Program Development

Understanding the specification

Prototyping

Testing, debugging

Simplyfing, improving

Optimizing

Domain knowledge

Problem solving

Sharpen pencil

Communication

Lunch

Algorithm, data structure

Planing

Program Development

© 20 August 2023
Objectives

- editing and refactoring
- errors and warnings
- style
- IDE’s
- problem solving
IDE (Integrated Development Environment)

IDE’s can be complicated to learn, diverse, and single-purpose, yet are valuable, because they:

- support the development process in many ways,
- unify the editing and testing in one application, and
- make development easier, faster, and less error prone.

IDE’s accomplish these things by hiding the details.

But it is helpful to understand what is going on.
Developing Java Programs – BlueJ

```java
/**
 * A class representing students for a simple database.
 * @author Michael Kolling
 * @version 1.0, January 1999
 */
public class Student extends Person {
    private String SID; // student ID number
    /**
     * Create a student with default settings.
     */
    public Student() {
        super("(unknown name)", 0000);
        SID = "(unknown ID)";
    }
    /**
     * Create a student with given name, year, and university.
     */
    public Student(String name, int year, University university) {
        super(name, year, university);
        SID = "(unknown ID)";
    }
}
```
Developing Java Programs – Eclipse
Developing Java Programs – Emacs

```
import java.util.Scanner;

public final class CopyText {
    public static void main (final String[] args) {
        final Scanner stdin = new Scanner(System.in);
        // Read the standard input line by line.
        while (stdin.hasNextLine()) {
            // There is another line in the input stream.
            final String line = stdin.nextLine(); // get the next line from input
            System.out.println (line); // write the line to output
        }
    }
}
```

```
// CopyText.java -- read the standard input stream as text and copy to standard out
import java.util.Scanner;

public final class CopyText {
    public static void main (final String[] args) {
        final Scanner stdin = new Scanner(System.in);
        // Read the standard input line by line.
        while (stdin.hasNextLine()) {
            // There is another line in the input stream.
            final String line = stdin.nextLine(); // get the next line from input
            System.out.println (line); // write the line to output
        }
    }
}
```
Developing Java Programs – Intellij

public class Foo {
    public int[] X = new int[]{1, 3, 5, 7, 9, 11};

    public void foo(boolean a, int x, int y, int z) {
        label1:
        do {
            try {
                if (x > 0) {
                    int someVariable = a ? x : y;
                    int anotherVariable = a ? x : y;
                } else if (x < 0) {
                    int someVariable = (y + z);
                    someVariable = x = x + y;
                } else {
                    label2:
                    for (int i = 0; i < 5; i++) doSome
                }
            }
        }
    }
}
- compile error
  - syntax error — Syntax.java
  - semantic error — Semantic.java
  - type error — Type.java

- style error — example program
  Style errors are mistakes in the program source code that contravene policy or hamper the ability of programmers to read and understand the program even though the program can be translated by the compiler into a executable program. A list of errors

- execution error or (fatal) runtime error — example program
  Runtime errors are mistakes that manifest themselves during the execution of the program. These errors prevent the computer from completing the execution of the program.

- logic error — example program
  Logic errors are mistakes in the behavior of the program even though the program can be translated into a running, executable program.
Java requires many suspicious behaviors to be flagged as errors (not just warnings). According to the Java Language Specification:
“It is a compile-time error if a statement cannot be executed because it is unreachable.”

In many languages suspicious code is given a warning, but the program may be executed anyway.
Warnings, as opposed to compile-time errors, have gradually been added to the Java language specification.

Java has optional warnings enabled by `javac -Xlint`. In Java 1.6 the complete list was:

```
cast, deprecation, divzero, empty, unchecked, fallthrough, path, serial, finally, overrides
```

The warnings deprecation and unchecked are checked in all cases (regardless of the command line options).

```
java -Xlint:all -Xlint:-serial
```
Thou shalt lint thy program
javac warnings

$javac -X [Java 16]
cast use of unnecessary casts.
classfile issues related to classfile contents.
deprecation use of deprecated items.
dep-ann
divzero division by constant integer 0.
empty empty statement after if.
fallthrough falling through from a case of a switch statement.
finally finally clauses that do not terminate normally.
options issues relating to use of command line options.
overrides issues regarding method overrides.
path invalid path elements on the command line.
rawtypes use of raw types.
serial Serializable classes with no serial version ID.
static accessing a static member using an instance.
try issues relating to use of try blocks.
unchecked unchecked operations.
varargs potentially unsafe vararg methods
javac warnings

$ javac --help-lint

The supported keys for -Xlint are:

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>auxiliaryclass</td>
<td>Warn about an auxiliary class that is hidden in a source file, and is used from other files.</td>
</tr>
<tr>
<td>cast</td>
<td>Warn about use of unnecessary casts.</td>
</tr>
<tr>
<td>classfile</td>
<td>Warn about issues related to classfile contents.</td>
</tr>
<tr>
<td>deprecation</td>
<td>Warn about use of deprecated items.</td>
</tr>
<tr>
<td>dep-ann</td>
<td>Warn about items marked as deprecated in JavaDoc but not using the @Deprecated annotation.</td>
</tr>
<tr>
<td>divzero</td>
<td>Warn about division by constant integer 0.</td>
</tr>
<tr>
<td>empty</td>
<td>Warn about empty statement after if.</td>
</tr>
<tr>
<td>exports</td>
<td>Warn about issues regarding module exports.</td>
</tr>
<tr>
<td>fallthrough</td>
<td>Warn about falling through from one case of a switch statement to the next.</td>
</tr>
<tr>
<td>finally</td>
<td>Warn about finally clauses that do not terminate normally.</td>
</tr>
<tr>
<td>missing-explicit-ctor</td>
<td>Warn about missing explicit constructors in public and protected classes in exported packages.</td>
</tr>
<tr>
<td>module</td>
<td>Warn about module system related issues.</td>
</tr>
<tr>
<td>opens</td>
<td>Warn about issues regarding module opens.</td>
</tr>
<tr>
<td>options</td>
<td>Warn about issues relating to use of command line options.</td>
</tr>
<tr>
<td>overloads</td>
<td>Warn about issues regarding method overloads.</td>
</tr>
<tr>
<td>overrides</td>
<td>Warn about issues regarding method overrides.</td>
</tr>
<tr>
<td>path</td>
<td>Warn about invalid path elements on the command line.</td>
</tr>
<tr>
<td>processing</td>
<td>Warn about issues regarding annotation processing.</td>
</tr>
<tr>
<td>rawtypes</td>
<td>Warn about use of raw types.</td>
</tr>
<tr>
<td>removal</td>
<td>Warn about use of API that has been marked for removal.</td>
</tr>
<tr>
<td>requires-automatic</td>
<td>Warn about use of automatic modules in the requires clauses.</td>
</tr>
<tr>
<td>requires-transitive-automatic</td>
<td>Warn about automatic modules in requires transitive.</td>
</tr>
<tr>
<td>static</td>
<td>Warn about accessing a static member using an instance.</td>
</tr>
<tr>
<td>strictfp</td>
<td>Warn about unnecessary use of the strictfp modifier.</td>
</tr>
<tr>
<td>synchronization</td>
<td>Warn about synchronization attempts on instances of value-based classes.</td>
</tr>
<tr>
<td>text-blocks</td>
<td>Warn about inconsistent white space characters in text block indentation.</td>
</tr>
<tr>
<td>try</td>
<td>Warn about issues relating to use of try blocks (i.e. try-with-resources).</td>
</tr>
<tr>
<td>unchecked</td>
<td>Warn about unchecked operations.</td>
</tr>
<tr>
<td>varargs</td>
<td>Warn about potentially unsafe vararg methods.</td>
</tr>
<tr>
<td>preview</td>
<td>Warn about use of preview language features.</td>
</tr>
</tbody>
</table>
Eclipse warns about semantic problems not required by the Java language specification
If you make a mistake and write a program that goes into an endless loop, and the computer runs out time or space resources and terminates your program prematurely, is this a runtime or a logic error?

Either, both, what difference does it make?
What is a compiler warning (as opposed to an error)?

Have you ever encountered a compiler warning issued by javac?
Indenting is very important; many annoying white-space complaints
• MagicNumber
• [Checkstyle IllegalToken] “Use double instead of float”
• [Checkstyle IllegalToken] “Avoid typecasts”
Integer.parseInt("42"); // String to int
Integer.valueOf("42"); // String to Integer
Double.parseDouble("42"); // String to double
Double.valueOf(42); // int or double to Double [double, auto-boxing]
Math.round(3.4D) // double to long
Math.ceil(3.4D) // double to double!
Math.floor(3.4D) // double to double!
Math.floorDiv(42L,43L) // long, long -> long
/* Coerce to double, create Double object, auto-unbox, discard object; lots of overhead */

double d = Double.valueOf(42);

/* Deprecated because new immutable records are more efficient than plain, old Java classes. */

Double d = new Double(42);

Java API doc Math
No good explicit function to convert a primitive integer to a primitive double, e.g., \texttt{Real(42)} in Ada, \texttt{fromIntegral(42)} in Haskell.

\begin{verbatim}
double x = 5L; // sometimes works
double x = 5;
float y = 5L;
float y = 5;
\end{verbatim}

A cast (implicit widening conversion) could be

\begin{verbatim}
double quotient = (double) 42 / 5; // Avoid cast

double meaningOfLife = 42; // some int or long expression
double quotient = meaningOfLife / 5.0D;

long x = Math.round (5.3D);
\end{verbatim}
```java
jshell> double x = 5L;
x => 5.0

jshell> double x = 5555555555555555555 L;
x => 5.5555555555555553 E18

jshell> long x = round (ceil (45.3D));
x => 46

jshell> long x = round (ceil (45.3F));
x => 46

jshell> int x = toIntExact (round (ceil (45.3D)));
x => 46
```
Thou shalt not use a cast

A case is a type name in parentheses, e.g., (int) 4.5D
Avoid mistakes by carefully converting from one data type to another
Thou shalt indent by three

(Four is perfectly reasonably, but we cannot check for three *or* four.)
Ideal Programs

Ideal programs are readable and well-designed
Editing versus refactoring.

Definition

Refactoring code is the process of restructuring existing code with knowledge of the programming language (e.g., the scope of identifiers), usually keeping the same behavior.

The intention is usually to improve the design, efficiency, or readability of the code. Refactoring code is “smart” editing.

“Dumb” editing text is oblivious to the structure, semantics, and behavior of the text, like replacing all occurrences of the letter ‘a’ in a source program with the letter ‘b’. This will likely create many syntax errors.

“Smart” editing (refactoring) code respects the structure, semantics, and behavior of the code, like replacing all uses of the identifier ‘a’ in a source program with the identifier ‘b’.

Many IDEs can perform intelligent changes like renaming identifiers, introducing methods, adding parameters to methods, adding declarations to remove magic numbers, and so on.
At what point does planning and thinking come in?

... understanding the requirements?
Where do ideas come from?

1. experience
2. problem solving
3. experimentation
4. AFK; pencil and paper
5. stack overflow
• Expect bugs
• Keep modules small
• Limit interactions
• Develop code incrementally
• Solve an easier problem
• Consider a recursive solution
• Build tools where appropriate
• Reuse software when possible
Problem Solving

René Descartes (1596–1650)
*Discours de la méthode*, 1637

1. Never assume, be critical, put aside your preconceived notions
   
   *Le premier était de ne recevoir jamis aucune chose pour vraie que je ne la connusse évidemment être telle;*

2. Decompose your problem until each piece becomes trivial.

3. Solve the simplest things first.

4. Keep revising your work so that nothing is forgotten.
Computational Thinking

1. Define. Manageable questions
2. Abstract. Transform into precise form
3. Compute. Identify and resolve issues
4. Interpret. Re-contextualize and refine