Graphics Foundations

Part 3.5

Non-uniform sprite sheets.

Uniform

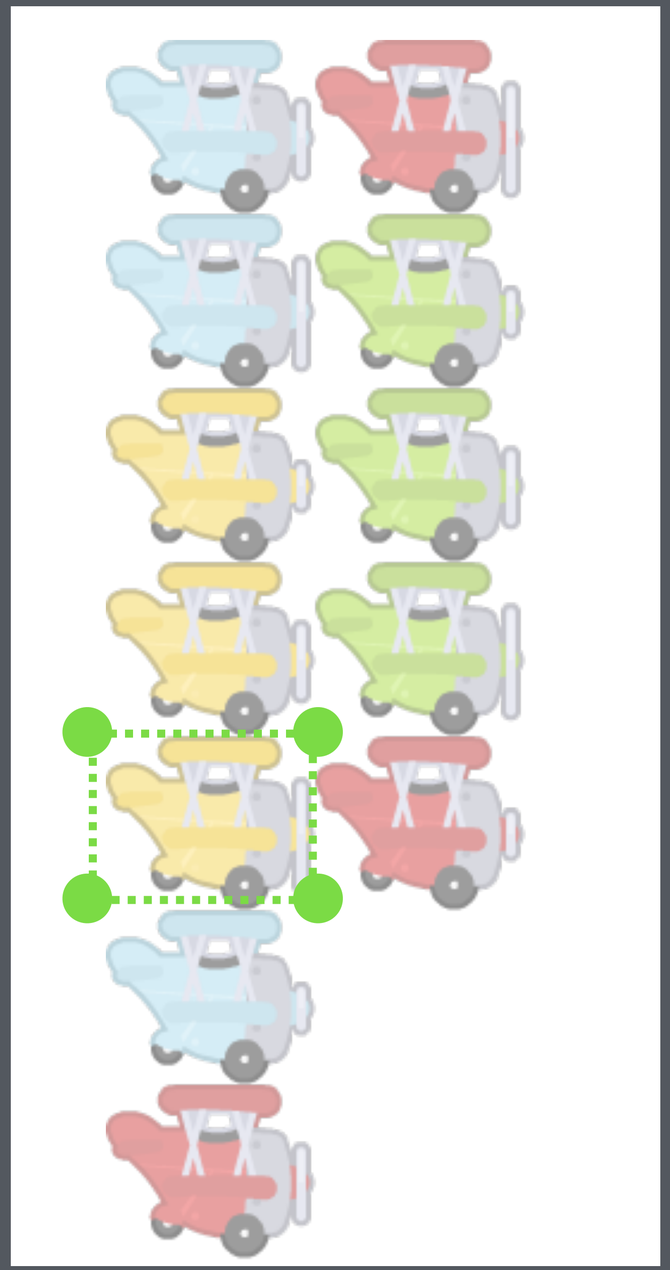
Non-uniform

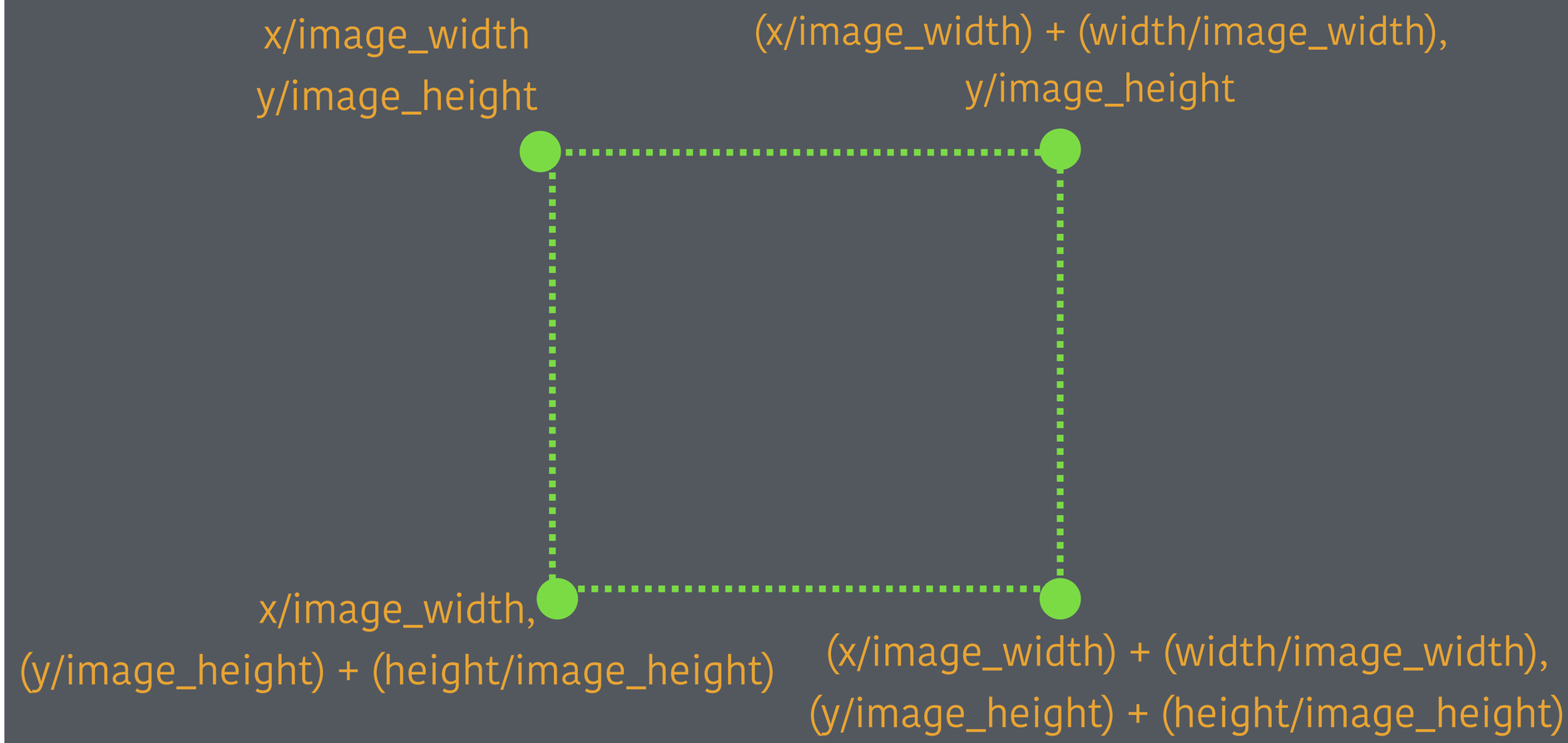
Need to keep a **list of coordinates** for non-uniform sprite sheets.

Texture atlas XML

```
<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();

        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, 0.2);
```

```
void SheetSprite::Draw() {
    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
}
```

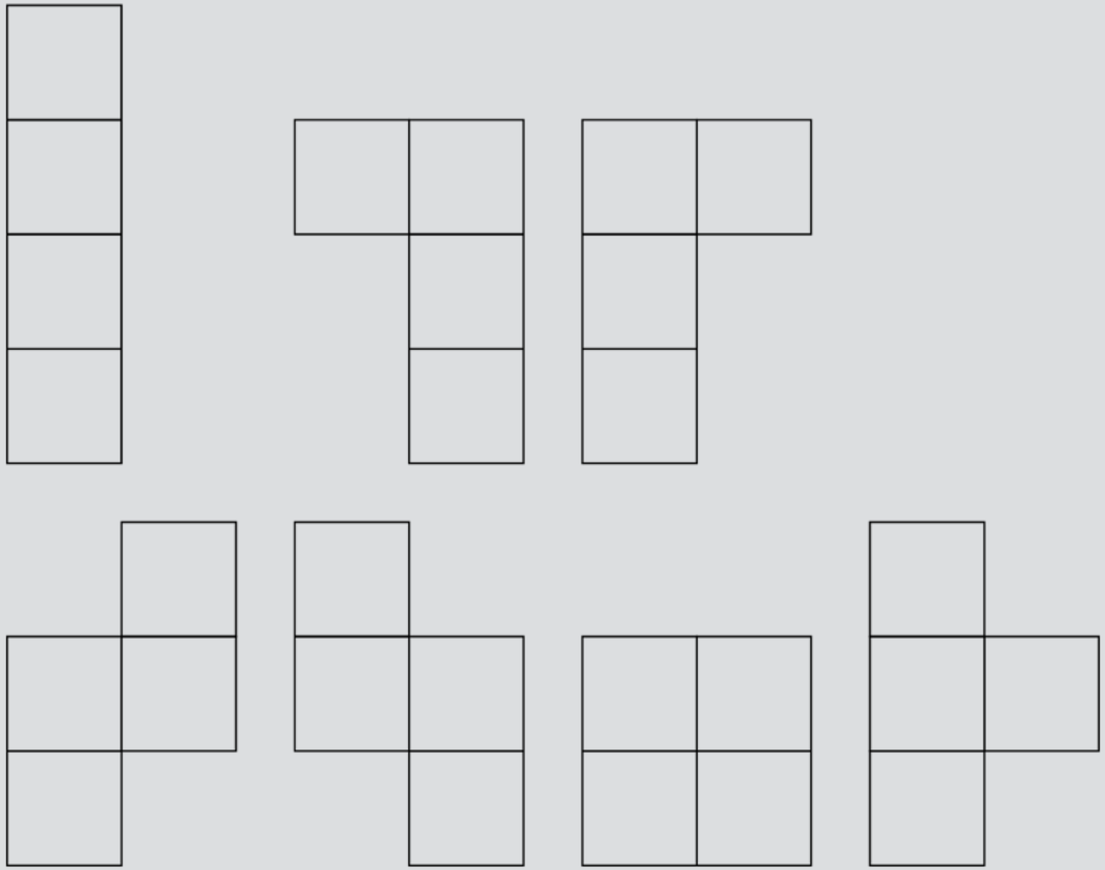
```
void ClassDemoApp::Render() {
    enemySprite.Draw();
}
```

Making **your own** texture atlases.

Shoebox sprite tool.

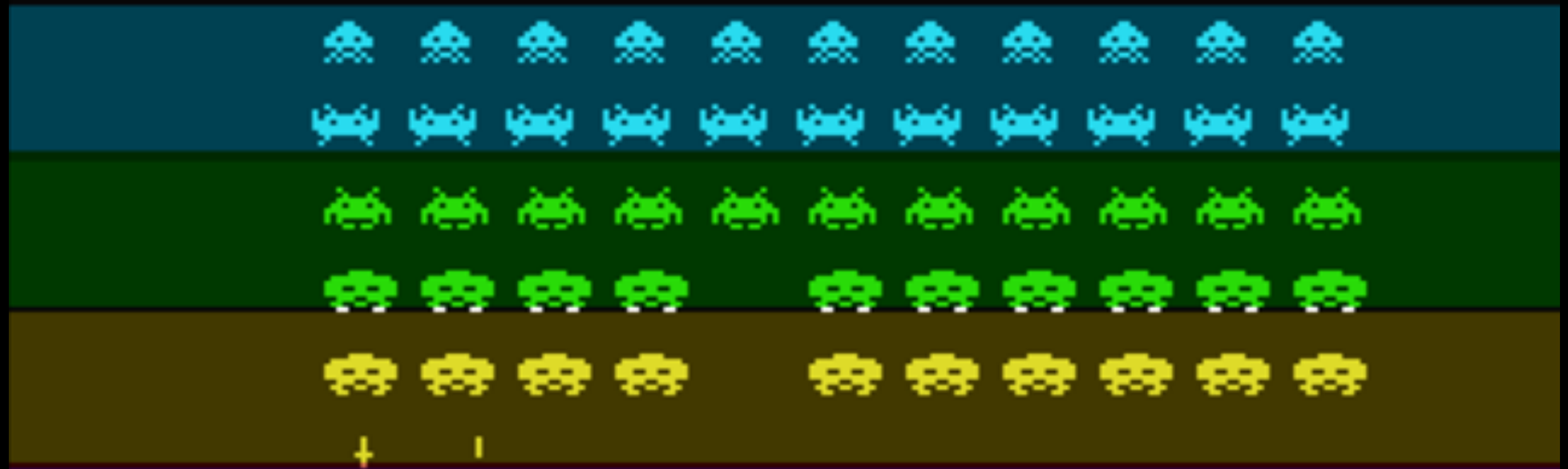
http://renderhjs.net/shoebox/

Game structure



Managing game objects.

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



CREDIT 00

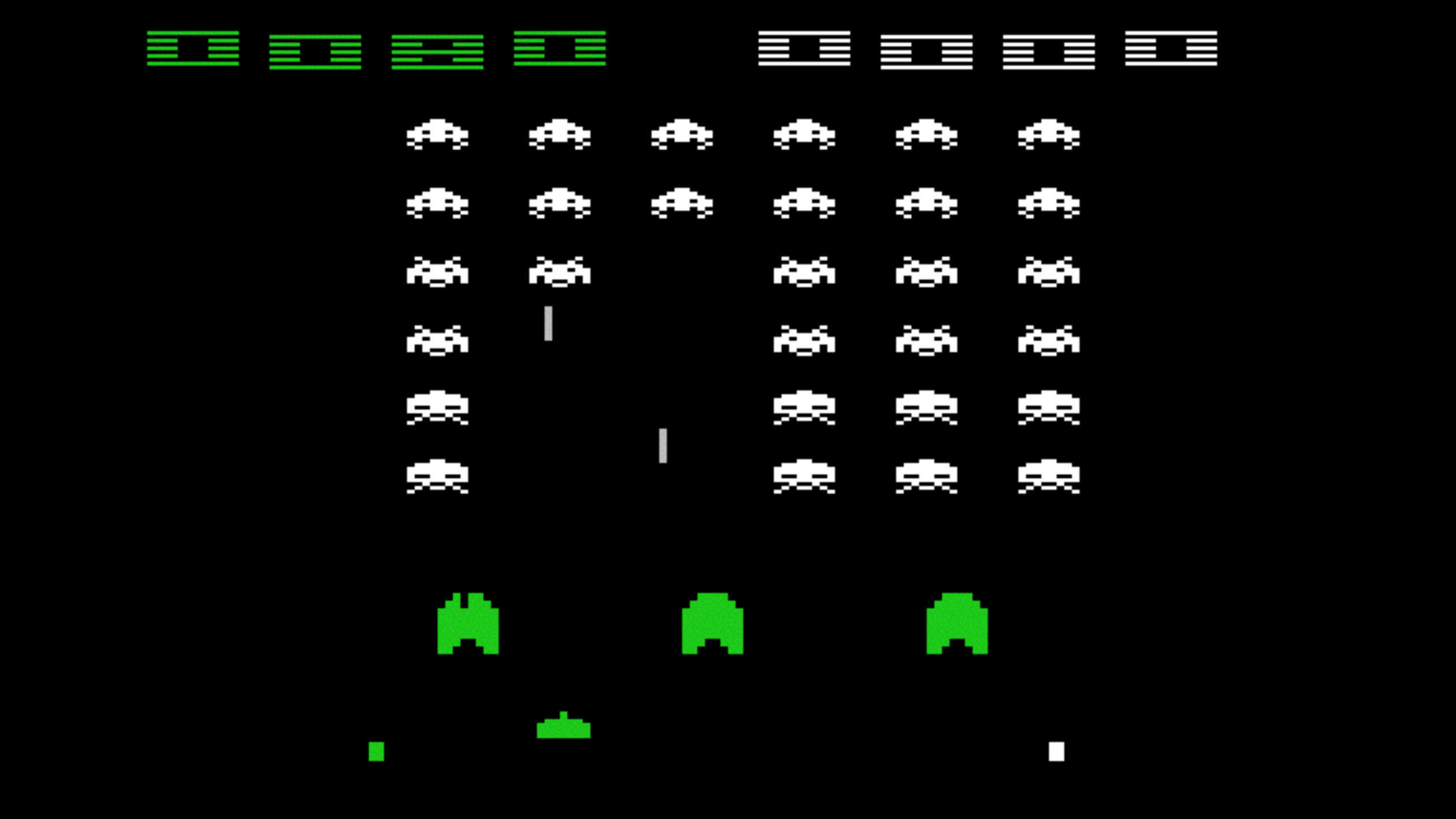
```
std::vector<Entity> entities;
```

```
    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 ClassDemoApp::Update(float elapsed) {

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

```
void ClassDemoApp::Render() {

    glClear(GL_COLOR_BUFFER_BIT);

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

Managing **dynamic** objects.




HEALTH
POWER
BOSS HEALTH
X 8
S
RANK
000.012.400
5
5
5 5
5 5
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.

```
std::vector<Bullet> bullets;
```

```
void shootBullet() {
    Bullet newBullet;
    newBullet.x = -1.2;
    newBullet.y = 0.0;
    newBullet.angle = (float)(45 - (rand() % 90));
    newBullet.speed = 2.0;
    bullets.push_back(newBullet);
}
```

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

```
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;
Bullet bullets[MAX_BULLETS];
```

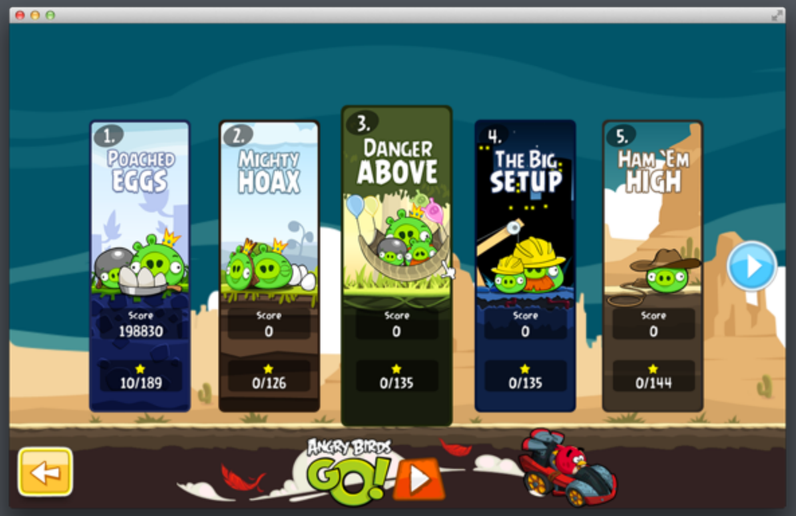
```
void ClassDemoApp::shootBullet() {

    bullets[bulletIndex].visible = true;
    bullets[bulletIndex].x = -1.2;
    bullets[bulletIndex].y = 0.0;
    bullets[bulletIndex].angle = (float)(45 - (rand() % 90));

    bulletIndex++;
    if(bulletIndex > MAX_BULLETS-1) {
        bulletIndex = 0;
    }
}
```

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

Game **states**.

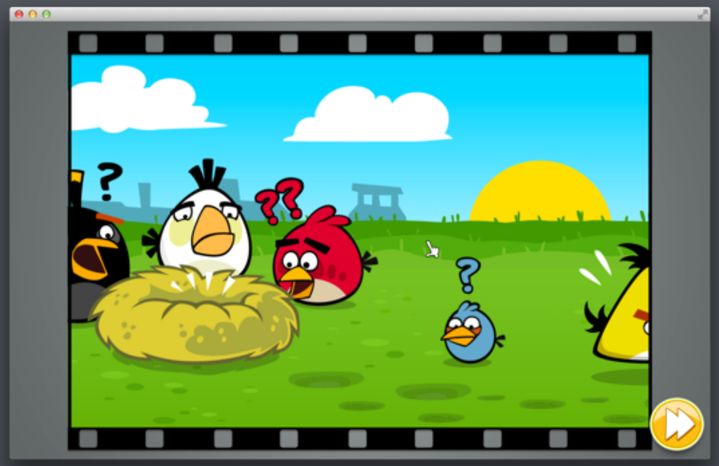
Main menu

Chapter select



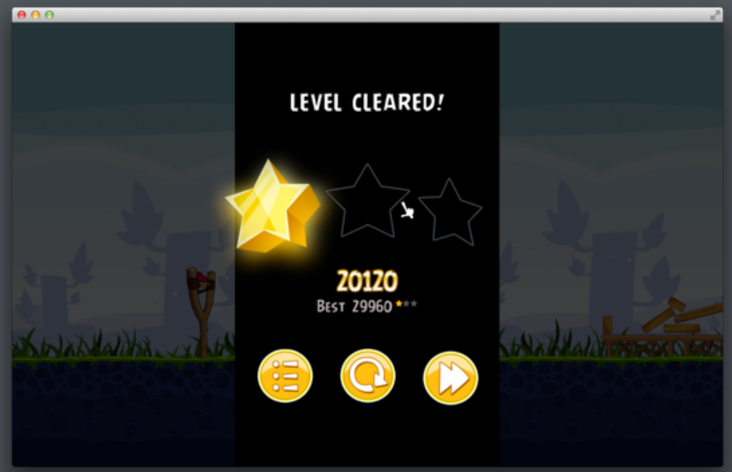
Level select

Cutscene



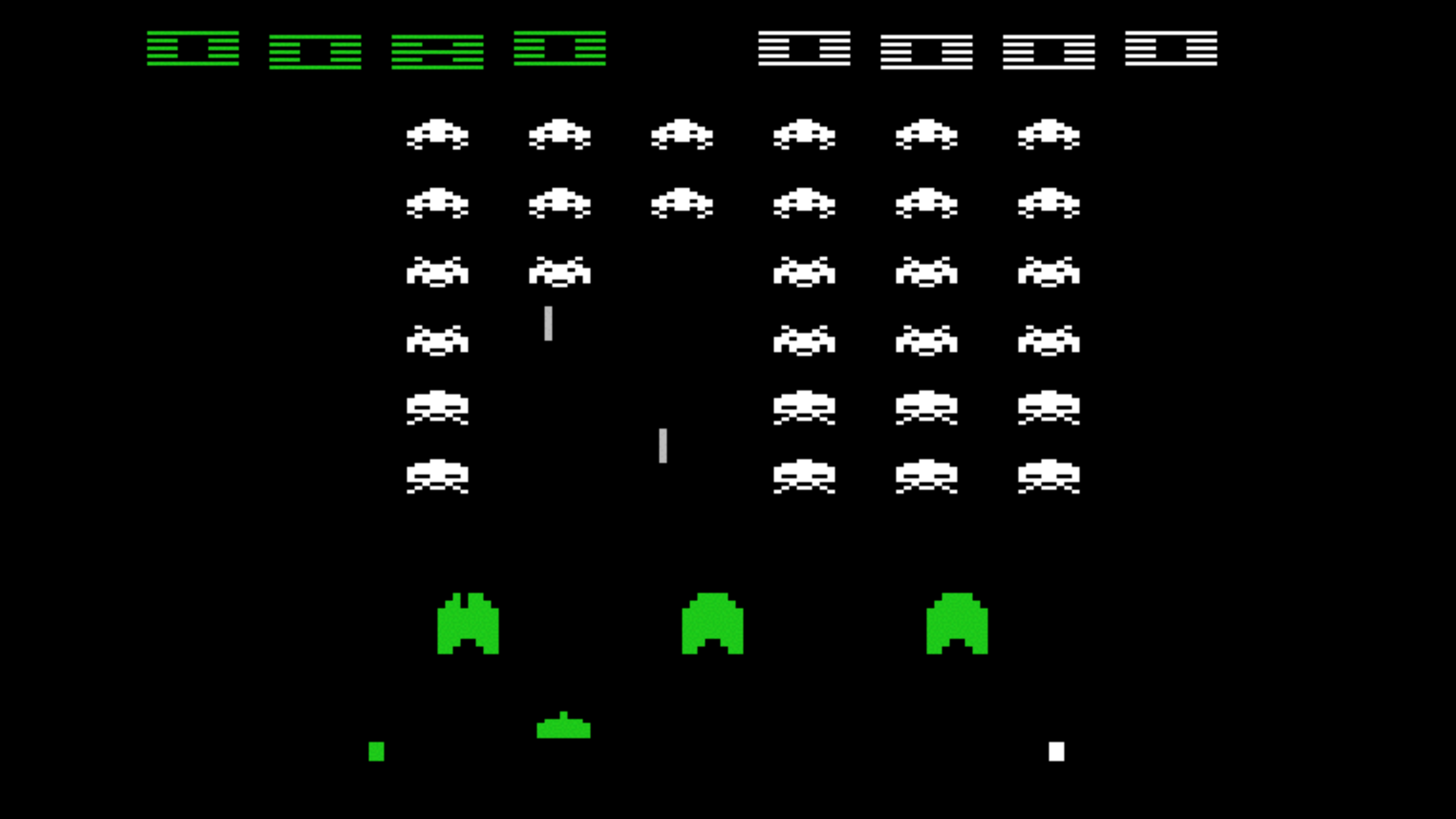
Game level

Win screen



```
enum GameState { STATE_MAIN_MENU, STATE_GAME_LEVEL };

int state;

void ClassDemoApp::Render() {
   switch(state) {
        case STATE_MAIN_MENU:
            RenderMainMenu();
        break;
        case STATE_GAME_LEVEL:
            RenderGameLevel();
        break;
    }
}

void ClassDemoApp::Update() {
   switch(state) {
        case STATE_MAIN_MENU:
            UpdateMainMenu();
        break;
        case STATE_GAME_LEVEL:
            UpdateGameLevel();
        break;
    }
}
```

```
enum GameState { STATE_MAIN_MENU, STATE_GAME_LEVEL };

int state;

void ClassDemoApp::Render() {
   switch(state) {
        case STATE_MAIN_MENU:
            mainMenu.Render();
        break;
        case STATE_GAME_LEVEL:
            gameLevel.Render();
        break;
    }
}

void ClassDemoApp::Update() {
   switch(state) {
        case STATE_MAIN_MENU:
            mainMenu.Update();
        break;
        case STATE_GAME_LEVEL:
            gameLevel.Update();
        break;
    }
}
```



Space Invaders

https://www.youtube.com/watch?v=437Ld_rKM2s

Assignment

- Make **Space Invaders**
- It must have **3 states**: **TITLE SCREEN**, **GAME** and **GAME OVER**
- It must **display text**
- It must use **sprite sheets**
- You can use **any graphics you want** (it doesn't have to be in space! :)