Topic 11
Scanner object, conditional execution

"There are only two kinds of programming languages: those people always ... [complain] about and those nobody uses."
— Bjarne Stroustrup, creator of C++

Input and System.in

- **interactive program**: Reads input from the console.
  - While the program runs, it asks the user to type input.
  - The input typed by the user is stored in variables in the code.
  - Can be tricky; users are unpredictable and misbehave.
  - But interactive programs have more interesting behavior.

- **Scanner**: An object that can read input from many sources.
  - Communicates with System.in
  - Can also read from files (Ch. 6), web sites, databases, ...

Scanner syntax

- The **Scanner class is found in the java.util package**.
  
  ```java
  import java.util.Scanner;
  ```

- **Constructing a Scanner object to read console input**:
  
  ```java
  Scanner name = new Scanner(System.in);
  ```

  - Example:
    
    ```java
    Scanner console = new Scanner(System.in);
    ```

Scanner methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>nextInt()</code></td>
<td>reads an int from the user and returns it</td>
</tr>
<tr>
<td><code>nextDouble()</code></td>
<td>reads a double from the user</td>
</tr>
<tr>
<td><code>nextLine()</code></td>
<td>reads a one-line String from the user</td>
</tr>
</tbody>
</table>
| `next()`     | reads a one-word String from the user
|              | Avoid when Scanner connected to System.in                |

- Each method waits until the user presses Enter.
- The value typed by the user is returned.

- **prompt**: A message telling the user what input to type.

  ```java
  System.out.print("How old are you? "); // prompt
  int age = console.nextInt();
  System.out.println("You typed " + age);
  ```
Scanner example

```java
import java.util.Scanner;

public class UserInputExample {
    public static void main(String[] args) {
        Scanner console = new Scanner(System.in);
        System.out.print("How old are you? ");
        int age = console.nextInt();
        System.out.println("years ");
        System.out.println(age + " years until retirement!");
    }
}
```

Console (user input underlined):

How old are you? 29
36 years until retirement!

Scanner example 2

```java
import java.util.Scanner;

public class ScannerMultiply {
    public static void main(String[] args) {
        Scanner console = new Scanner(System.in);
        System.out.print("Please type two numbers: ");
        int num1 = console.nextInt();
        int num2 = console.nextInt();
        int product = num1 * num2;
        System.out.println("The product is "+ product);
    }
}
```

Output (user input underlined):

Please type two numbers: 8 6
The product is 48

Input tokens (clicker question)

- **token**: A unit of user input, as read by the Scanner.
  - Tokens are separated by whitespace (spaces, tabs, new lines).
  - How many tokens appear on the following line of input?

```
23 John Smith 42.0 "Hello world" $2.50 "19"
```

A. 2 B. 6 C. 7

D. 8 E. 9

input tokens

- When a token is the wrong type, the program crashes. (runtime error)

```
System.out.print("What is your age? ");
int age = console.nextInt();
```

Output:

What is your age? **Timmy**
java.util.InputMismatchException
    at java.util.Scanner.nextInt(Unknown Source)
    at java.util.Scanner.nextInt(Unknown Source)
...
The if/else statement

reading: 4.1

The if statement

Executes a block of statements only if a test is true

```java
if (test) {
    statement;
    ...
    statement;
}
```

Example:
```java
double gpa = console.nextDouble();
if (gpa >= 2.0) {
    System.out.println("Application accepted.");
}
```

Relational expressions

- if statements and for loops both use logical tests.
  ```java
  for (int i = 1; i <= 10; i++) {
      ...
      if (i <= 10) {
          ...
  }
  ```
  
  - These are boolean expressions, seen in Ch. 5.

- Tests use relational operators:

<table>
<thead>
<tr>
<th>Operator</th>
<th>Meaning</th>
<th>Example</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>==</code></td>
<td>equals</td>
<td>1 + 1 == 2</td>
<td>true</td>
</tr>
<tr>
<td><code>!=</code></td>
<td>does not equal</td>
<td>3.2 != 2.5</td>
<td>true</td>
</tr>
<tr>
<td><code>&lt;</code></td>
<td>less than</td>
<td>10 &lt; 5</td>
<td>false</td>
</tr>
<tr>
<td><code>&gt;</code></td>
<td>greater than</td>
<td>10 &gt; 5</td>
<td>true</td>
</tr>
<tr>
<td><code>&lt;=</code></td>
<td>less than or equal to</td>
<td>126 &lt;= 100</td>
<td>false</td>
</tr>
<tr>
<td><code>&gt;=</code></td>
<td>greater than or equal to</td>
<td>5.0 &gt;= 5.0</td>
<td>true</td>
</tr>
</tbody>
</table>
Logical operators

Tests can be combined using logical operators:

<table>
<thead>
<tr>
<th>Operator</th>
<th>Description</th>
<th>Example</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;&amp;</td>
<td>and</td>
<td>(2 == 3) &amp;&amp; (-1 &lt; 5)</td>
<td>false</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or</td>
</tr>
<tr>
<td>!</td>
<td>not</td>
<td>!(2 == 3)</td>
<td>true</td>
</tr>
</tbody>
</table>

"Truth tables" for each, used with logical values p and q:

| p | q | p && q | p || q |
|---|---|--------|-------|
| true | true | true | true |
| true | false | false | true |
| false | true | false | true |
| false | false | false | false |

<table>
<thead>
<tr>
<th>p</th>
<th>!p</th>
</tr>
</thead>
<tbody>
<tr>
<td>true</td>
<td>false</td>
</tr>
<tr>
<td>false</td>
<td>true</td>
</tr>
</tbody>
</table>

Nested if/else

Chooses between outcomes using many tests

```java
if (test) {
    statement(s);
} else if (test) {
    statement(s);
} else {
    statement(s);
}
```

Example:
```java
if (x > 0) {
    System.out.println("Positive");
} else if (x < 0) {
    System.out.println("Negative");
} else {
    System.out.println("Zero");
}
```

Exercises

- Write a method that prints out if it is good weather to go for a bike ride. The weather is good if the temperature is between 40 degrees and 100 degrees inclusive unless it is raining, in which case the temperature must be between 70 degrees and 110 degrees inclusive
- Write a method that returns the largest of three numbers using if statements
- Write a method that determines if one day is before another day (given month and day)

Exercise

- Prompt the user to enter two people's heights in inches.
  - Each person should be classified as one of the following:
    - short (under 5'3")
    - medium (5'3" to 5'11")
    - tall (6' or over)
  - The program should end by printing which person is taller.

Height in feet and inches: 5 7
You are medium.

Height in feet and inches: 6 1
You are tall.

Person #2 is taller than person #1.
Exercises

- Write a method that asks a user for 3 numbers and returns true if the numbers are all distinct
- Write a method that determines if a number is a perfect number. A perfect number equals the sum of its integer divisors, excluding itself
  \[ 6 = 1 + 2 + 3, \text{ perfect} \]
  \[ 8 > 1 + 2 + 4, \text{ deficient} \]
  \[ 12 < 1 + 2 + 3 + 4 + 6, \text{ excessive} \]

Exercises

- Write a method that determines if we have time to go out for lunch. Inputs are distance to restaurant, average walking speed, time required to finish meal, time available, expected cost of meal, and money available
- times are expressed as whole number of minutes
- money is expressed as a double