Lecture 4 — Scopes and Converting Types

CITS2005 Object Oriented Programming

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Contents

- See Chapter 2 of the textbook
- More variables
- Scopes
- Type conversion and casting

Variables again!

- We've seen variables: `*type* variable-name;`
- The *`type`* describes what sort of thing the variable holds
- We use the `variable-name` to refer to the variable
- Variables only get one type; cannot be changed at runtime
- All variables must have a type
- Java checks the correctness of all operations based on types (an `int` cannot store a `String`)
- Java has *static* typing (instead of *dynamic* like Python, JavaScript, etc)

Variable Initialisation

```java
public class VariableInit {
    public static void main(String[] args) {
        double a = 4.5, b, c = 1.0;
        b = a+c;
        double d = a*b*c*2.0;
        System.out.println("d=" + d);
    }
}
```

- Variables can be initialised in many ways
- Comma separated, dynamic initialisation, declared and initialised separately

Variable Initialisation

```java
public class NoInit {
    public static void main(String[] args) {
        int i;
        System.out.println("i=" + i);
    }
}
```

- What happens if we don't initialise a variable?

Scopes

- So far, we have only looked at variables declared inside the `main` method
- They always exist after they are declared
- There are other places (*scopes*) where they can be declared
- Variables defined in a different scope exist for a different span of time

Scopes

- Every block of code inside curly braces $\{\ldots\}$ is a new scope
- The `main` method has a scope
- Each of the following examples have a scope

Scopes

```java
public class Scopes {
    public static void main(String[] args) {
        if (true) {
            // This is a scope
        }
        while (true) {
            // This is a scope
        }
        for (int i = 0; i < 10; i++) {
            // This is a scope
        }
        {
            // This is a scope (by itself!)
        }
    }
}
```

Scopes

```java
public class Scopes2 {
    public static void main(String[] args) {
        int x = 5;
        if (true) {
            // Duplicate names are not allowed!
            // int x = 2;
            int y = 10;
            System.out.println("x=" + x);
            System.out.println("y=" + y);
        }
        for (int i = 0; i < 1; i++) {
            int y = 20;
            System.out.println("x=" + x);
            System.out.println("y=" + y);
        }
        System.out.println("x=" + x);
        // y cannot be accessed here!
        // System.out.println("y=" + y);
    }
}
```

Scopes

```java
public class NestedScope {
    public static void main(String[] args) {
        int x = 5;
        if (true) {
            int y = 10;
            if (true) {
                int z = 20;
                // x, y, and z are all in scope here
            }
            // x and y are in scope here, but not z
        }
        // x is in scope here, but not y or z
    }
}
```

- Scopes can be nested and capture variables in the enclosing scope(s)

Scopes

```java
public class ScopeLoop {
    public static void main(String[] args) {
        for (int i = 0; i < 3; i++) {
            int j = 10;
            System.out.println("j=" + j);
            j = 100;
        }
    }
}
```

- Variables get reinitialised every time a scope is seen, even if it’s the same scope

Assignment Operator

- We saw lots of operators in the last lecture
- e.g., `+`, `-`, `&&`, `/`, `||`, and more
- Assignment = is also a kind of operator!
- `x = 1+y+5`
- It is a little different to usual
- The left side must be a variable
- The right side must evaluate to a value that can be stored in the variable
- All the other operators we saw produce a result, what is the result of assignment?

Assignment Operator

```
public class Assignment {
    public static void main(String[] args) {
        int x;
        int y = (x = 10);
        y++;
        System.out.println("x=" + x);
        System.out.println("y=" + y);
    }
}
```

- Assignment (=) evaluates to the value that is assigned

Compound Assignment

```java
public class CompoundAssignment {
    public static void main(String[] args) {
        int x = 1;
        x += 4;
        x -= 3;
        x *= 2;
        x /= 3;
        System.out.println("x=" + x);
    }
}
```

- Java allows a shorthand called *compound assignment*
- Works whenever the following would work `x = x + 1;`
- `+=, -=, *=, /=, %=, &=, |=, ^=`

Type Conversion

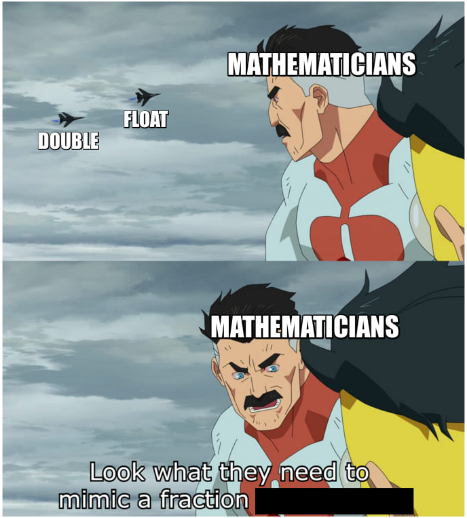
```java
public class AutomaticTypeConversion {
    public static void main(String[] args) {
        int num = 10;
        double d = num;
        System.out.println("num=" + num);
    }
}
```

- Sometimes we want to convert an integer value to a double
- Java allows *some* automatic type conversions like this
- When an assignment is made, an *automatic type conversion* happens when a *widening conversion* is allowed

Type Conversion

- `int` can be convert to `float` or `double`
- This is *widening* since `float` and `double` hold integer values and more
- The opposite direction would not be allowed since an `int` cannot always store a `float` value

Mid-lecture break



Type Conversion

```
public class AutomaticTypeConversion {
    public static void main(String[] args) {
        double d = 2.3;
        // Not allowed!
        // int num = d;
        int x = 10;
        long y = x;
        // Not allowed!
        // short z = x;
    }
}
```

- Recall that `short`, `int`, `long` are 16, 32, and 64 bits respectively
- We cannot convert from `double` to `int`
- We cannot convert from `int` to `short`
- But we can from `int` to `long` because any `int` fits in a `long`

Casting

```java
public class Casting {
    public static void main(String[] args) {
        double d = 66.3;
        int num = (int) d;
        char c = (char) num;
        long l = 11123456789L;
        int x = (int) l;
        System.out.println("num=" + num);
        System.out.println("c=" + c);
        System.out.println("x=" + x);
    }
}
```

- We can force Java to convert between types via a *cast*
- This happens when changing types might mean losing information (e.g., `double` to `int`)
- Floating point numbers are truncated

Casting

```
public class Casting {
    public static void main(String[] args) {
        double d = 66.3;
        int num = (int) d;
        char c = (char) num;
        long l = 11123456789L;
        int x = (int) l;
        System.out.println("num=" + num);
        System.out.println("c=" + c);
        System.out.println("x=" + x);
    }
}
```

- Integer types chop off higher order bits
- 10100010 00001000 10100011 11110010 → 10100011 11110010
- In this course, we only do this when we know the number will fit

Expressions

- An *expression* in Java has a similar meaning to mathematics
- It is something that must evaluate to some value
- `if (expression)...`
- `while (expression)...`
- `System.out.println(expression)`
- `int x = expression;`
- Sometimes, the types of values in an expression change: `3<4 && 1<2`

Type Promotion

```java
public class TypePromotion {
    public static void main(String[] args) {
        int x = 1;
        long y = 2;
        long z = x + y; // This is OK
        double d = z + y; // This is OK
        System.out.println(z);
        System.out.println(d);
    }
}
```

- If Java sees an operator (like +) with different types on either side, it does a *type promotion*
- For example, `x` is promoted to `long` before the operator is evaluated
- The resulting value will have the promoted type

Type Promotion

- `char`, `byte`, `short` are promoted to `int`
- `int` is promoted to `long`
- Any integer type is promoted to `float`
- `float` is promoted to `double`

Type Promotion and `char`

```
public class TypePromotion2 {
    public static void main(String[] args) {
        char a = 'a';
        char b = 'b';
        // Would only cast a!
        // char ab = (char) a + b;
        char ab = (char) (a + b);
        char c = (char) (b + 1);
        char z = 'y' + 1; // This is a special case!
    }
}
```

- `char` is (almost) always promoted to `int`, even if both sides are `char`!
- Since `int` cannot be converted to `char`, we need to *cast* it
- Observe that casting has very high precedence
- There is a special case for constant expressions!

A Note on Parentheses

- Parentheses in Java expressions work the same way as in maths
- They circumvent precedence and group things together
- `(a + b) * (c + d)`