Java RMI Tutorial

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Java RMI Concept

A way to invoke methods from a different address space, typically remotely but also locally.
Example

Local Machine (client)

RemoteObject remoteobject;
int sum;

sum = remoteobject.add(1,2);

System.out.println(sum);

Remote Machine (server)

RemoteObject remoteobject;

Public int add(int a, int b){
    return a+b;
}

1, 2

3
Java RMI Architecture

Basic components

- **Client**
  - Invokes a remote method on a remote object
- **Server**
  - Owns the remote objects and implements the remote methods
- **Registry**
  - Relates remote objects with names in plaintext
Java RMI in the TCP/IP Stack

- Middleware between transport and application layer
- Seamless to the programmer (remote object is handled as local object)
- Runs over TCP (reliable communication)

- **Stub**
  - Pretends to be the remote object

- **Skeleton**
  - Handles requests from stub / Talks to real remote object
Key Programming Elements

Classes, Interfaces & Methods

- `java.rmi.Remote`
  - Needs to be extended by the classes that contain RMI methods

- `java.rmi.registry.Registry`
  - Associates a name to a remote object
  - Key methods:
    - `bind(string, Remote)`
    - `lookup(string)`

- Static Methods
  - `LocateRegistry.getRegistry([string],[int])`
    - Static method to get the registry
  - `UnicastRemoteObject.exportObject(Remote,[int])`
    - Exports the remote object to JRE to receive remote calls

More in the java docs under the “java.rmi.*” packages!
Developing an Java RMI System

Implement
• Step 1: Define the interface of the remote object
• Step 2: Implement the server including the remote object
• Step 3: Implement the client

Compile
• Step 4: Compile source files normally

Run
• Step 5: Run rmiregistry
• Step 6: Run server
• Step 7: Run client
Step 1: Remote Object Interface

```java
import java.rmi.Remote;
import java.rmi.RemoteException;

public interface Hello extends Remote {
    String sayHello() throws RemoteException;
}
```

- It defines the remote object and the input/output of the remote methods
- It needs to extend “java.rmi.Remote” class
Step 2: Implement the Server (pt.1)

public class Server implements Hello {

    public Server() {}    
    public String sayHello() {
        return "Hello, world!";    
    }
    public static void main(String args[]) {...

}

• The Server needs to implement the methods defined in the interface
Step 2: Implement the Server (pt.2)

import java.rmi.server.UnicastRemoteObject;
...
public static void main(String args[]) {
    ...
    Server obj = new Server();
    Hello stub = (Hello) UnicastRemoteObject.exportObject(obj, 0);
    ...
}

- The remote object must be exported to the Java RMI runtime so that it may receive incoming remote calls
- Method exportObject takes care of the Server socket
- Second argument defines the port number (optional)
  - 0 for letting the OS choose the port
Step 2: Implement the Server (pt.3)

```java
import java.rmi.registry.Registry;
import java.rmi.registry.LocateRegistry;
...
public static void main(String args[]) {
    ...
    Registry registry = LocateRegistry.getRegistry();
    registry.bind("Hello", stub);
    ...
}
```

- Locate and get the name registry
  - Registry by default operates on port 1099
  - Unless another ip/port is specified in the arguments of `getRegistry`, it looks for the registry on `localhost (127.0.0.1)` in the default port (1099)
- Method `bind` registers the remote object (`stub`) with a name in plaintext
Step 3: Implement the Client

```java
import java.rmi.registry.Registry;
import java.rmi.registry.LocateRegistry;
...

public static void main(String args[]) {
    ...
    Registry registry = LocateRegistry.getRegistry(host);
    Hello stub = (Hello) registry.lookup("Hello");
    String response = stub.sayHello();
    ...
}
```

- Locate and get the name registry
- Retrieve the remote object using its plaintext name (method `lookup`)
- Invoke the remote methods
Steps 4-7: Compile and Run

- Compile normally
  > javac Hello.java Server.java Client.java

- Run registry
  > rmiregistry [runs on default port 1099]
  > rmiregistry 2001 [runs on chosen port, 2001]

- Run server
  > java -Djava.rmi.server.codebase=[url]/ Server

- Run client
  > java -Djava.rmi.server.codebase=[url]/ Client

The `java.rmi.server.codebase` property specifies the location, a codebase URL, from which the definitions for classes originating from this server can be downloaded.

If the classes are in the local file system use the file URL scheme (e.g. file:/%CD%/ for Windows).
References

Example is based on “Getting Started Using Java™ RMI” by Oracle

http://docs.oracle.com/javase/6/docs/technotes/guides/rmi/hello/hello-world.html
Exercise

The German mathematician Gottfried Leibniz developed the following method to approximate the value of $\pi$:

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \ldots$$

Write a Java RMI program that allows the user to specify the number of iterations used in this approximation, invokes a remote method in a RMI server that executes the algorithm, and displays the received value.