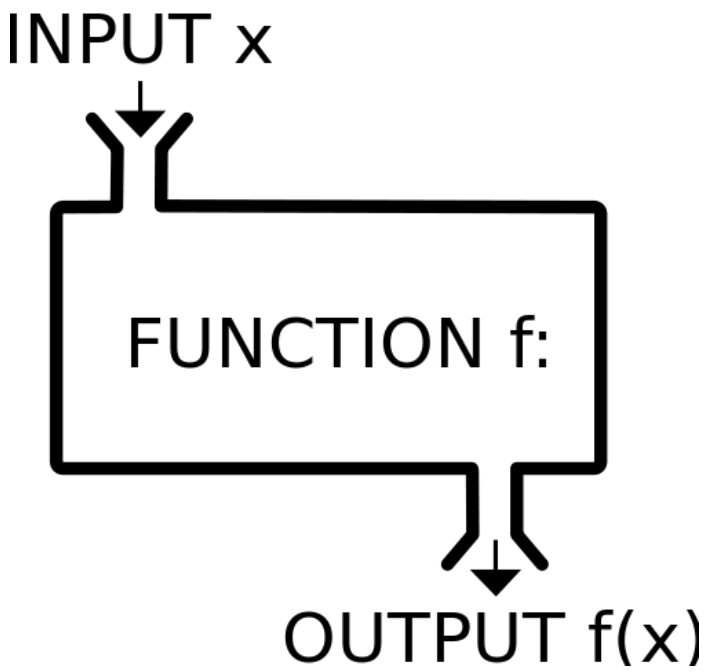
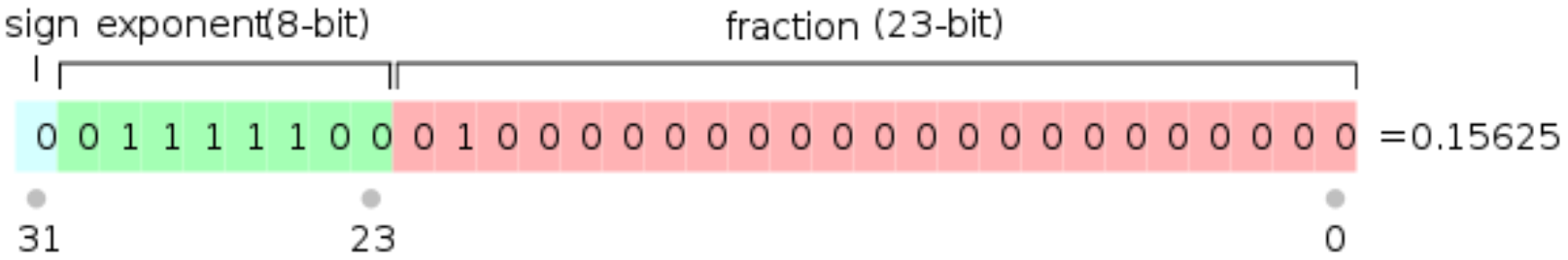
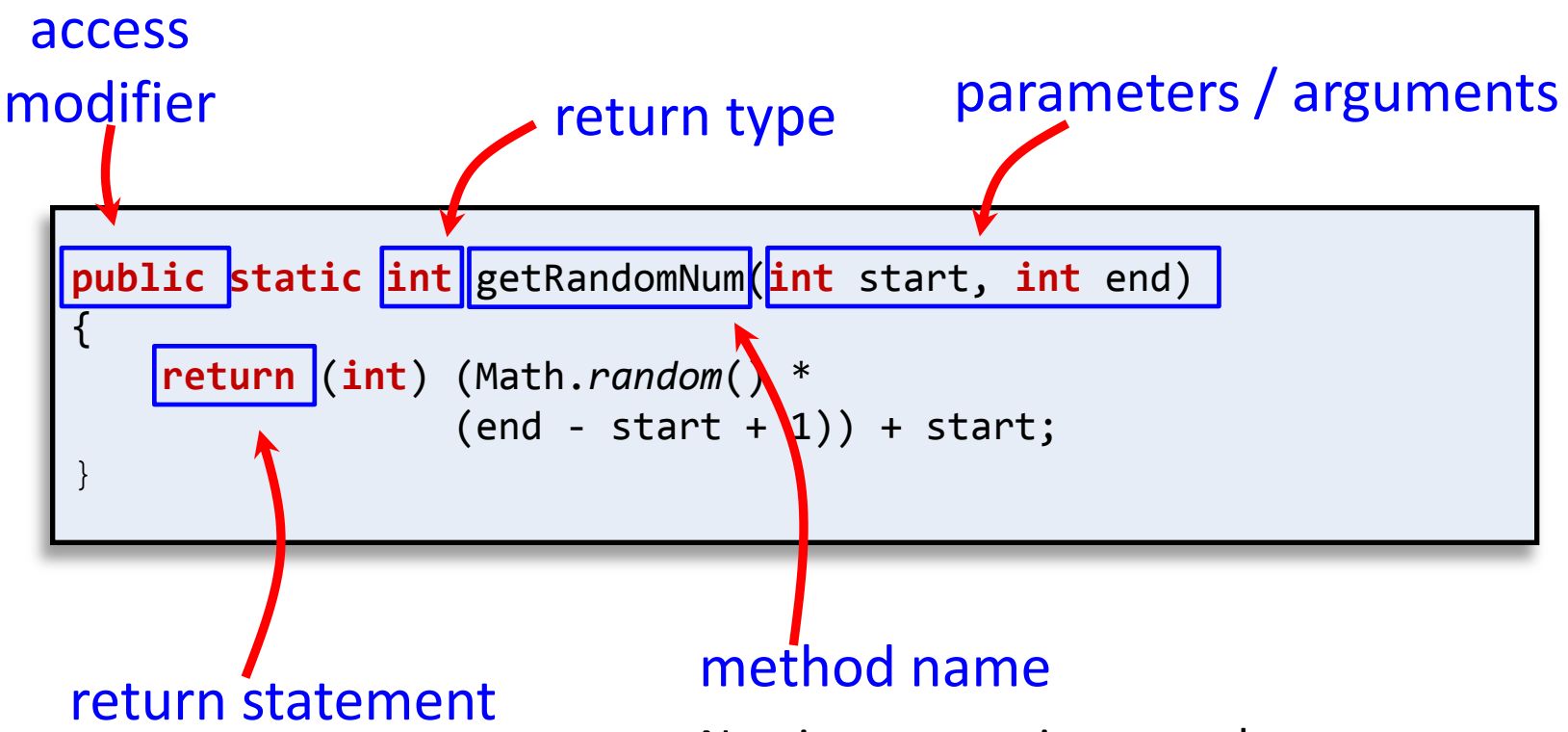
More on methods and variables





Terminology of a method

- Goal: helper method than can draw a random integer between `start` and `end` (inclusive)



Array parameters

- Arrays can be passed as arguments

```
public class AverageArray
{
    public static double average(int [] nums)
    {
        long total = 0;
        for (int i = 0; i < nums.length; i++)
            total += nums[i];
        return (double) total / (double) nums.length;
    }

    public static void main(String [] args)
    {
        int [] vals = new int[1000];
        for (int i = 0; i < vals.length; i++)
            vals[i] = RandomUtil.getRandomNum(1, 10);
        System.out.println("avg " + average(vals));
    }
}
```

```
% java AverageArray
avg 5.508
```

Array as a return value

- Arrays can be returned from methods
  - Method must create and fill in the array

```
public class ReturnArray
{
    public static double [] getRandomArray(int N)
    {
        double [] result = new double[N];
        for (int i = 0; i < N; i++)
            result[i] = Math.random();
        return result;
    }

    public static void main(String [] args)
    {
        double [] randNums = getRandomArray(Integer.parseInt(args[0]));
        for (int i = 0; i < randNums.length; i++)
            System.out.println("randNums[" + i + "] = " + randNums[i]);
    }
}
```

Pass by value

- Java passes parameters by value (by copy)
  - Changes to primitive type parameters do not persist after method returns
    - Primitive types: `int, double, char, long, boolean`

```
public static int sum(int a, int b)
{
   int result = a + b;
   a = 0;
   b = 0;
   return result;
}
```

```
int c = 2;
int d = 3;
System.out.println("sum = " + sum(c, d));
System.out.println("c = " + c);
System.out.println("d = " + d);
```

```
% java PassByVal
sum = 5
c = 2
d = 3
```

Pass by value

- Java passes parameters by value (by copy)
  - Changes to the *immutable* `String` type parameters do not persist after the method

```
public class StringPuzzler
{
    public static void printStuff(String word)
    {
        word = "best";
        System.out.print(word);
        word = "bestest";
    }

    public static void main(String [] args)
    {
        String word = "worst";
        System.out.print("It was the ");
        printStuff(word);
        System.out.print(" " + word + " of times");
    }
}
```

```
% java StringPuzzler
It was the best worst of times
```

Changing an array parameter

- Methods can change *elements* of passed array
  - Changes DO persist after the method

```
public class ArrayClearer
{
    public static void clear(int [] nums)
    {
        for (int i = 0; i < nums.length; i++)
            nums[i] = 0;
    }

    public static void main(String [] args)
    {
        int [] scores = {90, 85, 99, 45};
        for (int i = 0; i < scores.length; i++)
            System.out.print(scores[i] + " ");
        System.out.println();
        clear(scores);
        for (int i = 0; i < scores.length; i++)
            System.out.print(scores[i] + " ");
    }
}
```

```
% java ArrayClearer
90 85 99 45
0 0 0 0
```

Java primitive types (plus `String`)

Java type	what it stores	examples	default value
`byte`	tiny integer values -128 to 127	`3` `-87`	`0`
`short`	small integer values -32,768 to 32,767	`-3433` `123`	`0`
`int`	**integer values** **-2,147,483,648 to 2,147,483,647**	**`42`** **`1234`**	**`0`**
`long`	big integer values -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807	`5454` `-43984938`	`0`
`double`	**floating-point values**	**`9.95`** **`3.0e8`**	**`0.0`**
`float`	less precise floating-point values	`9.95f` `3.0e8f`	`0.0`
`boolean`	**truth values**	**`true`** **`false`**	**`false`**
`char`	**characters**	**`'a', 'b', '!'`**	**`'\u0000'`**
`String`	**Sequences of characters**	**`"Hello world!"`**	**`null`**

Equality: integer primitives

- Boolean operator ==
  - See if two variables are exactly equal
  - i.e. they have identical bit patterns
- Boolean operator !=
  - See if two variables are NOT equal
  - i.e. they have different bit patterns

```
int a = 5;

if (a == 5)
   System.out.println("yep it's 5!");

while (a != 0)
  a--;
```

This is a safe comparison since we are using an integer type.

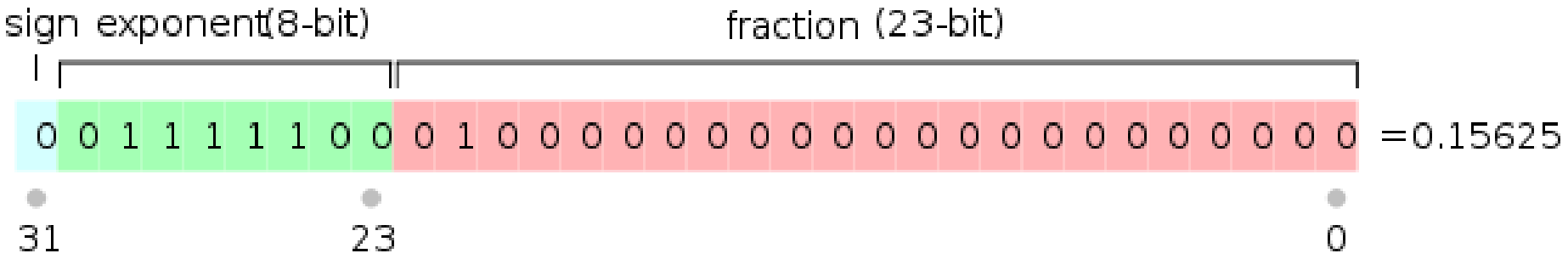
Equality: floating-point primitives

- Floating-point primitives
  - i.e. `double` and `float`
  - Only an approximation of the number
  - Use == and != at your own peril

```
double a = 0.1 + 0.1 + 0.1;
double b = 0.1 + 0.1;
double c = 0.0;

if (a == 0.3)
   System.out.println("a is 0.3!");

if (b == 0.2)
   System.out.println("b is 0.2!");

if (c == 0.0)
   System.out.println("c is 0.0!");
```

Equality: floating-point primitives

- Floating-point primitives
  - i.e. `double` and `float`
  - Only an approximation of the number



Floating-point numbers are shoved into a binary number.
32 bits for a `float`, 64-bits for a `double`

Equality: floating-point primitives

- Floating-point primitives
  - i.e. `double` and `float`
  - Only an approximation of the number
  - Use == and != at your own peril

```
double a = 0.1 + 0.1 + 0.1;
double b = 0.1 + 0.1;
double c = 0.0;

if (a == 0.3)
   System.out.println("a is 0.3!");

if (b == 0.2)
   System.out.println("b is 0.2!");

if (c == 0.0)
   System.out.println("c is 0.0!");
```

This works as long as no calculation has been done on 0.0 value and both are typed `double`.

```
b is 0.2!
c is 0.0!
```

Safe floating-point equality check

- Floating-point primitives
  - Check if sufficiently close to target value

```
double a = 0.1 + 0.1 + 0.1;
double b = 0.1 + 0.1;
double c = 0.0;
final double EPSILON = 1e-10;

if (Math.abs(a - 0.3) < EPSILON)
   System.out.println("a is 0.3!");

if (Math.abs(b - 0.2) < EPSILON)
   System.out.println("b is 0.2!");

if (c == 0.0)
   System.out.println("c is 0.0!");
```

```
a is 0.3!
b is 0.2!
c is 0.0!
```

Equality: String variables

- Comparing `String` variables
  - Using boolean operators ==, != will compile and run BUT:
    - Does *not* actually compare text in the `String` variables
    - Big cause of bugs for Java beginners!

```
String a = "hello";
String b = "hello";
String c = "hell" + "o";
String d = "hell";
d = d + "o";

if (a == b) System.out.println("a equals b!");
if (b == c) System.out.println("b equals c!");
if (c == d) System.out.println("c equals d!");
```

```
a equals b!
b equals c!
```

Equality: String variables

- Check equality with `equals()` method
  - Each letter must be the same (including case)

```
String a = "hello";
String b = "hello";
String c = "hell" + "o";
String d = "hell";
d = d + "o";

if (a.equals(b)) System.out.println("a equals b!");
if (b.equals(c)) System.out.println("b equals c!");
if (c.equals(d)) System.out.println("c equals d!");
```

```
a equals b!
b equals c!
c equals d!
```

Summary

- Static methods
  - Can take arrays as parameters
  - Can return an array as a result
    - Method is responsible for creating and filling array
- Changing parameters in a method
  - Changes to primitive types *DO NOT* persist
  - Changes to String types *DO NOT* persist
  - Changes to elements of arrays *DO* persist
- Primitive types have default values
  - Watch out for String `null` default
- Testing for equality
  - Be careful comparing `double` variables with ==, !=
  - Don't compare `String` variables with ==, !=