Math.random()
Why do we need randomness?

• Generate unique circumstances each time the program is run.

• More accurately represent real life.

• Make things less predictable.
How do we achieve randomness?

Math.random()
How do we achieve randomness?

Math.random()

Look in Math class (built into Java)
How do we achieve randomness?

Math.random()

Look in Math class (built into Java)

Call the method named random.
How do we achieve randomness?

Math.random()

Then what happens?  

link
How do we achieve randomness?

Math.random()

Then what happens?

A double is returned whose value is greater than or equal to 0.0 and less than 1.0:

0.888237
0.132
0.0
1.0
How do we achieve randomness?

Math.random()

Great, but what if we need a random double between 0 and 10 to simulate how much snow fell?
How do we achieve randomness?

Math.random()

Great, but what if we need a random double between 0 and 10 to simulate how much snow fell?

    double r = Math.random();

Since $0 \leq r < 1$, 
How do we achieve randomness?

Math.random()

Great, but what if we need a random double between 0 and 10 to simulate how much snow fell?

    double r = Math.random();

Since $0 \leq r < 1$,

    $10 \ast 0 \leq 10 \ast r < 10 \ast 1$

Thus, $0 \leq 10 \ast r < 10$. 
How do we achieve randomness?

Math.random()

Great, but what if we need a random double between 0 and 10 to simulate how much snow fell?

    double r = Math.random();

Since $0 \leq r < 1$,

    $10 \times 0 \leq 10 \times r < 10 \times 1$

Thus, $0 \leq 10 \times r < 10$. So set:

    double r = 10 * Math.random();

for a random double between 0 and 10 (not including 10).
How do we achieve randomness?

`Math.random()`

Great, but what if we need a random double between 3 and 10?

```java
    double r = Math.random();
```

Since $0 \leq r < 1$,

$$7 \times 0 \leq 7 \times r < 7 \times 1$$

Thus, $0 \leq 7 \times r < 7$

and, $0 + 3 \leq 7 \times r + 3 < 7 + 3 \implies 3 \leq 7 \times r + 3 < 10$

So set:

```java
    double r = 7 * Math.random() + 3;
```

for a random double between 3 and 10 (not including 10).
How do we achieve randomness?

In general, if we need a random double between $X$ and $Y$ (including $X$, but not $Y$),

$$\text{double } r = (Y - X) \times \text{Math.random()} + X;$$
How do we achieve randomness?

Math.random()

What if we need a random \texttt{integer} between 3 and 10?
Since \(0 \leq \text{Math.random()} < 1\),
\[
3 \leq 7 \times \text{Math.random()} + 3 < 10
\]
How do we achieve randomness?

Math.random()

What if we need a random **integer** between 3 and 10?

Since $0 \leq \text{Math.random()} < 1$,

$$3 \leq 7 \times \text{Math.random()} + 3 < 10$$

$$\lfloor \text{(int)} (7 \times \text{Math.random()}) + 3 \rfloor \leq ?$$
How do we achieve randomness?

Math.random()

What if we need a random integer between 3 and 10?

Recall that,

\[
\begin{align*}
\text{(int)} & \ 1.322 \ = \ 1 \\
\text{(int)} & \ 7.6894 \ = \ 7 \\
\text{(int)} & \ 9.9999 \ = \ 9 \\
\text{(int)} & \ 10.001 \ = \ 10 \\
\text{(int)} & \ 0.232 \ = \ 0
\end{align*}
\]

So,

\[
\text{(int)} \ \text{Math.random()} \ = \ ?
\]
How do we achieve randomness?

Math.random()

What if we need a random integer between 3 and 10?

Recall that,

\[
\begin{align*}
(int) \ 1.322 &= 1 \\
(int) \ 7.6894 &= 7 \\
(int) \ 9.9999 &= 9 \\
(int) \ 10.001 &= 10 \\
(int) \ 0.232 &= 0
\end{align*}
\]

So,

\[
(int) \ Math.random() = 0
\]
How do we achieve randomness?

Math.random()

What if we need a random integer between 3 and 10?
Since $0 \leq \text{Math.random()} < 1$,

$$3 \leq 7 \times \text{Math.random()} + 3 < 10$$

$$? \leq (\text{int})(7 \times \text{Math.random()} + 3) \leq ?$$
How do we achieve randomness?

Math.random()

What if we need a random \textbf{integer} between 3 and 10?

Since $0 \leq \text{Math.random()} < 1$,

\begin{align*}
3 & \leq 7 \times \text{Math.random()} + 3 < 10 \\
3 & \leq (\text{int})(7 \times \text{Math.random()}) + 3 \leq 9
\end{align*}

So we need,

\begin{align*}
3 & \leq (\text{int})(8 \times \text{Math.random()}) + 3 \leq 10
\end{align*}
How do we achieve randomness?

In general, if we need a random int between X and Y (including both X and Y),

\[
\text{double } r = (\text{int}) \left( (Y - X + 1) \times \text{Math.random()} \right) + X;
\]