

## Excercise Sheet 5

(To be processed until 23.11.)

## Lecture Distributed Systems Winter Term 2023/24

### Exercise 1: Programming: Factories

The design pattern “Factory” provides for delegating the creation of objects to another object, so that the latter can decide, for example, which concrete implementation of an abstract class is chosen. With Java-RMI one can use the design pattern to realize a remote object creation, which is not possible with `new`.

In the lecture already the example of a bank was mentioned, which can create account objects. It is neither necessary nor useful to register all account objects with the RMI registry. Instead, only the bank object that manages the accounts is registered.

In the archive [u05eFiles.zip](http://www.bs.informatik.uni-siegen.de/web/wismueller/v1/vs/u05eFiles.zip)<sup>1</sup> on the lecture’s web page you will find a code framework for this scenario, which contains, among other things, a client that communicates with the bank server via the following interfaces:

```
public interface Bank extends Remote
{
    Account newAccount(int accountNo) throws RemoteException; // new account
    Account getAccount(int accountNo) throws RemoteException;
    List<Account> getAllAccounts() throws RemoteException;      // all accounts
}
public interface Account extends Remote
{
    int getAccountNo() throws RemoteException;
    void deposit(double amount) throws RemoteException;
    void withdraw(double amount) throws RemoteException;
    String accountStatement() throws RemoteException;          // account number and balance
}
```

Supplement the implementation of the class `BankImpl` and test your program with the given client. The output should be:

```
Konto 123456789: 100000.0
Konto 234567890: 50000.0
Konto 345678901: 1020.0
Konto 123456789: 95000.0
Konto 234567890: 65000.0
Konto 345678901: 1050.0
```

What exactly does the `getAllAccounts()` method return to the client, i.e. what does the server send to the client?

### Exercise 2: Thread safety (Mandatory exercise for 6 CP)

Since Java RMI does not specify how many threads are provided on the server side for method calls, correct synchronization is required. Where and how can this be implemented in the following example?

Interface

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<sup>1</sup><http://www.bs.informatik.uni-siegen.de/web/wismueller/v1/vs/u05eFiles.zip>

```
public interface Number extends Remote {
    public void add(int i) throws RemoteException;
    public int value() throws RemoteException;
}
```

#### Client class

```
public class Client {
    public static void main(String[] args) {
        try {
            Number num = (Number)Naming.lookup(...);
            num.add(10);
            System.out.println(num.value());
            ...
        }
    }
}
```

#### Server Class

```
public class Server extends UnicastRemoteObject implements Number {
    private int number;

    public Number() throws RemoteException {}

    public void add(int i) {
        number = number + i;
    }

    public int value() {
        return(number);
    }
    ...
}
```

### Exercise 3: Programming: Client callback - progress bar (Mandatory exercise for 6 CP)

Client callbacks are remote calls that the server makes to the client. This is often done for user interaction, for example, to indicate the progress of a program. Based on the given code in the archive [u05eFiles.zip](http://www.bs.informatik.uni-siegen.de/web/wismueller/v1/vs/u05eFiles.zip)<sup>2</sup> on the lecture's web page, create a program that triggers a calculation on the server and contains a function `notifyProgress(int percent)` on the client side to output the calculation progress. To do this, simulate a calculation on the server within the method `doComputation(ProgressNotifier pn)` by making the current thread wait 600 milliseconds within a loop from 0 to 100 (you need the class `java.lang.Thread` for this). During the calculation, regularly call the `notifyProgress()` method for the output.

Note that for client callbacks, the client itself must be (or at least contain) a remote object. How does the client behave at its end if you simply inherit your class from `UnicastRemoteObject`? Why?

To solve the problem, you should export the callback object using the method

```
UnicastRemoteObject.exportObject(Remote obj, int port)
```

(where you should set `port = 0`) and at the end call the method

```
UnicastRemoteObject.unexportObject(Remote obj, boolean force)
```

(see Java documentation).

### Exercise 4: Name services

The most important operation that a naming service supports is the resolution of names, that is, searching for units by a given name. Discuss the following questions on this topic.

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<sup>2</sup><http://www.bs.informatik.uni-siegen.de/web/wismueller/v1/vs/u05eFiles.zip>

- a) Name an example where an address of a unit E must be further resolved to another address to actually be able to access E.
- b) Give examples of real IDs (general).
- c) Would you regard a URL such as `http://www.acme.org/index.html` as position independent? What about the URL `http://www.acme.nl/index.html`?
- d) Discuss the problems that arise from the use of aliases in a naming service and show whether and how these can be solved.

## Exercise 5: Name services

For reasons of scalability, naming services are usually organized hierarchically. Explain the basic functionality of such a hierarchical service. How do iterative and recursive name resolution differ?

## Exercise 6: Programmierung: JNDI

In the lecture two examples of JNDI were given, first the access to the RMI registry and the access to the local file system.

- a) What exactly is JNDI and what is it used for?
- b) Familiarize yourself with the basic use of JNDI. Change your HelloWorld program from the last exercises so that you can access the RMI registry using JNDI.
- c) Also implement and run the second example (“Local File System Access”) from chapter 4.2 of the lecture. Please refer to the jar files provided for download in the archive [u05eFiles.zip](http://www.bs.informatik.uni-siegen.de/web/wismueller/v1/vs/u05eFiles.zip)<sup>3</sup> on the lecture’s web page and to [this JNDI Tutorial](#) for help.

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<sup>3</sup><http://www.bs.informatik.uni-siegen.de/web/wismueller/v1/vs/u05eFiles.zip>