Lecture 2

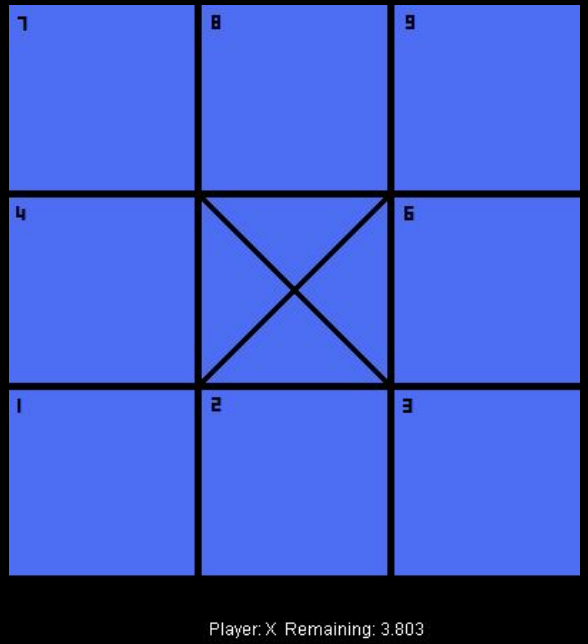
Announcements

Alchemy 1 is done!

- Initial feedback for Alchemy 1
  - Viewports are important – fix them now!
  - Panning/moving should be done on tick
  - Organize your projects well! If you're unsure about your design, talk to a TA
  - Keep our support code in a separate folder. Helps us grade.
- Next week your game will really start to take form!

Don’t Forget Tic

- Retries should all be returned
  - Please send us an email after you handin any retry
- A few more tips for the future…
  - Watch out for edge cases
  - Plan out game/engine separation before you start



Announcements

QUESTIONS?

Lecture 2

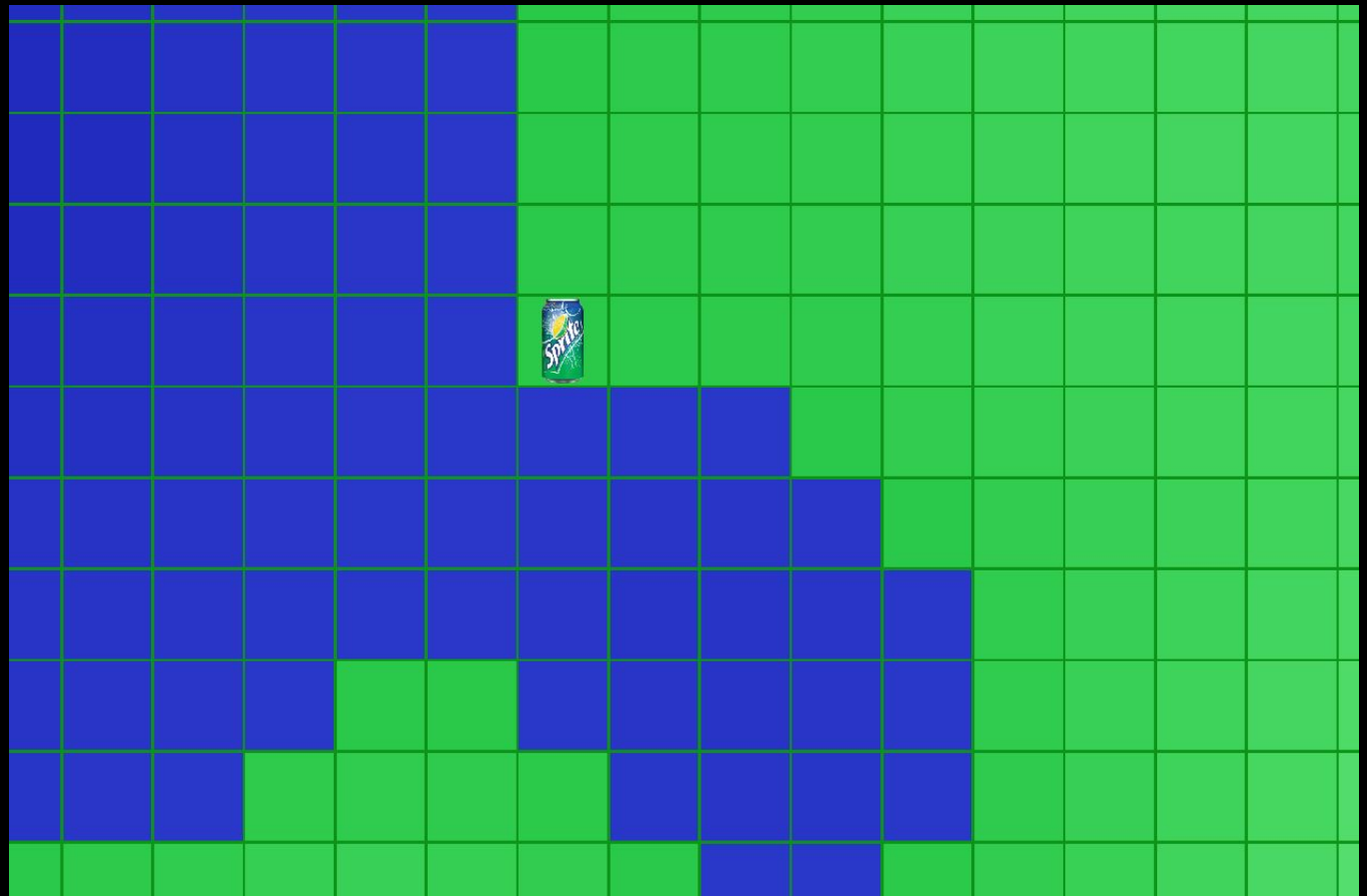
Hang in there!

Graphics II

Graphics II

WHAT'S A SPRITE?

THIS IS A SPRITE



Sprites as Bitmap Data

- “Raster” graphics
- Pre-constructed images dynamically placed on the screen
- Designed to represent one type of object in a game
  - Objects may reference different sprites depending on state

Sprites as Animation Data

- Sprites as a filmstrip
- Designed to represent frame-by-frame snapshots of a single game object
- Standardized padding, size, and spacing allows for easy drawing

Typical Sprite File Format

- Multiple sprites per file
- Additional information often (but not always) in config files:
  - Padding
  - Size
  - Locations of a particular object's sprites

Formatting “Standards”

Keep In Mind

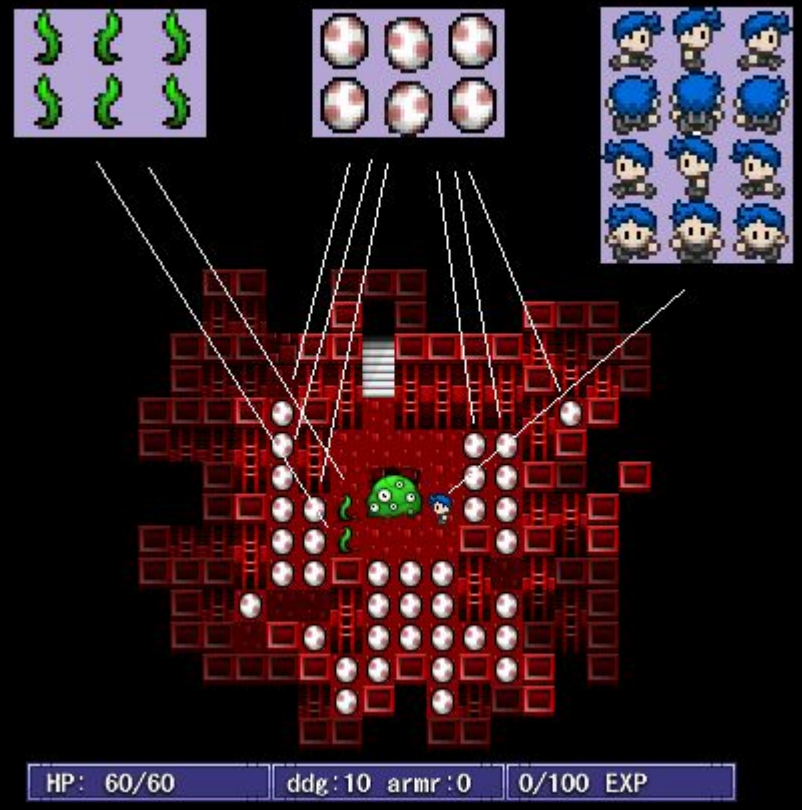
- Bounding box info and sprite info should be separate
- But keep in mind that they will need to coordinate with each other

Graphics II

IMPLEMENTING SPRITES

Sprite Loading

- You should only load a sprite sheet image once
  - Each behavior using the sprite maintains a reference to the sprite sheet
- Consider making a Resource class which loads in sprite sheets
  - Load in image
  - Handling image index for different sprites
  - Generalizable to other assets like maps, sounds, text, etc…



Drawing Sprites

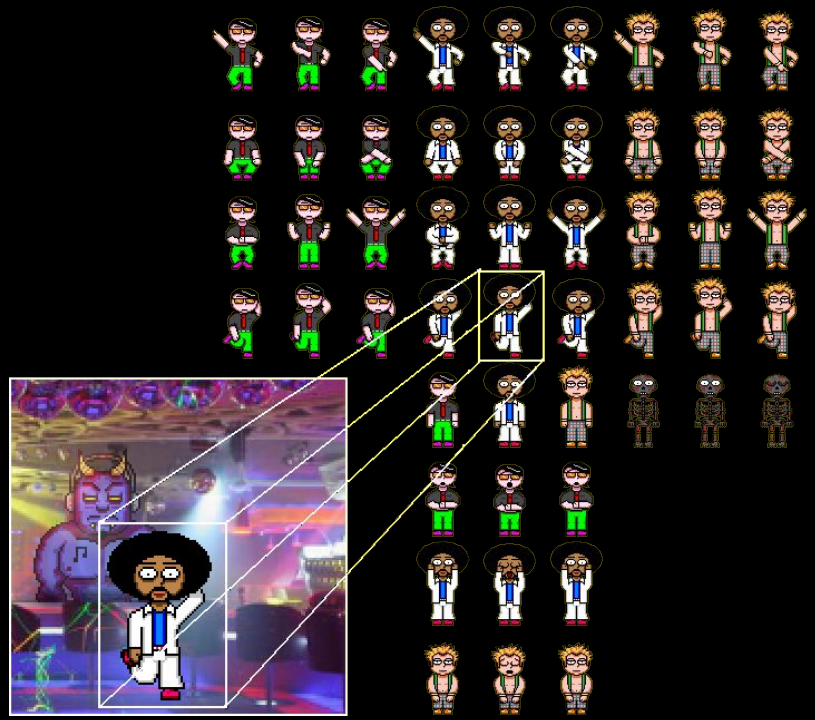
- About `g.drawImage(...)`
- Rare exception to the no JavaFX rule:
  - You're going to need to make a JavaFX image.
  - Pass the RELATIVE file path
- Your drawing routine should handle different padding and formats

Relative Paths

- For All Resource Files:
  - Don’t use absolute paths
  - “/gpfs/main/home/<login>/course/cs1971/tac/resources/spritesheet.png” is bad
  - “resources/spritesheet.png” is good
  - Absolute filepaths won’t work when we/your classmates try to test your game

Drawing Sprites

- Draw rectangular chunks from sprite sheet to the canvas
- Don’t cache sub images
  - It isn’t worth the space/time tradeoff
- Remember to draw from your single sprite sheet reference



SpriteBehavior

- Has a reference to sprite sheet resource
- Should implement `draw(GraphicsContext g)`
- Once it has a `GraphicsContext` object, it can draw itself

TransformBehavior

- Where should the SpriteBehavior draw the image?
- How big should the image be?
- TransformBehavior- stores a position and size
- The TransformBehavior is special
  - All game objects should have one, separate from their behavior list

Graphics II

QUESTIONS?

Lecture 2

Collision Detection

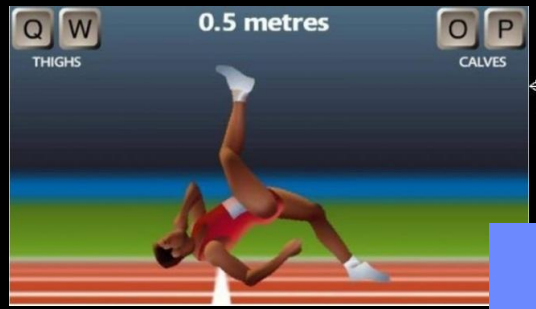
*It's possible that you might have a problem

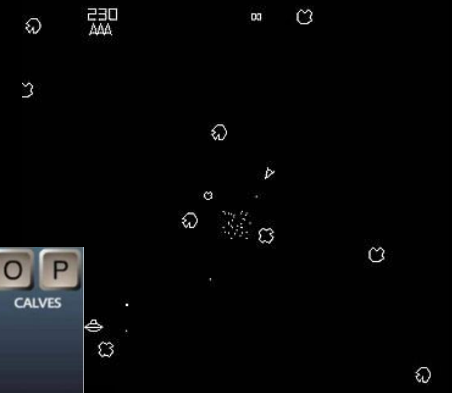
Collision Detection I

MOTIVATION

Collisions have consequences

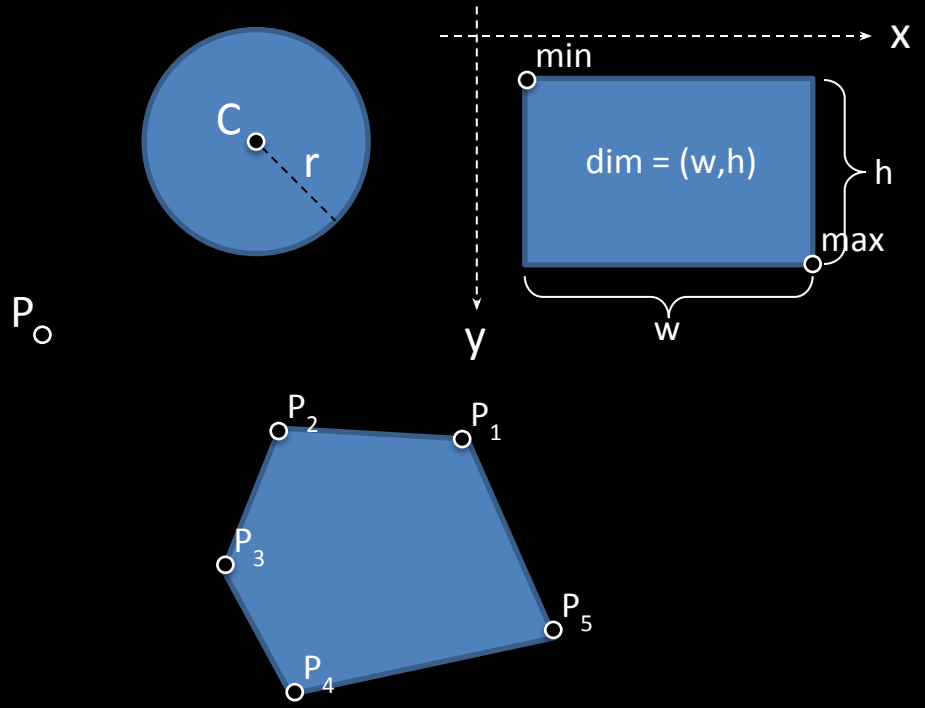
- Collision detection is central to the vast majority off games
- They're very important





What do we want to collide?

- Points
- Circles
- Axis-Aligned Boxes
- Convex polygons
  - Covered soon™
- Other shapes
  - Not covered

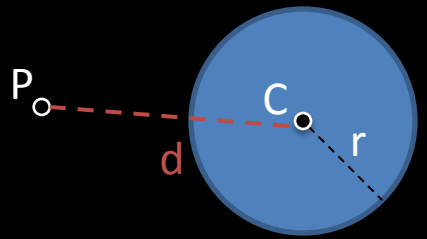


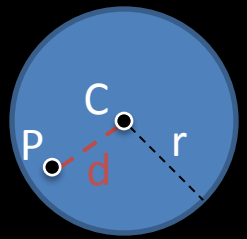
Collision Detection I

DETECTION ALGORITHMS

Point-Circle

- Check if the distance between the point and the center is less than or equal to the radius
- $||P - C||^2 \leq r^2$



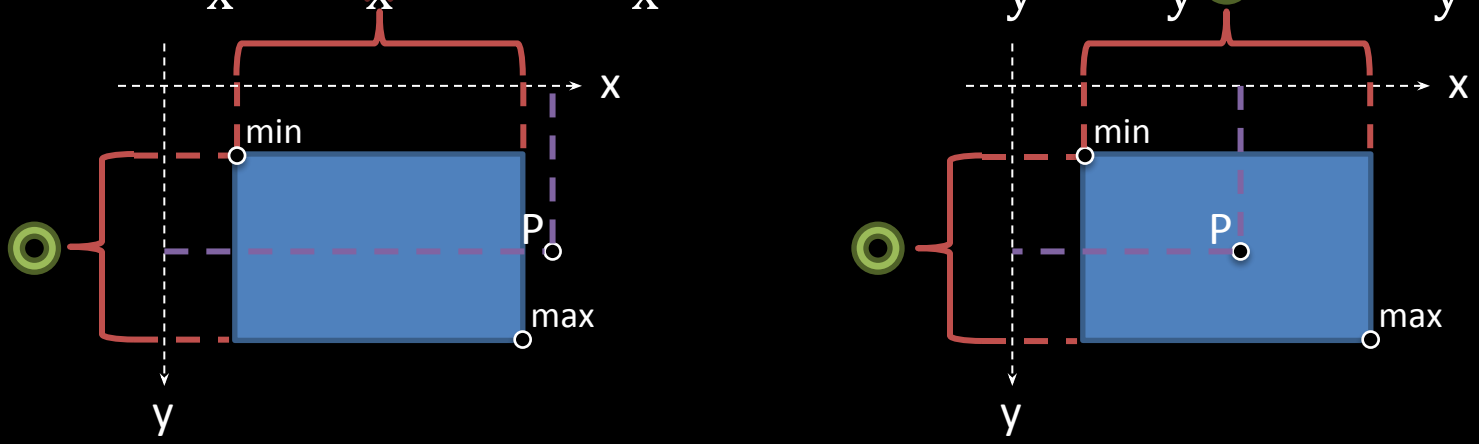


Circle-Circle

- Check if the distance between the two centers is less than or equal to the sum of the radii
- $||C_1 - C_2||^2 \leq (r_1 + r_2)^2$

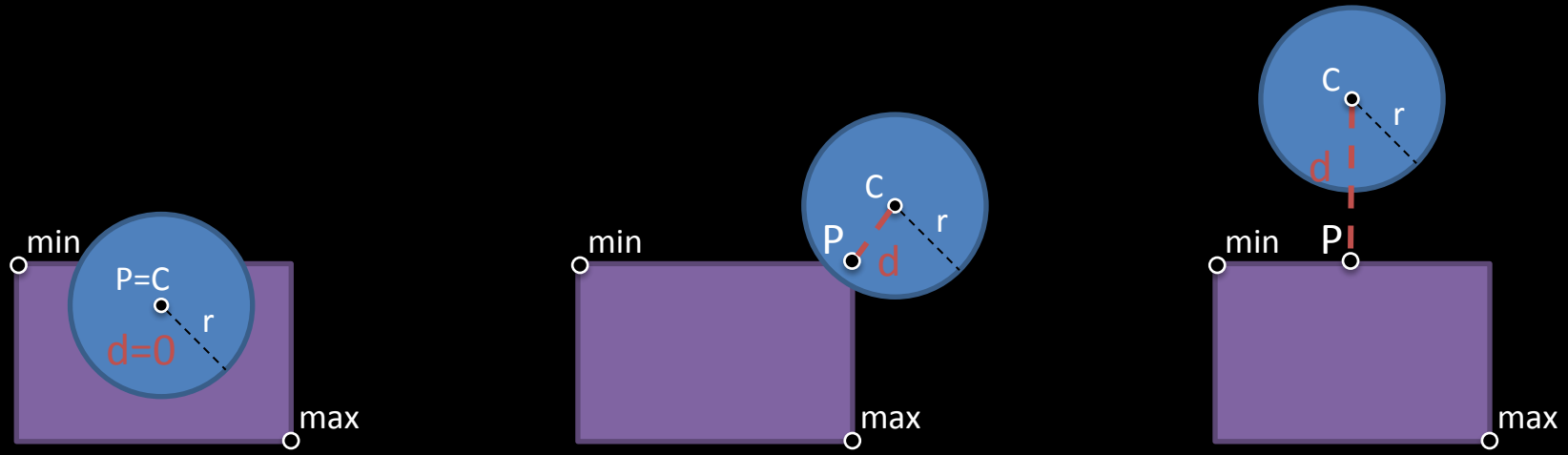
Point-AAB

- Check if the point is within range on each axis
- $\min_x \leq p_x \leq \max_x$ AND $\min_y \leq p_y \leq \max_y$



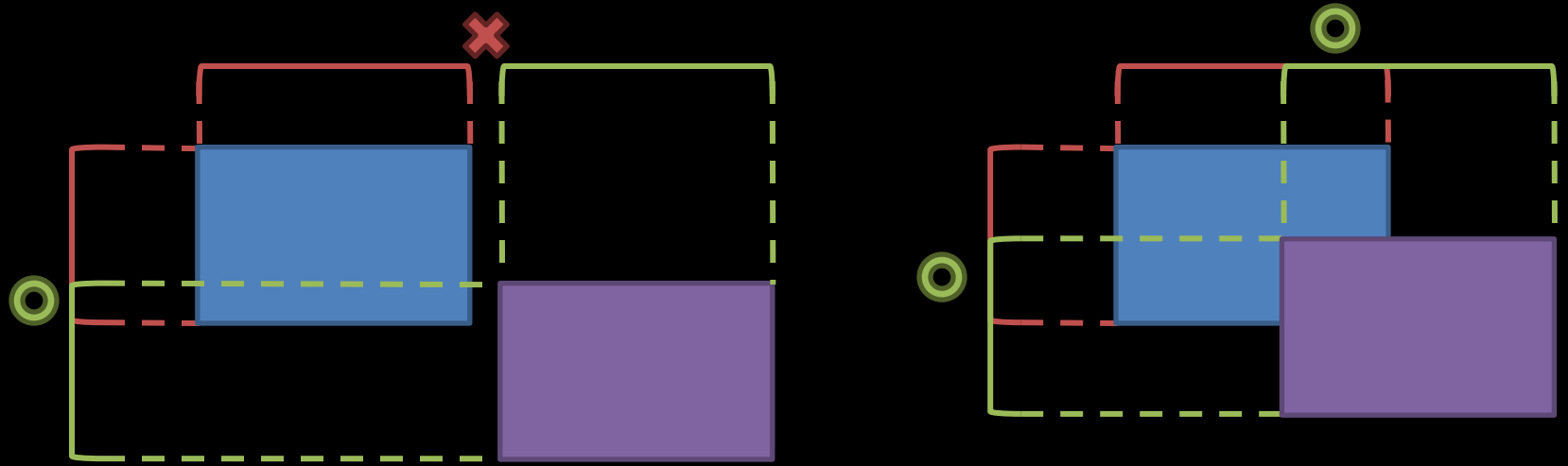
Circle-AAB

- Check if closest point to circle on AAB is in circle
  - Closest point: clamp C.x, C.y to [min.x, max.x], [min.y, max.y]
  - Then just do point-circle collision



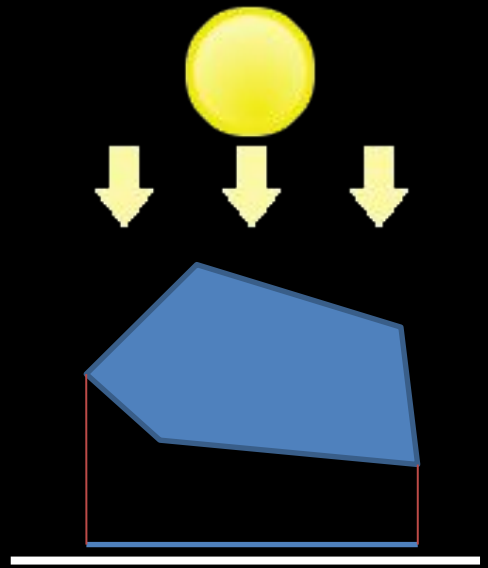
AAB-AAB

- Ensure overlap on each axis
- Project each box onto x and y axes
- Find all four `Interval`s, test for overlaps



Projection

- Imagine a light source with parallel rays
- Shape is between light source and axis
- “Shadow” cast on axis is shape’s projection onto that axis



Creating Projections

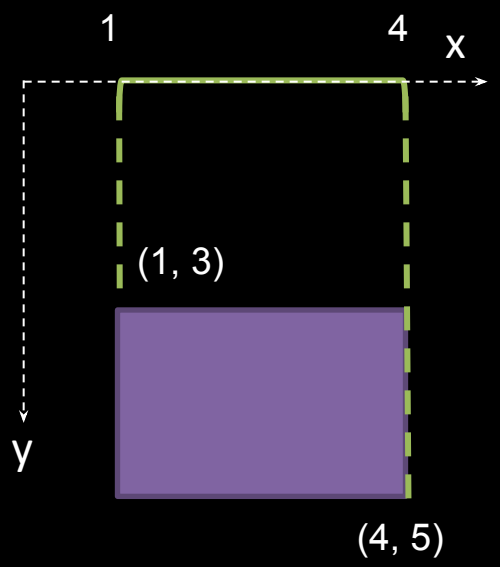
- Find the axis you want to project onto
  - This should be a normalized vector (length 1)
  - Vec2d has a normalize method
- x axis = Vec2d(1, 0)
- y axis = Vec2d(0, 1)

Creating Projections

- To project a point, take its dot product with the projection axis
  - `double p = point.dot(axis)`
  - Store `p` for later
- Vec2d has a dot product method

Creating Projections

- To project an AAB onto the x axis:
  - Project the top left and bottom right points onto the x axis
  - Store the two doubles in an `Interval`
  - The space between them on the x axis is the projection (shadow) of the AAB on the x axis



Projections ⇒ Collisions

- For each axis, check if the corresponding `Interval`s overlap
  - There should be two `Interval`s for each axis
- `Interval`s A and B overlap if and only if:
  - A min ≤ B max AND B min ≤ A max
- If both axes overlap, the shapes are colliding

Interval Class

- Stores two projections

```
public final class Interval {
    private double min;
    private double max;
    public bool overlap (Interval other)
}
```

Collision Detection I

COLLISION BEHAVIOR

Shapes

- AAB and Circle classes inherit from the same abstract class
  - Shape attributes
  - Implement collision checks
    - Point collisions are only for the mouse; no separate class needed

Collision Behavior

- Contains collision information for a game object
- Holds the specific Shape for that GameObject

Collision System

- Keeps track of all game objects that can collide
- Loops through all pairs of registered objects
- Checks if each pair is colliding
- If there is a collision, both are notified- only go through each pair once

Expanded Contract

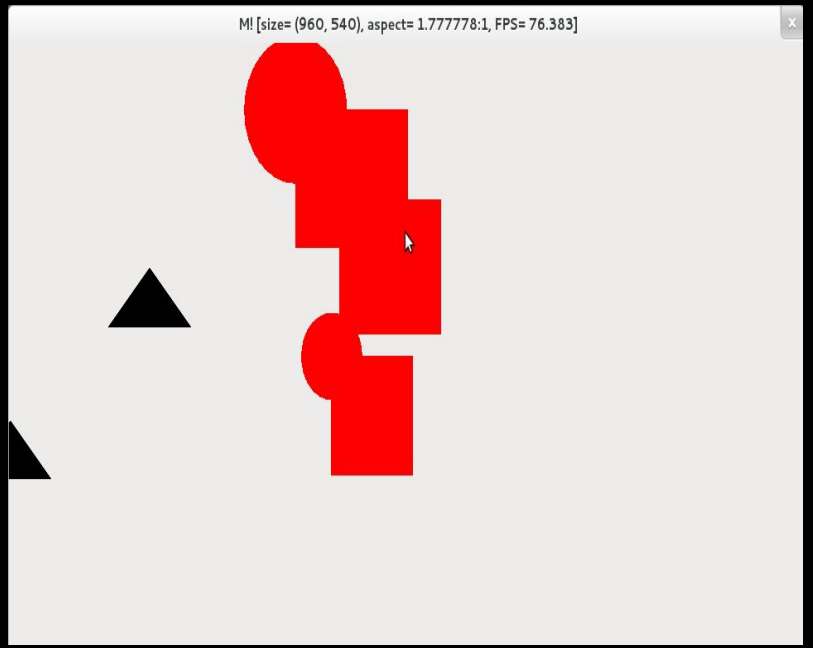
```
public void tick(long nanosSinceLastTick);
public void draw(Graphics2D g);
public void collide(GameObject o);
```

Collision Detection I

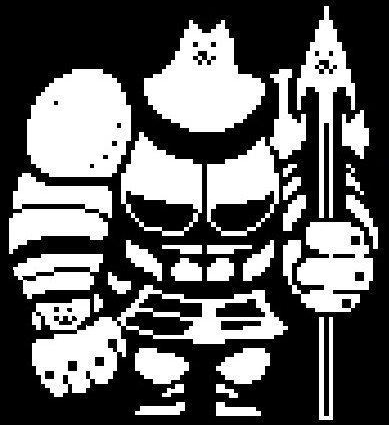
QUESTIONS?

Collision Debugger

- Easy way to test collisions
- Will give you stencil code
- You fill in the math



Lecture 2



Greater Dog.

Tips for Alchemy 2

Removing Units

- Beware the `ConcurrentModificationException`!
- Consider a removal queue
  - This can be generalized to multiple phases of ticks

```
/**
 * Cleans up the rectangles that a
 */
protected void purge() {
    for (Rect r : rects) {
        if (r.p2.y > 480) {
            rects.remove(r);
        }
    }
}
```

Sprites

- You'll need to have sprites in your game to make it pretty!
- Lots of sprites on the internet
- Stealing IP is fun and easy!
  - We do it every lecture
  - Be sure to call it fair use

Tips for Alchemy II

JAVA TIP OF THE WEEK

Double Dispatch

- If you have a `Circle` and an `AAB` but only know that they're `Shape`s, how do you determine which method to call?

```
void testCollide() {
     Shape s = new Circle();
     Shape s2 = new AAB();
     s.collides(s2);
}

interface Shape {
     collides(Circle c);
     collides(AAB aab);
     collides(Shape o);
}
```

```
boolean collides(Shape o) {
     if (o instanceof Circle) {
          return collides((Circle) o);
     } else if (o instanceof AAB) {
          return collides((AAB) o);
     } else {
          throw new IllegalArgumentException();
     }
}
```

Double Dispatch

```
interface Shape {
     collides(Shape o);
     collidesCircle(Circle c);
     collidesAAB(AAB aab);
}

public class Circle implements Shape {
     collides(Shape o) {
          return o.collidesCircle(this);
     }
     collidesCircle(Circle c) { /*code*/ }
     collidesAAB(AAB aab) { /*code*/ }
}
```

```
public class AAB implements Shape {
     collides(Shape o) {
          return o.collidesAAB(this);
     }
     collidesCircle(Circle c) { /*code*/ }
     collidesAAB(AAB aab) { /*code*/ }
}
```

Anonymous Methods

- Essentially an in-line class/interface
- All anonymous methods are inner classes
  - And therefore have a reference to the instance that creates them

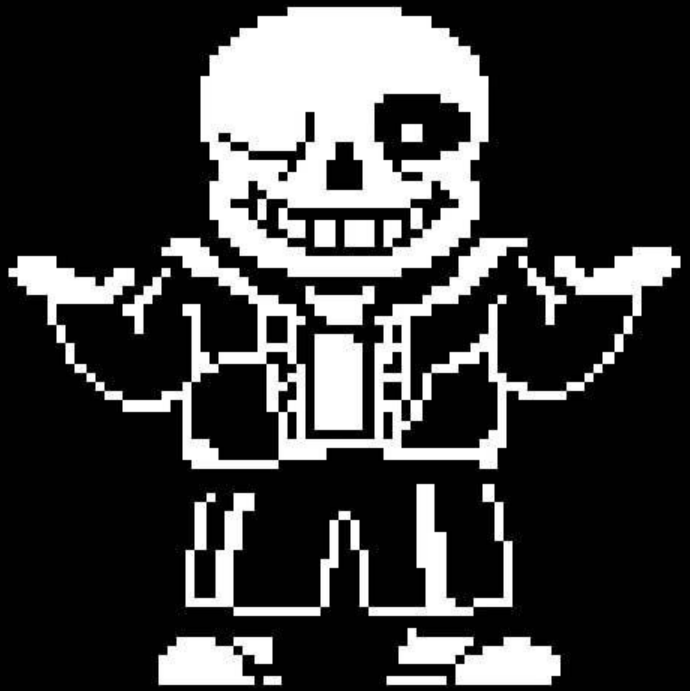
```
interface KeyHandler {
    public void onKeyPressed(KeyEvent e);
}

void addKeyHandler(KeyHandler h) {
    /*code*/
}

void init() {
    obj.addKeyHandler(e -> {
          /*code*/
     });
}
```

Tips for Alc II

QUESTIONS?

Game Design 1

Intro to Game Design



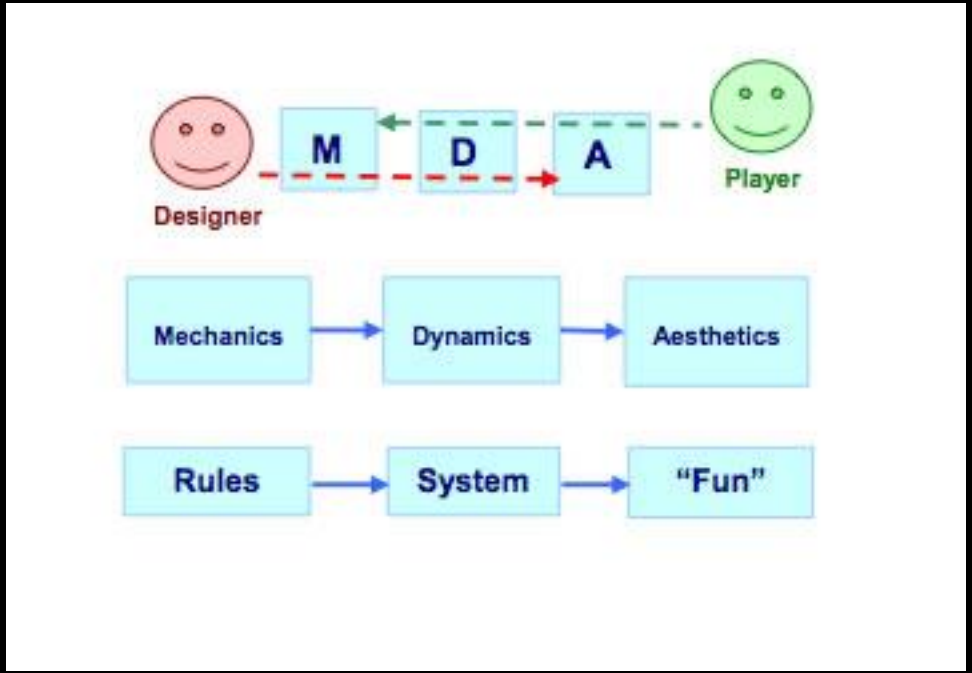
What is a game designer?

- A game designer creates the experience and the “feel,” and is not just a programmer
- Games are a delivery system for your ideas

Compared to other media

- Designers of movies, books, and plays are creating a linear experience
- Interactivity is the defining feature of video games as a medium of entertainment

MDA Framework



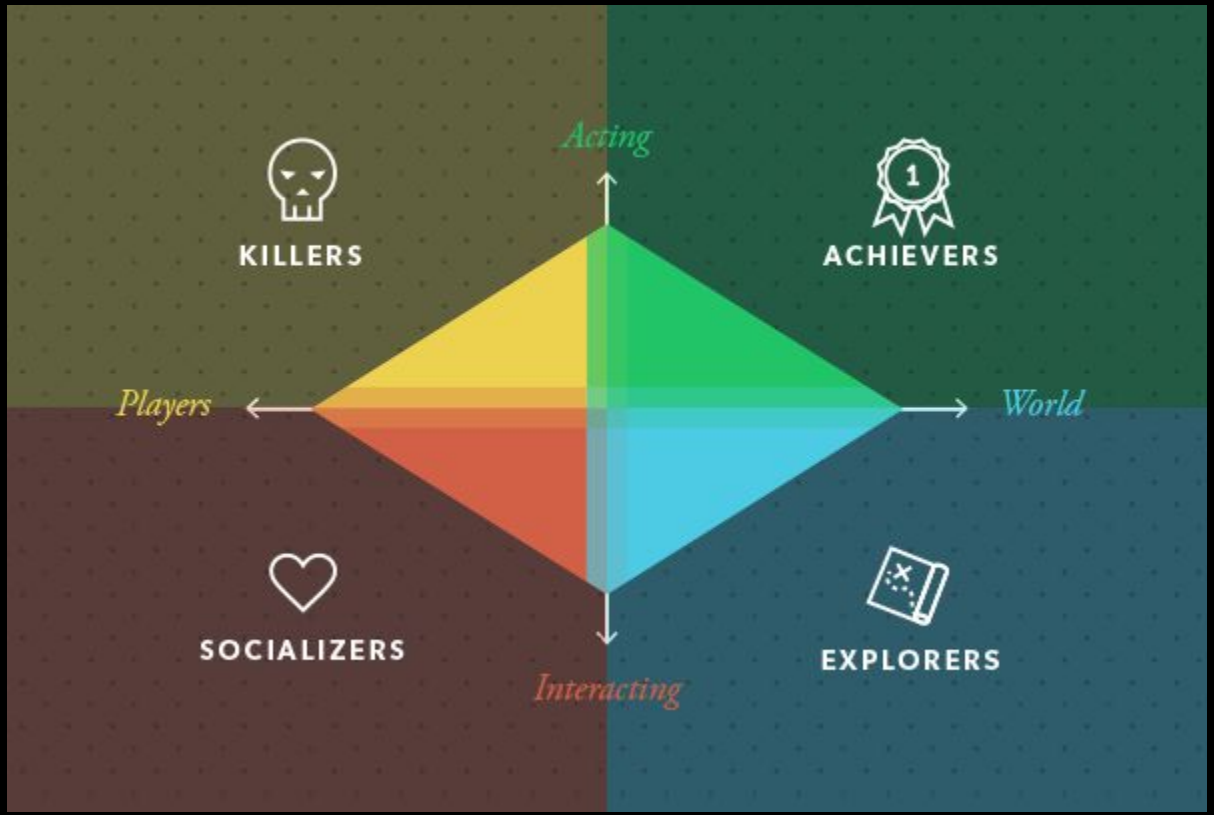
Where to begin?

- Approach from the player's perspective
  - What aesthetics do you want your game to have?
  - What do you want your players to feel?
- Create a basic idea that encapsulates those aesthetics
- Come up with dynamics that evoke the aesthetics
- First and foremost: know your audience!
  - Sunlab users? Competitive MOBA veterans? Kids?
  - Kids in the SunLab playing competitive MOBAs?

Further References

- Extra Credits: Playing Like a Designer
  - https://www.youtube.com/watch?v=_HmtmoGwpZc
  - https://www.youtube.com/watch?v=QKEzMz6FcXs
- MDA: A Formal Approach to Game Design
  - http://www.cs.northwestern.edu/~hunicke/MDA.pdf

Bartle's Taxonomy of Player Types



Further References

- Extra Credits: Bartle's Taxonomy
  - https://www.youtube.com/watch?v=yxpW2ltDNow
- Gamasutra (articles and news about game dev)
  - http://www.gamasutra.com

How to become a better designer?

- At Brown…
  - Make games, play games, come to BRGD
- Play lots of games!

Alchemy 1 Playtesting

yay!