# Statements

- Variable declaration

```
type variable;
```

- Assignment

```
variable = expression;
```

- Conditionals

```
if (cond) { statements; }
```

and

```
if (cond) { stmts1; } else { stmts2; }
```

- Loops

```
while (cond) { statements; }
```

- Method invocation (aka method call)

```
objectreference.methodname(parameters);
```

or

```
classname.methodname(parameters);
```

# Statements

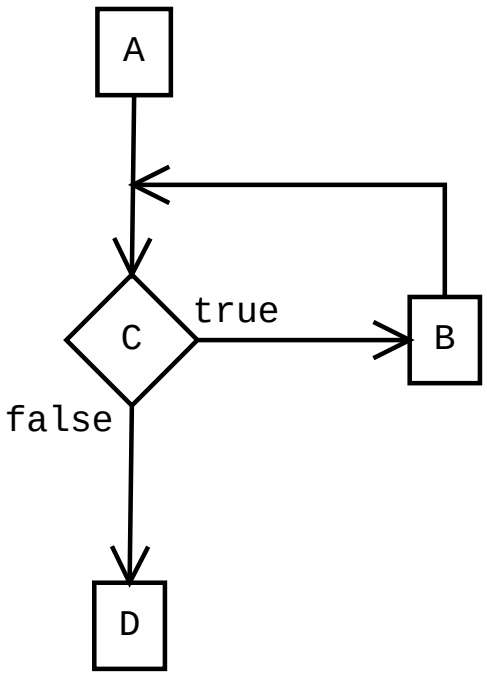
- The role of statements

| Statement | Role |
|---|---|
| Assignment | to change the value of a variable |
| Conditionals | to make decisions |
| Method calls | to send a message to an object,<br>to ask an object to perform an action |
| Static method calls | to execute a procedure |
| Loops | to repeat some action(s) several times |

# Loops

```
A;
while (C) {
  B;
}
D
```

- Control flow diagram:



# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| - | - |

(This table shows the values of the variables just before the statement in red is executed)

Printed:

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 1 | - |

Printed:

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 1 | 1 |

Printed:

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 1 | 1 |

Printed:

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 1 | 1 |

Printed:

1

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 1 | 3 |

Printed:

1

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 2 | 3 |

Printed:

1

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 2 | 3 |

Printed:

1

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 2 | 3 |

Printed:

1
3

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 2 | 5 |

Printed:

1
3

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 3 | 5 |

Printed:

1
3

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 3 | 5 |

Printed:

1
3

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 3 | 5 |

Printed:

```
1
3
5
```

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 3 | 7 |

Printed:

1
3
5

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println("Done");
```

| counter | number |
|---|---|
| 4 | 7 |

Printed:

1
3
5

# Loops

```
int counter, number;
counter = 1;
number = 1;
while (counter <= 3) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
System.out.println(“Done”);
```

| counter | number |
|---|---|
| 4 | 7 |

Printed:

```
1
3
5
Done
```

# Loops

- `while` is *not* the same as `if`

```
int maximum = scanner.nextInt();
int counter = 1;
int number = 1;
while (counter <= maximum) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
```

# Loops

- `while` is *not* the same as `if`

```
int maximum = scanner.nextInt();
int counter = 1;
int number = 1;
if (counter <= maximum) {
    System.out.println(number);
    number = number + 2;
    counter++;
}
```

- The while statement executes a statement or list of statements *repeteadely*, until its condition becomes false

- The if statement executes a statement or list of statements *once*, and only if its condition is true

# Loops

- A loop may not terminate

```
int maximum = scanner.nextInt();
int counter = 1;
int number = 1;
while (counter <= maximum) {
    System.out.println(number);
    number = number + 2;
}
```

- A loop will not terminate if its condition is always true
- The condition of a loop will remain true if its variables never change

# Counting occurrences

- Problem: count the number of times that the letter 'e' occurs in a given string.

# Counting occurrences

- Problem: count the number of times that the letter 'e' occurs in a given string.

- Analysis:
  - Input: a string $s$
  - Output: a positive integer $n$, equal to the number of times 'e' appears in $s$
  - Assumptions: $s$ is all lowercase

# Counting occurrences

- Design:
  - General idea: traverse *s* from left to right, and each time an 'e' is found, increment a counter.
  - Algorithm:
    1. Set *counter* to 0
    2. Set *index* to 0
    3. While *index* $<$ length of *s*, repeat:
       (a) Let *c* be the character at position *index* of *s*
       (b) If *c* is 'e', increment the *counter* by 1
       (c) Increment the *index* by 1

# Counting occurrences

```
String s;
int counter, index;
char c;
s = scanner.nextLine();
counter = 0;
index = 0;
while (index < s.length())
{
  c = s.charAt(index);
  if (c == 'e')
  {
    counter++;
  }
  index++;
}
```

# Abstraction

- The above algorithm does not change if instead of 'e', we count the occurrences of any letter x.

```
char x;
String s;
int counter, index;
char c;
s = scanner.nextLine();
x = scanner.nextChar();
counter = 0;
index = 0;
while (index < s.length())
{
  c = s.charAt(index);
  if (c == x)
  {
    counter++;
  }
  index++;
}
```

- This works for any value of x and any value of s

# Sum

- Problem: compute the sum of the first *n* positive integers for a given positive integer *n*

- Analysis:
  - Input: *n*
  - Output: $\sum_{i=1}^{n} i = 1 + 2 + 3 + ... + (n-1) + n$
  - Assumptions: $n \in \mathbb{N}$

- Design:

1. Set total to 0

2. Set i to 1

3. While i <= n, repeat:

   (a) Set total to total + i
   (b) Set i to i+1

# Sum

```
int n, i, total;
n = scanner.nextInt();
i = 0;
total = 0;
while (i <= n)
{
  total = total + i;
  i = i + 1;
}
System.out.println(total);
```

# Product

```
int n, i, total;
n = scanner.nextInt();
i = 0;
total = 0;
while (i <= n)
{
  total = total + n;
  i = i + 1;
}
System.out.println(total);
```

This computes

$$\sum_{i=1}^{n} n = n^2$$

# Factorial

- Problem: compute the product of the first *n* positive integers for a given positive integer *n*, i.e. the *factorial* of *n*

- Analysis:
  - Input: *n*
  - Output: $n! = \prod_{i=1}^{n} i = 1 \cdot 2 \cdot 3 \cdot ... \cdot (n-1) \cdot n$
  - Assumptions: $n \in \mathbb{N}$

- Design:

1. Set total to 0

2. Set i to 1

3. While i <= n, repeat:

   (a) Set total to total × i
   (b) Set i to i+1

# Factorial

```
int n, i, total;
n = scanner.nextInt();
i = 1;
total = 1;
while (i <= n)
{
  total = total * i;
  i = i + 1;
}
System.out.println(total);
```

# Guessing game

```
import java.util.Scanner;
import java.util.Random;

public class GuessingGame
{
  public static void main(String[] args)
  {
    int die, guess, points, game;
    final int ROUNDS = 10;
    Random generator;
    Scanner scanner;

    generator = new Random();
    scanner = new Scanner(System.in);

    points = 0;
    game = 1;
    while (game <= ROUNDS)
    {
      System.out.print("What is your guess? ");
      guess = scanner.nextInt();
```

```
        die = generator.nextInt(6) + 1;
        if (guess == die)
        {
          points++;
        }
        game++;
      }
      System.out.println(“You guessed ”+points+“ tim
    }
  }
```

# Reverse

- Problem: Given any string, print the string in reverse.
- Analysis:
  - Information involved: a string $w$.
  - Input: $w$
  - Output: a string $v$ which is the reverse of $w$
  - Definitions:
    - The *reverse* of a word $w$ is a word $v$ which has the the same characters as $w$, but in inverse order: the first letter of $v$ is the last of $w$, the second letter of $v$ is the second-to-last of $w$, etc.
  - Note: no restrictions on the string!

# Design

The design for only strings of size 4:

1. Obtain the word $w$
2. Create a new word $v$, initially empty
3. Add the last character of $w$ to the end of $v$
4. Add the third character of $w$ to the end of $v$
5. Add the second character of $w$ to the end of $v$
6. Add the first character of $w$ to the end of v
7. Print $v$

# Design

Generalise the design:

1. Create a new word $v$, initially empty
2. Add the last character of $w$ to the end of $v$
3. Add the second to last character of $w$ to the end of $v$
4. ...
5. Add the second character of $w$ to the end of $v$
6. Add the first character of $w$ to the end of v
7. Print $v$

# Design

Generalise the design:

1. Create a new word $v$, initially empty
2. Traverse the string $w$ from last character to first, adding the corresponding character at the end of $v$
3. Print $v$

# Design

Generalise the design:

1. Create a new word *v*, initially empty

2. Set a variable *index* to be the last index of *w*

3. While the *index* is larger or equal to 0, repeat:

   (a) Let *c* be the character at index, of the string w.
   (b) Append *c* to *v*
   (c) decrement *index* by 1

4. Print *v*

# Implementation

```
// This solution traverses w from right to left
String w, v;
int index;
char c;
w = scanner.nextLine();

v = “”;
index = w.length() - 1;
while (index >= 0)
{
  c = w.charAt(index);
  v = v + c;
  index--;
}
```

# Implementation

```
// This solution traverses w from left to right
String w, v;
int index;
char c;
w = scanner.nextLine();

v = "";
index = 0;
while (index <= w.length() - 1)
{
  c = w.charAt(index);
  v = "" + c + v;
  index++;
}
```

# Prime numbers

- Problem: determine whether a given positive integer is prime or not

# Prime numbers

- Analysis:
  - Input: an integer n
  - Output: a boolean: true if n is prime, false otherwise
  - Definitions:
    * A *prime* number is a number which is divisible only by 1 and itself
    * An integer *a* is *divisible* by *b* if there is an integer k such that $a = kb$
  - Assumptions: *n* is positive

# Prime numbers

- Basic idea: try to find a factor of $n$ (i.e. a number that divides $n$), between 1 and $n$. If such number exists. then $n$ is not prime, otherwise it is prime.

1. Set *is_prime* to true

2. Set $i$ to be 2

3. While $i < n$, repeat:

   (a) if $i$ divides $n$, then set *is_prime* to false
   (b) increment i by 1

4. Return the value of *is_prime*

# Prime numbers

```
boolean is_prime = true;
int i = 2;
while (i < n)
{
  if (n % i == 0)
  {
    is_prime = false;
  }
  i++;
}
```

# Prime numbers

```
boolean is_prime = true;
int i = 2;
while (i < n)
{
  if (n % i == 0)
  {
    is_prime = false;
    i = n;
  }
  i++;
}
```

# Prime numbers

```
boolean is_prime = true;
int i = 2;
while (i < n)
{
  if (n % i == 0)
  {
    is_prime = false;
    break;
  }
  i++;
}
```

# The end