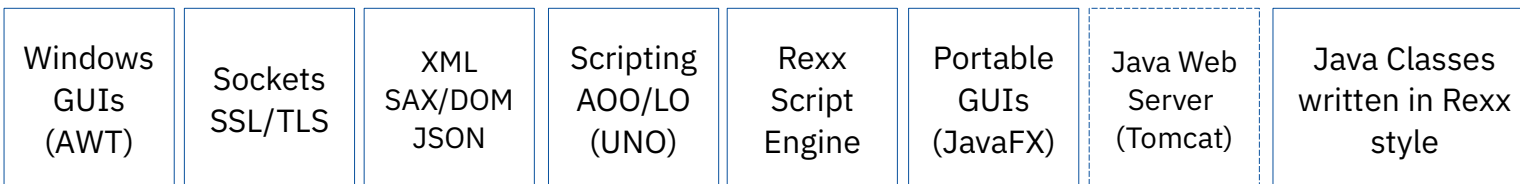
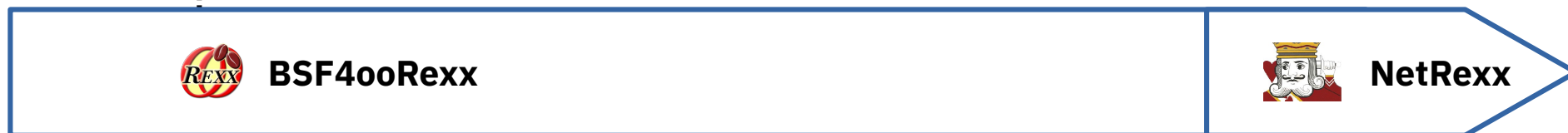


BSF4ooRexx

The Bean Scripting Framework for ooRexx

Business Programming 2



- Programming language with the following notable features
 - Compiles to machine instructions ("bytecode") of an *artificial processor*
 - Needs a "Java virtual machine (JVM)" to execute the bytecodes
 - JVMs are available for all important operating systems and hardware architectures
 - *Hence, a Java class or a Java program, once compiled can be run everywhere!*
 - Distributed with a (huge) "Java runtime environment (JRE)"
 - *A huge Java class library* that offers everything that an application may possibly need
 - E.g. Socket classes for Internet programming, GUI classes for graphical user interfaces, ...
 - Uncountable third party Java class libraries, most available as open-source (e.g. ASF)
 - Most important programs get programmed with Java (even Android applications!)
 - Many professional applications that are not programmed in Java offer Java APIs
 - E.g. SAP, OpenOffice/LibreOffice, ...
- Hence Java is truly a programmer's "treasure trove" for all operating systems!

- External Rexx function package
 - Allows to interact with the Java runtime environment (JRE)
 - Exploit functionality of Java classes
 - Exploit functionality of Java objects
 - ooRexx 5.0 and later
 - Package "BSF.CLS"
 - Camouflages Java as ooRexx
 - Supplies class BSF and public routines
- "Everything that is available in Java becomes directly available to ooRexx !"
 - Java: "write once, run everywhere!"
 - Windows, MacOS, Linux, ...

BSF4ooRexx: An Example



```
dim=.bsf~new("java.awt.Dimension", 100, 200)  
say dim~toString
```

```
::requires BSF.CLS      -- get Java support
```

Output:

```
java.awt.Dimension[width=100,height=200]
```

Downloading Java (Usually Free and Open-source)



- JRE versus JDK
 - JRE: "Java Runtime Environment", no compiler
 - JDK: "Java Development Kit", compiler & tools
- Java/JDK 8 LTS ("long term support")
 - Released spring 2014, supported until 2030 (Oracle, Azul)
- Java/JDK 17 LTS ("long term support", "modular Java")
 - Released fall 2021, supported at least until 2029 (Oracle, Azul)
- Suggestion: download OpenJDK *with JavaFX* support, e.g.
 - **Full JDK:** <<https://bell-sw.com/pages/downloads/>> ("Liberica", 2023-08-27)
 - **JDK FX:** <<https://www.azul.com/downloads/>> (2023-08-27)



Things to Know About Java, 1



- Strictly typed language
 - Primitive types
 - `boolean`, `byte`, `char`, `short`, `int`, `long`, `float`, `double`
 - Object-oriented types
 - Any Java class, e.g.
 - `java.awt.Dimension`, `java.lang.String`, `java.lang.System`, ...
 - Wrapper classes for primitive types
 - `java.lang.Boolean`, `java.lang.Byte`, `java.lang.Character`,
`java.lang.Short`, `java.lang.Integer`, `java.lang.Long`,
`java.lang.Float`, `java.lang.Double`
 - "boxing": wraps up a primitive value into a wrapper object
 - "unboxing": retrieves a primitive value from its wrapper object

Things to Know About Java, 2



- Case sensitive
 - Upper- and lowercase significant!
- Classes organized in packages
 - Package names may be compound
 - E.g. "java.lang"
 - Fully "qualified class name" includes package name
 - e.g. "java.lang.String"
 - "Unqualified class name"
 - e.g. "String"



Things to Know About Java, 3



- A Java class may consist of
 - Fields (comparable to ooRexx attributes) and
 - Methods (comparable to ooRexx methods)
- Fields and methods
 - Static fields and static methods
 - Sometimes dubbed "class fields" and "class methods"
 - Available to the class object and its instances
 - Otherwise "instance methods"
 - Only available to instances of a Java class



Things to Know About Java, 4



- A Java class, its fields and methods may be
 - "public"
 - These can be accessed by the "world" (everyone)
 - "private"
 - Only accessible within the Java class
 - "protected"
 - Only accessible within Java classes of the same package and subclasses
 - None of the above modifiers given ("package private")
 - Only accessible within Java classes of the same package, but to noone else



Things to Know About Java, 5



- Excellent documentation ("JavaDoc")
 - Extensive set of interlinked HTML documents
 - Created right from the comments in Java sources
 - Can be studied on the Internet, search e.g. with

```
javadoc 8 java.awt.Dimension
javadoc 8 Dimension
javadoc 17 java.awt.Dimension
javadoc 17 Dimension
```
- Documentation can be downloaded to local computer, e.g.
 - Java/JDK 8LTS ("long term support"):
 - <<https://www.oracle.com/java/technologies/javase-jdk8-doc-downloads.html>> (2023-08-27)
 - Java/JDK 17LTS ("long term support"):
 - <<https://www.oracle.com/java/technologies/javase-jdk17-doc-downloads.html>> (2023-08-27)



A Javadoc Example (JDK8LTS)



Class `XYZType`

`java.lang.Object`
`XYZType`

```
public class XYZType
    extends java.lang.Object
```

Field Summary

Fields

Modifier and Type	Field and Description
<code>static int</code>	<code>counter</code>

Constructor Summary

Constructors

Constructor and Description
<code>XYZType()</code>
<code>XYZType(java.lang.String initialValue)</code>

Method Summary

All Methods Instance Methods Concrete Methods

Modifier and Type	Method and Description
<code>java.lang.String</code>	<code>getInfo()</code>
<code>void</code>	<code>setInfo(java.lang.String aValue)</code>

BSF.CLS: Camouflages Java as ooRexx



- ooRexx class "**BSF**"
 - Allows to create Java objects
 - Needs at least fully qualified Java class name
- Invoking Java methods
 - Just send the name of the method to the Java object
 - Supply the arguments as documented, if any
 - Type conversions between ooRexx and Java are done automatically by BSF4ooRexx, if necessary
 - Return values are automatically converted by BSF4ooRexx, if necessary

BSF4ooRexx: Java Class "XYZType", 1



```
o=.BSF~new("XYZType")

say "o~getInfo:" o~getInfo

o~setInfo("Hello, from ooRexx...")
say "o~getInfo:" o~getInfo

::requires BSF.CLS  -- get Java support
```

Output without “XYZType.class” available:

```
Error 40.900: BSF4ooRexx/routine/BSF(), error 3: Java exception occurred:
[org.apache.bsf.BSFException: BSF4ooRexx subfunction "new": while attempting to load class
'XYZType', threw: [org.apache.bsf.BSFException: BSF4ooRexx subfunction "new": while attempting to
load class 'XYZType', threw exception: [java.lang.ClassNotFoundException: XYZType]]].]
```

Output with “XYZType.class” available:

```
o~getInfo: The NIL object
o~getInfo: Hello, from ooRexx...
```

XYZType.java



- “XYZType.java” (Source Code)

```
/* This is the most important class of all!  
 * Even if one does not believe this, this is so! ;)   
 * &Ouml;sterreich, Wien.  
 */  
  
public class XYZType // example class for demonstrating BSF4Rexx  
{  
    // constructors of this class (same name as class!)  
    public XYZType () { // constructor without arguments  
        counter=counter+1; // increase counter  
    }  
  
    public XYZType (String initialValue) { // constructor with argument  
        this(); // invoke constructor above (no argument)  
        info=initialValue; // save initial value  
    }  
  
    // keyword "static": class fields (attributes) and class methods  
    static public int counter=0; // field: will count # of instances  
  
    // instance fields (attributes) and instance methods  
    private String info = null; // field: no initial value per default  
  
    public String getInfo () { // accessor (getter) method (function)  
        return info; // return whatever "info" points to  
    }  
  
    public void setInfo (String aValue) { // setter method (function)  
        info=aValue; // save received value with "info"  
    }  
}
```

Compile Java source file with the Java compiler "javac" into "byte code":

```
javac XYZType.java
```

creates: **XYZType.class**

Create Java documentation with the utility "javadoc", place resulting files into the directory named docs:

```
javadoc -d docs XYZType.java
```

load documentation from: docs\index.html



BSF.CLS: Camouflages Java as ooRexx



- ooRexx class "**BSF**"
 - Allows to create Java objects
 - Needs at least fully qualified Java class name
- Possible arguments for creating Java objects
 - Can be found by studying the "Constructor" section in the Javadocs
 - Supply the arguments as documented after the fully qualified Java class name argument
 - Type conversions between ooRexx and Java are done automatically by BSF4ooRexx, if necessary

BSF4ooRexx: Java Class "XyzType", 2



```
o=.BSF~new("XyzType", "This value was supplied at Java object creation.")  
  
say "o~getInfo:" o~getInfo  
  
o~setInfo("Hello, from ooRexx...")  
say "o~getInfo:" o~getInfo  
  
::requires BSF.CLS  -- get Java support
```

Output:

```
o~getInfo: This value was supplied at Java object creation.  
o~getInfo: Hello, from ooRexx...
```


BSF.CLS: Camouflages Java as ooRexx



- Allows to import any Java class
 - **bsf.import(JavaClassName)**
 - Java class name
 - Use of the exact case is mandatory !
 - Java class name must be fully qualified !
- Imported Java class can be treated as if it were an ooRexx class
 - Allows to use the ooRexx "**new**"-method to create instances of the imported Java class
 - Possible arguments for creating Java objects can be found by studying the "Constructor" section in the Javadocs

BSF4ooRexx: Java Class "XyzType", 3



```
clz=BSF.import("XyzType")
o=clz~new("This value was supplied at Java object creation.")

say "o~getInfo:" o~getInfo

o~setInfo("Hello, from ooRexx...")
say "o~getInfo:" o~getInfo

::requires BSF.CLS -- get Java support
```

Output:

```
o~getInfo: This value was supplied at Java object creation.
o~getInfo: Hello, from ooRexx...
```

BSF.CLS: Camouflages Java as ooRexx



- Accessing, setting Java fields
 - ooRexx treats public fields as ooRexx attributes
 - Java "get" and "set" pattern methods for Java fields honored by BSF4ooRexx
 - Just use the field name following "get" and "set" only
 - Static fields can be accessed via the
 - Java class object or
 - Any of its instances



BSF4ooRexx: Java Class "XyzType", 4



```
clz=BSF.import("XyzType")
say "clz~counter:" clz~counter

o=clz~new("This value was supplied at Java object creation.")
say "clz~counter:" clz~counter
say "o ~counter:" o ~counter

say "o~getInfo:" o~getInfo

o~setInfo("Hello, from ooRexx...")
say "o~getInfo:" o~getInfo

clz~~new~~new~~new
say "clz~counter:" clz~counter "/" "o~counter:" o ~counter

::requires BSF.CLS -- get Java support
```

Output:

```
clz~counter: 0
clz~counter: 1
o ~counter: 1
o~getInfo: This value was supplied at Java object creation.
o~getInfo: Hello, from ooRexx...
clz~counter: 4 / o~counter: 4
```

BSF4ooRexx: Java Class "XyzType", 5



```
clz=BSF.import("XyzType")
say "clz~counter:" clz~counter

o=clz~new("This value was supplied at Java object creation.")
say "clz~counter:" clz~counter
say "o ~counter:" o ~counter

say "o~getInfo:" o~getInfo

o~info="Hello, from ooRexx..."
say "o~info:" o~info

clz~~new~~new~~new
say "clz~counter:" clz~counter "/" "o~counter:" o ~counter

::requires BSF.CLS -- get Java support
```

Output:

```
clz~counter: 0
clz~counter: 1
o ~counter: 1
o~getInfo: This value was supplied at Java object creation.
o~info: Hello, from ooRexx...
clz~counter: 4 / o~counter: 4
```

- About respecting case
 - Case of fully qualified Java class name
 - Always significant!
- Case of fields and method names insignificant!
 - Eases coding enormously

BSF4ooRexx: Java Class "XyzType", 6



```
clz=BSF.import("XyzType")
say "clz~COUNTER:" clz~COUNTER

o=clz~new("This value was supplied at Java object creation.")
say "clz~Counter:" clz~Counter
say "o ~cOUNTER:" o ~cOUNTER

say "o~getinfo:" o~getinfo

o~info="Hello, from ooRexx..."
say "o~iNf0:" o~iNf0

clz~~new~~new~~new
say "clz~Counter:" clz~Counter "/" "o~cOUNTER:" o ~cOUNTER

::requires BSF.CLS -- get Java support
```

Output:

```
clz~COUNTER: 0
clz~Counter: 1
o ~cOUNTER: 1
o~getinfo: This value was supplied at Java object creation.
o~iNf0: Hello, from ooRexx...
clz~Counter: 4 / o~cOUNTER: 4
```



BSF.CLS: Creating Java Arrays, 1



- Java arrays
 - Strictly typed
 - Fixed capacity
 - Indices start with value "0"
- Public routine "**bsf.createJavaArray(...)**"
 - Arguments
 - First argument gives the Java type
 - Fully qualified Java class name or Java class object
 - Each further argument is an integer value, denoting the maximum elements in that dimension



BSF.CLS: Creating Java Arrays, 2



- Public routine "**bsf.createJavaArray(...)**"
 - Resulting Java array can be used as if it was an ooRexx array object!
 - Indices start at "**1**" as with ooRexx arrays!
 - Possesses the fundamental *ooRexx array methods* like "**AT**", "**[]**", "**PUT**", "**[]=**", "**supplier**", and "**makeArray**"
 - Can be therefore used in ooRexx "**DO ... OVER**" and "**DO WITH ... OVER**" loops



BSF.CLS: Creating a Java Array



```
-- create a two-dimensional (5x10) Java Array of type String
arr=.bsf~bsf.createJavaArray("java.lang.String", 5, 10)

arr[1,1]="First Element in Java array."      -- place an element
arr~put("Last Element in Java array.", 5, 10) -- place another one

do o over arr      -- loop over elements in array (makearray)
  say o
end
say

do with index i item o over arr -- loop over elements in array (supplier)
  say i":" o
end

::requires BSF.CLS -- loads Java support
```

Output:

```
First Element in Java array.
Last Element in Java array.

1,1: First Element in Java array.
5,10: Last Element in Java array.
```



BSF4ooRexx: BSFCreateRexxProxy, 1



- **RexxProxy**
 - A *Java object* that proxies an ooRexx object
 - Allows Java to send messages to ooRexx objects
 - Any method invocations on the Java object will be forwarded as an ooRexx message to the proxied ooRexx object
 - All arguments supplied to the Java method are forwarded in the same sequence with the ooRexx message
 - BSF4ooRexx always appends an additional argument, "**slotDir**" (an ooRexx directory object) to the ooRexx message, which will contain information about the Java method invocation



BSF4ooRexx: BSFCreateRexxProxy, 2



- RexxProxy
 - **BSFCreateRexxProxy(rexxObj [, userData])**
 - Creates and returns a Java object that proxies "**rexxObj**"
 - If "**userData**" (any Rexx object) supplied, then it will be added to the "**slotDir**" directory
 - **BSFCreateRexxProxy(rexxObj [, [userData], jiClz[, ...]])**
 - "**jiClz**" can be one or more Java interface classes the returned RexxProxy can be used for!
 - **BSFCreateRexxProxy(rexxObj [, [userData], jaClz[, arg[,...]])**
 - "**jaClz**" is an abstract Java class, "**arg**" can be one or more arguments for creating an instance of it

BSF4ooRexx: RexxProxy, 1



```
rexXobj=.myClass~new
rexXobj~hello
say "---"
rp=BSFCreateRexxProxy(rexXobj)  -- create a Java RexxProxy object
rp~sendMessage("hello")      -- send via Java

::requires BSF.CLS  -- get Java support

::class myClass
::method hello
  say "hello from" pp(self)
```

Output:

```
hello from [a MYCLASS]
---
hello from [a MYCLASS]
```

BSF4ooRexx: RexxProxy, 2



```
rexObj=.myClass~new
rexObj~hello
say "---"
userData="This is some Rexx string."      -- sent only if invoked via Java
rp=BSFCreateRexxProxy(rexObj,userData)    -- create a Java RexxProxy object
rp~sendMessage("hello")                  -- send via Java

::requires BSF.CLS      -- get Java support

::class myClass
::method hello
  use arg slotDir      -- available only, if called from Java
  if slotDir~isA(.directory) then
    say "hello from" pp(self) "userData:" pp(slotDir~userData)
  else
    say "hello from" pp(self)
```

Output:

```
hello from [a MYCLASS]
---
hello from [a MYCLASS] userData: [This is some Rexx string.]
```

BSF4ooRexx: Roundup, 1/2



- External Rexx function package
 - BSF4ooRexx version [850](#) needs at least Java [8](#) or later, and ooRexx [5.0](#) or later
 - Allows interacting with Java classes and objects
- **"BSF.CLS"**
 - Camouflages Java as ooRexx
 - Allows easy creation of Java objects
 - Java class name *must be fully qualified and in exact case*
 - Allows sending ooRexx messages to Java objects
 - No strict casing, no strict typing necessary!



BSF4ooRexx: Roundup, 2/2



- BSFCreateRexxProxy()
 - Wraps up an ooRexx object in a Java object
 - Allows to send messages to ooRexx from Java
 - Very powerful if used with Java interface classes or Java abstract classes
 - Java abstract methods can be implemented in ooRexx!

- Please note
 - The following slides explain a built-in mechanism to BSF4ooRexx that you will probably never need to use
 - However, should you ever run into a situation where case or type becomes important for BSF4ooRexx to work, then the following slides will help you solve such a challenge easily

Addendum: Extremely Rare Cases, 1



- Possible (extremely!) rare case problem
 - Possible that a Java class has different fields and methods with the same name, but with different cases
 - For Java these are different fields and methods
 - BSF4ooRexx does not distinguish by default
- Possible (extremely!) rare type problem
 - Possible that a Java class has different methods with the same name and type-convertible primitive arguments, but with different behaviour
 - Solution: use the public routine **box("typeIndicator",value)** from the **BSF.CLS** package



Addendum: Extremely Rare Cases, 2



- To solve such rare problems
 - Wrap up primitive types using the public routine
 - `box("typeIndicator",value)`
- "Type indicators" are Rexx strings
 - Indicate primitive types must be used
 - "BOolean", "BYte", "CCharacter", "SHort", "Integer", "Long", "Float", "Double"
 - Special type indicators
 - "STring", turn into a Java string
 - "Object", value is a non-primitive value (only used for methods, see next slide)



Addendum: Extremely Rare Cases, 3



- To solve such rare problems the following methods are available for Java objects
 - Field related
 - **bsf.getFieldValueStrict(exactName)**
 - **bsf.setFieldValueStrict(exactName, [typeIndicator,] newValue)**
 - Method related
 - **bsf.invokeStrict(exactMethodName [, typeIndicator, argument]...)**
 - "**typeIndicator**" precedes each argument
 - Constructor related
 - If Java class was imported using `bsf.import(...)`, then
 - in addition to "**new**" the method "**newStrict**" is available, which expects each argument to be preceded by a "**typeIndicator**"



Addendum: Using "strict" BSF-methods



```
clz=BSF.import("XyzType")
say "clz~counter (strict):" clz~bsf.getFieldValueStrict("counter")

o=clz~newStrict("String", "This value was supplied at Java object creation.")
say "clz~counter (strict):" clz~bsf.getFieldValueStrict("counter")
say "o ~counter (strict):" o ~bsf.getFieldValueStrict("counter")

say "o~getInfo (strict):" o~bsf.invokeStrict("getInfo")

o~bsf.invokeStrict("setInfo", "String", "Hello, from ooRexx...")
say "o~getInfo (strict):" o~bsf.invokeStrict("getInfo")

clz~~newStrict~~new~~newStrict
say "clz~counter (strict):" clz~bsf.getFieldValueStrict("counter")
say "o~counter (strict):" o ~bsf.getFieldValueStrict("counter")

::requires BSF.CLS -- get Java support
```

Output:

```
clz~counter (strict): 0
clz~counter (strict): 1
o ~counter (strict): 1
o~getInfo (strict): This value was supplied at Java object creation.
o~getInfo (strict): Hello, from ooRexx...
clz~counter (strict): 4
o~counter (strict): 4
```