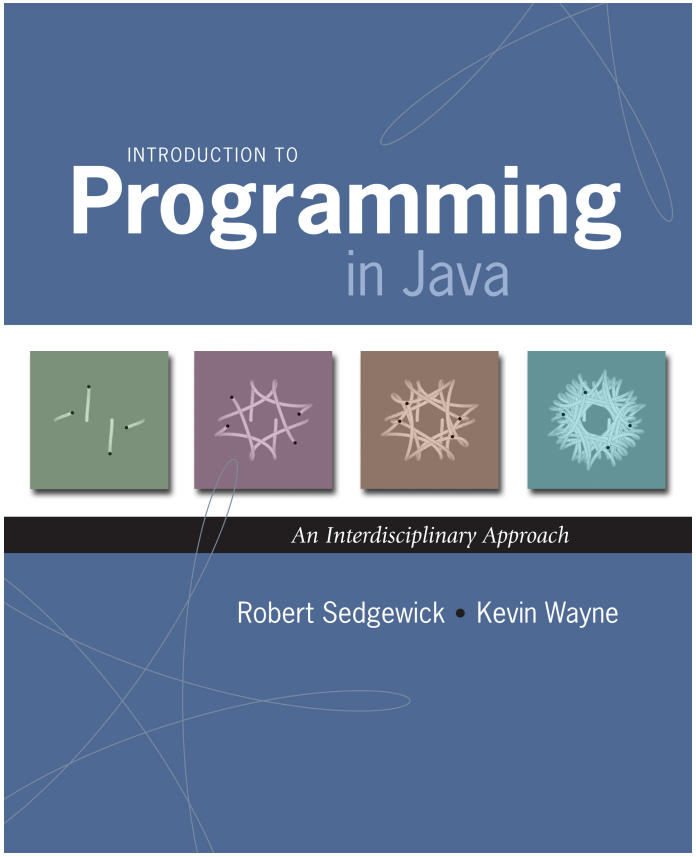
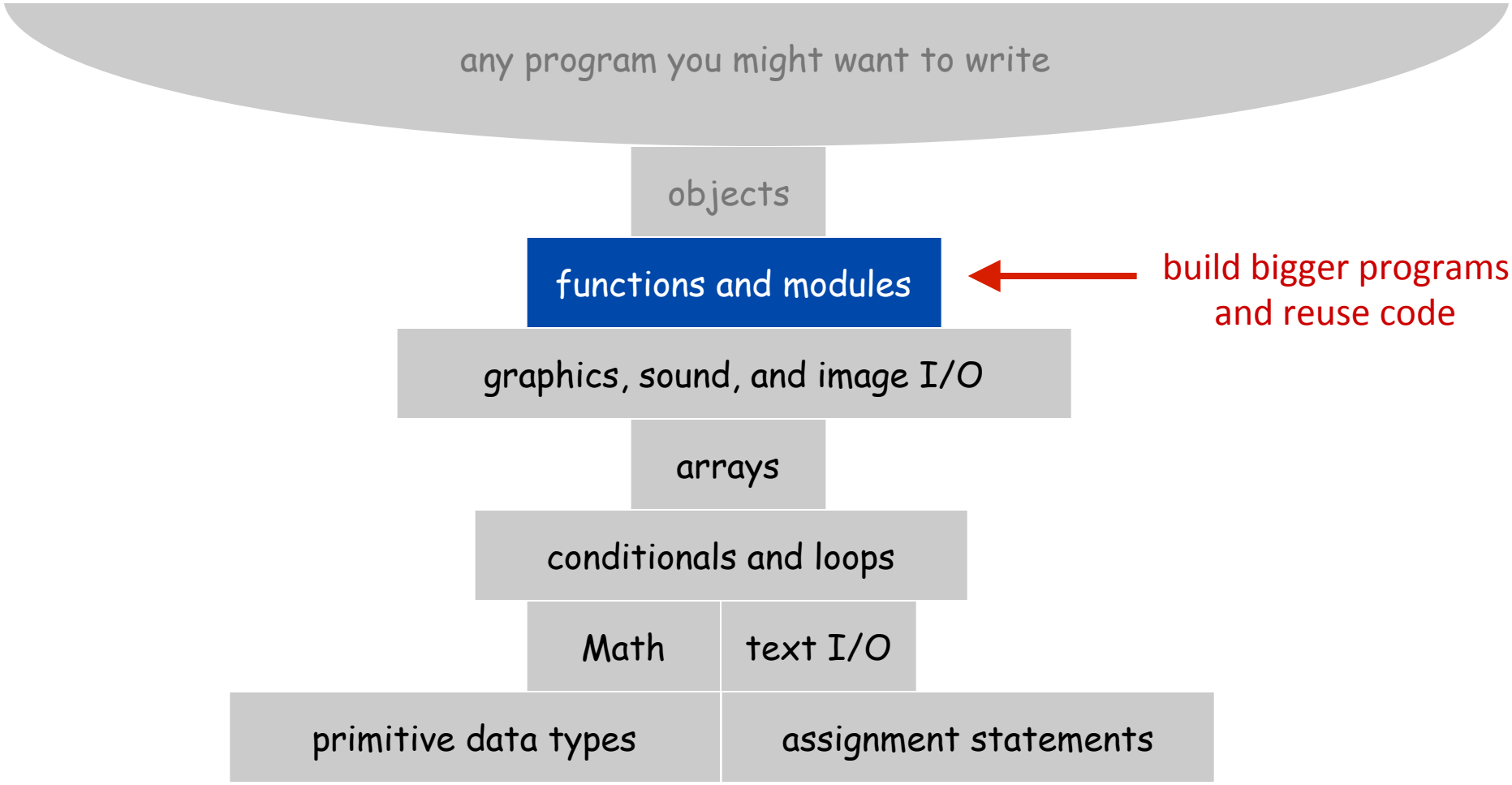
2.1 Functions



A Foundation for Programming



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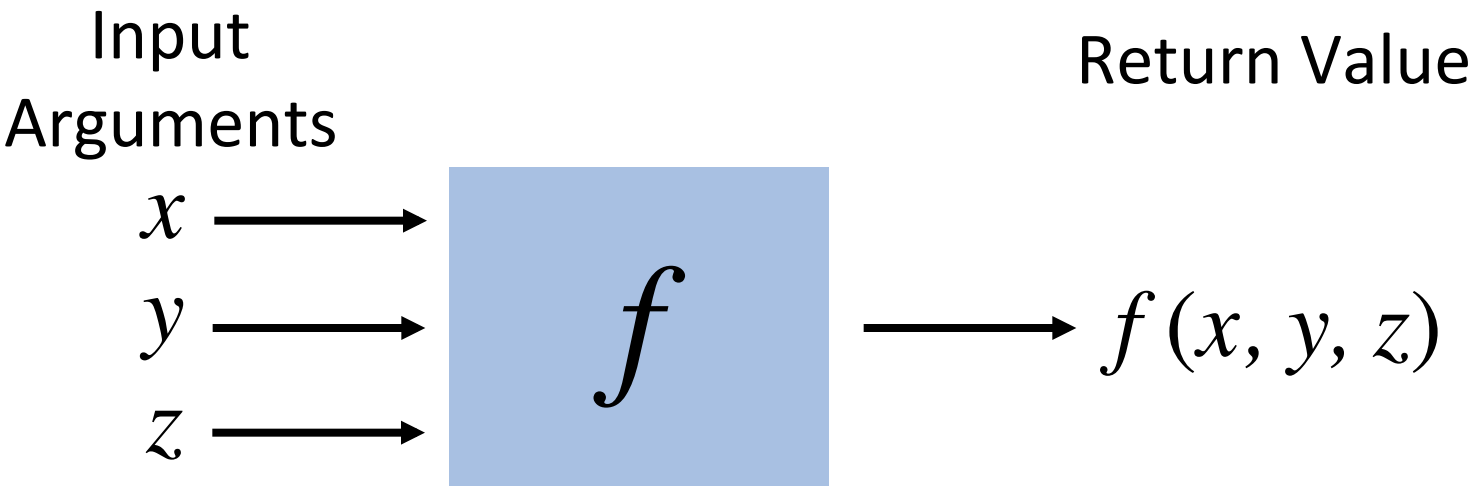
Functions

- Take in input arguments (zero or more)
- Perform some computation
  - May have side-effects (such as drawing)
- Return one output value



Functions (Static Methods)

- Applications:
  - Use mathematical functions to calculate formulas
  - Use functions to build modular programs

- Examples:
  - Built-in functions:

```
Math.random(), Math.abs(), Integer.parseInt()
```

  - I/O libraries:

```
ellipse(), beginShape(), size()
```

  - User-defined functions:

```
setup(), draw(), mousePressed()
```

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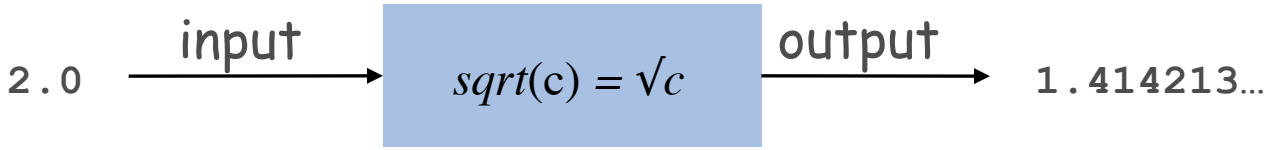
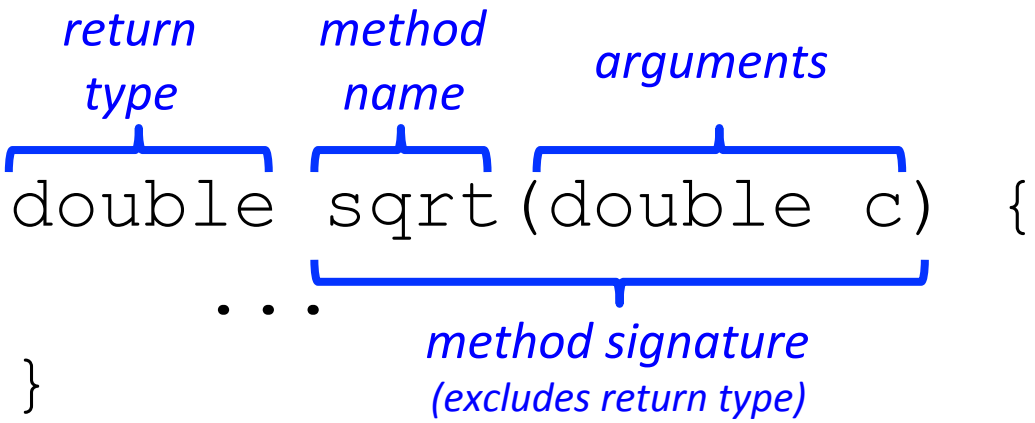
Anatomy of a Java Function

- Functions – It is easy to write your own
  - Example: `double sqrt(double c)`

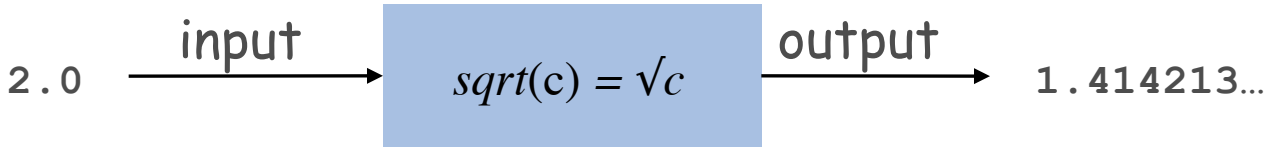




Please note that the method's signature is defined incorrectly in the figure on pg 188 of your textbook

Anatomy of a Java Function

- Functions – It is easy to write your own
  - Example: `double sqrt(double c)`




```
double sqrt(double c)
{
   if (c < 0) return Double.NaN;
   double err = 1e-15;
   double t = c;
   while (Math.abs(t - c/t) > err * t)
      t = (c/t + t) / 2.0;
   return t;
}
```

local variables

method body

return statement

call on another method

Organizing Your Program

- Functions help you organize your program by breaking it down into a series of steps
  - Each function represents some abstract step or calculation
  - Arguments let you make the function have different behaviors

- **Key Idea**: write something ONCE as a function then reuse it many times

Scope

Scope: the code that can refer to a particular variable

- A variable's scope is the entire code block (any any nested blocks) after its declaration

Simple example:

```
int count = 1;
for (int i = 0; i < 10; i++){
      count *= 2;
}
// using 'i' here generates
// a compiler error
```

Best practice: declare variables to limit their scope

Tracing Functions

```
String arg = "6"

int cube(int i) {
    int j = i * i * i;
    return j;
}

void setup() {
    int N = Integer.parseInt(arg);
    for (int i = 1; i <= N; i++)
        System.out.println(i + " " + cube(i));
}
```

```
1 1
2 8
3 27
4 64
5 125
6 216
```

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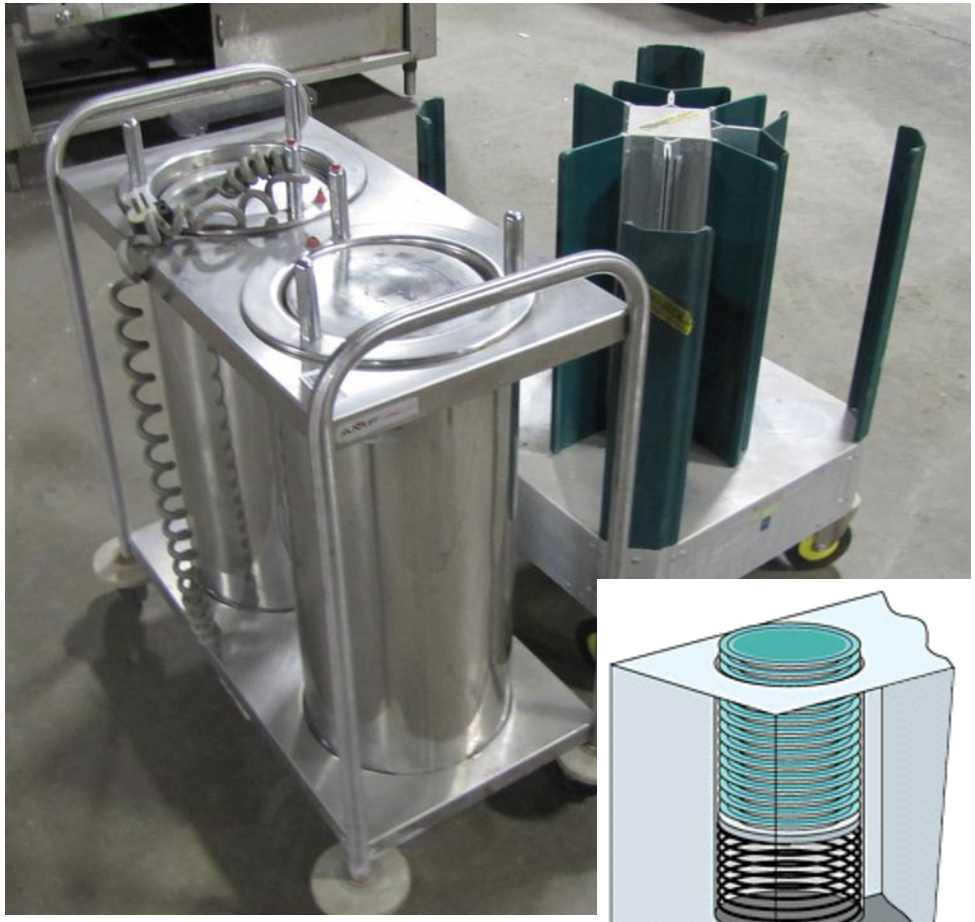
Last In First Out (LIFO) Stack of Plates



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Method Overloading

- Two or more methods *in the same class* may also have the same name
- This is called ***method overloading***

absolute value of an `int` *value*

```
int abs(int x)
{
   if (x < 0) return -x;
   else       return  x;
}
```

absolute value of a `double` *value*

```
double abs(double x)
{
   if (x < 0.0) return -x;
   else         return  x;
}
```

Method Signature

- A method is uniquely identified by
  - its **name** and
  - **its parameter list** (parameter types and their order)
- This is known as its ***signature***

Examples:

```
   int min (int a, int b)
double min (double a, double b)
 float min (float a, float b)
```

Return Type is Not Enough

- Suppose we attempt to create an overloaded `circle(double x, double y, double r)` method by using different return types:

```
void circle (double x, double y, double r) {...}

//returns true if circle is entirely onscreen, false otherwise
boolean circle (double x, double y, double r) {...}
```

- This is NOT valid method overloading because the code that calls the function can ignore the return value

```
circle(50, 50, 10);
```

  - The compiler can't tell which `circle()` method to invoke
  - Just because a method returns a value doesn't mean the calling code has to use it

Too Much of a Good Thing

Automatic type promotion and overloading can sometimes interact in ways that confuse the compiler

For example:

```
//version 1
void printAverage (int a, double b) {
     ...
}

//version 2
void printAverage (double a, int b) {
     ...
}
```

Why might this be problematic?

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Too Much of a Good Thing

```
void printAverage (int a, double b) {/*code*/}
void printAverage (double a, int b) {/*code*/}
```

- Consider if we do this:

```
void setup() {
     ...
     printAverage(4, 8);
     ...
}
```

- The compiler can't decide whether to:
  - promote 7 to 7.0 and invoke the first version of printAverage(), or
  - promote 5 to 5.0 and invoke the second version
- It will throw up its hands and complain
- Take-home lesson: don't be too clever with method overloading

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More Documentation

Method-level Documentation

- Method header format:

```
/**
 * Name: circleArea
 * PreCondition: the radius is greater than zero
 * PostCondition: none
 * @param radius - the radius of the circle
 * @return the calculated area of the circle
 */
double circleArea (double radius) {
    // handle unmet precondition
    if (radius < 0.0) {
        return 0.0;
    } else {
        return Math.PI * radius * radius;
    }
}
```

Method Documentation

- Clear communication with the class user is of paramount importance so that he can
  - use the appropriate method, and
  - use class methods properly.
- Method comments:
  - explain what the method does, and
  - describe how to use the method.
- Two important types of method comments:
  - ***precondition*** comments
  - ***post-conditions*** comments

Preconditions and Postconditions

- Precondition
  - What is assumed to be true when a method is called
  - If any pre-condition is not met, the method may not correctly perform its function.

- Postcondition
  - States what will be true after the method executes (assuming all pre-conditions are met)
  - Describes the side-effect of the method

An Example

Very often the precondition specifies the limits of the parameters and the postcondition says something about the return value.

```
/*Prints the specified date in a long format
      e.g.  1/1/2000 -> January 1, 2000
  Pre-condition:
       1 <= month <= 12
       day appropriate for the month
       1000 <= year <= 9999
  Post-condition:
       Prints the date in long format
*/
void printDate(int month, int day, int year)
{
  // code here
}
```