Game AI

Basic AI Concepts

States

Behaviors

Sensing

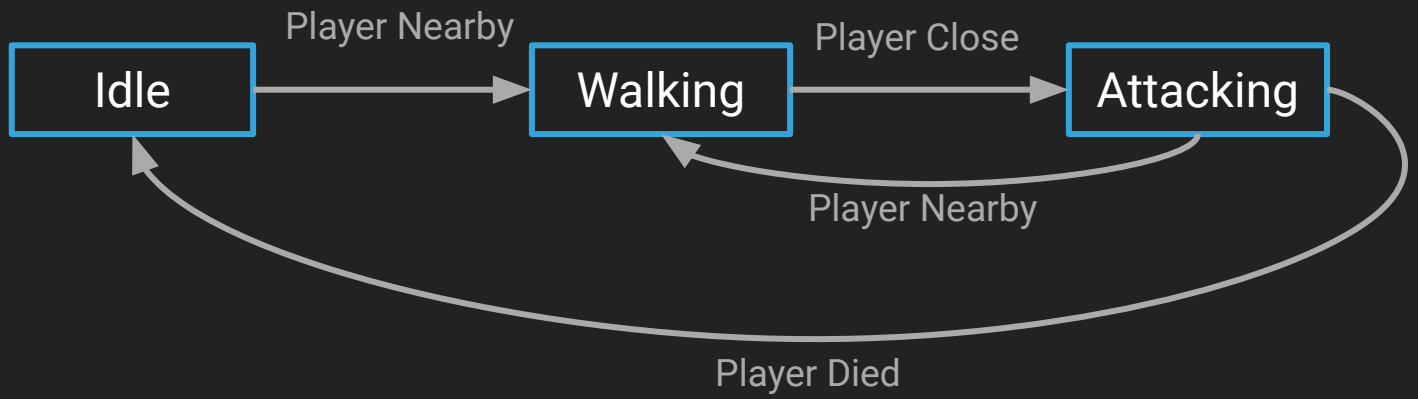
Finite State Machine

A model for something that can be in various states.

Can only be in one state at a time.

Transitions from state to state due to external input or when some condition is met.

Finite State Machine



Finite State Machine (Example)

```
enum AIState { IDLE, WALKING, ATTACKING };

AIState aiState = IDLE;

void AI() {
    switch (aiState) {
        case IDLE:
            if (/* player is nearby */) state = WALKING;
        break;

        case WALKING:
            if (/* player is in attack range */) {
                state = ATTACKING;
            } else {
                // Walk left to right
            }
```

Basic Behaviors

Walk in the direction I am facing.

Walk until hit obstacle, then reverse.

Patrolling (left to right within bounds/range).

Running and Jumping.

Flying (in a direction, oscillating, etc.)

Sensing

Distance to the Player

Direction of the Player

Pit and Obstacle Avoidance

Sensing

Distance to the Player

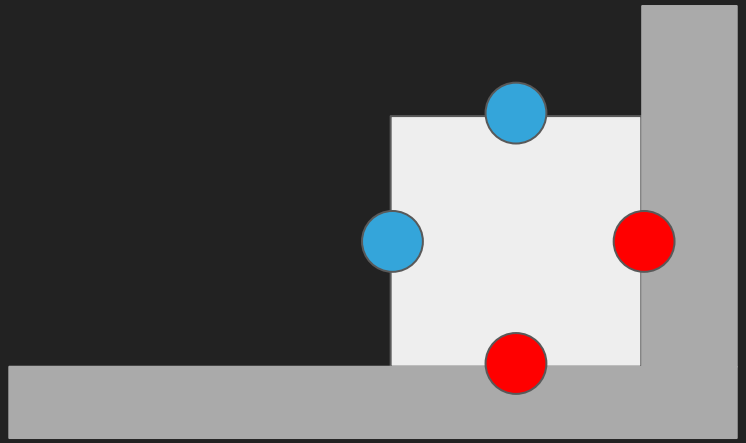
```
if (glm::distance(position, player.position) < 3.0f) {
    state = WALKING;
}
```

Sensing

Direction of the Player

```
if (player.position.x < position.x) {
   // player is to the left
} else {
   // player is to the right
}
```

Pit Avoidance



We already have collision flags...

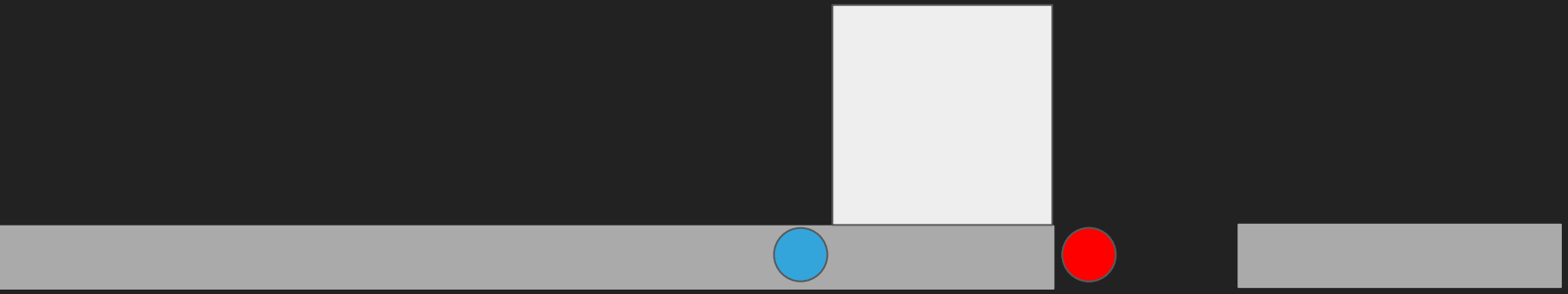
Pit Avoidance

We can add a point to the left and right to check for the floor.

Pit Avoidance

```
void Update() {
    glm::vec3 sensorRight =
        glm::vec3(position.x + 0.6f, position.y - 0.6f, 0);
```

Pit Avoidance



Check each “sensor” for collisions.
(point inside of a box)

Let’s Research!

Mario: Goomba, The Life of a Koopa Troopa

Ice Climber: Topi

Gradius: Various Flying Enemy Behaviors

Let’s Code!

Basic AI Behaviors

Level Design

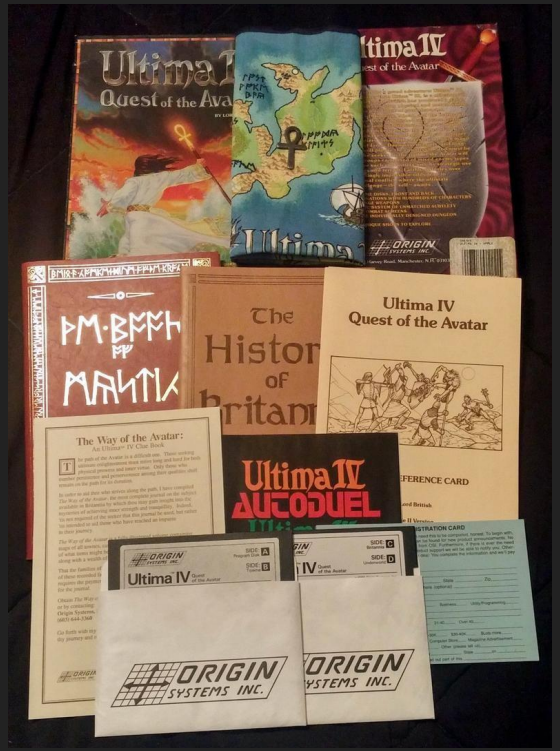
Back in my day...

In the past, video games would come with books, manuals and even maps.

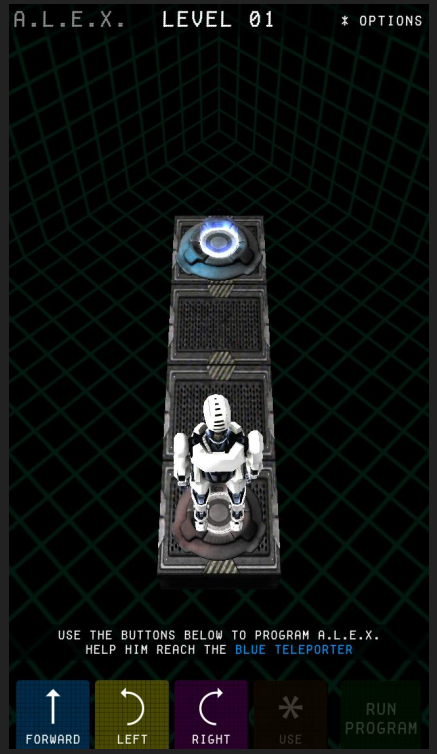
Modern games no longer include manuals and instead offer built-in tutorials and features such as auto-mapping.

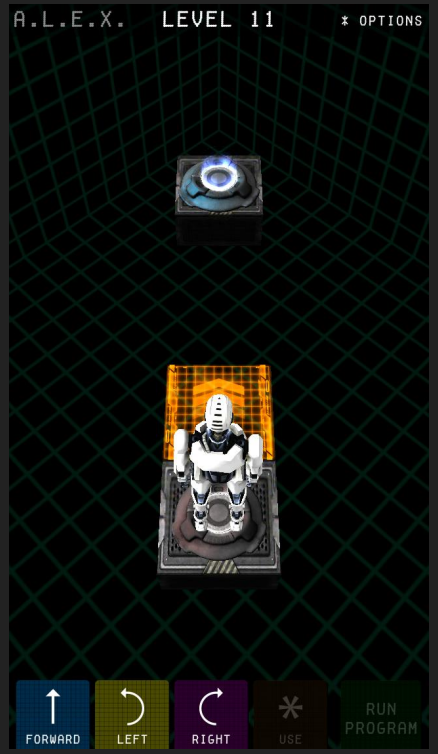
Let's teach our players to play, without them even knowing they are being taught.

(or being obvious it's a tutorial)

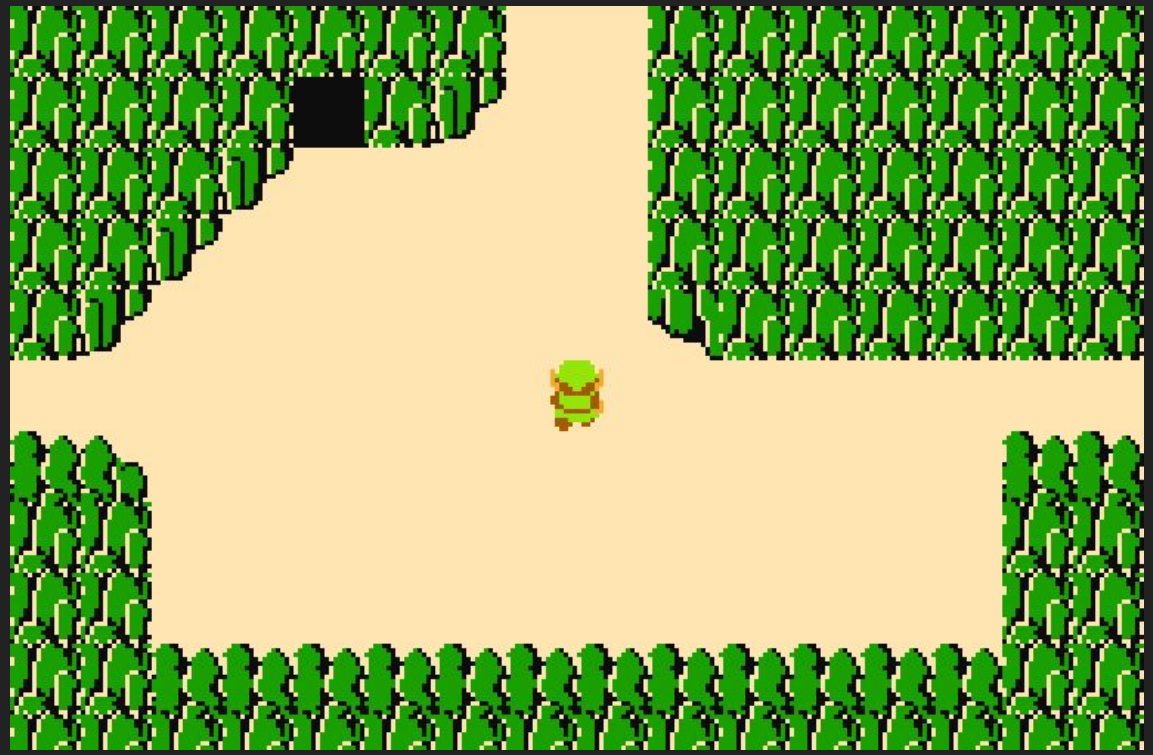


Teach the game’s mechanics through level design



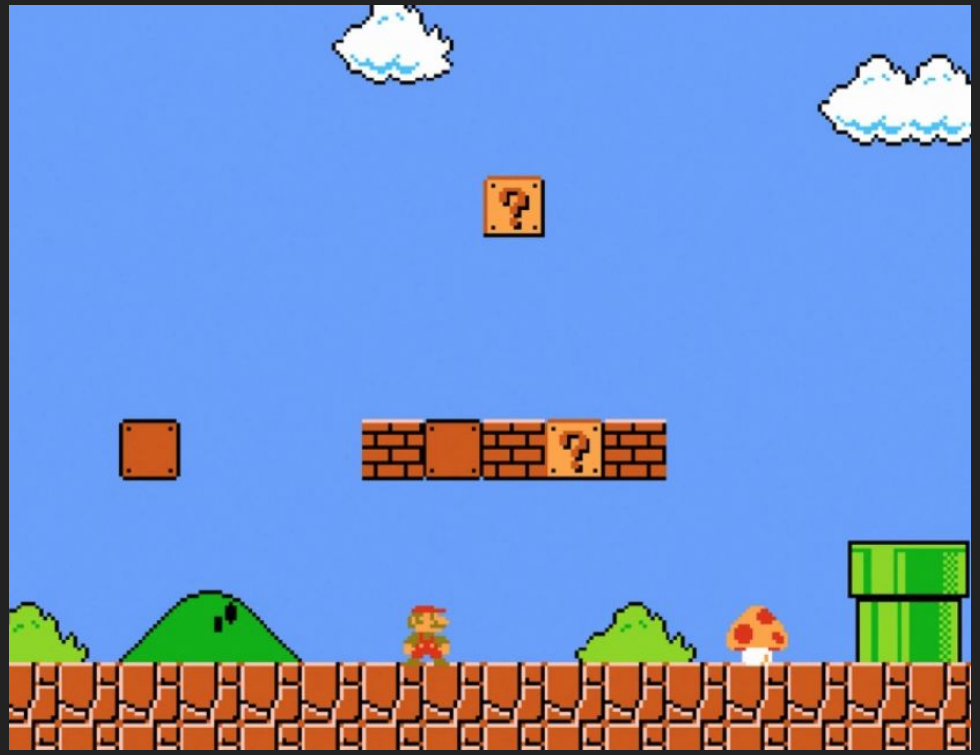


Teach the game’s mechanics through level design



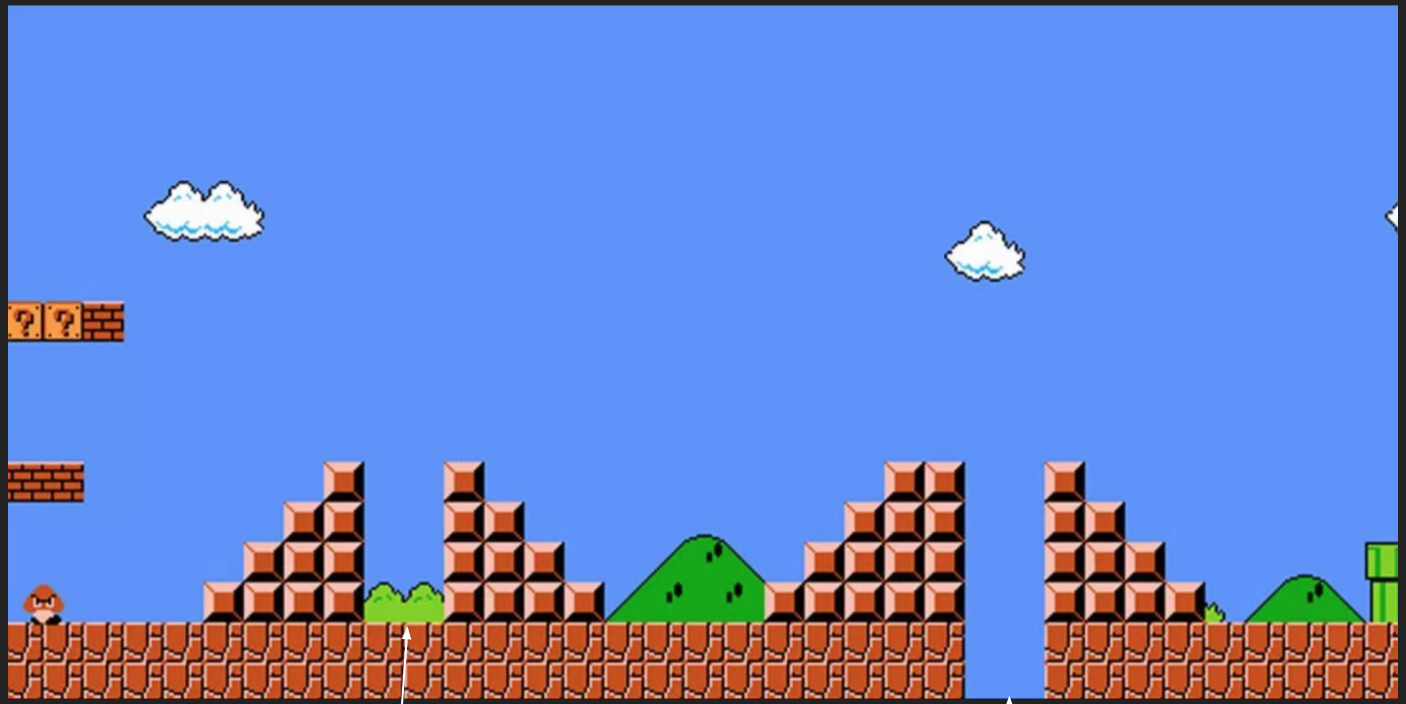
Teach the game’s mechanics through level design

Teach the game’s mechanics through level design



Illustrate the basic mechanics of the game in a low stakes environment.

Low stakes environment



Low stakes environment

Both “learn to climb” spots have a safe “try again” spot.

Explore Your Game’s Mechanic Through Level Design

Explore your game’s mechanic

Combine Mechanics

Design levels to teach one mechanic at a time, then add challenges that require combining mechanics.

Difficulty

Use level design to control the difficulty curve. Give your player more challenges as they get better at the mechanics in your game.

Video Time!

https://www.youtube.com/watch?v=zRGRJRUWafY

Shigeru Miyamoto : Legendary Game Designer

Creator of Super Mario, Legend of Zelda, Starfox and more.

Talks about Super Mario Level 1-1

Graph Paper!

Original Level Sketches from The Legend of Zelda

https://www.nintendo.co.uk/News/2016/December/Take-a-look-behind-the-scenes-with-design-documents-from-The-Legend-of-Zelda--1169414.html

Random Generation

vs.

Procedural Generation

Random Generation

Dungeons and Dragons

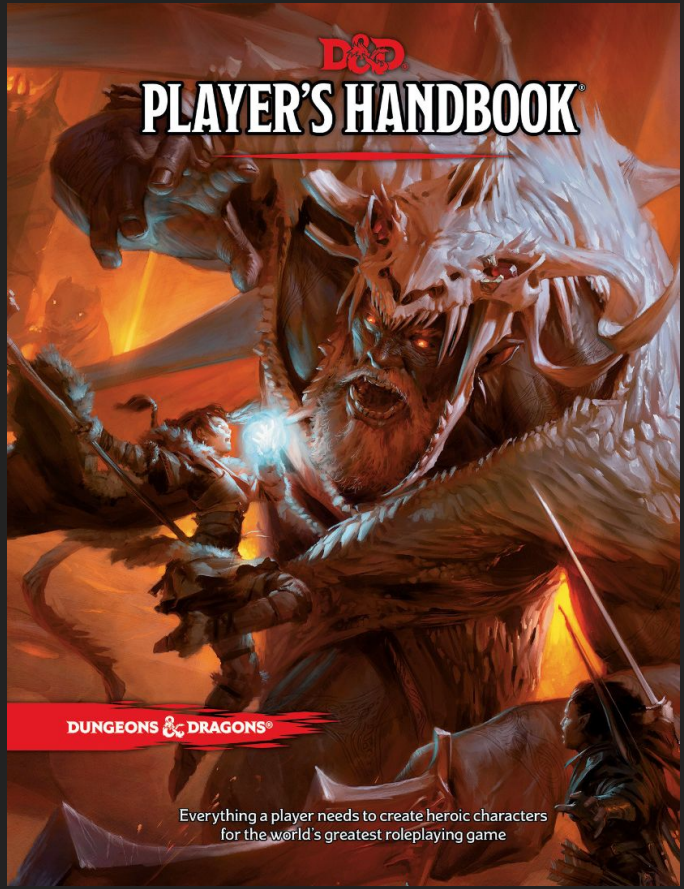
(random encounters)

Dungeons and Dragons

Paper based game

Everything is in your head

Dice… lots and lots of dice!



Illrigger Table III: Followers

Dice roll	Type of follower
01-08	1-10 thieves of 1st level
09-14	1-8 thieves of 1st-2nd level
15-19	1-6 thieves of 1st-4th level
20-23	1-4 thieves of 2nd-5th level
24-26	1-2 thieves of 3rd-6th level
27-28	1 thief of 4th-7th level
29-31	1-4 assassins of 1st-2nd level
32	1 assassin of 3rd-6th level
33-35	1-6 magic-users of 1st level
36-37	1-4 magic-users of 1st-2nd level
38	1-2 magic-users of 2nd-5th level
39-40	1-2 illusionists of 1st-2nd level
41	1 illusionist of 2nd-4th level
42-46	1-6 clerics of 1st-4th level
47-49	1-3 clerics of 2nd-5th level
50-51	1-2 clerics of 4th-7th level
52	1 cleric of 5th-8th level
53	1-2 cloistered clerics[1] of 1st-4th level
54-61	4-40 0-level men-at-arms of 1-6 hp each
62-67	1-10 fighters of 1st level
68-72	1-8 fighters of 1st-4th level
73-76	1-6 fighters of 2nd-5th level
77-79	1-4 fighters of 3rd-6th level
80-81	1-2 fighters of 4th-7th level
82	1 cavalier of 1st-6th level
83-84	1 hellcat or hell hound
85	6-24 mites
86	1 penanggalan
87	20-200 duergar plus females and young
88	20-200 orcs plus females and young
89	30-300 goblins plus females and young
90	10-100 hobgoblins plus females and young
91	1 blue dragon
92	1 ghost
93	1 spectre
94	1 wight
95	1 wraith
96	2 manticore
97	1-8 fire giants plus females and young
98	1-4 NPCs of any lawful evil class or subclass
99	special (see subtable on next page)

d100	Encounter
18–20	1d3 **winged kobolds** with 1d6 **kobolds**
21–25	The partially eaten carcass of a mammoth, from which 1d4 weeks of rations can be harvested
26–29	2d8 hunters (**tribal warriors**)
30–35	1 **half-ogre**
36–40	Single-file tracks in the snow that stop abruptly
41–45	1d3 **ice mephits**
46–50	1 **brown bear**
51–53	1d6 + 1 **orcs**
54–55	1 **polar bear**
56–57	1d6 **scouts**
58–60	1 **saber-toothed tiger**
61–65	A frozen pond with a jagged hole in the ice that appears recently made
66–68	1 **berserker**
69–70	1 **ogre**
71–72	1 **griffon**
73–75	1 **druid**
76–80	3d4 refugees (**commoners**) fleeing from orcs
81	1d3 **veterans**
82	1d4 **orogs**
83	2 **brown bears**
84	1 **orc Eye of Gruumsh** with 2d8 **orcs**
85	1d3 **winter wolves**
86–87	1d4 **yetis**
88	1 **half-ogre**
89	1d3 **manticores**
90	1 **bandit captain** with 2d6 **bandits**
91	1 **revenant**
92–93	1 **troll**
94–95	1 **werebear**
96–97	1 **young remorhaz**
98	1 **mammoth**
99	1 **young white dragon**
00	1 **frost giant**

Really Bad Chess

really bad chess

chess with totally random pieces

For everyone who quit playing chess
(and everyone who loves playing chess)

ranked

rank: 65

But this board...
looks a little tougher.

Quintet

Example Json:

```
"title": "Asteroid Field",
"locationType": "neutral",
"respawn": true,
"universeSeed": 2021
```

Just need to send 1 number to other players to generate entire scenes!

Procedural Generation

No Man’s Sky

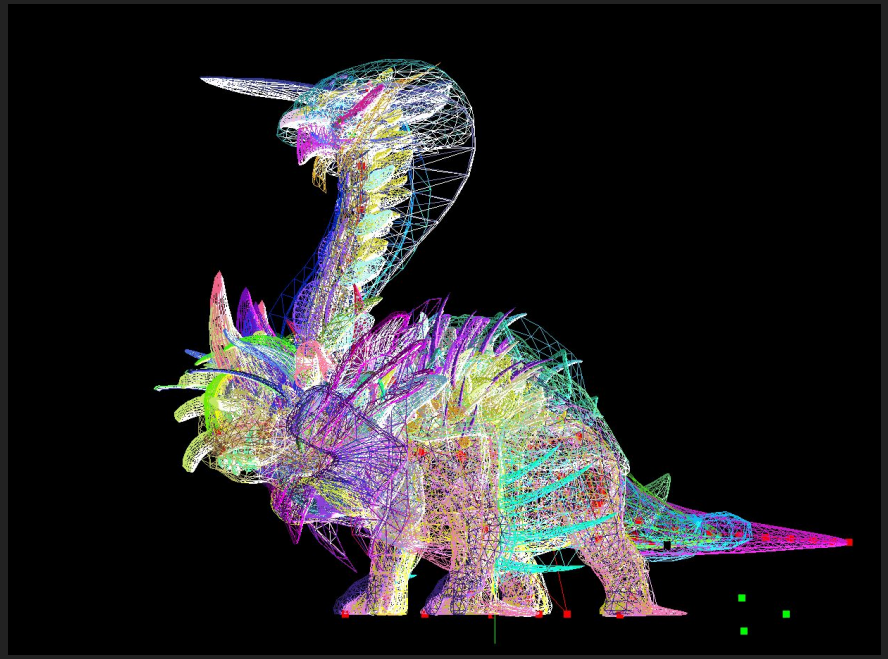
"18 quintillion planets"

(sounds like 2^64 to me)

Trivia: This datatype in C++ is called a “unsigned long long”

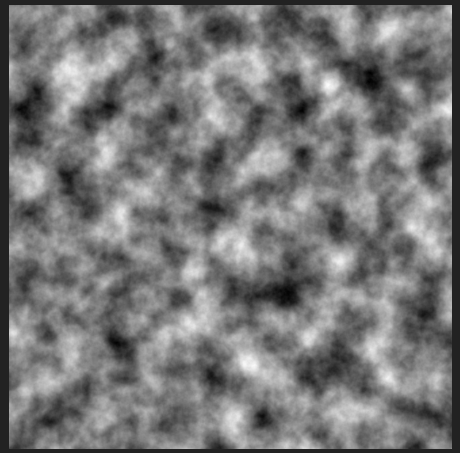

Golguin Prime
6.0 Rad

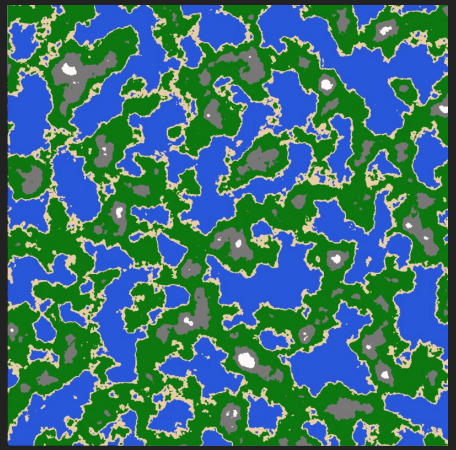

Ethenev VI
6.5 Rad
Multitool Repair Scanner
Gather Ferrite Dust: 0/75
Extract Ferrite Dust by shooting small rocks
Use to fire the mining beam



Minecraft

(perlin noise)





“Perlin noise is a type of gradient noise developed by Ken Perlin in 1983 as a result of his frustration with the "machine-like" look of computer graphics at the time.”
- https://en.wikipedia.org/wiki/Perlin_noise

https://www.youtube.com/watch?v=IKB1hWWedMk

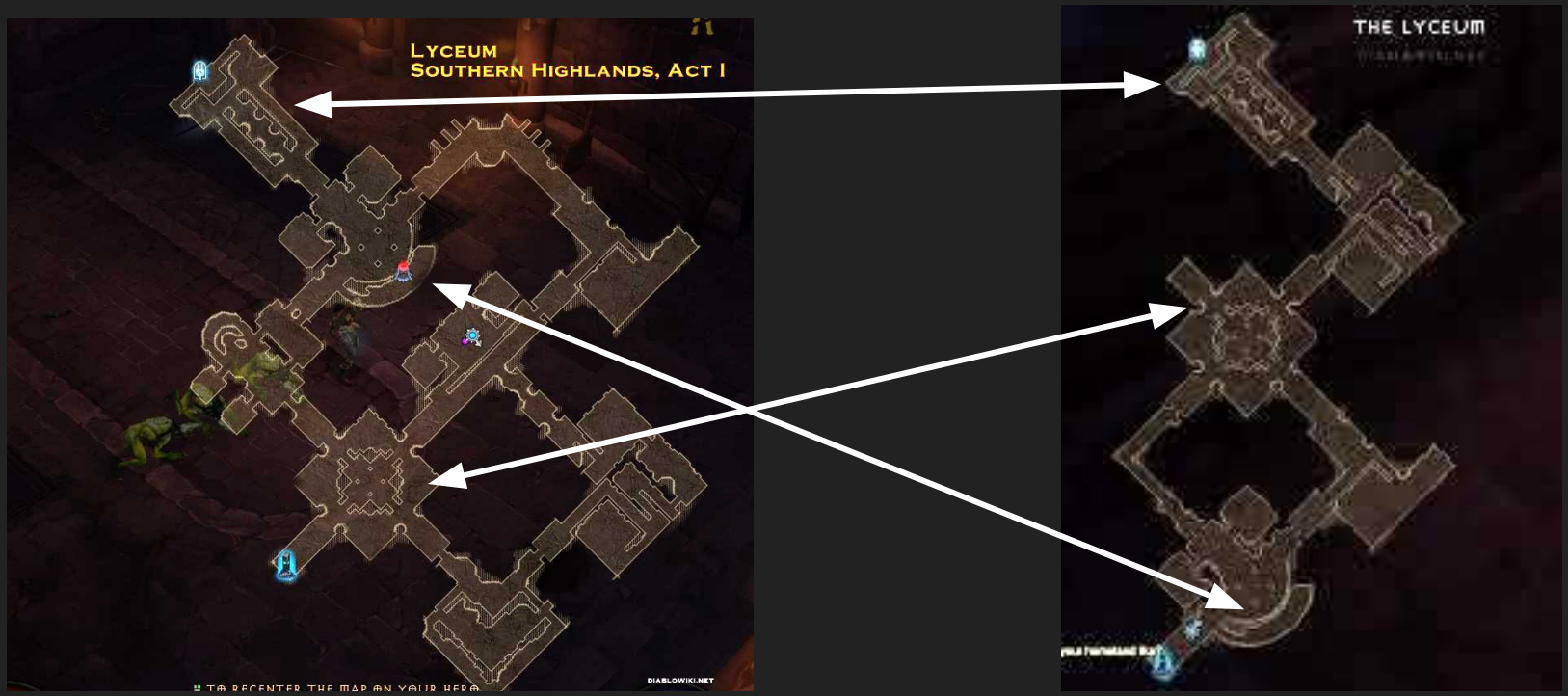
https://www.youtube.com/watch?v=bG0uEXV6aHQ

https://catlikecoding.com/unity/tutorials/noise-derivatives/

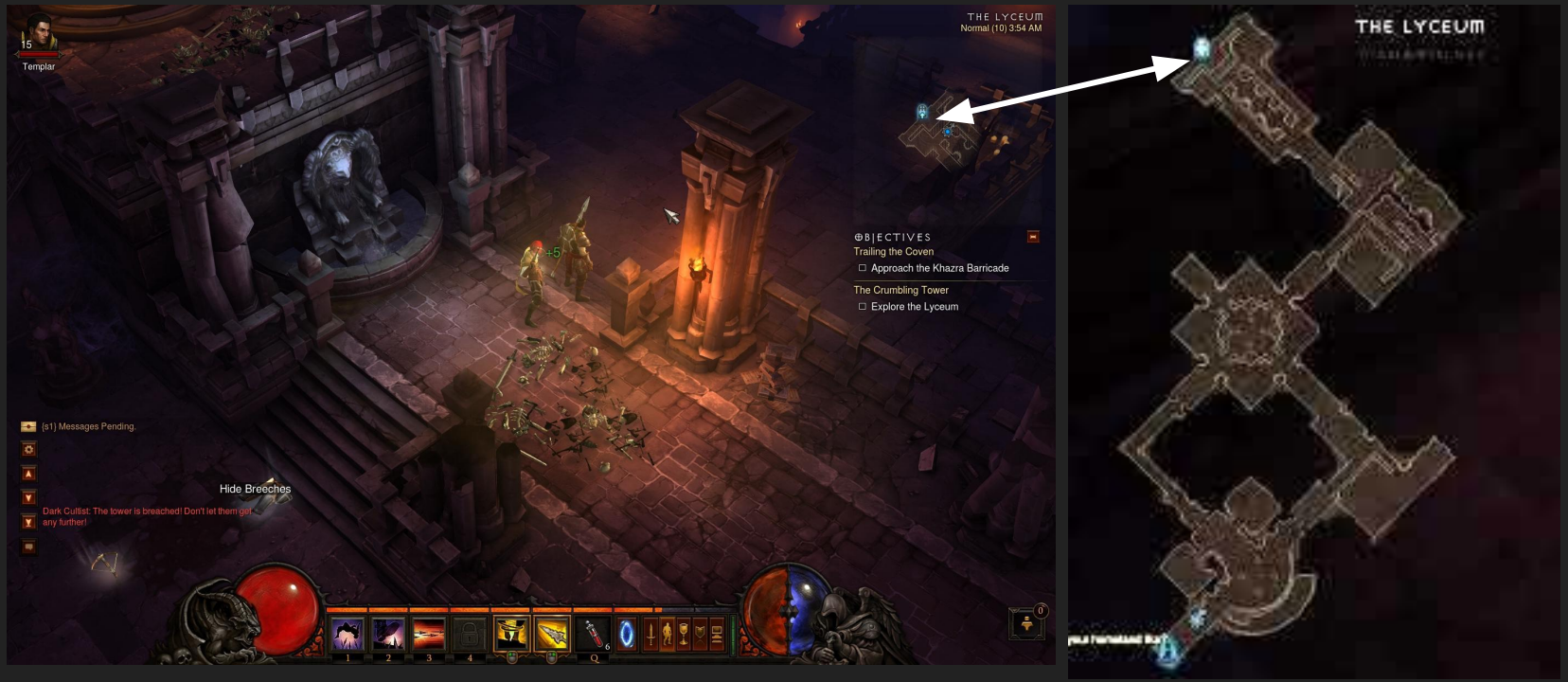
Diablo 3

(other Diablo games did this too)

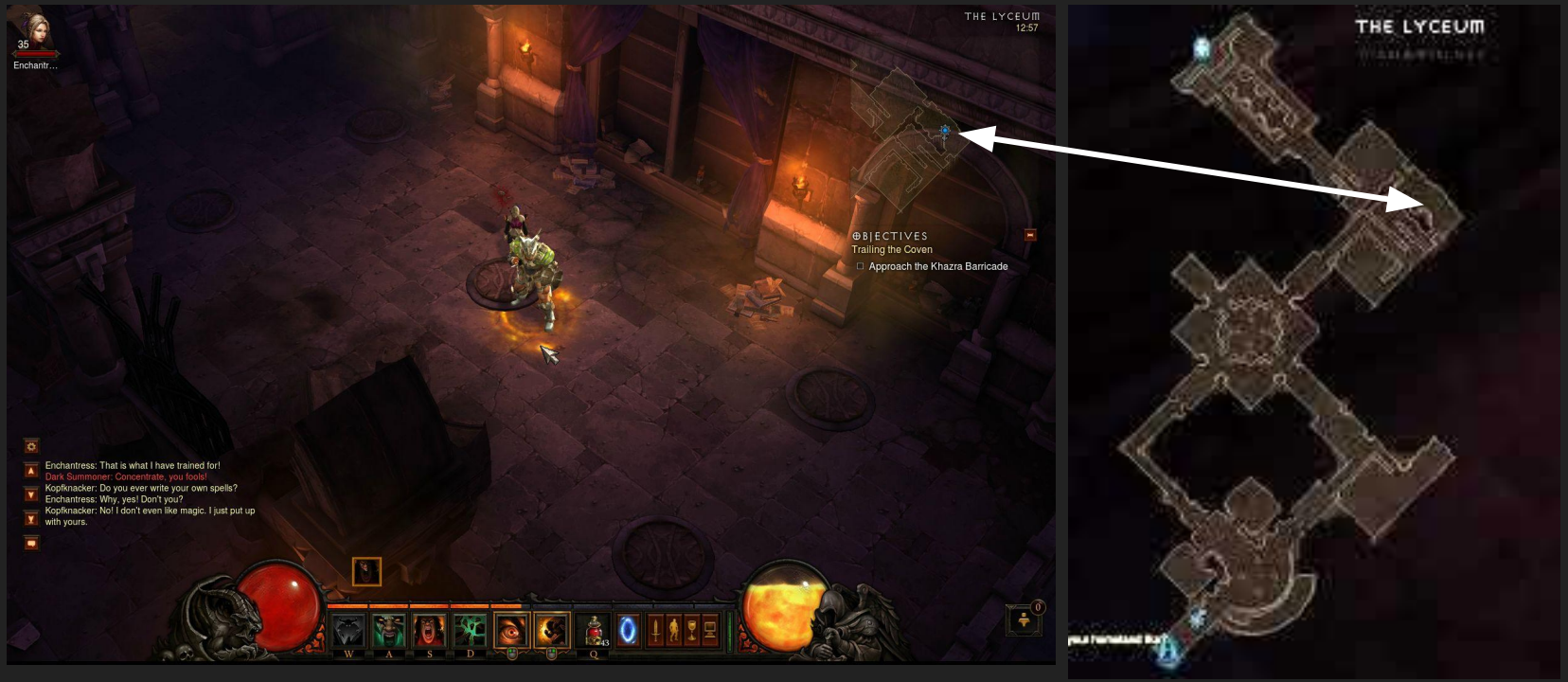
Diablo 3



Diablo 3


15
Templar
THE LYCEUM
Normal (10) 3:54 AM
+5
OBJECTIVES
Trailing the Coven
Approach the Khazra Barricade
The Crumbling Tower
Explore the Lyceum
(s1) Messages Pending.
Hide Breeches
Dark Cultist: The lower is breached! Don't let them get any further!
THE LYCEUM

Diablo 3


35
Enchantr…
THE LYCEUM
12:57
OBJECTIVES
Trailing the Coven
Approach the Khazra Barricade
Enchantress: That is what I have trained for!
Dark Summoner: Concentrate, you fools!
Kopfknacker: Do you ever write your own spells?
Enchantress: Why, yes! Don't you?
Kopfknacker: No! I don't even like magic. I just put up with yours.
W
A
S
D
Q
THE LYCEUM

Spelunky

Spelunky

Spelunky

New Levels Every Time

Based on “Rooms”

Lots of Replayability

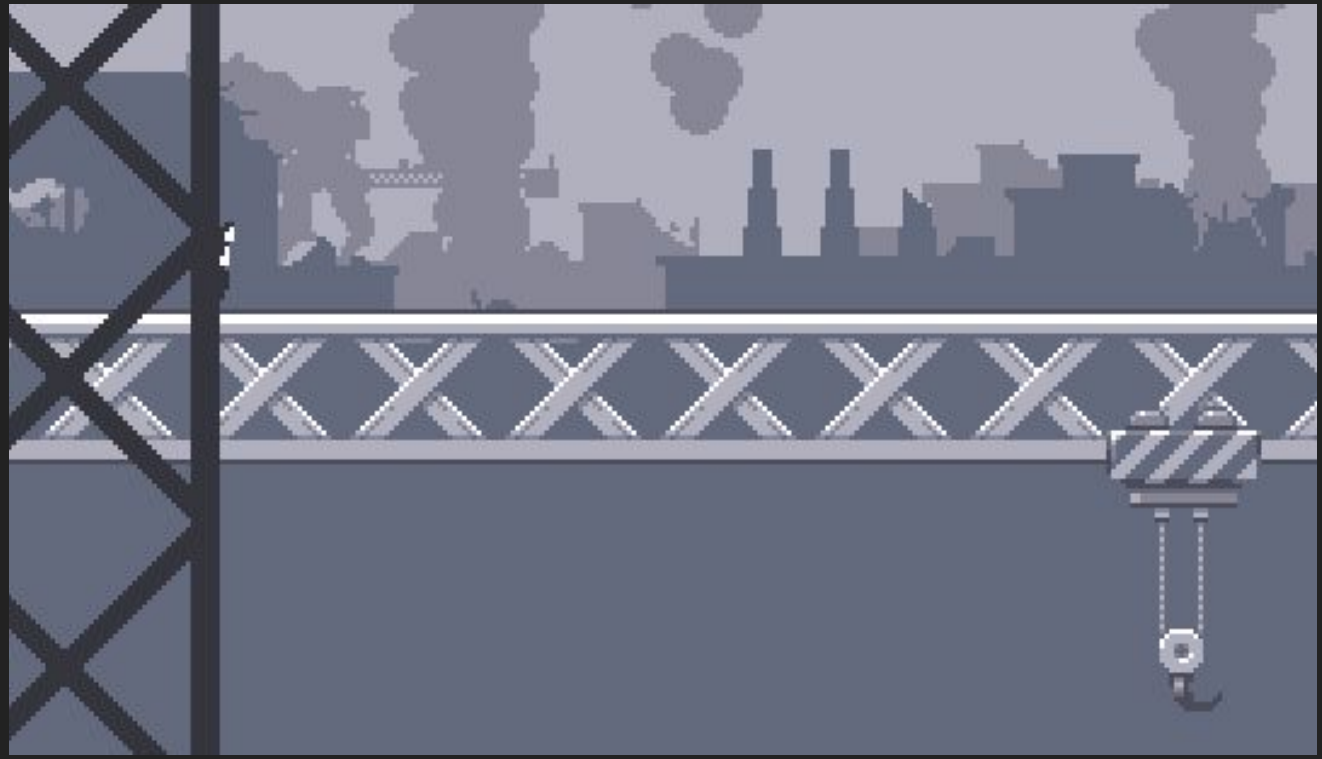
Level Generation in Spelunky

http://tinysubversions.com/spelunkyGen/

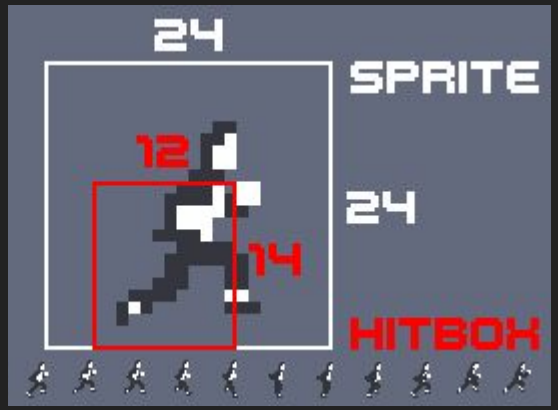
Canabalt

(endless runner)

Canabalt



Canabalt


24
SPRITE
12
24
14
HITBOX

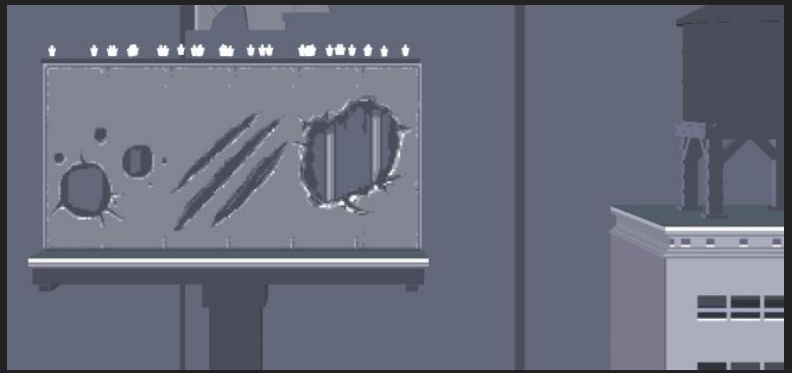

817m
Active Viewing Area: 480x160


8
BONUS
SPACE

Character at far left to give player time to react.

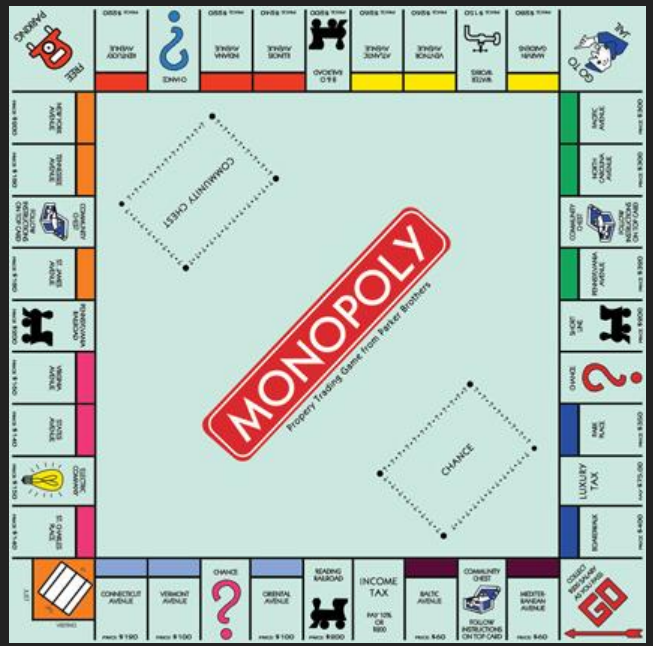
Calculations are done to make sure all jumps are possible!

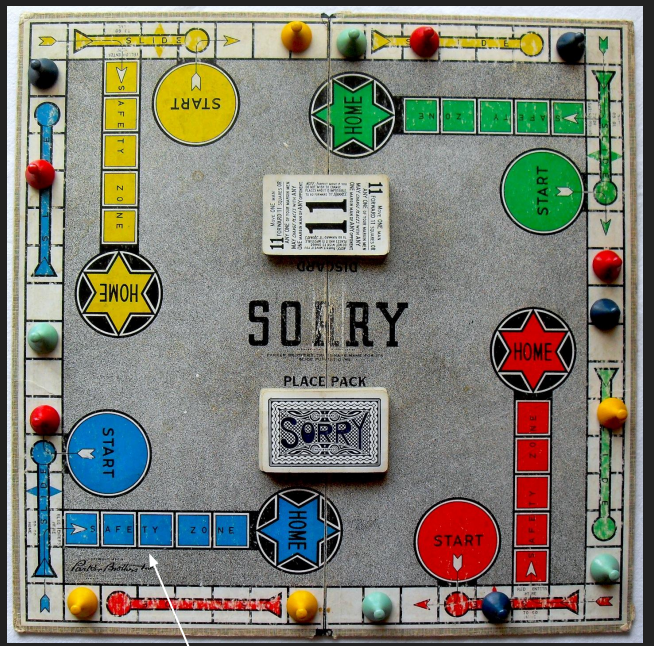
Obstacles on rooftops.



Board Design

Track Style





Signaling and Labels, plenty of text.

Tiles / Grids


STUDY
HALL
LOUNGE
LIBRARY
BILLIARD ROOM
DINING ROOM
CONSERVATORY
BALL ROOM
KITCHEN
X
Clue

Standards

Board Design

Board Design