# “Nuts and Bolts” (*)

covering

** variables
** assignment
** keywords

** primitive types
** basic operations
** control structures

Chapter 3 (sections 3.1–3.5; 3.8) – “Core Java” book
Chapters 1+3 – “Head First Java” book
Chapters 2–4 – “Introduction to Java Programming” book
Chapter 2 (sections 2.1 – 2.5) – “Java in a Nutshell” book

(*) Basic, practical details of Java.

Queen Mary
University of London

# Java Program Structure

Basic Program Template:

```
class ClassName {
   public static void main(String[] args) {
      // declarations of variables and methods
      // intermingled with statements
   }
}
```

# Example: a simple operation

```
/**
 *  A simple operation.
 */
public class MyOperation {
   public static void main(String[] args) {
      int a = 6;
      int b = 5;
      int product = a * b;
      System.out.println("a=" + a);
      System.out.println("b=" + b);
      System.out.println("product=" + a + "*" + b + "=" + product);
   }
}
```

data type
variables
constants
expressions

```
a=6
b=5
product = 6*5=30
```

# Variables

- Unlike almost every other language, variables in Java can be declared anywhere in a program (though the program logic may require you to define certain variables before certain statements).

- The format for variable declarations is essentially the same as in C.

- Thus you can either declare variables as follows:

Variable Declaration

```
typeName name1, name2, ... namen;
typeName name1 = initvalue;
```

# Basic data types

- Java is strongly typed and strongly classed.
  - Only variables with the same types or classes can be used together.

| Primitive Types | |
|---|---|
| `byte, short, int, long:` | for integers |
| `float, double:` | for real numbers |
| `boolean:` | for boolean values |
| `char:` | for characters |

- Every data type in Java has a default value, and sometimes a variable will be initialised to this default value.

Always get in the habit of initialising your variables.
We will see later when Java uses default values and when it does not.

What about Strings?
In Java, Strings are not a primitive data type; they are objects. More about this later …

# Primitive Data Types: Quick Reference

| Type | Representation | Default value | Storage | Maximum value |
|---|---|---|---|---|
| byte | signed integer | 0 | 8 bits | +127 |
| short | signed integer | 0 | 16 bits | +32767 |
| int | signed integer | 0 | 32 bits | +2147483647 |
| long | signed integer | 0L | 64 bits | over $+10^{18}$ |
| float | floating point | 0.0f | 32 bits | over $+10^{38}$ |
| double | floating point | 0.0d | 64 bits | over $+10^{308}$ |
| boolean | true or false | false | 1 bit | N/A |
| char | UNICODE | u0000 | 16 bits | uFFFF |

Be Careful Bears Shouldn’t Ingest Large Furry Dogs! ☺

# Naming Guidelines: variables + identifiers

- The rules for variable names (and indeed all identifiers*)* follow the same conventions as in C:
  - The convention is to intercap names, e.g.

    `staffSalary` is preferred to `staff-salary`
  - Variables and methods should start with lowercase:

    ```
    int x;
    int myVariable = 0;
    public void myMethod();
    ```
  - Class names should start with uppercase:

    ```
    public class Example {}
    public class MyFirstJavaProgram {}
    ```
  - Use pronounceable names.
  - Use names that are descriptive (but be brief), e.g.

    `calculatePower()` or `calcPower()`,
    not `calculateThePowerOfTheInputVariable()`

# Variable Names: Good Examples

```
int anInteger = 42;
byte smallNumber = 2;
short shortNumber = 1234;
long aVeryLongNumber = 86827263927L;
float ratio = 0.2363F;


double delta = 453.523311903;
char topGrade = ‘A’;
char another = ‘c’;
boolean flag = true;
boolean done = false;
```

If you write `long aVeryLongNumber = 86827263927`, Java “interprets” this as an `int` variable.

If you write `float ratio = 0.2363`, Java “interprets” this as a `double` variable.

… and things for you to try out!

# Java Reserved Words

- Every programming language has keywords that cannot be used as identifiers; so does Java. Some of the Java keywords are:

abstract
**boolean**
break
**byte**
case
catch
**char**
**class**
const
continue
do
**double**

else
extends
final
finally
**float**
for
goto
if
implements
import
instanceof
**int**

interface
**long**
native
new
null
package
private
protected
**public**
return
**short**
**static**

super
switch
synchronized
this
throw
throws
transient
try
**void**
volatile
while

# Assignments and Operators (1/2)

- As in C, assignments are done via the **=** statement

```
int i;
i = 9;
i = i + 1;      // i has the value 10
```

- Java also provides the **++** and **--** operators to increment and decrement an **int** variable by **1**:

```
int i;
i = 9;     // i has the value 9
i++;       // i has the value 10
i--;       // i has the value 9
```

# Assignments and Operators (2/2)

```
i++;
```

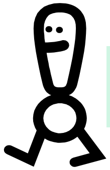
is essentially the same as

```
i = i + 1;
```

Increments and Decrements

| | |
|---|---|
| postincrement: `i++` | preincrement: `++i` |
| postdecrement: `i--` | predecrement: `--i` |

- A post operation causes the variable to be used ‘as is’ in the current statement, and it is incremented or decremented afterwards.
- A pre operation causes the variable to first be incremented or decremented, and then it is used in the current statement.



Try to use only post operations to begin with!

# (Assignment) Operators

- Operators for numeric values in Java are essentially the same as in C:
- Examples:

```
int i, j, k;
i = 9;
j = 3;
k = 2;
i = i * (j + k);     // i=?
j = i / 4;           // j=?
k = i % 4;           // k=?
```

| Operators | |
|---|---|
| + | addition |
| * | multiplication |
| % | remainder |
| - | subtraction |
| / | division |

- All arithmetic operators can be combined with assignment statements.

- Examples:

```
int c=3;
c += 7;  // c = c + 7 = ?
c -= 5;  // c = c - 5 = ?
c *= 6;  // c = c * 6 = ?
c /= 3;  // c = c / 3 = ?
c %= 3;  // c = c % 3 = ?
```

… and things for you to try out!

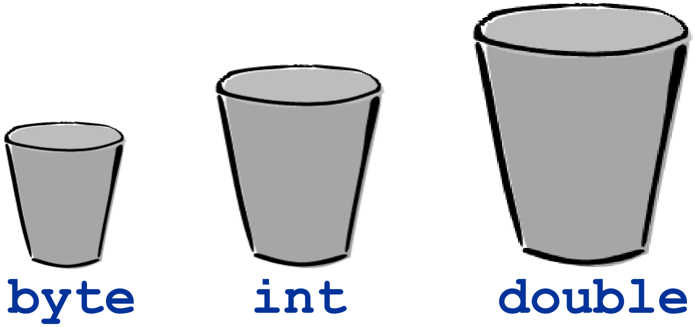
# Type Cast and Casting Primitive Variables

- Conversion between numeric types:

  `byte => short => int => long => float => double`

- In the other direction, e.g. `float => int`,
  we have to use the type cast operator.

| Type Cast |
|---|
| (type) expression |



- When a variable is declared, it is like a cup has been created for that variable of exactly the right size and shape.
- It can only ever be of that size and shape:
  - it cannot change
  - the only things that can use that cup must be of that size and shape!

# Example: Type Cast

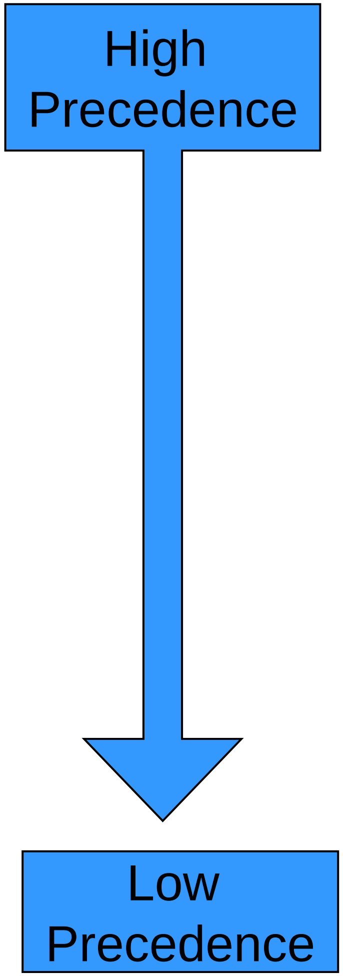
```
/**
  * ExampleTypeCast: prints an example of type casting
  * @author Raul Mondragon
  */
class ExampleTypeCast {
  public static void main(String[] args) {
    double x = 6.8;
    int i, j;
    j = (int)(x + 1.3);
    i = (int) x + (int) 1.3;
    System.out.println("j = " + j + "," + "i = " + i);
  }
}
```

The output is:

```
j = 8,i = 7
```

# Operator Precedence

Equal Precedence


High Precedence

Low Precedence

| Operators | Precedence |
|---|---|
| postfix | `expr++ expr--` |
| unary | `++expr --expr +expr -expr ~ !` |
| multiplicative | `* / %` |
| additive | `+ -` |
| shift | `<< >> >>>` |
| relational | `< > <= >= instanceof` |
| equality | `== !=` |
| bitwise AND | `&` |
| bitwise exclusive OR | `^` |
| bitwise inclusive OR | `\|` |
| logical AND | `&&` |
| logical OR | `\|\|` |
| conditional | `? :` |
| assignment | `= += -= *= /= %= &= ^= \|= <<= >>= >>>=` |

More information at:
https://docs.oracle.com/javase/tutorial/java/nutsandbolts/operators.html

# Other Precedence Rules

- Operators with higher precedence are evaluated before operators with relatively lower precedence.

- Operators on the same line have equal precedence.

- Equal precedence:
  - binary operators (except assignment) are evaluated from left to right
  - assignment operators are evaluated right to left

# Precedence Operators: general advice

- Some operators may behave a bit differently in other languages! For example, never say something like:

✗
```
int i = 0;
i = i++;      // now i is 0, not 1
```

- Keep it simple: try to use `++` and `--` only in standalone statements, not in expressions.
  - You will be expected to be able to decipher (examples of this):

    `int x = a++ + 5;` but not `int x = a++ + ++a;`

  - Similarly, avoid mixing assignment and truth tests or other statements:

✗
```
if ((a=5) == b)
  int k = j + (a=5);
```

- Always use brackets to make your conditions more readable. Example:

  `a + b * c` is more readable as

  `a + (b * c)`

- You should use brackets even if you want to follow operator precedence rules.

# Practice Exercises

1. Which of the following are NOT Java keywords?

   `class, public, thrown, x, extends`

2. Write Java statements to do the following:
   - Declare an `int` variable `count` with initial value `10`.
   - Add `10` to it, and create a new variable `result` that is equal to `count*count`.
   - Set variable `count` equal to `count` divided by `4`.

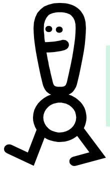
   What are the variables `count` and `result` equal to?

# Control Structures and Relational Operations

- Java provides all the obvious control structures:
  - Selection
    - `if ...`
    - `if ... else ...`
    - `switch`
  - Repetition
    - `while ...`
    - `do ... While ...`
    - `for`

## Relational Operators

| | |
|---|---|
| > | greater than |
| < | less than |
| <= | less than or equal to |
| >= | greater than or equal to |
| == | equality test |
| != | unequality test |



Don’t use = where you mean ==.

# Logical operators: and, or, not

- Java also provides "and", "or", and "not" operators:

| | |
|---|---|
| `&&` | and |
| `\|\|` | or |
| `!` | not |

- Examples:

`&&`

| | |
|---|---|
| true && true | true |
| true && false | false |
| false && true | false |
| false && false | false |

`||`

| | |
|---|---|
| true \|\| true | true |
| true \|\| false | true |
| false \|\| true | true |
| false \|\| false | false |

`!`

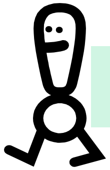
| | |
|---|---|
| !true | false |
| !false | true |

# if and if-else statements

```
public class Grade {
   public static void main(String[] args) {
      int grade = 70;
      if (grade >= 40) {
         System.out.println("passed");
      }
   }
}
```

Relational expression: it must evaluate to a **boolean** value.

```
public class Grade {
  public static void main(String[] args) {
    int grade = 30;
    if (grade >= 40) {
      System.out.println("passed");
    }
    else {
      System.out.println("failed");
    }
  }
}
```



Can also have nested **if-else** statements.

# Common error & things to be careful of

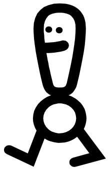
```
int a = 1;
int b = 0;

if (a = b) {
   // action ...
}
else {
   // action ...
}
```

```
if(a==b)
```

- Example:

```
if ((j>i) && (j<k) && (j<=j) && (i++>4)) {
   System.out.println(“no”);
}
```

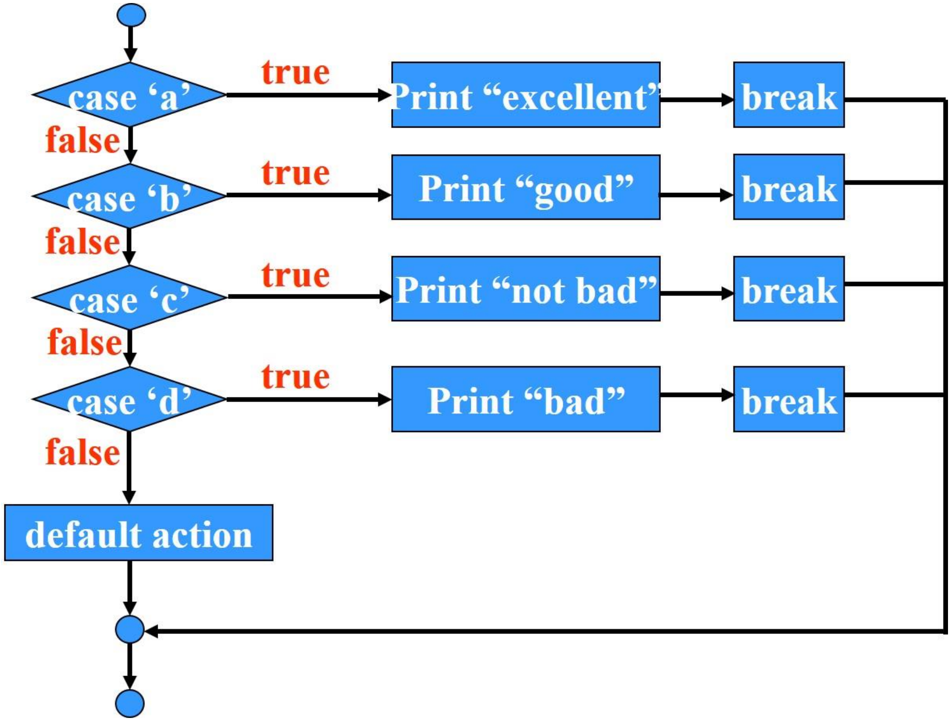


Use brackets (parentheses) to make your conditions readable!

… and things for you to try out!

# The `switch` statement

```
char grade = 'a';
switch (grade) {
   case 'a':
      System.out.println("excellent");
      break;
   case 'b':
      System.out.println("good");
      break;
   case 'c':
      System.out.println("not bad");
      break;
   case 'd':
      System.out.println("bad");
      break;
   default:
      System.out.println("no such grade!");
}
```



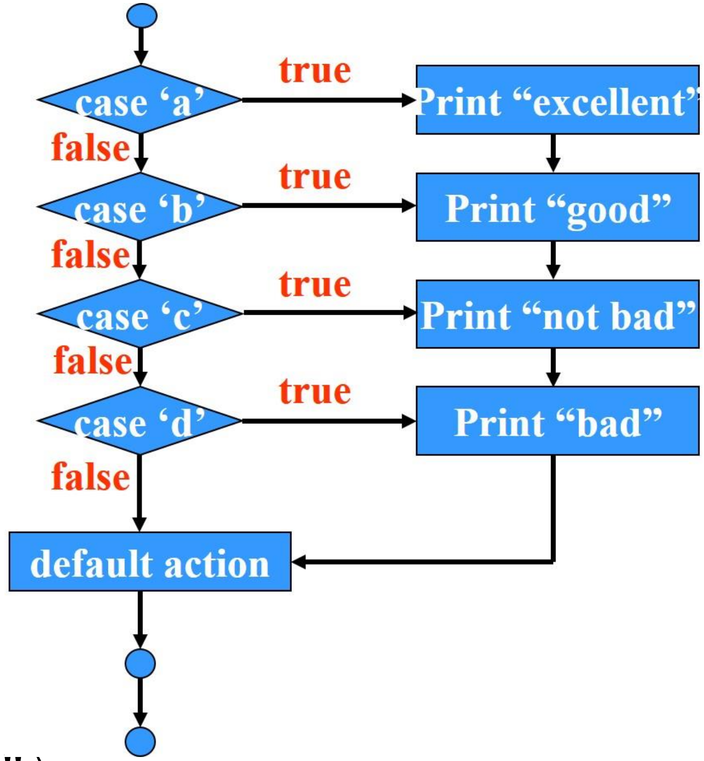
**`break`** – causes the remainder of the **`switch`** statement to be skipped

**`default`** – action in case none of the cases match

# Example: `switch` with missing `breaks`

```
char grade = 'a';

switch (grade) {
  case 'a':
    System.out.println("excellent");
  case 'b':
    System.out.println("good");
  case 'c':
    System.out.println("not bad");
  case 'd':
    System.out.println("bad");
  default:
    System.out.println("no such grade!");
}
```



```
excellent
good
not bad
bad
no such grade
```

# Conditional Operator

| Conditional Operator |
|---|
| **? :** shorthand **if-else** |

```
a = (test? b:c);  // a=b if test is true,
                  // else a=c.
```

Another example:

```
int total =10;
total = (total > 5) ? total+1 : total*2;
```

↓ same as

```
int total =10;
if (total > 5)
   total = total + 1;
else
   total = total * 2;
```

# The `for` statement

- Essentially the same as in C:

```
for (int i = 0; i < 3; i++) {
   System.out.println(“i = ” + i);
}
```

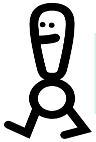
Generates:

```
i = 0
i = 1
i = 2
```

| | |
|---|---|
| Backwards | `for (int n = 10; n >= -6; n--)` |
| Empty | `for (int n = 0; n <= -6; n++)` |
| Nested | `for (int i = 0; i <= 10; i++)`<br>`  for (int j = 0; j <= 78; j++)` |
| Endless | `for (int n = 0; ; n++)`<br>`for ( ; ; )` |

Unfinished use of **`break`** to pass control to the end of the loop

```
for (int n=0; n<=30; n++) {
 // other code
  if(n==10) break; // leaves the for loop when n=10
}
```



The **`int`** is declared <u>and</u> initialised in the **`for`** statement.

# The while and do-while statements

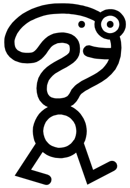
```java
int i = 0;
do {
   System.out.println("i = " + i);
   i++;
} while (i < 3);
```

Generates (for both examples):

```
i = 0
i = 1
i = 2
```

OR

```java
int i = 0;
while (i < 3) {
   System.out.println("i = " + i);
   i++;
}
```



How can we write this code as a **for** loop?

# The break and continue statements

```
class TestBreak {
  public static void main(String[] args) {
     for (int i = 0; i < 10; i++) {
       if (i == 5) break;
      System.out.println("i = " + i);
     }
     System.out.println("Finished.");
  }
}
```

Quitting the loop …

```
class TestContinue {
  public static void main(String[] args) {
     for (int i = 0; i < 10; i++) {
       if (i == 5) continue;
      System.out.println("i = " + i);
     }
     System.out.println("Finished.....");
  }
}
```

Skipping the current iteration …

… and things for you to try out!

# Practice Exercises

1. Write Java statement(s) to determine if the value of an integer variable **`num`** is even or odd.
2. What is the output of the program below?

```
public class Test {
  public static void main(String[] args) {
    int i = 5;
    while (i >= 1) {
      int num = 1;
      for (int j = i; j <= i; j++) {
        System.out.print(num + "xxx");
        num *= 2;
      }
      System.out.println();
      i--;
    }
  }
}
```