Graphics
The Plan

- Hardware
- Coordinate System
- Built-in Shapes
- User-defined Shapes
- Sprites and Shapes
- Making a Sprite
Hardware

- **Monitor**
  - Resolutions (640x480, 800x600, 1280x1024)
  - Bit depth (8, 15, 16, 24, 32)
  - Refresh rate (75-85 Hz)

- **Video Card**
  - Assists monitor
  - Optimizes graphics
Coordinate Systems

- Cartesian
- Polar
- Screen (Graphics)
- Java 2D (Graphics2D)
Coordinate Systems

- **Cartesian**
  - Rectangular
  - X increases to the right
  - Y increases as you go up
  - Origin typically at center
  - Real valued
Coordinate Systems

- **Polar**
  - $r$ increases as distance from the origin increases
  - $\theta$ increases in the counterclockwise direction
  - Grid lines make concentric circles and sectors
  - Origin typically at center
  - $r$ is real valued
  - $\theta$ is from 0 to $2\pi$
Coordinate Systems

- **Conversion between Cartesian and Polar**
  - \([x, y] = [r\cos(\theta), r\sin(\theta)]\)
  - \(r = \sqrt{x^2 + y^2}\)
  - \(\theta = \arccos\left(\frac{x}{r}\right)\) if \(y > 0\)
  - \(\theta = -\arccos\left(\frac{x}{r}\right)\) if \(y \leq 0\)
  - No need to memorize this, but you may see it in the code
Coordinate Systems

- **Screen (Graphics)**
  - Rectangular
  - $X$ increases to the right
  - $Y$ increases as you go down
  - Origin at upper left
  - Non-negative integer valued

```
0   x

y
```
Coordinate Systems

- **Java 2D (Graphics2D)**
  - Rectangular
  - X increases to the right
  - Y increases as you go **down**
  - Origin at upper left
  - Real valued (approximated)
Coordinate Systems

- **Java2D to Screen conversion**
  - Simple – round the floating point to an integer (or just truncate)

- **Screen to Java2D conversion**
  - None needed because integers are approximated by reals
Coordinate Systems

Why use Java2D coordinate system?

- Smoother motion
- Integer values often need to be rounded which can lead to more calculation error
- Simpler to rotate and expand
Built-in Shapes

In `java.awt.geom` package

- `Ellipse2D.Double`
- `Rectangle2D.Double`
- `RoundRectangle2D.Double`
- All constructed with `(x, y, width, height)`
- What about circles and squares?
User-defined Shapes

Also in java.awt.geom

- **GeneralPath**
  - Lines
  - Curves
    - Quadratic
    - Cubic
  - Can be transformed via AffineTransform

- **Area**
  - Constructive Area Geometry
  - Useful tool for finding intersections
Shapes

All classes so far are all Shapes

- Can draw them using a Graphics2D
- Can get boundary information
- Can be used to make a Sprite...
Sprites and Shapes

Sprites have

- Size
- Shape
- Orientation
- Location
- Color
- Optionally a Tracker
Making a Sprite

How to make a Sprite:

1. Extend Sprite
2. In the constructor
   a. Call super()
   b. Make any Shape
   c. Call setShape(yourShape)
Making a Sprite

```java
package tipgame.game.test.sprite;

import java.awt.geom.*;

public class SquareSprite
      extends Sprite
{
    public SquareSprite()
    {
        super();
        Rectangle2D.Double rectangle;
        rectangle=new Rectangle2D.Double(0, 0, 1, 1);
        setShape(rectangle);
    }
}
```

How to make a Sprite:
1. Extend Sprite
2. In the constructor
   a.   Call super()
   b.   Make any Shape
   c.   Call
        setShape(yourShape)
Making a Sprite

See the video game engine web site for the source code examples that follow

http://www.cs.duke.edu/~cjj1/professional/tipgame/
Making a Sprite

In the constructor of LightSprite:

```java
super();
Area area=new Area();
Rectangle2D.Double box=new Rectangle2D.Double(0, 0, 0.2, 0.6);
area.add(new Area(box));
Ellipse2D.Double circle=new Ellipse2D.Double(0.02, 0.02, 0.16, 0.16);
area.subtract(new Area(circle));
circle=new Ellipse2D.Double(0.02, 0.22, 0.16, 0.16);
area.subtract(new Area(circle));
circle=new Ellipse2D.Double(0.02, 0.42, 0.16, 0.16);
area.subtract(new Area(circle));
setShape(area);
```

❖ What does this look like?
Making a Sprite

In the constructor of TriangleSprite:

```java
super();
GeneralPath path=new GeneralPath();
path.moveTo(0.0f, 0.0f);
path.lineTo(1.0f, (float)Math.sqrt(3));
path.lineTo(-1.0f, (float)Math.sqrt(3));
path.closePath();
setShape(path);
```

❖ How could you make a space ship shape?