We’re almost ready to make a game!

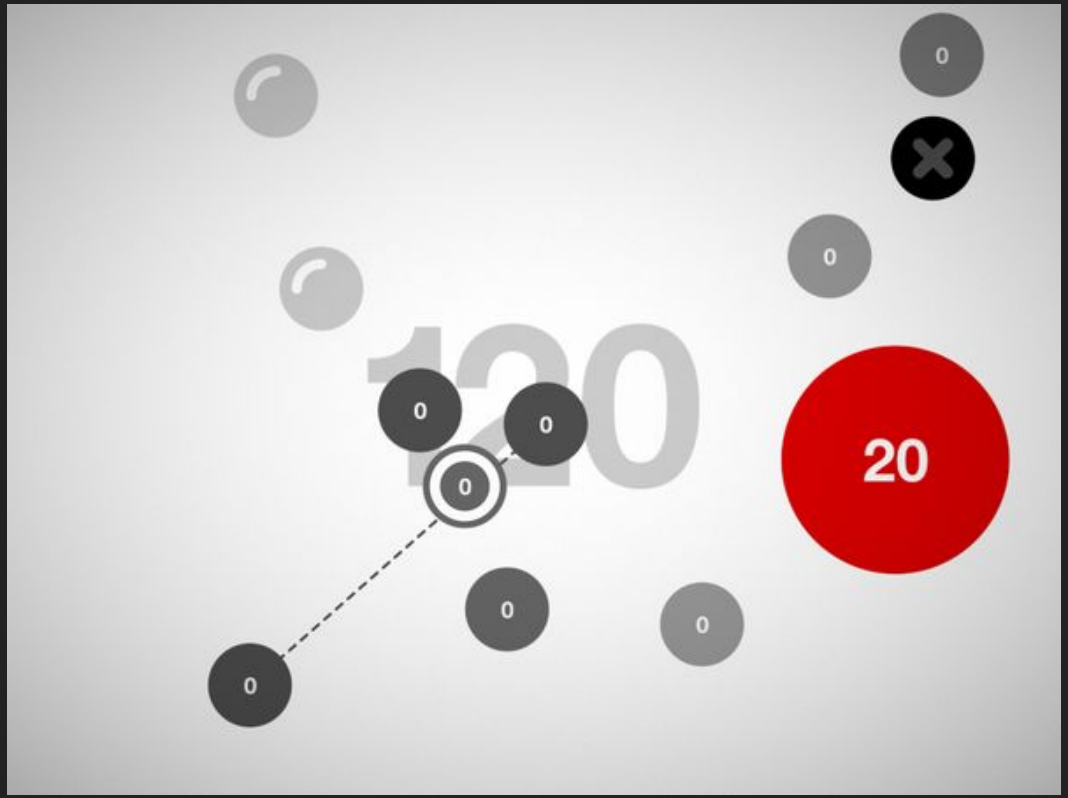
What we've learned so far...

Initializing SDL, OpenGL, creating a window.
Drawing a triangle.
Transformations: translation, rotation, scale.
Handling timing.
Loading images and rendering textures.
Keyboard, controller and mouse input.
Movement based on unit vector, speed and elapsed time.

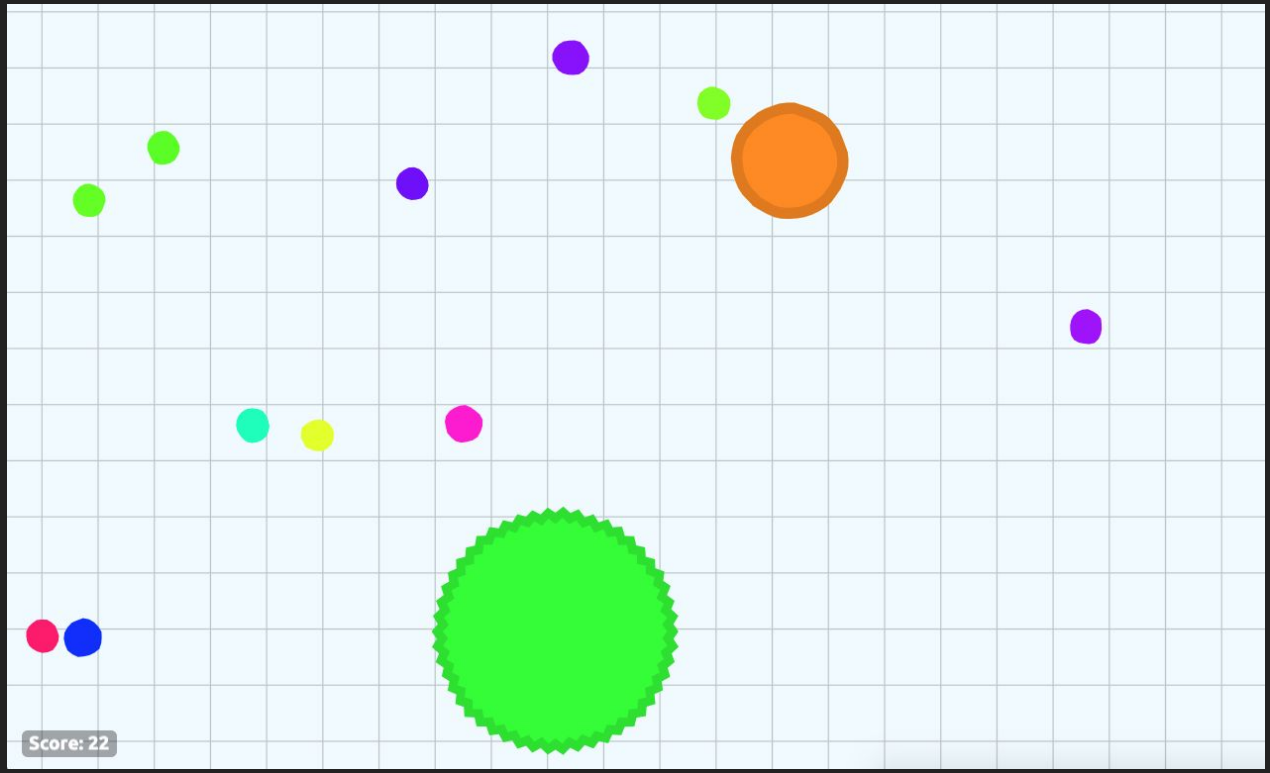
We need one more thing to make our first game...

Collision Detection!

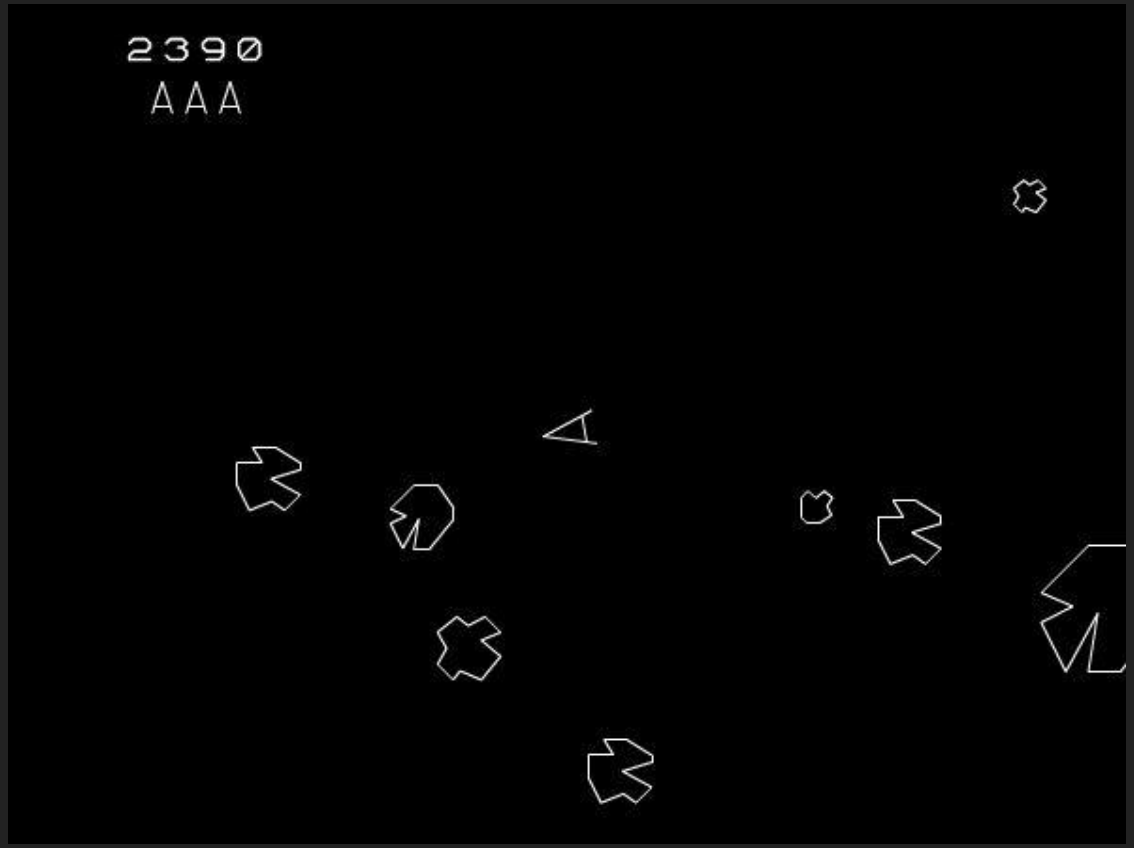
Circle - Circle Collision Detection



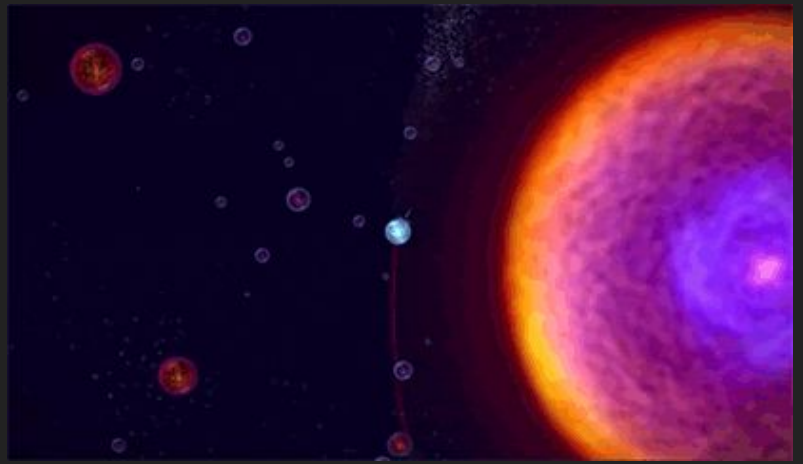
Hundreds (iOS/Android)



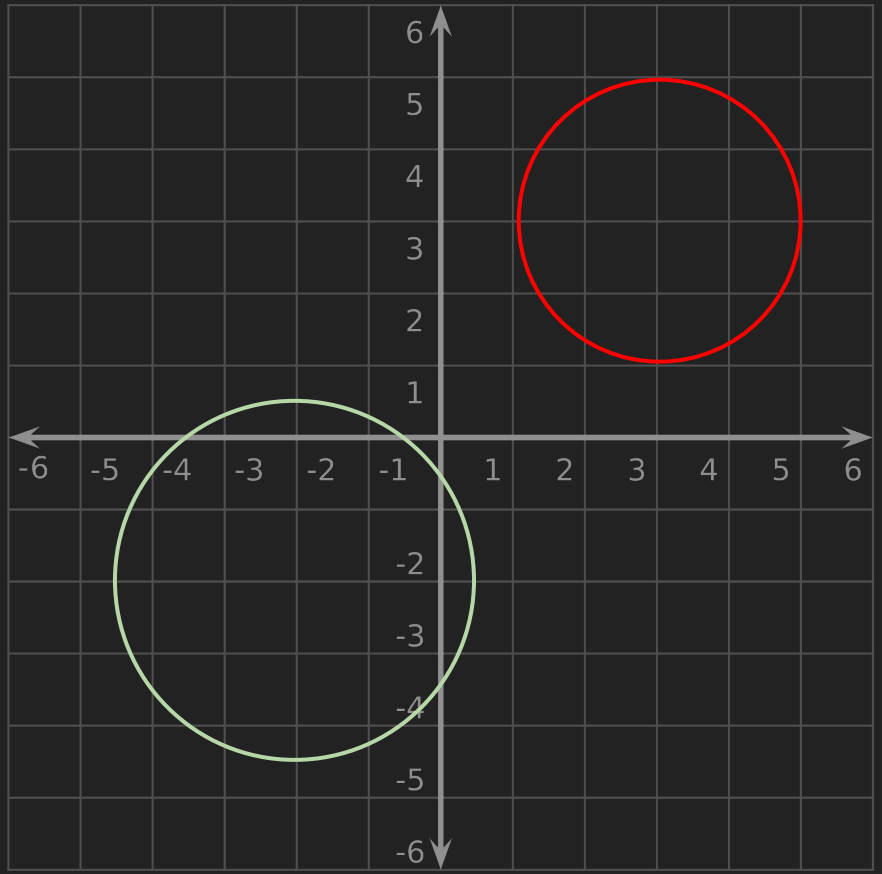
https://agar.io



Asteroids - 1979 Arcade



Osmos
by Andy Nealen
NYU Professor!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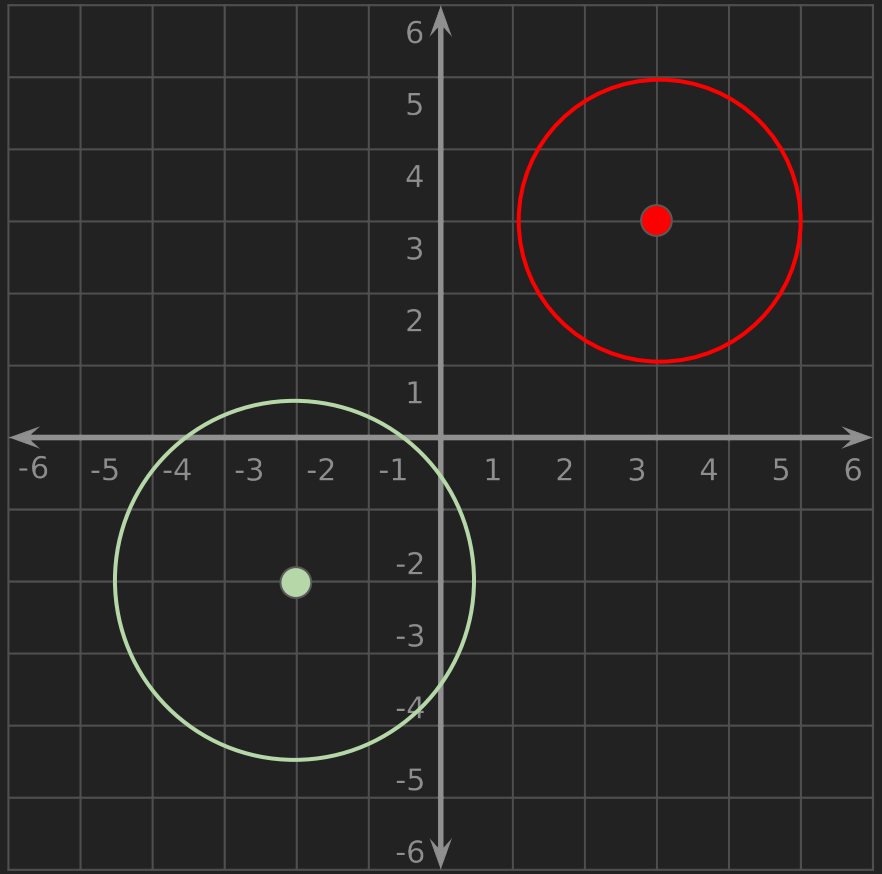
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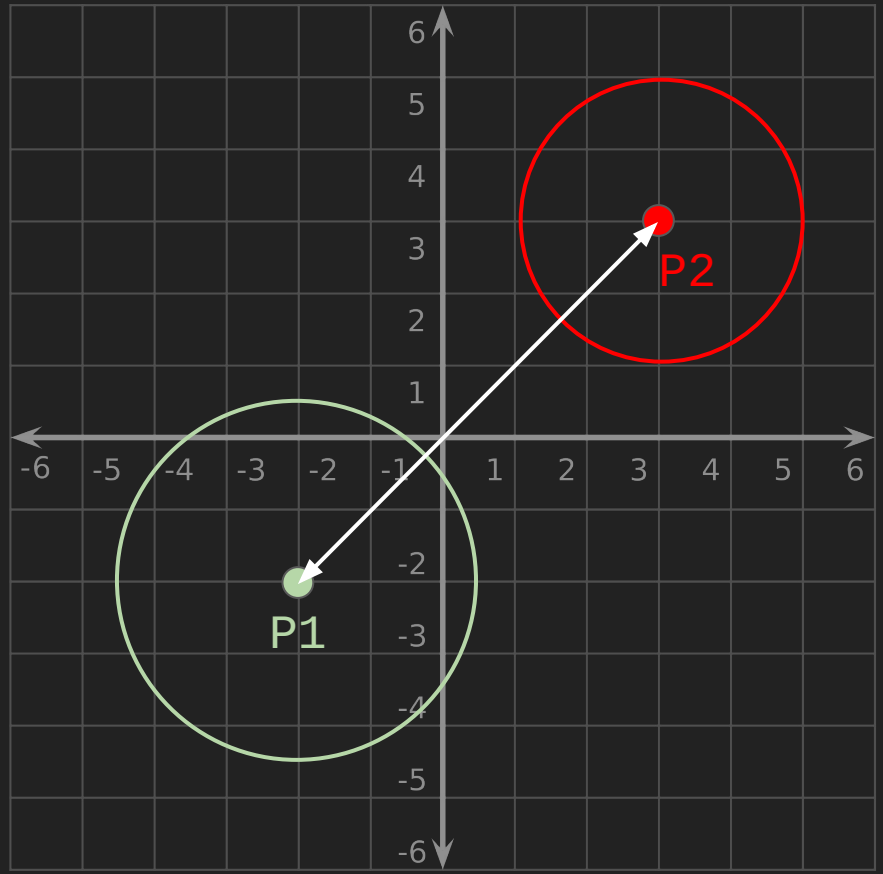


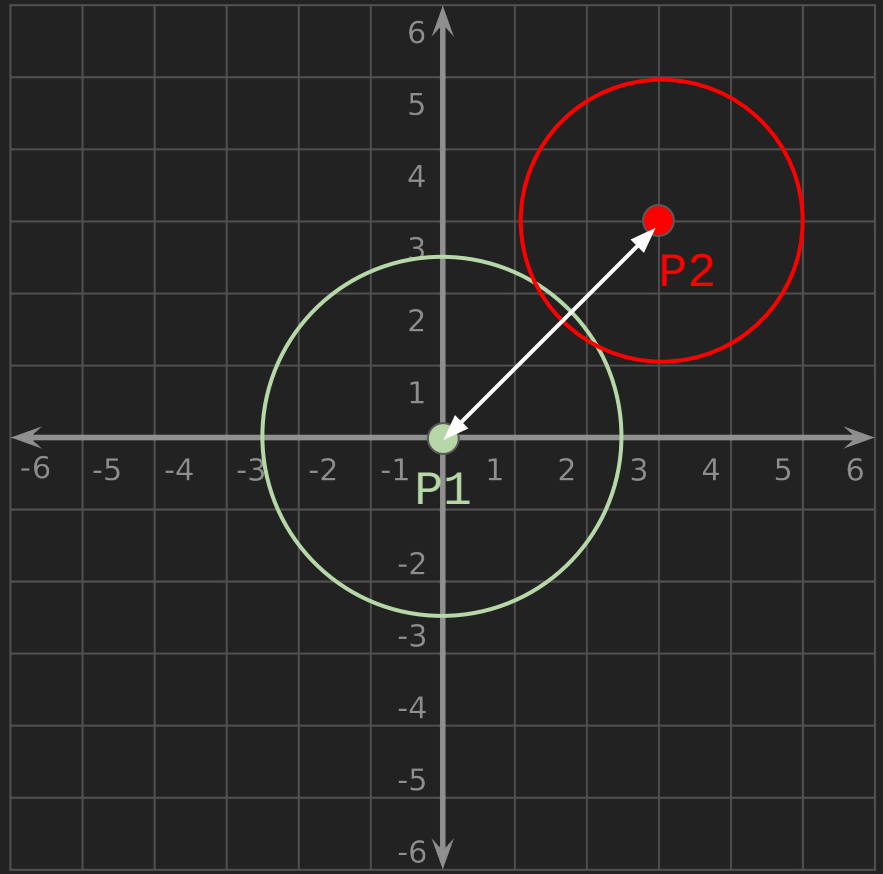
Radius: 3
P1: -2, -2

Radius: 2
P2: 3, 3

Radius + Radius = 5

Distance: 7.07
(Pythagorean Theorem)

distance > (radius + radius)



Radius: 3
P1: 0, 0

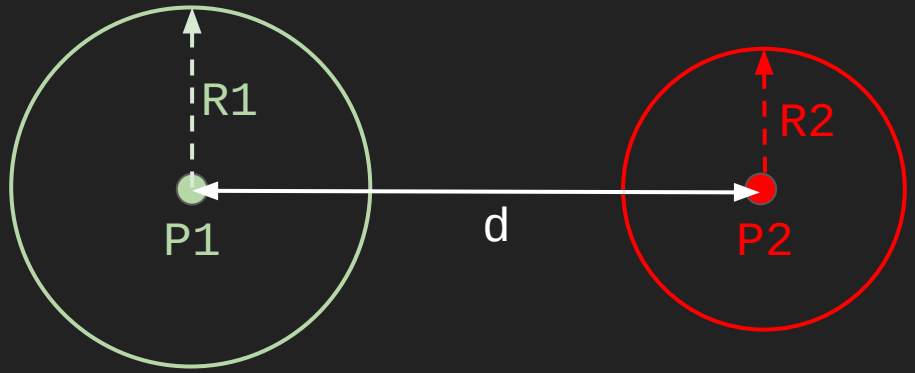
Radius: 2
P2: 3, 3

Radius + Radius = 5

Distance: 4.24
(Pythagorean Theorem)

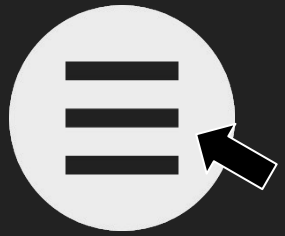
distance < (radius + radius)

Circle - Circle Collision Detection



If the distance between the center of the circles is less than the sum of the radii, they are colliding.

Point - Circle Collision Detection



Click on UI, move the player, select a target.

Point - Circle Collision Detection

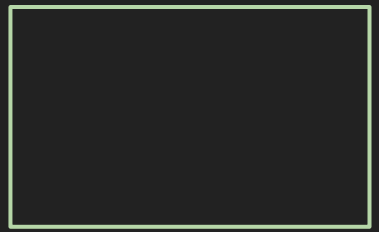
If the distance between the point and the circle center is less than the radius, they are colliding.

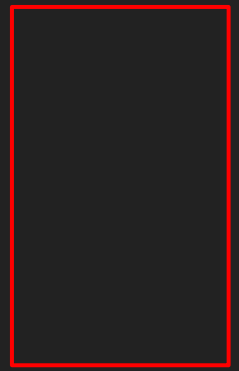
Box - Box
Collision Detection

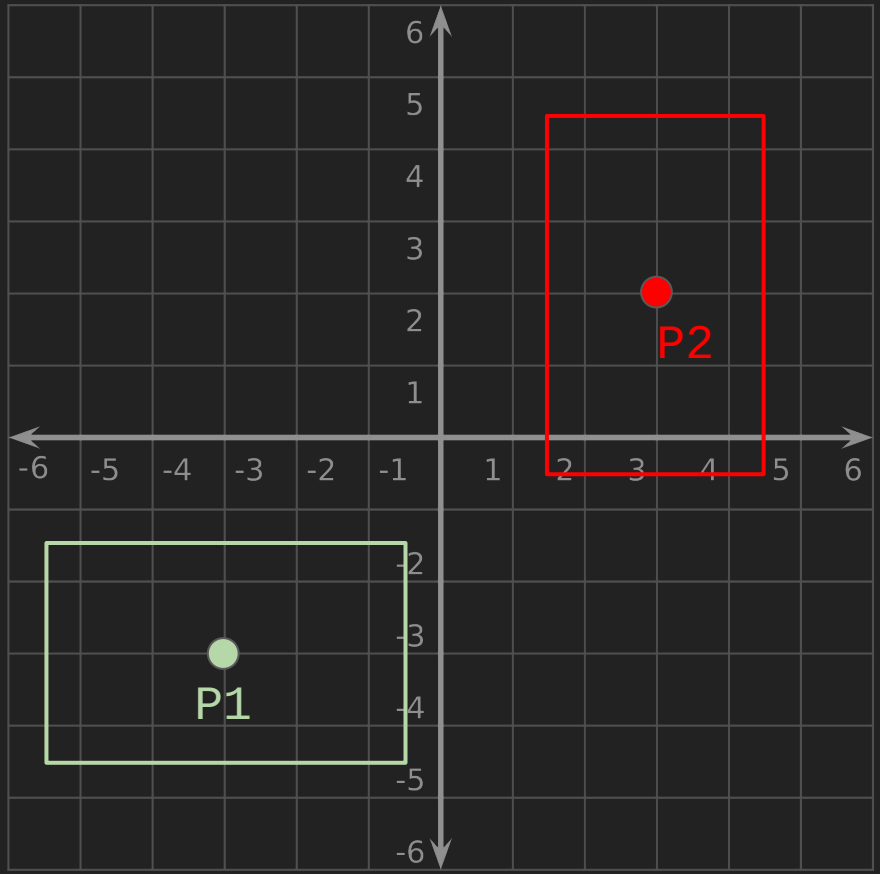
The Legend of Zelda (NES)

A Link to the Past (SNES)

Street Fighter (Arcade)



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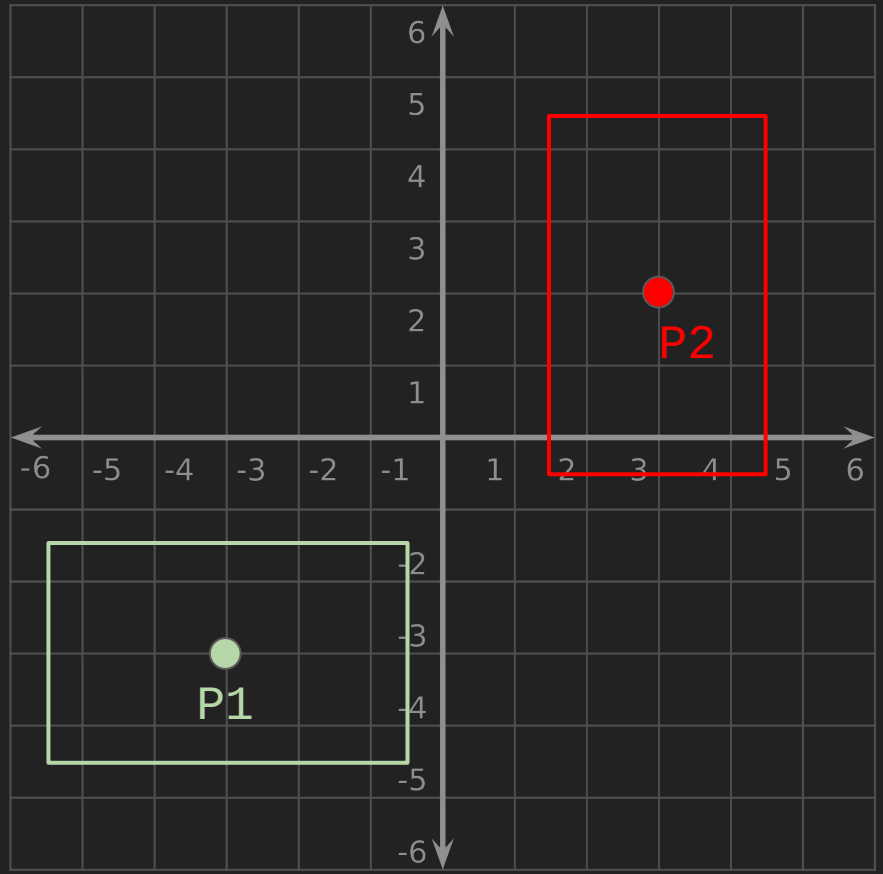
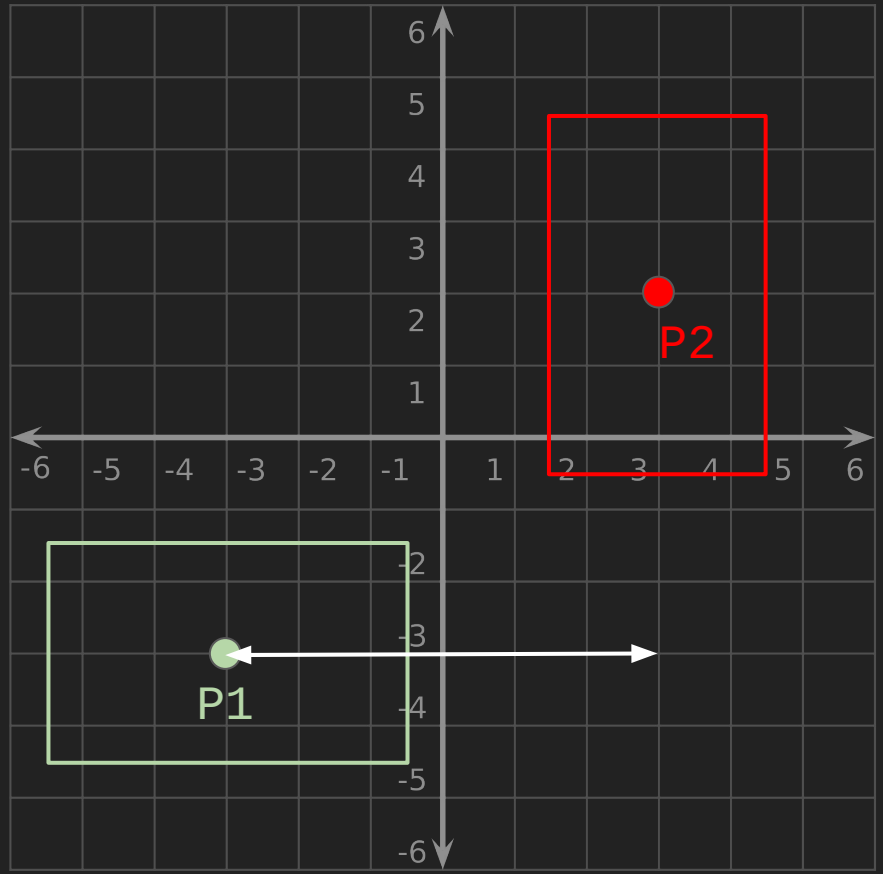


Width: 5 Height: 3
P1: -3, -3

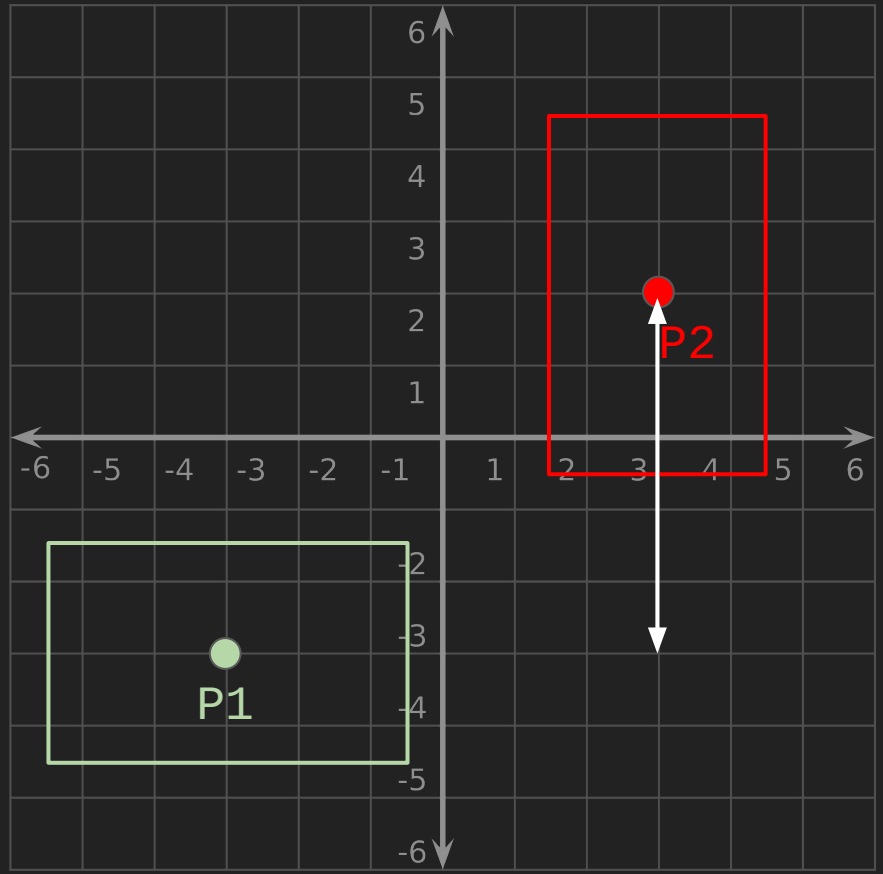
Width: 3 Height: 5
P2: 3, 2



Width: 5 Height: 3
P1: -3, -3

Width: 3 Height: 5
P2: 3, 2

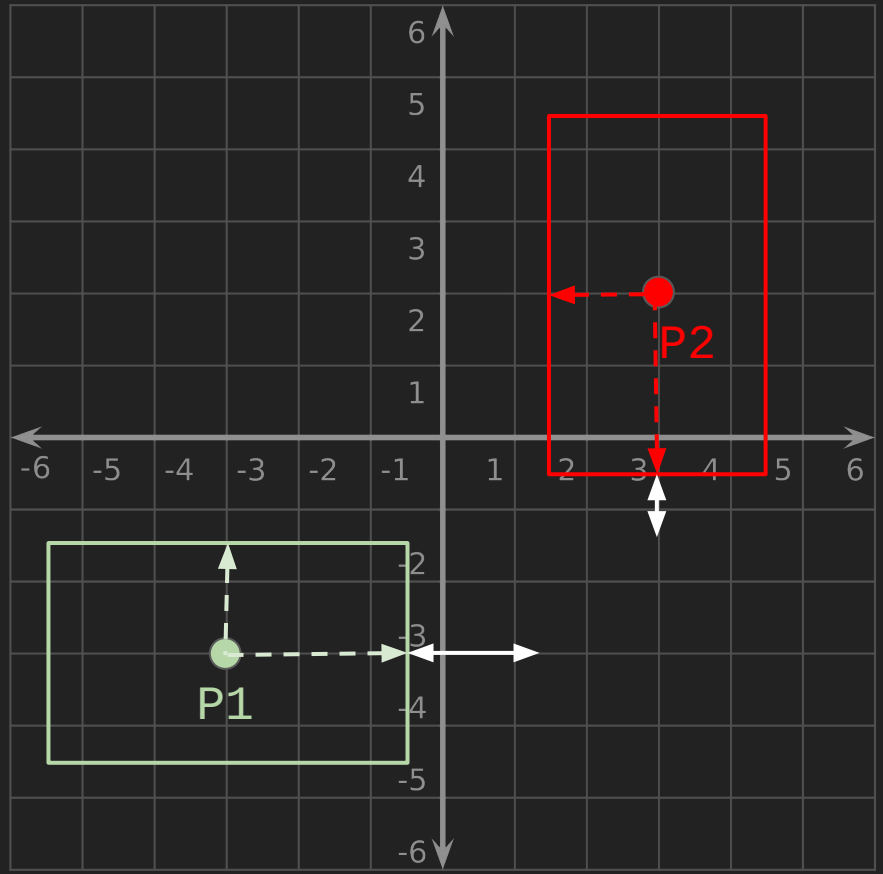
X Diff: 6 fabs(x2 - x1)



Width: 5 Height: 3
P1: -3, -3

Width: 3 Height: 5
P2: 3, 2

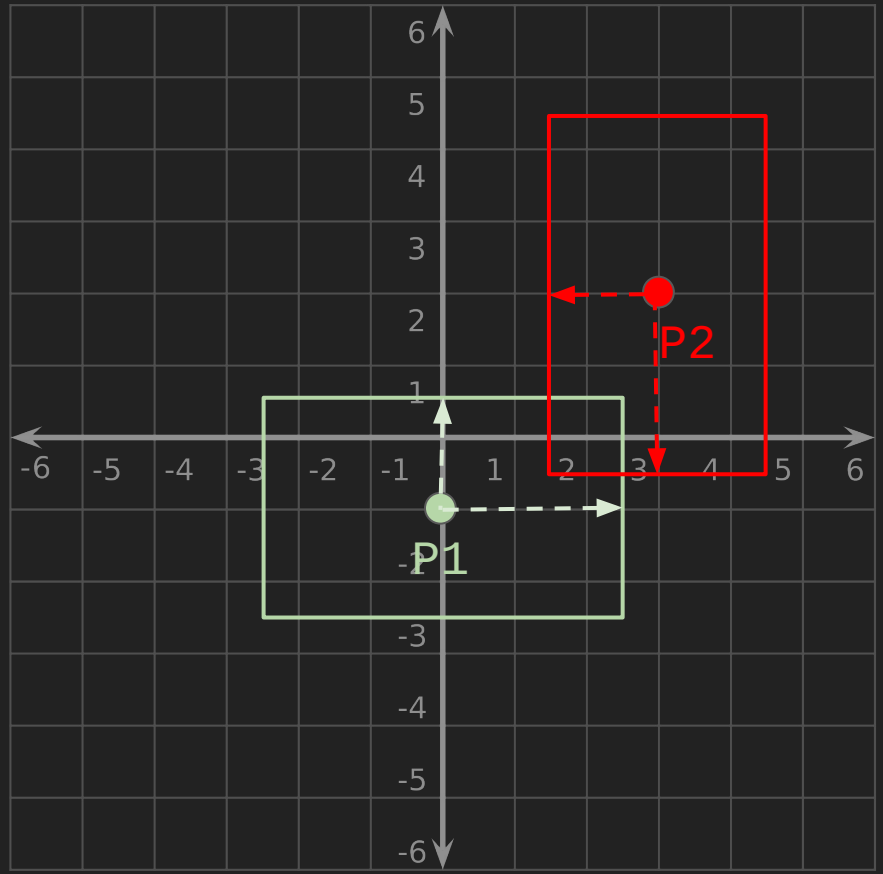
X Diff: 6 fabs(x2 - x1)
Y Diff: 5 fabs(y2 - y1)




```
Width: 5          Height: 3
P1: -3, -3

Width: 3          Height: 5
P2: 3, 2

X Diff: 6         fabs(x2 - x1)
Y Diff: 5         fabs(y2 - y1)
```

X Distance = XDiff - (W1 + W2) / 2
Y Distance = YDiff - (H1 + H2) / 2

X Distance = 2, Y Distance = 1
(both need to be < 0 to be colliding)

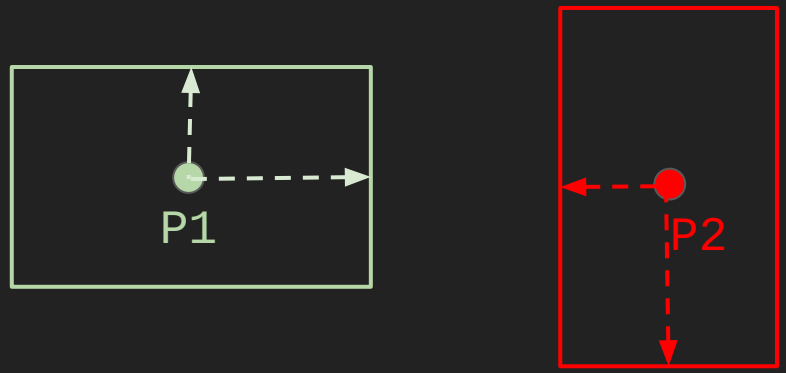



```
Width: 5          Height: 3
P1: 0, -1

Width: 3          Height: 5
P2: 3, 2

X Diff: 3         fabs(x2 - x1)
Y Diff: 3         fabs(y2 - y1)
```

X Distance = XDiff - (W1 + W2) / 2
Y Distance = YDiff - (H1 + H2) / 2

X Distance = -1, Y Distance = -1
(both are < 0 = colliding)

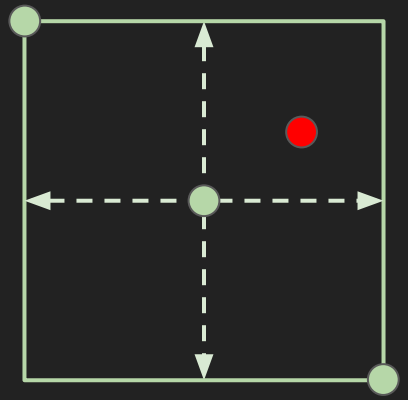
Box - Box Collision Detection




```
float xdist = fabs(x2 - x1) - ((w1 + w2) / 2.0f);
float ydist = fabs(y2 - y1) - ((h1 + h2) / 2.0f);

if (xdist < 0 && ydist < 0) // Colliding!
```

Point - Box Collision Detection

Point - Box Collision Detection



Get the top left and bottom right corners.
Check if the X,Y of the point is inside.

Let’s get organized!

```
modelMatrix = glm::mat4(1.0f);
modelMatrix = glm::translate(modelMatrix, player_position);
program.SetModelMatrix(modelMatrix);

float vertices[]  = { -0.5, -0.5, 0.5, -0.5, 0.5, 0.5, -0.5, -0.5, 0.5, 0.5, -0.5, 0.5 };
float texCoords[] = { 0.0, 1.0, 1.0, 1.0, 1.0, 0.0, 0.0, 1.0, 1.0, 0.0, 0.0, 0.0 };

glBindTexture(GL_TEXTURE_2D, playerTextureID);

glVertexAttribPointer(program.positionAttribute, 2, GL_FLOAT, false, 0, vertices);
glEnableVertexAttribArray(program.positionAttribute);

glVertexAttribPointer(program.texCoordAttribute, 2, GL_FLOAT, false, 0, texCoords);
glEnableVertexAttribArray(program.texCoordAttribute);

glDrawArrays(GL_TRIANGLES, 0, 6);

glDisableVertexAttribArray(program.positionAttribute);
glDisableVertexAttribArray(program.texCoordAttribute);
```

“I’ve got a bad feeling about this.”

Entities!




Make a Class/Header

```
class Entity {
public:

    glm::vec3 position;
    glm::vec3 movement;
    float speed;

    GLuint textureID;

    Entity();

    void Update(float deltaTime);
    void Render(ShaderProgram *program);
};
```

Make a Class/Header

```
void Entity::Update(float deltaTime)
{
    position += movement * speed * deltaTime;
}

void Entity::Render(ShaderProgram *program) {
    glm::mat4 modelMatrix = glm::mat4(1.0f);
    modelMatrix = glm::translate(modelMatrix, position);
    program->SetModelMatrix(modelMatrix);

    float vertices[]  = { -0.5, -0.5, 0.5, -0.5, 0.5, 0.5, -0.5, -0.5, 0.5, 0.5, -0.5, 0.5 };
    float texCoords[] = { 0.0, 1.0, 1.0, 1.0, 1.0, 0.0, 0.0, 1.0, 1.0, 0.0, 0.0, 0.0 };

    glBindTexture(GL_TEXTURE_2D, textureID);

    glVertexAttribPointer(program->positionAttribute, 2, GL_FLOAT, false, 0, vertices);
    glEnableVertexAttribArray(program->positionAttribute);

    glVertexAttribPointer(program->texCoordAttribute, 2, GL_FLOAT, false, 0, texCoords);
    glEnableVertexAttribArray(program->texCoordAttribute);

    glDrawArrays(GL_TRIANGLES, 0, 6);

    glDisableVertexAttribArray(program->positionAttribute);
    glDisableVertexAttribArray(program->texCoordAttribute);
}
```

The Game Loop

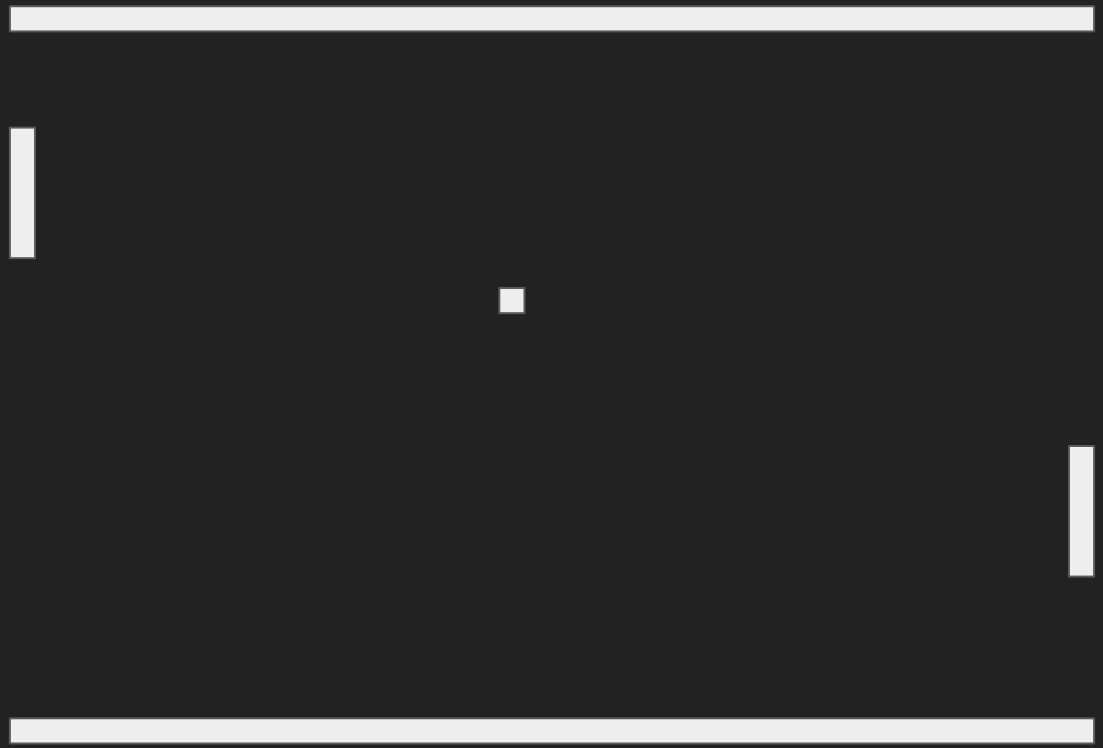
ProcessInput()
- player.movement = ...

Update()
- Calculate deltaTime
- for each entity:
  - entity.Update(deltaTime);

Render()
- Clear the screen
- for each entity:
  - entity.Render(program);

You’re ready to make your first game!

Pong!



Project 2: Pong

Make Pong!

- Needs a paddle on each side that can move individually.
- Needs a object that bounces off of the paddles and top/bottom wall.

Does not need to keep score but must detect when someone wins.

Can use images or untextured polygons.

Can use keyboard, mouse or joystick input.

- You can have both players using the keyboard if you want.

Commit your code to your GitHub repository.

Post the link in the Assignments area.

For example, your link might look like:

https://github.com/tonystark/CS3113/P2/