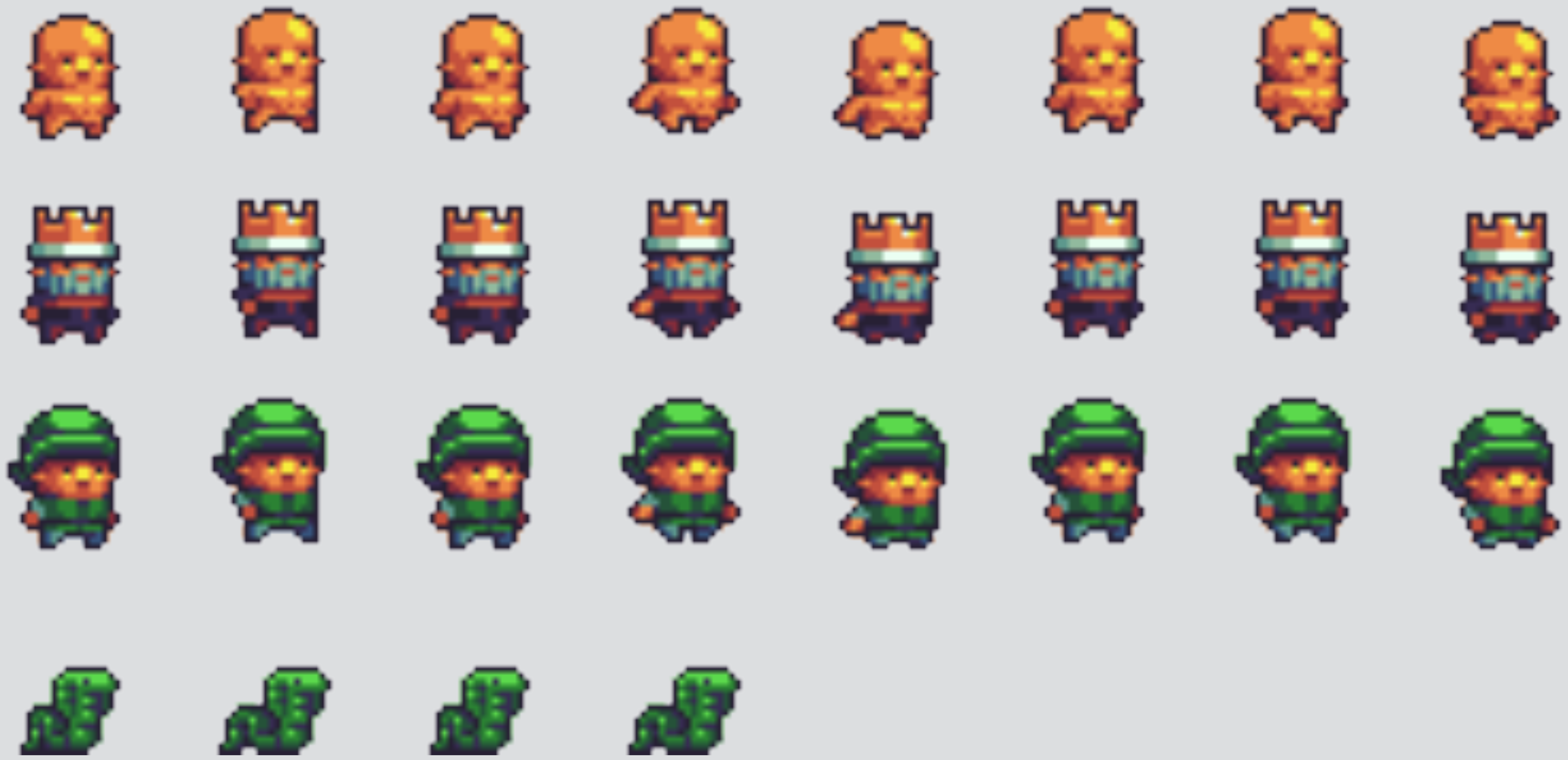
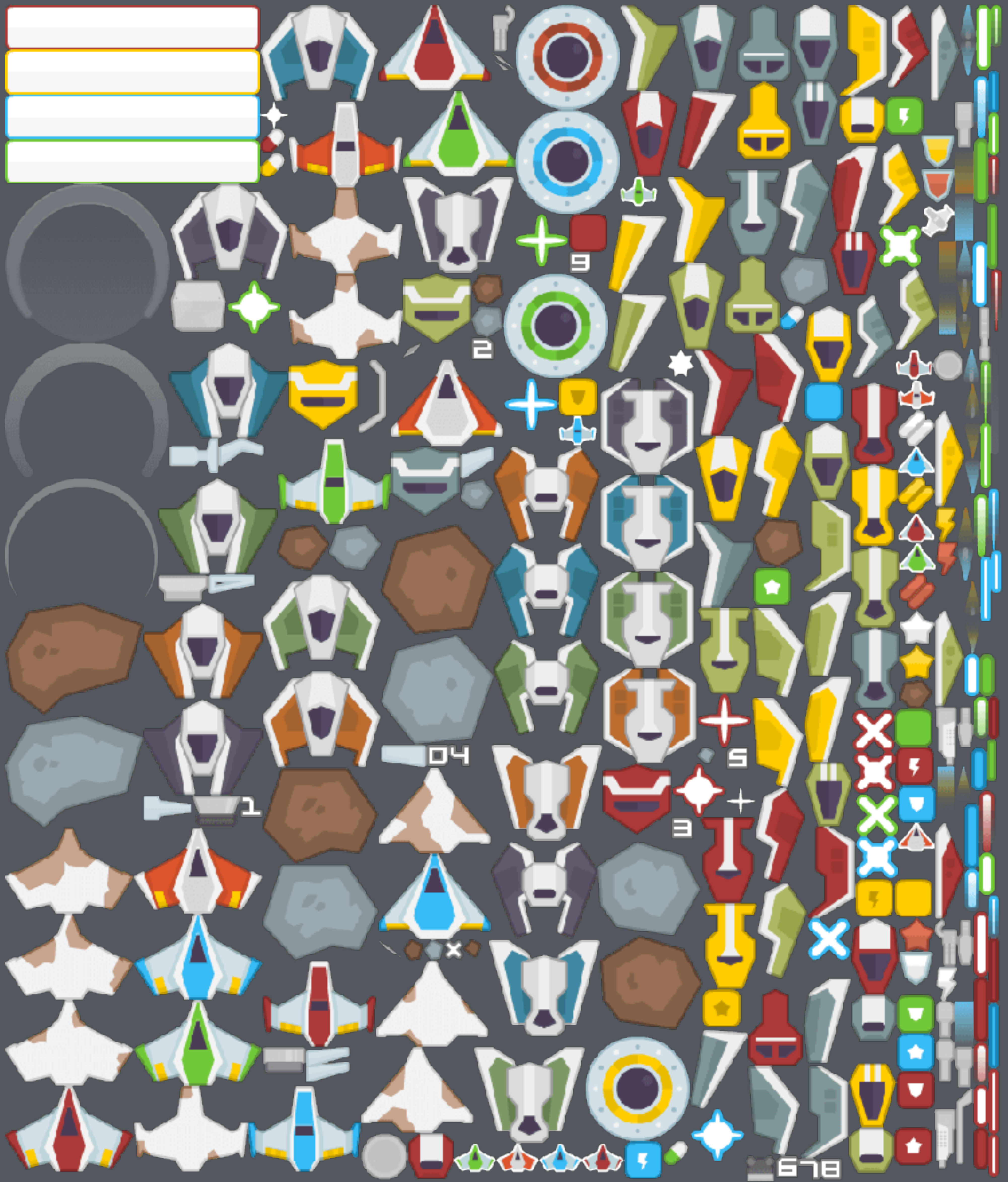
Graphics Foundations

Part 3.5

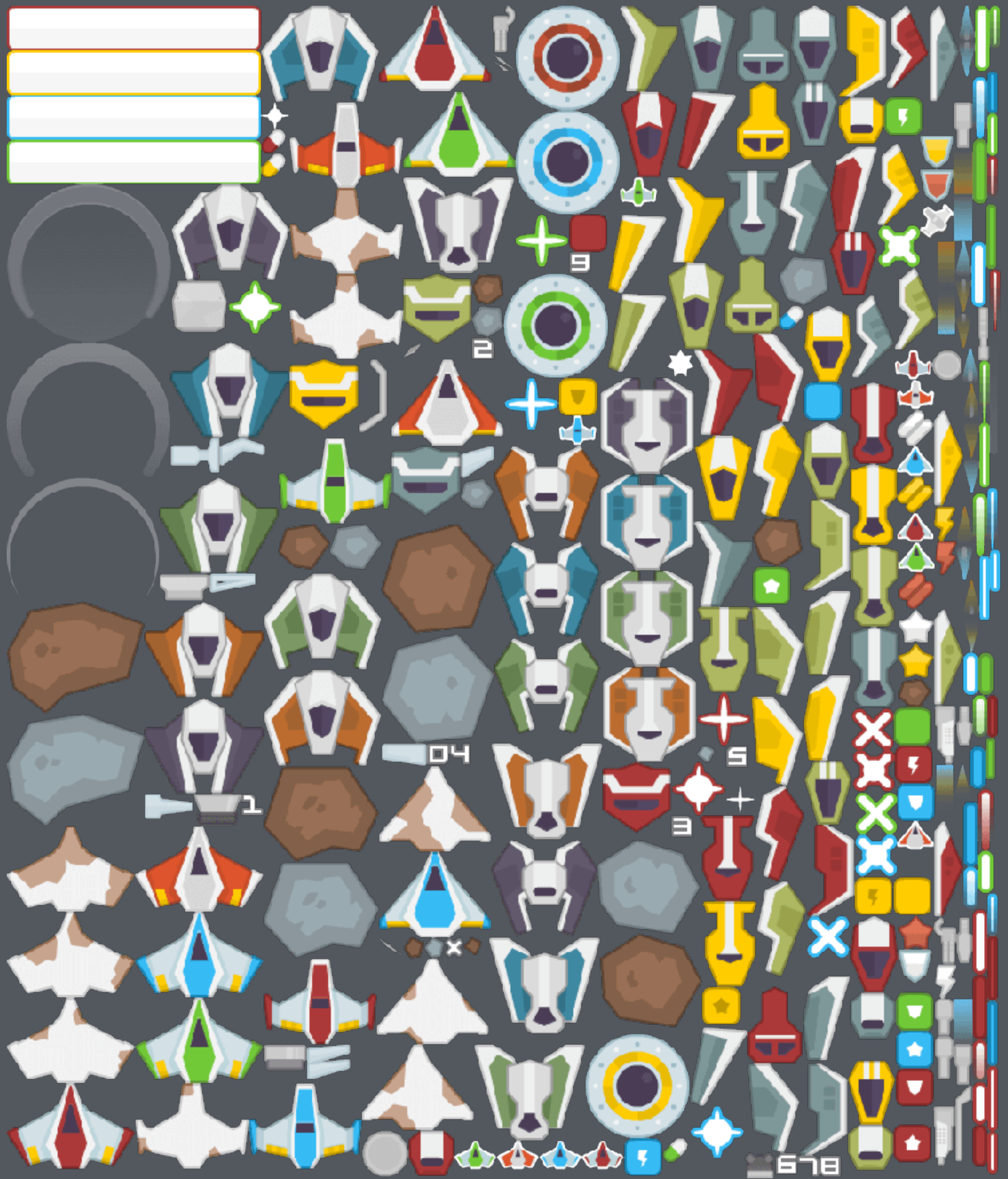
Non-uniform sprite sheets.

Uniform





Non-uniform

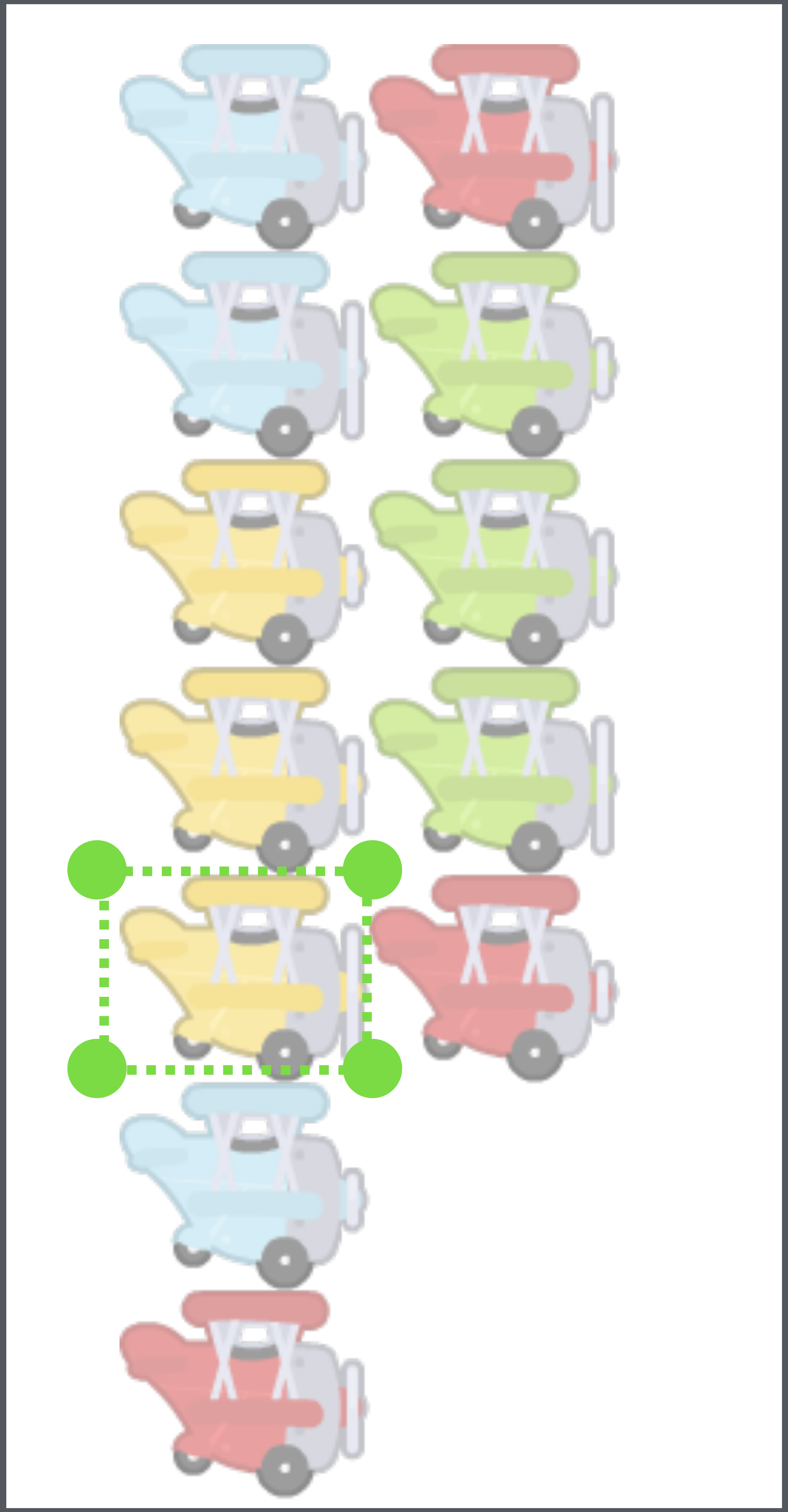


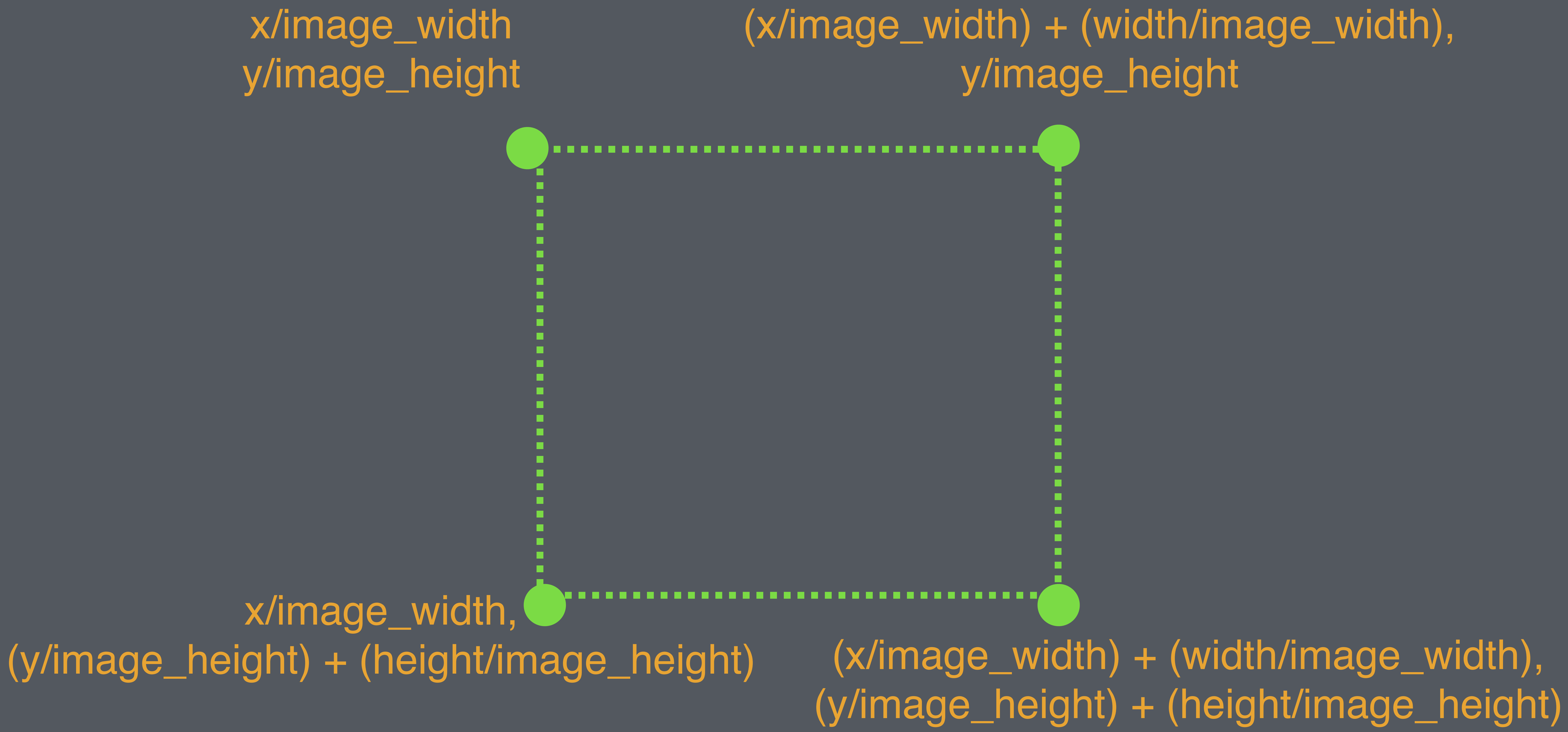
Need to keep a list of coordinates for non-uniform sprite sheets.

Texture atlas XML

```xml
<TextureAtlas imagePath="sheet.png">
    <SubTexture name="beam0.png" x="143" y="377" width="43" height="31"/>
    <SubTexture name="beam1.png" x="327" y="644" width="40" height="20"/>
    <SubTexture name="beam2.png" x="262" y="907" width="38" height="31"/>
    <SubTexture name="beam3.png" x="396" y="384" width="29" height="29"/>
    <SubTexture name="beam4.png" x="177" y="496" width="41" height="17"/>
    <SubTexture name="beam5.png" x="186" y="377" width="40" height="25"/>
    <SubTexture name="beam6.png" x="120" y="688" width="43" height="23"/>
    <SubTexture name="beamLong1.png" x="828" y="943" width="15" height="67"/>
    <SubTexture name="beamLong2.png" x="307" y="309" width="25" height="64"/>
    <SubTexture name="bold_silver.png" x="810" y="837" width="19" height="30"/>
    <SubTexture name="bolt_bronze.png" x="810" y="467" width="19" height="30"/>
    <SubTexture name="bolt_gold.png" x="809" y="437" width="19" height="30"/>
    <SubTexture name="buttonBlue.png" x="0" y="78" width="222" height="39"/>
    <SubTexture name="buttonGreen.png" x="0" y="117" width="222" height="39"/>
    <SubTexture name="buttonRed.png" x="0" y="0" width="222" height="39"/>
    <SubTexture name="buttonYellow.png" x="0" y="39" width="222" height="39"/>
    <SubTexture name="cockpitBlue_0.png" x="586" y="0" width="51" height="75"/>
    <SubTexture name="cockpitBlue_1.png" x="736" y="862" width="40" height="40"/>
    <SubTexture name="cockpitBlue_2.png" x="684" y="67" width="42" height="56"/>
    <SubTexture name="cockpitBlue_3.png" x="336" y="384" width="60" height="61"/>
    <SubTexture name="cockpitBlue_4.png" x="637" y="0" width="47" height="67"/>
    <SubTexture name="cockpitBlue_5.png" x="627" y="144" width="48" height="75"/>
```

Sprite uvs:




x/image_width
y/image_height
(x/image_width) + (width/image_width),
y/image_height
x/image_width,
(y/image_height) + (height/image_height)
(x/image_width) + (width/image_width),
(y/image_height) + (height/image_height)

```
class SheetSprite {
    public:
        SheetSprite();
        SheetSprite(unsigned int textureID, float u, float v, float width, float height, float
size);

        void Draw(ShaderProgram *program);

        float size;
        unsigned int textureID;
        float u;
        float v;
        float width;
        float height;
};




    spriteSheetTexture = LoadTexture("sheet.png");

    mySprite = SheetSprite(spriteSheetTexture, 425.0f/1024.0f, 468.0f/1024.0f, 93.0f/1024.0f, 84.0f
1024.0f, 0.2f);
```

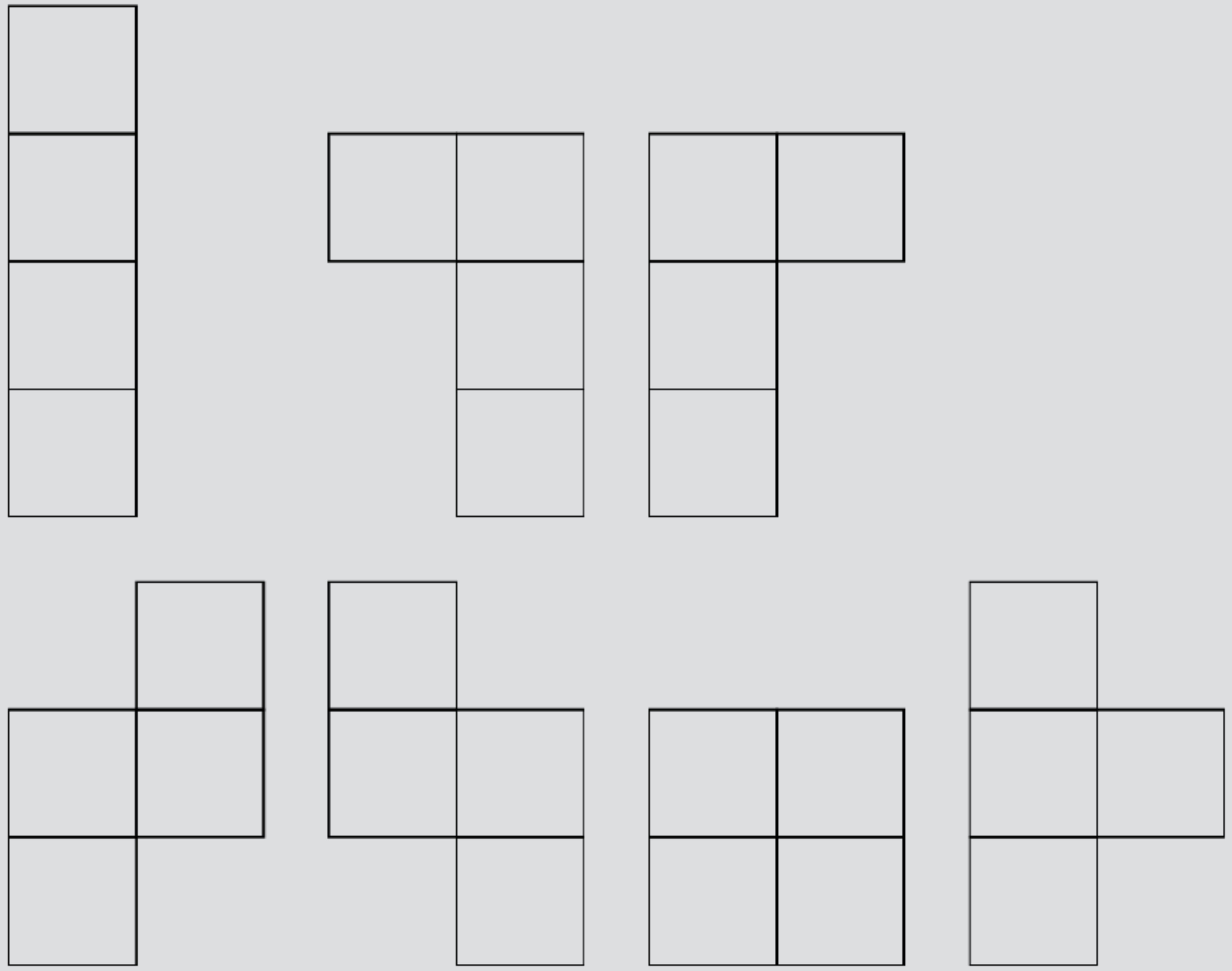
```
void SheetSprite::Draw(ShaderProgram *program) {
    glBindTexture(GL_TEXTURE_2D, textureID);

    GLfloat texCoords[] = {
        u, v+height,
        u+width, v,
        u, v,
        u+width, v,
        u, v+height,
        u+width, v+height
    };

    float aspect = width / height;
    float vertices[] = {
       -0.5f * size * aspect, -0.5f * size,
        0.5f * size * aspect, 0.5f * size,
       -0.5f * size * aspect, 0.5f * size,
        0.5f * size * aspect, 0.5f * size,
       -0.5f * size * aspect, -0.5f * size ,
        0.5f * size * aspect, -0.5f * size};

    // draw our arrays
}


void Render() {
    enemySprite.Draw(program);
}
```

Making your own texture atlases.

Shoebox sprite tool.

http://renderhjs.net/shoebox/

Game structure



Managing game objects.

Entities

```
class Vector3 {
    public:

        Vector3(float x, float y, float z);

        float x;
        float y;
        float z;

};
```

A simple vector class will help us keep track of coordinates.

```
class Entity {
    public:

        void Draw();

        Vector3 position;
        Vector3 velocity;
        Vector3 size;

        float rotation;

        SheetSprite sprite;

        float health;
        float somethingElse;
};
```

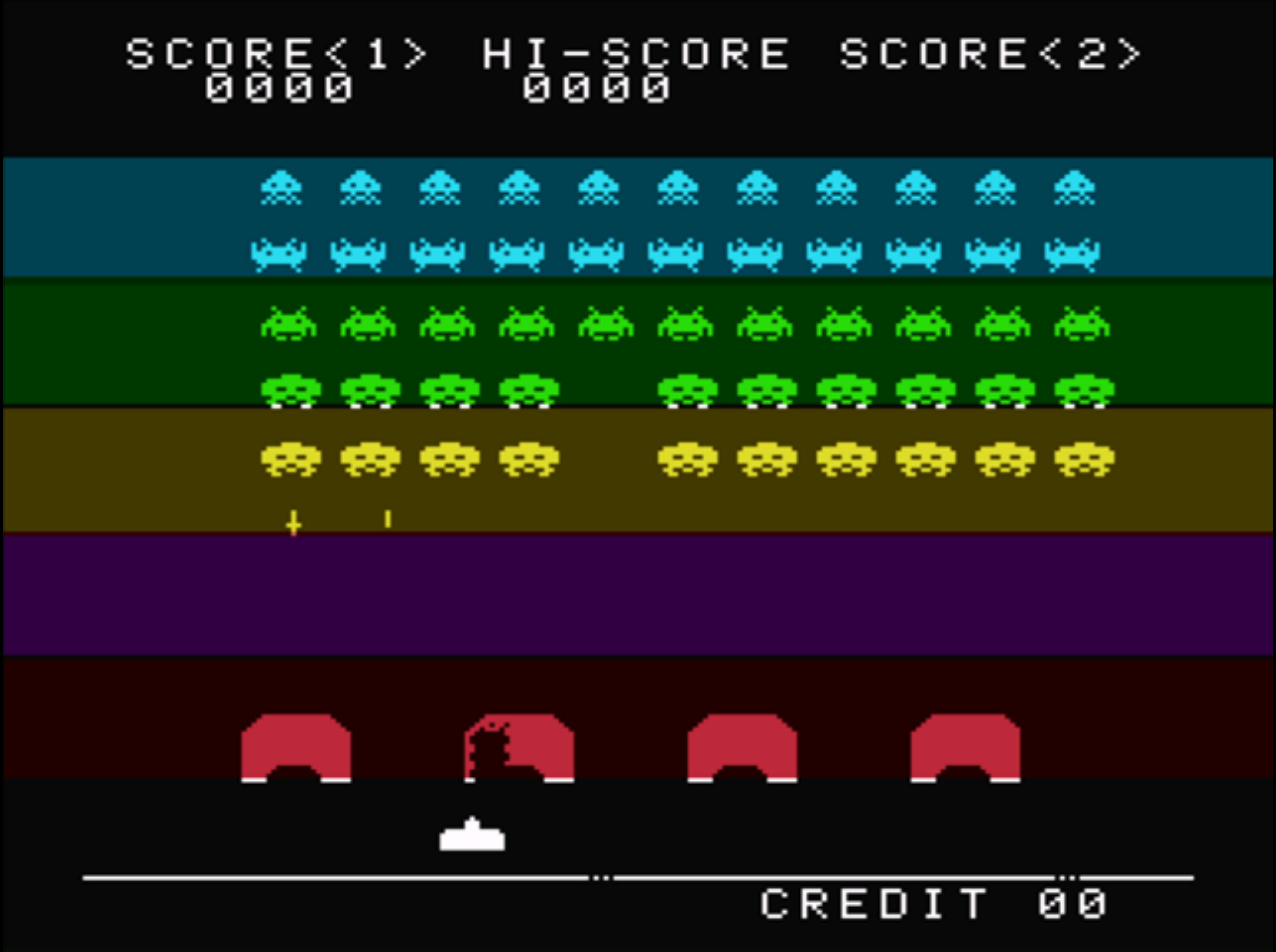
Entities are a useful way for us to think about objects in the game.

138 70
114030
39746
588
281/450
Edad Imperial
Conquerors
02:46:02 (Normal) (Moderada)

-Paladín: creación finalizada-

NecroSoul: 62945/46116
Alfredo el Grande: 29287/37223
Hernán Cortés: 34548/34548
~~Ambrosio: 24000/24000~~
Uesugi Kenshin: 19438/20043
~~Kai Kobad: 11405/15423~~

Onagro de asedio
70/70
75+1
0/8
8+1
Teutones
NecroSoul


SCORE<1> HI-SCORE SCORE<2>
0000 0000
CREDIT 00

```
std::vector<Entity> entities;
```

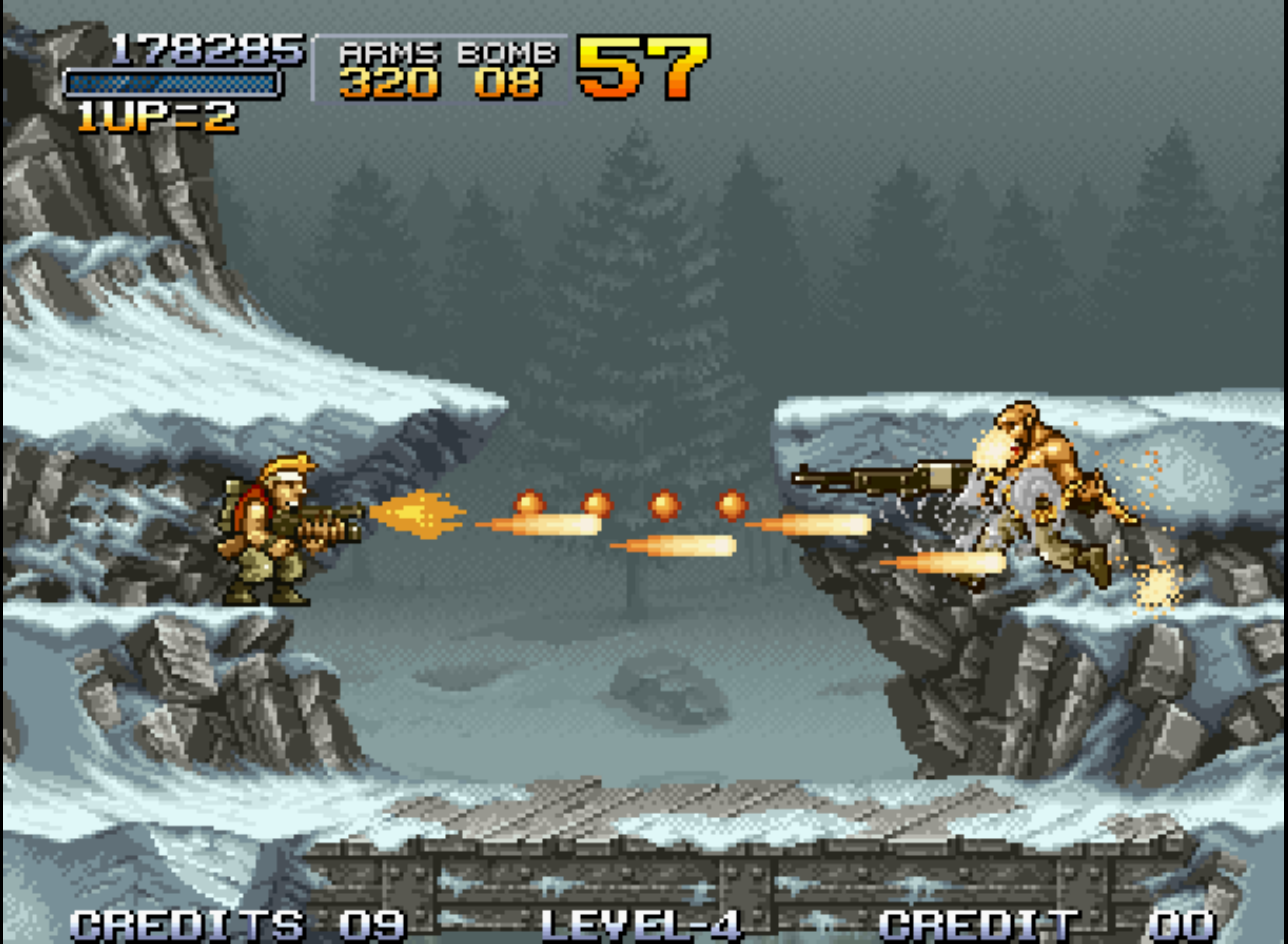
```
    Entity myEntity;
    myEntity.sprite = SheetSprite(spriteSheetTexture, 425.0f/1024.0f, 468.0f/1024.0f,
93.0f/1024.0f, 84.0f/1024.0f, 0.2);
    entities.push_back(myEntity);
```

```
void Update(float elapsed) {

    for(int i=0; i < entities.size(); i++) {
        entities[i].Update(elapsed);
    }
}
```

```
void Render() {

    glClear(GL_COLOR_BUFFER_BIT);

    for(int i=0; i < entities.size(); i++) {
        entities[i].sprite.Draw(program);
    }
}
```

Managing dynamic objects.

HEALTH
BOSS HEALTH
X 8
S
RANK
POWER
000.012.400
BULLET
MAGMA
MINE
SHOCK WAVE
CHAIN


178285
ARMS BOMB
320 08
57
1UP=2
CREDITS 09
LEVEL-4
CREDIT 00

Dynamic object creation vs. object pools

Dynamic object creation

Dynamic object creation

- Can be dynamically sized.
- Objects must be manually removed.
- No limit on how many objects can be on the screen.

```cpp
std::vector<Entity> bullets;
```

```cpp
void shootBullet() {
    Entity newBullet;
    newBullet.position.x = -1.2f;  // where the bullet starts X
    newBullet.position.y = 0.0f;     // where the bullet starts Y
    newBullet.velocity.y = 2.0f;
    newBullet.timeAlive = 0.0f;
    bullets.push_back(newBullet);
}
```

```cpp
bool shouldRemoveBullet(Entity bullet) {
    if(bullet.timeAlive > 0.4) {
        return true;
    } else {
        return false;
    }
}
```

```cpp
bullets.erase(std::remove_if(bullets.begin(), bullets.end(), shouldRemoveBullet), bullets.end());

for(int i=0; i < bullets.size(); i++) {
    bullets[i].Update(elapsed);
}
```

Object pools.

Object pools.

- Less prone to memory leaks.
- Have a maximum number of objects.
- Allocated all at once.
- Know how fast things will run with maximum objects.

Object pools.

```
#define MAX_BULLETS 30
int bulletIndex = 0;
Entity bullets[MAX_BULLETS];
for(int i=0; i < MAX_BULLETS; i++) {
    bullets[i].x = -2000.0f;
}
```

```
void shootBullet() {

    bullets[bulletIndex].x = -1.2;
    bullets[bulletIndex].y = 0.0;
    bulletIndex++;
    if(bulletIndex > MAX_BULLETS-1) {
        bulletIndex = 0;
    }
```

```
for(int i=0; i < MAX_BULLETS; i++) {
    bullets[i].Update(elapsed);
}
```

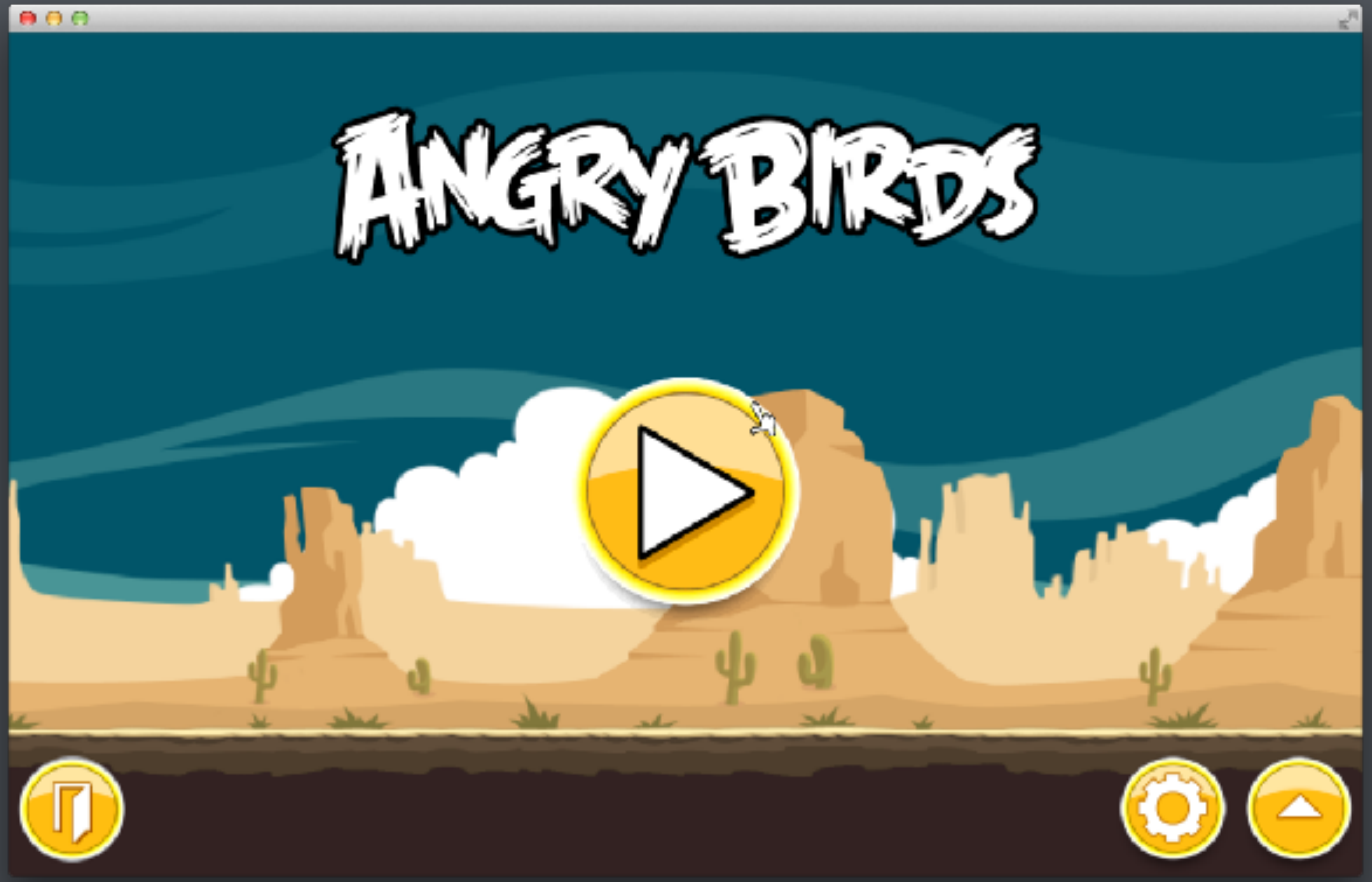
Game state and game mode.

Game state.

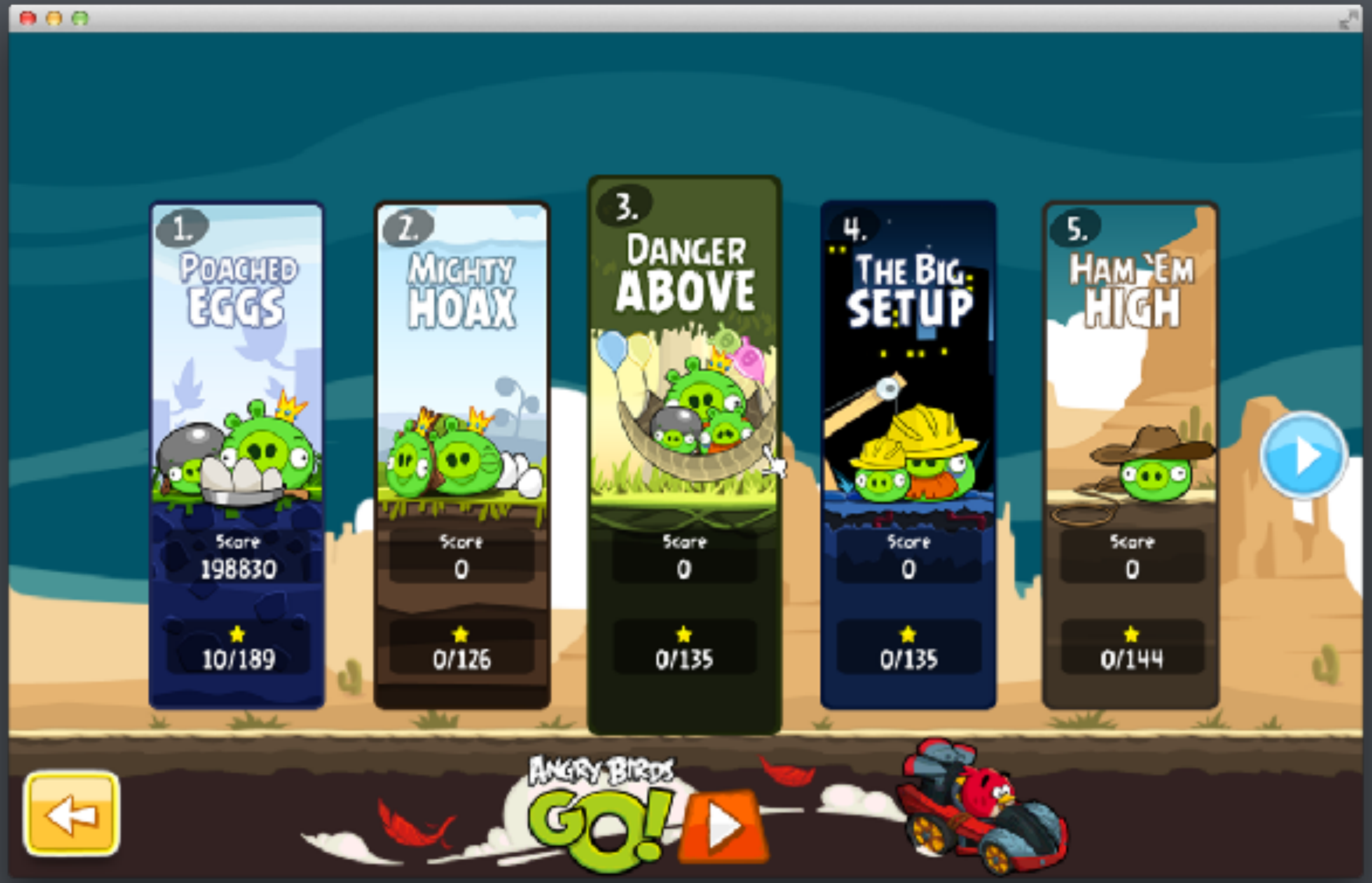
```
class GameState {
    public:

     Entity player;
    Entity enemies[12];
    Entity bullets[30];
    int score;
};

GameState state;

void RenderGame(const GameState &state) {
  // render all the entities in the game
  // render score and other UI elements
}

void UpdateGame(GameState &state, float elapsed) {
  // move all the entities based on time elapsed and their velocity
}

void ProcessInput(GameState &state) {
}
```

Game mode.

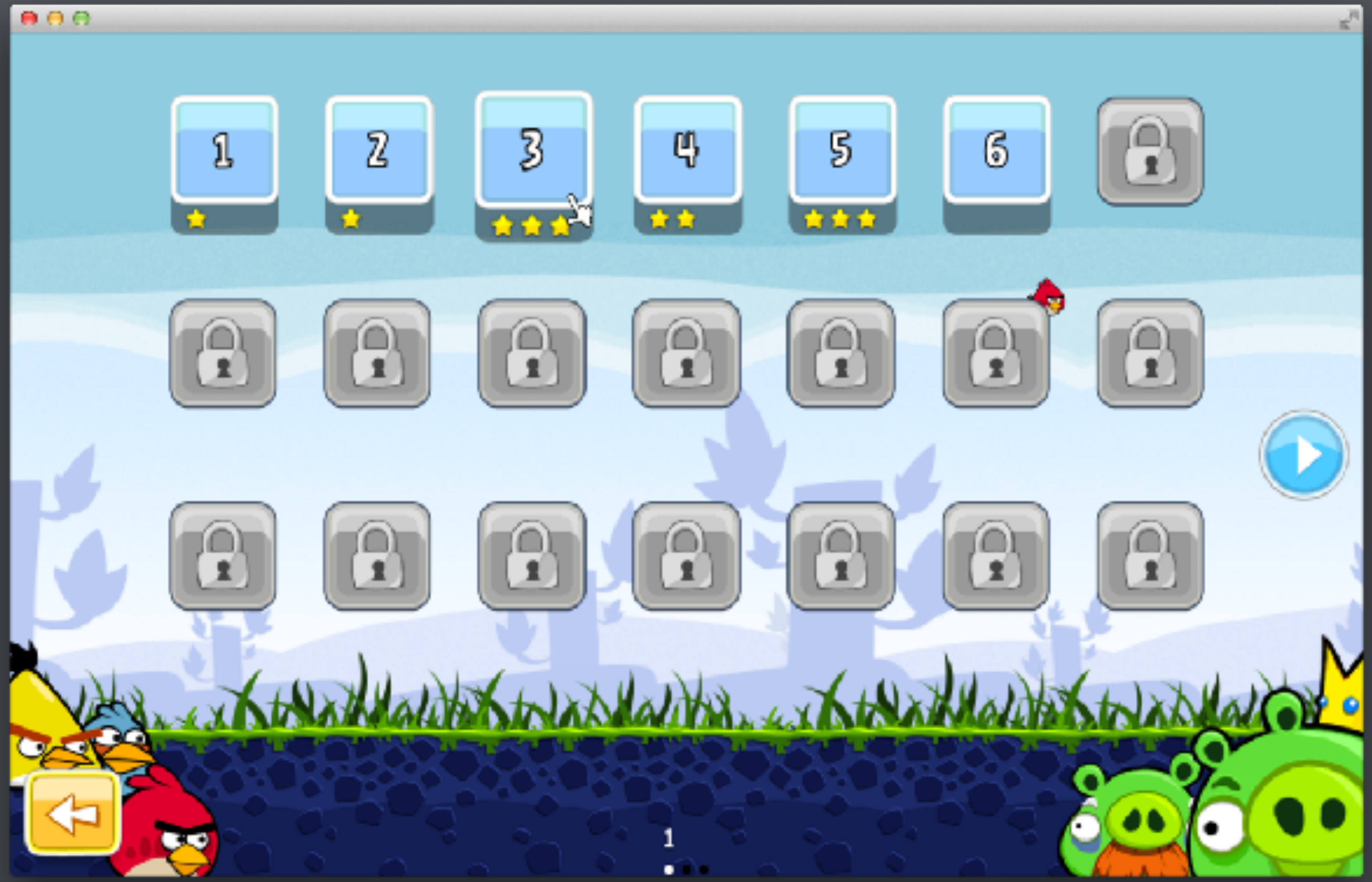
Main menu



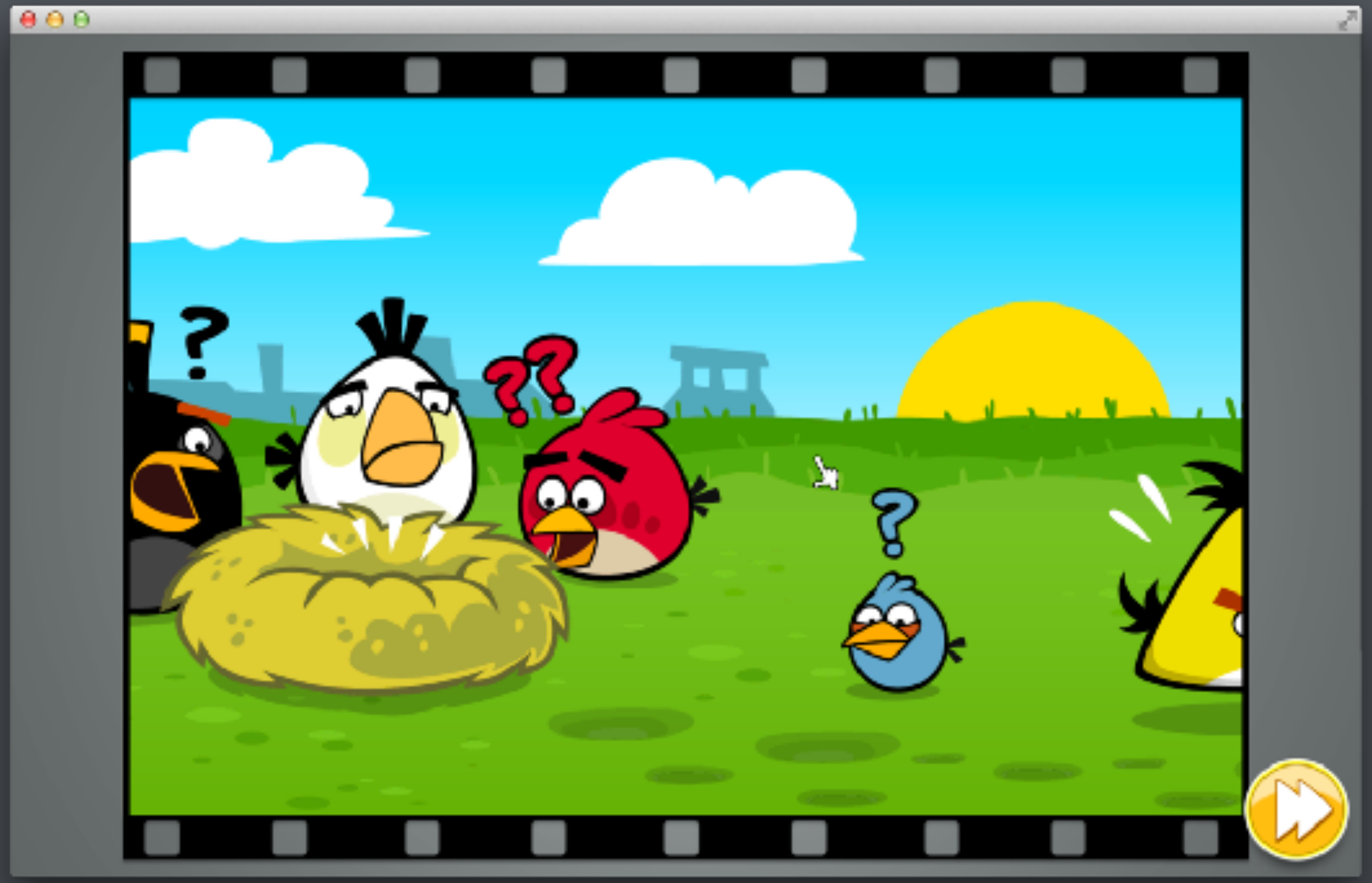
Chapter select



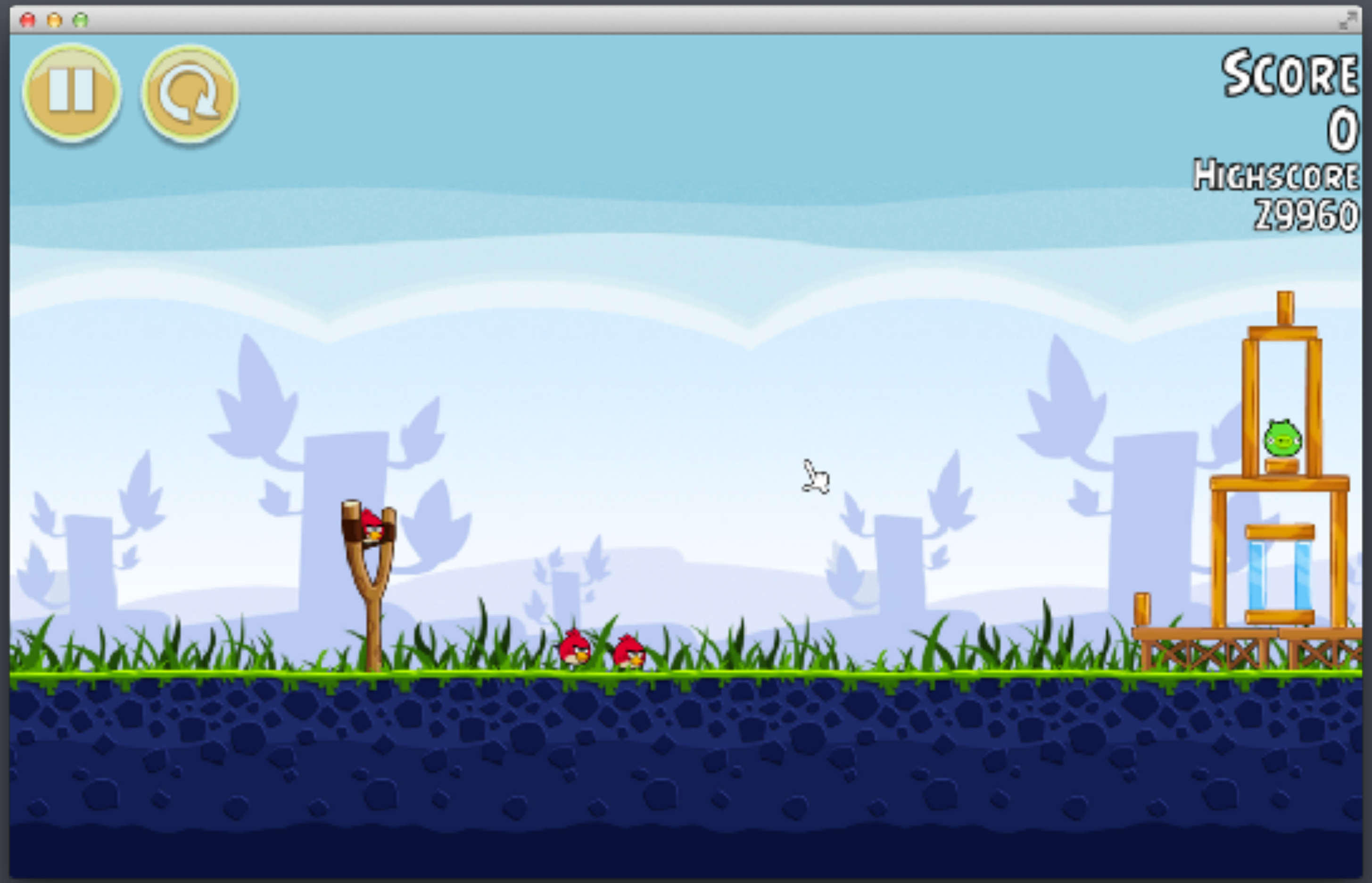
Level select



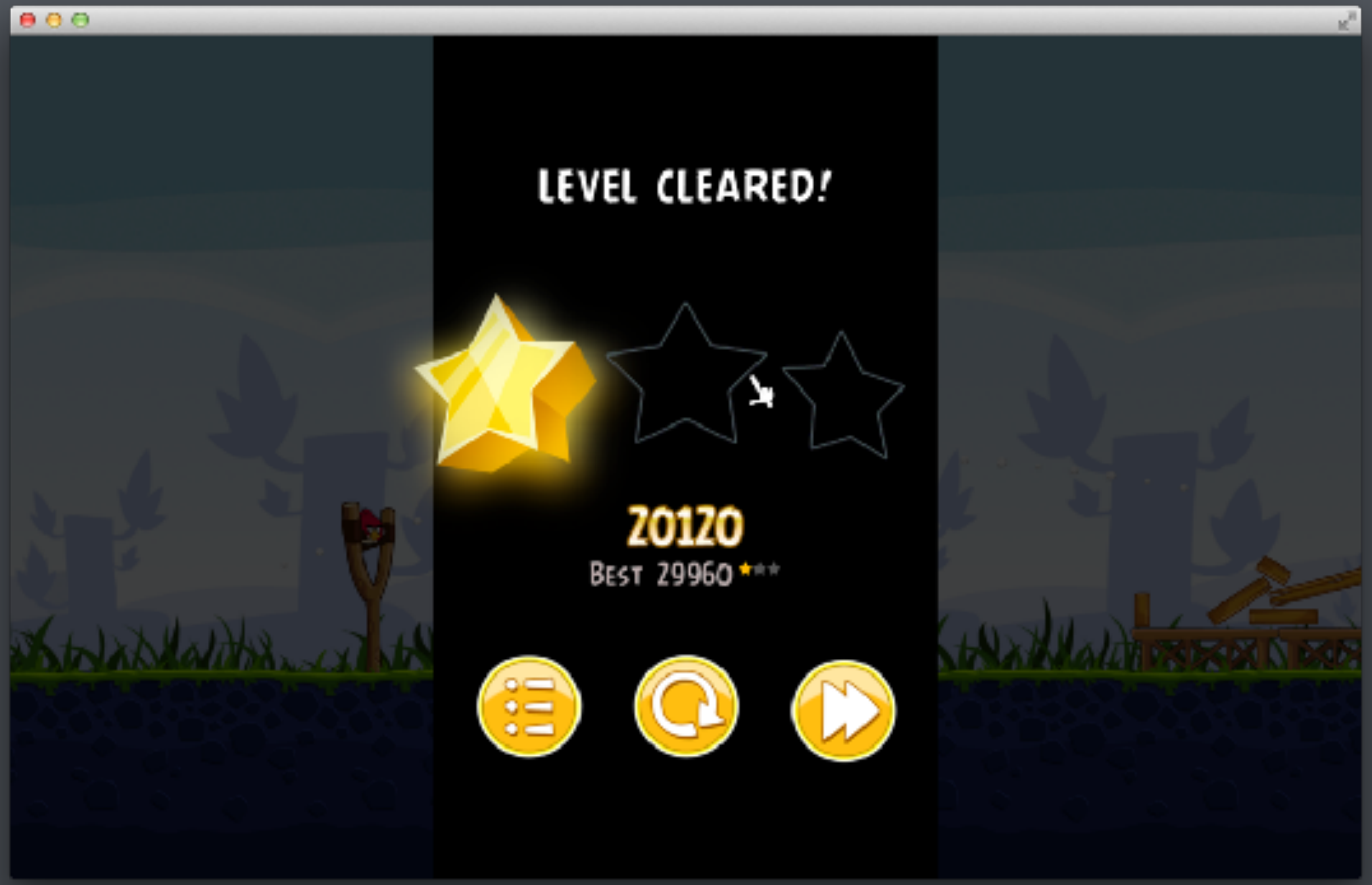
Cutscene



Game level



Win screen



```
enum GameMode { STATE_MAIN_MENU, STATE_GAME_LEVEL, STATE_GAME_OVER};

GameMode mode;
GameState state;

void Render() {
   switch(mode) {
        case STATE_MAIN_MENU:
            RenderMainMenu();
        break;
        case STATE_GAME_LEVEL:
            RenderGameLevel(state);
        break;
    }
}
void Update(float elapsed) {
   switch(mode) {
        case STATE_MAIN_MENU:
            UpdateMainMenu(elapsed);
        break;
        case STATE_GAME_LEVEL:
            UpdateGameLevel(state, elapsed);
        break;
    }
}
void ProcessInput() {
   switch(mode) {
        case STATE_MAIN_MENU:
            ProcessMainMenuInput();
        break;
        case STATE_GAME_LEVEL:
            ProcessGameLevelInput(state);
        break;
    }
}
```

```
enum GameMode { STATE_MAIN_MENU, STATE_GAME_LEVEL, STATE_GAME_OVER};

GameMode mode;
MainMenu mainMenu;
GameLevel gameLevel;

void Render() {
   switch(mode) {
        case STATE_MAIN_MENU:
            mainMenu.Render();
        break;
        case STATE_GAME_LEVEL:
            gameLevel.Render();
        break;
    }
}
void Update(float elapsed) {
   switch(mode) {
        case STATE_MAIN_MENU:
            mainMenu.Update(elapsed);
        break;
        case STATE_GAME_LEVEL:
            gameLevel.Update(elapsed);
        break;
    }
}
void ProcessInput() {
   switch(mode) {
        case STATE_MAIN_MENU:
            mainMenu.ProcessInput();
        break;
        case STATE_GAME_LEVEL:
            gameLevel.ProcessInput();
        break;
    }
}
```

Space Invaders

https://www.youtube.com/watch?v=axlx3o0codc

Assignment

- Make Space Invaders
- It must have 2 game modes: TITLE SCREEN and GAME LEVEL and use a game state.
- It must display text
- It must use sprite sheets (uniform or non)
- You can use any graphics you want (it doesn't have to be in space! :)