

java math random range

Java Math Random Range: Mastering Random Number Generation in Java

java math random range is a topic that often comes up when developers want to generate random numbers within a specific interval in Java. Whether you're building a game, simulating data, or simply need random values for testing, understanding how to effectively use Java's random number capabilities is essential. In this article, we'll explore how to generate random numbers in Java within a given range, best practices, common pitfalls, and alternative methods for more control and flexibility.

Understanding the Basics of Java Math Random Range

Java provides a built-in method to generate random numbers through the Math class. The method `Math.random()` returns a double value greater than or equal to 0.0 and less than 1.0. This is a great starting point, but if you want random numbers within a certain range — say between 5 and 15 — you need to do some calculations to scale and shift the output accordingly.

The fundamental idea is to multiply the 0-to-1 value by the size of the range, then add the minimum value of the range. This approach transforms the unit interval into the desired range.

How to Generate a Random Double in a Range

Suppose you want a random double between min and max:

```
```java
double randomValue = min + (Math.random() * (max - min));
```
```

Here's what happens:

- `Math.random()` generates a value between 0.0 (inclusive) and 1.0 (exclusive).
- Multiplying by `(max - min)` scales this to a range of 0 to the size of your desired interval.
- Adding `min` shifts the range from `0...(max-min)` to `min...max`.

This method is straightforward and works well for floating-point numbers.

Generating Random Integers in a Range

Generating random integers within a range requires a slight modification since

`Math.random()` produces a double. You typically cast the result to `int` after scaling it properly.

Here's a common pattern to get an integer between `min` (inclusive) and `max` (inclusive):

```
```java
int randomInt = min + (int)(Math.random() * ((max - min) + 1));
```
```

Why add 1 to `(max - min)`? Because `Math.random()` can never return 1, so multiplying by `(max - min + 1)` ensures the max value can be reached after the cast.

Common Pitfalls When Using Java Math Random Range

While `Math.random()` is convenient, there are some nuances to watch out for when dealing with ranges.

Inclusive vs. Exclusive Bounds

By default, `Math.random()` excludes 1 but includes 0. This means the maximum value after scaling is never quite reached unless you adjust the upper bound as shown above. Forgetting this can cause off-by-one errors, especially with integers.

Type Casting Consequences

Casting to `int` truncates the decimal part, effectively applying a floor operation. If you're not careful, the randomness distribution can be skewed if you don't correctly scale the range.

Performance Considerations

For simple use cases, `Math.random()` is fine. However, if you require many random numbers or need better performance and thread safety, other options like `java.util.Random` or `ThreadLocalRandom` might be more suitable.

Exploring Alternatives: `java.util.Random` and `ThreadLocalRandom`

While `Math.random()` is easy to use, Java offers more robust random number generators, which provide better control and features.

Using `java.util.Random` for Ranges

The `Random` class has methods like `nextInt(int bound)` which returns a random integer between 0 (inclusive) and the specified bound (exclusive). To generate a random integer between min and max (inclusive), you can do:

```
```java
Random rand = new Random();
int randomInt = rand.nextInt((max - min) + 1) + min;
```
```

This approach is often preferred because it reads more clearly and offers additional methods for different data types.

`ThreadLocalRandom` for Concurrent Applications

If you're working with multi-threaded applications, `ThreadLocalRandom` is designed for better performance without contention:

```
```java
int randomInt = ThreadLocalRandom.current().nextInt(min, max + 1);
```
```

Here, the `nextInt(int origin, int bound)` method generates numbers from origin (inclusive) to bound (exclusive), so adding 1 to max ensures inclusion.

Tips for Using Java Math Random Range Effectively

When working with random numbers in Java, here are some practical tips to keep in mind:

- **Define clear bounds:** Always specify whether your range is inclusive or exclusive to avoid confusion.
- **Use appropriate methods:** Prefer `Random` or `ThreadLocalRandom` for better control and performance over `Math.random()` in complex applications.
- **Consider seeding:** If you want reproducible results (e.g., for testing), initialize `Random` with a seed.

- **Avoid bias:** When scaling, ensure you multiply by the correct range size, especially with integers, to maintain a uniform distribution.
- **Use constants:** Define min and max as constants or variables rather than hardcoding numbers to improve readability and maintainability.

Practical Examples of Java Math Random Range

Let's look at some real-world scenarios where generating random numbers in a range is useful.

Random Number for a Dice Roll

Simulating a dice roll requires a random integer from 1 to 6:

```
```java
int diceRoll = 1 + (int)(Math.random() * 6);
```
```

Alternatively, with Random:

```
```java
Random rand = new Random();
int diceRoll = rand.nextInt(6) + 1;
```
```

Randomizing Array Indices

If you want to pick a random element from an array, you need a random index between 0 and array length - 1:

```
```java
int randomIndex = (int)(Math.random() * array.length);
Object randomElement = array[randomIndex];
```
```

Using Random:

```
```java
Random rand = new Random();
int randomIndex = rand.nextInt(array.length);
```
```

Generating Random Colors

For generating RGB color values, each color channel ranges from 0 to 255:

```
```java
int red = (int)(Math.random() * 256);
int green = (int)(Math.random() * 256);
int blue = (int)(Math.random() * 256);
Color randomColor = new Color(red, green, blue);
```
```

Behind the Scenes: How Math.random() Works

`Math.random()` internally uses an instance of `java.util.Random` seeded with the current time. This means it generates pseudo-random numbers using deterministic algorithms. While suitable for most applications, it is not cryptographically secure.

For security-sensitive cases, Java provides the `SecureRandom` class, which uses more complex algorithms and sources of randomness.

Using SecureRandom for Cryptographically Strong Random Numbers

```
```java
SecureRandom secureRand = new SecureRandom();
int secureRandomInt = secureRand.nextInt((max - min) + 1) + min;
```
```

This is especially useful in applications like token generation, password creation, or cryptographic keys.

Summary of Methods to Generate Java Math Random Range Values

| Method | Usage Example | Notes |
|--------------------------------------|--|-------------------------------------|
| <code>Math.random()</code> | <code>`min + Math.random() * (max - min)`</code> | Simple, returns double |
| <code>Math.random() + casting</code> | <code>`min + (int)(Math.random() * ((max - min) + 1))`</code> | For integers, careful with bounds |
| <code>java.util.Random</code> | <code>`rand.nextInt((max - min) + 1) + min`</code> | More control, reusable instances |
| <code>ThreadLocalRandom</code> | <code>`ThreadLocalRandom.current().nextInt(min, max+1)`</code> | Best for multithreaded environments |

| SecureRandom | `secureRand.nextInt((max - min) + 1) + min` | For cryptographic randomness |

Exploring these options allows you to select the best tool for your Java applications based on your requirements.

Mastering the concept of java math random range opens up many possibilities in software development. Whether you're generating random game elements, simulating data, or implementing secure systems, understanding how to generate random numbers correctly and efficiently is a valuable skill. Experiment with these methods, consider your specific needs, and enjoy the flexibility that Java's random number generation provides.

Frequently Asked Questions

How do you generate a random integer within a specific range in Java using Math.random()?

You can generate a random integer within a range [min, max] using: `int randomNum = (int)(Math.random() * (max - min + 1)) + min;`

What is the purpose of multiplying Math.random() by (max - min + 1) when generating a random number?

Multiplying Math.random() by (max - min + 1) scales the random value from the default range [0.0, 1.0) to [0, max - min + 1), which corresponds to the size of the desired integer range.

Does Math.random() in Java include the upper bound when generating random numbers?

No, Math.random() generates a double value in the range [0.0, 1.0), meaning it includes 0.0 but excludes 1.0.

Can Math.random() generate negative numbers in Java?

No, Math.random() generates only positive double values in the range [0.0, 1.0), so it cannot generate negative numbers directly.

How do you generate a random double within a specific range using Math.random() in Java?

You can generate a random double within [min, max) using: `double randomValue = min + (Math.random() * (max - min));`

What is the difference between using `Math.random()` and `Random` class for generating random numbers in Java?

`Math.random()` is a static method that returns a double between 0.0 and 1.0, while the `Random` class provides more methods and control, such as generating ints, longs, booleans, and can be seeded for reproducibility.

Is it possible to generate a random number within a range that excludes the upper bound using `Math.random()`?

Yes, by using the formula $\text{min} + \text{Math.random()} * (\text{max} - \text{min})$, you generate a random double in $[\text{min}, \text{max})$, excluding max.

How can you generate a random boolean value using `Math.random()` and a range?

You can generate a random boolean by checking if `Math.random() < 0.5` (true) or `>= 0.5` (false), effectively splitting the range $[0.0, 1.0)$ into two halves.

What are common pitfalls when using `Math.random()` for generating random integers in a range?

Common pitfalls include off-by-one errors in the range calculation, casting before scaling (which truncates the value incorrectly), and misunderstanding that `Math.random()` never returns 1.0.

Additional Resources

Java Math Random Range: A Comprehensive Examination of Generating Random Numbers in Java

java math random range is a fundamental concept for developers who require randomization within specific bounds. Whether it's for games, simulations, or randomized testing, generating random numbers within a given range is a common necessity in Java programming. This article delves into the nuances of random number generation in Java, focusing on the math random range techniques, their implementation, advantages, limitations, and best practices.

Understanding Java's Random Number

Generation

Java provides several ways to generate random numbers, but the core method often referenced is the `Math.random()` function. This built-in method returns a double value greater than or equal to 0.0 and less than 1.0, essentially producing a pseudorandom decimal number within the $[0,1)$ interval. However, when developers need a random number within a specific range, additional calculations become necessary to scale and transform this base output.

The Basics of `Math.random()`

The `Math.random()` method is convenient due to its simplicity and direct availability without requiring object instantiation. It leverages a pseudorandom number generator (PRNG) internally, typically using a Linear Congruential Generator (LCG). This approach is fast and sufficient for many applications but lacks cryptographic security.

Example:

```
```java
double randomValue = Math.random();
System.out.println(randomValue); // Outputs a value between 0.0 (inclusive) and 1.0
(exclusive)
```
```

While this produces a decimal number between 0 and 1, real-world use cases often demand integers or decimals within defined boundaries.

Generating Random Numbers Within a Range

Transforming the output of `Math.random()` to fit a desired range requires scaling and shifting the original $[0,1)$ interval. The formula commonly used is:

```
```java
int randomInRange = (int)(Math.random() * (max - min + 1)) + min;
```
```

Here, ``min`` and ``max`` are the inclusive lower and upper bounds of the target range. This formula ensures that the random integer falls between min and max, inclusive.

Breaking Down the Formula

- `**Math.random()*` produces a value between 0.0 and 1.0 (exclusive).
- Multiplying by ``(max - min + 1)`` scales the value to a range of size ``(max - min + 1)``.
- Casting to ``(int)`` truncates the decimal, resulting in an integer from 0 up to ``(max - min)``.

- Adding ``min`` shifts the range to start at the desired minimum value.

For example, to generate a random number between 10 and 20 inclusive:

```
```java
int randomNum = (int)(Math.random() * (20 - 10 + 1)) + 10;
```
```

This method is straightforward but requires careful attention to the formula to avoid off-by-one errors or range exclusions.

Alternative Approaches: The Random Class

While `Math.random()` is widely used, Java's ``java.util.Random`` class offers more flexibility and additional methods. For example, ``Random.nextInt(int bound)`` returns a pseudorandom, uniformly distributed int value between 0 (inclusive) and the specified bound (exclusive).

To generate an integer within a range using ``Random``:

```
```java
import java.util.Random;

Random rand = new Random();
int randomNum = rand.nextInt((max - min) + 1) + min;
```
```

This approach is often preferred because ``Random`` provides methods for different data types and can be seeded for reproducibility, a feature that `Math.random()` lacks unless the underlying PRNG is replaced.

Pros and Cons of Math.random() for Range Generation

Advantages

- **Simplicity:** No need to instantiate objects. Ideal for quick, one-off random values.
- **Availability:** Part of the core Java API and requires no imports.
- **Lightweight:** Minimal overhead in terms of performance.

Limitations

- **Type Limitations:** Returns a double, meaning additional casting is necessary for integers.
- **Predictability:** Not suitable for cryptographic purposes due to predictable PRNG.
- **Lack of Flexibility:** No direct support for generating numbers of other data types or distributions.

Best Practices for Using Java Math Random Range

When implementing random range generation in Java, developers should consider the following best practices to ensure accuracy and maintainability:

Validate Input Ranges

Always verify that the minimum value is less than or equal to the maximum value. Failing to do so can result in unexpected behavior or runtime exceptions.

Use Appropriate Data Types

Match the data type of the random number to the application's needs. For integer ranges, ensure proper casting and formula usage. For floating-point ranges, adjust the scaling without casting.

Example for floating-point within range:

```
```java
double randomDouble = min + (Math.random() * (max - min));
```
```

Consider Thread Safety

In concurrent applications, `Math.random()` uses a shared `Random` instance internally, which can lead to contention. Using `ThreadLocalRandom` (available from Java 7) is often better suited for multi-threaded environments.

```
```java
import java.util.concurrent.ThreadLocalRandom;

int randomNum = ThreadLocalRandom.current().nextInt(min, max + 1);
```
```

This approach provides efficient, thread-safe random number generation with range support.

Comparative Insights: Math.random() vs Random vs ThreadLocalRandom

| Feature | Math.random() | java.util.Random | ThreadLocalRandom |
|--------------------------|--|----------------------------|------------------------------|
| Requires object creation | No | Yes | No |
| Thread safety | Shared instance, not ideal for concurrency | Not thread-safe by default | Designed for multithreading |
| Range support | Manual scaling required | Built-in nextInt(bound) | Built-in nextInt(min, max) |
| Performance | Fast for simple use | Moderate overhead | Optimized for concurrent use |
| Seeding capability | No direct control | Yes | Yes |

This table highlights why modern Java development often favors `ThreadLocalRandom` for applications that require scalable, efficient random number generation within ranges.

Common Pitfalls in Java Math Random Range Implementation

Developers frequently encounter subtle errors when implementing random range generation:

- **Off-by-One Errors:** Neglecting to add 1 to the range size may exclude the maximum value.
- **Incorrect Casting:** Casting before multiplying can truncate numbers unexpectedly.
- **Negative Range Values:** Not handling cases where min or max are negative can lead to incorrect outcomes.
- **Over-reliance on Math.random():** For advanced use cases, such as cryptography or simulations requiring reproducibility, Math.random() performance and security are inadequate.

Practical Use Cases of Java Math Random Range

Random range generation has broad applications across software development:

Gaming

Randomized events such as dice rolls, enemy spawning, and loot drops often require integers within specific ranges. Using `Math.random()` or `Random` with proper scaling allows developers to simulate these mechanics effectively.

Simulations and Modeling

Scientific simulations may need floating-point numbers in defined intervals to model probabilities or physical quantities. Floating-point random range generation using `Math.random()` scaled formulas is common.

Testing and Automation

Generating random test data within acceptable ranges helps in automated testing scenarios, ensuring robustness against edge cases.

Enhancing Randomness Beyond `Math.random()`

For applications demanding higher quality randomness, developers may explore alternatives:

- **SecureRandom:** Provides cryptographically strong random numbers but with performance costs.
- **SplittableRandom:** Introduced in Java 8, offers better performance and statistical quality for parallel streams.
- **Third-party Libraries:** Libraries such as Apache Commons Math provide extensive random number utilities and distributions.

Integrating these alternatives depends on the requirements for randomness quality, speed, and thread safety.

In exploring java math random range, it becomes evident that while Math.random() offers a simple entry point for generating random numbers within a range, its limitations prompt developers to consider other classes like Random or ThreadLocalRandom for more robust and thread-safe implementations. Understanding the mechanisms behind range scaling, data type considerations, and concurrency implications is essential for producing reliable and maintainable code in Java applications that utilize randomness.

[Java Math Random Range](#)

java math random range: *Java All-In-One Desk Reference For Dummies* Doug Lowe, Barry A. Burd, 2011-02-25 Eight minibooks comprising nearly 900 pages give developers the tips and techniques they need to get up and running on the new J2SE 6 (Java Standard Edition 6) and JDK 6 (Java Development Kit 6) This friendly, all-inclusive reference delivers the lowdown on Java language and syntax fundamentals as well as Java server-side programming, with explanations, reference information, and how-to instructions for both beginning and intermediate-to-advanced programmers Minibooks cover Java basics; programming basics; strings, arrays, and collections; programming techniques; Swing; Web programming; files and databases; and fun and games

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THIS Keyword 2. Java Command Line Arguments Chapter 5 Java Inheritance 1. Java Abstract Class and Methods 2. Concept of Inheritance Java and Java Polymorphism Chapter 6 Memory 1. Java Stack and Heap 2. Java Static Methods and Variables 3. How Garbage Collection Works in Java? Chapter 7 Conditional Loops 1. How to Loop/Iterate an array in Java 2. Java Switch Case Tutorial Chapter 8 Exception Handling 1. Java Exception Handling 2. Guide to Java Exception Hierarchy 3. Create User Defined Exception in Java 4. How to use throws keyword in Java Exception Chapter 9 Math 1. Java Math Class Tutorial 2. Chapter 10 Important Stuff 3. Multithreading in Java 4. How to use Date in Java 5. How to use Java Timer and Example

java math random range: *Multimedia Introduction to Programming Using Java* David Gries, Paul Gries, 2005-11-30 Although vital to modern software development, Java and object-oriented programming can pose significant challenges to newcomers. This text, unique in both scope and approach and accompanied by interactive content that you may find on extras.springer.com, addresses that learning curve by providing a careful, classroom-tested presentation of Java -- from the fundamentals of variables, types, and expressions to procedural concepts like loops and sophisticated object-oriented ideas. *Multimedia Introduction to Programming Using Java* anchors its pedagogy in the program ProgramLive that you may find at extras.springer.com, a complete multimedia module in itself. Containing over 250 recorded lectures with synchronized animation, ProgramLive allows users to see, first-hand and in real time, processes like stepwise refinement of algorithms, development of loops, execution of method calls and associated changes to the call stack, and much more. The zip file also includes all programs from the book, 35 guided instruction sets for closed lab sessions, and a 70-page hyperlinked glossary. Additional key features of this work: Provides clear and accessible treatment of all aspects of a first course, along with more advanced topics such as recursion, exceptions, interfaces, inner classes, and GUIs. Introduces objects and classes early in the exposition, rendering object-oriented programming intuitive and natural. Develops programs, rather than simply showcasing them. Supports all concepts through complementary lectures on the zip-file featured on extras.springer.com. Contains numerous self-help exercises that encourage readers to practice programming. Emphasizes rigor and accuracy through user-friendly exposition and a flexible organizational style. With its comprehensive appendices and bibliography, systematic approach, and helpful interactive programs on extras.springer.com, this exciting work provides the key tools they needed for successful object-oriented programming. It is ideal for use at the undergraduate and graduate beginning level, whether in the classroom or for distance learning; furthermore, the text will also be a valuable self-study resource or reference volume in any programmer's library.

java math random range: Java For Dummies Quick Reference Doug Lowe, 2012-06-05 A reference that answers your questions as you move through your coding The demand for Android programming and web apps continues to grow at an unprecedented pace and Java is the preferred language for both. *Java For Dummies Quick Reference* keeps you moving through your coding while you solve a problem, look up a command or syntax, or search for a programming tip. Whether you're a Java newbie or a seasoned user, this fast reference offers you quick access to solutions without requiring that you wade through pages of tutorial material. Leverages the true reference format that is organized with quick answers and solutions so you can read less and do more Offers new elements such as a syntax guide, command guide, special generics and annotation section, and programming tips Boasts a new, compact trim size that easily goes where you go for convenient referencing *Java For Dummies Quick Reference* helps you move quickly and efficiently through Java without missing a beat!

java math random range: ESSENTIAL JAVA FOR SCIENTISTS AND ENGINEERS Brian H. Hahn, Katherine M. Malan, 2002-05-30 ESSENTIAL JAVA FOR SCIENTISTS AND ENGINEERS

java math random range: Foundational Java David Parsons, 2020-09-21 Java is now well-established as one of the world's major programming languages, used in everything from desktop applications to web-hosted applications, enterprise systems and mobile devices. Java applications cover cloud-based services, the Internet of Things, self-driving cars, animation, game

development, big data analysis and many more domains. The second edition of Foundational Java: Key Elements and Practical Programming presents a detailed guide to the core features of Java – and some more recent innovations – enabling the reader to build their skills and confidence through tried-and-trusted stages, supported by exercises that reinforce the key learning points. All the most useful and commonly applied Java syntax and libraries are introduced, along with many example programs that can provide the basis for more substantial applications. Use of the Eclipse Integrated Development Environment (IDE) and the JUnit testing framework is integral to the book, ensuring maximum productivity and code quality when learning Java, although to ensure that skills are not confined to one environment the fundamentals of the Java compiler and run time are also explained. Additionally, coverage of the Ant tool will equip the reader with the skills to automatically build, test and deploy applications independent of an IDE. Topics and features:

- Presents the most up-to-date information on Java, including Java 14
- Examines the key theme of unit testing, introducing the JUnit 5 testing framework to emphasize the importance of unit testing in modern software development
- Describes the Eclipse IDE, the most popular open source Java IDE and explains how Java can be run from the command line
- Includes coverage of the Ant build tool
- Contains numerous code examples and exercises throughout
- Provides downloadable source code, self-test questions, PowerPoint slides and other supplementary material at the website <http://www.foundjava.com>

This hands-on, classroom-tested textbook/reference is ideal for undergraduate students on introductory and intermediate courses on programming with Java. Professional software developers will also find this an excellent self-study guide/refresher on the topic. Dr. David Parsons is National Postgraduate Director at The Mind Lab, Auckland, New Zealand. He has been teaching programming in both academia and industry since the 1980s and writing about it since the 1990s.

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java math random range: *Java 8 Recipes* Carl Dea, Mark Beaty, Freddy Guime, John OConner, Josh Juneau, 2014-09-25 Java 8 Recipes offers solutions to common programming problems encountered while developing Java-based applications. Fully updated with the newest features and techniques available, Java 8 Recipes provides code examples involving Lambdas, embedded scripting with Nashorn, the new date-time API, stream support, functional interfaces, and much more. Especial emphasis is given to features such as lambdas that are newly introduced in Java 8. Content is presented in the popular problem-solution format: Look up the programming problem that you want to solve. Read the solution. Apply the solution directly in your own code. Problem solved! The problem-solution approach sets Java 8 Recipes apart. Java 8 Recipes is focused less on the language itself and more on what you can do with it that is useful. The book respects your time by always focusing on a task that you might want to perform using the language. Solutions come first. Explanations come later. You are free to crib from the book and apply the code examples directly to

your own projects. Covers the newly-released Java 8, including a brand new chapter on lambdas
Focuses especially on up-and-coming technologies such as Project Nashorn and Java FX 2.0 Respects
your time by focusing on practical solutions you can implement in your own code

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java math random range: *Java 9 Recipes* Josh Juneau, 2017-05-31 Quickly find solutions to dozens of common programming problems encountered while building Java applications. Content is presented in the popular problem-solution format. Look up the programming problem that you want to resolve. Read the solution. Apply the solution directly in your own code. Problem solved! This revised edition covers important new features such as Java 9's JShell and the new modularity features enabling you to separate code into independent modules that perform discrete tasks. Also covered are the new garbage collection algorithm and completely revamped process API. Enhanced JSON coverage is provided as well as a new chapter on JavaServer Faces development for web applications. What You'll Learn Develop Java SE applications using the latest in Java SE technology Exploit advanced features like modularity and lambdas Use JShell to quickly develop solutions Build dynamic web applications with JavaScript and Project Nashorn Create great-looking web interfaces with JavaServer Faces Generate graphics and work with media such as sound and video Add internationalization support to your Java applications Who This Book Is For Both beginning Java programmers and advanced Java developers

java math random range: *Java* Harvey M. Deitel, Paul J. Deitel, 1997 Software -- Programming Languages.

java math random range: *Java 7 Recipes* Josh Juneau, Mark Beaty, Carl Dea, Freddy Guime, John OConner, 2012-03-20 Java 7 Recipes offers solutions to common programming problems encountered every day while developing Java-based applications. Fully updated with the newest features and techniques available, Java 7 Recipes provides code examples involving Servlets, Java FX 2.0, XML, Java Swing, and much more. Content is presented in the popular problem-solution format: Look up the programming problem that you want to solve. Read the solution. Apply the solution directly in your own code. Problem solved! The problem-solution approach sets Java 7 Recipes apart from other books on the topic. Java 7 Recipes is focused less on the language itself and more on what you can do with it that is useful. The book respects your time by always focusing on a task that you might want to perform using the language. Solutions come first. Explanations come later. You are free to crib from the book and apply the code examples directly to your own projects. Covers all-new release of Java: Java 7 Focuses especially on up-and-coming technologies such as Java FX 2.0 Respects your time by focusing on practical solutions you can implement in your own code

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