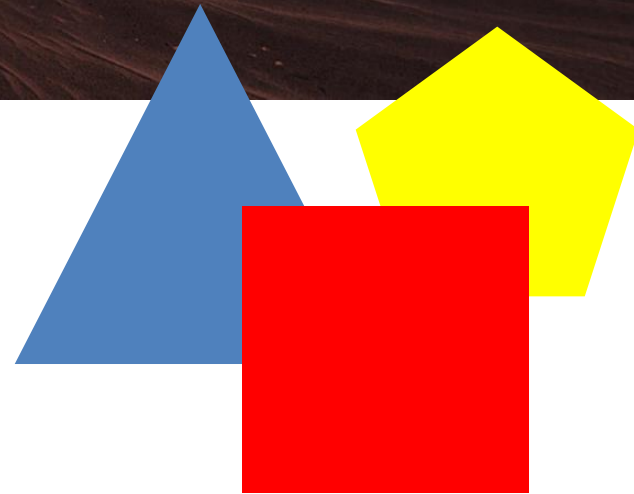
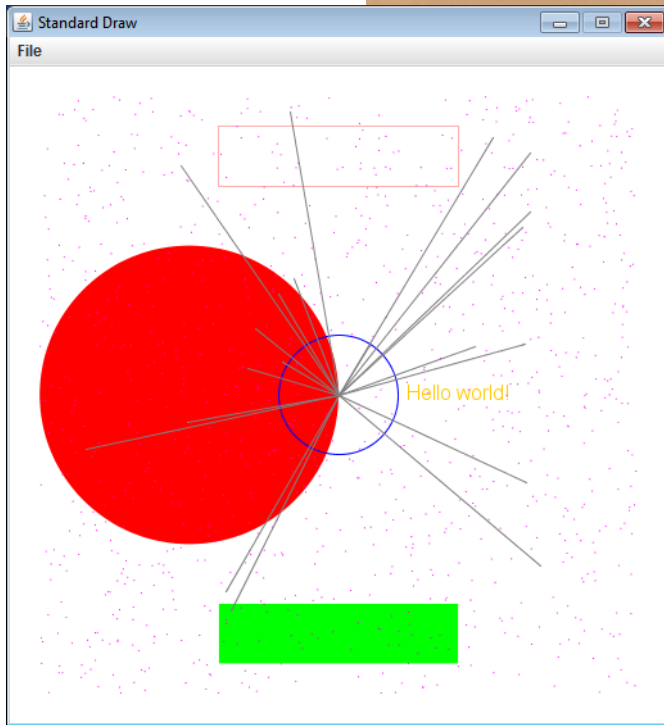
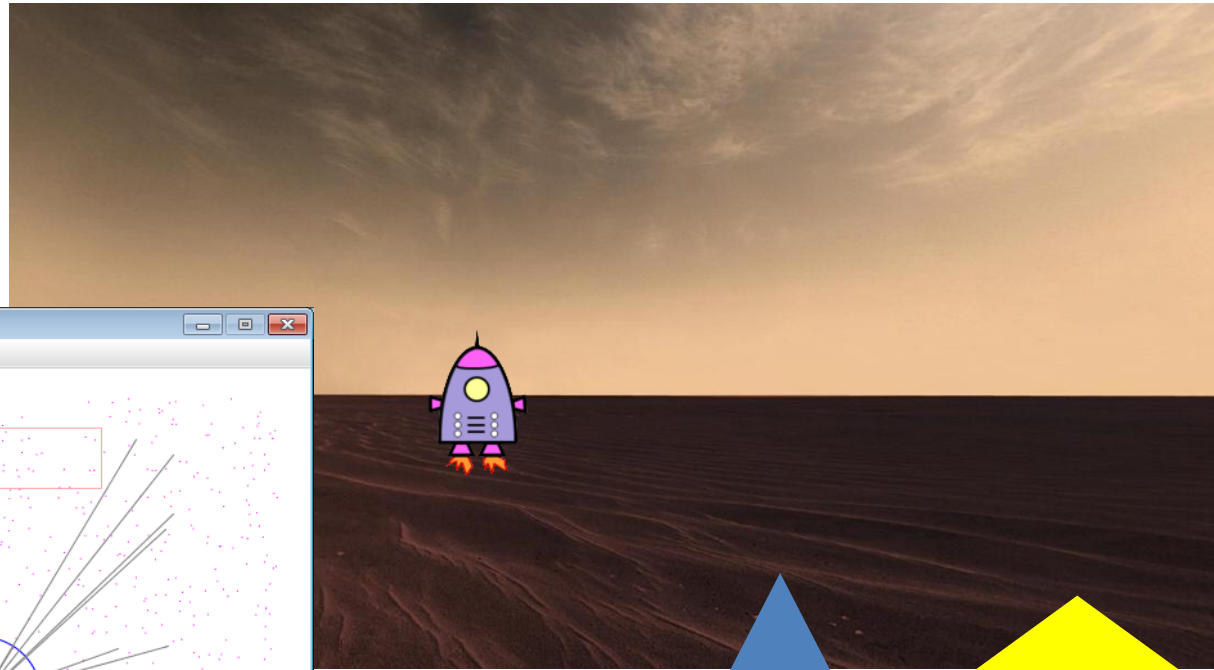


# Graphics and sound



# Input and output thus far

- Input

- Parsing **command line arguments**
- **Reading from a file** using standard input
- **Reading text typed** by a user

- Output

- **Display text to console**

```
Level: 0
. . ! . . . . .
. . . . . . . .
. . . . . . . .
. . . . . . . .
. . . . * . . . .
. . . . . . . .
. . . . . . . .
. . . . . . . .
. . . . . . . .
. . . . . . . #
Direction? s
You walked south
Zombie went east
```

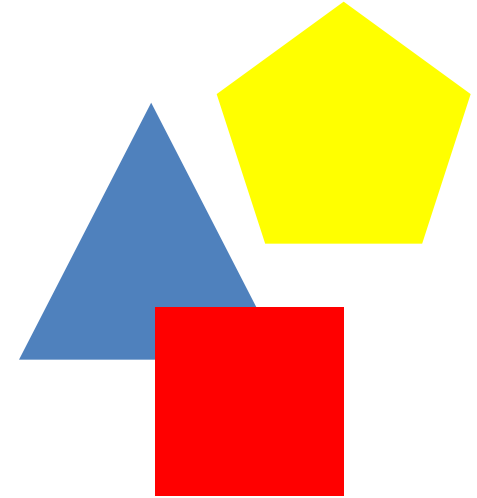
# New input/output capabilities

- **StdDraw**

- Draw shapes and images
- Make animated programs
- Get real-time keyboard input

- **StdAudio**

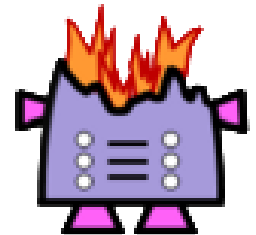
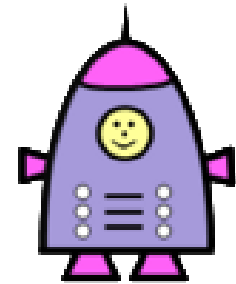
- Playback of record sounds
- Generate your own sounds



# StdDraw overview

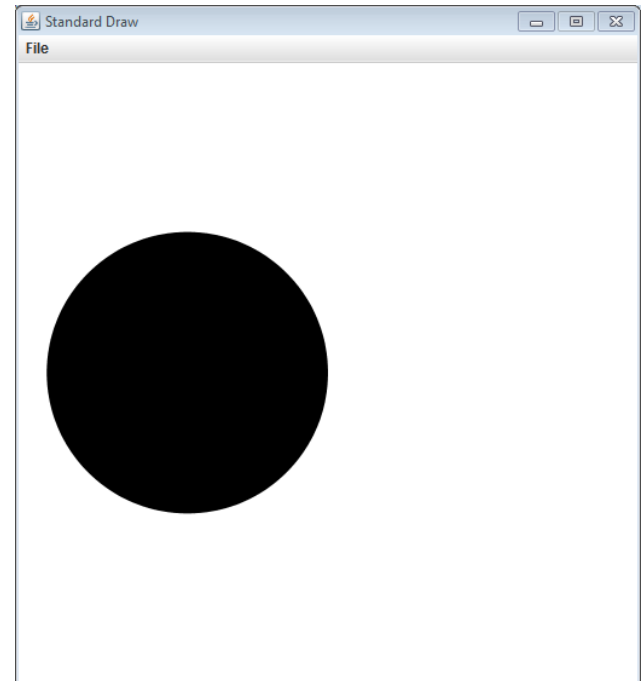
- StdDraw

- Like StdIn, we'll use another class: **StdDraw**
- Put **StdDraw.java** in **directory** with your program
- Draw simple things:
  - Rectangles, circles, lines, polygons, text
  - Make them different colors
- Draw images loaded from a file:
  - e.g. spaceship, Mars background, etc.
- Animate things:
  - e.g. bouncing ball, video games



# Hello drawing!

```
public class HelloDraw
{
    public static void main(String [] args)
    {
        StdDraw.filledCircle(0.25, 0.5, 0.25);
    }
}
```



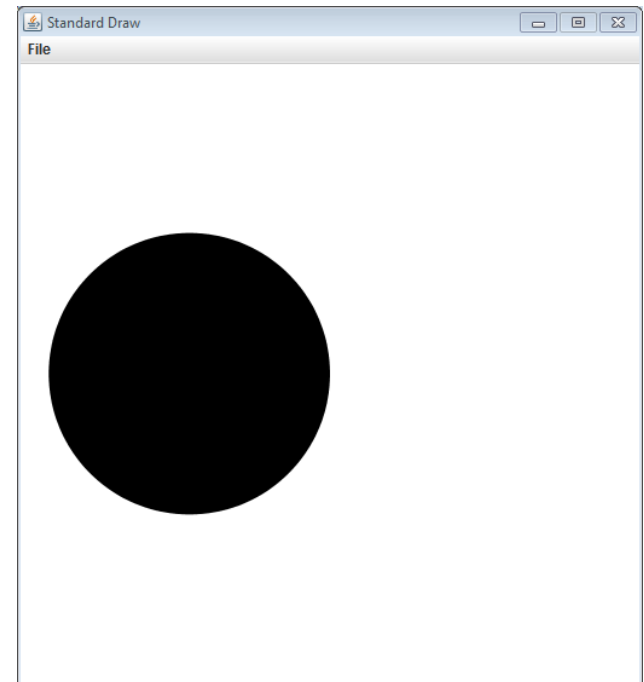
# Arguments to `filledCircle()`

```
public class HelloDraw
{
    public static void main(String [] args)
    {
        StdDraw.filledCircle(0.25, 0.5, 0.25);
    }
}
```

Put the circle at x  
coordinate 0.25

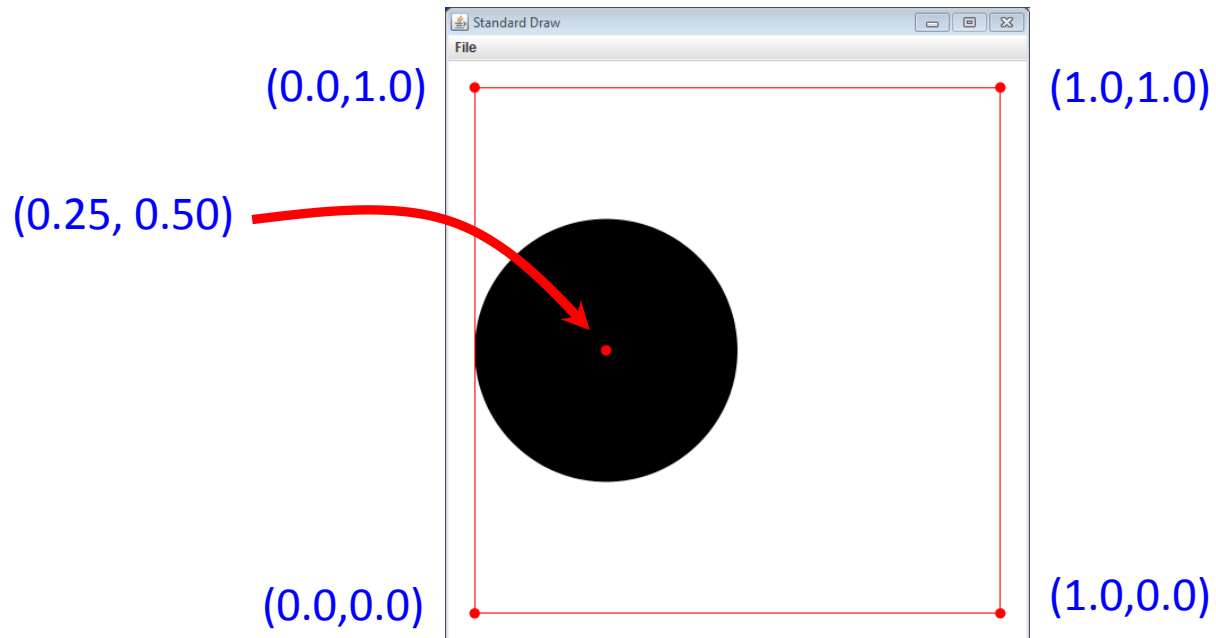
Put the circle at y  
coordinate 0.5

Make the circle be  
of radius 0.25



# Default coordinate system

```
public class HelloDraw
{
    public static void main(String [] args)
    {
        StdDraw.filledCircle(0.25, 0.5, 0.25);
    }
}
```



# Other shapes and text

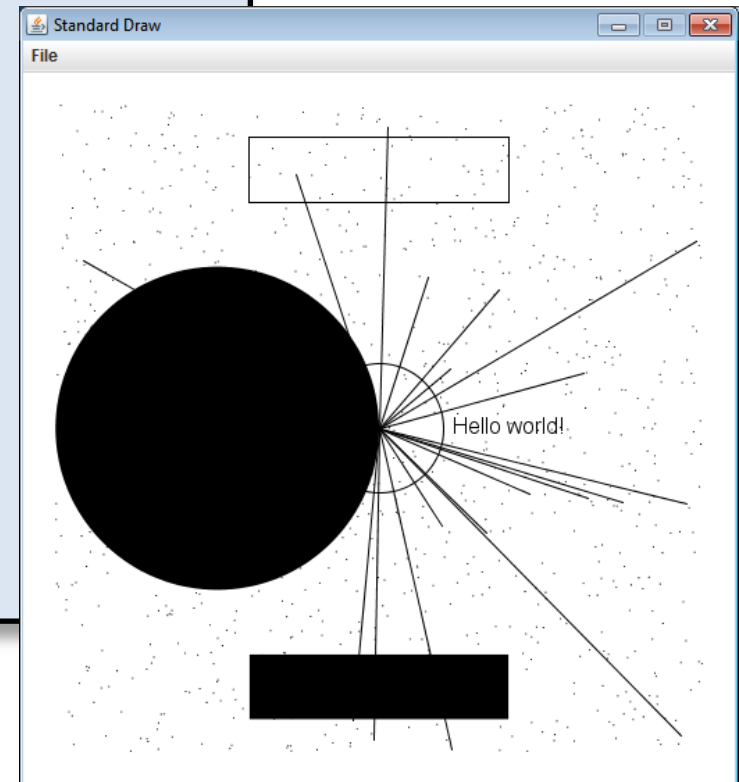
```
public class DrawShapes
{
    public static void main(String [] args)
    {
        StdDraw.filledCircle(0.25, 0.5, 0.25);
        StdDraw.circle(0.5, 0.5, 0.1);

        StdDraw.filledRectangle(0.5, 0.1, 0.2, 0.05);
        StdDraw.rectangle(0.5, 0.9, 0.2, 0.05);

        StdDraw.text(0.7, 0.5, "Hello world!");

        for (int i = 0; i < 1000; i++)
            StdDraw.point(Math.random(),
                          Math.random());

        for (int i = 0; i < 20; i++)
            StdDraw.Line(0.5,
                        0.5,
                        Math.random(),
                        Math.random());
    }
}
```





# Adding color

```
public class DrawShapesColor
{
    public static void main(String [] args)
    {
        StdDraw.setPenColor(StdDraw.RED);
        StdDraw.filledCircle(0.25, 0.5, 0.25);
        StdDraw.setPenColor(StdDraw.BLUE);
        StdDraw.circle(0.5, 0.5, 0.1);

        StdDraw.setPenColor(StdDraw.GREEN);
        StdDraw.filledRectangle(0.5, 0.1, 0.2, 0.05);
        StdDraw.setPenColor(StdDraw.PINK);
        StdDraw.rectangle(0.5, 0.9, 0.2, 0.05);

        StdDraw.setPenColor(StdDraw.ORANGE);
        StdDraw.text(0.7, 0.5, "Hello world!");

        StdDraw.setPenColor(StdDraw.MAGENTA);
        for (int i = 0; i < 1000; i++)
            StdDraw.point(Math.random(), Math.random());

        StdDraw.setPenColor(StdDraw.GRAY);
        for (int i = 0; i < 20; i++)
            StdDraw.line(0.5, 0.5, Math.random(), Math.random());
    }
}
```

```
StdDraw.BLACK
StdDraw.BLUE
StdDraw.CYAN
StdDraw.DARK_GRAY
StdDraw.GRAY
StdDraw.GREEN
StdDraw.LIGHT_GRAY
StdDraw.MEGENTA
StdDraw.ORANGE
StdDraw.PINK
StdDraw.RED
StdDraw.WHITE
StdDraw.YELLOW
```

# Adding color

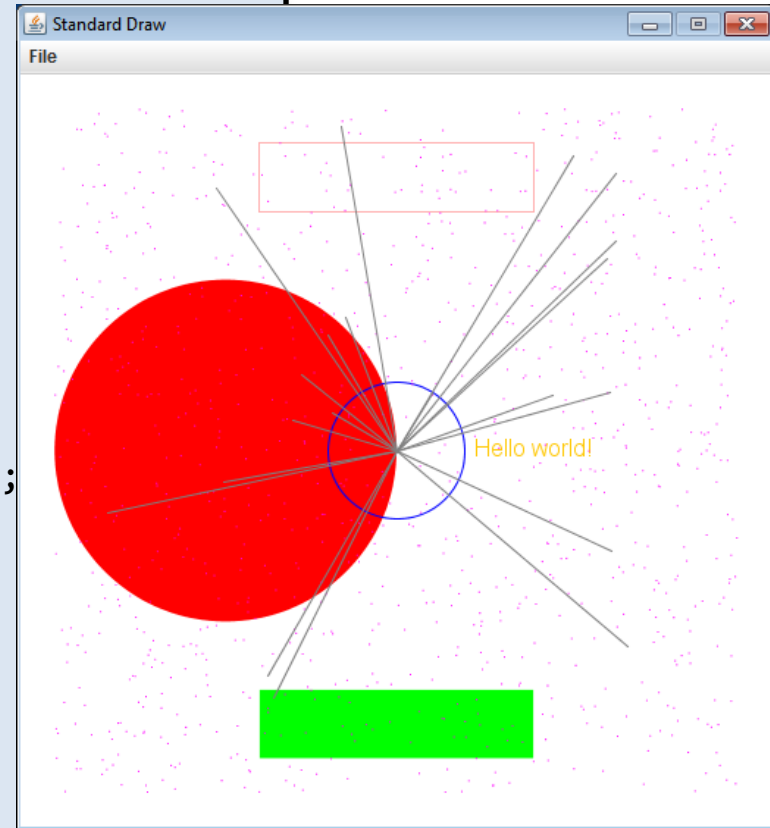
```
public class DrawShapesColor
{
    public static void main(String [] args)
    {
        StdDraw.setPenColor(StdDraw.RED);
        StdDraw.filledCircle(0.25, 0.5, 0.25);
        StdDraw.setPenColor(StdDraw.BLUE);
        StdDraw.circle(0.5, 0.5, 0.1);

        StdDraw.setPenColor(StdDraw.GREEN);
        StdDraw.filledRectangle(0.5, 0.1, 0.2, 0.05);
        StdDraw.setPenColor(StdDraw.PINK);
        StdDraw.rectangle(0.5, 0.9, 0.2, 0.05);

        StdDraw.setPenColor(StdDraw.ORANGE);
        StdDraw.text(0.7, 0.5, "Hello world!");

        StdDraw.setPenColor(StdDraw.MAGENTA);
        for (int i = 0; i < 1000; i++)
            StdDraw.point(Math.random(), Math.random());

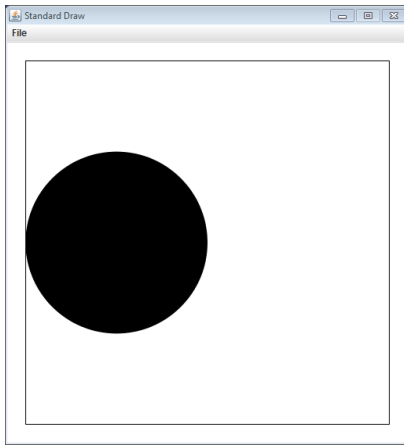
        StdDraw.setPenColor(StdDraw.GRAY);
        for (int i = 0; i < 20; i++)
            StdDraw.line(0.5, 0.5, Math.random(), Math.random());
    }
}
```



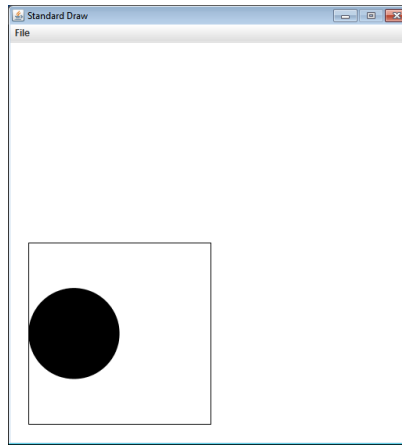
# Changing coordinate size

- Often convenient to use different coordinates
  - 0.0 to 1.0 is default x-size and y-size
  - Change x-size `StdDraw.setXscale(double min, double max)`
  - Change y-size `StdDraw.setYscale(double min, double max)`

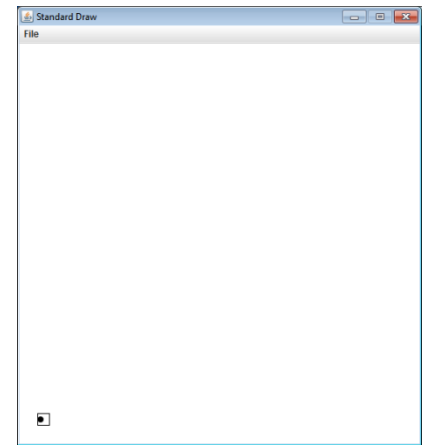
```
StdDraw.filledCircle(0.25, 0.5, 0.25);  
StdDraw.rectangle(0.5, 0.5, 0.5, 0.5);
```



```
StdDraw.setXScale(0.0, 1.0);  
StdDraw.setYScale(0.0, 1.0);
```



```
StdDraw.setXScale(0.0, 2.0);  
StdDraw.setYScale(0.0, 2.0);
```



```
StdDraw.setXScale(0.0, 30.0);  
StdDraw.setYScale(0.0, 30.0);
```

# Drawing images

- Loading image from file
  - Supports various formats such as JPG and PNG
  - Put image files in same directory with program
  - `StdDraw.picture(double x, double y, String filename)`

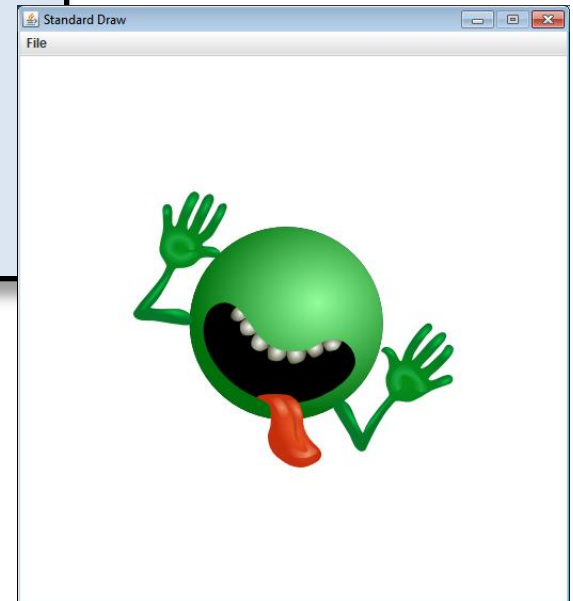
```
public class DrawImage
{
    public static void main(String [] args)
    {
        StdDraw.picture(0.5, 0.5, args[0]);
    }
}
```

# Drawing images

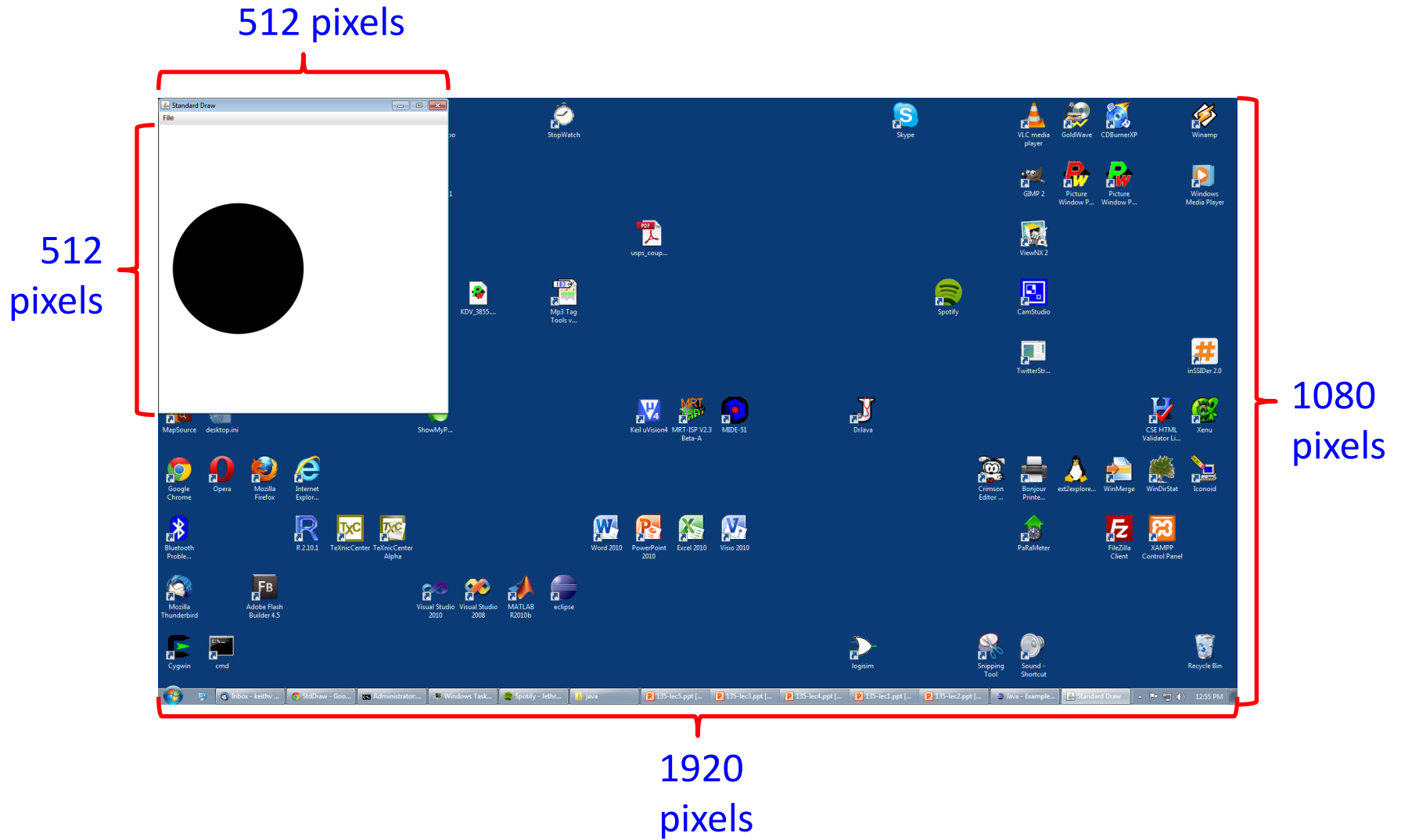
- Loading image from file
  - Supports various formats such as JPG and PNG
  - Put image files in same directory with program
  - `StdDraw.picture(double x, double y, String filename)`

```
public class DrawImage
{
    public static void main(String [] args)
    {
        StdDraw.picture(0.5, 0.5, args[0]);
    }
}
```

```
% java DrawImage dont_panic.png
```

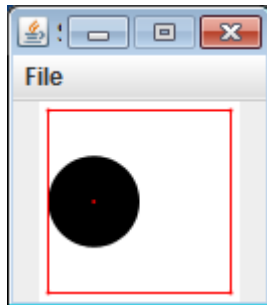


# Window size

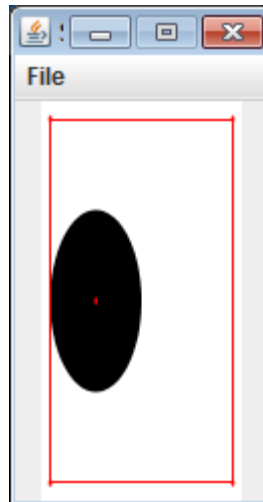


# Changing window size

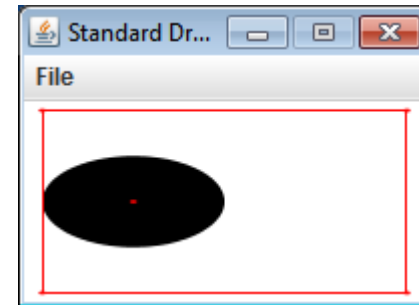
- Window size
  - Defaults size 512 x 512 pixels
  - To set different size:
    - `StdDraw.setCanvasSize(int width, int height)`
  - Call just once at start of program



100 x 100



100 x 200



200 x 100

# Animating things

- Animation loop

- Clear previous drawing

- StdDraw.clear() (or draw a picture over the screen)

- Draw new stuff

- Sleep for awhile

- StdDraw.show(int timeMs)

- Repeat

```
public class SpinningImage
{
    public static void main(String [] args)
    {
        int degrees = 0;
        while (true)
        {
            StdDraw.clear();
            StdDraw.picture(0.5, 0.5, args[0], degrees);
            degrees = (degrees + 1) % 360;
            StdDraw.show(10);
        }
    }
}
```



# Keyboard input

- Responding to keyboard input
  - Problem: StdIn waits for text then enter key
  - StdDraw gives us real-time keyboard input
    - Check if key was pressed: `StdDraw.hasNextKeyTyped()`
    - Find out the key: `StdDraw.nextKeyTyped()`
  - Note: **must click on drawing window first**
  - Example:
    - Make image spin clockwise on 'a'
    - Make image spin counterclockwise on 's'
    - Stop spinning on any other key

# Interactive spinning image

```
public class SpinningImageKey
{
    public static void main(String [] args)
    {
        int degrees = 0;
        int direction = 0;
        while (true)
        {
            StdDraw.clear();
            StdDraw.picture(0.5, 0.5, args[0], degrees);

            if (StdDraw.hasNextKeyTyped())
            {
                char ch = StdDraw.nextKeyTyped();
                if (ch == 'a')
                    direction = 1;
                else if (ch == 's')
                    direction = -1;
                else
                    direction = 0;
            }
            degrees = (degrees + direction) % 360;
            StdDraw.show(10);
        }
    }
}
```

# Adding sound

- **StdAudio**

- **Plays sound files** in .wav, .au, .mid format

- Plays one time

- StdAudio.play(String filename)

- Also can play raw audio in double []

- For creating your own sounds

- Example, add audio to our spinning image:

```
public class SpinningImageKeyAudio
{
    public static void main(String [] args)
    {
        StdAudio.play(args[1])
        ...
    }
}
```

# Additional information

- Many more methods in StdDraw and StdAudio
  - Full documentation:
    - <http://introcs.cs.princeton.edu/java/stdlib/javadoc/StdDraw.html>
    - <http://introcs.cs.princeton.edu/java/stdlib/javadoc/StdAudio.html>

```
void line(double x0, double y0, double x1, double y1)
```

```
void point(double x, double y)
```

```
void circle(double x, double y, double r)
```

```
void filledCircle(double x, double y, double r)
```

```
void square(double x, double y, double r)
```

```
void filledSquare(double x, double y, double r)
```

```
void polygon(double [] x, double [] y)
```

```
void filledPolygon(double [] x, double [] y)
```

```
void text(double x, double y, String s)
```

```
void setFont(Font f)
```

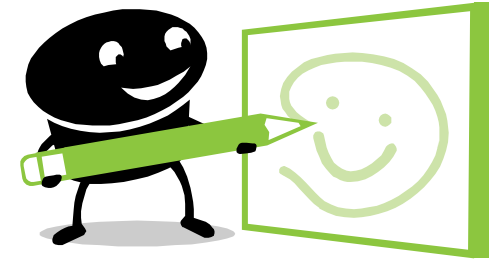
```
void setPenColor(Color c)
```

```
...
```

# Summary

- Drawing

- Easy to do with StdDraw.java
- Draw primitive shapes
- Draw images from a file
- Create animation loops
- Get keyboard input from users



- Audio

- Play audio files

