

# Static methods

```
int getRandomNumber()  
{  
    return 4; // chosen by fair dice roll.  
             // guaranteed to be random.  
}
```

<http://xkcd.com/221/>

Not actually a valid  
Java static method...

# Programs thus far



- One big `main()`:

```
public class DiceRolling
{
    public static void main(String [] args)
    {
        int rolls = 0;
        int sum = 0;
        int target = (int) (Math.random() * 12) + 1;

        System.out.println("Rolling dice until I get " + target + ".");

        do
        {
            int dice1 = (int) (Math.random() * 6) + 1;
            int dice2 = (int) (Math.random() * 6) + 1;
            sum = dice1 + dice2;
            System.out.println(dice1 + " + " + dice2 + " = " + sum);
            rolls++;
        }
        while (sum != target);
        System.out.println("It took " + rolls + " rolls.");
    }
}
```

# Programs thus far



- One big `main()`:

```
public class DiceRolling
{
    public static void main(String [] args)
    {
        int rolls = 0;
        int sum = 0;
        int target = (int) (Math.random() * 12) + 1;

        System.out.println("Rolling dice until I get " + target);

        do
        {
            int dice1 = (int) (Math.random() * 6) + 1;
            int dice2 = (int) (Math.random() * 6) + 1;
            sum = dice1 + dice2;
            System.out.println(dice1 + " + " + dice2 + " = " + sum);
            rolls++;
        }
        while (sum != target);
        System.out.println("It took " + rolls + " rolls.");
    }
}
```

```
% java DiceRolling
Rolling dice until I get 4.
6 + 1 = 7
3 + 3 = 6
5 + 5 = 10
5 + 1 = 6
3 + 3 = 6
6 + 2 = 8
1 + 4 = 5
4 + 3 = 7
5 + 5 = 10
5 + 4 = 9
4 + 1 = 5
1 + 6 = 7
6 + 4 = 10
2 + 2 = 4
It took 14 rolls.
```

# Programs thus far



- Problems with one big `main()`:
  - Doesn't scale to complex programs
  - Often find ourselves repeating similar code

```
public class DiceRolling
{
    public static void main(String [] args)
    {
        int rolls = 0;
        int sum = 0;
        int target = (int) (Math.random() * 12) + 1;

        System.out.println("Rolling dice until I get " + target + ".");

        do
        {
            int dice1 = (int) (Math.random() * 6) + 1;
            int dice2 = (int) (Math.random() * 6) + 1;
            sum = dice1 + dice2;
            ...
        }
    }
}
```

# Using static methods

- Static methods

- Already seen loads of “helper” methods:

```
System.out.println("Hello world");
StdDraw.setPenColor(StdDraw.GRAY);
int num      = Integer.parseInt(args[0]);
double r     = Double.parseDouble(args[1]);
int x        = StdIn.readInt();
double rand  = Math.random();
double v     = Math.pow(10.0, -2.3582);
StdDraw.setXscale(0.0, 10.0);
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```

Some methods  
return a value.

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```

Some methods  
take a single  
parameter.

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int x        = StdIn.readInt();
double rand  = Math.random();
double v     = Math.pow(10.0, -2.3582);
StdDraw.setXscale(0.0, 10.0);
```

Some methods  
take no  
parameters

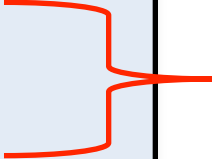


# Using static methods

- Static methods

- Already seen loads of “helper” methods:

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System.out.println("Hello world");
StdDraw.setPenColor(StdDraw.GRAY);
int num      = Integer.parseInt(args[0]);
double r     = Double.parseDouble(args[1]);
int x        = StdIn.readInt();
double rand  = Math.random();
double v     = Math.pow(10.0, -2.3582);
StdDraw.setXscale(0.0, 10.0);
```



Some methods  
take two  
parameters.

# Methods

- **Methods:**
  - Like a mathematical function
    - Given some inputs, produce an output value
  - Methods allows **building modular programs**
    - Reuse code, only invent the wheel once
  - When a method is called:
    - Control **jumps to the method** code
    - **Argument passed to method** copied to parameter variables used in method
    - **Method executes** and (optionally) **returns a value**
    - Execution **returns to calling code**

# Flow of control

```
public class MethodJumping
{
    public static void printWorld()
    {
        System.out.print("world");
    }
    public static int addNums(int num1, int num2)
    {
        int result = num1;
        result = num1 + num2;
        return result;
    }
    public static void main(String [] args)
    {
        System.out.print("Hello ");
        System.out.print(" ");
        printWorld();
        System.out.print(", 1 + 2 = ");
        int a = addNums(1, 2);
        System.out.println(a);
    }
}
```

# Let's make our own method

- **Goal:** general purpose helper than can **draw a random integer between X and Y (inclusive)**

```
public static int getRandomNum(int start, int end)
{
    return (int) (Math.random() *
                 (end - start + 1)) + start;
}
```

# Anatomy of a method

- **Goal:** general purpose helper than can **draw a random integer between X and Y (inclusive)**

"Everybody can call me"

"I promise to return a value of this type"

"I need to know these things to do my job"

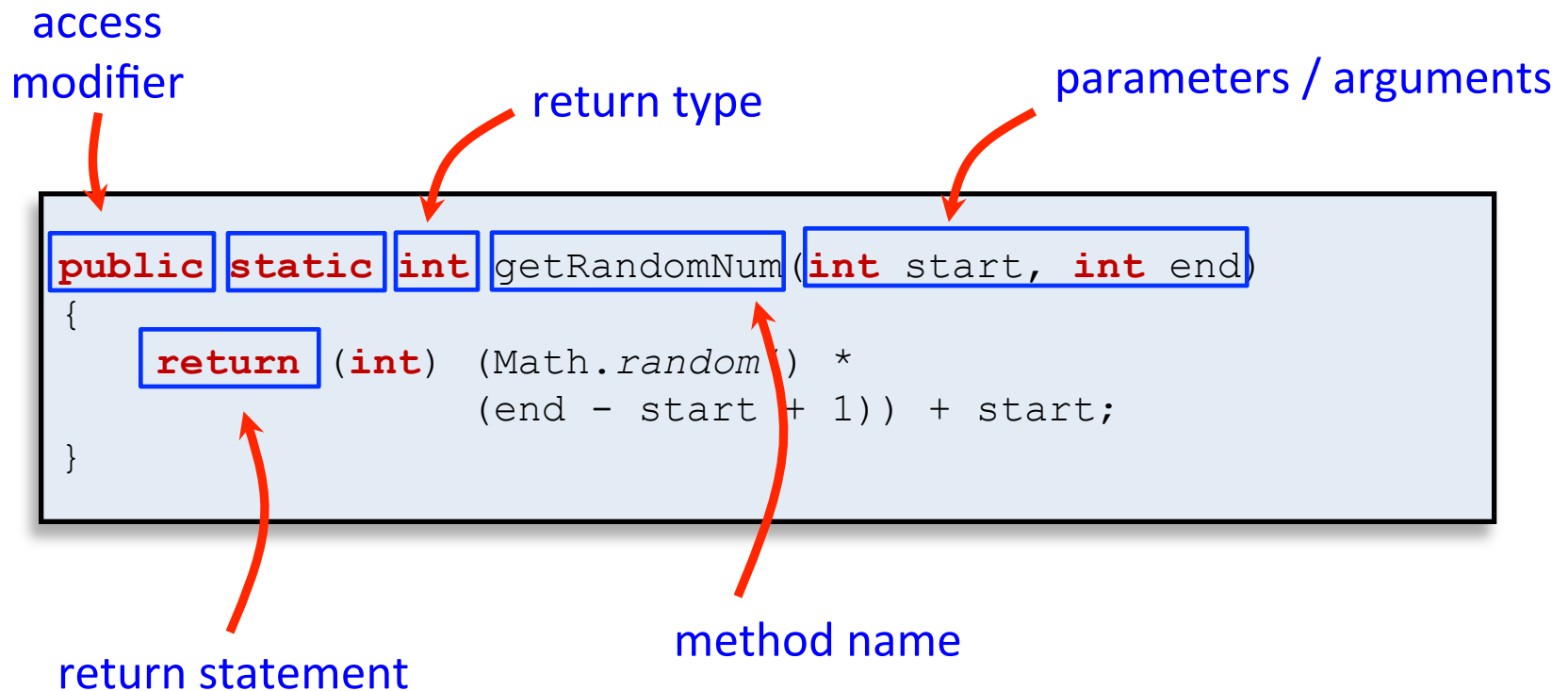
```
public static int getRandomNum(int start, int end)
{
    return (int) (Math.random() *
                (end - start + 1)) + start;
}
```

"All done, end this method and return the result to whoever called me"

"The name I demand people use when they want my random goodness"

# Anatomy of a method

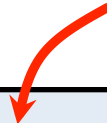
- **Goal:** general purpose helper than can **draw a random integer between X and Y (inclusive)**



# Method signature

- **Signature:** a method's name plus the number and type of its parameters

method's signature



```
public static int getRandomNum(int start, int end)
{
    return (int) (Math.random() *
                 (end - start + 1)) + start;
}
```

# Calling our new method

- Use handy new method in `DiceRolling`
  - Add somewhere inside `public class {}`'s

```
public class DiceRolling
{
    public static int getRandomNum(int start, int end)
    {
        return (int) (Math.random() *
                    (end - start + 1)) + start;
    }

    public static void main(String [] args)
    {
        int rolls = 0;
        int sum = 0;
        int target = getRandomNum(1, 12);

        System.out.println("Rolling dice until I get " + target + ".");
        do
        {
            int dice1 = getRandomNum(1, 6);
            int dice2 = getRandomNum(1, 6);
            sum = dice1 + dice2;
            ...
        }
    }
}
```



# Calling our new method

- **Alternative: put method in new class**
  - Allows us to create a class with a bunch of helper methods (just like `StdIn.java`, `StdDraw.java`)

```
public class RandomUtil
{
    // Return random integer in [start, end] inclusive
    public static int getRandomNum(int start, int end)
    {
        return (int) (Math.random() *
                     (end - start + 1)) + start;
    }

    // Return random integer in [0, end] inclusive
    public static int getRandomNum(int end)
    {
        return (int) (Math.random() * (end + 1));
    }
}
```

`getRandomInt()`  
is overloaded:  
Two methods with  
same name, but  
different  
signatures  
(different number  
of parameters).

# Using our new class

- Put `RandomUtil.java` in same directory
  - Methods qualified with `RandomUtil.` in front

```
public class DiceRolling
{
    public static void main(String [] args)
    {
        int rolls = 0;
        int sum = 0;
        int target = RandomUtil.getRandomNum(1, 12);

        System.out.println("Rolling dice until I get " + target + ".");
        do
        {
            int dice1 = RandomUtil.getRandomNum(1, 6);
            int dice2 = RandomUtil.getRandomNum(1, 6);
            sum = dice1 + dice2;
            System.out.println(dice1 + " + " + dice2 + " = " + sum);
            rolls++;
        }
        while (sum != target);
        System.out.println("It took " + rolls + " rolls.");
    }
}
```

# A safer version

- **Problem:** What if caller sends in  $\text{start} > \text{end}$ ?

```
public static int getRandomNum(int start, int end)
{
    return (int) (Math.random() *
                (end - start + 1)) + start;
}
```

```
while (true)
    System.out.print(RandomUtil.getRandomNum(3,1) + " ");
```

```
3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
3 3 3 3 3 3 3 3 3 3 3 3 ...
```

# A safer version

```
public static int getRandomNum(int start, int end)
{
    if (start < end)
        return (int) (Math.random() *
                    (end - start + 1)) + start;
    return (int) (Math.random() *
                (start - end + 1)) + end;
}
```

As soon as a  
return is hit,  
method done

```
while (true)
    System.out.print(RandomUtil.getRandomNum(3,1) + " ");
```

```
3 1 1 1 2 2 3 1 1 1 3 2 3 1 2 1 3 3 2 2 2 2 1 3 1 3 1 3 3
3 1 3 2 1 2 3 1 2 2 3 2 1 1 3 2 2 2 1 3 2 2 2 3 3 1 1 1 3
3 3 1 3 2 1 3 3 1 3 3 3 3 1 1 2 1 1 3 1 1 3 1 1 2 2 2 2 2
1 2 3 2 2 3 3 3 3 2 1 2 2 ...
```

# 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);
```

# 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;
}
```

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

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

# Pass by value

```
public static int sum(int c, int d)
{
    int result = c + d;
    c = 0;
    d = 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 = " + c);
```

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

# 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
```



# Quiz: variable scope

What lines are the following variables in scope?

nums

total

vals

i

```
00 public class AverageArray
01 {
02     public static double average(int [] nums)
03     {
04         long total = 0;
05         for (int i = 0; i < nums.length; i++)
06             total += nums[i];
07         return (double) total / (double) nums.length;
08     }
09
10     public static void main(String [] args)
11     {
12         int [] vals = new int[1000];
13         for (int i = 0; i < vals.length; i++)
14             vals[i] = RandomUtil.getRandomNum(1, 10);
15         System.out.println("avg " + average(vals));
16     }
17 }
```

# Quiz: variable scope

What lines are the following variables in scope?

nums **4-7**

total **4-7**

vals **12-15**

i **5-6, 13-14**

```
00 public class AverageArray
01 {
02     public static double average(int [] nums)
03     {
04         long total = 0;
05         for (int i = 0; i < nums.length; i++)
06             total += nums[i];
07         return (double) total / (double) nums.length;
08     }
09
10     public static void main(String [] args)
11     {
12         int [] vals = new int[1000];
13         for (int i = 0; i < vals.length; i++)
14             vals[i] = RandomUtil.getRandomNum(1, 10);
15         System.out.println("avg " + average(vals));
16     }
17 }
```

# Quiz: variable scope

What is the value of total printed at the end of main() ?

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00 public class AverageArray
01 {
02     public static double average(int [] nums)
03     {
04         long total = 0;
05         for (int i = 0; i < nums.length; i++)
06             total += nums[i];
07         return (double) total / (double) nums.length;
08     }
09
10     public static void main(String [] args)
11     {
12         long total = 123;
13         int [] vals = new int[1000];
14         for (int i = 0; i < vals.length; i++)
15             vals[i] = RandomUtil.getRandomNum(1, 10);
16         System.out.println("avg " + average(vals));
17         System.out.println("total " + total);
18     }
19 }
```

# Quiz: variable scope

What is the value of total printed at the end of main() ?

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What if we remove line 4?

```
00 public class AverageArray
01 {
02     public static double average(int [] nums)
03     {
04         long total = 0;
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12         long total = 123;
13         int [] vals = new int[1000];
14         for (int i = 0; i < vals.length; i++)
15             vals[i] = RandomUtil.getRandomNum(1, 10);
16         System.out.println("avg " + average(vals));
17         System.out.println("total " + total);
18     }
19 }
```

# Quiz: variable scope

What is the value of total printed at the end of main() ?

123

What if we remove line 4?

Compile error: total cannot be resolved to a variable

```
00 public class AverageArray
01 {
02     public static double average(int [] nums)
03     {
04         for (int i = 0; i < nums.length; i++)
05             total += nums[i];
06         return (double) total / (double) nums.length;
07     }
08
09     public static void main(String [] args)
10     {
11         long total = 123;
12         int [] vals = new int[1000];
13         for (int i = 0; i < vals.length; i++)
14             vals[i] = RandomUtil.getRandomNum(1, 10);
15         System.out.println("avg " + average(vals));
16         System.out.println("total " + total);
17     }
18 }
```

# Quiz: variable scope

What if we remove  
line 12?

```
00 public class AverageArray
01 {
02     public static double average(int [] nums)
03     {
04         long total = 0;
05         for (int i = 0; i < nums.length; i++)
06             total += nums[i];
07         return (double) total / (double) nums.length;
08     }
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10     public static void main(String [] args)
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17         System.out.println("total " + total);
18     }
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What if we remove  
line 12?

**Compile error:  
total cannot be  
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14             vals[i] = RandomUtil.getRandomNum(1, 10);
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16         System.out.println("total " + total);
17     }
18 }
```

# Summary

- **Static methods**
  - **Helper functions** that perform calculations, output data, etc.
  - Methods have **input parameters** and an (optional) **return value**
  - We're already experts at using them
    - `StdDraw.show(100)`, `StdIn.readInt()`, `Math.abs()`
  - Now we can make our own methods!