Design patterns
Design patterns

• a general reusable solution to a commonly occurring problem within a given context in software design (Wikipedia)

• Gamma, E., Helm, R., Johnson, R., Vlissides, J. (1995). Design Patterns: Elements of Reusable Object-Oriented Software

• classification
  – creational
  – structural
  – behavioral
  – ...
Singleton pattern

• only a single instance of a given class

```java
public class Singleton {

    private static final Singleton INSTANCE = new Singleton();

    private Singleton() {
    }

    public static Singleton getInstance() {
        return INSTANCE;
    }
}
```
Singleton pattern

- another implementation

```java
public enum Singleton{
    INSTANCE;

    private Singleton() {
    
    }
}
```

- usage
  - java.lang.Runtime
  - ...

Factory pattern

- creation of new objects

- a (static) method creating new objects
  - polymorphism during creation

- advantages
  - hiding creation
  - full control over types and number of instances
  - ...

- examples
  - `static Integer valueOf(int i)`
  - `static <E> List<E> of(E... elements)`
public class Complex {
    public double real;
    public double imaginary;

    public static Complex fromCartesian(double real, double imaginary) {
        return new Complex(real, imaginary);
    }

    public static Complex fromPolar(double modulus, double angle) {
        return new Complex(modulus * Math.cos(angle), modulus * Math.sin(angle));
    }

    private Complex(double real, double imaginary) {
        this.real = real;
        this.imaginary = imaginary;
    }
}
public static ImageReader createImageReader(ImageInputStreamProcessor iisp) {
    if (iisp.isGIF()) {
        return new GifReader(iisp.getInputStream());
    } else if (iisp.isJPEG()) {
        return new JpegReader(iisp.getInputStream());
    } else {
        throw new IllegalArgumentException("Unknown image type.");
    }
}
Factory pattern

• Disadvantage
  - cannot be extended (private constructor)
  - walk-around – protected constructor
    • dangerous – the factory method can be ignored
java.util.logging
Overview

• API for logging

  - an application uses the **Logger**
    - methods log()
  - **Logger** creates **LogRecord** and passes it to **Handler**
  - **Handler** prints out messages
    - on screen, to a file,...
  - **Filter** – filtering logged messages
  - **Formatter** – formatting the messages
  - **LogManager** – typically is not directly used
    - the single global object; manages the loggers
Logger

- hierarchical structure – tree
  - the logger sends messages also to the ancestor
  - names of the loggers should copy the hierarchy of classes

- several levels of messages
  - `java.util.logging.Level`
    - SEVER
    - WARNING
    - INFO
    - CONFIG
    - FINE
    - FINER
    - FINEST
  - it can be specified from which level the messages should be logged (messages with a lower level are ignored)
Handler

• several available handlers
  – Handler – the abstract class
    • other handlers extend it
  – StreamHandler – logs to an OutputStream
  – ConsoleHandler – to the System.err
  – FileHandler – to a file
    • to a single file or file “rotation”
  – SocketHandler – to a socket
  – MemoryHandler – to a memory buffer
• own handler
  – extending the Handler
Formatter

- SimpleFormatter
  - text
  - "human-readable"
- XMLFormatter
  - xml
Logging

• methods of the Logger
  - by the level
    • sever(String msg)
    • warning(String msg)
    • ...
  - generic ones
    • log(Level l, String msg)
    • log(Level l, String msg, Object o)
    • log(Level l, String msg, Throwable t)
  - with a logging source
    • logp(Level l, String sourceClass, String sourceMethod, String msg)
    • ...
  - “lazy” logging
    • void log(Level level, Supplier<String> msgSupplier)
    • void severe(Supplier<String> msgSupplier)
Example

```java
static Logger logger =
    Logger.getLogger("cz.cuni.mff.java.logging.TestLog");
...
logger.info("doing stuff");
try{
    ...
} catch (Throwable ex){
    logger.log(Level.WARNING, "exception occurred", ex);
}
logger.info("done");
```
"External" configuration

- using properties
  - `java.util.logging.config.file`
    - common format for properties (name=value)
      - `<logger>.handlers = ...` a list of handlers for the given logger
      - `<logger>.level =` a level for the given logger
      - ....
      - without the initial name – the root logger
  - `java.util.logging.config.class`
    - the class responsible for loading the configuration
      - the previous property then can have no meaning
System.Logger

- many different (external) logging libraries
  - Log4J, SLF4J...

- System.Logger System.getLogger(String name)
  - since Java 9
  - returns a logger
    - which one is used – depends on “configuration”
      - “configuration” via service loader – will be in NPRG021
    - by default – java.util.logging

- System.Logger
  - void log(System.Logger.Level level, String msg)
  - void log(System.Logger.Level level, Supplier<String> msgSupplier)
  - ...

java.util

Time, date
java.util.Date

- represents time with millisecond precision
  - since 1.1.1970
- most of the methods are deprecated
  - since JDK1.1 replaced by Calendar
- constructors
  - Date()
    - an instance will hold time at which it was allocated
  - Data(long date)
    - an instance will hold the given time
- methods – in fact comparisons only
  - boolean after(Date d)
  - boolean before(Date d)
  - int compareTo(Date d)
- other ones are deprecated
java.util.Calendar

• abstract class
• the only non-abstract child
  – GregorianCalendar
• static attributes
  – what can be obtained/set
    • YEAR, MONTH, DAY_OF_WEEK, DAY_OF_MONTH, HOUR, MINUTE, SECOND, AM_PM, ...
  – months – JANUARY, FEBRUARY, ...
  – days in a week – SUNDAY, MONDAY, ...
  – other – AM, PM, ...
java.util.Calendar: methods

- obtaining an instance – static methods
  - getInstance()
  - default timezone
    - getInstance(TimeZone tz)
- getting/setting time
  - Date getTime()
  - long getTimeInMillis()
  - void setTime(Date d)
  - void setTimeInMillis(long t)
- comparison
  - boolean before(Object when)
  - boolean after(Object when)
java.util.Calendar: methods

• obtaining individual fields
  – int get(int field)
  – ex. int day = cal.get(Calendar.DAY_OF_MONTH)

• setting individual fields
  – void set(int field, int value)
  – ex. cal.set(Calendar.MONTH, Calendar.SEPTEMBER)
  – resulting time in milliseconds is recalculated just during calls get(), getTime(), getTimeInMillis()

• adding to fields
  – void add(int field, int delta)
  – if necessary, modifies other fields also
  – resulting time in milliseconds is recalculated immediately

• adding to fields without modification of other fields
  – void roll(int field, int amount)
  – void roll(int field, boolean up)
java.util.TimeZone

- representation of a time zone
- understands summer/winter time
- obtaining a time zone
  - TimeZone getDefault()
    - static method
    - returns the timezone set in a system
  - TimeZone getTimeZone(String ID)
    - returns required time zone
- possible ID
  - String[] getAvailableIDs()
    - static method
- IDs have a form
  - "America/Los_Angeles"
  - GMT +01:00
Java

java.time
java.time

• since Java 8, replacement of Calendar
  – Calendar is not deprecated
• instances of java.time... are typically immutable
  – contrary to instances of Calendar

• Instant
  – an instantaneous point on the time-line
  – creation
    • static Instant now()
    • static Instant ofEpochMilli(long milli)
    • static Instant parse(CharSequence text)
  – methods
    • plus(...(...), minus(...(...), ...
    • int get(TemporalField field)
java.time

• Duration
  - amount of time between two time points
  - ex:
    • Instant start = Instant.now();
    • ...
    • Instant end = Instant.now();
    • Duration duration =
      Duration.between(start, end);

• creation
  • static Duration ofDays(long days)
  • static Duration ofHours(long hours)
  • static Duration ofMinutes(long minutes)
  • ...

• methods
  • long toDays()
  • long toHours()
  • ...
java.time

- LocalDate
- LocalTime
- LocalDateTime

- date/time without timezone
- creation
  - (LocalDate | LocalTime | LocalDateTime).now()
  - LocalDate.of(int year, int month, int dayOfMonth)
    - ...of(...)
- methods
  - plus, minus, get, ...

- ZonedDateTime
  - date and time with timezone
  - zone = ZoneId
java.util

Timer
Usage

- scheduling tasks for future execution
  - one-time or repeated
- task = TimerTask
- all tasks in a single timer are executed in a single thread
  - a task should finish quickly
- scheduling a task
  - void schedule(TimerTask t, Date d)
    - schedules the task for the given time
  - void schedule(TimerTask t, Date d, long period)
    - schedules the task repeatedly
    - period – time in milliseconds between executions
Usage

- scheduling a task (cont.)
  - void schedule(TimerTask t, long delay)
    - schedules the task after given delay
  - void schedule(TimerTask t, long delay, long period)
    - schedules the task repeatedly
    - period – time in milliseconds between executions
  - void scheduleAtFixedRate(TimerTask t, Date d, long period)
  - void scheduleAtFixedRate(TimerTask t, long delay, long period)
    - schedules the task repeatedly
    - period – time in milliseconds between executions relatively to initial execution
Usage

- **the method** `void cancel()`
  - cancels the timer
  - no further scheduled tasks are executed
  - currently executed task is finished
  - can be called repeatedly
    - further calls do nothing

- **the class** `TimerTask`
  - implements the interface `Runnable`
  - abstract class – the `run()` method must be implemented
  - other methods
    - `void cancel()`
      - cancels the task
    - `long scheduledExecutionTime()`
      - time of the most recent actual execution
Modern “timer”

```java
ScheduledExecutorService scheduler = Executors.newScheduledThreadPool(1);

Runnable task = new Runnable() {
    public void run() {
        ...
    }
};

scheduler.scheduleAtFixedRate(task, 0, 120, SECONDS);

...  

scheduler.shutdown();
```
java.util

java.util.regex
java.util.regex

- regular expressions
- classes Pattern and Matcher
- typical usage

```java
Pattern p = Pattern.compile("a*b");
Matcher m = p.matcher("aaaaaab");
boolean b = m.matches();
```

- Matcher
  - `matches()` – matches the entire string
  - `find()` – looking for the next subsequence that matches the pattern
• warning - “special characters”
  – e.g. a regex matching the back-slash
    "\\\\"

  – "\Q......\E"
    • quoting all the characters in between
Localization
java.util.Locale

• represents a specific geographical, political, or cultural region
• defines how to print out texts, numbers, currency, time
• creation
  – Locale(String language)
  – Locale(String language, String country)
  – Locale(String language, String country, String variant)
    – ex. new Locale("cs", "CZ")
• static Locale[] getAvailableLocales()
  – returns all installed locales
• static Locale getDefault()
  – returns the default locale
java.util.ResourceBundle

• contains "localized" objects
  – e.g. strings
• bundle always belongs to a group with common base name – e.g. MyResources
  – full name of a bundle = base name + locale id
  – ex. MyResources_cs, MyResources_de, MyResources_de_CH
  – default bundle – with the base name only
  – each bundle in a group holds the same objects transformed for a particular locale
  – if requested bundle is not available, the default one is used
ResourceBundle: Usage

• obtaining bundles
  - ResourceBundle.getBundle("MyResources")
  - ResourceBundle.getBundle("MyResources", currentLocale)

• bundle contains tuples key/value
  - keys are the same for oal locales in a group, the value is different

• usage
  ResourceBundle rs =
    ResourceBundle.getBundle("MyResources");
  ...
  button1 = new Button(rs.getString("OkKey"));
  button1 = new Button(rs.getString("CancelKey"));
ResourceBundle: Usage

- keys – String type
- value – any type
- obtaining an object from the buffer
  - String getString(String key)
  - String[] getStringArray(String key)
  - Object getObject(String key)
    - ex: int[]
      ai=(int[])rs.getObject("intList");

- ResourceBundle – abstract class
- two implementations
  - ListResourceBundle
  - PropertyResourceBundle
- abstract class
- children must redefine the method
  - Object[][] getContents()
PropertiesResourceBundle

- is not abstract
- no other class is directly created
- localized strings are in files
- a name of the file
  - base name + locale + ".properties"
  - ex. myresources.properties
    myresources_cs.properties
- obtaining the bundle
  - ResourceBundle.getBundle("myresources")
- the format of the file
  - key=value
  - # comment till the end of the line
Own implementation

• extending directly ResourceBundle
• overriding methods
  - Object handleGetObject(String key)
  - Enumeration getKeys()

public class MyResources extends ResourceBundle {
    public Object handleGetObject(String key) {
        if (key.equals("okKey")) return "Ok";
        if (key.equals("cancelKey")) return "Cancel";
        return null;
    }
}

public class MyResources_cs extends ResourceBundle {
    public Object handleGetObject(String key) {
        // nemusí definovat všechny klíče
        if (key.equals("cancelKey")) return "Zrušit";
        return null;
    }
}