Programs, Statements, Variables

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General

- Documentation:
  - Java language specification: all details of the programming language.
  - Java Platform API specification: all standard class libraries for input/output, graphics, ... (API: application programming interface).
- Various programming environments:
  - Free: Java Development Kit (JDK), Eclipse, Netbeans, ...
  - Commercial: JDeveloper, IntelliJ, ...
- Two kinds of Java programs:
  - Applications: standalone programs.
  - Applets: programs embedded into Web pages.

We focus on Java applications in this course.

Java Source Code

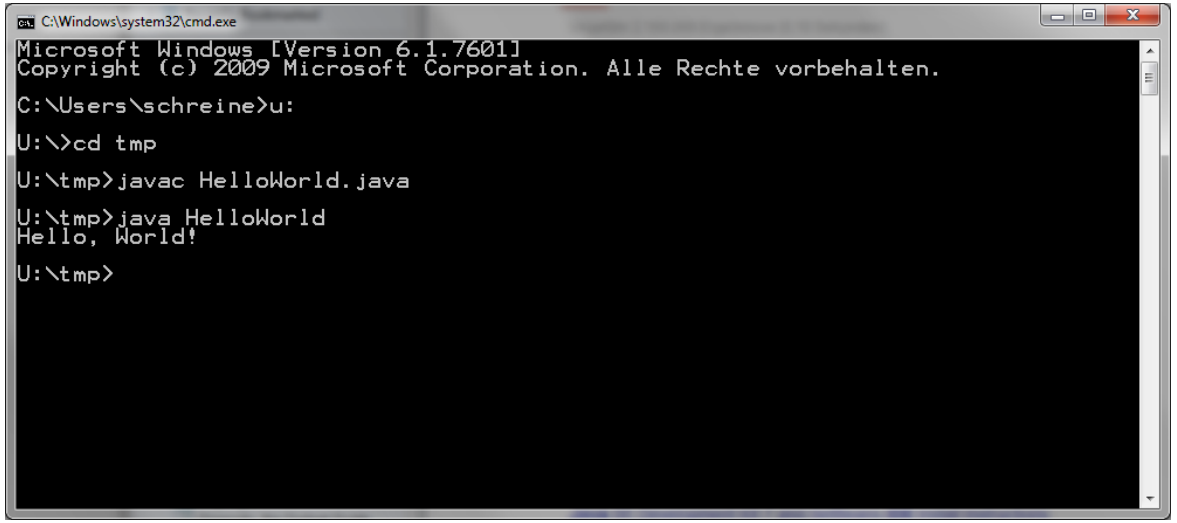
```
public class Name
{
  public static void main(String[] args)
  {
    ...
  }
}
```

- Class *Name*.
  - *Name* is a Java identifier, e.g. `Prog_2A`.
- Method `main`:
  - Body { ... } contains statements executed by program.
- File *Name*`.java`

```
javac Name.java
java Name
```

Example

```
public class HelloWorld // HelloWorld.java
{
  public static void main(String[] args)
  {
    System.out.println("Hello, World!");
  }
}
```



Source Code Format

Format does not have any logical significance

```
public class Name {
  public static void main(String[] args) {
    ...
  }
}
```

```
public class Name { public static void main ( String [ ] args ) { ... } }
```

- May insert/remove empty space or lines.
- Only sequence of tokens matters:
  - `public`, `class`, *Name*, {, ...

Source code must be readable by other people.

Source Code Conventions

- Use indentation to exhibit program structure:
  - After token {, start a new line and indent it by e.g. 2 characters.
- Do not use more than 78 characters per line.
  - Break a longer line into two lines.
- Use English for identifiers.
  - Foreign programmers may have to read your source code.
- Write comments.
  - Descriptions in natural language (English).
  - Ignored by compiler, help humans to understand program.
  - Most important: class and method headers.

Find your own style and stick to it consistently.

Comments

```
// ---------------------------------------------------------------------
// Example.java
// Show the general structure of a Java application
//
// Author:  Wolfgang Schreiner <Wolfgang.Schreiner@fhs-hagenberg.ac.at>
// Created: August 18, 2001
// Changed: August 19, 2001
//   Changed the name of the class.
// ---------------------------------------------------------------------
public class Example
{
  // -------------------------------------------------------------------
  // print a sample string to the standard output stream
  // -------------------------------------------------------------------
  public static void main(String[] args)
  {
    System.out.println("Hello, World!");
  }
}
```

Basic Text Output

- Method body consists of sequence of statements.
  - Each statement terminated by a semicolon (`;`).
  - Compiled to one or more machine instructions.
  - Executed in the order in which they occur.
  - Effect which is internal to program or influences external environment.
- Output statements:

  `System.out.print(`*string*`)`
  `System.out.println(`*string*`)`

  - `print`: prints a string (sequence of characters) to the standard output (typically: terminal).
  - `println`: prints the string and starts a new line afterwards.

Can write programs that generate multiple lines of output.

Example

- Main Method:

```
public static void main(String[] args)
{
  System.out.print("One, ");
  System.out.print("two, ");
  System.out.println("three.");
  System.out.println("We are done.");
}
```

- Output:

```
One, two, three.
We are done.
```

Printing of Integers

- May print integer numbers and strings:

```
System.out.print("1 plus 1 is ");
System.out.print(2);
System.out.println(".");
```

- Output:

```
1 plus 1 is 2.
```

- Simpler form:

```
System.out.println(1 + " plus " + 1 + " is " + 2 + ".");
```

  - Compiler converts number 2 to string "2".
  - Operator + concatenates strings.
  - Same output as above.

String Literals

- Character " delimits string literals.
- Use escape sequence \" to include " in literal:
  - Statement:

```
System.out.println("He said \"Hello\" and left.");
```

  - Output:

```
He said "Hello" and left.
```

- Also escape character \ has to be escaped:
  - Statement:

```
System.out.println("C:\\windows\\system");
```

  - Output:

```
C:\windows\system
```

More Escape Sequences

- New line character `\n` and tabulator `\t`:
  - Statement:

```
System.out.println("He said:\n\tYes.\nShe said:\n\tNo.");
```

  - Output:

```
He said:
        Yes.
She said:
        No.
```

Various other escape sequences (see reference manual).

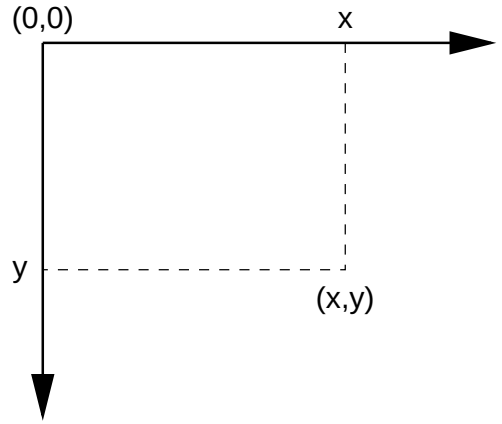
Basic Graphical Output

- Simple framework provided by file `kwm.jar`:

```
import kwm.*;
import java.awt.*;
public class Name {
   public static void main(String[] args) {
     Drawing.begin("title", width, height);
     Drawing.graphics.operation(...);
     ...
     Drawing.end();
   }
}
```

- `Drawing.graphics.operation(...);`
  - Statements to paint graphics on the screen.

Graphical Coordinate System



- Coordinate units are given in screen pixels.

Second coordinate grows from top to bottom.

Graphical Operations

Operation	Description
`drawRect(`x`, `y`, `w`, `h`)`	draw rectangle $[x \ldots x+w, y \ldots y+h]$
`drawOval(`x`, `y`, `w`, `h`)`	draw oval $[x \ldots x+w, y \ldots y+h]$
`drawLine(`$x1$`, `$y1$`, `$x2$`, `$y2$`)`	draw line from $(x1, y1)$ to $(x2, y2)$
`drawString(`s`, `x`, `y`)`	draw string s at (x, y)
`fillRect(`x`, `y`, `w`, `h`)`	fill rectangle $[x \ldots x+w, y \ldots y+h]$
`fillOval(`x`, `y`, `w`, `h`)`	fill oval $[x \ldots x+w, y \ldots y+h]$
`setColor(`c`)`	set drawing color to c

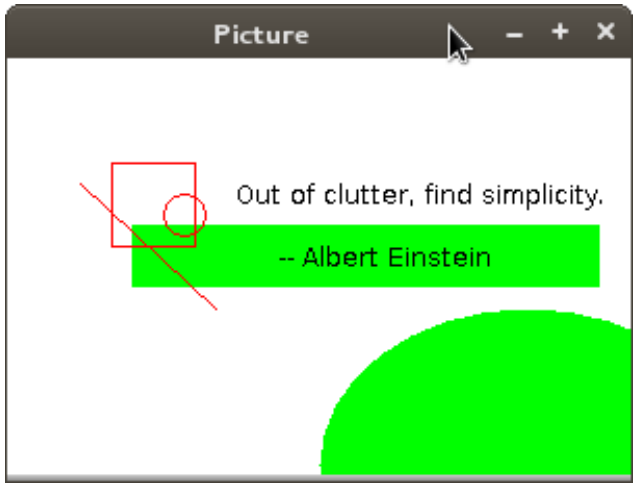
```
Drawing.graphics.fillRect(60, 80, 225, 30);
```

- Draw a rectangle whose left upper corner is 60 pixels to the right and 80 pixels down and that extends 225 pixels to the right and 30 pixels down.

```
Drawing.graphics.setColor(Color.red);
```

- Set the drawing color of the following operations to red.

Example



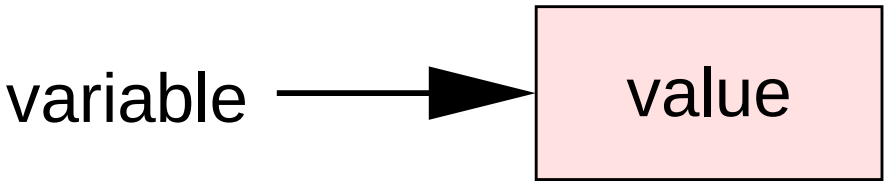

```
public static void main(String[] args) {
  Drawing.begin("Picture", 300, 200);

  Drawing.graphics.setColor(Color.green);
  Drawing.graphics.fillRect (60, 80, 225, 30);
  Drawing.graphics.fillOval (150, 120, 200, 150);
  Drawing.graphics.setColor(Color.red);
  Drawing.graphics.drawRect (50, 50, 40, 40);
  Drawing.graphics.drawOval (75, 65, 20, 20);
  Drawing.graphics.drawLine (35, 60, 100, 120);
  Drawing.graphics.setColor(Color.black);
  Drawing.graphics.drawString ("Out of clutter, find simplicity.", 110, 70);
  Drawing.graphics.drawString ("-- Albert Einstein", 130, 100);

  Drawing.end();
}
```

Variables

- Program data are kept in variables:
  - Name for a memory address at which a data value is stored.
  - Container/box that contains values.



- Variable declaration.
  - Creation of a variable and initialization with a value.
- Variable assignments.
  - Modification of the variable content.

Variable Declarations

- Variable declaration:
  1. reserve a portion of memory space to hold a particular type of value,
  2. to initialize this portion with a particular value of this type,
  3. refer further on to this portion by a particular name.
- Statements:

```
String name = "Markus";
int age = 21;
System.out.println(name + " is " + age + " years old.");
```

  – Variable $name$ of type `String` initialized as "Markus".
  – Variable $arge$ of type int initialized as 21.
- Output:

```
Markus is 21 years old.
```

Variable Declarations

- General Format:

  type identifier = *value*;

  – *type* denotes the kind of data that the variable may hold, e.g. `int` for integer numbers and `String` for character strings;

  – *identifier* is the name of the variable which may be used from the point of the declaration to the end of the method;

  – *value* is the initial value of the variable.

- Naming convention:

  – Variable names usually start with a lower-case letter.

  – `i`, `number`, `temperature`.

It is an error to declare a variable twice (in the same scope).

Assignments

- Assignment statement:

  identifier `=` *value* `;`

  – "*identifier* becomes *value*".

  – Write the value denoted by the right hand side to the variable identified by the left hand side.

- Program:

```
int x = 3;
x = x+1;
```

  – Right: "x becomes $x+1$".

  – Wrong: "x is $x+1$".

  – Old value: 3; new value: 4.

"Varying" means "changing".

Example

- Statements:

```
String name = "Markus";
int age = 21;
System.out.println(name + " is " + age + " years old.");
name = "Michaela";
age = 23;
System.out.println(name + " is " + age + " years old.");
```

- Output:

```
Markus is 21 years old.
Michaela is 23 years old.
```

Effect of a statement depends on the values of the variables used.

Assignments

- Value in assignment must be of declared variable type.
  - Program:

```
int age = 21;
age = "twentyone";
```

  - Compiler:

```
Main.java:6: incompatible types
found   : java.lang.String
required: int
    age = "twentyone";
          ^
```

- May omit initialization, if assigned before first use:

```
int age;
age = 21;
System.out.println(age);
```

Constant Declarations

- Constant Declaration:

  ```
  final type identifier = value;
  ```

  – *identifier* is declared as "constant".

  – Value cannot be changed any more (no assignment possible).

- Use constant declarations for special values:

  ```
  final int MAX_VALUE = 127;
  final String SYS_DIR = "c:\\windows";
  ```

  – Names of constants often written in capital letters to distinguish them from variables.

"Constant" means "not changing".

Choosing Variable Names

- Name should be a noun denoting the value it holds:

```
int temperature = 17;
int maximumTemperature = 17;
String directoryName = "c:\\windows";
```

- Names should better not be too long:

```
int maxTemp = 17;
String dirName = "c:\\windows";
```

- Names should not be too short:

```
int mt = 17;
String dn = "c:\\windows";
```

- Annotate declarations by comments:

```
int temp = 0;     // temperature taken in last measurement
int maxTemp = 0;  // maximum temperature of all measurements
int avgTemp = 0;  // average temperature of all measurements
```