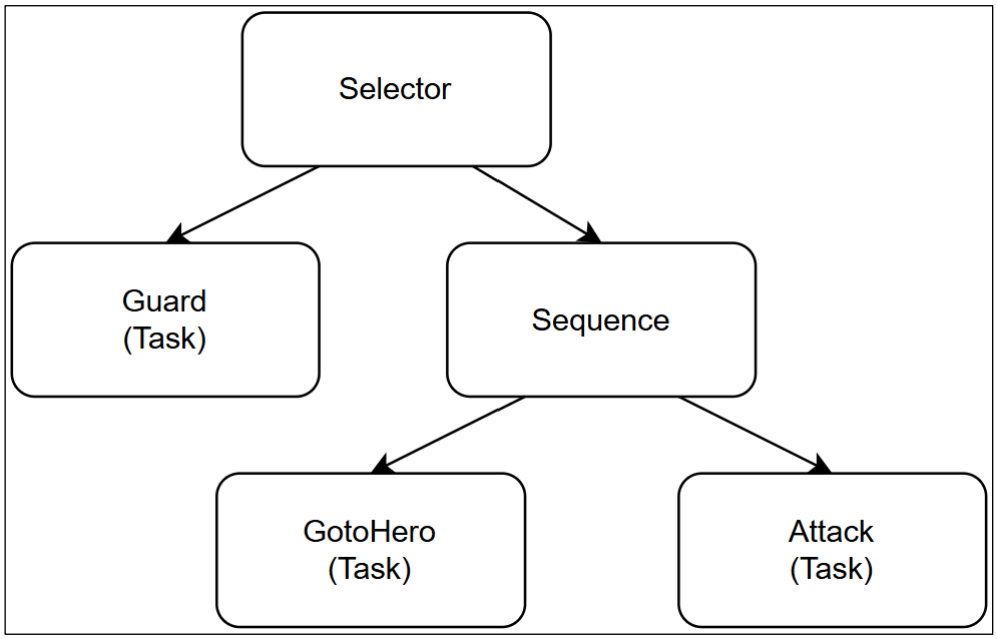

Up, Down, Left, Right: Move the target
W, S: Move the target forward and backward.

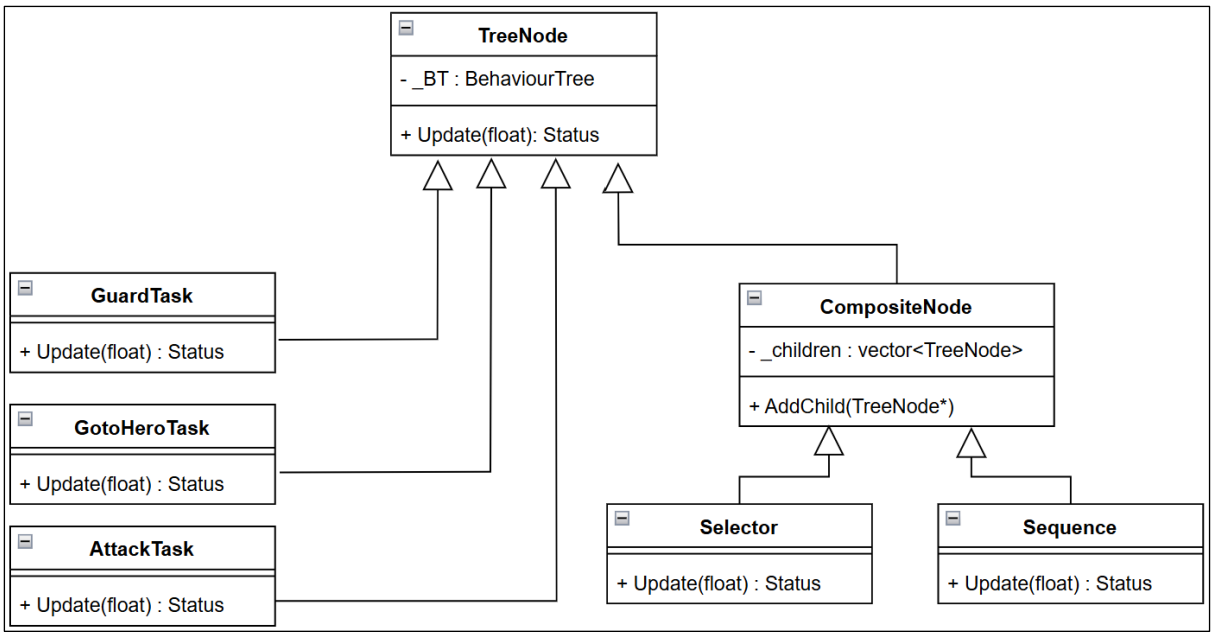
Chapter 9: Building AI Opponents

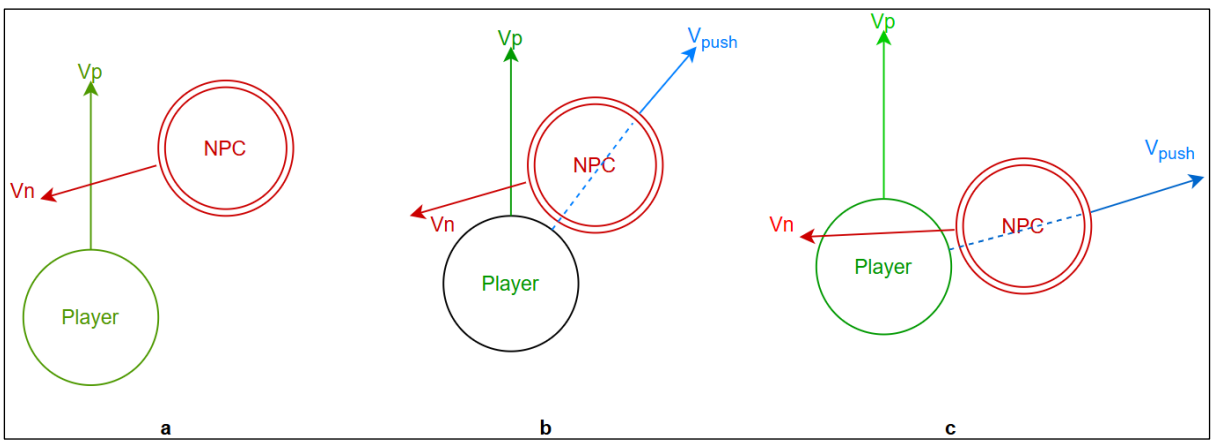


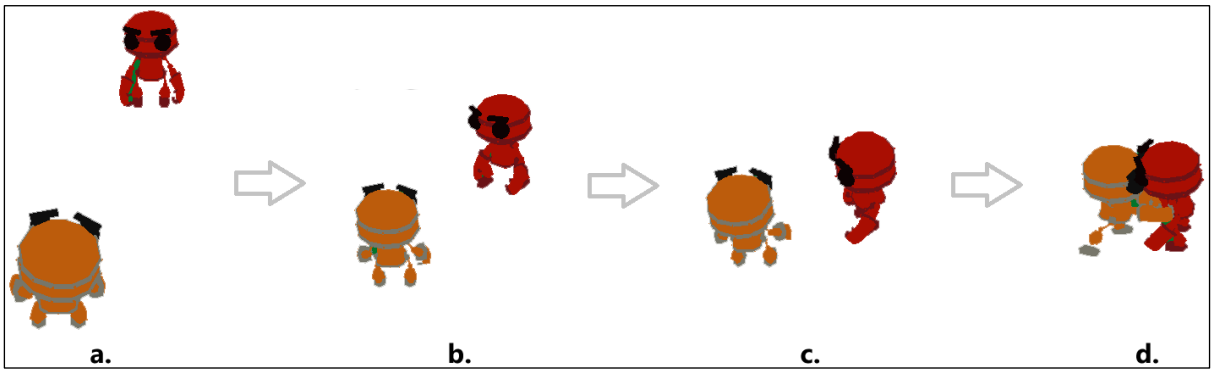


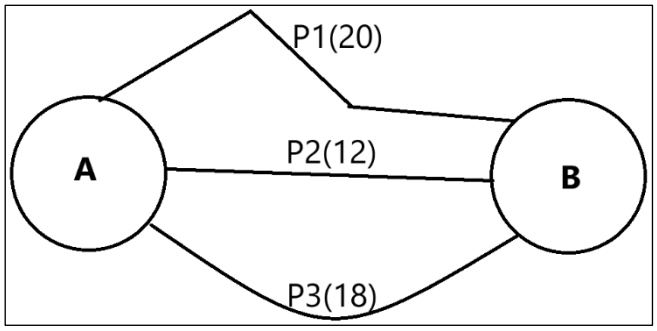


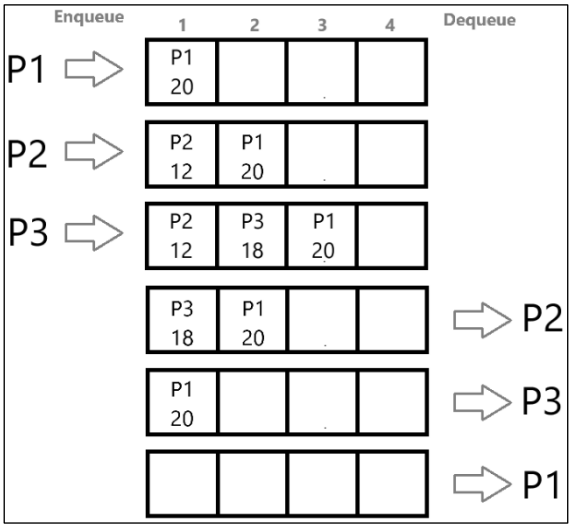

Selector
Guard
(Task)
Sequence
GotoHero
(Task)
Attack
(Task)

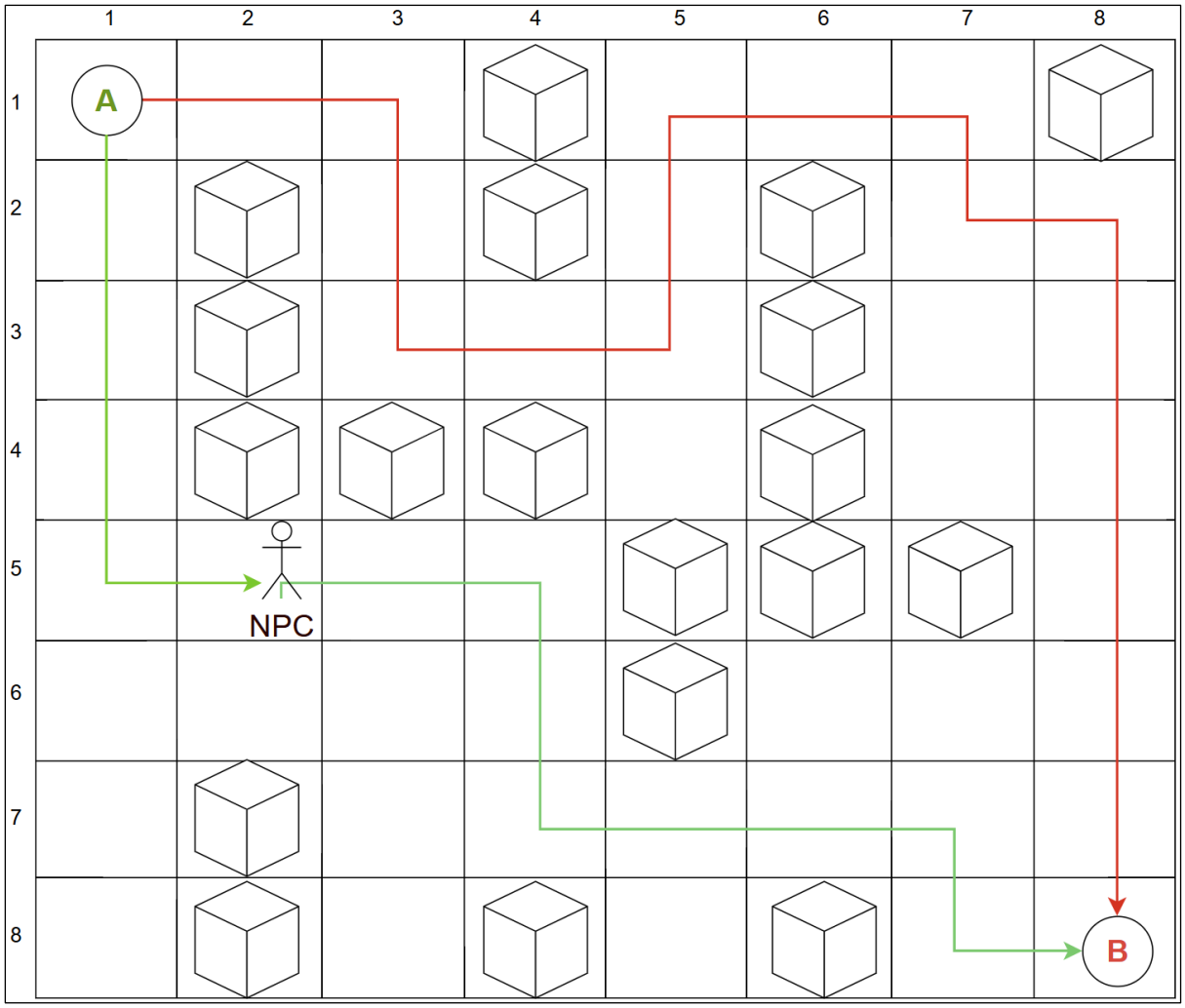

TreeNode
- _BT : BehaviourTree
+ Update(float): Status
GuardTask
+ Update(float) : Status
GotoHeroTask
+ Update(float) : Status
AttackTask
+ Update(float) : Status
CompositeNode
- _children : vector<TreeNode>
+ AddChild(TreeNode*)
Selector
+ Update(float) : Status
Sequence
+ Update(float) : Status


Vp
NPC
Vn
Player
a
Vp
Vpush
NPC
Vn
Player
b
Vp
Vpush
Vn
NPC
Player
c

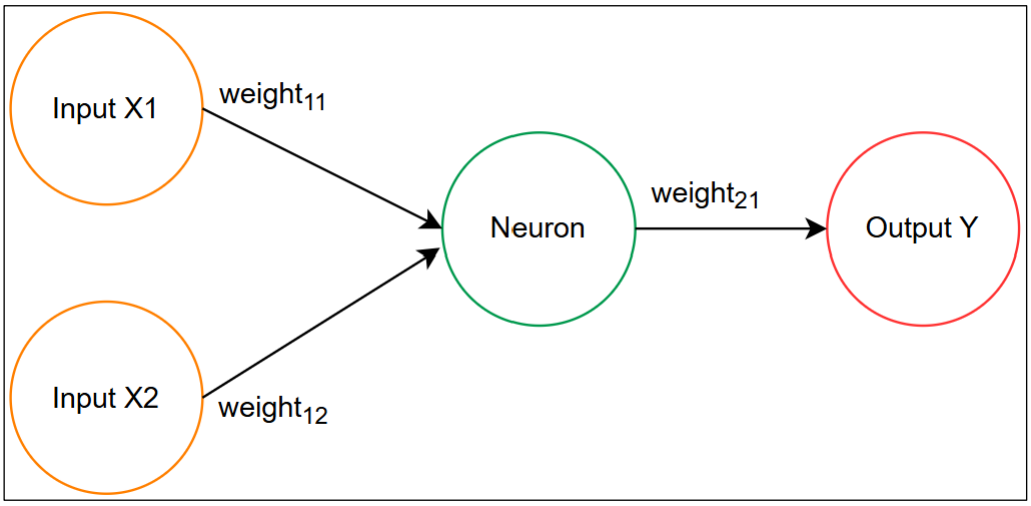

a.
b.
c.
d.

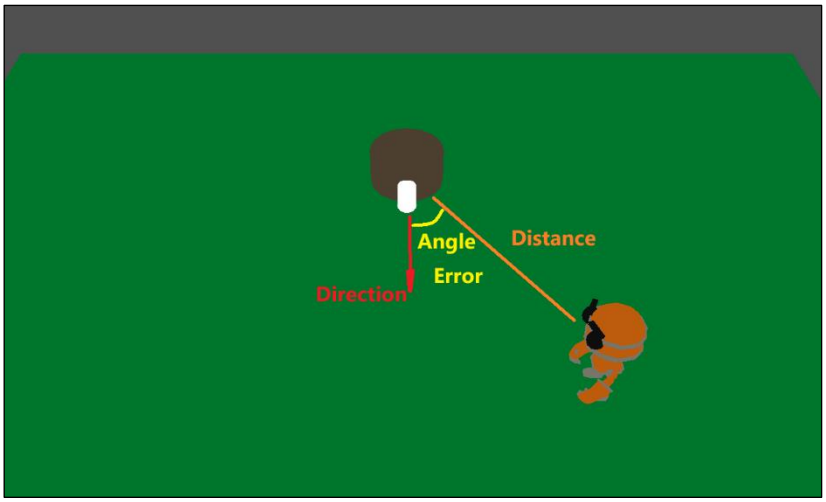

P1(20)
A
P2(12)
B
P3(18)

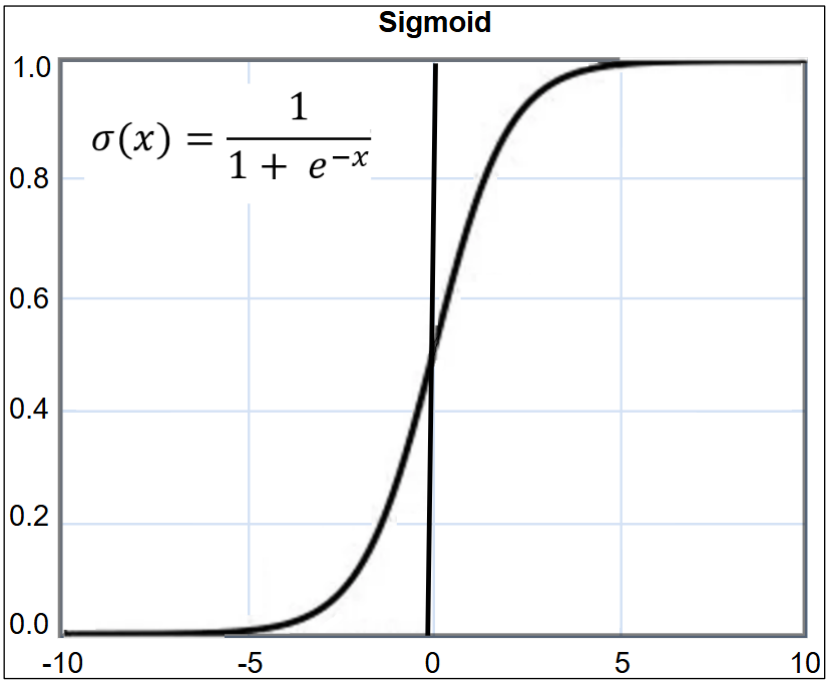

Enqueue
1
2
3
4
Dequeue
P1
P2
P3
P1 20
P2 12
P1 20
P2 12
P3 18
P1 20
P3 18
P1 20
P1 20
P2
P3
P1

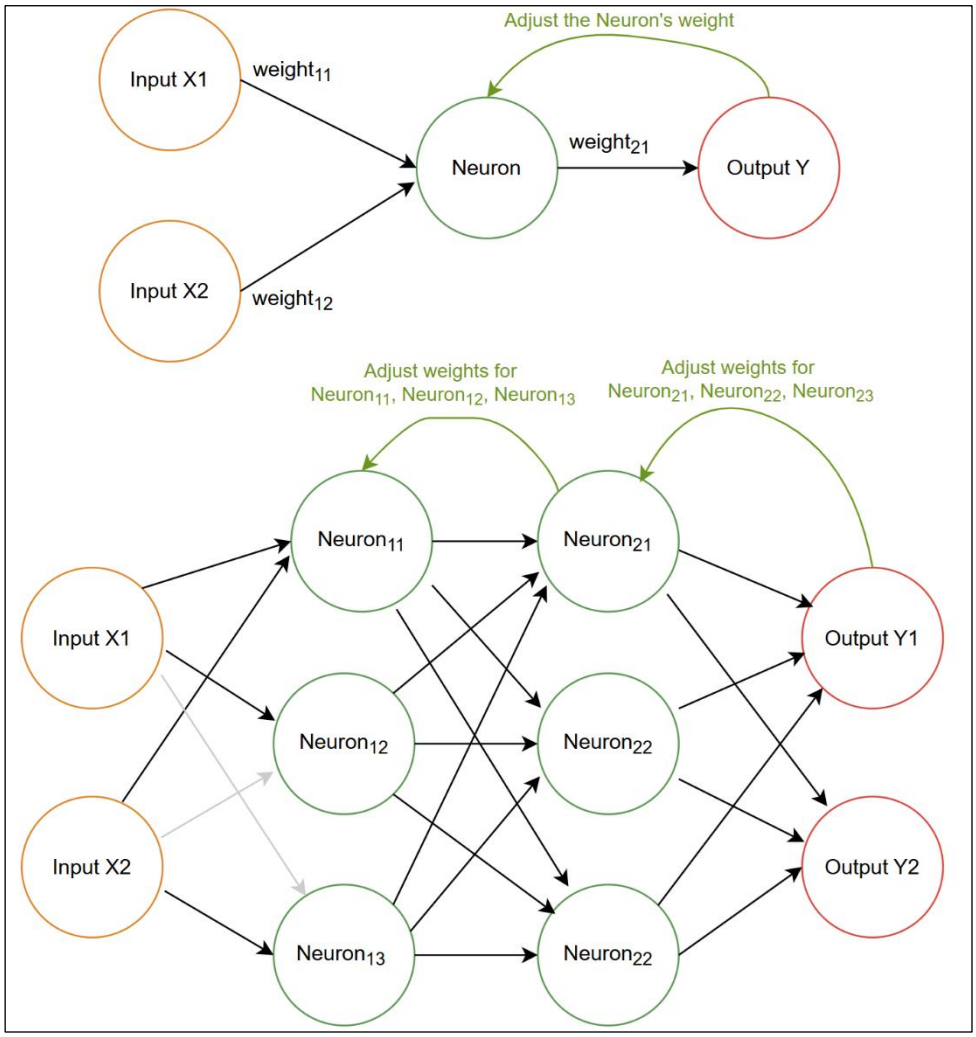

1
2
3
4
5
6
7
8
A
NPC
B

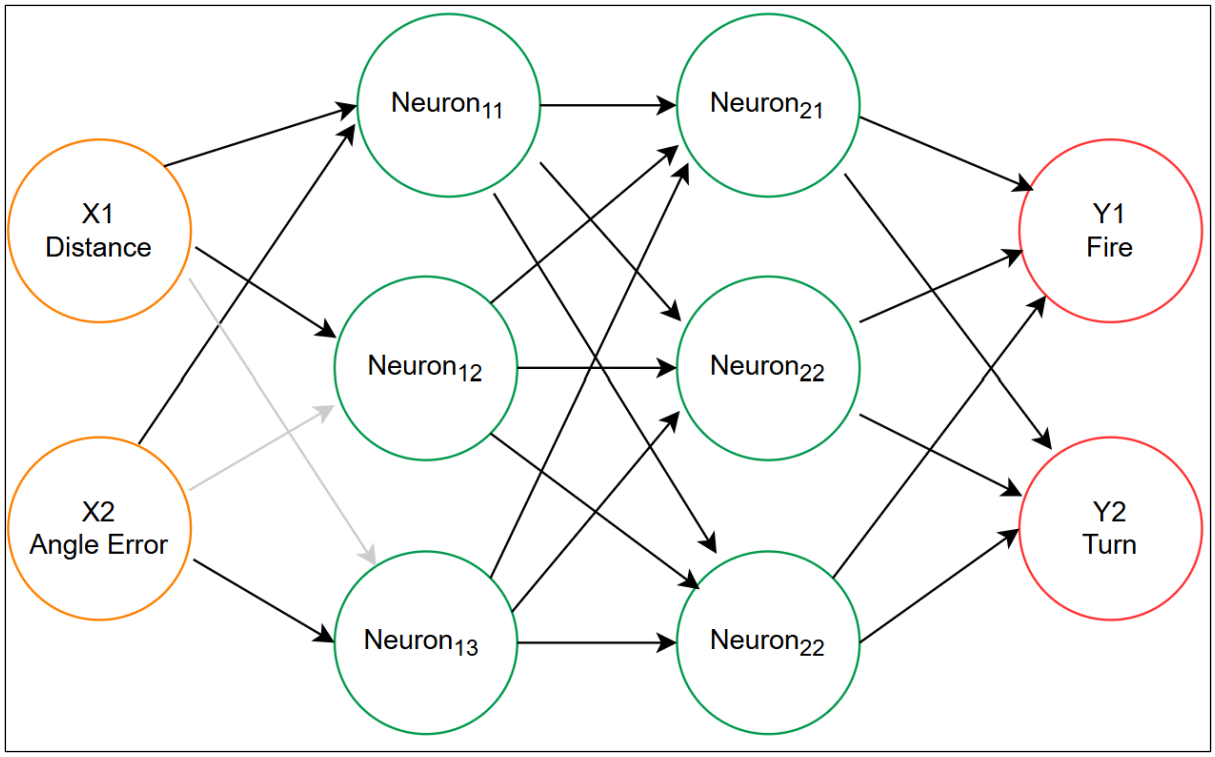
Chapter 10: Machine Learning Algorithms for Game AI

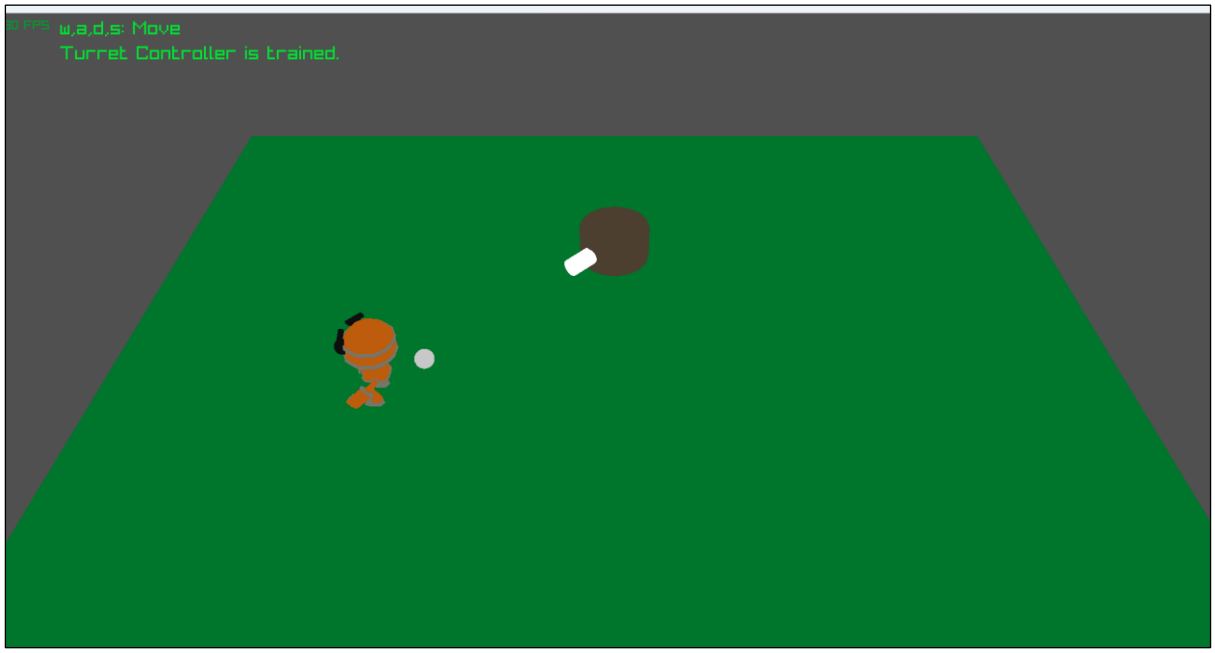


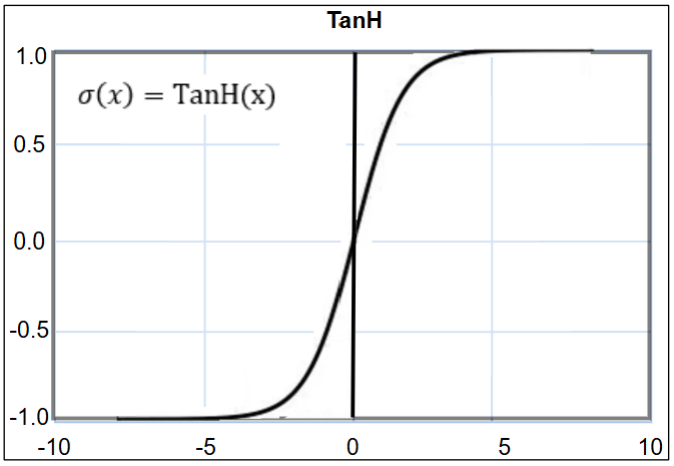


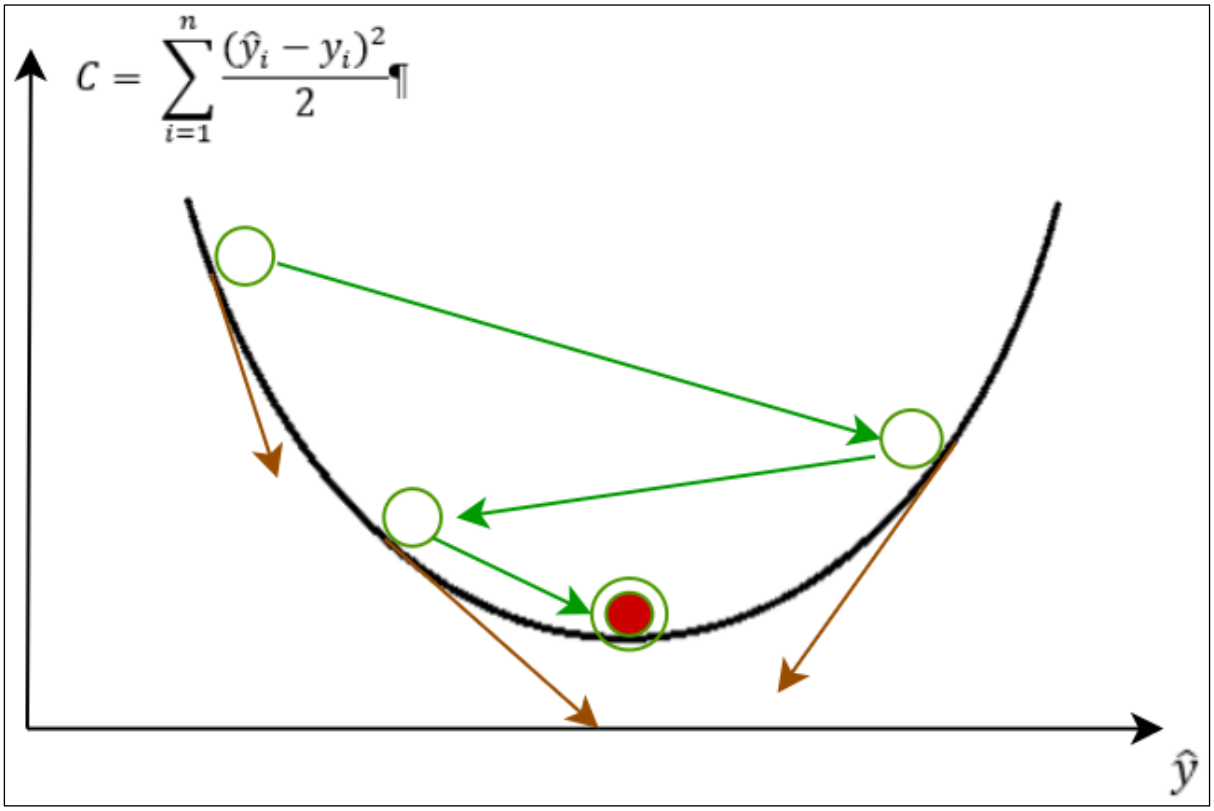



Adjust the Neuron's weight
Input X1
weight11
Neuron
weight21
Output Y
Input X2
weight12
Adjust weights for
Neuron11, Neuron12, Neuron13
Adjust weights for
Neuron21, Neuron22, Neuron23
Neuron11
Neuron21
Input X1
Output Y1
Neuron12
Neuron22
Input X2
Output Y2
Neuron13
Neuron22


X1
Distance
X2
Angle Error
Neuron11
Neuron12
Neuron13
Neuron21
Neuron22
Neuron22
Y1
Fire
Y2
Turn


w,a,d,s: Move
Turret Controller is trained.


TanH
$\sigma(x) = \text{TanH(x)}$
1.0
0.5
0.0
-0.5
-1.0
-10
-5
0
5
10


$C = \sum_{i=1}^{n} \frac{(\hat{y}_i - y_i)^2}{2}$
$\hat{y}$

Chapter 11: Continuing Your Learning Journey

