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Object-Oriented Programming 2

Internationalization – I18n

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Outline – I18n

- What is I18n?
- `java.lang.Locale`
- Culture Dependent Content
- Formatting
- Sorting

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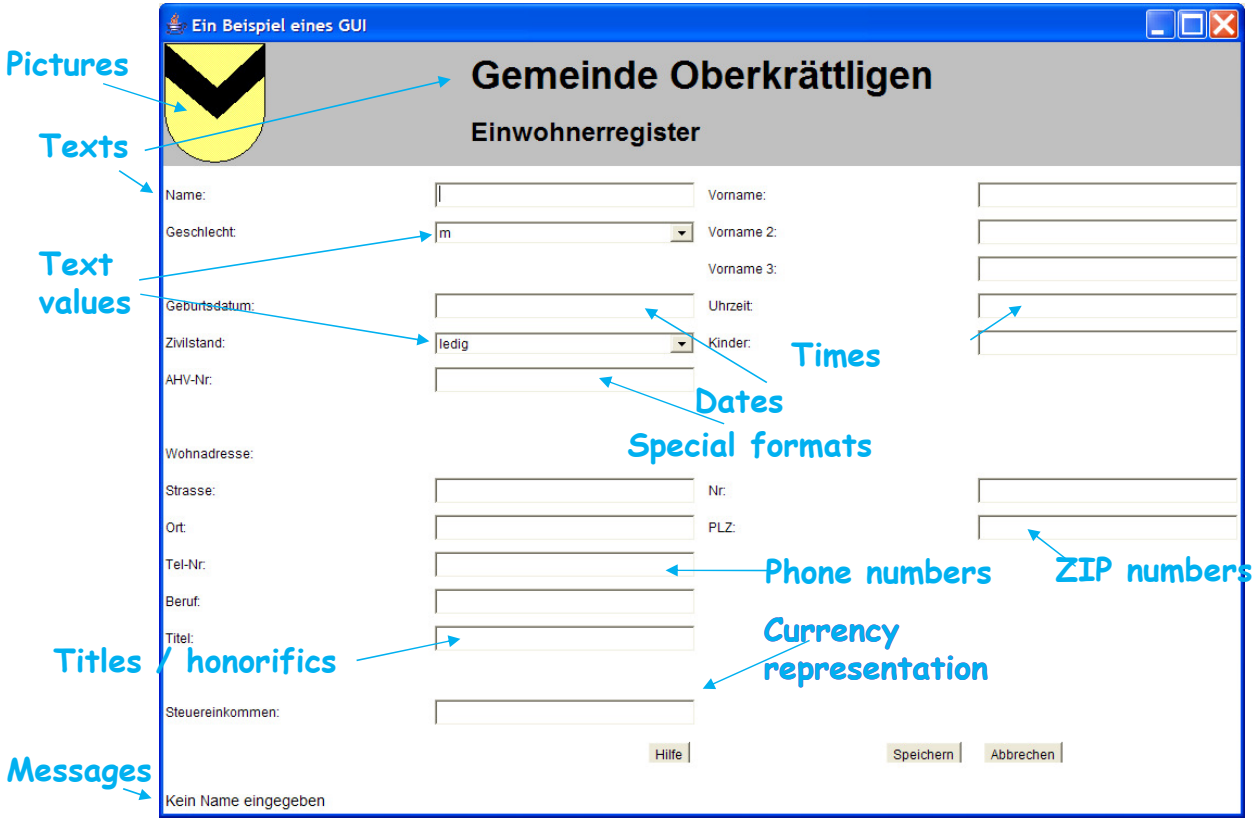
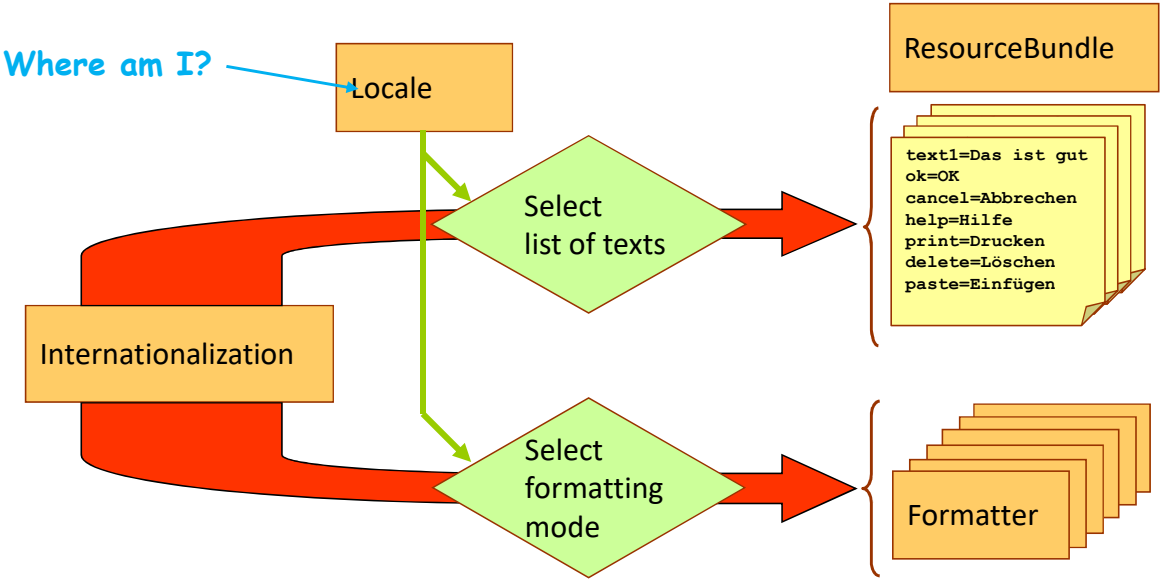
Let‘s look at an example:



Internationalization

The Principles of Internationalization



Internationalization

- Where can I get the information about in which country I am, which language I have to use etc ?
  - from `java.lang.Locale`

- Do I have to write all specific adaptations for text, pictures etc. myself ?
  - No, there are plenty of ready-made classes, mostly in `java.util.*` and `java.text.*`, such as
    - `ResourceBundle, PropertyResourceBundle, ListResourceBundle`
    - `Format, DateFormat, MessageFormat, NumberFormat`
    - `Calendar, GregorianCalendar`
    - `Collator` (for sorting/searching)
    - etc.

Outline

- What is I18n?
- **`java.lang.Locale`**
- Culture Dependent Content
- Formatting
- Sorting

What is a Locale ?

Where do I get the Locale from ?

- A Locale object contains the country and the language of the host machine. It may specify other characteristics, too, such as a vendor or browser indication.
- The JVM sets up a Locale containing these data which is then called Default Locale.
- You may change the contents of the Locale or preset a new default Locale (for your JVM only!)

```
Locale locale = Locale.getDefault();
```

Internationalization

- How do I use a Locale object?
- By asking it explicitly its country or language

```
Locale locale = Locale.getDefault();
String country = locale.getCountry();
String language = locale.getLanguage();
String variant = locale.getVariant();

// or lists of all known countries or languages
String[] countries = locale.getISOCountries();
String[] languages = locale.getISOLanguages();
```

- By passing the Locale to locale-sensitive objects, e.g. to objects of ResourceBundle, Format, Collator etc.

Exercise: My Locale

Write a small program that displays the Locale in your environment. Find out what is the default Locale in your system.

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Internationalization for Texts/Messages

- **`ResourceBundle`** is a specialized Collection to store locale-dependent information

- It offers two relevant features for internationalization:
  - **`ResourceBundle`** consists of a list of {key, value} pairs of items (values may be texts or any kind of objects)
  - **`ResourceBundle`** allows retrieval of a Locale-specific list; if there is no list exactly matching the Locale, it provides the best-possible fit
  - May be backed by property files for different locales

```
# This is the UITexts_fr properties file
computer = ordinateur
disk = disque dur
monitor = écran
keyboard = clavier
```

Internationalization for Texts/Messages

ResourceBundle = set of classes sharing the same base name:

```
UITexts
UITexts_de
UITexts_en_GB
UITexts_fr_CA_UNIX
```

However you don't need to implement classes. You just provide property files with the same name as the class and the file extension **.property**

Selecting a ResourceBundle is done as follows:

```
Locale current = new Locale("fr", "CA", "UNIX");
ResourceBundle introLabels =
   ResourceBundle.getBundle("UITexts", current);
```

Exercise: ResourceBundle

Run the `ResourceBundleDemo.java` on your machine.

Insert another language in the supported locals and provide a resource bundle for it.

Look up the correct notation on http://www.localeplanet.com/java/.

Internationalization for Texts/Messages

- Texts and objects are requested from a ResourceBundle using `getString()`
- Thus, an application using localized items looks as follows:

```
Locale current = Locale.getDefault();
ResourceBundle uiTexts = ResourceBundle.getBundle("UITexts", current);
//...

// get a text from the resource bundle
statusLine.setText(uiTexts.getString("fileNotFound"));
```

Attention
`MissingResourceExeption`
could be thrown

Internationalization for Texts/Messages

- To avoid **`MissingResourceExeption`** use a private method, e.g.

```
private String getI18nString(String key) {
   try {
     return bundle.getString(key);
   } catch (MissingResourceException e) {
     System.err.println("Missing key " + key + " in " +
            bundle.getBaseBundleName());
     return "! " + key + " !";
   }
 }
```

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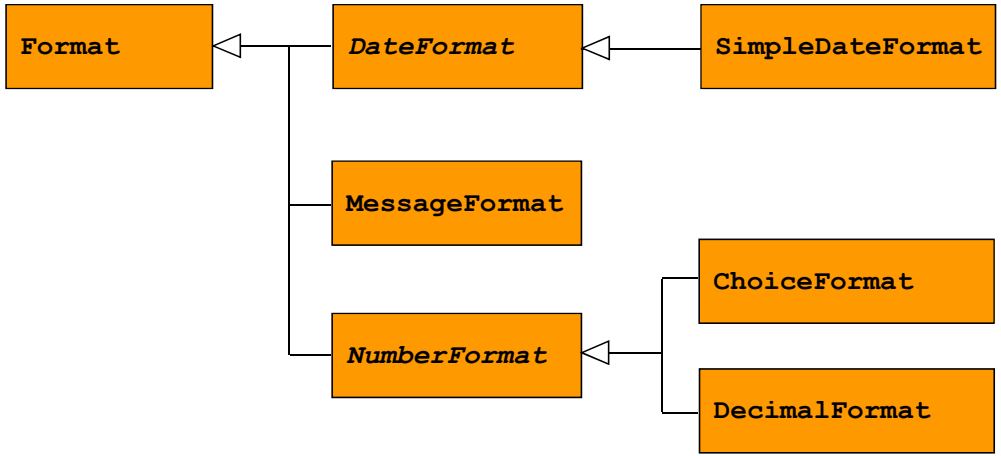
Internationalized Formatting

The `Format` class and its descendants is used to do locale-dependent formatting of texts, dates/times and numbers/currencies

`Format` offers the following subclasses for internationalization:



Internationalized Formatting

- Use the static **`getXXXInstance()`** method of the **`Format`** subclasses to create an instance that can format objects in your program
  - E.g to create a formatter for time.

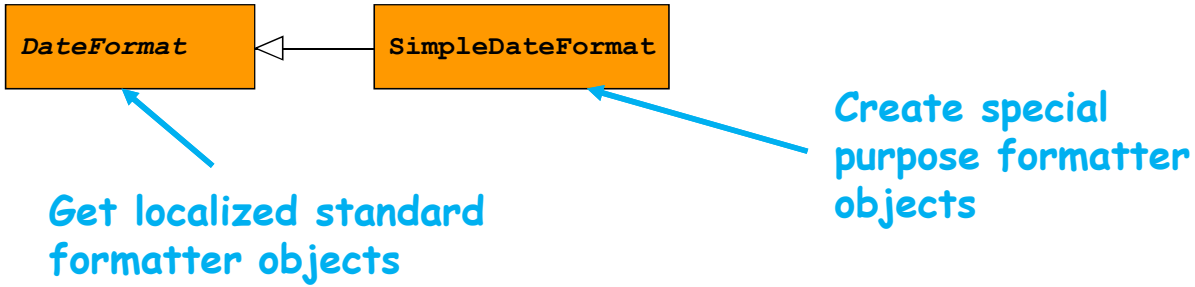
```
DateFormat timeFormatter =
      DateFormat.getTimeInstance(DateFormat.MEDIUM, Locale.GERMAN);
```

- Almost all **`Format`** subclasses offer a

```
Locale[] getAvailableLocales()
```

method returning an array of those Locales which are supported by this class.

Internationalized Date/Time Formatting



- Although `DateFormat` is an abstract class, it has static factory methods to create formatter objects for date, time, date&time and time zone
- The `SimpleDateFormat` class is used when you have to create a specific format which doesn‘t correspond to any of the standard representations

Date/Time Formatting Using Standard Formatters

A standard formatter is created by:

```
DateFormat timeFormatter =  DateFormat.getTimeInstance(int style, Locale aLocale);
```

The specific item to be formatted; may be time, date or both

The formatting style to be used → next slide

The Locale to be used

- ... and used:

```
DateFormat timeFormatter =
    DateFormat.getTimeInstance(DateFormat.MEDIUM, Locale.GERMAN);
String myText = timeFormatter.format(myDate); // or
StringBuffer myTextBuffer =  timeFormatter.format(myDate, buffer,
fieldPosition);
```

Date/Time Formatting Using Standard Formatters

Examples (DateTimeFormatter):

Style	Locale	Format
`SHORT`	France	18/10/04 13:30
	Germany	18.10.04 13:30
	England	18/10/04 13:30
`MEDIUM`	France	18 oct. 2004 13:30:00
	Germany	18.01.2004 13:30:00
	England	18-Oct-2004 13:30:00
`LONG`	France	18 octobre 2004 13:30:00 CET
	Germany	18. Oktober 2004 13:30:00 MEZ
	England	18 October 2004 13:30:00 CET
`FULL`	France	lundi 18 octobre 2004 13 h 30 CET
	Germany	Montag, 18. Oktober 2004 13.30 Uhr MEZ
	England	Monday, 18 October 2004 13:30:00 o'clock CET

Exercise: Date and Time Formatter

Write a program that creates the different date and time formats (SHORT, MEDIUM, LONG, FULL) for at least 3 languages.

Date/Time Formatting Using Standard Formatters

- A standard formatter can also be used for input parsing:

```
DateFormat dateFormatterFull =
    DateFormat.getDateInstance(DateFormat.FULL, Locale.GERMAN);

myDate = dateFormatterFull.parse("Mittwoch, 4. April 2018");
```

Can throw a ParseException

- By default, the formatter also accepts date or time values not adhering to the Locale's representation (*lenient*); this feature may be turned off if required

```
dateFormatterMed.setLenient(false);
```

- See: **`ParseDemo.java`**

Date/Time Formatting Using SimpleDateFormat

The `SimpleDateFormat` class is a parameterizable formatter for special purposes. It is created by specifying a format string when calling its constructor. In the most simple form this is:

```
SimpleDateFormat simpleFormat =
  new SimpleDateFormat(pattern);
```

where the `pattern` specifies the format to be applied, e.g.

Date and Time Pattern	Result
"yyyy.MM.dd G 'at' HH:mm:ss z"	2001.07.04 AD at 12:08:56 PDT
"EEE, MMM d, ''yy"	Wed, Jul 4, '01
"h:mm a"	12:08 PM
"hh 'o''clock' a, zzzz"	12 o'clock PM, Pacific Daylight Time
"K:mm a, z"	0:08 PM, PDT

Date/Time Formatting Using SimpleDateFormat

Sb	Meaning	Pres.	Ex.	Sb	Meaning	Pres.	Ex.
G	Era designator	Text	AD	k	Hour in day (1-24)	Num.	24
y	Year	Year	1996	K	Hour in AM/PM (0-11)	Num.	0
M	Month in year	Month	July	h	Hour in AM/PM (1-12)	Num.	12
w	Week in year	Num.	27	m	Minute in hour	Num.	30
W	Week in month	Num.	2	s	Second in minute	Num.	55
D	Day in year	Num.	189	S	Millisecond	Num.	978
d	Day in month	Num.	10	z	Time zone	General time zone	GMT
F	Day of week in month	Num.	2	Z	Time zone	RFC 822 time zone	-0800
E	Day in week	Text	Friday	'	Escape for text	Delim.	'at'
a	AM/PM marker	Text	PM	''	Single quote	Literal	o''clock
H	Hour in day (0-23)	Num.	0				

Doing Arithmetics with Date/Time

Sometimes you have to do arithmetics with dates or times.
For this you may use the Calendar classes. Java provides the **`GregorianCalendar`** only, but there are many others available as Open Source.

```
Calendar rightNow = Calendar.getInstance();
rightNow.setDate(now);

rightNow.add(Calendar.DAY_OF_MONTH, -5);
```

Further explanations on the Java API documentation

New Date and Time API

- Human Time
  - local date/time: **`LocalDate`**
  - Zoned time: **`ZonedDateTime`**
- Package **`java.time.*`**

- Examples **`LocalDate`**

```
LocalDate today = LocalDate.now();

LocalDate einsteinBirthday = LocalDate.of(1879, Month.MARCH, 14);

LocalDate lastDayinFebruar = einsteinBirthday.minusMonths(1)
     .with(TemporalAdjusters.lastDayOfMonth());

LocalDate programmersDay =  LocalDate.of(2015,1,1).plusDays(256);
```

New Date and Time API

- Examples **`LocalTime`**

```
LocalTime atTen = LocalTime.of(10, 00);

LocalTime tenFifteen = atTen.plusMinutes(15);

LocalTime breakfestTime = tenFifteen.minusHours(2);
```

- **`LocalDateTime`** combines **`LocalDate`** and `LocalTime`

```
LocalDateTime jdk8Release = LocalDateTime.of(2014,3,18,8,30);
```

Formatting new Date and Time

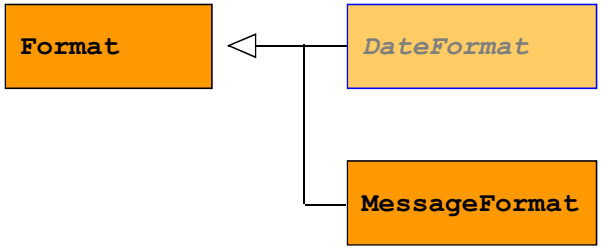

```
Locale currentLocale = new Locale("en","us");
LocalDate date = LocalDate.now();

DateTimeFormatter  formatter =
    DateTimeFormatter.ofLocalizedDate(FormatStyle.FULL).withLocale(currentLocale);
System.out.println(formatter.format(date));
 // or alternatively
System.out.println(date.format(formatter));

LocalTime time = LocalTime.now();
formatter =
DateTimeFormatter.ofLocalizedTime(FormatStyle.MEDIUM).withLocale(currentLocale);
System.out.println(formatter.format(time));

LocalDateTime dateTime = LocalDateTime.now();
formatter = DateTimeFormatter.ofLocalizedDateTime(FormatStyle.LONG,FormatStyle.SHORT)
           .withLocale(currentLocale);
System.out.println(formatter.format(dateTime));
```

Message Formatting



MessageFormat helps you to format complex messages such as

```
At 12:30 PM on Jul 3, 2053, there was a gravitation anomaly on planet 7.
```

MessageFormat is not an abstract class, and it doesn‘t have static factory methods to create formatter objects. Instead, it is parameterized at creation time by the constructor.

`MessageFormat` cannot be given a Locale, i.e. you have to create a class per Locale yourself.

Message Formatting

This message

```
At 12:30 PM on Jul 3, 2053, there was a gravitation anomaly on planet 7.
```

was obtained by

```
String pattern =
  "At {1,time} on {1,date}, there was {2} on planet {0,number,integer}."

Object[] arguments = {
  new Integer(7), new Date(System.currentTimeMillis()), "a gravitation anomaly"
};

String result = MessageFormat.format(pattern, arguments);
```

Also possible to pass as optional parameters

Further explanations on the Java API documentation

Message Formatting

MessageFormat uses patterns of the following form:

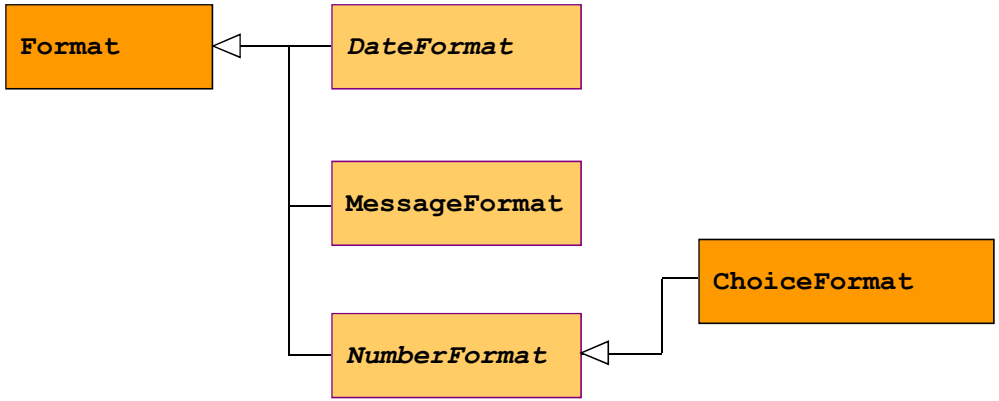
MessageFormatPattern:
    String
    MessageFormatPattern FormatElement String

FormatElement:
    { *ArgumentIndex* }
    { *ArgumentIndex* , *FormatType* }
    { *ArgumentIndex* , *FormatType* , *FormatStyle* }

FormatType: one of
    number date time choice

FormatStyle:
    short medium long full integer currency percent *SubformatPattern*

Advanced Message Formatting using ChoiceFormat



ChoiceFormat helps you to reflect different grammatical forms such as

```
The directory ABCD contains no files.
The directory ABCD contains one file.
The directory ABCD contains 128 files.
```

Message Formatting

`MessageFormat` and `ChoiceFormat` have proven to be very „tricky“ classes!!!
Read the API doc carefully and do in-depth unit testing!

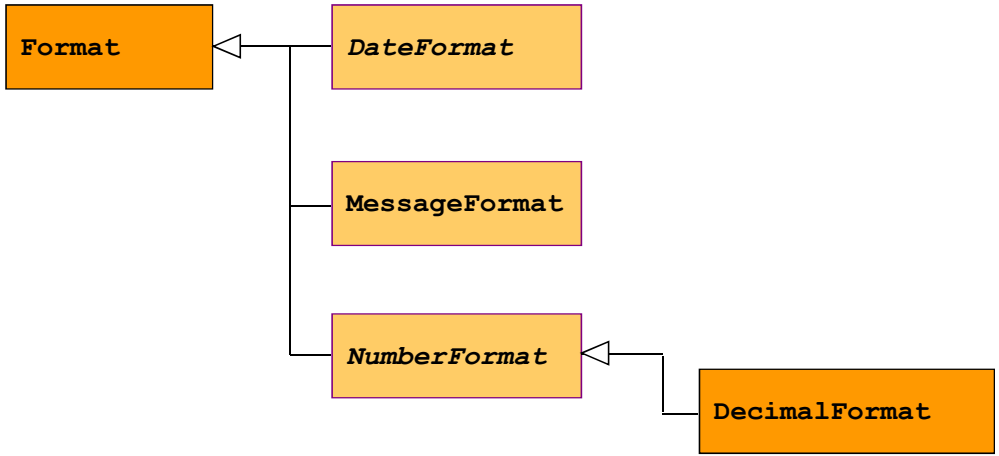
`MessageFormat` and `ChoiceFormat` are not thread-safe!
If you intend to use these objects from different threads, protect them by synchronization!

Especially, `MessageFormat` can be nicely used with Resource Bundles .

Exercise: ChoiceFormat

Analyse the program FormatDemo.java.

Formatting Numbers and Currencies



`DecimalFormat` provides you with conversion functions for numbers and currencies as well as a special representation for percentages.

As with `DateFormat`, actual `DecimalFormat` instances are created using the appropriate factory method of `NumberFormat`, such as `getCurrencyInstance()`, `getNumberInstance()` etc.

Number/Currency Formatting Using NumberFormat

A standard localized formatter is created by:

```
NumberFormat someFormatter = NumberFormat.getNumberInstance(Locale aLocale);
```

The specific item to be formatted;
may be
`getCurrencyInstance(...)`
`getIntegerInstance(...)`
`getNumberInstance(...)`
`getPercentInstance(...)`

The Locale to be used
(or no parameter → using the default Locale)

Number representation is done according to the specific rules of the applicable Locale.
If you need a specific format, use DecimalFormat with an explicit setup!

Number/Currency Formatting Using NumberFormat

A standard formatter can also be used for input parsing:

```
NumberFormat numberFormatter = NumberFormat.getNumberInstance();

Number number = format.parse("1234.5678", new ParsePosition(2));
```

will return Number(34.5678)

By default, the formatter also accepts numbers not adhering to the Locale‘s representation.

Be careful with too large numbers:

- If possible these are returned as `Long` objects – if too large, as a `Double` truncated at the low end.
- If you explicitly use `setParseBigDecimal()`, values will be returned as `BigDecimal` objects.

Exercise: NumberFormat

Analyse the program NumberFormatDemo.java.

Number Formatting Using DecimalFormat

As with `SimpleDateFormat`, `DecimalFormat` is used when special formatting is required.

A formatting pattern is described by the following characters:

char	Meaning
0	Digit; will pad if necessary
#	Digit; zero shows as space
.	Decimal separator
-	Negative prefix (minus)
,	Grouping separator
E	Mantissa-Exponent separator

char	Meaning
;	Pos./Neg. pattern separator
%	*100, shows as percentage
‰	*1000, shows as per mille (\u2030)
¤	Currency sign (\u00A4 or local)
‘	To quote special char. in prefix or suffix (see API descr.)

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Sorting

Sorting is done using a comparator telling which of two elements is first / second in a given ordering scheme.

Sorting of text must take into account the pecularities of the alphabetic sorting for each language.

This is done by a class named `Collator`.

A standard localized collator is created by e.g.:

```
Collator fr_FR_Collator = Collator.getInstance(new Locale("fr", "FR"));

Collator defaultCollator = Collator.getInstance();  // to use the default Locale
```

Sorting

```
abstract class java.text.Collator mplements Comparator<Object>, Cloneable
```

Methods:

- `static Collator getInstance()` Collator for current Locale
- `static Collator getInstance(Locale desiredLocale)` Collator for given Locale.

- `abstract int compare(String source, String target)`
  Compares 2 strings. Return value is <0, 0 or >0.

- `int compare( Object o1, Object o2 )`
  Compares 2 objects. Calls `compare((String)o1, (String)o2)`.

Sorting

Sorting an array of Strings is then done as follows (using a plain BubbleSort algorithm):

```
Collator defaultCollator = Collator.getInstance();
String tmp;
for (int i = 0; i < words.length; i++) {
  for (int j = i + 1; j < words.length; j++) {
    if (defaultCollator.compare(words[i], words[j]) > 0) {
      tmp = words[i];
      words[i] = words[j];
      words[j] = tmp;
    }
  }
}
```

Exercise: Collater

Analyse the program CollatorDemo.java.

Sorting

Of course, you may also use the same comparator as an ordering criterion for an ordered set, such as :

```
Comparator myCollator =
  (Comparator) Collator.getInstance();

TreeSet orderedSet = new TreeSet<String>(myCollator);
```

… which allows you to insert, remove or search your Strings (words/phrases) according to the Locale‘s ordering.