Java Classes & Statements

M250 Tutorial 03

Contents

1 Agenda

- Introductions
- Adobe Connect reminders
- *Adobe Connect* — if you or I get cut off, wait till we reconnect (or send you an email)
- Classes: Introduction

- Statements: Select, Iteration and others
- JShell (optional)
- Some useful Web & other references
- Time: about 1 hour
- Do ask questions or raise points.
- Slides/Notes M250Tutorial20241117ClassesStmntsPrsntn2024J

Introductions — Phil

- *Name* Phil Molyneux
- *Background*
  - Undergraduate: Physics and Maths (Sussex)
  - Postgraduate: Physics (Sussex), Operational Research (Brunel), Computer Science (University College, London)
  - Worked in Operational Research, Business IT, Web technologies, Functional Programming
- *First programming languages* Fortran, BASIC, Pascal
- *Favourite Software*
  - Haskell — pure functional programming language
  - Text editors TextMate, Sublime Text — previously Emacs
  - Word processing in LaTeX — all these slides and notes
  - Mac OS X
- *Learning style* — I read the manual before using the software

Introductions — You

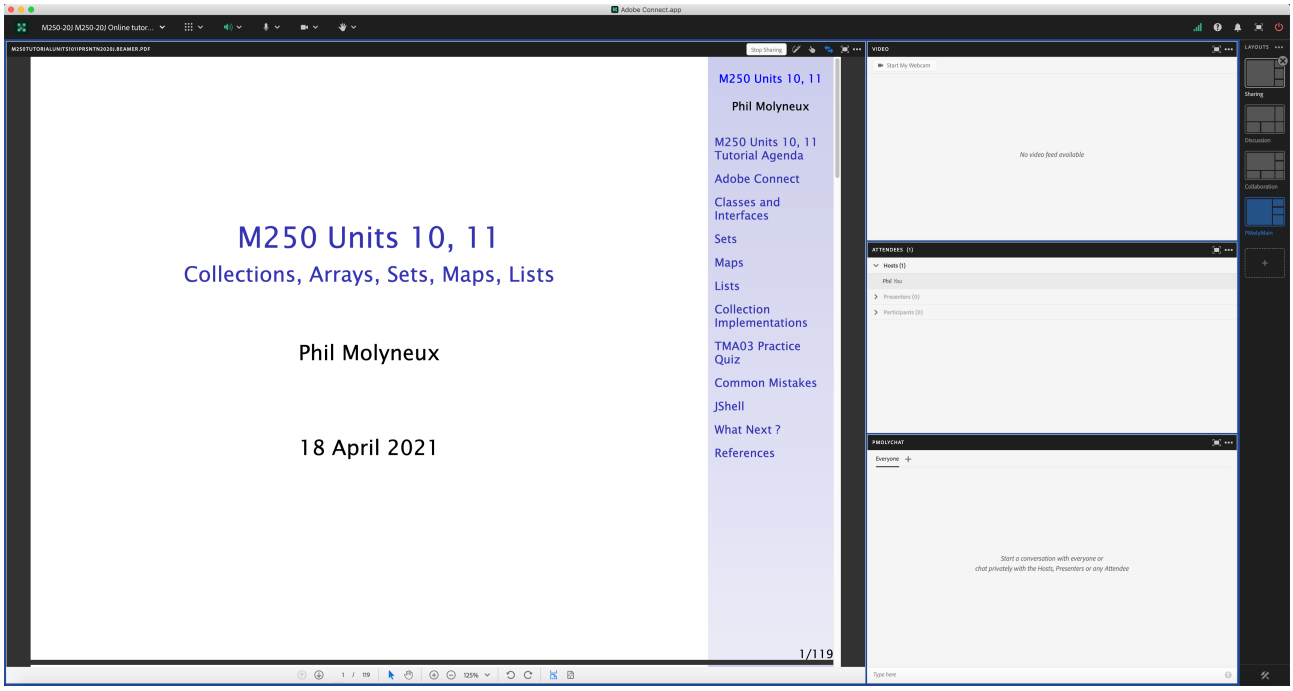
- *Name* ?
- *Favourite software/Programming language* ?
- *Favourite text editor or integrated development environment (IDE)*
- List of text editors, Comparison of text editors and Comparison of integrated development environments
- *Other OU courses* ?
- *Anything else* ?

ToC

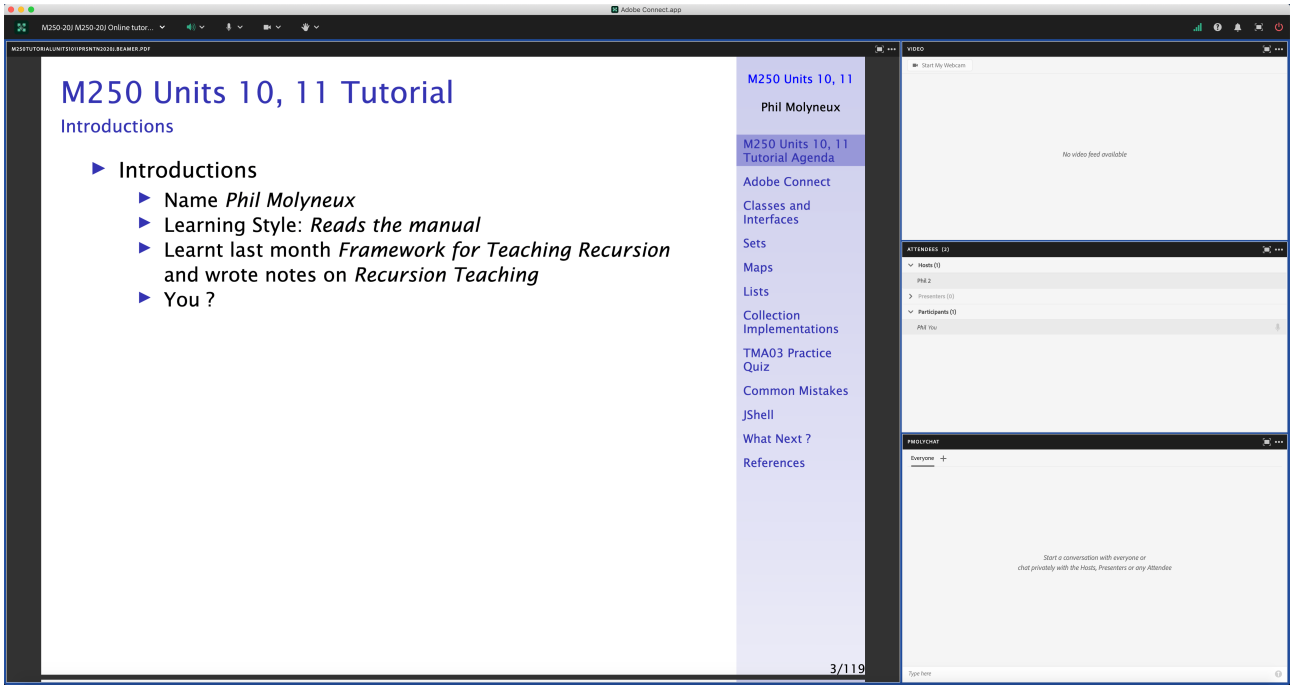
2 Adobe Connect Interface and Settings

2.1 Adobe Connect Interface

Adobe Connect Interface — Host View



Adobe Connect Interface — Participant View



2.2 Adobe Connect Settings

Adobe Connect — Settings

- **Everybody** *Menu bar* › *Meeting* › Speaker & Microphone Setup
- *Menu bar* › *Microphone* › Allow Participants to Use Microphone ✔

- Check Participants see the entire slide including slide numbers bottom right **Workaround**
  - *Disable Draw* *Share pod* › *Menu bar* › *Draw icon*
  - *Fit Width* *Share pod* › *Bottom bar* › *Fit Width icon* ✔
- *Meeting* › Preferences › General › **Host Cursor** › Show to all attendees
- *Menu bar* › *Video* › Enable **Webcam** for Participants ✔
- Do not *Enable single speaker mode*
- Cancel hand tool
- Do not enable green pointer
- **Recording** Meeting › Record Session ✔
- **Documents** Upload PDF with drag and drop to share pod
- Delete *Meeting* › Manage Meeting Information › Uploaded Content and *check filename* › *click on delete*

Adobe Connect — Access

- **Tutor Access**

  TutorHome › M269 Website › Tutorials

  Cluster Tutorials › M269 Online tutorial room

  Tutor Groups › M269 Online tutor group room

  Module-wide Tutorials › M269 Online module-wide room

- **Attendance**

  TutorHome › Students › View your tutorial timetables

- **Beamer Slide Scaling** 440% (422 x 563 mm)
- **Clear Everyone's Status**

  Attendee Pod › Menu › Clear Everyone's Status

- **Grant Access** and send link via email

  Meeting › Manage Access & Entry › Invite Participants...

- **Presenter Only Area**

  Meeting › Enable/Disable Presenter Only Area

Adobe Connect — Keystroke Shortcuts

- Keyboard shortcuts in Adobe Connect
- **Toggle Mic** ⌘ + M (Mac), Ctrl + M (Win) (On/Disconnect)
- **Toggle Raise-Hand status** ⌘ + E
- **Close dialog box** ⎋ (Mac), Esc (Win)
- **End meeting** ⌘ + \

2.3 Adobe Connect — Sharing Screen & Applications

- Share My Screen › Application tab › Terminal for Terminal
- Share menu › Change View › Zoom in for mismatch of screen size/resolution (Participants)
- (Presenter) Change to 75% and back to 100% (solves participants with smaller screen image overlap)
- Leave the application on the original display
- Beware blued hatched rectangles — from other (hidden) windows or contextual menus
- Presenter screen pointer affects viewer display — beware of moving the pointer away from the application
- First time: System Preferences › Security & Privacy › Privacy › Accessibility

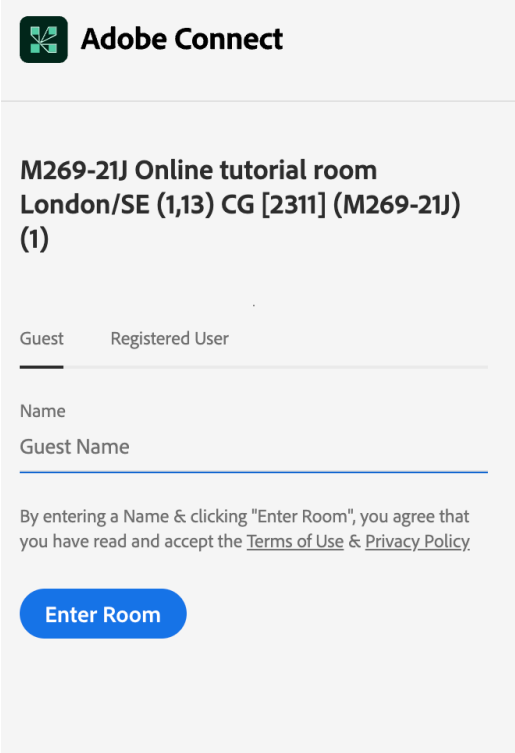
2.4 Adobe Connect — Ending a Meeting

- *Notes for the tutor only*
- **Student:** Meeting › Exit Adobe Connect
- **Tutor:**
- **Recording** Meeting › Stop Recording ✔
- **Remove Participants** Meeting › End Meeting... ✔
  - Dialog box allows for message with default message:
  - *The host has ended this meeting. Thank you for attending.*
- **Recording availability** *In course Web site for joining the room, click on the eye icon in the list of recordings under your recording* — edit description and name
- **Meeting Information** Meeting › Manage Meeting Information — can access a range of information in Web page.
- **Delete File Upload** Meeting › Manage Meeting Information › Uploaded Content tab select file(s) and click Delete
- **Attendance Report** see course Web site for joining room

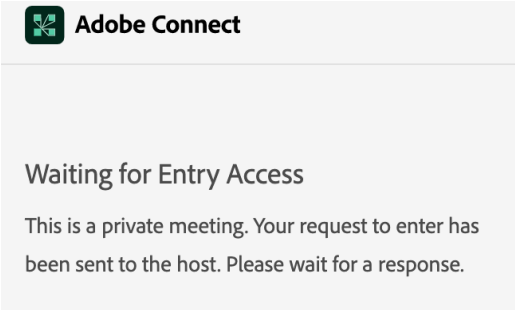
2.5 Adobe Connect — Invite Attendees

- **Provide Meeting URL** Menu › Meeting › Manage Access & Entry › Invite Participants...
- **Allow Access without Dialog** Menu › Meeting › Manage Meeting Information provides new browser window with *Meeting Information* Tab bar › Edit Information
- Check *Anyone who has the URL for the meeting can enter the room*
- Default *Only registered users and accepted guests may enter the room*
- **Reverts to default next session but URL is fixed**
- Guests have blue icon top, registered participants have yellow icon top — same icon if URL is open

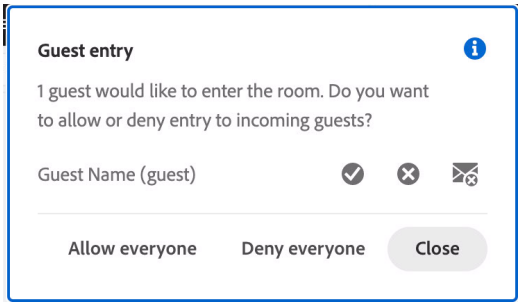
- See Start, attend, and manage Adobe Connect meetings and sessions
- Click on the link sent in email from the Host
- Get the following on a Web page
- As *Guest* enter your name and click on Enter Room



- See the *Waiting for Entry Access* for *Host* to give permission



- *Host* sees the following dialog in *Adobe Connect* and grants access



2.6 Layouts

- **Creating new layouts** example *Sharing* layout

- Menu › Layouts › Create New Layout... › Create a New Layout dialog › Create a new blank layout and name it *PMolyMain*
- New layout has no Pods but does have Layouts Bar open (see Layouts menu)
- **Pods**
- Menu › Pods › Share › Add New Share and resize/position — initial name is *Share n* — rename *PMolyShare*
- **Rename Pod** Menu › Pods › Manage Pods... › Manage Pods › Select › Rename or Double-click & rename
- Add Video pod and resize/reposition
- Add Attendance pod and resize/reposition
- Add Chat pod — rename it *PMolyChat* — and resize/reposition
- Dimensions of **Sharing** layout (on 27-inch iMac)
  - Width of Video, Attendees, Chat column 14 cm
  - Height of Video pod 9 cm
  - Height of Attendees pod 12 cm
  - Height of Chat pod 8 cm
- **Duplicating Layouts** does *not* give new instances of the Pods and is probably not a good idea (apart from local use to avoid delay in reloading Pods)
- **Auxiliary Layouts** name *PMolyAux0n*
  - Create new Share pod
  - Use existing Chat pod
  - Use same Video and Attendance pods

2.7 Chat Pods

- **Format Chat text**
- Chat Pod › menu icon › My Chat Color
- Choices: Red, Orange, Green, Brown, Purple, Pink, Blue, Black
- Note: Color reverts to Black if you switch layouts
- Chat Pod › menu icon › Show Timestamps

2.8 Graphics Conversion for Web

- Conversion of the screen snaps for the installation of Anaconda on 1 May 2020
- Using GraphicConverter 11
- File › Convert & Modify › Conversion › Convert
- Select files to convert and destination folder
- Click on Start selected Function or ⌘+⏎

2.9 Adobe Connect Recordings

- *Menu bar* › *Meeting* › Preferences › Video
- Aspect ratio › Standard (4:3) (not Wide screen (16:9) default)
- Video quality › Full HD (1080p not High default 480p)
- **Recording** *Menu bar* › *Meeting* › Record Session ✔
- **Export Recording**
- *Menu bar* › *Meeting* › Manage Meeting Information
- *New window* › Recordings › *check Tutorial* › Access Type button
- check Public › check Allow viewers to download
- **Download Recording**
- *New window* › Recordings › *check Tutorial* › Actions › Download File

ToC

3 Classes: Introduction

3.1 Classes Overview and Structure

- A **class** represents a concept, a template for creating instances (objects)
- An **object** is an instance of a concept (a class)
- A classDeclaration of `class C` has the form

```
classModifiers class C extendsClause implementsClause
  classBody
```

- extendsClause and implementsClause refer to superclasses and interface (see later in M250)
- For a top-level class classModifiers may be a list of `public` and at most one of `abstract` or `final`
- The classBody contains declarations of fields, constructors, methods, nested classes, nested interfaces, and initialiser blocks (M250 mainly uses the first three)
- The declarations *may* appear in any order but you should use the order suggested in *M250 Code Conventions*

```
{
  fieldDeclarations
    /* class (static) variables */
    /* instance variables */
  constructorDeclarations
  methodDeclarations
}
```

- A source file may begin with `package` (not used in M250) and `import` declarations (to be covered later)

```
class Point {
  int x, y ;

  Point(int x, int y) {
    this.x = x ;
    this.y = y ;
  }

  void move(int dx, int dy) {
    x = x + dx ;
    y = y + dy ;
  }

  public String toString() {
    return "(" + x + "," + y + ")" ;
  }
}
```

- The `Point` class is declared to have two instance fields `x` and `y`, one constructer, and two instance methods

```
jshell> Point p1 = new Point(3,4)
p1 ==> (3,4)

jshell> p1 = p1.move(1,2)
|  Error:
|  incompatible types: void cannot be converted to Point
|  p1 = p1.move(1,2)
|       ^----------^

jshell> p1.move(1,2)

jshell> p1
p1 ==> (4,6)
```

- Notice the error message — `move()` works by side effect

ToC

3.2 TMA01 Practice Quiz

- Open BlueJ and create a new Project
- Project > New Project...
- There may be a problem navigating folders — in that case use the text box
- Create new class Edit > New Class... M250Colour

```
/**
 * Write a description of class M250Colour here.
 *
 * @author (your name)
 * @version (a version number or a date)
 */
public class M250Colour
{
```

```
}
```

- (a)(i) Write a `private` instance field `String hexColour`
- (a)(ii) Write a constructor for `M250Colour` initialising `hexColour` to `"#000000"`

```
10   // instance variables
11   private String hexColour ;

13   /**
```

```
14      * Constructor for objects of class M250Colour
15      */
16     public M250Colour()
17     {
18        // initialise instance variables
19        hexColour = "#000000" ;
20     }
```

- (a)(iii) Write a getter method for `hexColour`

```
23     /**
24      * Returns the value of hexColour of the receiver
25      *
26      * @return hexColour of the receiver
27      */
28     public String getHexColour(){
29       return this.hexColour ;
30     }
```

- Notice I prefer K&R layout
- (b)(i) Write a public method `isValidLength(String hStr)` to check `hStr` has 7 characters

```
48     /**
49      * Returns true if the input String has length 7
50      *
51      * @return true if the input String has length 7
52      */
53     public boolean isValidLength(String hStr){
54       final int hexStrLen = 7 ;
55       return hStr.length() == hexStrLen ;
56     }
```

- Note alternative

```
public boolean isValidLength(String hStr){
  return hStr.length() == 7;
}
```

- (b)(ii) Write `isValidFirst(String hStr)` to check the first character is `'#'`

```
63     public boolean isValidFirst(String hStr){
64       final char hexStrPrefix = '#' ;
65       return hStr.length() > 0
66              && (hStr.charAt(0) == hexStrPrefix) ;
67     }
```

- Alternative

```
public boolean isValidFirst(String hStr){
  return hStr.length() > 0
         && (hStr.charAt(0) == '#');
}
```

- (b)(iii) Write a method `isValidCharacters(String hStr)` to check the rest of the characters are valid hex

```
74     public boolean isValidCharacters(String hStr){
75       boolean validChr ;
76       int hStrLen = hStr.length() ;
77       char hStrCharAtI ;

79       for (int i = 1 ; i <= hStrLen - 1 ; i++) {
80         hStrCharAtI = hStr.charAt(i) ;
81         validChr
82           =  (('0' <= hStrCharAtI
83                && hStrCharAtI <= '9')
84               || ('A' <= hStrCharAtI
```

```
85                && hStrCharAtI <= 'F')) ;
86        if (!validChr) {
87          return false ;
88        }
89      }
90      return true ;
91    }
```

- (b)(iii) What are the errors in:

```
public boolean isValidCharacters(String h){

  for (int position = 1; position < 7; position ++){
    if ((h.charAt(position) >= 0
         && h.charAt(position) <= 9)
        || (h.charAt(position) >= 'A'
            && h.charAt(position) <= 'F')){
      return true;
    }
  }
  return false;
}
```

1. In the code for `isValidCharacters()` there is a `for` loop with an `if` condition — if the condition is `true` for at least one character in the 6 (six) characters then the whole lot are regarded as valid — the loop will only return `false` if the `if` condition always evaluates to `false`
2. The condition is comparing a character to the values denoted by `0` and `9` and not the characters `'0'` and `'9'` — why does this not generate an error ? Because in Java characters are regarded as numeric types — so in the comparison, the character is coerced to its value as a Unicode code point — for example, `'2'` has Unicode code point 50 so is coerced to 50

- (b)(iii) Alternative

```
public boolean isValidCharactersA(String hStr)
{
   String validValues = "0123456789ABCDEF" ;
   int hStrLen = hStr.length() ;
   String hSubStr ;

   for(int index = 1; index <= hStrLen - 1; index++)
   {
     hSubStr = hStr.substring(index, index + 1) ;
     if (!validValues.contains(hSubStr)) {
         return false ;
     }
   }
   return true ;
}
```

- (b)(iii) Alternative with Regular Expressions

```
public boolean isValidCharactersB(String hStr)
{
   return hStr.matches(".[A-F0-9]+") ;
}
```

- `matches()` is an instance method of the class `String`
- `".[A-F0-9]+"` string representing a regular expression
- `.` metacharacter matches any single character
- `[A-F0-9]` is a character class matching any one of A to F or 0 to 9
- `+` matches the preceding pattern 1 or more times

- Class Pattern in Package java.util.regex describes the syntax
- (b)(iv) Write a method `isValidHexColour(String hStr)` that combines the three checks

```
98    public boolean isValidHexColour(String hStr){
99      return isValidLength(hStr)
100            && isValidFirst(hStr)
101            && isValidCharacters(hStr) ;
102   }
```

- (b)(iv) Write a method `isValidHexColour(String hStr)` using regular expressions

```
  public boolean isValidHexColour(String hStr) {
    return hStr.matches("#[A-F0-9]{6}") ;
  }
```

- {6} matches 6 copies of the preceding regular expression

```
jshell> public boolean isValidHexColour(String hStr) {
   ...>   return hStr.matches("#[A-F0-9]{6}") ;
   ...> }
   ...>
|  created method isValidHexColour(String)

jshell> boolean b1 =
   ...>   isValidHexColour("#FFAABB")
b1 ==> true

jshell> boolean b2 =
   ...>   isValidHexColour("FFAABB")
b2 ==> false

jshell> boolean b3 =
   ...>   isValidHexColour("#FAB")
b3 ==> false

jshell> boolean b4 =
   ...>   isValidHexColour("#FFAABBCC")
b4 ==> false
```

- (c) Write a setter method for M250Colour that outputs an appropriate message

```
35    public void setHexColour(String hStr){
36      boolean validStr = isValidHexColour(hStr) ;
37      String msg ;

39      if (validStr) {
40        msg = ("Colour␣" + hStr + "␣is␣valid") ;
41        this.hexColour = hStr ;
42      } else {
43        msg = ("Colour␣" + hStr + "␣is␣not␣valid") ;
44      }
45      System.out.println(msg) ;
46    }
```

- Not returning a boolean by incomplete expression

```
  jshell>    public boolean isValidLength(String hStr){
     ...>      return hStr.length();
     ...>    }
     ...>
  |  Error:
  |  incompatible types: int cannot be converted to boolean
  |       return hStr.length();
  |              ^-----------^
```

- Using assignment where you meant equality test

```
  jshell>    public boolean isValidLength(String hStr){
     ...>      return hStr.length() = 7;
```

```
   ...>    }
   ...>
|  Error:
|  unexpected type
|    required: variable
|    found:    value
|       return hStr.length() = 7;
|              ^-----------^
```

- Example usage in JShell
- `mClr` is a reference to an object — it is displayed in JShell in the form `<class>@<hexDigits>`
- See Object toString() method for an explanation

```
jshell> M250Colour mClr = new M250Colour()
mClr ==> M250Colour@68de145

jshell> String str1 = mClr.getHexColour()
str1 ==> "#000000"

jshell> mClr.setHexColour("#FF0000")
Colour #FF0000 is valid

jshell> String str2 = mClr.getHexColour()
str2 ==> "#FF0000"

jshell> String str3 = mClr.getClass().getName()
          + '@' + Integer.toHexString(mClr.hashCode())
str3 ==> "M250Colour@68de145"
```

- The `toString()` method for class `Object` returns a string in the form `<className>@hexDigits`
- `getClass().getName() + '@' + Integer.toHexString(hashCode())`
- See StackOverflow: Object reference
- See Object toString() Method in Java
- Example usage in JShell
- Note that `isValidLength()`, `isValidFirst()`, `isValidCharacters()`, `isValidHexColour()` are *instance methods*

```
jshell> M250Colour mClr = new M250Colour()
mClr ==> M250Colour@306a30c7

jshell> boolean b1 = isValidLength("asdf")
|  Error:
|  cannot find symbol
|    symbol:   method isValidLength(java.lang.String)
|  boolean b1 = isValidLength("asdf");
|               ^-----------^

jshell> boolean b1 = mClr.isValidLength("asdf")
b1 ==> false
```

- what *might* (almost certainly) wrong with the following:

```
public boolean isValidHexColour(String h){

  if (isValidCharacters(h) == true
      && isValidFirst(h) == true
      && isValidLength(h) == true){
    return true;
  } else {
    return false;
  }
}
```

1. What happens if the string is empty ?
2. If the first character is not valid, it is not worth checking the rest

- The following does not compile — what is the error message and why ?

```
public boolean isValidCharactersA(String h) {
  for (int i = 1; i < 8; i++) {
    if (!(   (h.charAt(i)>= 48
              && h.charAt(i) <= 57)
          || (h.charAt(i) >= 65
              && h.charAt(i) <= 70))) {
      return false;
    }
    return true;
  }
}
```

- Here is the error message — but why ?

```
jshell> public boolean isValidCharactersA(String h) {
   ...>   for (int i = 1; i < 8; i++) {
   ...>     if (!(   (h.charAt(i)>= 48
   ...>               && h.charAt(i) <= 57)
   ...>           || (h.charAt(i) >= 65
   ...>               && h.charAt(i) <= 70))) {
   ...>       return false;
   ...>     }
   ...>     return true;
   ...>   }
   ...> }
   ...>
|  Error:
|  missing return statement
|  public boolean isValidCharactersA(String h) {
|                                                ^
```

- If a method is declared to have a return type, then the method must return a value — it must not be possible for execution to reach the end of a method body without executing a `return` statement (see *Java Language Specification (JLS)* Section 8.4.7 (Edition 13) *Method Body* for full details, but a bit formal)
- Why is the compiler saying *Missing return* when we can see two and the code is bound to hit one ?
- The compiler has to work for *every* syntactically valid program so it has to have some *effectively computable* rules
- We go back to *Java Language Specification (JLS)* Section 14.21 (Edition 13) *Unreachable Statements* and try and work out what the Java compiler is expected to do with *for* statements
- Essentially a *for* statement *can complete normally* if the statement is reachable and the condition is not a constant `true`
- So in terms of program flow the compiler doesn't know whether the loop terminates or not
- The analysis of the compiler is a syntactic check on where the program execution could go
- to work out whether an arbitrary block of code or statement would or would not terminate is equivalent to solving the Halting problem which we know is not solvable (see M269)
- So the code is missing a `return` statement *after* the `for` loop

- However, if the compiler had accepted the code, then it would still have returned `true` if the first character was valid

ToC

3.3 Field, Method and Constructor Declarations

- A field holds a value inside an object (if non-static) or a class (if static)
- A fieldDeclaration has one of the forms

```
fieldModifiers type fieldName1, fieldName2, ... ;
fieldModifiers type fieldName1 = initializer1, ... ;
```

- fieldModifiers may be a list of the modifiers `static`, `final`, `transient` and `volatile` (last two not in M250) and at most one of the access modifiers `private`, `protected`, `public`
- A field `f` in a class `C` declared `static` is a class field and can be referred to as `C.f` or `o.f` where `o` is an expression of type `C` — in the declaration of `C` it can be referred to as `f`
- A field not declared `static` is an instance field

	Member Visibility			
Accessible to	**Public**	**Protected**	**Default**	**Private**
Defining class	Yes	Yes	Yes	Yes
Class in same package	Yes	Yes	Yes	No
Subclass in different package	Yes	Yes	No	No
Nonsubclass different package	Yes	No	No	No

Table from Evans and Flanagan (2014, p 126)

- A method must be declared inside a class
- A methodDeclaration declaring method `m` has the form

```
methodModifiers returnType m(formalList) throwsClause
  methodBody
```

- The formalList is a comma-separated list of zero or more *formal parameter declarations*, of one of the forms

```
parameterModifier type parameterName
parameterModifier type... parameterName
```

- The parameterModifier may be `final` meaning that the parameter cannot be modified inside the method
- The second form of parameter declaration can only appear last and declares a parameter array (TODO: check if this is used in M250)
- The purpose of a constructor in class `C` is to initialize new objects (instances) of the class
- A constructorDeclaration in class `C` has the form

```
constructorModifiers C(formalList) throwsClause
  constructorBody
```

- The constructorModifiers may be a list of at most one of `private`, `protected` and `public`
- Constructors may be overloaded in the same way as methods
- The constructor signature (a list of parameter types in formalList) is used to distinguish constructors in the same class
- A constructor may call another overloaded constructor in the same class using the syntax

```
this(actualList)
```

- A class that does not explicitly declare a constructor implicitly declares a public, argumentless *default constructor* whose only (implicit) action is to call the superclass constructor

```
public C() { super() ; }
```

- A class `C` may be declared a *subclass* of class `B` by an extendsClause of the form

```
class C extends B {...}
```

- The very first action of a constructor in `C` may be an explicit call to a constructor in superclass `B`
- If a constructor `C(...)` does not explicitly call `super(...)` as its first action, then it implicitly calls the argumentless default constructor `B()` as its first action, as if by `super()`

ToC

4 Statements: Summary

4.1 Statements Overview

- A statement may change the computer's state: value of variables, fields, array elements, the contents of files and so on — the execution of a statement may:
- terminate normally (and execution continues with the next statement, if any) or
- terminate abruptly by throwing an exception or
- exit by executing a `return` statement (if inside a method or constructor) or
- exit a switch or loop by executing a `break` statement or
- exit the current iteration of a loop and start a new iteration by executing a `continue` statement or
- does not terminate at all (eg, `while (true) {}`)

ToC

4.2 Expression & Block Statements

- An expression statement is an expression followed by a `;`

```
expression ;
```

- The only forms of expression that may be used here are assignments, increment and decrements, method call, and object creation
- A block statement is a sequence of variable declarations, class declarations and statements

```
{
  variableDeclarations
  classDeclarations
  statements
}
```

- An empty statement consists of ; only — it is equivalent to the block statement { }

ToC

4.3 Selection Statements

- The if statement has the form

```
if (condition)
  trueBranch
```

- The if-else statement has the form

```
if (condition)
  trueBranch
else
  falseBranch
```

- The condition must have type boolean or Boolean
- trueBranch and falseBranch are statements
- What is wrong with the following

```
if (dataAvailable) ;
  processData() ;
```

```
if (dataAvailable)
  processData() ;
  reportResults() ;
```

```
if (dataAvailable)
  processData() ;
  reportResults() ;
else
  reportNoData() ;
```

```
if (dataAvailable) ;
  processData() ;
```

- The trueBranch is an empty statement (;)

```
if (dataAvailable)
  processData() ;
  reportResults() ;
```

- reportResults() ; will always be executed

```
if (dataAvailable)
  processData() ;
  reportResults() ;
else
  reportNoData() ;
```

- Will not compile
- **Moral** Always use block statements
- A `switch` statement has the form

```
switch (expression) {
  case constant1: branch1
  case constant2: branch2
  ...
  default: branchN
}
```

- expression must be of type `int`, `short`, `char`, `byte` or a boxed version of these or `String` or an enum type
- Each branch is a sequence of statements, usually terminated by `break` or `return` (if inside a method or constructor) or `continue` (inside a loop).
- If a branch is not exited by `break`, `return`,or `continue`, then execution continues with the next branch in the switch regardless of the `case` clauses, until a branch exits or the switch ends
- (not used in M250)

ToC

4.4 Iteration Statements

- A `for` statement has the form

```
for (initialization ; condition ; step)
  body
```

- initialization is a variableDeclaration or an expression
- condition is an expression of type `boolean` or `Boolean`
- step is an expression
- body is a statement
- initialization and step may be comma-separated lists of expressions
- initialization, condition and step may be empty. An empty condition is equivalent to `true`
- The `for` statement is executed as follows

1. The initialization is executed
2. The condition is evaluated. If it is `false`, the loop terminates.
3. If it is `true` then
   (a) the body is executed

(b) the step is executed

(c) execution continues at (2.)

- What does the following code do ?

```
for (int i = 1 ; i <= 4 ; i++) {
  for (int j = 1 ; j <= i ; j++) {
    System.out.print("*") ;
  }
  System.out.println() ;
}
```

```
jshell>   for (int i = 1 ; i <= 4 ; i++) {
   ...>     for (int j = 1 ; j <= i ; j++) {
   ...>       System.out.print("*") ;
   ...>     }
   ...>     System.out.println() ;
   ...>   }
   ...>
*
**
***
****
```

- A `while` statement has the form

```
while (condition)
  body
```

- condition is an expression of type `boolean` or `Boolean` and body is a statement
- It is executed as follows:

1. The condition is evaluated. If it is `false`, the loop terminates
2. If it is `true`, then

   (a) The body is executed

   (b) Execution continues at (1.)

- Example linear search with `while` loop

```
String[] wdays =
  {"Monday","Tuesday","Wednesday"
  ,"Thursday","Friday","Saturday","Sunday"} ;

int wdayno(String wday) {
  int i = 0 ;
   while (i < wdays.length
          && ! wday.equals(wdays[i])) {
     i++ ;
   }
   if (i < wdays.length) {
     return i ;
   } else {
     return -1 ;
   }
} ;
```

```
String[] wdays =
  {"Monday","Tuesday","Wednesday"
  ,"Thursday","Friday","Saturday","Sunday"} ;

int wdayno(String wday) {
  int i = 0 ;
   while (i < wdays.length
          && ! wday.equals(wdays[i])) {
     i++ ;
   }
```

```
    if (i < wdays.length) {
      return i ;
    } else {
      return -1 ;
    }
  } ;
```

```
jshell> int d1 = wdayno("Friday") ;
d1 ==> 4

jshell> int d2 = wdayno("Dimanche") ;
d2 ==> -1
```

- Write code using a `while` statement that is equivalent to a `for` loop statement
- Write code using a `while` statement that is equivalent to a `for` loop statement

```
initialization
while (condition) {
  body
  step
}
```

```
for (initialization ; condition ; step)
  body
```

- Note that this is different behaviour to the `for` statement in Python where assignments to variables in the suite of the loop does not change the assignments made in the target list
- See Python: for statement

4.4.1 foreach statement

```
for (tx x : expression)
  body
```

- The *expression* must have type `Iterable<t>` where `t` is a subtype of type `tx`
- Iterators obtained from *expression* will generate elements that can be assigned to `x`
- *expression* must be a statement

```
int[] primes = new int[] {2,3,5,7,11,13,17,19,23,29} ;
for (int n : primes) {
  System.out.println(n) ;
}
```

```
int[] iarr = new int[] { 2, 3, 5, 7, 11 } ;
int sum = 0 ;
for (int p : iarr) {
  sum = sum + p ;
}
System.out.println("sum = " + sum) ;
```

```
jshell> System.out.println("sum = " + sum) ;
sum = 28
```

- Note that `print` and `println` convert a value to textual representation and outputs it to a PrintWriter or PrintStream (System.out is a PrintStream)
- Python programmers may be tempted by the following but see the error

```
jshell> System.out.println("sum = ", sum) ;
|  Error:
|  no suitable method found for println(java.lang.String,int)
|      method java.io.PrintStream.println() is not applicable
|        (actual and formal argument lists differ in length)
//and lots of other error messages
```

- Explicitly going through an iterable using `for`
- Example 79 from Sestoft (2016,page 57)

```
Iterable<Integer> ible = fromTo(13, 17);
for (Iterator<Integer> iter = ible.iterator(); iter.hasNext(); /* none */) {
  int i = iter.next();
  System.out.println(i);
}
```

- Method `fromTo` generates an Iterable collection

```
jshell>   Iterable<Integer> ible = fromTo(13, 17);
   ...>   for (Iterator<Integer> iter = ible.iterator(); iter.hasNext(); /* none */) {
   ...>     int i = iter.next();
   ...>     System.out.println(i);
   ...>   }
   ...>
ible ==> 1FromToIterable@7aec35a
13
14
15
16
17
```

- Method `fromTo` generates an Iterable collection
- Example 143 from Sestoft (2016, page 113)

```
public Iterable<Integer> fromTo(final int m, final int n) {
  class FromToIterator implements Iterator<Integer> {
    private int i = m;
    public boolean hasNext() { return i <= n; }
    public Integer next() {
      if (i <= n)
        return i++;
      else
        throw new NoSuchElementException();
    }
    public void remove() { throw new UnsupportedOperationException(); }
  }
  class FromToIterable implements Iterable<Integer> {
    public Iterator<Integer> iterator() {
      return new FromToIterator();
    }
  }
  return new FromToIterable();
}
```

ToC

4.5 Returns, Exits and Exceptions

- A `return` statement with an expression argument has the form:

```
return expression ;
```

- This form of `return` must occur in the body of a method (not constructor) whose return type is a supertype or boxed or unboxed version of the type of expression

- The return statement is executed as follows:
- expression is evaluated to some value v
- It then exits the method and continues execution at the method call expression that called the method
- The value of that expression will be v, possible after application of a widening, boxing or unboxing conversion
- wdayno using a for loop

```
int wdayno(String wday) {
  for (int i = 0 ; i < wdays.length ; i++) {
    if (wday.equals(wdays[i])) {
      return i ;
    }
  }
  return -1 ;
}
```

- Notice that the final return is after the for loop
- What is the effect of the code below?

```
int wdayno(String wday) {
  for (int i = 0 ; i < wdays.length ; i++) {
    if (wday.equals(wdays[i])) {
      return i ;
    }
  return -1 ;
  }
}
```

```
jshell> int wdayno(String wday) {
   ...>   for (int i = 0 ; i < wdays.length ; i++) {
   ...>     if (wday.equals(wdays[i])) {
   ...>       return i ;
   ...>     }
   ...>   return -1 ;
   ...>   }
   ...> }
   ...>
|  Error:
|  missing return statement
|    int wdayno(String wday) {
|                            ^
```

- A break statement is legal only inside a loop or switch and has one of the forms

```
break ;
break labelName ;
```

- Executing break exits the innermost enclosing loop or switch and continues execution after that loop or switch
- A continue statement is legal only inside a loop and has one of the forms

```
continue ;
continue labelName ;
```

- Executing continue terminates the current iteration of the innermost enclosing loop and continues execution at the step in for loops or the condition in while and do-while loops
- A label statement has the form

```
labelName : statement
```

- The scope of labelName is statement, where it can be used in `break` or `continue`
- Use of labels is evidence of poor program design
- Just don't
- A `throw` statement has the form:

```
throw expression ;
```

- The type of expression must be a subtype of class `Throwable`
- The `throw` statement is executed as follows:
- expression is evaluated to obtain an exception object `v`
- If it is `null` then a `NullPointerException` is thrown
- Otherwise the exception object `v` is thrown
- The enclosing block statement terminates abruptly
- The thrown exception may be caught by a dynamically enclosing `try-catch` statement
- If the exception is not caught then the entire program execution will be aborted
- A `try-catch` statement is used to catch particular exceptions thrown by a code block
- It has the following form:

```
try
  body
catch (E1 x1) catchBody1
catch (E21 | E22 | ... | E2k x2) catchBody2
...
finally finallyBody
```

- All the various bodies are block statements
- There can be zero or more `catch` clauses and the `finally` clause may be absent, but there must be at least one `catch` or `finally` clause

```
class WeekdayException extends Exception {
  public WeekdayException(String wday) {
    super("Illegal weekday: " + wday) ;
  }
}

int wdayno(String wday) throws WeekdayException {
  for (int i = 0; i < wdays.length; i++) {
    if (wday.equals(wdays[i])) {
      return i ;
    }
  }
  throw new WeekdayException(wday) ;
}
```

```
jshell> class WeekdayException extends Exception {
   ...>   public WeekdayException(String wday) {
   ...>     super("Illegal weekday: " + wday) ;
   ...>   }
   ...> }
   ...>
```

```
jshell> int wdayno(String wday) throws WeekdayException {
   ...>   for (int i = 0; i < wdays.length; i++) {
   ...>     if (wday.equals(wdays[i])) {
   ...>       return i ;
   ...>     }
   ...>   }
   ...>   throw new WeekdayException(wday) ;
   ...> }
   ...>

jshell> int d4 = wdayno("Dimanche")
|  Exception REPL.dJShelld31dWeekdayException:
        Illegal weekday: Dimanche
|        at wdayno (#25:7)
|        at (#27:1)
```

ToC

4.6 assert Statement

- The assert statement has one of the following forms:

```
assert booleanExpression ;
assert booleanExpression : expression ;
```

- booleanExpression must have type boolean or Boolean
- expression must be of type boolean, char, double, float, int, long, a boxed version of these or Object
- When assertions are enabled at run-time, every execution of the assert command will evaluate booleanExpression
- If the result is true, program execution contines normally
- If the result is false, the assertion fails, and an AssertionError will be thrown
- In the second form, expression will be evaluated, and its value passed to the appropriate AssertionError constructor
- See Unit 8 section 7

```
assert x > 2 : "x was " + x ;
```

ToC

5 JShell

- JShell is a Java *read-eval-print loop (REPL)* introduced in 2017 with JDK 9
- Java Shell User's Guide (Release 12, March 2019)
- Tools Reference: jshell
- JShell Tutorial (30 June 2019)
- How to run a whole Java file added as a snippet in JShell? (15 July 2019)

ToC

6 What Next ?

Programming, Debugging, Psychology

Although programming techniques have improved immensely since the early days, the process of finding and correcting errors in programming — known graphically if inelegantly as *debugging* — still remains a most difficult, confused and unsatisfactory operation. The chief impact of this state of affairs is psychological. Although we are happy to pay lip-service to the adage that to err is human, most of us like to make a small private reservation about our own performance on special occasions when we really try. It is somewhat deflating to be shown publicly and incontrovertibly by a machine that even when we do try, we in fact make just as many mistakes as other people. If your pride cannot recover from this blow, you will never make a programmer.

Christopher Strachey, Scientific American 1966 vol 215 (3) September pp112–124

- To err is human, to really foul things up requires a computer.
- Attributed to Paul R. Ehrlich in 101 Great Programming Quotes
- Attributed to Bill Vaughn in Quote Investigator
- Derived from Alexander Pope (1711, An Essay on Criticism)
- *To Err is Humane; to Forgive, Divine*
- This also contains

  A little learning is a dangerous thing;

  Drink deep, or taste not the Pierian Spring
- In programming, this means you have to *read the fabulous manual* (RTFM)

Chps 1–4, TMA01

- Chps 4–5, Iteration, collections; Functional Java (optional)
- Tutorial 03 10:00 Sunday 17 November 2024 online
- TMA01 Thursday 12 December 2024
- Chps 6,7 Arrays
- Tutorial 04 10:00 Sunday 19 January 2025 online
- Chps 8–10 Inheritance
- Tutorial 05 10:00 Sunday 16 February 2025 online
- TMA02 Thursday 6 March 2025

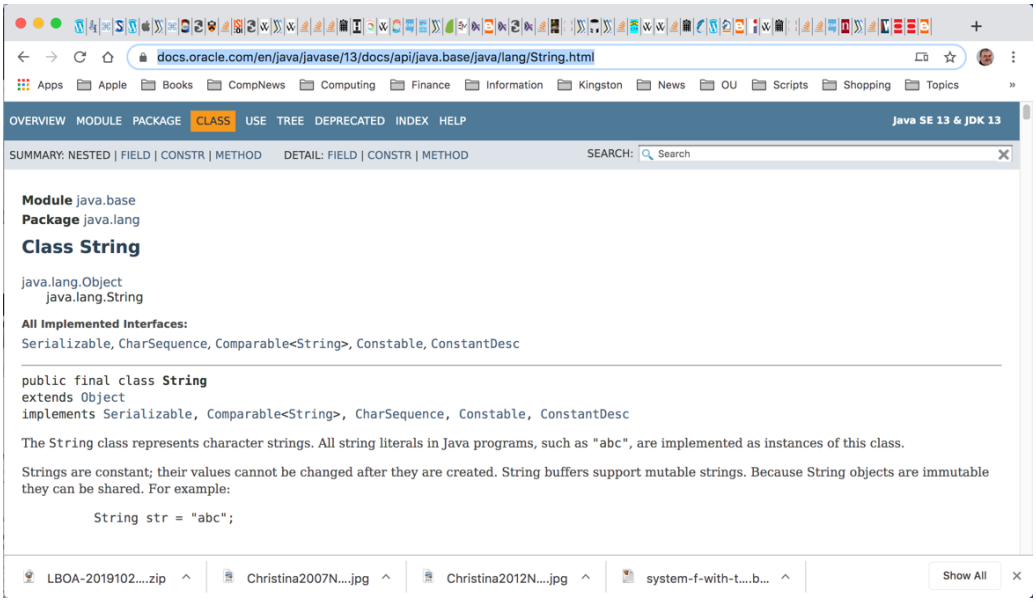
ToC

7 Web Links & References

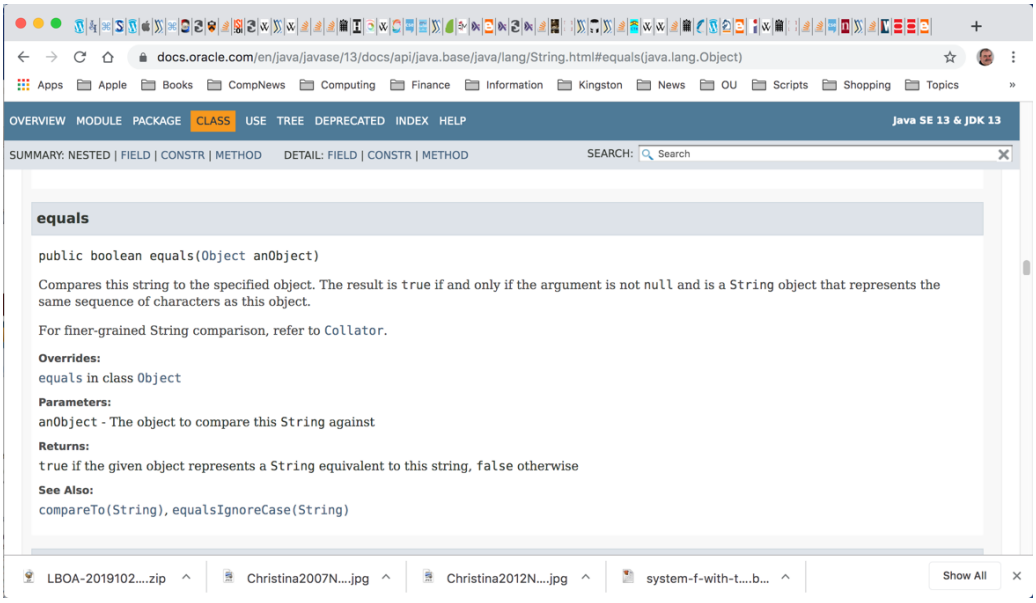
7.1 Java Documentation

- Java Documentation — BlueJ has JDK 7 embedded, JDK 13 is current (2019)

- JDK 13 Documentation
- Java Platform API Specification
- Java Language Specification
- JDK Documentation > API Documentation > java.base
  - java.lang — fundamental classes for the Java programming language
  - java.util — Collections framework



- `Strings` are *immutable* objects
- See java.lang.StringBuilder for *mutable* strings
- In a *functional programming approach* everything is immutable — it makes life simpler (but at a cost)



- Remember (==) tests for *identity* — what does this mean ?

ToC

7.2 Books Phil Likes

- M250 is self contained — you do not need further books — but you might like to know about some:
- Sestoft (2016) — the best short reference
- Evans and Flanagan (2018) — the best longer reference
- Barnes and Kölling (2016) — the BlueJ book — see www.bluej.org for documentation and tutorial
- Bloch (2017) — guide to best practice

ToC

References

Barnes, David J. and Michael Kolling (2009). *Objects First with Java*. Pearson Education, fourth edition. ISBN 0-13-606086-2. URL http://www.bluej.org/objects-first/.

Barnes, David J. and Michael Kolling (2011). *Objects First with Java*. Pearson Education, fifth edition. ISBN 0132835541. URL http://www.bluej.org/objects-first/.

Barnes, David J. and Michael Kölling (2016). *Objects First with Java*. Pearson, sixth edition. ISBN 1292159049. URL http://www.bluej.org/objects-first/. 27

Bloch, Joshua (2017). *Effective Java*. Addison-Wesley Professional, third edition. ISBN 9780134685991. 27

Darwin, Ian F (2014). *Java Cookbook*. O'Reilly, third edition. ISBN 9781449337049.

Evans, Benjamin J and David Flanagan (2014). *Java In A Nutshell*. O'Reilly, sixth edition. ISBN 1449370829. URL https://github.com/kittylyst/javanut6-examples. 15

Evans, Benjamin J and David Flanagan (2018). *Java In A Nutshell*. O'Reilly, seventh edition. ISBN 1492037257. 27

Felleisen, Matthias and Daniel P. Friedman (1998). *A Little Java, A Few Patterns*. MIT Press. ISBN 0262561158. URL http://felleisen.org/matthias/BALJ-index.html.

Gosling, James; Bill Joy; Guy L. Steele Jr.; Gilad Bracha; and Alex Buckley (2014). *The Java Language Specification, Java SE 8 Edition (Java Series) (Java (Addison-Wesley))*. Addison Wesley, eighth edition. ISBN 013390069X. URL https://docs.oracle.com/en/java/javase/12/index.html.

Naftalin, Maurice and Philip Wadler (2006). *Java Generics and Collections*. O'Reilly. ISBN 059610247X.

Schildt, Herbert (2018a). *Java: A Beginner's Guide*. McGraw-Hill, eighth edition. ISBN 1260440214. URL http://mhprofessional.com/9781260440218-usa-java-a-beginners-guide-eighth-edition-group.

Schildt, Herbert (2018b). *Java: The Complete Reference, Eleventh Edition*. McGraw-Hill, eleventh edition. ISBN 1260440230. URL http://mhprofessional.com/9781260440232-usa-java-the-complete-reference-eleventh-edition-group.

Sestoft, Peter (2002). *Java Precisely*. MIT Press. ISBN 0-262-69276-7.

Sestoft, Peter (2005). *Java Precisely*. MIT, second edition. ISBN 0262693259.

Sestoft, Peter (2016). *Java Precisely*. MIT, third edition. ISBN 0262529076. URL http://www.itu.dk/people/sestoft/javaprecisely/. 27

Thimbleby, Harold (1999). A critique of Java. *Software: Practice and Experience*, 29(5):457–478.

Waldo, Jim (2010). *Java: The Good Parts*. O'Reilly. ISBN 9780596803735. URL http://shop.oreilly.com/product/9780596803742.do.

ToC