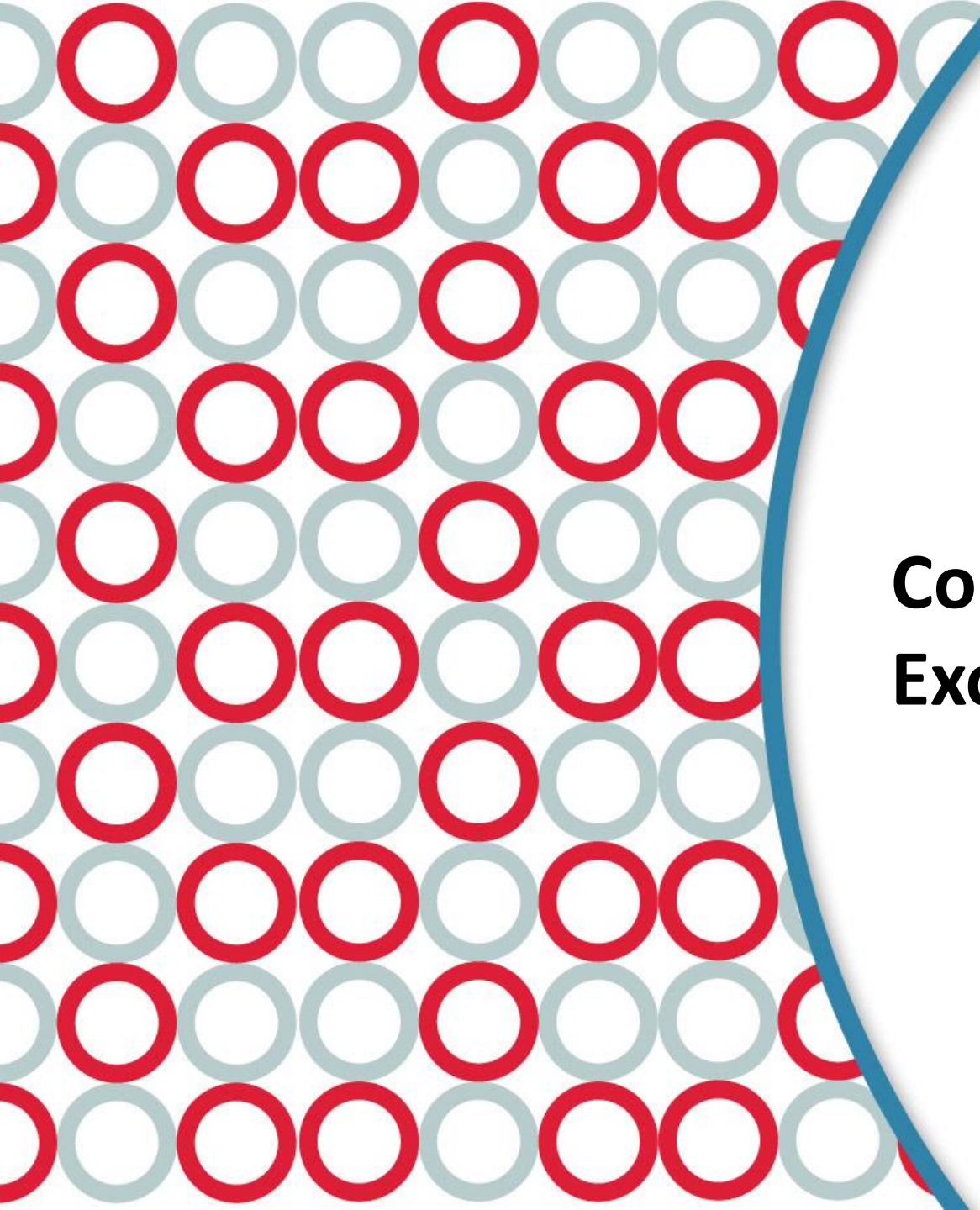

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Programming in Java

Core Java Classes & Exception Handling

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Agenda for This Session

1. **Exception handling** – the role of exceptions; exception types; try-catch; try with resources; throwing exceptions; handling multiple exceptions; using stack-trace; finally block and its applications.
2. **Core Java classes**
   - Strings - creating and manipulating strings, concatenation, comparing, immutability, string pool; methods: length(), charAt(), indexOf(), substring(), toLowerCase()/UpperCase(), equals() and equalsIgnoreCase(), startsWith() and endsWith(), contains(), replace(), trim();
   - StringBuilder – mutability and chaining; methods: append(), insert(), delete(), reverse(), toString(), charAt(), indexOf(), length() and substring();
   - Functional Programming – lambdas, Stream API, default and static methods in interfaces;
   - Java Date/Time API – working with dates and times
   - NIO2 API – working with files and directories, Input and Output streams, Readers and Writers.
   - JDBC - database drivers, connecting to MySQL/PostgreSQL database using DriverManager. Using Statement / PreparedStatement. Using ResultSet.

Exception handling

Where to Find the Code?

Java Web Development projects and examples are available @ GitHub:

https://github.com/iproduct/course-java-fd

Exception Handling in Java

- Obligatory exception handling in Java → secure and reliable code
- Separation of concerns: business logic from exception handling code
- Class **Throwable** → classes Error и Exception
- Generating Exceptions – keyword **throw**
- Exception handling:
  - **try – catch – finally** block
  - Delegating the handling to the caller method - **throws**

Try-Catch-Finally Block

- Operator **try** for demarcation of un-reliable code, multiple **catch** blocks for catching exceptions, and **finally** clause for garateed clean-up in the end:

```
try {
    // code that can throw Exceptions: Ex1, Ex2,  …
} catch(Ex1 ex) {  // excuted only when Ex1 is thrown
    // handling problem 1 (Ex1)
} catch(Ex2 ex) {  // excuted only when Ex2 is thrown
    // handling problem 2 (Ex2)
} finally {
    // executed always independently of whether an exception was thrown or not
}
```

Exception Handling in Java - II

- Implementing custom exceptions
- Using stack trace
- Unchecked exceptions extending **RuntimeException**
- Guaranteed completion using **finally**

Novelties in Exception Handling since Java 7

- Multi-**catch** clause:

```
catch (Exception1|Exception2 ex) {
    ex.printStackTrace();
}
```

- Program block **try-with-resources**

```
String readInvoiceNumber(String myfile) throws IOException
{
    try (BufferedReader input = new
                BufferedReader(new
                    FileReader(myfile))) {
        return input.readLine();
    }
}
```

Strings and Regular Expressions

Strings & StringBulider

- **String** class provides **immutable** objects – i.e. any operation on the string creates a new object in heap.
- Basic operations in the class **String** – length(), charAt(), indexOf(), substring(), toLowerCase()/UpperCase(), equals(), equalsIgnoreCase(), startsWith() and endsWith(), contains(), replace(), trim()
- **StringBulider** – it provides an efficient way to modify the strings, by implementing the Reusable Design Pattern: **Builder** – for incremental string building.
- Basic operations in the class **StringBulider** – append(), insert(), delete(), reverse(), toString(), charAt(), indexOf(), length() and substring()
- Formatted output - method **format()** and class **Formatter**. Specifiers:

%[argument_index$][flags][width][.precision]conversion

Conversion in Type Formatting

- d – decimal, integral types
- c – character (unicode)
- b - boolean
- s - String
- f – float, double (with decimal point)
- e - float, double (scientific notation)
- x – hexadecimal value of integral types
- h – hexadecimal hash code

Regular Expressions - I

- Symbolic classes:

– **.** Any character (may or may not match line terminators)

– **\d** A digit: [0-9]

– **\D** A non-digit: [^0-9]

– **\s** A whitespace character: [\t\n\x0B\f\r]

– **\S** A non-whitespace character: [^\s]

– **\w** A word character: [a-zA-Z_0-9]

– **\W** A non-word character: [^\w]

Regular Expressions - II

- Qualifiers:

–**X?** X, once or not at all

–**X*** X, zero or more times

–**X+** X, one or more times

–**X{n}** X, exactly n times

–**X{n,}** X, at least n times

–**X{n,m}** X, at least n but not more than m times

- **Greedy, Reluctant (?) & Possessive (+)** qualifiers
- **Capturing Group - (X)**

Regular Expressions - III

- Class **Pattern** – basic methods:

public static Pattern compile(String regex)

public Matcher matcher(CharSequence input)

public static boolean matches(String regex,CharSequence input)

public String[] split(CharSequence input, int limit)

- Class **Matcher** – basic methods:

public boolean matches()

public boolean lookingAt()

public boolean find(int start)

public int groupCount() и **public String group(int group)**

Functional Programming & Streams API

Functional Interfaces in Java 8+

- Functional interface = interface with Single Abstract Method (SAM) => **@FunctionalInterface**
- Examples:

```
public interface Comparator<T> {
    int compare(T o1, T o2);
}
public interface ActionListener extends EventListener {
    public void actionPerformed(ActionEvent e);
}
public interface Runnable {
    public void run();
}
public interface Callable<V> {
    V call() throws Exception;
}
```

Labmda Expressions – **java.util.function**

Examples:

```
(int x, int y) -> x + y
() -> 42
(a, b) -> a * a + b * b;
(String s) -> { System.out.println(s); }
book -> book.getAuthor().fullName()
voter -> voter.getAge() >= legalAgeOfVoting
(person1, person2) -> person1.getAge() - person2.getAge()
(song1, song2) ->
                song1.getArtist().compareTo(song2.getArtist())
```

Lambda Expressions Formatting Rules

- Lambda expressions (functions) can have arbitrary namber of arguments, which are enclosed in parentheses and separated by commas. Their type can be declared or not inferred by the context of use (target typing). If there is exactly one parameter, the parentheses are not required.
- The body of lambda expressions is composed by arbitrary language constructs (statements), each finishing with **;** and the body is enclosed in curly braces }. If there is a single expression that needs to be returned by the function, then we can skip the curly braces and return keyword – the value of the expression is automatically returned as function result.

Package **java.util.function**

- **Predicate<T>** – predicate = a boolean expression representing a property of the argument object
- **Function<A,R>**: function which receives an argument A and transforms it to a result R
- **Supplier<T>** – method **get()** returns a new instance each time it is called – an object factory
- **Consumer<T>** – accepts and argument (**accept()** method) and executes an operation consuming that argument
- **UnaryOperator<T>** – single argument operator T -> T
- **BinaryOperator<T>** – binary operator (T, T) -> T

Stream API (1)

Examples:

```
books.stream().map(book -> book.getTitle())
      .collect(Collectors.toList());

books.stream()
      .filter(w -> w.getDomain() == PROGRAMMING)
      .mapToDouble(w -> w.getPrice()) .sum();

document.getPages().stream()
      .map(doc -> Documents.characterCount(doc))
      .collect(Collectors.toList());

document.getPages().stream()
      .map(p -> pagePrinter.printPage(p))
      .forEach(s -> output.append(s));
```

Stream API (2)

Examples:

```
document.getPages().stream()
        .map(page -> page.getContent())
        .map(content -> translator.translate(content))
        .map(translated -> new Page(translated))
        .collect(Collectors.collectingAndThen(
                Collectors.toList(),
                pages -> new
        Document(translator.translate(document.getTitle()), pages)));
```

Method Referencves

- Static method references – Class::staticMethod
- Instance method references – object::instanceMethod
- Class constructor references – Class::new

```
Comparator<Person> namecomp =
Comparator.comparing(Person::getName);

Arrays.stream(pageNumbers)
      .map(doc::getPageContent)
      .forEach(Printers::print);

pages.stream().map(Page::getContent)
      .forEach(Printers::print);
```

Static and Default Interface Methods

- Method with default implementation are called virtual extension methods or defender methods, because they allow the interfaces to be extended without breaking existing implementations.
- Static methods allow to provide additional utility methods, such as factory methods directly in the interfaces, instead of creating auxiliary utility classes such as Arrays and Collections.

Default and Static Methods Usage Example

```
@FunctionalInterface
interface Event {
    Date getDate();
    default String getDateFormatted() {
          return String.format("%1$td.%1$tm.%1$tY", getDate());
    }
    public static <T, U extends Comparable<? super U>>
    Comparator<T> comparing(Function<T, U> getKey) {
        return (c1, c2) -> getKey.apply(c1).compareTo(getKey.apply(c2));
    }
}
Event current = () -> new Date();
System.out.println(current.getDateFormatted());
```

Resources

- Oracle tutorial – lambda expressions - http://docs.oracle.com/javase/tutorial/java/javaOO/lambdaexpressions.html
- Java SE 8: Lambda Quick Start - http://www.oracle.com/webfolder/technetwork/tutorials/obe/java/Lambda-QuickStart/index.html
- OpenJDK Lambda Tutorial - https://github.com/AdoptOpenJDK/lambda-tutorial

Date & Time API

Novelties in Java 8+: Date-Time API (JSR 310)

- Allows flexible processing (incl. time based calculations) with dates and periodes
- Package: **java.time**
- Supported standards: **ISO-8601, Unicode Common Locale Data Repository (CLDR), Time-Zone Database (TZDB)**
- Example:

```
LocalDate today = LocalDate.now();
LocalDate reportDay =
today.with(TemporalAdjusters.lastDayOfMonth());
LocalDate paymentDay = reportDay.plusDays(5);
```

Advantages of Date-Time API

- **Clear** - methods in the API are well defined and their behavior is clear and expected
- **Fluent** - provides a fluent interface, making the code easy to read, most methods do not allow null values => can be chained together:

```
LocalDate today = LocalDate.now();
LocalDate paymentDay = today
        .with(TemporalAdjusters.lastDayOfMonth())
        .minusDays(2);
```

Advantages of Date-Time API

- **Immutable** - after the object is created, it cannot be modified. To alter the value of an immutable object, a new object must be constructed as a modified copy of the original => thread-safe. This affects the API in that most of the methods used to create date or time objects are prefixed with of, from, or with, rather than constructors, and there are no set methods. For example:

```
LocalDate dateOfBirth =
      LocalDate.of(2012, Month.MAY, 14);
LocalDate firstBirthday = dateOfBirth.plusYears(1);
```

- **Extensible** - wherever possible. For example, you can define your own time adjusters and queries, or build your own calendar system.

Date and Time API: Main Classes (1)

- **Clock** – allows access to the current moment, date and time for a time zone
- **Instant** – momentary point on the time axis
- **LocalDate** –local date without time and zone: 2014-12-20
- **LocalTime** – local time without date and zone: 14:25:15
- **LocalDateTime** – local date and time without zone: 2014-12-20T14:25:15
- **MonthDay** – day of month –12-20 => December 20
- **Duration** – time period – e.g. 2 minuts and 52 seconds
- **Period** – time period in days – e.g. 3 years 2 months and 4 days

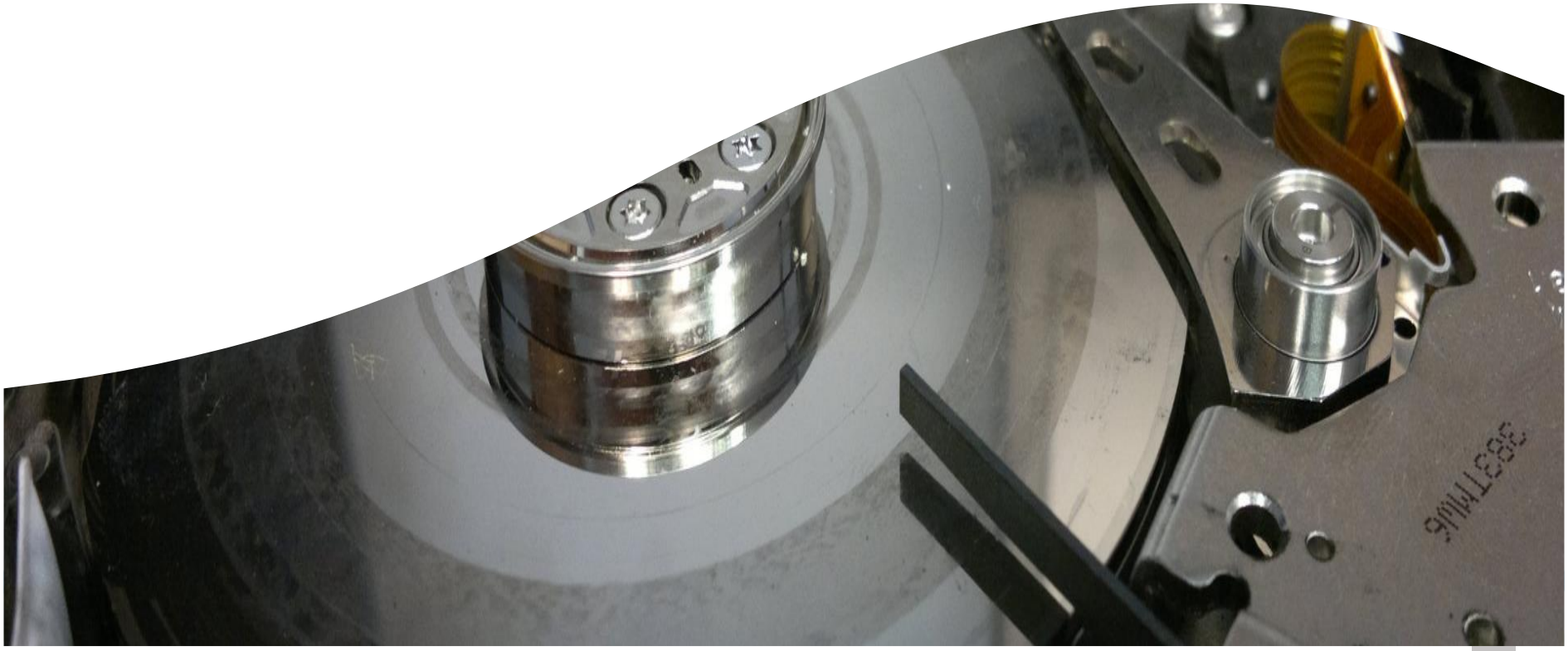
Date and Time API: Main Classes (2)

- **OffsetDateTime** – date and time + time zone: 2014-12-20T09:15:00+02:00
- **OffsetTime** – time + time zone: 09:15:00+02:00.
- **Year** – year - e.g. 2014
- **YearMonth** – month in year – напр. 2014-12
- **ZonedDateTime** – similar to OffsetDateTime + time-zone ID: 2014-12-20T10:15:30+01:00 Europe/Sofia
- **ZoneId** – time-zone ID – e.g. Europe/Rome
- **ZoneOffset** – time offset from Greenwich/UTC – e.g. +02:00

Date and Time API – Example

```
LocalDate today = LocalDate.now();
LocalDate dateOfBirth = LocalDate.of(1982, Month.MAY, 14);
LocalDateTime now = LocalDateTime.now();
LocalTime timeOfBirth = LocalTime.of(14, 50);
LocalDateTime dateTimeOfBirth = LocalDateTime.of(dateOfBirth,
timeOfBirth);
Period howOld = Period.between(dateOfBirth, today);
Duration age = Duration.between(dateTimeOfBirth, now);
long daysOld = ChronoUnit.DAYS.between(dateOfBirth, today);
System.out.println("Your age are: " + howOld.getYears() + " years, "
    + howOld.getMonths() + " months, and " + howOld.getDays()
    + " days. (" + age.toDays() + " /" + daysOld + "/ days total)");
```

Java IO. New IO (NIO) 2



Agenda for This Session

- I/O basics,
- AutoCloseable,
- Closeable and Flushable interfaces,
- I/O exceptions,
- Serialization,
- java.io. and nio

Java I/O

- Input/Output from/to:

✓ Memory
✓ String
✓ Between different threads
✓ Files
✓ Console
✓ Network sockets

- Different data types – bytes / characters. Encoding.

- Common and extensible architecture of Java I/O system using Decorator design pattern.

Class **File** – Working with Files and Dirs

- Class ***File***
- Represents a file or a directory.
- Methods ***getName()*** and ***list()***
- Getting file information
- Creating, renaming and deleting directories.

Input and Output Streams

- Input streams – class ***InputStream*** and its inheritors
- Output streams – class ***OutputStream*** and its inheritors
- Decorator design pattern
- Decorators - class ***FilterInputStream*** and its inheritors, class ***FilterOutputStream*** and its inheritors

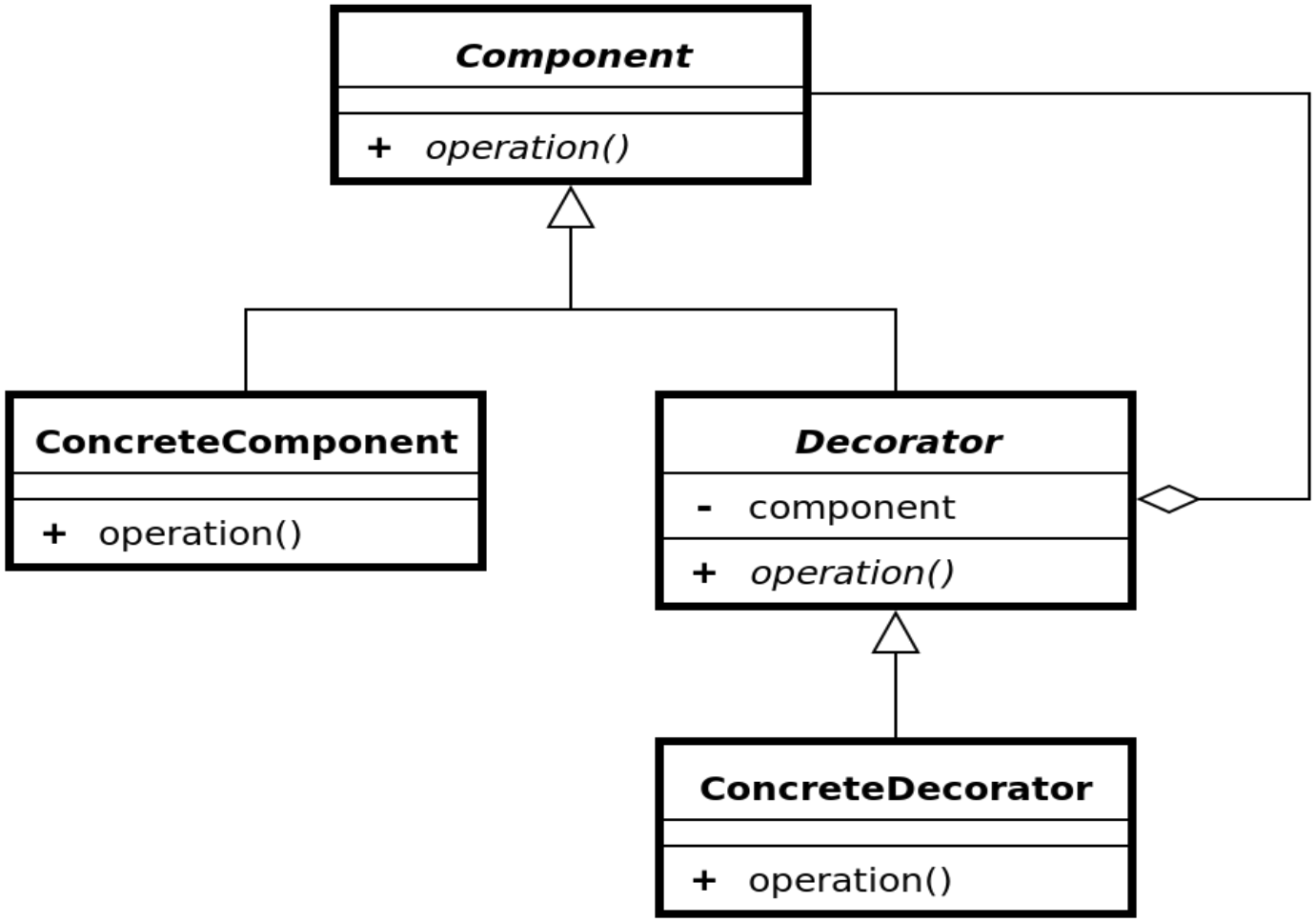
Input Streams: ***InputStream***

- **FileInputStream** – reads data from file
- **ByteArrayInputStream** – reads data from memory
- **StringBufferInputStream** – reads data from StringBuffer
- **ObjectInputStream** – de-serializes Objects and primitives
- **PipedInputStream** – receives data from another thread
- **SequenceInputStream** – combines several InputStreams
- **FilterInputStream** – decorates wrapped input streams with additional functionality

Output Streams: ***OutputStream***

- **FileOutputStream** – writes data to file
- **ByteArrayOutputStream** – writes data to memory buffer
- **ObjectOutputStream** – serializes objects and primitives
- **PipedOutputStream** – sends data to another thread
- **FilterOutputStream** – decorates wrapped InputStreams with additional functionality

Decorator Design Pattern



Input Stream Decorators

- **DataInputStream** – reads primitive types
- **BufferedInputStream** – buffers the input, allows reading lines instead of characters
- **DigestInputStream** – calculates content hash using algorithms such as: SHA-1, SHA-256, MD5
- **DeflaterInputStream** – data compression
- **InflaterInputStream** – data decompression
- **CheckedInputStream** – calculates checksum (Adler32, CRC32)
- **CipherInputStream** – decrips data (using Cipher)

Output Stream Decorators

- **PrintStream** – provides convenient methods for printing different data types, processes exceptions
- **DataOutputStream** – writes primitive data types
- **BufferedOutputStream** – output buffering
- **DigestOutputStream** – calculates content hash using algorithms such as: SHA-1, SHA-256, MD5
- **DeflaterOutputStream** – data compression
- **InflaterOutputStream** – data decompression
- **CheckedOutputStream** – checksum computation
- **CipherInputStream** – encrips data (using Cipher)

Reading Character Data: ***Reader***
Adaptor Class: ***InputStreamReader***

- **FileReader** – reads character data from file
- **CharArrayReader** - reads character data from memory
- **StringReader** – reads character data from String
- **PipedReader** – receives character data from a thread
- **FilterReader** – Reader decorator base class

Writing Character Data : *Writer*
Adaptor Class: *OutputStreamWriter*

- **FileWriter** – writes character data to file
- **CharArrayWriter** - writes character data to array
- **StringWriter** – writes character data to StringBuffer
- **PipedWriter** – sends character data to another thread
- **FilterWriter** – base class for Writer decorators
- **PrintWriter** – formatted output in string format, handles all exceptions

Reader / Writer Decorators

- **BufferedReader** – character input buffering
- **PushbackReader** – allows characters to be read without consuming
- **BufferedWriter** – character output buffering
- **StreamTokenizer** – allows parsing of character input (from Reader) token by token

Direct Access Files

- Class ***RandomAccessFile***.
- Access modes
- Method ***seek()***
- Usage examples.

- Standard I/O to/from console. Redirecting.

New More Effective I/O Implementation: New I/O

- Java New I/O – package ***java.nio.**** introduced in JDK 1.4
- Uses low level OS mechanisms and structures to allow more effective, faster and non-blocking IO.
- Underlying all types of Streams (FileInputStream, FileOutputStream, RandomAccessFile) as well as network socket streams.

New More Effective I/O Implementation: New I/O

- Buffers for primitive data types: **java.nio.Buffer, ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer**
- Channels – new low level IO abstraction: **java.nio.channels.Channel, FileChannel, SocketChannel**
- Supports different encodings: **java.nio.charset.Charset**

New More Effective I/O Implementation: New I/O

- Supports read/write locking of arbitrary sections of a file up to Integer.MAX_VALUE байта (2 GiB). Depending on OS can allow shared locking: **tryLock( )** or **lock( )** of the class **java.nio.channels.FileChannel**

- Allows multiplexing of I/O operations for implementing scalable servers processing multiple sessions using a single thread asyncronously: **java.nio.channels.Selector** и **SelectableChannel**

Compression: GZIP, ZIP. JAR Files

- File compression – gzip, zip. Check Sum.
- Application deployment using .jar archives. JAR file manifest.
- **jar** [options] archive [manifest] files

c – creates new archive
x / x файл – extracts specific/all files from an archive
t – prints archive content table
f – necessary to specify the file we read/write from/to
m – if we provide a manifest file
M – do not create manifest file automatically
0 – without compression
v – verbose output

Object Serialization

- Interface ***Serializable*** **–** all fields are serialized except those marked as ***transient***
- Interface ***Externalizable*** **–** we serialize all fields explicitely
- Methods ***readObject()*** and ***writeObject()*** **–** ***Serializable*** + customization where necessary
- Examples

Novelties in Java 7 - JSR 203: NIO.2 (1)

- New NIO packages: java.nio.file, java.nio.file.attribute
- FileSystem – allows a unified aceess to different file systems using URI or the method FileSystems.getDefault(). A factory for file system object creation. Methods: getPath(), getPathMatcher(), getFileStores(), newWatchService(), getUserPrincipalLookupService().
- FileStore – models a drive, partition or a root directory. Can be accessed using FileSystem.getFileStores()

Novelties in Java 7 - JSR 203: NIO.2 (1)

- Path – represents a file or directory path in the file system. Has a hierarchical structure – a sequence of directories separated using an OS specific separator ('/' или '\'). Provides methods for composing, decomposing, comparing, normalizing, transforming relative and absolute paths, watching for file and directory changes, conversion to/from File objects (java.io.File.toPath() и Path.toFile()).
- Files – utility class providing static methods for manipulation (creation, deletion, renaming, attributes change, content access, automatic MIME type inference, etc.) of files, directories, symbolic links, etc.

Resources

- Sun Microsystems Java™ Technologies webpage – http://java.sun.com/
- New I/O във Wikipedia: http://en.wikipedia.org/wiki/New_I/O
- Уроци за новостите в JSR 310: Date and Time API http://docs.oracle.com/javase/tutorial/datetime/
- Уроци за новостите в JSR 203: NIO.2 http://download.oracle.com/javase/tutorial/essential/io/fileio.html

Java DataBase Connectivity (JDBC)

Java Database Connectivity (JDBC)

- **Java Database Connectivity** (**JDBC**) is an application programming interface (API) in Java, which allows the clients to access, extract, and modify data in a relational database.

- JDBC-to-ODBC bridge allows connections to all ODBC-compatible data-sources from Java.

JDBC Example (1)

```
Scanner sc = new Scanner(System.in);
Properties props = new Properties();

System.out.println("Enter  username (default root): ");
String user = sc.nextLine().trim();
user = user.length() > 0 ? user : "root";
props.setProperty("user", user);

String password = sc.nextLine().trim();
password = password.length() > 0 ? password : "root";
props.setProperty("password", password);
```

JDBC Example (2)

```
// 1. Load jdbc driver (optional)
try {
        Class.forName("com.mysql.cj.jdbc.Driver");
} catch (ClassNotFoundException e) {
        e.printStackTrace();
        System.exit(0);
}
System.out.println("Driver loaded successfully.");

// 2. Connect to DB
Connection connection =
     DriverManager.getConnection(
       "jdbc:mysql://localhost:3306/employees?useSSL=false",
props);
System.out.println("Connected successfully.");
```

JDBC Example (3)

```
// 3. Execute query
PreparedStatement stmt =
    connection.prepareStatement("SELECT * FROM employees JOIN
salaries ON employees.emp_no=salaries.emp_no WHERE
salaries.salary > ?");


System.out.println("Enter  minimal salary (default 20000): ");
String salaryStr = sc.nextLine().trim();
double salary = Double.parseDouble(salaryStr);

stmt.setDouble(1, salary);
ResultSet rs = stmt.executeQuery();
```

JDBC Example (4)

```
// 4. Process results
while (rs.next()) {
      System.out.printf("| %-15.15s | %-15.15s | %10.2f |\n",
              rs.getString(2),
              rs.getString("last_name"),
              rs.getDouble("salary")
      );
}

// 5. Close connection and statement
connection.close();
```

Novelties in JDBC™ 4.1: try-with-resources

- java.sql.Connection, java.sql.Statement and java.sql.ResultSet implement the interface **AutoCloseable**:

```
Class.forName("com.mysql.jdbc.Driver");                    //Load MySQL DB driver
try (Connection c = DriverManager.getConnection(dbUrl, user, password);
   Statement s = c.createStatement() ) {
   c.setAutoCommit(false);
   int records = s.executeUpdate("INSERT INTO product "    //Insert new product
       + "VALUES ('CP-00002', 'Lenovo', 790.0, 'br', 'Latop')");
   System.out.println("Successfully inserted "+ records + " records.");
   records = s.executeUpdate("UPDATE product "             //Update product price
                  + "SET price=470, description='Classic laptop' "
                  + "WHERE code='CP-00001'");
   System.out.println("Successfully updated "+ records + " records.");
   c.commit();                                             //Finish transaction
}
```

Resources

- Wikipedia – Free Online Enciclopedia – http://wikipedia.org/
- Oracle® Java™ Technologies webpage – http://www.oracle.com/technetwork/java/
- Oracle®: The Java Tutorials: Lesson: JDBC Basics – http://docs.oracle.com/javase/tutorial/jdbc/basics/index.html
- Oracle®: Новости в JDBC™ 4.1 – http://docs.oracle.com/javase/7/docs/technotes/guides/jdbc/jdbc_41.html
- Joshua Bloch: Automatic Resource Management (V.2) – https://docs.google.com/View?id=ddv8ts74_3fs7483dp

Thank's for Your Attention!

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