Useless Fact of the Day

- You could stuff 1,300 Earths into Jupiter, and about 1,000,000 Earths into the Sun.
- At the equator, the Earth’s surface is rotating at 1,532 feet per second (about 1,000 miles per hour). Earth is also zooming in its orbit around the sun at over 18 miles per second.

Hardware

- Monitor
- **Pixels** (square)
- Common resolutions: 640x480 (in the 1990s), 800x600, 1024x768, 1280x1024
- Ratio of 1 and 1/3
- Widescreen Resolutions normally have a ratio of 1.6
- “Golden Ratio” is about 1.618033989
- The “most aesthetically pleasing rectangle” is the golden rectangle

Topics

- Graphics Hardware
- Coordinate Systems
- Shapes
- GeneralPath and CAG
Hardware

- Monitor
  - **Bit depth**: how many bits are used to code for the color of each pixel?
    - Common: 8, 15, 16, 24, 32
    - # of colors possible: $2^{16}$
      - 8-bit: 256; 16-bit: 65536; 24-bit: 16.7 million
    - 32-bit is really 24-bits for colors and 8 bits for an alpha channel (for transparency)
  - **Refresh rate**: how many times per second does the monitor redraw the screen?
    - Common: 75-85 Hz

Coordinate Systems

- Cartesian - real-valued
- Polar - real-valued
- Screen - integer-valued
- FANG Engine - real-valued

Shapes

- Built-in to the java.awt.geom package:
  - Ellipse2D.Double
  - Rectangle2D.Double (a.k.a. Rectangle)
  - RoundRectangle2D.Double
  - All constructed with (x, y, width, height)

FANG Engine Coordinates

- The FANG Engine has a frame rate of about 24 frames per second (same as a movie projector)
- FANG Engine stores location and size in fractions of the canvas width/height
- This allows for sub-pixel accuracy in position
- Why is that important?
  - If we stored position with only integer pixels (no fractions of pixels), the slowest an object could move is 1 pixel per frame (which means the object would take 20 seconds to traverse the height of a 480-pixel canvas)
  - But what if you wanted an Unnecessarily Slow Moving Dipping Mechanism?
  - Also reduces round-off error, and it is simpler to do calculations (scaling/rotation/movement) with floating-point numbers than integers
Shapes

- User-defined Shape-making classes (also in java.awt.geom):
  - GeneralPath
  - Lines
  - Curves (Quadratic and Cubic)
  - Area
  - Constructive Area Geometry (CAG)

GeneralPath Example

- Making a triangle:
  ```java
  GeneralPath path = new GeneralPath();
  path.moveTo(0.0, 0.0);
  path.lineTo(1.0, Math.sqrt(3));
  path.lineTo(-1.0, Math.sqrt(3));
  path.closePath();
  ```

- Making a Sprite with the triangle:
  ```java
  Sprite triangleSprite;
  triangleSprite = new Sprite(path);
  ```

Constructive Area Geometry (CAG) Example

- Making a rectangle with three holes in it:
  ```java
  Area area = new Area();
  Rectangle box = new Rectangle(0, 0, 20, 60);
  area.add(new Area(box));
  Ellipse2D.Double circle = new Ellipse2D.Double(2, 2, 16, 16);
  area.subtract(new Area(circle));
  Ellipse2D.Double circle = new Ellipse2D.Double(2, 22, 16, 16);
  area.subtract(new Area(circle));
  Ellipse2D.Double circle = new Ellipse2D.Double(2, 42, 16, 16);
  area.subtract(new Area(circle));

  Sprite trafficLightSprite;
  trafficLightSprite = new Sprite(area);
  ```