
Introduction

COMP3021 Website: <https://course.cse.ust.hk/comp3021/>
(Videos of lectures will be made available at Canvas)



Shing-Chi Cheung
Computer Science & Engineering
HKUST

Zoom Meeting IDs

■ Lecture

- ❑ Zoom meeting ID: 970 5066 9046; Password is not enforced for the time being

■ Lab

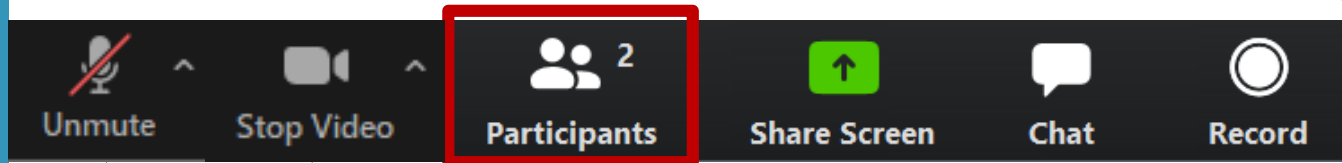
- ❑ Zoom meeting ID: 950 3710 8712; Password: 3021
- ❑ Lab starts on Week 1

Class and Lab Protocol

Launch the
Participants
window

Use this digital
hand to raise
questions

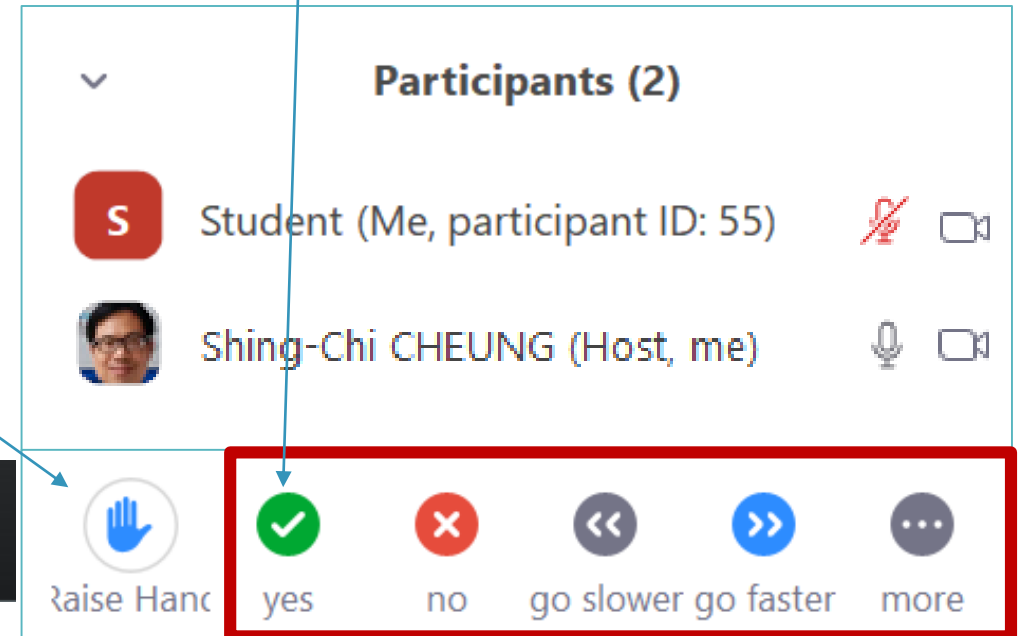
When you have finished an
in-class task such as
watching a video



Student (Participant)

Enable your video during lecture

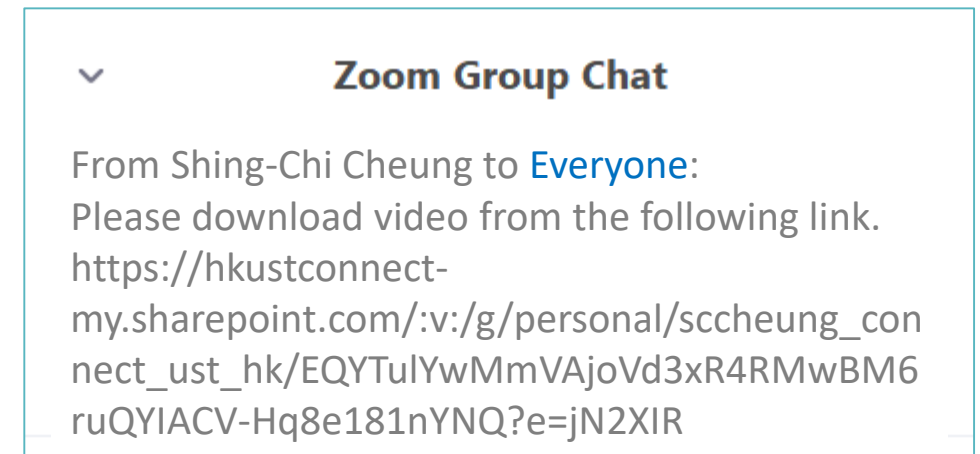
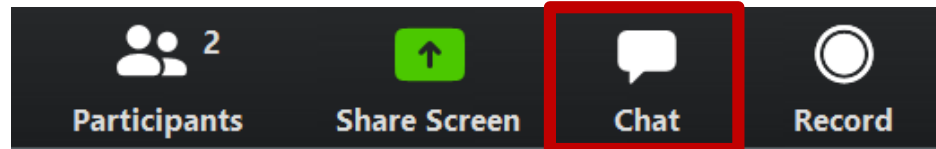
Enable your microphone only when you
ask or answer questions



- Click to **YES** to respond
- Click **NO** to respond

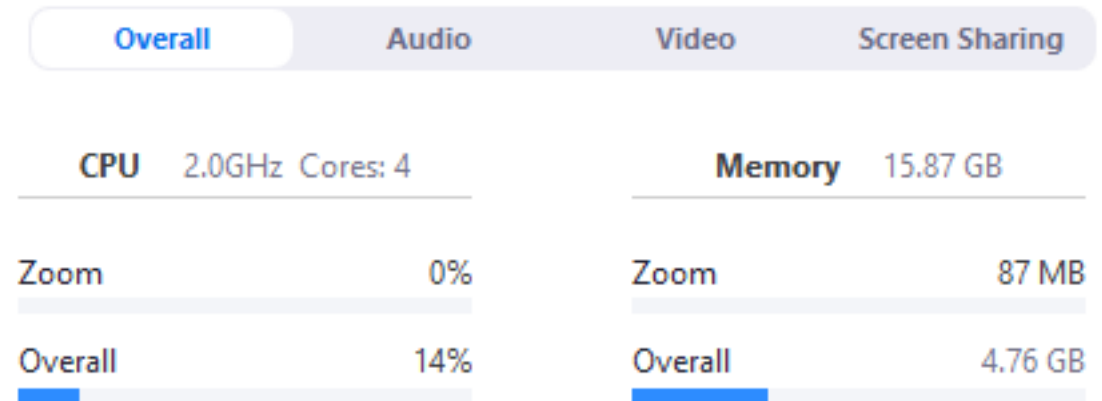
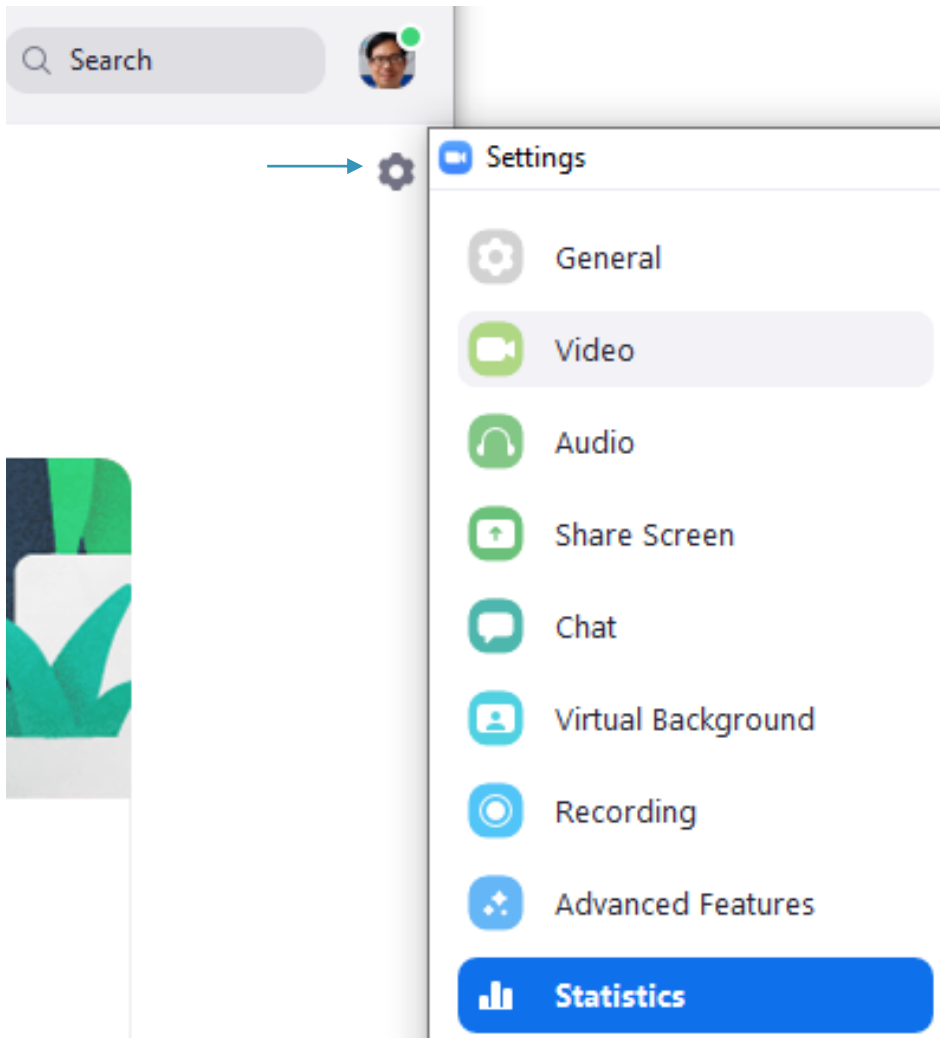
DON'T use chat to ask questions

Student (Participant)



Click to launch the chat window to see messages from instructors or TAs but don't use it to ask or answer questions

Do I have a good Zoom connection?



Do I have a good Zoom connection?

Overall

Audio

Video

Screen Sharing

Item name	Send	Receive
Frequency	24 KHz	32 KHz
Latency	13 ms	12 ms
Jitter	5 ms	3 ms
Packet loss - Avg(Max)	0.0% (0.0%)	1.9% (3.3%)

Overall

Audio

Video

Screen Sharing

Item name	Send	Receive
Latency	-	11 ms
Jitter	-	1 ms
Packet loss - Avg(Max)	-	1.6% (6.1%)
Resolution	-	926x720
Frame Per Second	-	26 fps

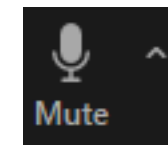
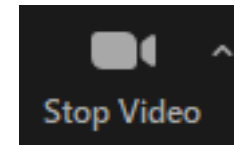
If you do not have good network connection, please download videos from hkustconnect mirror site BEFORE class

DOWNLOAD VIDEOS ...

https://hkustconnect-my.sharepoint.com/:v:/g/personal/sccheung_connect_ust_hk/EQYTulYwMmVAjoVd3xR4RMwBM6ruQYIACV-Hq8e181nYNQ

Class Interaction Protocol

- Check if your video camera and microphone are working before class
- Enable your video camera during the whole class
- Don't turn on your microphone unless you ask or answer questions
- When you have questions, click the raise hand button 🙋 under Participants
- Ask and answer questions using microphone
 - Don't use Chat to ask or answer questions
- Lower the digital hand 🙋 after asking or answering questions



Learning outcomes

- Ability to develop Java programs (with latest features)
 - ❑ Implement **object-oriented** concepts in Java.
 - ❑ Organize, compile and deploy Java program files.
 - ❑ Program **exceptions** and **lambdas**.
 - ❑ Define **generic** functions and classes in Java.

Learning outcomes

- Ability to use Java packages in programming
 - ❑ Design and implement **multi-threaded** Java applications.
 - ❑ Design and implement interactive **graphics** in Java.
 - ❑ Design and implement **event handlers** in Java.
 - ❑ Design and implement **functional interfaces**.

Learning outcomes

- Ability to apply tools and practices for Java programming
 - ❑ Design and implement **unit test** cases in a unit testing framework.
 - ❑ Follow good Java programming **practices**.
 - ❑ Use an award-winning integrated development environment (**IDE**) for Java application development.

Learning outcomes

**In simplicity:
You become a
competent Java developer!**



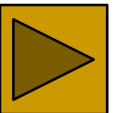
Being Competent in Programming?

A Strategy: Make programmers
held accountable to buggy code



<https://www.youtube.com/watch?v=3dF-POFE30E> (3:50)

Mirror: https://hkustconnect-my.sharepoint.com/:v:/g/personal/sccheung_connect_ust_hk/EQYTulYwMmVAjoVd3xR4RMwBM6ruQYIACV-Hq8e181nYNQ (3:50)



Being Programming Competent?

Are we doing this in the course ...

NO! Be competent by learning the **best practices** and **language design principles**



What Did Earlier Classmates Say?

Original

課程時間：2016年秋季
授課教授：Cheung Shing Chi

总体来说真的很不错，学到了很多東西。professor也很与时俱进，GUI部分讲的也不再是swing，而是javafx，而且最后也讲了java8新加入的lambda expression。每一章professor都会从 **design principle** 的角度来讲为什么 **java designer** 会这样设计等等。

By Google Translate

Semester: 2016 Fall
Instructor: Cheung, Shing Chi

Overall it was really good and I learned a lot. The professor is also very advancing with the times. The GUI part is no longer about swing, but javafx, and finally the new lambda expression of java8. In each chapter, the professor always explained from the perspective of the **design principle on why the java designer will design like this** and so on.

Source: <http://ug.msss.ust.hk/cwiki>

What Did Earlier Classmates Say?

Original

課程時間：2018年fall季
授課教授：CHEUNG, Shing Chi

我覺得教授：很用心，每个concept都会解释一下为什么developer会选择这样做，基本不会有不清晰不明白的地方；ppt内容经常更新，经常一个topic会改两三次；email问问题还是很快回覆的

By Google Translate

Semester: 2018 Fall
Instructor: Cheung, Shing Chi

I think the professor: very careful, for each concept he will explain why developers choose to do this, there will be no unclear points; ppt content is updated frequently, often a topic will be changed two or three times; email asks questions quickly Reply

Source: <http://ug.msss.ust.hk/cwiki>

QUESTIONS?



May I know ...



How to get good grade?

DON'Ts ...



Miss lectures

Miss labs

Miss assignments

Miss quiz

Miss examination

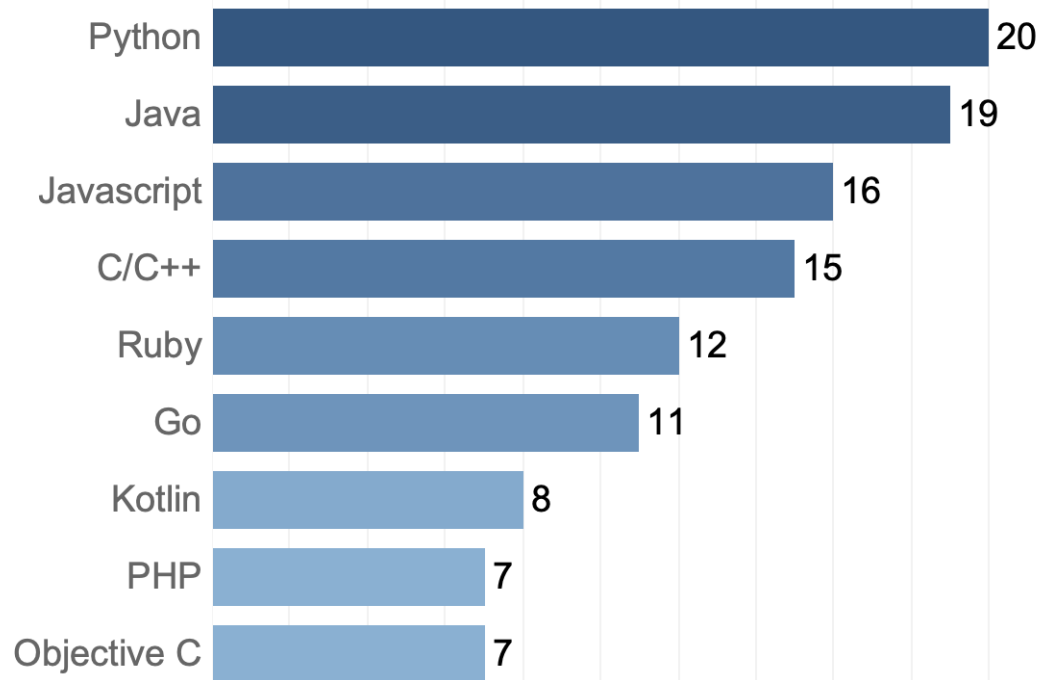
Copy from classmates

DOs ...



Study notes before and after classes
Try all class examples and lab
exercises
Understand concepts
Make use of self-learning center
Practice more












Most Widespread Languages at Top Unicorns



BELLEVUE, Wash., July 11, 2019 (GLOBE NEWSWIRE) -- Coding Dojo today released research into the programming and software development technologies used at the top privately-held startups in the US valued at over \$1 billion; otherwise known as “unicorn” companies. This research includes lists of the most common programming languages, frameworks and database technologies across all 25 unicorns and a breakdown of which companies are using which languages.

Source: <https://www.globenewswire.com/news-release/2019/07/11/1881446/0/en/Coding-Dojo-Identifies-the-Most-In-Demand-Programming-Languages-at-Top-US-Unicorns.html>

Top Programming Languages

Rank	Language	Type	Score
1	Python ▼	  	100.0
2	Java ▼	  	95.3
3	C ▼	  	94.6
4	C++ ▼	  	87.0
5	JavaScript ▼		79.5

The Top 3
Programming Languages
in 2020

– opinion by an KOL on
YouTube
<https://www.youtube.com/watch?v=bjFvcFjJpE0>

IEEE Spectrum July 2020 (<https://spectrum.ieee.org/at-work/tech-careers/top-programming-language-2020>)

Top Programming Languages

6	R ▼	🖥️	78.6
7	Arduino ▼	🔧	73.2
8	Go ▼	🌐 🖥️	73.1
9	Swift ▼	📱 🖥️	70.5
10	Matlab ▼	🖥️	68.4

What are the next five top programming languages?



IEEE Spectrum July 2020 (<https://spectrum.ieee.org/at-work/tech-careers/top-programming-language-2020>)

Overall

- Learning Java is fun and fruitful!
- Gain programming maturity

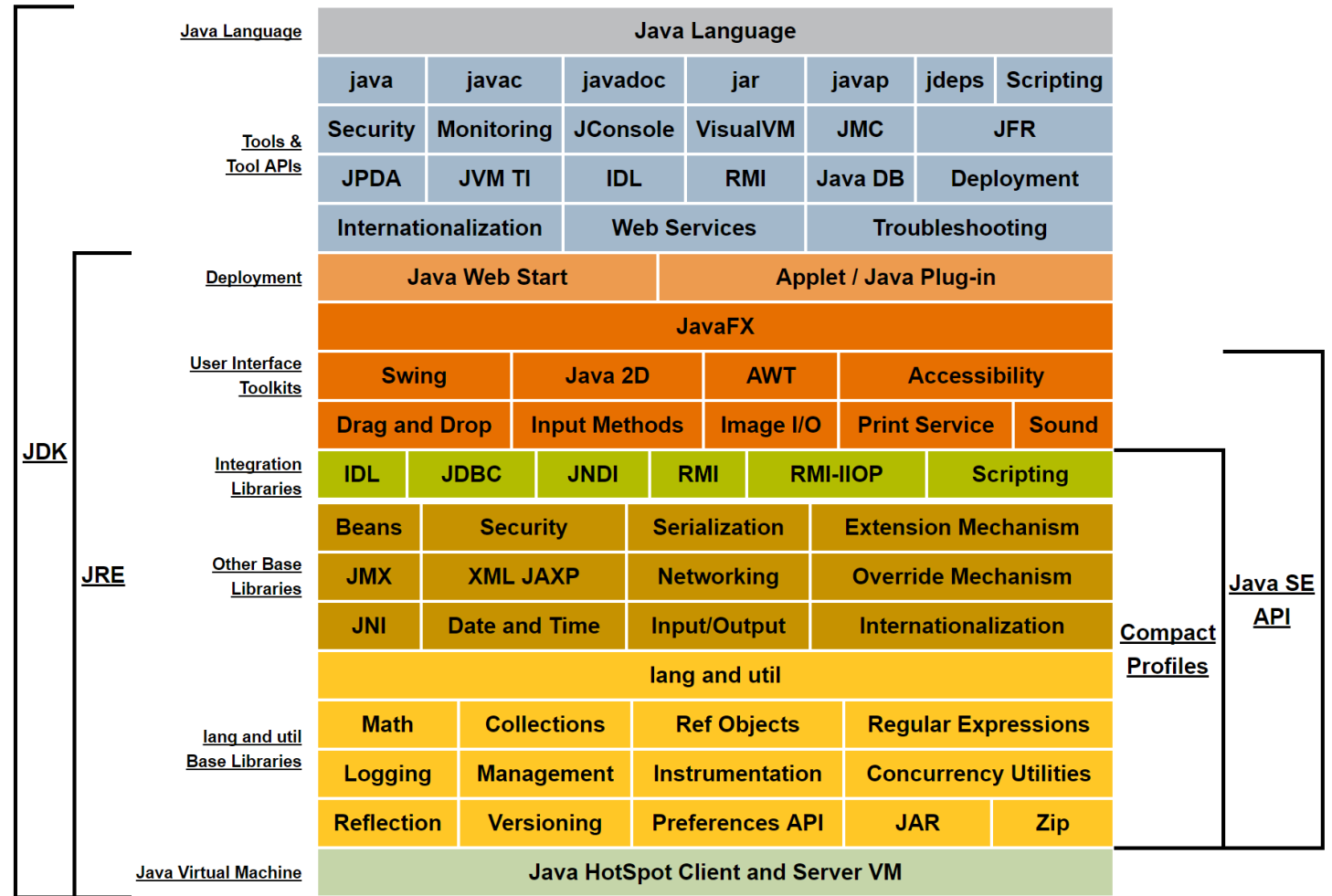
But:

- Probably the most intensive Java course offered by universities (at least in Hong Kong)
- Read class notes and lab materials in advance

What is Java Standard Edition (SE)?

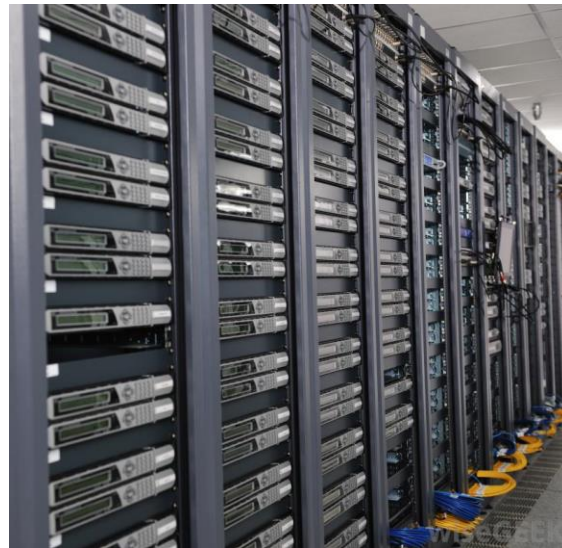
What are the differences between Java Development Kit (JDK) and Java Runtime Environment (JRE)?

This course needs JDK



What is Java used for?

- To develop applications on **servers**
- To develop applications on **cloud** platforms
- To develop applications on **Android** devices
- As a **vehicle** to learn other languages: Kotlin, Scala, Go, C#, JavaScript, ...



A Continual Evolving Language

- Initiated as the Green project by James Gosling in 1991
- Rich support of library packages



The earliest version that supports JavaFX and Lambda

The earliest version that supports local-variable type inference

Version Name	Code Name	Release Date
JDK 1.0	Oak	Jan 1996
JDK 1.1	(none)	Feb 1997
J2SE 1.2	Playground	Dec 1998
J2SE 1.3	Kestrel	May 2000
J2SE 1.4	Merlin	Feb 2002
Java SE 5	Tiger	Sep 2004
Java SE 6	Mustang	Dec 2006
Java SE 7	Dolphin	Jul 2011
→ Java SE 8*		Mar 2014
Java SE 9		Sep 2017
→ Java SE 10		Mar 2018



A Continual Evolving Language

- Since J2SE 1.4, Java is governed by the Java Community Process (JCP)
- Java grew from a few hundred library classes in JDK1.0 to 3,000+ classes in J2SE 5
- The OpenJDK community is providing the long term support for the public

- Oracle will not provide non-commercial long term support of Java

Version Name	Code Name	Release Date
JDK 1.0	Oak	Jan 1996
JDK 1.1	(none)	Feb 1997
J2SE 1.2	Playground	Dec 1998
J2SE 1.3	Kestrel	May 2000
J2SE 1.4	Merlin	Feb 2002
Java SE 5	Tiger	Sep 2004
Java SE 6	Mustang	Dec 2006
Java SE 7	Dolphin	Jul 2011
Java SE 8*		Mar 2014
Java SE 9		Sep 2017
Java SE 10		Mar 2018

A Continual Evolving Language

- Java 11 is an LTS (Long Term Support) release
- OpenJDK provides free update support for Java 11 until Sep 2026
 - ❑ Bug fixes and security updates
- Java will provide a new LTS release every 3 years
 - ❑ Update support for 8 years
 - ❑ Java 17 will be the next LTS



Version Name	Code Name	Release Date
Java SE 11*		Sep 2018
Java SE 12		Mar 2019
Java SE 13		Sep 2019
Java SE 14		Mar 2020
Java SE 15		Sep 2020
Java SE 16		Mar 2021
Java SE 17*		Sep 2021
Java SE 18		To be confirmed
Java SE 19		
Java SE 20		
Java SE 21		

A Continual Evolving Language

- Java provides a rich set of APIs (libraries) organized under different packages
- Java library is growing fast!
- API documentation is available at
 - <https://docs.oracle.com/en/java/javase/14/docs/api/index.html>

Classes in Java SDK

- 4569 in [java 14](#)
- 4545 in [java 13](#)
- 4433 in [java 12](#)
- 4411 in [java 11](#)
- 6002 in [java 10](#)
- 6005 in [java 9](#) 2017
- 4240 in [java 8](#) 2014
- 4024 in [java 7](#)
- 3793 in [java 6](#)
- 3279 in [java 5.0](#)
- 2723 in [java 1.4.2](#)
- 1840 in [java 1.3.1](#)

1765 more classes
1517 more classes
2002

A Continual Evolving Language

- Initiated as the Green project by James Gosling in 1995

- Rich support of library packages

We discuss the **use** of Java language as well as the **considerations** in designing the language.

Version Name	Code Name	Release Date
JDK 1.0	Oak	Jan 1996
JDK 1.1	(none)	Feb 1997
J2SE 1.2	Playground	Dec 1998
J2SE 1.3	Kestrel	May 2000
J2SE 1.4	Merlin	Feb 2002
Java SE 5	Tiger	Sep 2004
Java SE 6	Mustang	Dec 2006
Java SE 7	Dolphin	Jul 2011
Java SE 8		Mar 2014
Java SE 9		Sep 2017
Java SE 10		Mar 2018
Java SE 11		Sep 2018
Java SE 12		Mar 2019



7 Key Design Principles of Java



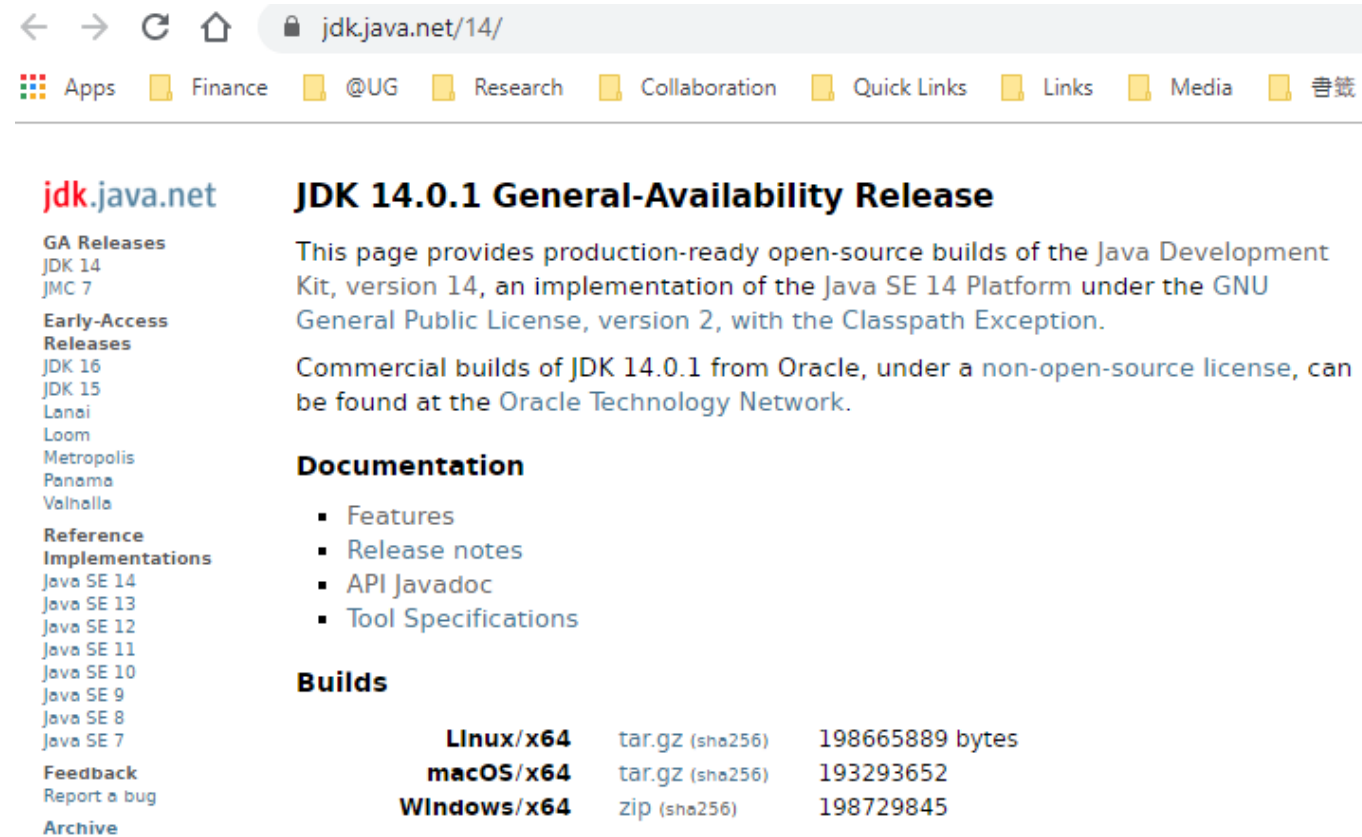
- Strongly typed, statically typed
 - ❑ characters cannot be casted as integers
 - ❑ String is a type by itself; not an array of characters
- Highly object-oriented
 - ❑ All Java classes inherit from the **Object** class
- Single class inheritance
- No pointer manipulation
- No need to worry about memory allocation and deallocation
 - ❑ Memory is managed automatically by a Garbage Collector in JVM
- Compiled bytecodes can be run on any computers equipped with a JVM
- Designed to support multithreading



LET'S PROGRAM

Java SE Development Kit (JDK) ver 14

- We will use Java SE 14
- Bundled with
 - ❑ javac (Java compiler)
 - ❑ java (Java runtime)
 - ❑ javadoc (Java documentation)
 - ❑ JUnit (Java unit testing)



The screenshot shows the JDK 14.0.1 General-Availability Release page. The browser address bar shows 'jdk.java.net/14/'. The page has a navigation bar with links for Apps, Finance, @UG, Research, Collaboration, Quick Links, Links, Media, and 書籤. The main content area is divided into two columns. The left column contains links for GA Releases (JDK 14, JMC 7), Early-Access Releases (JDK 16, JDK 15, Lanai, Loom, Metropolis, Panama, Valhalla), Reference Implementations (Java SE 14, Java SE 13, Java SE 12, Java SE 11, Java SE 10, Java SE 9, Java SE 8, Java SE 7), Feedback, Report a bug, and Archive. The right column features the title 'JDK 14.0.1 General-Availability Release', a paragraph describing the production-ready open-source builds, a note about commercial builds, a 'Documentation' section with links to Features, Release notes, API Javadoc, and Tool Specifications, and a 'Builds' section with a table of download links and sizes for Linux/x64, macOS/x64, and Windows/x64.

Platform	Download Link	Size
Linux/x64	tar.gz (sha256)	198665889 bytes
macOS/x64	tar.gz (sha256)	193293652
Windows/x64	zip (sha256)	198729845

<https://jdk.java.net/14/>

IntelliJ



Version: 2020.1.2
Build: 201.7846.76
3 June 2020

[Release notes](#)

Download IntelliJ IDEA

Windows

macOS

Linux

Ultimate

For web and enterprise development

DOWNLOAD

.EXE
▼

Free trial

Community

For JVM and Android development

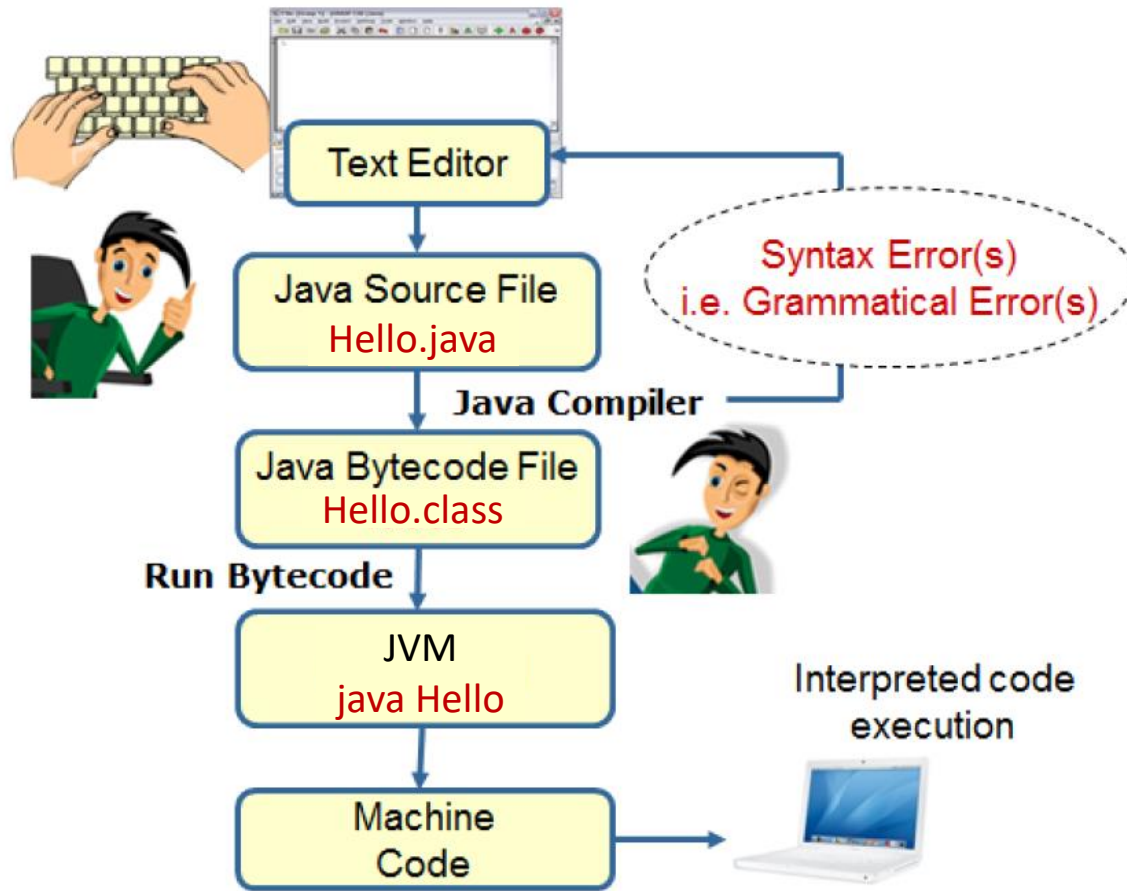
DOWNLOAD

.EXE
▼

Free, open-source

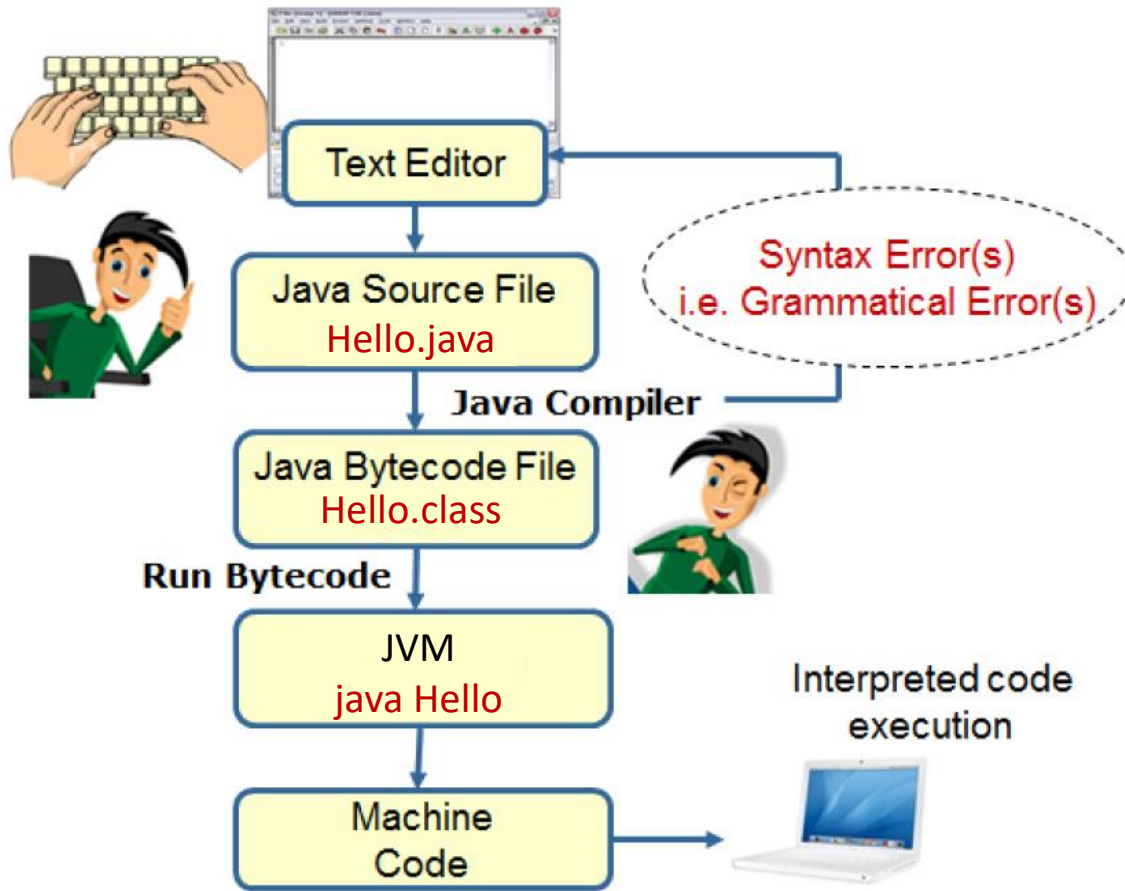
Download IntelliJ IDEA at: <https://www.jetbrains.com/idea/download/>
Understand useful IntelliJ features: <https://www.jetbrains.com/idea/features/>

Development Cycle of a Java Program



- Write Java source code using an editor, saving the code to a **.java** file.
- Invoke **javac** to compile each .java source file into a **.class** bytecode file.
- Invoke **java** to bring up a JVM and run the bytecode files.

Combined Compilation and Execution



- We can launch **single-file source-code** programs since Java 11
- Up to Java 10:
 - ❑ `javac Hello.java` // compile
 - ❑ `java Hello <args>` // execute
- Since Java 11:
 - ❑ // compile and execute
 - ❑ `java Hello.java <args>`

Using Preview Features in Command Line

■ Compile

- ❑ `javac --enable-preview --release 14 Hello.java`

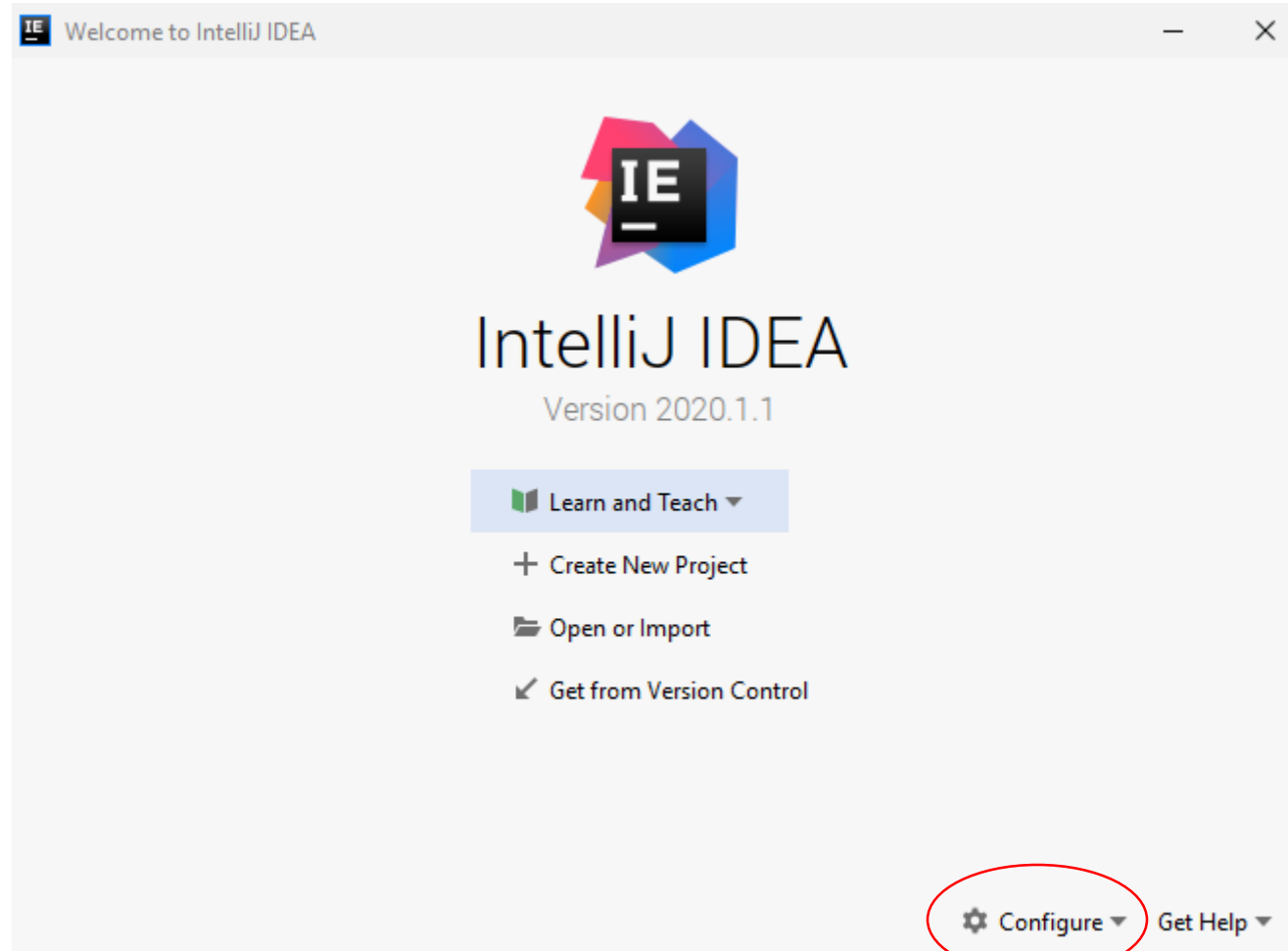
■ Execute

- ❑ `java --enable-preview Java14 Hello <args>`

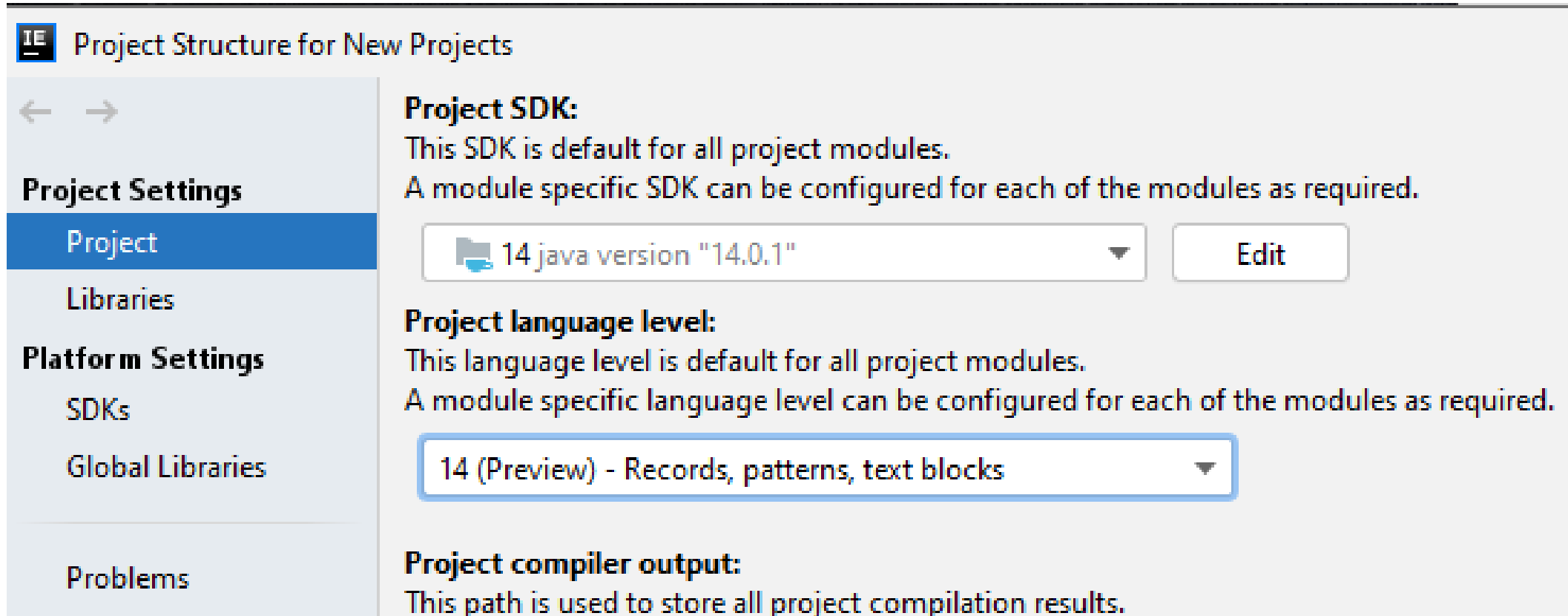
■ Compile & Execute

- ❑ `java --enable-preview Java14 Hello.java <args>`

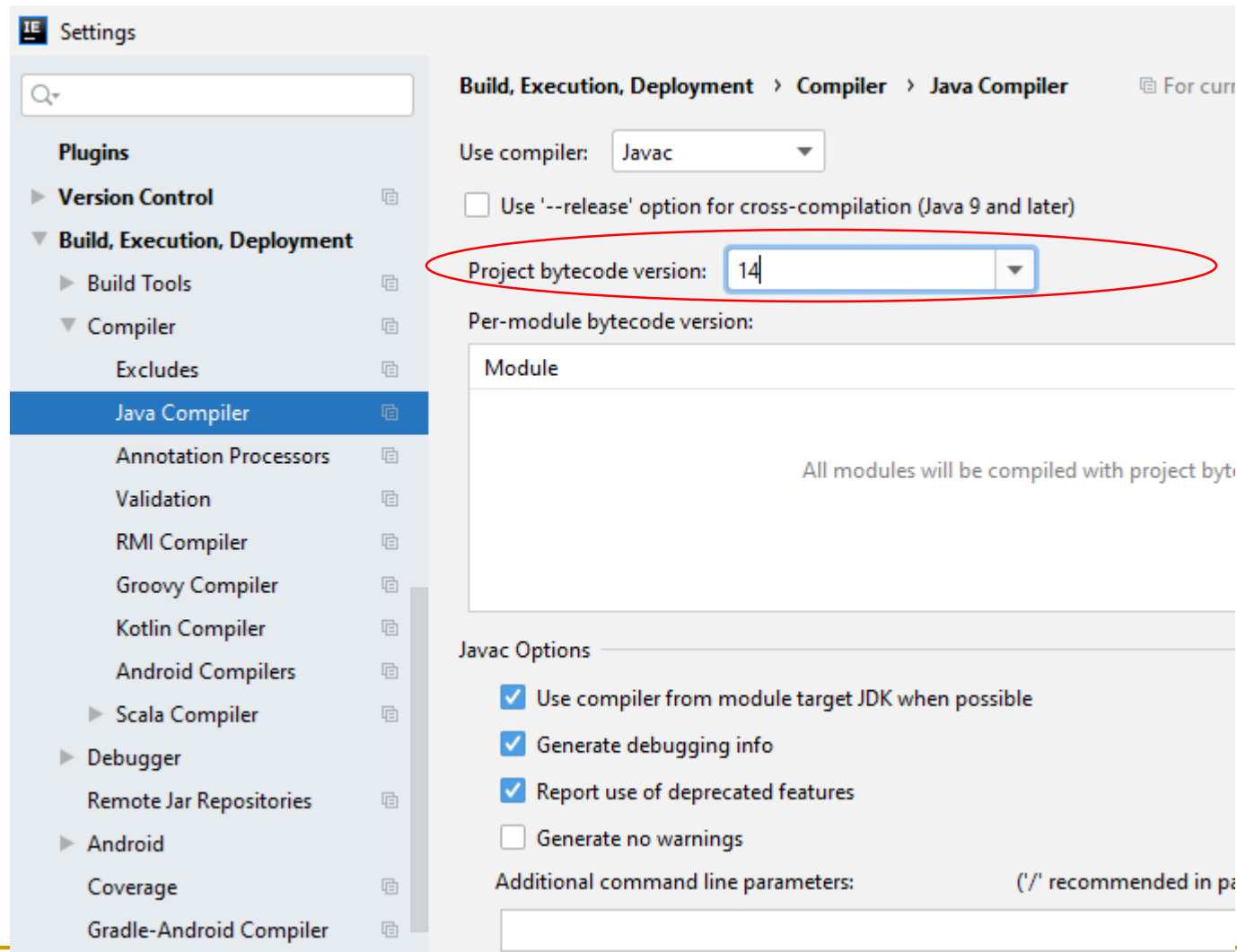
Configuring IntelliJ IDEA



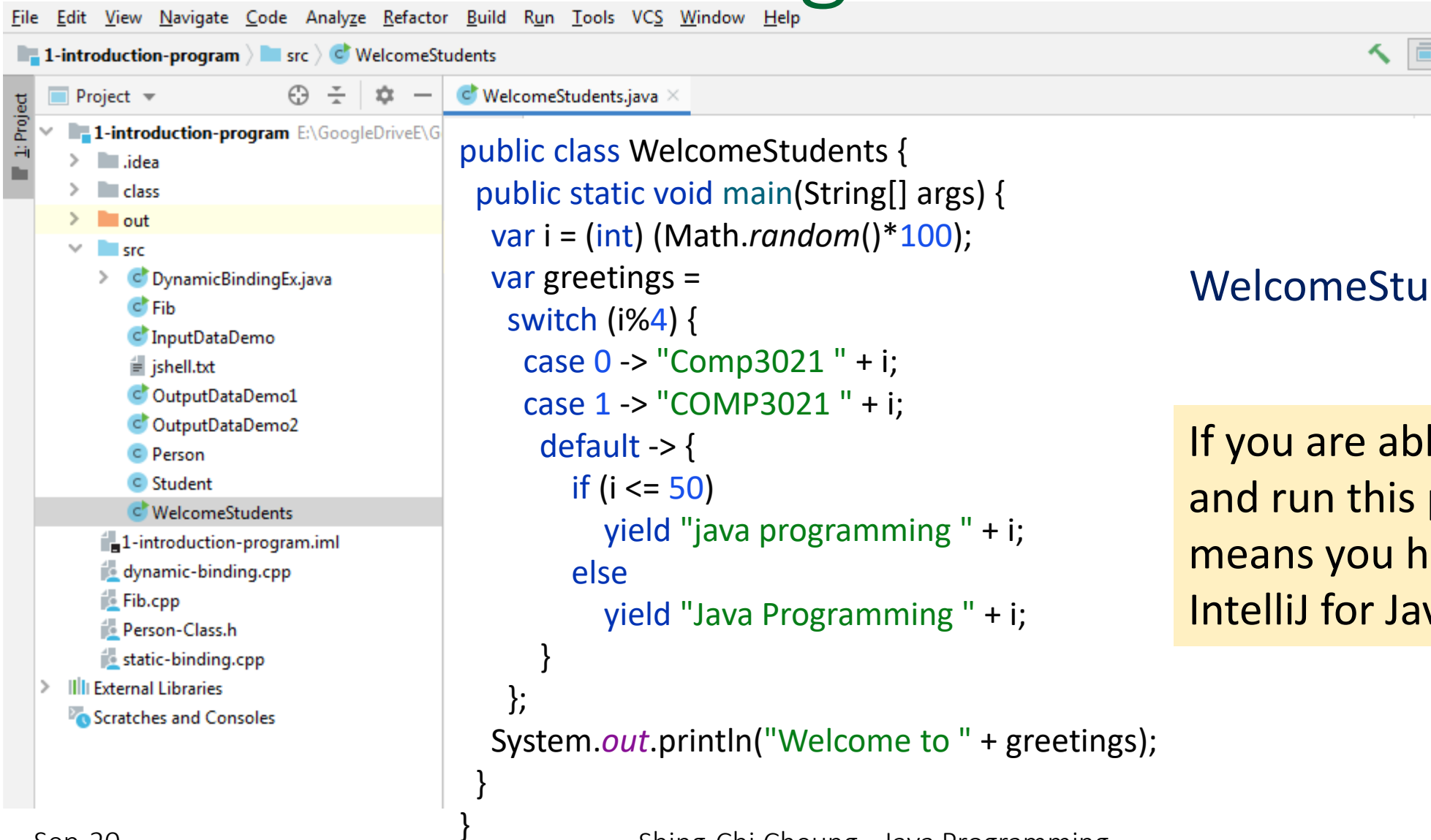
Project Structure Configuration



Setting



Our First Java Program



The screenshot shows an IDE window with the following structure:

- Menu bar: File, Edit, View, Navigate, Code, Analyze, Refactor, Build, Run, Tools, VCS, Window, Help
- Breadcrumb: 1-introduction-program > src > WelcomeStudents
- Project View (Left):
 - 1-introduction-program (E:\GoogleDrive\G)
 - .idea
 - class
 - out
 - src
 - DynamicBindingEx.java
 - Fib
 - InputDataDemo
 - jshell.txt
 - OutputDataDemo1
 - OutputDataDemo2
 - Person
 - Student
 - WelcomeStudents
 - 1-introduction-program.iml
 - dynamic-binding.cpp
 - Fib.cpp
 - Person-Class.h
 - static-binding.cpp
 - External Libraries
 - Scratches and Consoles

- Editor View (Right):

```
public class WelcomeStudents {  
    public static void main(String[] args) {  
        var i = (int) (Math.random()*100);  
        var greetings =  
            switch (i%4) {  
                case 0 -> "Comp3021 " + i;  
                case 1 -> "COMP3021 " + i;  
                default -> {  
                    if (i <= 50)  
                        yield "java programming " + i;  
                    else  
                        yield "Java Programming " + i;  
                }  
            };  
        System.out.println("Welcome to " + greetings);  
    }  
}
```

WelcomeStudents.java

If you are able to compile and run this program, it means you have set up IntelliJ for Java 14 correctly.

Enhanced switch in Java 14

```
int days = switch(month) {  
    case 1, 3, 5, 7, 8, 10, 12 -> 31;  
    case 4, 6, 9, 11 -> 30;  
    case 2 -> {  
        System.out.print("Enter year: ");  
        Scanner scanner = new Scanner(System.in);  
        int year = scanner.nextInt();  
        if (year % 4 == 0)  
            yield 29;  
        else  
            yield 28;  
    }  
    default -> 0;  
};
```

Since Java 14, **yield** becomes the keyword used in switch expression to return a value.

A Note on `System.out.println`

- System dependence – `System.out.println(msg)`
 - Windows outputs “`\r\n`” as the line separator
 - Unix outputs “`\n`” as the line separator
- System independence – `System.out.print(msg+“\n”)`
 - Always outputs “`\n`” as the line separator

Define multiple classes in a source file?

- Yes but only one of them can be public
- The public class must have the same name as the source file

```
class A {  
    public void funcX() { System.out.println("funcX in A"); }  
    public void funcY() { System.out.println("funcY in A"); }  
}
```

```
class B extends A {  
    public void funcY() { System.out.println("funcY in B"); }  
}
```

```
public class DynamicBindingEx {  
    public static void main(String[] args) {  
        A obj = new B();  
        obj.funcY();  
    }  
}
```

DynamicBindingEx.java

JShell: An Interactive Java Shell

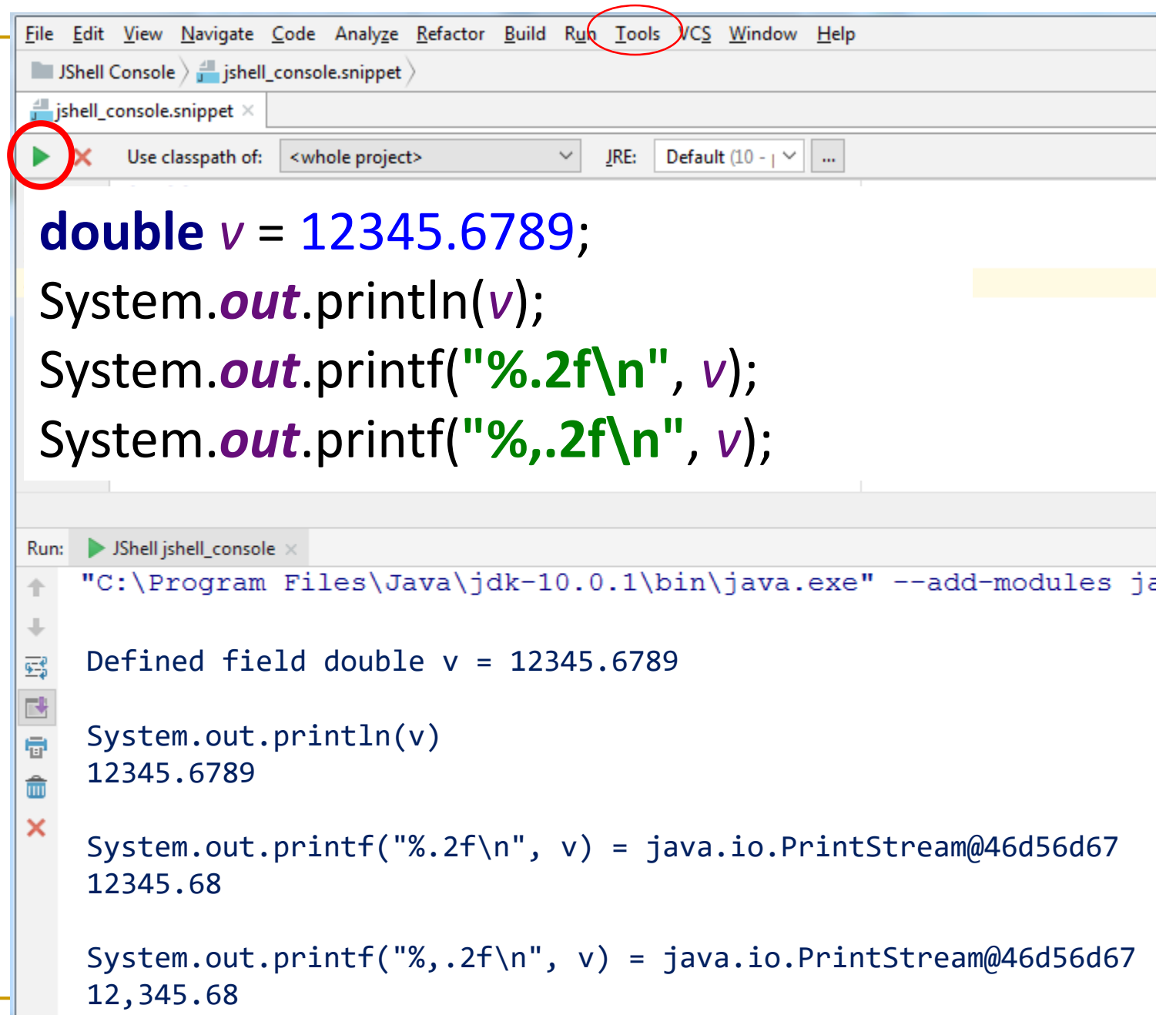
- A shell supported since Java 9 for dynamic interaction (known as Read-Evaluate-Print-Loop)
- Useful to try out library calls without writing a Java program
- Resource
 - ❑ <https://www.pluralsight.com/guides/getting-started-with-jshell>



JShell

Tools ->
JShell Console ...

demo



```
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
JShell Console > jshell_console.snippet >
jshell_console.snippet x
Use classpath of: <whole project> JRE: Default (10 - | > ...

double v = 12345.6789;
System.out.println(v);
System.out.printf("%.2f\n", v);
System.out.printf("%,.2f\n", v);

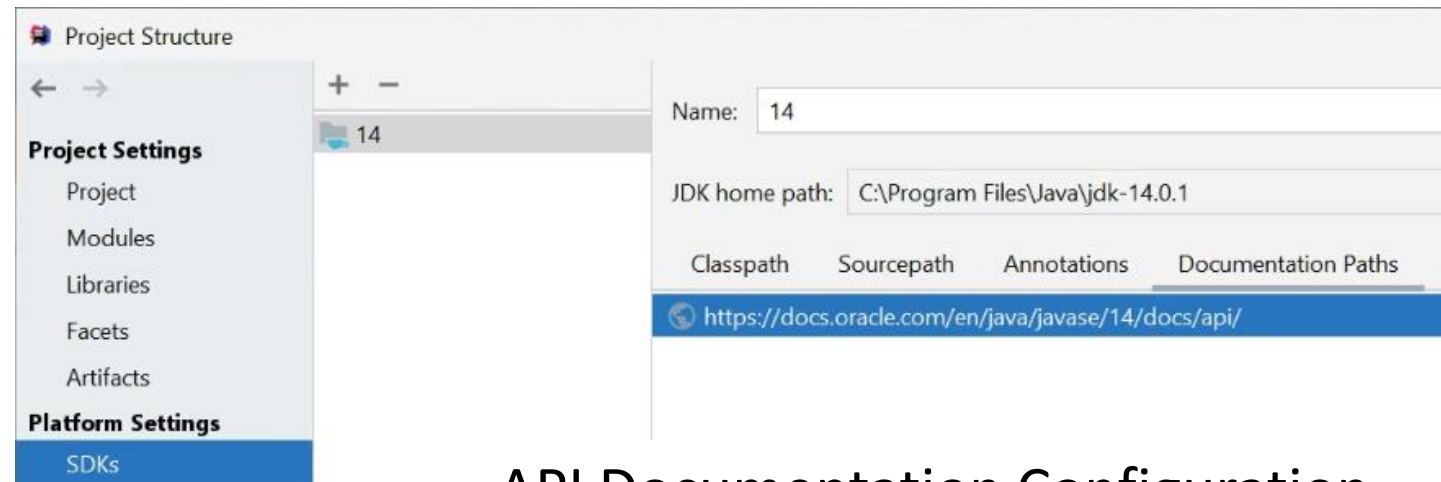
Run: JShell jshell_console x
"C:\Program Files\Java\jdk-10.0.1\bin\java.exe" --add-modules ja
Defined field double v = 12345.6789
System.out.println(v)
12345.6789
System.out.printf("%.2f\n", v) = java.io.PrintStream@46d56d67
12345.68
System.out.printf("%,.2f\n", v) = java.io.PrintStream@46d56d67
12,345.68
```

JavaDoc

- We can generate a nicely formatted API documentation from Java comments
- These comments are written in specified format
- On-the-fly: **CTL-Q** (Win/Linux) or **CTL-J** (Mac)
- HTML JavaDoc: **Tools -> Generate JavaDoc...**

Java API Documentation

- The whole Java 14 API documentation is generated by JavaDoc
- Configure IntelliJ Documentation Paths
- Press **Shift-F1** to view external API documentation of a library class
- Press **CTL-Q** (Win/Linux) or **CTL-J** (Mac) to view inline API documentation of a library class



API Documentation Configuration

Terminology from C++ to Java

C++	Java
Non-static data member	Instance variable
Static data member	Static variable
Non-static member function	Instance Method
Static member function	Static Method
Base class	Superclass
Derived class	Subclass
Pointer variable	Reference variable
Inherits	Extends
Function overloading	Method overloading
Function overriding	Method overriding

Why learning Java?

- Learn advanced programming concepts
 - ❑ Adopted by most recent programming languages
 - ❑ C#, Objective-C, Scala, GO, Ruby, Kotlin, ...
- Learn good OO programming practice
 - ❑ Adopted by open source project development and enterprises



<https://www.youtube.com/watch?v=RnqAXuLZlaE> (3:13)



Things to do after class ...

Useful Supplements and Links

- Conversion from C++ to Java

- <https://course.cse.ust.hk/comp3021/notes/c++2java.pdf>

- Running IntelliJ for the first time

- https://www.youtube.com/watch?v=c0efB_CKOYo

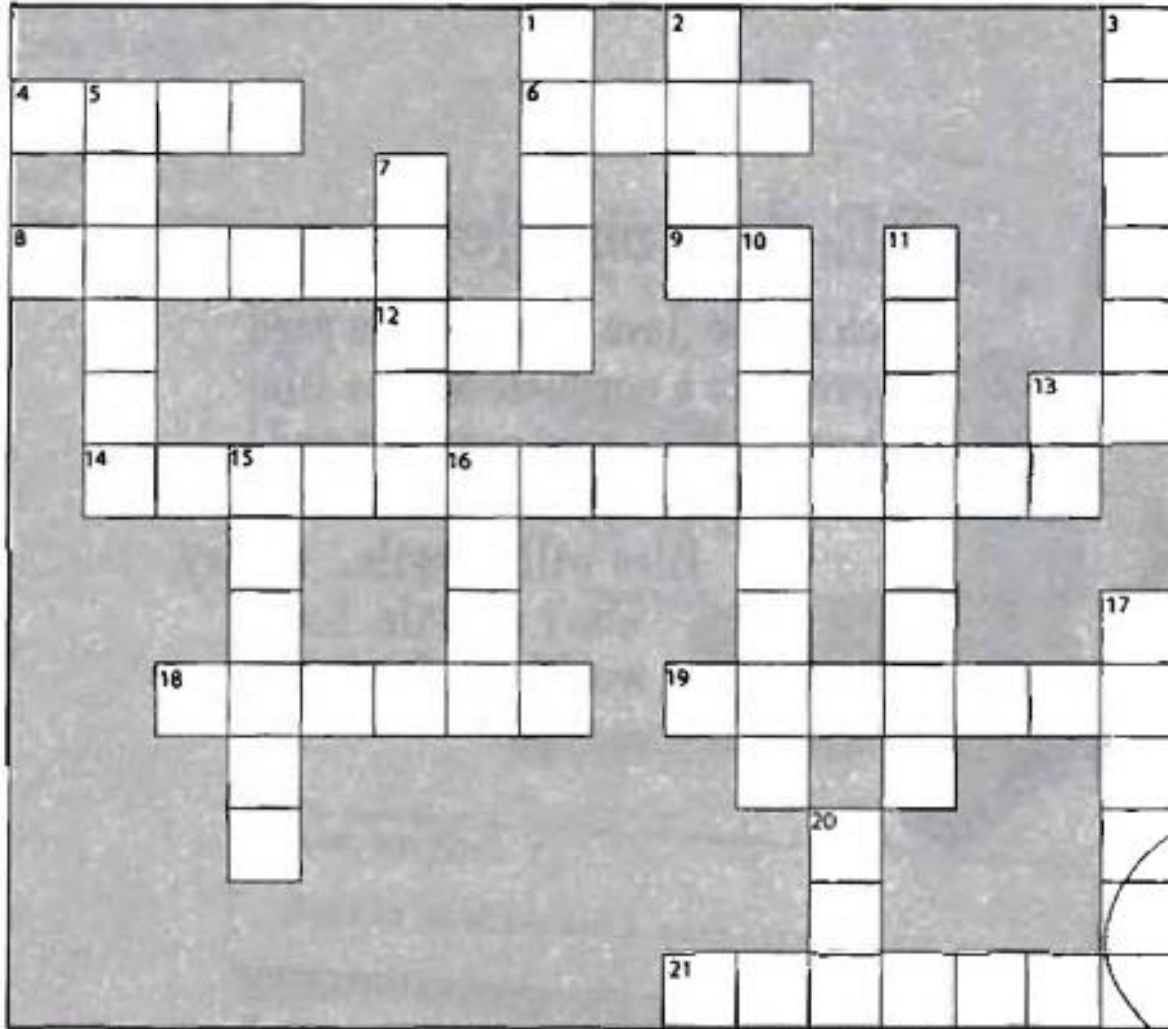
- Discover IntelliJ IDEA

- <https://www.jetbrains.com/help/idea/discover-intellij-idea.html>

- Guided Tour around the IntelliJ User Interface

- <https://www.jetbrains.com/help/idea/guided-tour-around-the-user-interface.html>

Java Cross Puzzle



Across

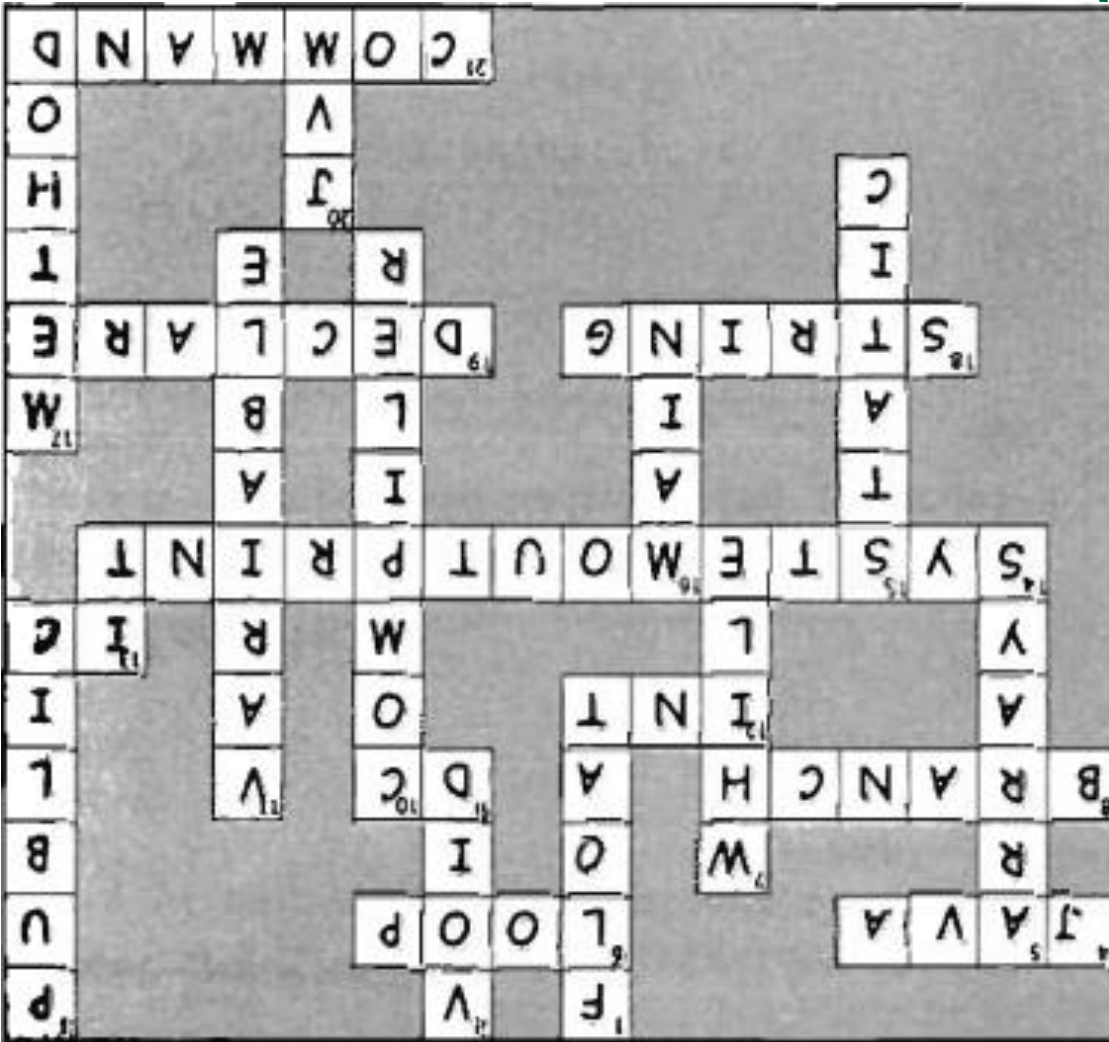
- 4. Command-line invoker
- 6. Back again?
- 8. Can't go both ways
- 9. Acronym for your laptop's power
- 12. number variable type
- 13. Acronym for a chip
- 14. Say something
- 18. Quite a crew of characters
- 19. Announce a new class or method
- 21. What's a prompt good for?

Down

- 1. Not an integer (or _____ your boat)
- 2. Come back empty-handed
- 3. Open house
- 5. 'Things' holders
- 7. Until attitudes improve
- 10. Source code consumer
- 11. Can't pin it down
- 13. Dept. of LAN jockeys
- 15. Shocking modifier
- 16. Just gotta have one
- 17. How to get things done
- 20. Bytecode consumer

extracted from Head First Java

Java Cross Puzzle (Soln)



Down

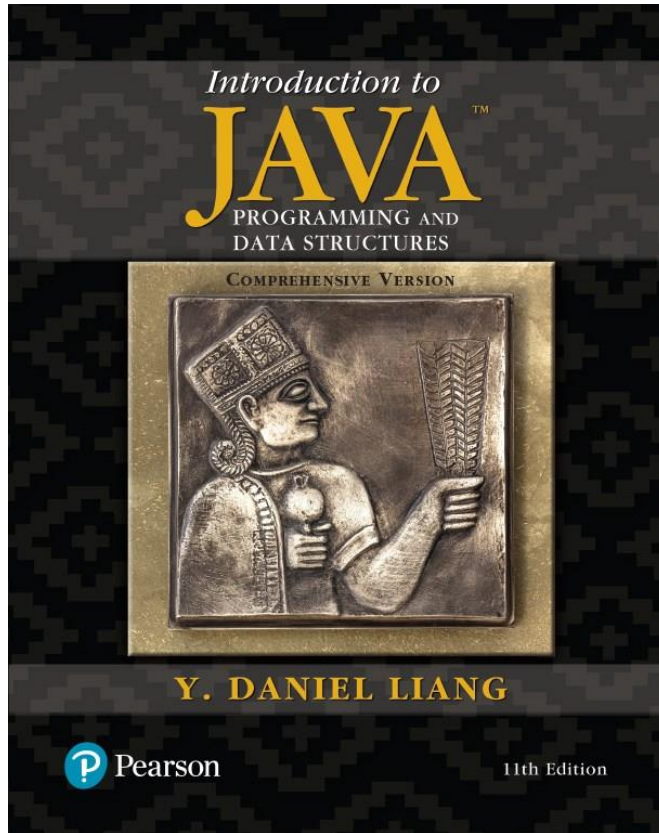
1. Not an integer (or your boat)
 2. Come back empty-handed
 3. Open house
 4. Command-line invoker
 5. Things' holders
 6. Back again?
 7. Until attitudes improve
 8. Can't go both ways
 9. Acronym for your laptop's power
 10. Source code consumer
 11. Can't pin it down
 12. number variable type
 13. Acronym for a chip
 14. Say something
 15. Shocking modifier
 16. Just gotta have one
 17. How to get things done
 18. Quite a crew of characters
 19. Announce a new class or method
 20. Bytecode consumer
 21. What's a prompt good for?

Across

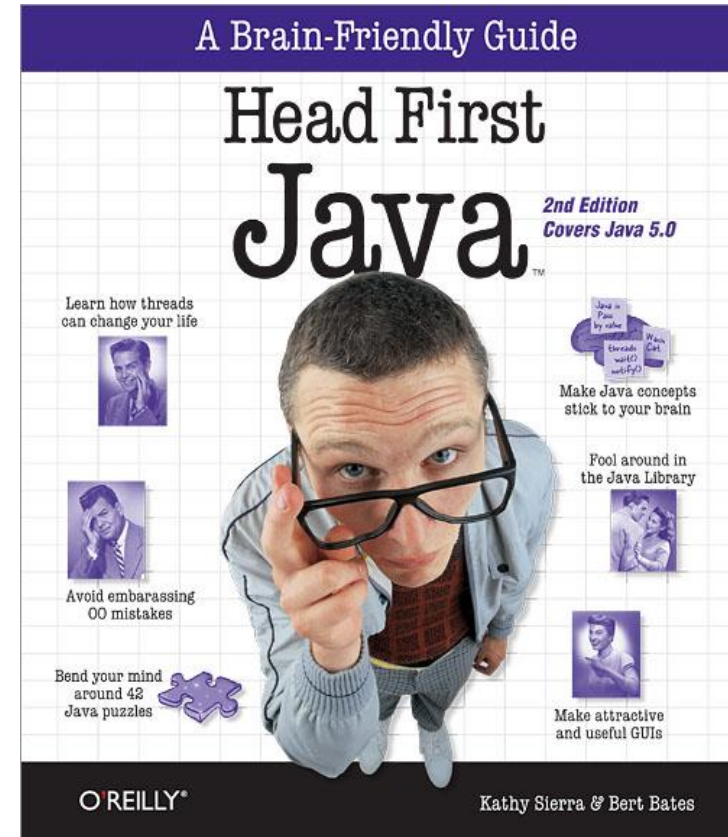
extracted from Head First Java

Final Notes ...

Reference Books



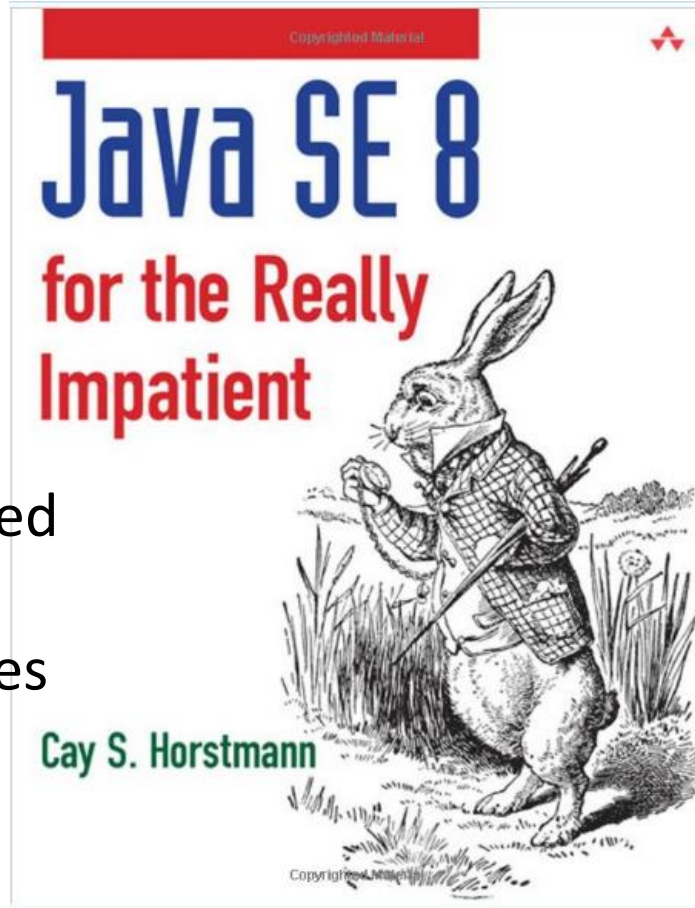
Cover features up to Java 7 and Java FX of Java 8



Cover features up to Java 5

References

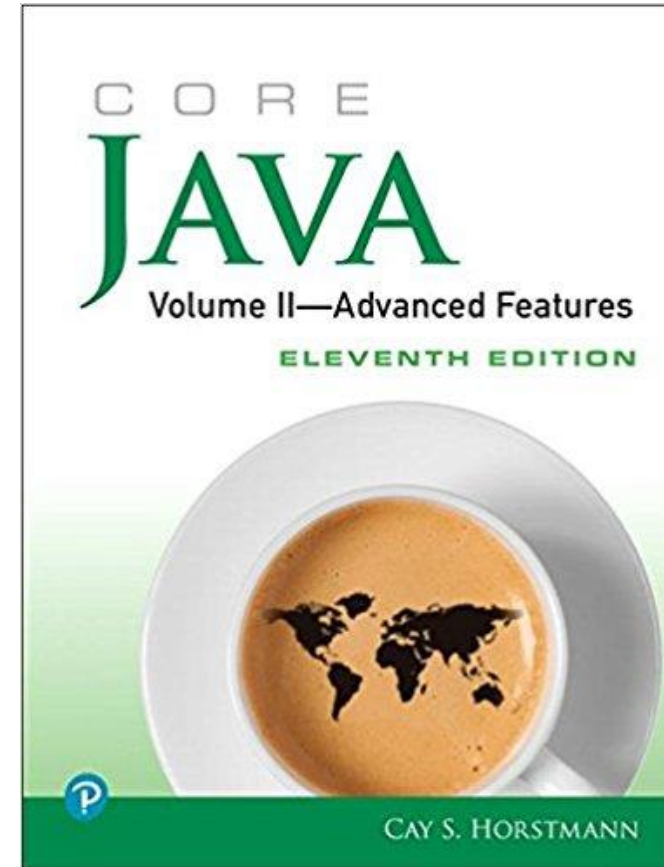
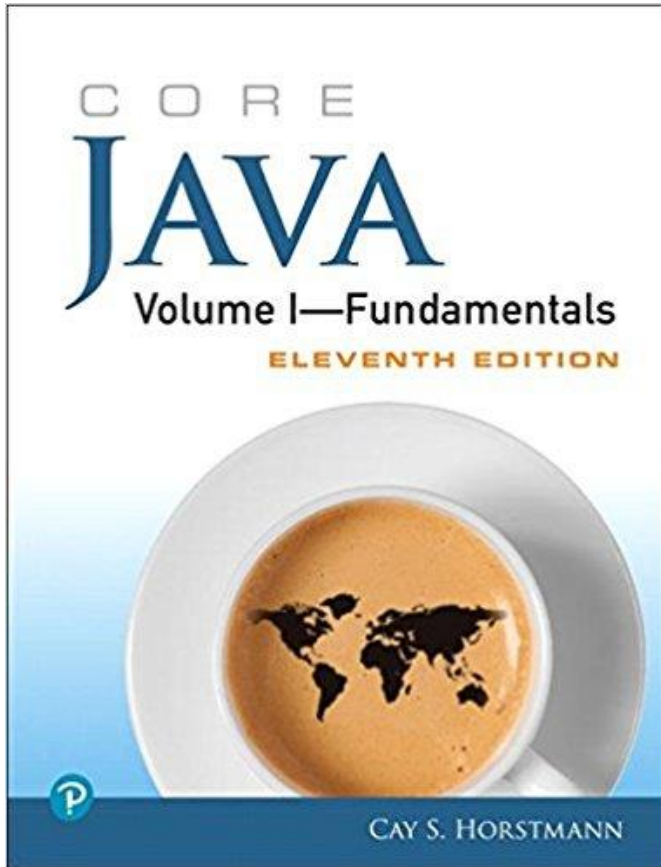
Recommended
reference on
Java 8 features



A popular Youtube video on
Java tutorial for Beginners

<https://www.youtube.com/watch?v=eIrMbAQSU34>

References



A nice reference for Java Practitioners – covers up to Java 11 features

Other Nice Recommendation Lists

- 18 Best Java Books for Beginners in 2019
 - https://dev.to/codegym_cc/18-best-java-books-for-beginners-in-2019-fme
- 10 Books Java Developers Should be Reading in 2019
 - <https://dzone.com/articles/10-books-java-developers-should-read-in-2019>
- Top 10 Books of All-Time for Java Programmers
 - <https://dzone.com/articles/10-all-time-great-books-for-java-programmers-best>

**“Eighty percent of success is
showing up.”**

- Woody Allen

In-class Quizzes (from Sep 22)

- To award those who do reading and show up.
- The participation of quizzes contribute to 8%.
- Quizzes will be conducted using Zoom Polling features.
 - <https://itsc.ust.hk/services/academic-teaching-support/teaching-tools/prs/iprs>

Submit Labs and Assignments on Time!



No Plagiarism in this course!



Assignments must be individual work. Plagiarism is unfair to your classmates and will be severely penalized!

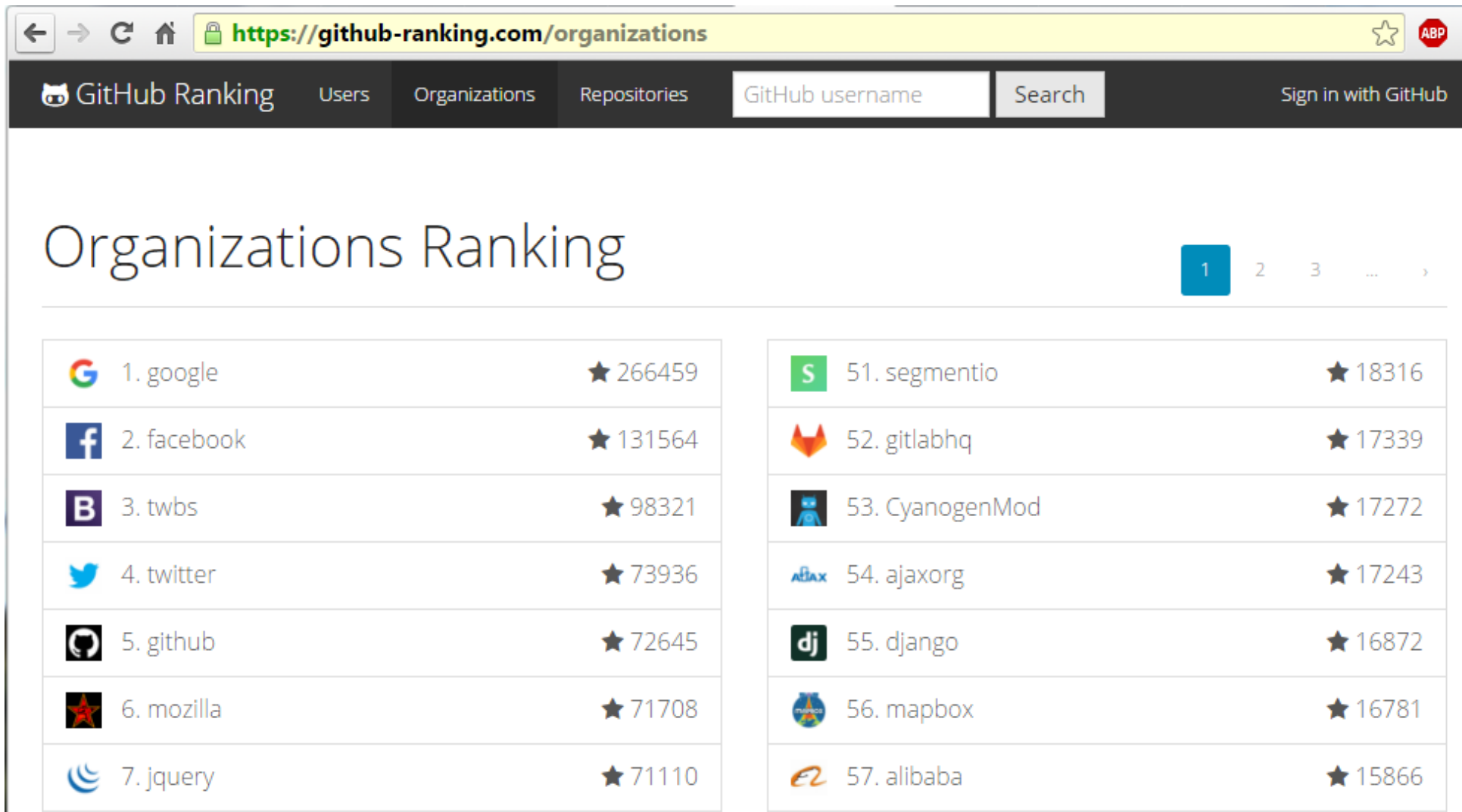
Lab Arrangement

Successful completion of a lab:

- 1. Attendance on Zoom over 25 minutes
- 2. Submission to CASS by deadline



Code management using GitHub



The screenshot shows the GitHub Ranking website at <https://github-ranking.com/organizations>. The page title is "Organizations Ranking". It displays a list of organizations ranked by their GitHub star count. The top 7 organizations are listed on the left, and the next 7 are on the right, starting from rank 51. The table includes the organization's logo, its name, and its star count.

Organizations Ranking	
1. google	★ 266459
2. facebook	★ 131564
3. twbs	★ 98321
4. twitter	★ 73936
5. github	★ 72645
6. mozilla	★ 71708
7. jquery	★ 71110
51. segmentio	★ 18316
52. gitlabhq	★ 17339
53. CyanogenMod	★ 17272
54. ajaxorg	★ 17243
55. django	★ 16872
56. mapbox	★ 16781
57. alibaba	★ 15866

First
step to
become
a top
coder!

