Topic 10
return values, Math methods

"Thinking like a computer scientist means more than being able to program a computer. It requires thinking at multiple levels of abstraction."

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Based on slides by Mike Scott.
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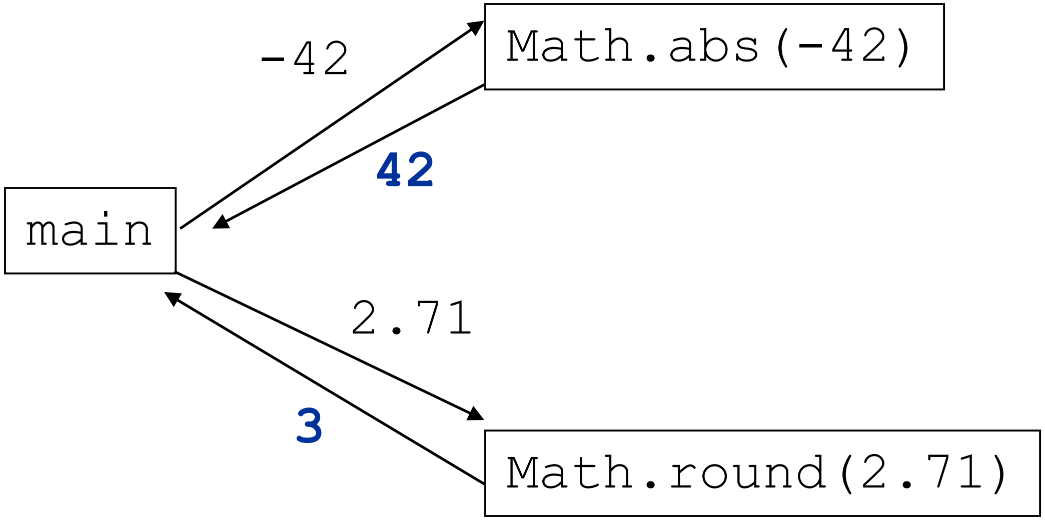
https://www.cs.utexas.edu/~scottm/cs312/handouts/slides/topic10_return_values.pdf

Based on slides by Marty Stepp and Stuart Reges from http://www.buildingjavaprograms.com/

Return

- **return**: To send out a value as the result of a method.
  - The opposite of a parameter:
    - Parameters send information *in* from the caller to the method.
    - Return values send information *out* from a method to its caller.
      - A call to the method can be used as part of an expression.



Returning a value from a method

```
public static type name(parameters) {
    statements;
    ...
    return expression;
}
```

- Example:

```
// Returns the slope of the line between the given points.
public static double slope(int x1, int y1, int x2, int y2) {
    double dy = y2 - y1;
    double dx = x2 - x1;
    return dy / dx;
}
```

`slope(5, 11, 1, 3)` returns `2.0`

Return examples

```
// Converts degrees Fahrenheit to Celsius.
public static double fToC(double degreesF) {
    double degreesC = 5.0 / 9.0 * (degreesF - 32);
    return degreesC;
}

// Computes triangle hypotenuse length given its side lengths.
public static double hypotenuse(int a, int b) {
    double c = Math.sqrt(a * a + b * b);
    return c;
}
```

- You can shorten the examples by returning an expression:

```
public static double fToC(double degreesF) {
    return 5.0 / 9.0 * (degreesF - 32);
}
```

Common error: Not storing

- a `return` statement DOES NOT send a variable's name back to the calling method.

```
public static void main(String[] args) {
    slope(0, 0, 6, 3);
    System.out.println("The slope is " + result);
  // ERROR: result not defined

}
public static double slope(int x1, int x2, int y1, int y2) {
    double dy = y2 - y1;
    double dx = x2 - x1;
    double result = dy / dx;
    return result;
}
```

Fixing the common error

- Instead, returning sends the variable's *value* back.
  - – The returned value must be stored into a variable or used in an expression to be useful to the caller.

```
public static void main(String[] args) {
    double s = slope(0, 0, 6, 3);
    System.out.println("The slope is " + s);
}

public static double slope(int x1, int x2, int y1, int y2) {
    double dy = y2 - y1;
    double dx = x2 - x1;
    double result = dy / dx;
    return result;
}
```

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- What is the output of the following code?

```
int x = 5;
int y = 7;
System.out.print(m(x, y) + " " + x + " " + m(y, x));

public static int m(int x, int y) {
      x += 2;
      System.out.print(x + " ");
      y -= 2;
      return x * y;
}
```

A. 7 9 35 5 27

B. 7 7 35 7 27

C. 7 5 9 27 35

D. 35 7 5 9 27

E. None of A - D are correct

Exercise

- In physics, the *displacement* of a moving body represents its change in position over time while accelerating.
  - Given initial velocity v_0 in m/s, acceleration a in m/s^2, and elapsed time t in s, the displacement of the body is:
  - Displacement = $v_0 t + ½ a t^2$
- Write a method `displacement` that accepts v_0, a, and t and computes and returns the change in position.
  - example: `displacement(3.0, 4.0, 5.0)` returns `65.0`

Exercise solution

```
public static double displacement(
        double v0, double a,
        double t) {

    double d = v0 * t + 0.5
            * a * Math.pow(t, 2);
    return d;
}
```

Exercises

- write a method to
  - return the int average of 3 ints
  - return the double average of 3 ints
  - return the average of a given number of rolls of 2 six sided dice
  - calculate and return N factorial (N!).
  - return the number of seconds in a given number of years.
  - return the Nth digit of a given integer.
  - return the distance between two points.

Exercise

- If you drop two balls, which will hit the ground first?
  - Ball 1: height of 600m, initial velocity = 25 m/sec downward
  - Ball 2: height of 500m, initial velocity = 15 m/sec downward
- Write a program that determines how long each ball takes to hit the ground (and draws each ball falling).

- Total time is based on the force of gravity on each ball.
  - Acceleration due to gravity ≅ 9.81 m/s^2, downward
  - Displacement = $v_0 t + ½ a t^2$

Ball solution

```
// Simulates the dropping of two balls from various heights.
import java.awt.*;

public class Balls {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(600, 600);
        Graphics g = panel.getGraphics();

        int ball1x = 100,  ball1y =   0,  v01 = 25;
        int ball2x = 200,  ball2y = 100,  v02 = 15;

        // draw the balls at each time increment
        for (double t = 0; t <= 10.0; t = t + 0.1) {
            g.setColor(Color.GRAY);
            panel.fillRect(0, 0, 600, 600);
            g.setColor(Color.RED);
            double disp1 = displacement(v01, t, 9.81);
            g.fillOval(ball1x, ball1y + (int) disp1, 10, 10);
            double disp2 = displacement(v02, t, 9.81);
            g.fillOval(ball2x, ball2y + (int) disp2, 10, 10);

            panel.sleep(50);   // pause for 50 ms
}
    }
    ...
```