# Basic Game Physics

# Gravity
# Jumping
# Movement
(somewhat automagically)

# Topics:
# Fixed Timestep
# Velocity
# Acceleration (Gravity)

# Fixed Timestep

# Currently, our timestep is as fast as our computer can go as well as variable.

```
float lastTicks = 0;

void Update() {
    float ticks = (float)SDL_GetTicks() / 1000.0f;
    float deltaTime = ticks - lastTicks;
    lastTicks = ticks;

    player_position += player_movement * deltaTime;
}
```

# Variable Timestep

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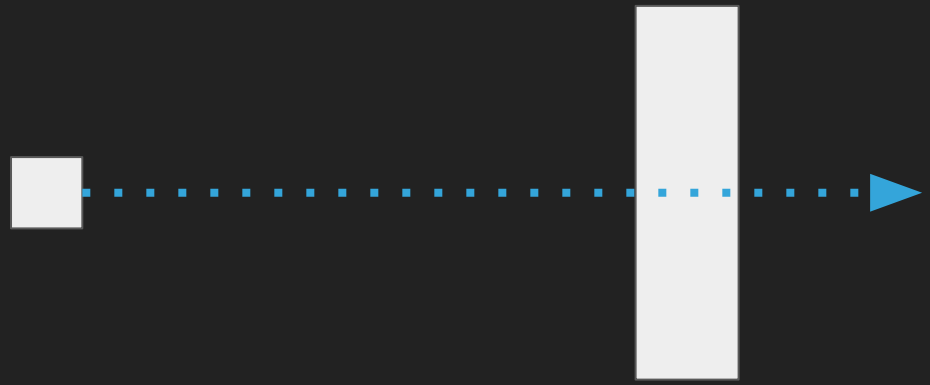
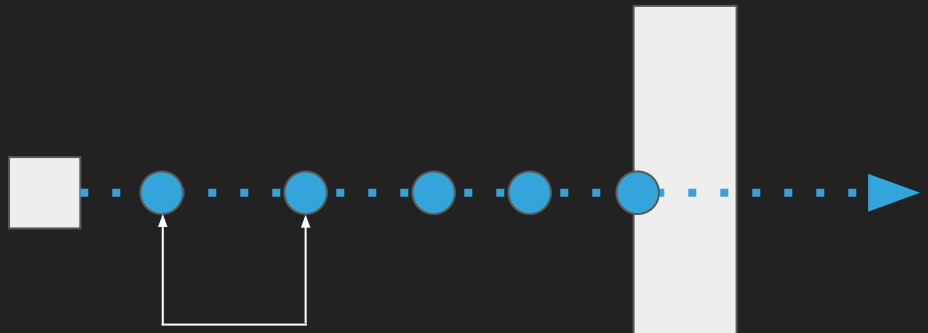
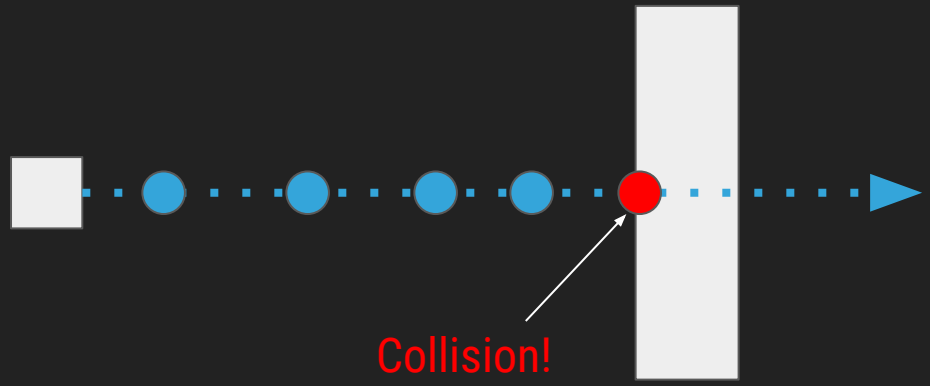


# Variable Timestep



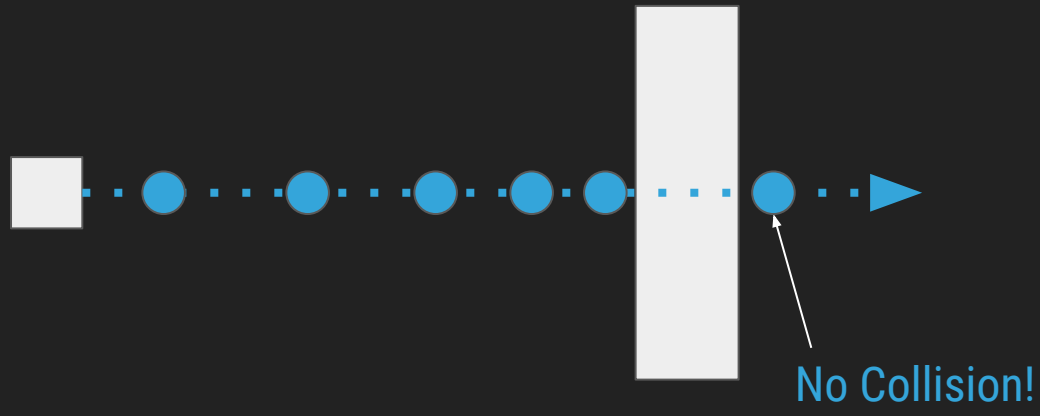
Elapsed time since last frame

# Variable Timestep




(everything worked out OK here)

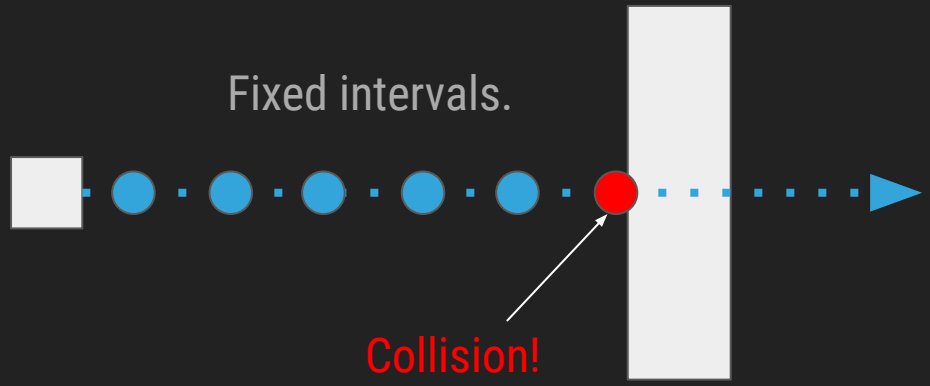
# Variable Timestep




Due to our variable timestep, we “skipped over” the object.

To keep physics behaviors the same, we want to use a fixed timestep.

# Fixed Timestep




(everything worked out OK here)

```
#define FIXED_TIMESTEP 0.0166666f
float lastTicks = 0;
float accumulator = 0.0f;

void Update() {
    float ticks = (float)SDL_GetTicks() / 1000.0f;
    float deltaTime = ticks - lastTicks;
    lastTicks = ticks;

    deltaTime += accumulator;
    if (deltaTime < FIXED_TIMESTEP) {
        accumulator = deltaTime;
        return;
    }

    while (deltaTime >= FIXED_TIMESTEP) {
        // Update. Notice it's FIXED_TIMESTEP. Not deltaTime
        state.player.Update(FIXED_TIMESTEP);

        deltaTime -= FIXED_TIMESTEP;
    }

    accumulator = deltaTime;
}
```

# Gravity

# Gravity

(Acceleration due to Gravity)

$9.81\ m/s^2$

# Gravity

## (Acceleration due to Gravity)

```
player.acceleration = glm::vec3(0, -9.81f, 0);
```

# Acceleration

## Rate of change of velocity.

```
velocity.x += acceleration.x * elapsed;
velocity.y += acceleration.y * elapsed;

// You can also do this
velocity += acceleration * elapsed;
```

# Velocity

## Change of position over time.

```
position.x += velocity.x * elapsed;
position.y += velocity.y * elapsed;

// You can also do this
position += velocity * elapsed;
```

# Putting it all together:

```
player.acceleration = glm::vec3(0, -9.81f, 0);

void Update(float deltaTime) {  // player’s update
    velocity += acceleration * deltatime;
    position += velocity * elapsed;
}
```

Notice if **acceleration** never changes,
**velocity** will keep accumulating.

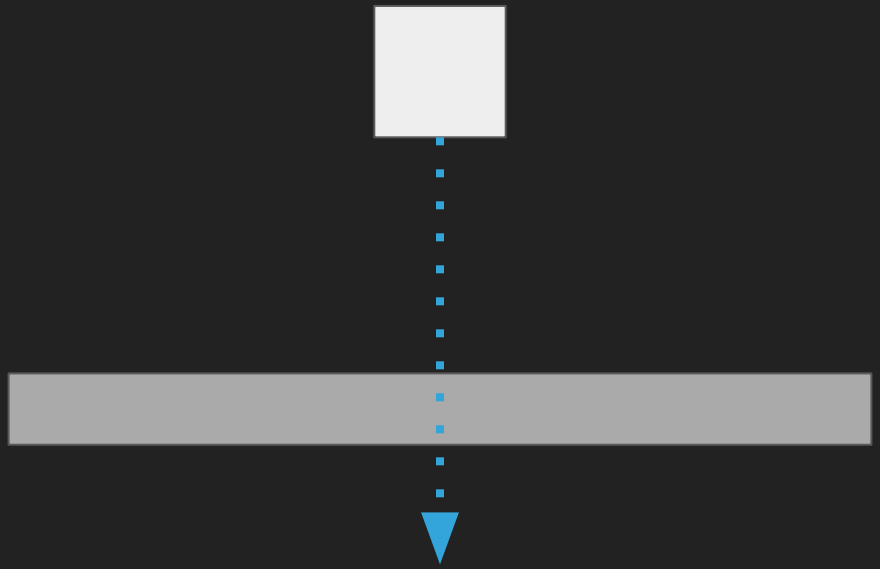
# Let’s Code!

Example: FixedTimestep

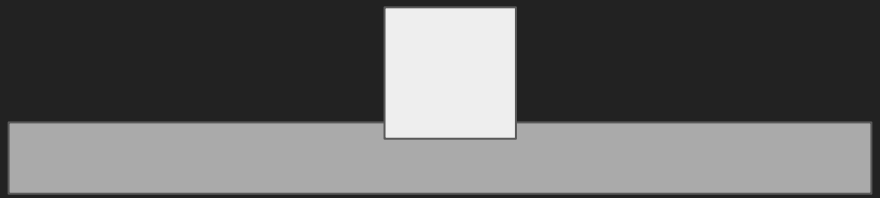
Review
Add platforms
Add collision detection

# We Got Stuck!

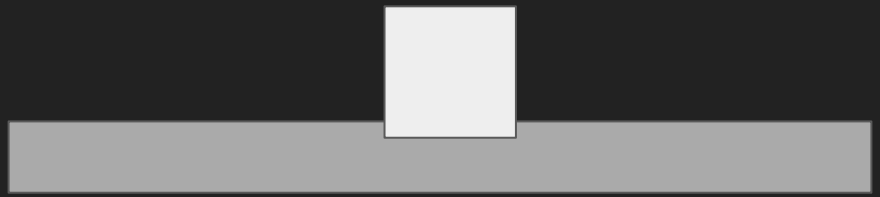
# Check for Overlap



# Check for Overlap



# Check for Overlap



```
float ydist = fabs(position.y - platform.position.y);
float penetrationY = fabs(ydist - height / 2 - platform.height / 2);
```

```
bool Entity::CheckCollision(Entity other)
{
    float xdist = fabs(position.x - other.position.x) - ((width + other.width) / 2.0f);
    float ydist = fabs(position.y - other.position.y) - ((height + other.height) / 2.0f);

    if (xdist < 0 && ydist < 0) return true;

    return false;
}

void Entity::Update(float deltaTime, Entity *platforms)
{
    velocity += acceleration * deltaTime;
    position += velocity * deltaTime;

    for (int i = 0; i < 4; i++)
    {
        if (CheckCollision(platforms[i]))
        {
            float ydist = fabs(position.y - platforms[i].position.y);
            float penetrationY = fabs(ydist - (height / 2) - (platforms[i].height / 2));

            if (position.y >= platforms[i].position.y) {
                position.y += penetrationY;
                if (velocity.y < 0) velocity.y = 0;
            } else {
                position.y -= penetrationY;
                if (velocity.y > 0) velocity.y = 0;
            }
        }
    }
}
```

# Let’s Code!

Update Collision Detection!
Add Jumping!
Add Moving!