

# Java™ magazine

By and for the Java community 

DECORATOR DESIGN PATTERN 67 | JAVA QUIZ 78

NOVEMBER/DECEMBER 2018

**LARGEST  
JAVA SURVEY  
EVER**  
RESULTS PAGE 15

## Java Present and Future

39

WHAT'S NEW  
IN JAVA 11

52

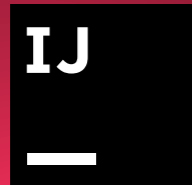
JAVA'S NEW  
LICENSING  
EXPLAINED

56

PROJECT  
VALHALLA

62

FUTURE OF  
JAVAFX

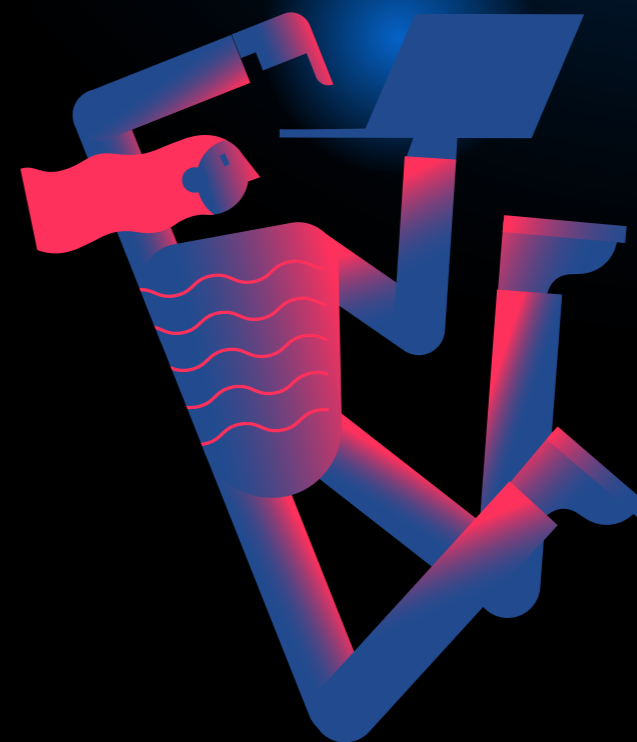


# IntelliJ IDEA

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Indepth coding assistance  
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By Simon Maple and Andrew Binstock  
What 10,500 Java developers tell us about  
their projects, their tools, and themselves

**LARGEST  
JAVA SURVEY  
EVER**  
RESULTS PAGE 15

## COVER FEATURES

**39**

### WHAT'S NEW IN JDK 11?

By Raoul-Gabriel Urma  
and Richard Warburton

New features facilitate  
writing lambdas, ease  
HTTP and WebSocket  
communications, and  
help the JDK better  
handle inner classes.

**52**

### UNDERSTANDING ORACLE JDK RELEASES IN TRANSITION

By Donald Smith  
Oracle JDK, Oracle  
OpenJDK, and the end of  
public updates for Java 8

**56**

### VALUE TYPES ARE COMING TO THE JVM

By Ben Evans  
How Project Valhalla  
will simplify access  
to many Java objects

**62**

### THE FUTURE OF JAVAFX

By Johan Vos  
JavaFX 11 marks a  
major turning point  
in the UI framework's  
development.

## OTHER FEATURES

**67**

### The Decorator Design Pattern in Depth

By Ian Darwin  
Add functionality to a class without  
modifying it.

**78**

### Fix This

By Simon Roberts and Mikalai Zaikin  
More intermediate and advanced  
test questions

## DEPARTMENTS

**04**

### From the Editor

Intriguing data points from the Java survey

**06**

### Letters

Comments, questions, suggestions,  
and kudos

**08**

### Java Books

Review of *Testing Java Microservices*

**09**

### Events

Upcoming Java conferences and events

**12**

### User Groups

Central Ohio JUG

**61**

### Java Proposals of Interest

JEP 343: Packaging tool for  
self-contained Java apps

**91**

### Contact Us

Have a comment? Suggestion? Want to  
submit an article proposal? Here's how.



A man with short, graying hair and glasses is walking towards the camera on a city sidewalk. He is wearing a light blue, long-sleeved button-down shirt with a subtle pattern and blue jeans with a brown leather belt. He is holding a silver folder or tablet under his left arm. The background is a blurred city street with other pedestrians and buildings.

Large surveys surface results that belie the common wisdom.

**JVM Languages.** This question inquired about the principal JVM language used by respondents. As you'd expect, Java came in first by a wide margin. The big surprise is that Clojure, the functional-style JVM language, came in second, beating out Kotlin and Groovy by a whisker and ahead of Scala by a somewhat larger margin. Several key points add some context to these numbers. Kotlin's greatest adoption is on the Android platform, where it is now an officially

**Static Analysis.** Currently, 36% of developers don't use static checking tools at all. This is hard to explain, because studies have repeatedly

A vertical promotional graphic for the Oracle Code Roadshow. The background is a dark blue gradient with abstract, overlapping geometric shapes in lighter shades of blue and white. At the top, a red rectangular banner contains the word "ORACLE" in white, uppercase, sans-serif font. Below this, on the left side, is a white icon of a cloud with two overlapping rectangular windows in front of it; the front window contains the code symbols "</>". In the center, the text "Level Up at Oracle Code" is written in a large, bold, white sans-serif font. Below this, a paragraph of white text reads: "Step up to modern cloud development. At the Oracle Code roadshow, expert developers lead labs and sessions on PaaS, Java, mobile, and more." Further down, the text "Get on the list for event updates:" is displayed in a smaller white font, followed by the URL "go.oracle.com/oraclecoderoadshow" in a white sans-serif font. At the bottom, there are two white rectangular boxes. The first box contains the text "developer.oracle.com" in a bold red sans-serif font. The second box, positioned slightly to the right and below the first, contains the text "#developersrule" in a black sans-serif font.

05



SEPTEMBER/OCTOBER 2018

## Comments as Design Elements

I'm so totally on board with your suggestions in your editorial "Using Comments to Design Classes," in the September/October issue—particularly your example of using a comment to describe what you're planning to do. I've been pseudocoding since 1985, when I graduated from Troy State University. To everyone who is willing to listen here on my development team, I say "write it down in English." Listen to what you wrote and rewrite it, if necessary, before you write a line of code. You will be amazed how easy your software development life will become!

I just want to say thank you for your editorial piece. I am printing it now, and it is going up on my cube wall.

—Peter Pahules  
Scottsdale, Arizona

## Step-by-Step Guide for Using Jakarta EE

I built a step-by-step guide for implementing the project described by Josh Juneau in his article “Jakarta EE: Building Microservices with Java EE’s Successor,” in the September/October issue. I’ve made it available for your readers to access.

—Mikalai Zaikin  
Minsk, Belarus

*Editor Andrew Binstock responds: This excellent tutorial contains a step-by-step setup of the IDE, the server, and finally of the implementation of the project, complete with numerous screenshots and hands-on tips. The guide is available in the Java Magazine [download area](#) or directly as a PDF file [here](#). Zaikin is a coauthor of the “Fix This” quiz column that appears in every issue.*

## Covering Containers—and More

There is so much happening with Java these days that it's a relief to get the straight dope from *Java Magazine*. However, one topic I'd like to see more coverage of is developing container-based applications. Can you wrangle some content about that?

—Will Rubin  
Bend, Oregon

*Editor Andrew Binstock responds: Thanks for the kind words. We are indeed planning coverage of containers. In fact, here are the topics scheduled for 2019:*

- *January/February: Lightweight frameworks*
- *March/April: Big data*
- *May/June: Containers (and coverage of Java 12)*
- *July/August: Libraries (our annual issue)*
- *September/October: Java 13 and a preview of Java 14*
- *November/December: Testing*

*As always, editorial calendars are subject to change.*

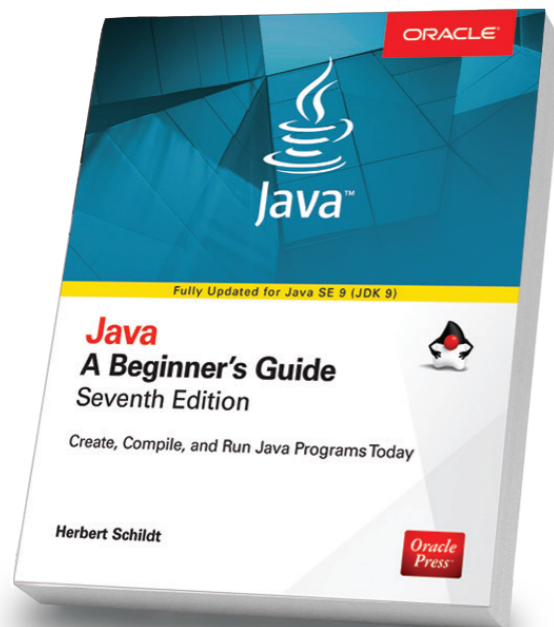
## Corrigenda

In the September/October 2018 issue, we were less than clear about where the unpublished listings are located for Josh Juneau’s article “Jakarta EE: Building Microservices with Java EE’s Successor.” They are located [here](#). Note a small update to one of the files has been made since publication of the article.

## Contact Us

We welcome comments, suggestions, grumbles, kudos, article proposals, and chocolate chip cookies. All but the last two might be edited for publication. If your note is private, please indicate this in your message. Write to us at [javamag\\_us@oracle.com](mailto:javamag_us@oracle.com). For other ways to reach us, see the last page of this issue.

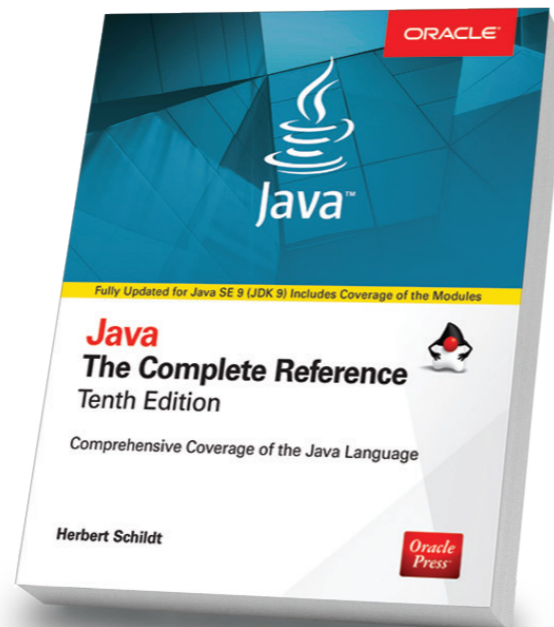
Written by leading experts in Java, Oracle Press books offer the most definitive, complete, and up-to-date coverage of Java available.



## Java: A Beginner's Guide, 7th Edition

*Herb Schildt*

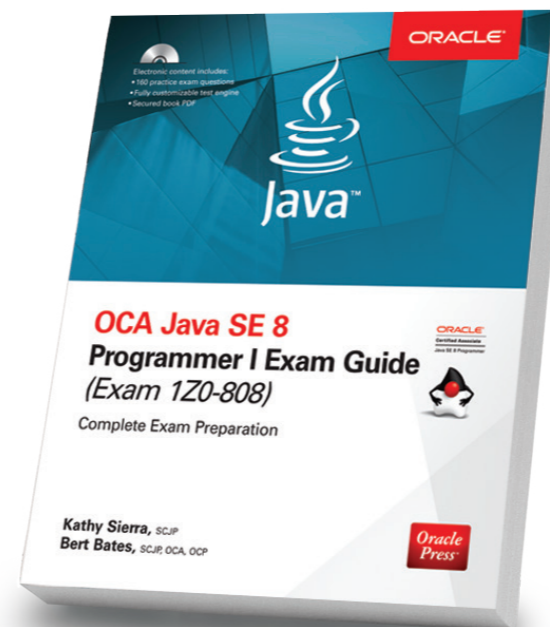
Revised to cover Java SE 9, this book gets you started programming in Java right away. Free online supplement covering key new features in JDK 10 available for download on the book's page on [OraclePressBooks.com](http://OraclePressBooks.com)



## Java: The Complete Reference, 10th Edition

*Herb Schildt*

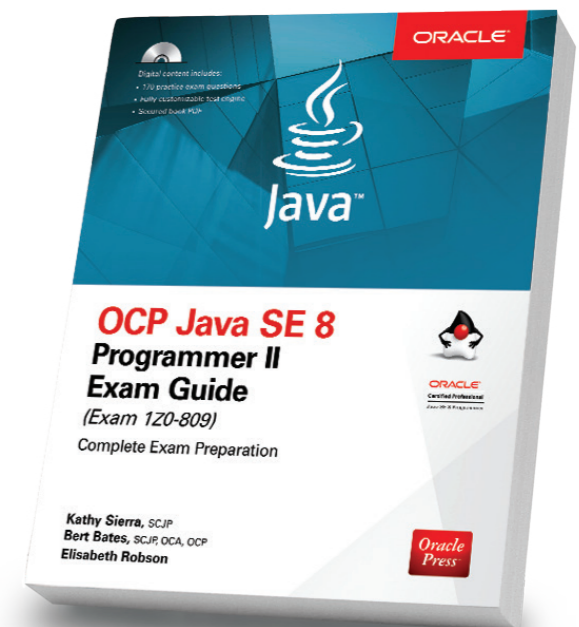
Updated for Java SE 9, this book shows how to develop, compile, debug, and run Java programs. Visit the book's page on [OraclePressBooks.com](http://OraclePressBooks.com) to download free supplements on JDK's key new features.



## OCA Java SE 8 Programmer I Exam Guide (Exam 1Z0-808)

*Kathy Sierra, Bert Bates*

Get complete coverage of all objectives for Exam 1Z0-808. Electronic practice exams include more than 200 questions that help you prepare for this challenging test.



## OCP Java SE 8 Programmer II Exam Guide (Exam 1Z0-809)

*Kathy Sierra, Bert Bates, Elisabeth Robson*

Prepare for the OCP Exam 1Z0-809 with this comprehensive guide which offers every subject appearing on the exam. Includes more than 350 practice questions.



## 08

Overall, *Testing Java Microservices* is a good introduction to the issues of testing microservices that run on the JVM (they need not be written in Java as the title would imply). However, its greatest value is to organizations that are evaluating Arquillian or are already committed to its use as their primary microservices testing framework. —*Andrew Binstock*



## **CodeMash 2019**

JANUARY 8–11, 2019

SANDUSKY, OHIO

CodeMash is an event that educates developers on current practices, methodologies, and technology trends in a variety of platforms and development languages including Java, .NET, Ruby, Python, and PHP. The Java track features presentations from many Java Champions.

## **Codemotion Berlin**

NOVEMBER 20–21

BERLIN, GERMANY

Codemotion conferences are devoted to developers sharing the latest tech information and best practices among the tech community worldwide. Confirmed speakers at this event include Picnic CTO Daniel Gebler, Apache Software Foundation member Kanchana Welagedara, and Microsoft Senior Program Manager Christian Heilmann. The event is open to all languages and technologies and features coding lectures and workshops.

## **Topconf Tallinn 2018**

NOVEMBER 20–22

TALLINN, ESTONIA

Topconf Tallinn is an international software conference covering Java, open source, agile development, architecture, and new languages.

## **Voxxed Days Cluj-Napoca**

NOVEMBER 21–22

CLUJ-NAPOCA, ROMANIA

This conference brings together well-known speakers, core developers of popular open source technologies, and professionals willing to share their knowledge

and experience. Scheduled speakers include Agile expert Venkat Subramaniam and Java Champion Vlad Mihalcea.

## **JVM-Con**

NOVEMBER 27–28

COLOGNE, GERMANY

Among the topics slated for this German conference devoted to JVM languages are the JRE, concurrency, Java EE, mobile, and cloud-native development. (Website in German.)

## **Codemotion Milan**

NOVEMBER 29–30

MILAN, ITALY

Codemotion conferences are devoted to developers sharing the latest tech information and best practices among the tech community worldwide. Confirmed speakers at this event include Rogue Wave Senior Software Engineer Enrico Zimuel, ThoughtWorks Quality Analyst Wamika Singh, and Accenture Manager Maurizio Mangione. The event is open to all languages and technologies and features coding lectures and workshops.

**Clojure/conj 2018**

NOVEMBER 29–DECEMBER 1  
DURHAM, NORTH CAROLINA

This event is expected to draw more than 400 Clojure developers from around the world for three days of cutting-edge Clojure, ClojureScript, and functional programming talks.

**DevTernity**

NOVEMBER 30–DECEMBER 1  
RIGA, LATVIA

The DevTernity forum covers the latest developments in coding, architecture, operations, security, leadership, and many other IT topics. Venkat Subramaniam, author of *Programming Concurrency on the JVM* and *Functional*

*Programming in Java*, is slated to be one of the featured speakers.

**The Lead Developer Austin**

DECEMBER 6  
AUSTIN, TEXAS

This conference for tech leads, engineering managers, and CTOs promises a day of inspiring talks and practical takeaways to help you become a better team leader. Topics planned for discussion include refactoring, code review, and GraphQL.

**ArchConf 2018**

DECEMBER 10–13  
CLEARWATER, FLORIDA

ArchConf is an educational event for software architects, techni-

cal leaders, and senior developers presented by the No Fluff Just Stuff software symposium. Among scheduled sessions are talks on applying design patterns, building serverless applications, machine learning, and scalable microservices.

**KubeCon + CloudNativeCon**

DECEMBER 10, COMMUNITY EVENTS  
AND LIGHTNING TALKS  
DECEMBER 11–13, CONFERENCE  
SEATTLE, WASHINGTON

The Cloud Native Computing Foundation's flagship North American conference gathers adopters and technologists from leading open source and cloud native communities to further the education and advancement of cloud native computing.

**EmTech Asia**

JANUARY 22–23, 2019  
SINGAPORE

EmTech Asia is an international conference hosted in collaboration with *MIT Technology Review*. Talks and presentations focus on emerging technologies.

**SnowCamp 2019**

JANUARY 23, 2019, WORKSHOPS  
JANUARY 24–25, 2019, CONFERENCE  
JANUARY 26, 2019, UNCONFERENCE  
GRENOBLE, FRANCE

SnowCamp is a developer conference held in the French Alps that focuses on innovation, exchange, and research exploring web, cloud, DevOps, and software architecture topics. The event features a mix of sessions in French and English. The last day, dubbed “unconference,” offers a unique opportunity to socialize with peers and speakers on the ski slopes.

**DevConf.cz**

JANUARY 25–27, 2019  
BRNO, CZECH REPUBLIC

DevConf.cz is an open source developer and DevOps conference. There is no admission or ticket charge for DevConf.cz events, but free registration is required. All talks, presentations, and workshops will be conducted in English. Topics under consideration this year include blockchain, middleware, machine learning, and immutable operating systems.



### jSpirit

JANUARY 25–27, 2019

HAUSHAM, GERMANY

jSpirit is a new community-organized, nonprofit Java “unconference” in the Bavarian Alps featuring two days of sessions at the Lantenhammer Erlebnisdestillerie Hausham followed by two days of skiing. A mini-conference for kids, jSpirit4Kids, is slated for January 28.

### Domain-Driven Design Europe

JANUARY 28–30, 2019, WORKSHOPS

JANUARY 31–FEBRUARY 1, 2019, CONFERENCE

AMSTERDAM, THE NETHERLANDS

This software development and engineering event spans analy-

sis, modeling and design, systems thinking and complexity theory, architecture, testing and refactoring, visualization, and collaboration.

### O'Reilly Software Architecture Conference

FEBRUARY 3–4, 2019, TRAINING

FEBRUARY 4–6, 2019, TUTORIALS AND CONFERENCE

NEW YORK, NEW YORK

This event consists of four days of in-depth professional software architecture training on topics ranging from domain-driven design and event-driven microservices to database architecture.

### Jfokus

FEBRUARY 4–6, 2019

STOCKHOLM, SWEDEN

Sweden's largest developer conference will cover Java and JVM languages, as well as best practices and emerging technologies. On February 4, the conference will hold the Jfokus VM Tech Summit, which is an open technical collaboration among language designers, compiler writers, tool builders, runtime engineers, and VM architects.

### JSConf Hawaii

FEBRUARY 7–8, 2019

HONOLULU, HAWAII

The inaugural Hawaiian JSConf for JavaScript developers promises a fun and welcoming gathering where diversity thrives and attendees can discuss JavaScript as a technology and grow it as a community.

### DeveloperWeek SF Bay Area

FEBRUARY 20–24, 2019

OAKLAND, CALIFORNIA

The DeveloperWeek expo and conference series gathers 8,000 participants for a weeklong, technology-neutral programming conference and associated

area events. Tracks include artificial intelligence, blockchain development, popular programming languages, microservices, and mobile.

### AgentConf 2019

FEBRUARY 21–24, 2019

DORNBIRN AND LECH, AUSTRIA

AgentConf is an international event that combines software development and skiing and features talks by world-class engineers envisioning the future of mobile and web technologies. Speaker sessions are hosted in Dornbirn; skiing and networking take place in Lech.

### Embedded World 2019

FEBRUARY 26–28, 2019

NUREMBERG, GERMANY

Now celebrating its 17th year, this annual embedded systems developer event will focus on the state of embedded intelligence, which is shaping systems ranging from autonomous vehicles to image recognition and embedded vision systems to preventive and demand-driven maintenance in small edge computers as well as high-performance cloud servers.

```
//events/
```

## QCon London

MARCH 4–6, 2019, CONFERENCE

MARCH 7–8, 2019, WORKSHOPS

*LONDON, ENGLAND*

Although the content has not yet been announced, past QCon conferences have offered several Java tracks along with tracks related to web development, DevOps, cloud computing, and more.

Proposed session topics include machine learning, software ethics, and DSLs.

# Devnexus

MARCH 6-8, 2019

ATLANTA, GEORGIA

Devnexus is an international open source developer conference. Its stated goal is to connect developers from all over the world, provide affordable education, and promote open source values. Past presenters have included Java experts Donald Raab and Venkat Subramaniam.

# ConFoo Montreal

MARCH 13–15, 2019

MONTREAL, CANADA

This multitechnology conference for web developers promises 155 presentations and typically features sessions tailored for Java and JVM developers.

## JavaLand 2019

MARCH 19–21, 2019

BRÜHL, GERMANY

This annual conference features lectures on subjects such as core Java and JVM languages, micro-services architecture, front-end development, and much more.

## Voxxed Days Zürich

MARCH, 2019 (DATES NOT FINALIZED)

ZÜRICH, SWITZERLAND

Voxxed Days Zürich shares the Devovx philosophy that content comes first and draws internationally renowned and local speakers discussing topics such as cloud development, containers, machine learning, and programming languages. The schedule of speakers had not yet been announced at press time.

Are you hosting an upcoming Java conference that you would like to see included in this calendar? Please send us a link and a description of your event at least 90 days in advance at [javamag\\_us@oracle.com](mailto:javamag_us@oracle.com). Other ways to reach us appear on the last page of this issue.

```
//user groups/
```

# CENTRAL OHIO JUG



The Central Ohio Java Users Group, [COJUG](#), was founded in 1997 and has been going strong ever since. Hosted in Columbus, Ohio, COJUG holds two meetings the second Tuesday of every month—one during the lunch hour and one in the evening. These meetings usually present the same

speaker and content, but offering two meeting times helps to accommodate attendees' schedules. This format has also enabled the group to more than double regular attendance, averaging more than 70 attendees each month from a mailing list of more than 650 members.

Eleven years ago, COJUG, along with several other local user groups including the .NET user group, started a conference called CodeMash that combined the different technology interests and communities. The conference is held each January in Sandusky, Ohio. Northern Ohio in January might seem like a strange location and time, but holding the conference at the Kalahari indoor water park with an associated free kids' conference called KidzMash makes this a warm and family-friendly experience. The four-day event attracts more than 2,200 developers and architects. Over the years, CodeMash has hosted many Java Champions and regional JUG leaders as presenters. The next event takes place January 8 to 11, 2019.

If you are interested in getting involved in COJUG as an attendee, speaker, or sponsor, please visit the COJUG [website](http://cojug.org) or email the user group at [cojug@cojug.org](mailto:cojug@cojug.org) for details.

**DEVELOPER EVENTS FROM THE DEVOXX & VOXXED FAMILY**  
**COMING IN 2019**

**DEVOXX™**

**DEVOXX.COM**

**FRANCE 17-19 APRIL**

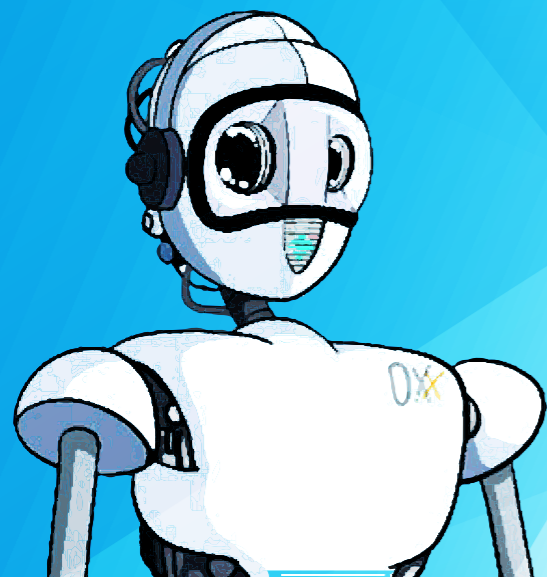
**UK 8-10 MAY**

**POLAND 24-27 JUNE**

**UKRAINE DATE TBA**

**BELGIUM DATE TBA**

**MOROCCO DATE TBA**



**BUCHAREST 20-22 MARCH**

**ZURICH 21 MARCH**

**MILAN 13 APRIL**

**CERN 1 MAY**

**MELBOURNE 14 MAY**

**FRONTEND, BUCHAREST 22 MAY**

**MINSK 24-25 MAY**

**SINGAPORE 30-31 MAY**

**ATHENS 31 MAY-1 JUNE**

**LUXEMBOURG DATE TBA**

**TICINO DATE TBA**

**MICROSERVICES, PARIS DATE TBA**

**THESSALONIKI DATE TBA**

**CLUJ-NAPOCA DATE TBA**

**VOXXEDDAYS**

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SIMON **MAPLE**

ANDREW BINSTOCK

# The Largest Survey Ever of Java Developers

# What 10,500 Java developers tell us about their projects, their tools, and themselves

The data presented in the following report was taken from more than 10,500 questionnaires. If you were one of those survey-takers, *many* thanks for putting aside the time to share your experience for the benefit of others. Snvk and *Java Magazine* conducted the survey by publishing its availability to the Java community at large, to Java user groups (JUGs), and to subscribers of *Java Magazine*. As an inducement to complete the survey, Snvk and *Java Magazine* promised a contribution to Devxxx4kids.

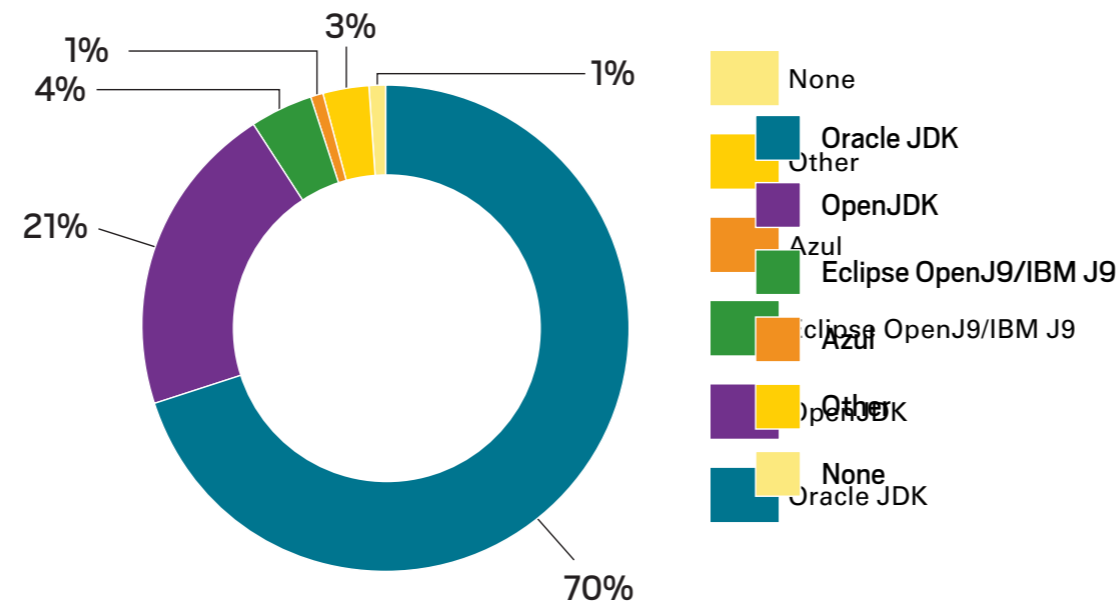
Information regarding respondents, including geographical location, company size of their employer (if any), age, and experience with Java are presented at the end of this survey.

## About Your JDK

## 1. Which Java vendor's JDK do you use in production for your main applications?

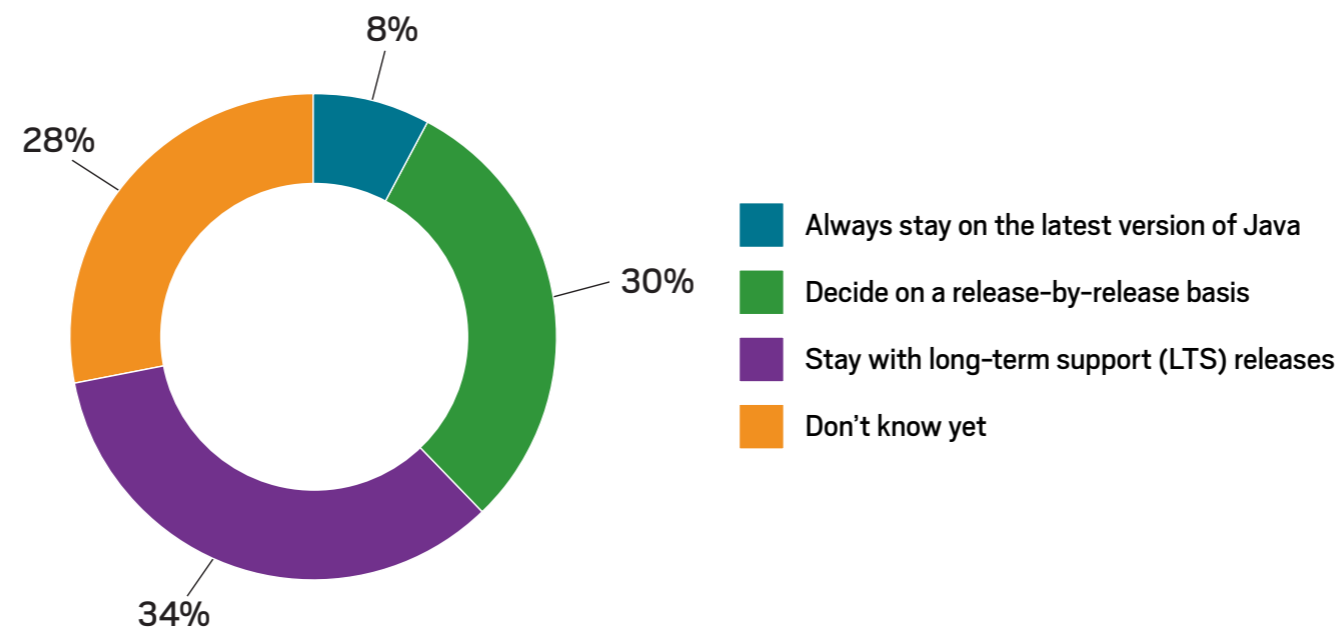
We start the report with a core question. With so many vendors providing their own JDK implementations, which offerings are developers using in production for their applications? We can see the dominance that Oracle JDK and OpenJDK have over everyone else. With 7 in 10 developers opting to use the Oracle JDK and a further 2 in 10 opting for the OpenJDK, there isn't much competition. However, future licensing and support changes might cause these numbers to differ in the future.

BINSTOCK PHOTOGRAPH BY BOB ADLER/STUDIO AT  
GETTY IMAGES FOR ORACLE



## 2. How do you plan to respond to Java's new release cycle?

While the Java 9 release brought with it some major architectural changes, it also introduced a new release cadence in which Java SE versions ship every six months. Every two to three years, a long-term support (LTS) release offers longer-term support, such as security updates. This question asks how development teams will respond to the new release cadence. The responses







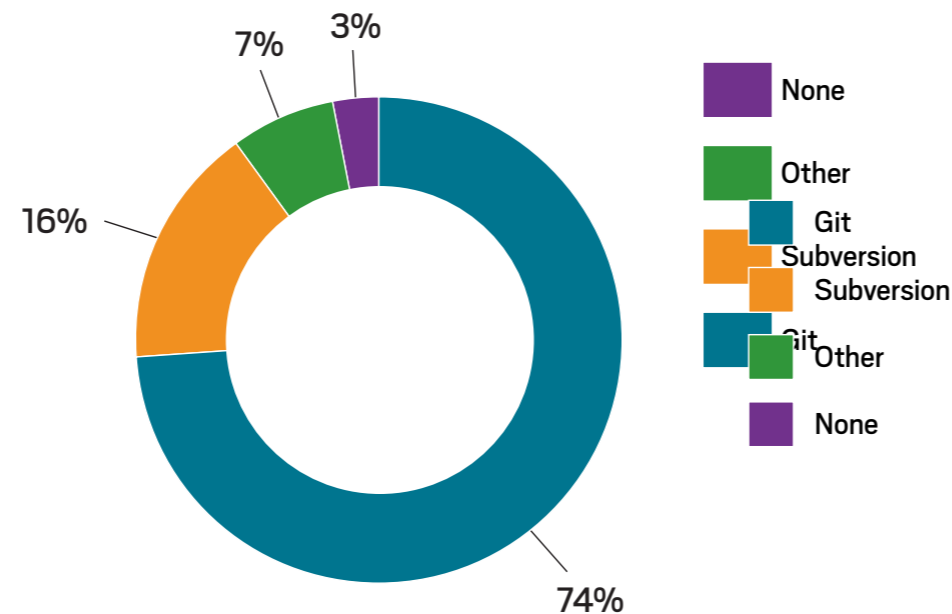






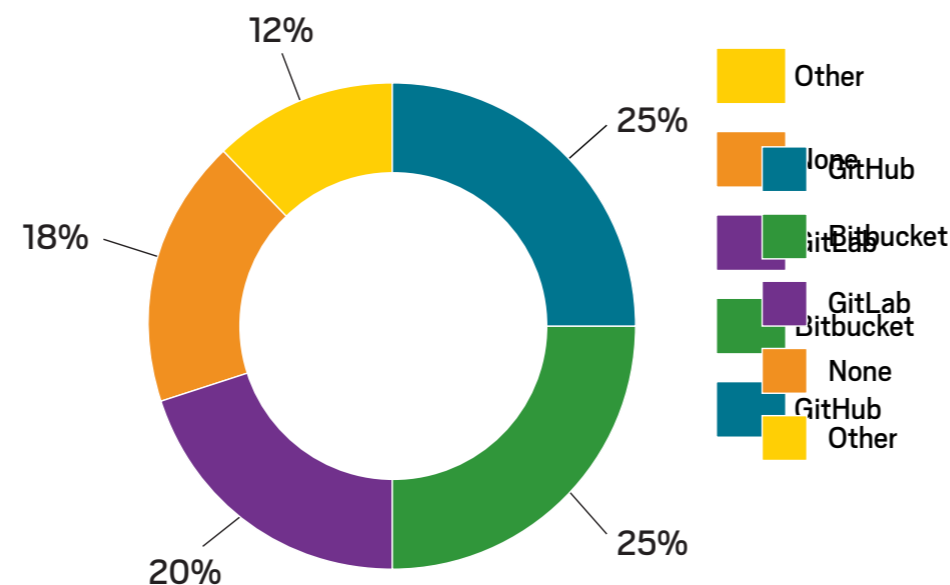


respondents; and somehow in 2018, 3% of people still don't use source code management whatsoever. Sometimes, there are no words.



## 11. Which code repository do you use for your main project?

With code repositories, the story is quite different from source code management: much more spread out, with GitHub and Bitbucket neck and neck at 25% each and GitLab close behind at 20%. We could call those the “big three” of project hosting. Note that this question is not just











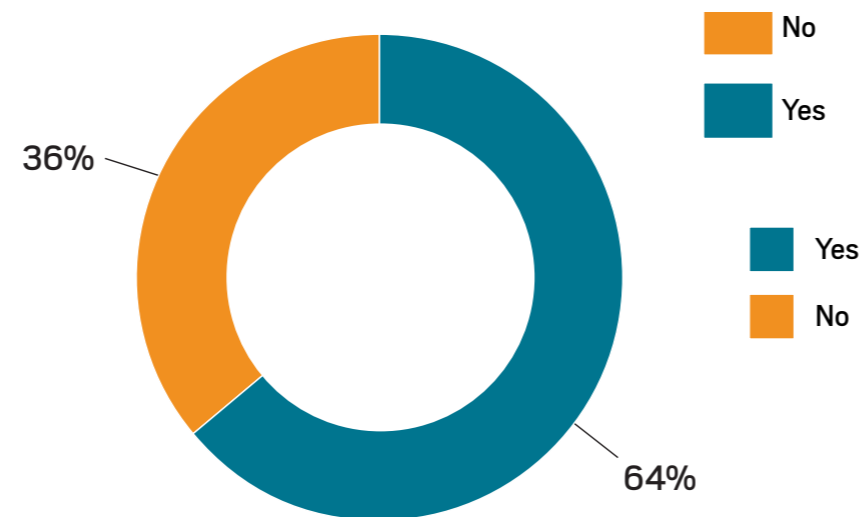




at 15%. In the larger enterprise app server category, Oracle WebLogic has a slight lead over WebSphere. The “Other” category contains Apache TomEE and Liberty Profile at 1% each, which lead that group.

## 21. Do you develop on the same application server you use in production?

Despite the obvious dangers, more than one-third of respondents develop on a different server from the one they use in production—trading the possible cost of failures for the convenience. Surprisingly, those who state they use different application servers (or none) in development actually have a wide variety of apps and servers in production. We were expecting mostly the larger monolith-suited app servers that could cause developers pain to use locally, but the ratios were comparable.



**22. How many open source (direct) dependencies does your main application have?**

It would be interesting to know how many people had to check to see how many direct dependencies their application has. We'd bet it was the vast majority of you. It's a good thing we didn't ask for direct and transitive dependencies too! In fact, almost 1 in 4 respondents openly state they don't know how many dependencies they have. This might be because of the way the application is distributed across a more complex build system. We can see from the results that fewer than 1 in 20 respondents don't use any open source dependencies, whereas the over-

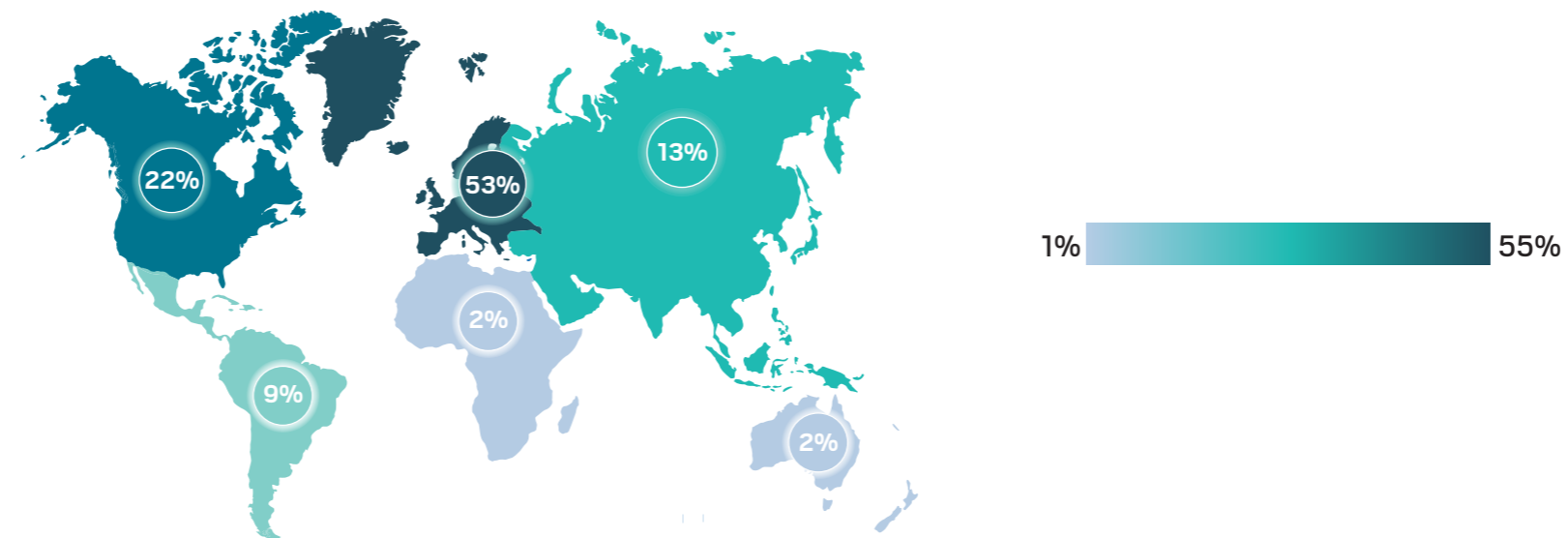




## About You

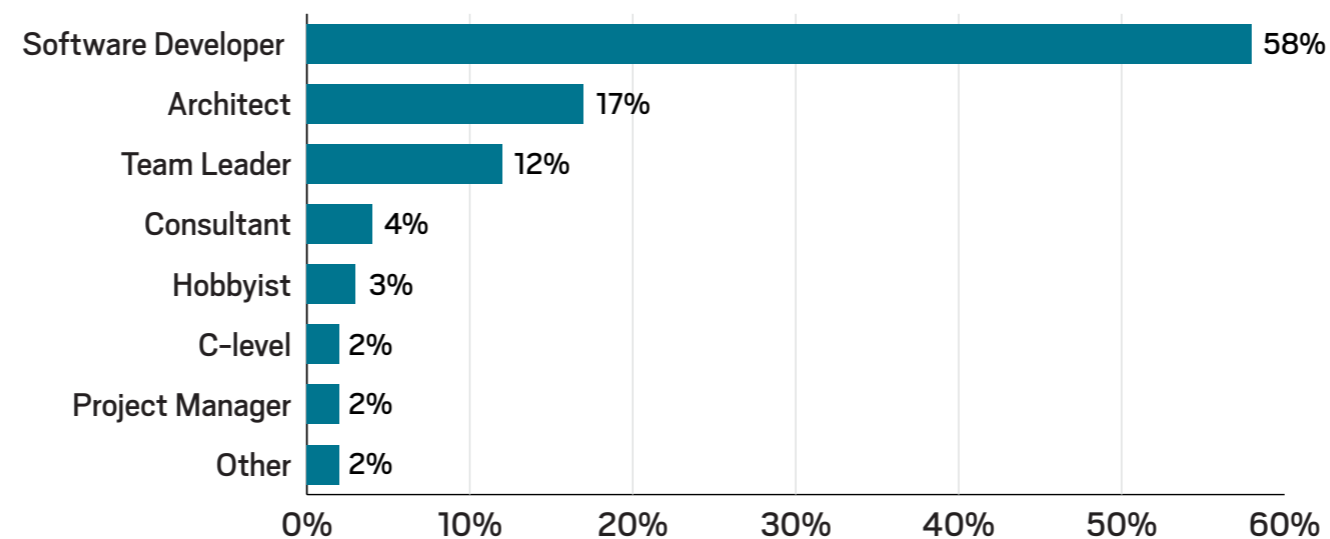
## 25. Where do you do your development work?

Not much to say here, other than we expected more respondents to come from North America.



**26. How would you describe yourself?**

We can see the vast majority of respondents are technical, with 87% being either developers, team leaders, or architects. More than half state they are software developers, and 2% of respondents were C-level who took the time to fill out our survey.















```
URLConnection.setRequestMethod("GET");

try (BufferedReader in = new BufferedReader(new
InputStreamReader(httpURLConnection.getInputStream())) {
    String response = in.lines().collect(Collectors.joining());
    System.out.println(response);
}
```





















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# ORACLE®



# Oracle JDK, Oracle OpenJDK, and the end of public updates for Java 8

## From the BCL to the GPL

## Functionally Identical and Interchangeable

52





## What Should They Be Called?

Ideally, you could simply refer to all Oracle JDK builds as the “Oracle JDK,” under either the GPL or the commercial license depending on your situation. However, for historical reasons while the small remaining differences exist, Oracle will refer to them separately as Oracle’s OpenJDK builds and the Oracle JDK.

## Java 8 and the End of Public Updates

Whatever you call it, migrating to Java 11 should be under active consideration, because very shortly (January 2019), Java SE 8 will reach the end of public updates for commercial users. By that time, Oracle will have provided almost five years of continuous, free public updates. For commercial users who need to stay on Java SE 8 for a longer period of time, Oracle offers the Oracle Java SE Subscription so they can continue to benefit from support and regular updates to Java SE 8, including stability, performance, and security patches. Users wishing to continue with free updates and patches should move on to later releases, the most current of which is Java 11, as mentioned above.

However, Oracle will continue to provide free public updates of Oracle Java SE 8 for *personal* desktop use until at least December 2020. During that time, personal users should contact their application providers and encourage them to migrate their applications to the most recent version of Java, or else switch to alternative applications.

Going forward, Oracle intends to provide free public updates to the Oracle JDK and Oracle OpenJDK builds for at least the six-month period until the next release. Commercial users can then get a support subscription for subsequent updates on long-term releases of the JDK or switch to an OpenJDK release.

All these changes—to licensing, to multiple releases, and to support options—are intended to give developers and companies the choice to use Java at no cost or with paid support. </article>

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## Project Valhalla

Within OpenJDK, a long-term research project known as [Project Valhalla](#) has been investigating the possibility of extending Java and the JVM in new directions. Its mission statement is to be “a venue to explore and incubate advanced Java VM and language feature candidates.” One of the primary goals of the project is “to align JVM memory layout behavior with the cost model of modern hardware.”

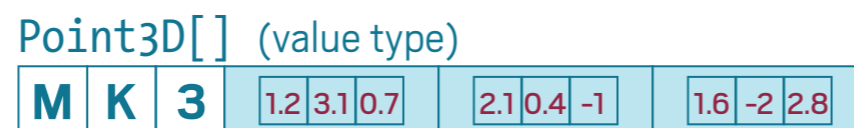
From a developer’s perspective, one of the main outcomes of Valhalla is intended to be the arrival of a new class of values in the Java ecosystem, referred to as *value types*. These new value types are expected to be small, immutable, identityless types. Brian Goetz, the Java language architect, has used the phrase “codes like a class, works like an int” to describe how a typical user will interact with the finished version of the value types feature.

Example use cases for value types include numeric types, tuples, and more-advanced possibilities (such as algebraic data types). There is also the possibility that some existing types could be retrofitted and evolve to become represented as value types. For example, `Optional`, `LocalDate`, and lambda expressions are all candidates that could become value types in a future release if that proves to be feasible.

Removing the commitment to maintaining object identity enables optimizations such as the following:

- Removing the memory overhead of object headers
- Flattening of value types stored in fields (or arrays) rather than storing by indirection
- Reducing the memory footprint and load on garbage collectors

If this new form of value can be implemented on the JVM for types such as the spatial points discussed previously, a memory layout such as that shown in **Figure 4** would be far more efficient, because it would be *flattened* and many cache misses could be avoided. This arrangement



**Figure 4. Possible future memory layout**













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## Visitor Pattern



MIKALAI ZAIKIN

More intermediate and advanced test questions

If you're a regular reader of this quiz, you know these questions simulate the level of difficulty of two different certification tests. Those marked "intermediate" correspond to questions from the [Oracle Certified Associate exam](#), which contains questions for a preliminary level of certification. Questions marked "advanced" come from the [1Z0-809 Programmer II exam](#), which is the certification test for developers who have been certified at a basic level of Java 8 programming knowledge and now are looking to demonstrate more-advanced expertise.

**Question 1 (intermediate).** What is true about the enhanced `for` statement? Choose one.

- A. The loop cannot iterate directly over `java.util.HashSet`.
- B. The loop can iterate directly over `java.util.Map`.
- C. The loop does not provide access to the index of the current element.
- D. The loop supports deletion of the current element during execution of the loop.
- E. Early termination of the loop via a `break` statement is prohibited.

**Question 2 (advanced).** Given the following code and assuming the numbers at the left are line numbers, not part of the source file:

```
11: public class Ex2<T extends Runnable, String> {
12:     String s = "Hello";
13:     public void test(T t) {
14:         t.run();
15:     }
16: }
```

























