NetRexx Programming Guide

RexxLA

Version 3.01 of April 17, 2012

THE REXX LANGUAGE ASSOCIATION
NetRexx Programming Series
ISBN 978-90-819090-0-6

Publication Data

The responsible publisher of this edition is identified as *IBizz IT Services and Consultancy*, Amsteldijk 14, 1074 HR Amsterdam, a registered company governed by the laws of the Kingdom of The Netherlands.

This edition is registered under ISBN 978-90-819090-0-6

Contents

The NetRexx Programming Series

This book is part of a library, the *NetRexx Programming Series*, documenting the NetRexx programming language and its use and applications. This section lists the other publications in this series, and their roles. These books can be ordered in convenient hardcopy and electronic formats from the Rexx Language Association.

Quick Beginnings Guide	This guide is meant for an audience that has done some programming and wants a quick start. It starts with a quick tour of the language, and a section on installing the NetRexx translator and how to run the reference implementation. It also contains help for troubleshooting if anything in the installation does not work as designed., and states current limits and restrictions of the open source reference implementation.
Programming Guide	The Programming Guide is the one manual that at the same time teaches programming, shows lots of examples as they occur in the real world, and explains about the internals of the translator and how to interface with it.
Language Reference	Referred to as the NRL, this is the formal definition for the language, documenting its syntax and semantics, and prescribing minimal functionality for language implementors. It is the definitive answer to any question on the language, and as such, is subject to approval of the NetRexx Architecture Review Board on any release of the language (including its NRL).
NJPipes Reference	The Data Flow oriented companion to NetRexx, with its CMS Pipes compatible syntax, is documented in this manual. It discusses installing and running Pipes for NetRexx, and has ample examples of defining your own stages in NetRexx.

Typographical conventions

In general, the following conventions have been observed in the NetRexx publications:

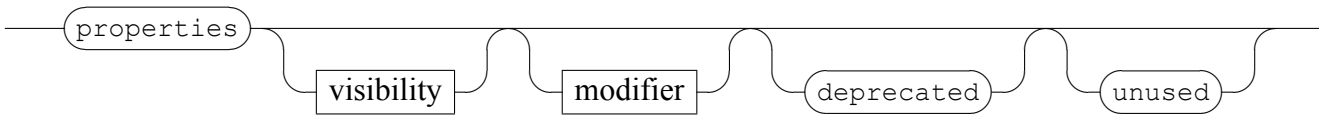
- Body text is in this font
- Examples of language statements are in a **bold** type
- Variables or strings as mentioned in source code, or things that appear on the console, are in a `typewriter` type
- Items that are introduced, or emphasized, are in an *italic* type
- Included program fragments are listed in this fashion:

Listing 1: Example Listing

```
-- salute the reader
say 'hello reader'
```

- Syntax diagrams take the form of so-called *Railroad Diagrams* to convey structure, mandatory and optional items

  Properties



Introduction

The Programming Guide is the book that has the broadest scope of the publications in the *NetRexx Programming Series*. Where the *Language Reference* and the *Quick Beginnings* need to be limited to a formal description and definition of the NetRexx language for the former, and a Quick Tour and Installation instructions for the latter, this book has no such limitations. It teaches programming, discusses computer language history and comparative linguistics, and shows many examples on how to make NetRexx work with diverse techologies as TCP/IP, Relational Database Management Systems, Messaging and Queuing (MQ™) systems, J2EE Containers as JBOSS™ and IBM WebSphere Application Server™, discusses various rich- and thin client Graphical User Interface Options, and discusses ways to use NetRexx on various operating platforms. For many people, the best way to learn is from examples instead of from specifications. For this reason this book is rich in example code, all of which is part of the NetRexx distribution, and tested and maintained. This has had its effect on the volume of this book, which means that unlike the other publications in the series, it is probably not a good idea to print it out in its entirety; its size will relegate it to being used electronically.

Acknowledgements

As this book is a compendium of decades of Rexx and NetRexx knowledge, it stands upon the shoulders of many of its predecessors, many of which are not available in print anymore in their original form, or will never be upgraded or actualized; we are indebted to many anonymous (because unacknowledged in the original publications) authors of IBM product documentation, and many others that we do know, and will thank in the following. If anyone knows of a name not mentioned here that should be, please be in touch.

A big IOU goes out to Alan Sampson, who singlehandedly contributed more then one hundred NetRexx programming examples. The Redbook authors (Peter Heuchert, Frederik Haesbrouck, Norio Furukawa, Ueli Wahli) have provided an important document that has shown, in an early stage, how almost everything on the JVM is easier done in NetRexx. Kermit Kiser also provided examples and did maintenance on the translator. If anyone feels their copyright is violated, please do let us know, so we can take out offending passages or modify them beyond recognition. As the usage of all material in this publication is quoted for educational use, and consists of short fragments, a fair use clause will apply in most jurisdictions.

1

Meet the Rexx Family

1.1 Once upon a Virtual Machine

On the 22nd of March 1979, to be precise, Mike Cowlishaw of IBM had a vision of an easier to use command processor for VM, and wrote down a specification over the following days. VM™ (now called z/VM) is the original Virtual Machine operating system, stemming from an era in which time sharing was acknowledged to be the wave of the future and when systems as CTSS (on the IBM 704) and TSS (on the IBM 360 Family of computers) were early timesharing systems, that offered the user an illusion of having a large machine for their exclusive use, but fell short of virtualising the entire hardware. The CP/CMS system changed this; CP virtualised the hardware completely and CMS was the OS running on CP. CMS knew a succession of command interpreters, called EXEC, EXEC2 and Rexx™ (originally REX - until IBM Legal interfered) - the EXEC roots are the explanation why some people refer to an NetRexx program as an "exec". As a prime example of a *backronym*, Rexx stands for "Restructured Extended Executor". It can be defended that Rexx came to be as a reaction on EXEC2, but it must be noted that both command interpreters shipped around the same time. From 1988 on Rexx was available on MVS/TSO and other systems, like DOS, Amiga and various Unix systems. Rexx was branded the official SAA procedures language and was implemented on all IBM's Operating Systems; most people got to know Rexx on OS/2. In the late eighties the Object-Oriented successor of Rexx, Object Rexx, was designed by Simon Nash and his colleagues in the IBM Winchester laboratory. Rexx was thereafter known as Classic Rexx. Several open source versions of Classic Rexx were made over the years, of which Regina is a good example.

1.2 Once upon another Virtual Machine

In 1995 Mike Cowlishaw ported Java™ to OS/2™ and soon after started with an experiment to run Rexx on the JVM™. With Rexx generally considered the first of the general purpose scripting languages, NetRexx ™ is the first alternative language for the JVM. The 0.50 release, from April 1996, contained the NetRexx runtime classes and a translator written in Rexx but tokenized and turned into an OS/2 executable. The 1.00 release came available in January 1997 and contained a translator bootstrapped to NetRexx . The Rexx string type that can also handle unlimited precision numerics is called Rexx in Java and NetRexx . Where Classic Rexx was positioned as a system *glue* language and application macro language, NetRexx is seen as the one language that does it all,

delivering system level programs or large applications.

Release 2.00 became available in August 2000 and was a major upgrade, in which interpreted execution was added. Until that release, NetRexx only knew *ahead of time* compilation (AOT).

Mike Cowlishaw left IBM in March 2010. IBM announced the transfer of NetRexx source code to the Rexx Language Association (RexxLA) on June 8, 2011, 14 years after the v1.0 release.

On June 8th, 2011, IBM released the NetRexx source code to RexxLA under the ICU open source license. RexxLA shortly after released this as NetRexx 3.00 and has followed with updates.

1.3 Features of NetRexx

Ease of use The NetRexx language is easy to read and write because many instructions are meaningful English words. Unlike some lower level programming languages that use abbreviations, NetRexx instructions are common words, such as **say**, **ask**, **if...then...else**, **do...end**, and **exit**.

Free format There are few rules about NetRexx format. You need not start an instruction in a particular column, you can also skip spaces in a line or skip entire lines, you can have an instruction span many lines or have multiple instructions on one line, variables do not need to be pre-defined, and you can type instructions in upper, lower, or mixed case.

Convenient built-in functions NetRexx supplies built-in functions that perform various processing, searching, and comparison operations for both text and numbers. Other built-in functions provide formatting capabilities and arithmetic calculations.

Easy to debug When a NetRexx exec contains an error, messages with meaningful explanations are displayed on the screen. In addition, the **trace** instruction provides a powerful debugging tool.

Interpreted The NetRexx language is an interpreted language. When a NetRexx exec runs, the language processor directly interprets each language statement, or translates the program in JVM bytecode.

Extensive parsing capabilities NetRexx includes extensive parsing capabilities for character manipulation. This parsing capability allows you to set up a pattern to separate characters, numbers, and mixed input.

Seamless use of JVM Class Libraries NetRexx can use any class, and class library for the JVM (written in Java or other JVM languages) in a seamless manner, that is, without the need for extra declarations or definitions in the source code.

2

Learning to program

2.1 Console Based Programs

One way that a computer can communicate with a user is to ask questions and then compute results based on the answers typed in. In other words, the user has a conversation with the computer. You can easily write a list of NetRexx instructions that will conduct a conversation. We call such a list of instructions a program. The following listing shows a sample NetRexx program. The sample program asks the user to give his name, and then responds to him by name. For instance, if the user types in the name Joe, the reply Hello Joe is displayed. Or else, if the user does not type anything in, the reply Hello stranger is displayed. First, we shall discuss how it works; then you can try it out for yourself.

Listing 2.1: Hello Stranger

```
1 /* A conversation */
2 say "Hello! What's your name?"
3 who=ask
4 if who = '' then say "Hello stranger"
5 else say "Hello" who
```

Briefly, the various pieces of the sample program are:

`/* ... */` A comment explaining what the program is about. Where Rexx programs on several platforms must start with a comment, this is not a hard requirement for NetRexx anymore. Still, it is a good idea to start every program with a comment that explains what it does.

`say` An instruction to display Hello! What' s your name? on the screen.

`ask` An instruction to read the response entered from the keyboard and put it into the computer's memory.

`who` The name given to the place in memory where the user's response is put.

`if` An instruction that asks a question.

`who = ''` A test to determine if who is empty.

`then` A direction to execute the instruction that follows, if the tested condition is true.

`say` An instruction to display Hello stranger on the screen.

`else` An alternative direction to execute the instruction that follows, if the tested condition is not true. Note that in NetRexx , else needs to be on a separate line.

`say` An instruction to display Hello, followed by whatever is in who on the screen.

The text of your program should be stored on a disk that you have access to with the help of an *editor* program. On Windows, notepad or (notepad++), jEdit, X2 or SlickEdit

are suitable candidates. On Unix based systems, including MacOSX, vim or emacs are plausible editors. If you are on z/VM or z/OS, XEDIT or ISPF/PDF are a given. More about editing NetRexx code in chapter 23.1, *Editor Support*, on page 63.

When the text of the program is stored in a file, let's say we called it `hello.nrx`, and you installed NetRexx as indicated in the *NetRexx Quick Beginning Guide*, we can run it with

```
nrc -exec hello
```

and this will yield the result:

```
\nr portable processor, version \nr after3.01, build 1-20120406-1326
Copyright (c) RexxLA, 2011.  All rights reserved.
Parts Copyright (c) IBM Corporation, 1995,2008.
Program hello.nrx
===== Exec: hello =====
Hello! What's your name?
```

If you do not want to see the version and copyright message every time, which would be understandable, then start the program with:

```
nrc -exec -nologo hello
```

This is what happened when Fred tried it.

```
Program hello.nrx
===== Exec: hello =====
Hello! What's your name?
Fred
Hello Fred
```

The **ask** instruction paused, waiting for a reply. Fred typed Fred on the command line and, when he pressed the ENTER key, the **ask** instruction put the word Fred into the place in the computer's memory called "who". The **if** instruction asked, is "who" equal to nothing:

```
who = ''
```

meaning, is the value of "who" (in this case, Fred) equal to nothing:

```
"Fred = ''
```

This was not true; so, the instruction after `then` was not executed; but the instruction after `else`, was.

But when Mike tried it, this happened:

```
Program hello.nrx
===== Exec: hello =====
Hello! What's your name?

Hello stranger
Processing of 'hello.nrx' complete
```

Mike did not understand that he had to type in his name. Perhaps the program should have made it clearer to him. Anyhow, he just pressed ENTER. The **ask** instruction put " (nothing) into the place in the computer's memory called "who". The **if** instruction asked, is:

```
who = ''
```

meaning, is the value of "who" equal to nothing:

```
'' = ''
```

In this case, it was true. So, the instruction after **then** was executed; but the instruction after **else** was not.

2.2 Comments in programs

When you write a program, remember that you will almost certainly want to read it over later (before improving it, for example). Other readers of your program also need to know what the program is for, what kind of input it can handle, what kind of output it produces, and so on. You may also want to write remarks about individual instructions themselves. All these things, words that are to be read by humans but are not to be interpreted, are called comments. To indicate which things are comments, use:

```
/* to mark the start of a comment
*/ to mark the end of a comment.
```

The `/*` causes the translator to stop compiling and interpreting; this starts again only after a `*/` is found, which may be a few words or several lines later. For example,

```
/* This is a comment. */
say text /* This is on the same line as the instruction */
/* Comments may occupy more
than one line. */
```

NetRexx also has line mode comments - those turn a line at a time into a comment. They are composed of two dashes (hyphens, in listings sometimes fused to a typographical *em dash* - remember that in reality they are two *n dashes*.

```
-- this is a line comment
```

2.3 Strings

When the translator sees a quote (either " or ') it stops interpreting or compiling and just goes along looking for the matching quote. The string of characters inside the quotes is used just as it is. Examples of strings are:

```
'Hello'
"Final result: "
```

If you want to use a quotation mark within a string you should use quotation marks of the other kind to delimit the whole string.

```
"Don't panic"
'He said, "Bother"'
```

There is another way. Within a string, a pair of quotes (of the same kind as was used to delimit the string) is interpreted as one of that kind.

```
'Don''t panic' (same as "Don't panic" )
 "He said, ""Bother""" (same as 'He said, "Bother"')
```

2.4 Clauses

Your NetRexx program consists of a number of *clauses*. A clause can be:

1. A *keyword instruction* that tells the interpreter to do something; for example,

   ```
   say  "the word"
   ```

   In this case, the interpreter will display the word on the user's screen.
2. An *assignment*; for example,

   ```
   Message = 'Take care!'
   ```
3. A *null* clause, such as a completely blank line, or

   ```
   ;
   ```
4. A *method call instruction* which invokes a *method* from a *class*

   ```
   'hiawatha'.left(2)
   ```

2.5 When does a Clause End?

It is sometimes useful to be able to write more than one clause on a line, or to extend a clause over many lines. The rules are:

- Usually, each clause occupies one line.
- If you want to put more than one clause on a line you must use a semicolon (;) to separate the clauses.
- If you want a clause to span more than one line you must put a dash (hyphen) at the end of the line to indicate that the clause continues on the next line. If a line does not end in a dash, a semicolon is implied.

What will you see on the screen when this exec is run?

Listing 2.2: RAH Exec

```
1 /* Example: there are six clauses in this program */ say "Everybody cheer!"
2 say "2"; say "4" ; say "6" ; say "8" ; say "Who do we" -
3 "appreciate?"
```

2.6 Loops

We can go on and write clause after clause in a program source files, but some repetitive actions in which only a small change occurs, are better handled by the **loop** statement. This always reminds me about an anecdote that Andy Hertzfield tells[1]:

> Bob's background looked to be a lot stronger in hardware than software, so we were somewhat skeptical about his software expertise, but he claimed to be equally adept at both. His latest project was a rebellious, skunk-works type effort to make a low cost version of the Star called "Cub" that used an ordinary Intel microprocessor (the 8086), which was heresy to the PARC orthodoxy, who felt that you needed custom, bit-slice processors to get sufficient performance for a Star-type machine. Bob had written much of the software for Cub himself.
>
> "I've got lots of software experience", he declared, "in fact I've personally written over 350,000 lines of code."

[1] http://www.folklore.org

I thought that was pretty impressive, although I wondered how it was calculated. I couldn't begin to honestly estimate how much code I have written, since there are too many different ways to construe things.

That evening, I went out to dinner with my friend Rich Williams, who started at Apple around the same time that I did. Rich had a great sense of humor. I told him about the interview that I did in the afternoon, and how Bob Belleville claimed to have written over 350,000 lines of code.

"Well, I bet he did", said Rich, "but then he discovered loops!"

Imagine an assignment to neatly print out a table of exchange rates for dollars and euros for reference in a shop. We could of course make the following program:

Listing 2.3: Without a loop

```
say  1 'euro equals'  1  * 2.34 'dollars'
say  2 'euro equals'  2  * 2.34 'dollars'
say  3 'euro equals'  3  * 2.34 'dollars'
say  4 'euro equals'  4  * 2.34 'dollars'
say  5 'euro equals'  5  * 2.34 'dollars'
say  6 'euro equals'  6  * 2.34 'dollars'
say  7 'euro equals'  7  * 2.34 'dollars'
say  8 'euro equals'  8  * 2.34 'dollars'
say  9 'euro equals'  9  * 2.34 'dollars'
say 10 'euro equals' 10  * 2.34 'dollars'
```

This is valid, but imagine the alarming thought that the list is deemed a success and you are tasked with making a new one, but now with values up to 100. That will be a lot of typing.

The way to do this is using the **loop**[2] statement.

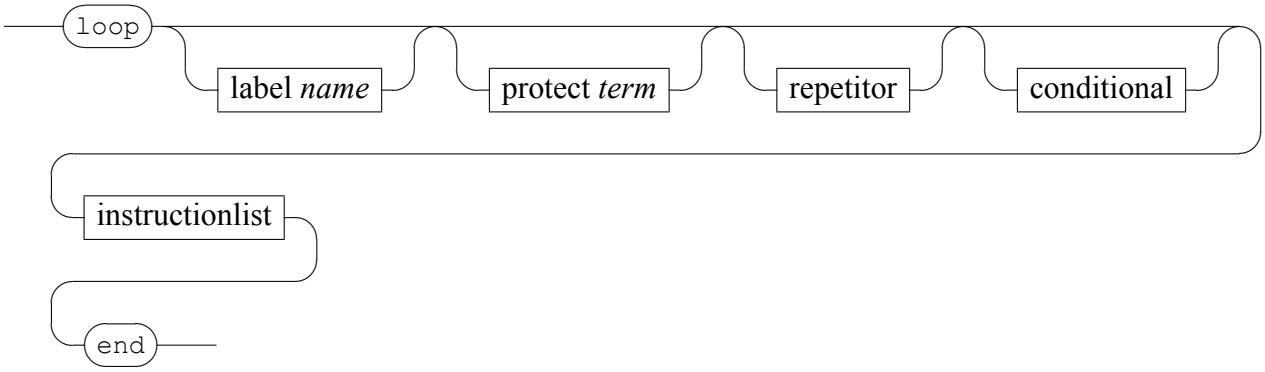
Listing 2.4: With a loop

```
loop i=1 to 100
  say i 'euro equals' i * 2.34 'dollars'
end
```

Now the *loop index variable* `i` varies from 1 to 100, and the statements between `loop` and `end` are repeated, giving the same list, but now from 1 to 100 dollars.

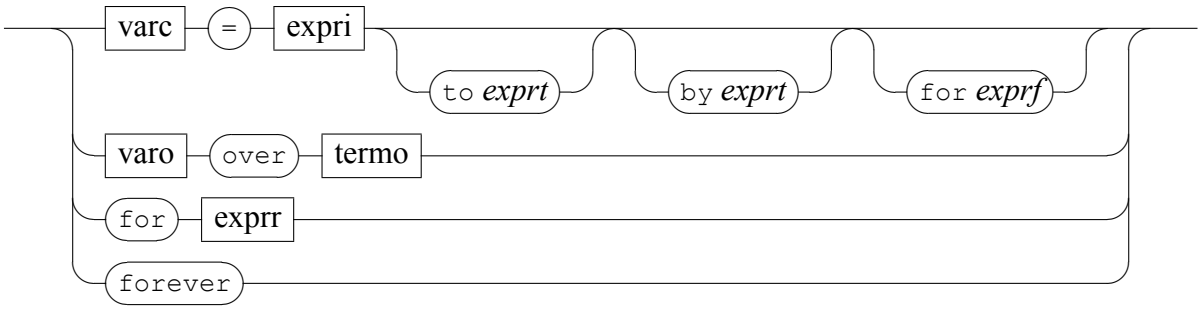
We can do more with the **loop** statement, it is extremely flexible. The following diagram is a (simplified, because here we left out the *catch* and *finally* options) rundown of the ways we can loop in a program.

loop

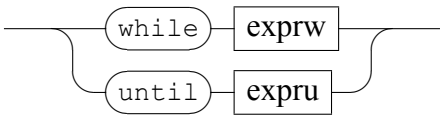


[2]Note that Classic Rexx uses **do** for this purpose. In recent Open Object Rexx versions **loop** can also be used.

repetitor



conditional



A few examples of what we can do with this:

- Looping forever - better put, without deciding beforehand how many times

Listing 2.5: Loop Forever

```
loop forever
  say 'another bonbon?'
  x = ask
  if x = 'enough already' then leave
end
```

The `leave` statement breaks the program out of the loop. This seems futile, but in the chapter about I/O we will see how useful this is when reading files, of which we generally do not know in advance how many lines we will read in the loop.

- Looping for a fixed number of times without needing a loop index variable

Listing 2.6: Loop for a fixed number of times without loop index variable

```
loop for 10
   in.read() /* skip 10 lines from the input file */
end
```

- Looping back into the value of the loop index variable

Listing 2.7: Loop Forever

```
loop i = 100 to 90 by -2
  say  i
end
```

This yields the following output:

```
===== Exec: test =====
100
98
96
94
92
90
Processing of 'test.nrx' complete
```

2.7 Special Variables

We have seen that a *variable* is a place where some data, be it character date or numerical data, can be held. There are some special variables, as shown in the following program.

Listing 2.8: NetRexx Special Variables

```
/* NetRexx */
options replace format comments java crossref savelog symbols binary

class RCSpecialVariables

method RCSpecialVariables()
  x = super.toString
  y = this.toString
  say '<super>'x'</super>'
  say '<this>'y'</this>'
  say '<class>'RCSpecialVariables.class'</class>'
  say '<digits>'digits'</digits>'
  say '<form>'form'</form>'
  say '<[1, 2, 3].length>'
  say [1, 2, 3].length
  say '</[1, 2, 3].length>'
  say '<null>'
  say null
  say '</null>'
  say '<source>'source'</source>'
  say '<sourceline>'sourceline'</sourceline>'
  say '<trace>'trace'</trace>'
  say '<version>'version'</version>'

  say 'Type an answer:'
  say '<ask>'ask'</ask>'

  return

method main(args = String[]) public static

  RCSpecialVariables()

  return
```

`this` The special variables **this** and **super** refer to the current instance of the class and its superclass - what this means will be explained in detail in the chapter **Classes** on page 21, as is the case with the **class** variable.

`digits` The special variable **digits** shows the current setting for the number of decimal digits - the current setting of **numeric digits**. The related variable **form** returns the current setting of **numeric form** which is either `scientific` or `engineering`.

`null` The special variable **null** denotes the *empty reference*. It is there when a variable has no value.

`source` The **source** and **sourceline** variables are a good way to show the sourcefile and sourceline of a program, for example in an error message.

`trace` The **trace** variable returns the current trace setting, which can be one of the words `off var methods all results`.

`version` The **version** variable returns the version of the NetRexx translator that was in use at the time the clause we processed; in case of interpreted execution(see chapter 4 on 13, it returns the level of the current translator in use.

The result of executing this exec is as follows:

```
===== Exec: RCSpecialVariables =====
<super>RCSpecialVariables@4e99353f</super>
```

```
<this>RCSpecialVariables@4e99353f</this>
<class>class RCSpecialVariables</class>
<digits>9</digits>
<form>scientific</form>
<[1, 2, 3].length>
3
</[1, 2, 3].length>
<null>

</null>
<source>Java method RCSpecialVariables.nrx</source>
<sourceline>21</sourceline>
<trace>off</trace>
<version>\nr 3.02 27 Oct 2011</version>
Type an answer:
hello fifi
<ask>hello fifi</ask>
```

It might be useful to note here that these special variables are not fixed in the sense of that they are not *Reserved Variables*. NetRexx does not have reserved variables and any of these special variables can be used as an ordinary variable. However, when it is used as an ordinary variable, there is no way to retrieve the special behavior.

3

NetRexx as a Scripting Language

You can use NetRexx as a simple scripting language without having knowledge of, using any of the features that is needed in a Java program that runs on the JVM.

Scripts can be written very fast. There is no overhead, such as defining a class, constructors and methods, and the programs contain only the necessary instructions.

The scripting feature can be used for test purposes. It is an easy and convenient way of entering some statements and testing them. The scripting feature can also be used for the start sequence of a NetRexx application.

Scripts can be interpreted or compiled - there is no rule that a script needs to be interpreted. In both cases, interpreted or compiled, the NetRexx translator adds the necessary overhead to enable the JVM to execute the resulting program.

4

NetRexx as an Interpreted Language

5

NetRexx as a Compiled Language

6

Calling non-JVM programs

Although NetRexx currently misses the `Address` facility that Classic Rexx and Object Rexx do have, it is easy to call non-JVM programs from a NetRexx program - not as easy as calling a JVM class of course, but if the following recipe is observed, it will show not to be a major problem. The following example is reusable for many cases.

Listing 6.1: Calling Non-JVM Programs

```
/* script\NonJava.nrx

   This program starts an UNZIP program, redirect its output,
   parses the output and shows the files stored in the zipfile */

parse arg unzip zipfile .

-- check the arguments - show usage comments
if zipfile = '' then do
   say 'Usage: Process unzipcommand zipfile'
   exit 2
end

do
   say "Files stored in" zipfile
   say "-".left(39,"-") "-".left(39,"-")
   child = Runtime.getRuntime().exec(unzip ' -v' zipfile) -- program start

   -- read input from child process
   in   = BufferedReader(InputStreamReader(child.getInputStream()))
   line = in.readline

   start = 0    -- listing of files are not available yet
   count = 0
   loop while line \= null
      parse line sep  program
      if sep = '-------' then start = \start
      else
        if start then do
           count = count + 1
           if count // 2 > 0 then say program.word(program.words).left(39) '\-'
                             else say program.word(program.words)
        end
      line = in.readline()
   end

   -- wait for exit of child process and check return code
   child.waitFor()
   if child.exitValue() \= 0 then
      say 'UNZIP return code' child.exitValue()

 catch IOException
    say 'Sorry cannot find' unzip
 catch e2=InterruptedException
    e2.printStackTrace()
end
```

Just firing off a program is no big deal, but this example (in script style) shows how easy it is to access the in- and output handles for the environment that executes the program, which enables you to capture the output the non-jvm program produces and do useful things with it.[3] Line 17 starts the external command using the JVM `Runtime` class in a process called `child`. In line 20 we create a `BufferedReader` from the `child` processes' output. This is called an InputStream but it might as well have been called an OutputStream- everything regarding I/O is relative - but fortunately the designers of the JVM took care of deciding this for you. In lines 25-35 we loop through the results and show the files stored in the zipfile. Note that we **do** (line 14) have to **catch** (line 42) the *IOException* that ensues if the runtime cannot find the `unzip` program, maybe because it is not on the path or was not delivered with your operating system.

[3] This is akin to what one would do with *queue* on z/VM CMS and *outtrap* on z/OS TSO in Classic Rexx.

7

Using NetRexx classes from Java

If you are a Java programmer, using a NetRexx class from Java is just as easy as using a Java class from NetRexx . NetRexx compiles to Java classes that can be used by Java programs. You should import the netrexx.lang package to be able to use the short class name for the Rexx (NetRexx string and numerics) class.

A NetRexx method without a returns keyword can return nothing, which is the void type in Java, or a Rexx string. NetRexx is case independent[4]; Java is case dependent. NetRexx generates the Java code with the case used in the class and method instructions. For example, if you named your class Spider in the NetRexx source file, the resulting Java class file is Spider.class. The public class name in your source program must match the NetRexx source file name. For example, if your source file is `SPIDER.NRX`, and your class is `Spider`, NetRexx generates a warning and changes the class name to `SPIDER` to match the file name. A Java program using the class name Spider would not find the generated class, because its name is `SPIDER.class` - if the compile succeeded, which is not guaranteed in case of casing mismatches. If you have problems, compile your NetRexx program with the **options -keepasjava -format**. You then can look at the generated java file for the correct spelling style and method parameters.

[4] With the default of `options nostrictcase` in effect.

8

Classes

8.1 Classes

8.2 Properties

8.3 Methods

8.4 Inheritance

8.5 Overriding Methods

8.6 Overriding Properties

9

Using Packages

Any non-toy, non-trivial program needs to be in a package. Only examples in programming books (present company included) have programs without package statements. The reason for this is that there is a fairly large chance that you will give something a name that is already used by someone else for something else. Things are not their names[5], and the same names are given to wildly dissimilar things. The *package* construct is the JVM's approach to introducing *namespaces* into the total set of programs that programmers make. Different people will probable write some method that is called `listDifferences` sometime. With all my software in a package called `com.frob.nitz` and yours in a package called `com.frob.otzim`, there is no danger of our programs calling the wrong class and listing the wrong differences.

It is imperative to understand this chapter before continuing - it is a mechanical nuts-and-bolts issue but an essential one at that.

9.1 The package statement

The final words about the NetRexx **package** statement is in the NetRexx Language Reference, but the final statement about the package *mechanism* is in the JVM documentation.

9.2 Translator performance consequences

Because the NetRexx translator has to scan all packages that it can see (meaning a recursive scan of the directories below its own level in the directory tree, and on its classpath, it is often advisable (and certainly if . (a dot, representing the current directory) is part of the classpath) to do development in a subdirectory, instead of, for example, the top level home directory. If a large number of packages and classes are visible to the translator, compile times will be negatively impacted.

9.3 Some NetRexx package history

All IBM versions of NetRexx had the translator in a package called

```
COM.ibm.netrexx.process
```

[5] Willard Van Orman Quine, Word and Object, MIT Press, 1960, ISBN 0-262-67001-1

The official, SUN ordained convention for package names was, to prepend the reversed domain name of the vendor to the package name, while uppercasing the top level domain. NetRexx , being one of the first programs to make use of packages, followed this convention, that was quickly dropped by SUN afterwards, probably because someone experienced what trouble it could cause with version management software that adapted to case-*sensitive* and case-*insensitive* file systems. For NetRexx , which had started out keenly observing the rules, this insight came late, and it is a sober fact that as a result some needlessly profane language was uttered on occasion by some in some projects that suffered the consequences of this. With the first RexxLA release of NetRexx in 2011, the package name was changed to `org.netrexx`, while the runtime package name was kept as `netrexx.lang`, because some major other languages also follow this convention.

9.4 CLASSPATH

Most implementations of Java use an environment variable called CLASSPATH to indicate a search path for Java classes. The Java Virtual Machine and the NetRexx translator rely on the CLASSPATH value to find directories, zip files, and jar files which may contain Java classes. The procedure for setting the CLASSPATH environment variable depends on your operating system (and there may be more than one way).

- For Linux and Unix (BASH, Korn, or Bourne shell), use:

  ```
  CLASSPATH=<newdir>:\$CLASSPATH
  export CLASSPATH
  ```

- Changes for re-boot or opening of a new window should be placed in your /etc/profile, .login, or .profile file, as appropriate.
- For Linux and Unix (C shell), use:

  ```
  setenv CLASSPATH <newdir>:\$CLASSPATH
  ```

  Changes for re-boot or opening of a new window should be placed in your .cshrc file. If you are unsure of how to do this, check the documentation you have for installing the Java toolkit.
- For Windows operating systems, it is best to set the system wide environment, which is accessible using the Control Panel (a search for “environment” offsets the many attempts to relocate the exact dialog in successive Windows Control Panel versions somewhat).

10

Incorporating Class Libraries

10.1 The Collection Classes

11

Input and Output

11.1 The File Class

11.2 Streams

11.3 Line mode I/O

11.3.1 Line mode I/O using BufferedReader and PrintWriter

11.3.2 Line mode I/O using BufferedReader and BufferedWriter

11.4 Byte Oriented I/O

11.5 Data Oriented I/O

11.6 Object Oriented I/O using Serialization

11.7 The NIO Approach

12

Algorithms in NetRexx

12.1 Factorial

A *factorial* is the product of an integer and all the integers below it; the mathematical symbol used is ! (the exclamation mark). For example 4! is equal to 24 (because 4*3*2*1=24). The following program illustrates a recursive (a method calling itself) and an iterative approach to calculating factorials.

Listing 12.1: Factorial

```
/* NetRexx */

options replace format comments java crossref savelog symbols nobinary

numeric digits 64 -- switch to exponential format when numbers become larger than 64
    digits

say 'Input a number: \-'
say
do
  n_ = long ask -- Gets the number, must be an integer

  say n_'! =' factorial(n_) '(using iteration)'
  say n_'! =' factorial(n_, 'r') '(using recursion)'

  catch ex = Exception
    ex.printStackTrace
end

return

method factorial(n_ = long, fmethod = 'I') public static returns Rexx signals
    IllegalArgumentException

  if n_ < 0 then -
    signal IllegalArgumentException('Sorry, but' n_ 'is not a positive integer')

  select
    when fmethod.upper = 'R' then -
      fact = factorialRecursive(n_)
    otherwise -
      fact = factorialIterative(n_)
    end

  return fact

method factorialIterative(n_ = long) private static returns Rexx

  fact = 1
  loop i_ = 1 to n_
    fact = fact * i_
    end i_

  return fact

method factorialRecursive(n_ = long) private static returns Rexx
```

```
45
46   if n_ > 1 then —
47     fact = n_ * factorialRecursive(n_ — 1)
48   else —
49    fact = 1
50
51   return fact
```

Executing this program yields the following result:

```
===== Exec: RCFactorial =====
Input a number:
42
42! = 1405006117752879898543142606244511569936384000000000 (using iteration)
42! = 1405006117752879898543142606244511569936384000000000 (using recursion)
```

As you can see, fortunately, both approaches come to the same conclusion about the results. In the above program, both approaches are a bit intermingled; for more clarity about how to use recursion, have a look at this:

Listing 12.2: Factorial Recursive

```
1 class Factorial
2 numeric digits 64
3
4   method main(args=String[]) static
5     say factorial_(42)
6
7   method factorial_(number) static
8     if number = 0 then return 1
9     else return number * factorial_(number—1)
```

In this program we can clearly see that the factorial_ method, that takes an argument `number` (which is of type Rexx if we do not specify it to be another type), calls itself in the method body. This means that at runtime, another copy of it is run, with as argument number that the first invocation returns (the result of 42*41), and so on.

In general, a recursive algorithm is considered more elegant, while an iterative approach has a better runtime performance. Some language environments are optimized for recursion, which means that their processors can spot a recursive algorithm and optimize it by not making many useless copies of the code. Some day in the near future the JVM will be such an environment. Also, for some problems, for example the processing of tree structures, using a recursive algorithm seems much more natural, while an iterative algorithm seems complicated or forced.

12.2 Fibonacci

Listing 12.3: Fibonacci

```
1 /* NetRexx */
2 options replace format comments java crossref savelog symbols
3
4 numeric digits 210000                  /*prepare for some big ones.     */
5 parse arg x y .                        /*allow a single number or range.*/
6 if x == '' then do                     /*no input? Then assume —30—>+30*/
7  x = —30
8  y = —x
9  end
10
11 if y == '' then y = x             /*if only one number, show fib(n)*/
12 loop k = x to y                   /*process each Fibonacci request.*/
13  q = fib(k)
```

```
 w = q.length                    /*if wider than 25 bytes, tell it*/
 say 'Fibonacci' k"="q
 if w > 25 then say 'Fibonacci' k "has a length of" w
 end k
exit

/*----------------------------------------FIB subroutine (non-recursive)---*/
method fib(arg) private static
 parse arg n
 na = n.abs

 if na < 2 then return na             /*handle special cases.          */
 a = 0
 b = 1

 loop j = 2 to na
   s = a + b
   a = b
   b = s
   end j

 if n > 0 | na // 2 == 1 then return  s /*if positive or odd negative... */
                         else return -s /*return a negative Fib number.  */
```

13

Using Parse

14

Using Trace

15

User Interfaces

15.1 AWT

15.2 Web Applets using AWT

Web applets can be written one of two styles:

- Lean and mean, where binary arithmetic is used, and only core Java classes (such as *java.lang.String*) are used. This is recommended for optimizing webpages which may be accessed by people using a slow internet connection. Several examples using this style are included in the NetRexx package like the two listed below.

Listing 15.1: Nervous Texxt

```
/*  NervousText applet in NetRexx: Test of text animation.
    Algorithms, names, etc. are directly from the Java version by
    Daniel Wyszynski and kwalrath, 1995
*/
options binary

class NervousTexxt extends Applet implements Runnable

  separated = char[]
  s = String
  killme = Thread
  threadSuspended = boolean 0

  method init
    resize(300,50)
    setFont(Font("TimesRoman", Font.BOLD, 30))
    s = getParameter("text")
    if s = null then s = "NetRexx"

    separated = char[s.length]
    s.getChars(0, s.length, separated,0)

  method start
    if killme \= null then return
    killme = Thread(this)
    killme.start

  method stop
    killme = null

  method run
    loop while killme \= null
      Thread.sleep(100)
      this.repaint
    catch InterruptedException
    end
    killme = null

  method paint(g=Graphics)
```

```
    loop i=0 to s.length-1
      x_coord = int Math.random*10+15*i
      y_coord = int Math.random*10+36
      g.drawChars(separated, i, 1, x_coord, y_coord)
    end

  method mouseDown(evt=Event, x=int, y=int) returns boolean
    if threadSuspended then killme.resume
                       else killme.suspend
    threadSuspended = \threadSuspended
    return 1
```

Listing 15.2: ArchText

```
/* ArchText applet: multi-coloured text on a white background */
/* Mike Cowlishaw  April 1996,  December 1996                 */
options binary

class ArchText extends Applet implements Runnable

 text  ="NetRexx"                              /* default text */
 tick  =0                                    /* display counter */
 timer =Thread null                            /* timer thread */
 shadow=Image                                  /* shadow image */
 draw  =Graphics                            /* where we can draw */

 method init
  s=getParameter("text")             /* get any provided text */
  if s\=null then text=s
  shadow=createImage(getSize.width, getSize.height)  /* image */
  draw=shadow.getGraphics
  draw.setColor(Color.white)                      /* background */
  draw.fillRect(0, 0, getSize.width, getSize.height)    /* .. */
  draw.setFont(Font("TimesRoman", Font.BOLD, 30))     /* font */

 method start
  if timer=null then timer=Thread(this)          /* new thread */
  timer.setPriority(Thread.MAX_PRIORITY)       /* time matters */
  timer.start                                /* start the thread */

 method stop
  if timer=null then return                  /* have no thread */
  timer.stop                                   /* else stop it */
  timer=null                                  /* .. and discard */

 method run                                /* this runs as thread */
  loop while timer\=null
    tick=tick+1                                  /* next update */
    hue=((tick+133)//191)/191
    draw.setColor(Color.getHSBColor(hue, 1, 0.7))
    draw.drawString(text, 0, 30)
    this.repaint                                /* .. and redraw */
    Thread.sleep(119)                            /* wait awhile */
  catch InterruptedException
  end
  timer=null                                        /* discard */

 method update(g=Graphics)         /* override Applet's update */
  paint(g)                          /* method to avoid flicker */

 method paint(g=Graphics)
  g.drawImage(shadow, 0, 0, null)
```

- Full-function, where decimal arithmetic is used, and advantage is taken of the full power of the NetRexx runtime *Rexx* class.

  An example using this style is the below *WordClock.nrx*.

Listing 15.3: WordClock

```
/* WordClock -- an applet that shows the time in English.     */
```

```
/*                                                                  */
/*   Parameters:                                                    */
/*                                                                  */
/*     face —— the font face to use                                 */
/*     size —— the font size to use                                 */
/*                                                                  */
/* ———————————————————————————————————————————————————————————— */
/* Based on the ancient QTIME.REXX, and typical Java applets. */

class WordClock extends Applet implements Runnable

 timer=Thread null                          /* the timer thread */
 offsetx; offsety                             /* text position */
 now                                           /* current time */

 method init
  /* Get parameters from the <applet> markup */
  face=getParameter("face")                          /* font face */
  if face=null then face="TimesRoman"
  size=getParameter("size")
  if size=null then size="20"                        /* font size */

  setFont(Font(face, Font.BOLD, size))
  resize(size*20, size*2)                      /* set window size */
  offsetx=size/2                  /* and where text will start */
  offsety=size*3/2                          /* note Y is from top */
  parse Date() . . . now .      /* initial time is fourth word */

 method start
  if timer=null then timer=Thread(this)          /* new thread */
  timer.setPriority(Thread.MAX_PRIORITY)       /* time matters */
  timer.start                                /* start the thread */

 method stop
  if timer\=null then do                          /* have thread */
    timer.stop                                   /* .. so stop it */
    timer=null                                  /* .. and discard */
    end

 method run
  /* Use the Java Date class to get the time */
  loop while timer\=null
    parse Date() . . . now .            /* time is fourth word */
    this.repaint                                 /* redisplay */
    parse now ':' ':'secs                       /* where in minute */
    wait=30-secs                  /* calculate delay in seconds */
    if wait<=0 then wait=wait+60
    /* say 'secs, wait:' secs wait */
    Thread.sleep(1000*wait)           /* wait for milliseconds */
  catch InterruptedException
    say 'Interrupted...'
  end
  timer=null                                             /* done */

 method paint(g=Graphics)
  g.drawString(wordtime(now), offsetx, offsety)    /* show it */

 /* WORDTIME —— a cut-down version of QTIME.REXX
    Arg1 is the time string (hh:mm:ss)
    Returns the time in english, as a Rexx string
    */
 method wordtime(arg) static returns Rexx
  /* Extract the hours, minutes, and seconds from the time.   */
  parse arg hour':'min':'sec
  if sec>29 then min=min+1                   /* round up minutes */

  /* Nearness phrases — this time using an array              */
  near=Rexx[5]                                      /* five items */
  near[0]=''                                          /* exact */
  near[1]=' just gone';  near[2]=' just after'         /* after */
  near[3]=' nearly';     near[4]=' almost'            /* before */

  mod=min//5               /* where we are in 5 minute bracket */
  out="It's"near[mod]             /* start building the result */
```

```
76   if min>32 then hour=hour+1          /* we are TO the hour... */
77   min=min+2      /* shift minutes to straddle a 5-minute point */
78
79   /* Now special-case the result for Noon and Midnight hours  */
80   if hour//12=0 & min//60<=4 then do
81     if hour=12 then return out 'Noon.'
82     return 'Midnight.'
83     end
84
85   min=min-(min//5)                      /* find nearest 5 mins */
86   if hour>12
87    then hour=hour-12               /* get rid of 24-hour clock */
88    else
89     if hour=0 then hour=12        /* .. and allow for midnight */
90
91   /* Determine the phrase to use for each 5-minute segment    */
92   select
93     when min=0  then nop                /* add "o'clock" later */
94     when min=60 then min=0                              /* ditto */
95     when min= 5 then out=out 'five past'
96     when min=10 then out=out 'ten past'
97     when min=15 then out=out 'a quarter past'
98     when min=20 then out=out 'twenty past'
99     when min=25 then out=out 'twenty-five past'
100    when min=30 then out=out 'half past'
101    when min=35 then out=out 'twenty-five to'
102    when min=40 then out=out 'twenty to'
103    when min=45 then out=out 'a quarter to'
104    when min=50 then out=out 'ten to'
105    when min=55 then out=out 'five to'
106    end
107
108  numbers='one two three four five six'-      /* continuation */
109    'seven eight nine ten eleven twelve '
110  out=out numbers.word(hour)            /* add the hour number */
111  if min=0 then out=out "o'clock"  /* .. and o'clock if exact */
112
113  return out'.'                     /* return the final result */
114
115 /* Mike Cowlishaw,  December 1979 - January 1985. */
116 /* NetRexx version March 1996; applet April 1996. */
```

If you write applets which use the NetRexx runtime (or any other Java classes that might not be on the client browser), the rest of this section may help in setting up your Web server.

A good way of setting up an HTTP (Web) server for this is to keep all your applets in one subdirectory. You can then make the NetRexx runtime classes (that is, the classes in the package known to the Java Virtual Machine as *netrexx.lang*) available to all the applets by unzipping NetRexxR.jar into a subdirectory *netrexx/lang* below your applets directory.
For example, if the root of your server data tree is

```
D:\mydata
```

you might put your applets into

```
D:\mydata\applets
```

and then the NetRexx classes (unzipped from NetRexxR.jar) should be in the directory

```
D:\mydata\applets\netrexx\lang
```

The same principle is applied if you have any other non-core Java packages that you want to make available to your applets: the classes in a package called *iris.sort.quicksorts* would go in a subdirectory below *applets* called *iris/sort/quicksorts*, for example.

Note that since Java 1.1 or later it is possible to use the classes direct from the NetRexxR.jar file.

15.3 Swing

Swing is the most commonly used name for the second attempt from the SUN engineers to provide a graphical user interface library for the JVM. With AWT also acknowledged by SUN to be a quick attempt that was made just before release of the first Java package, it became clear that it was rather taxing on system resources without compensation by a pretty look. A case in point is the event mechanism, that indiscriminately sends around mouse and keyboard events even when nobody is listening to them. The architecture for Swing prescribes registering for events before they are produced, and tries to have the drawing done by the Java graphics engine instead of leaning heavily on the operating system's native GUI functionality. The user interface widgets that are produced by Java are called 'light' and their looks can be changed by applying different skins, called *'look-and-feel'* (LAF) libraries.

In the first months of its existence Swing gathered quite a bad reputation because it made the Java 1.2 releases that contained it very slow in starting up programs that used the library. Consequently, much was invested in performance studies by SUN engineers and these problems were solved. One of the things that came out is that dividing the libraries in a great many classes, done for performance reasons, worked counterproductive. All these problems were solved over the years, and developments in hardware and multithreading took care of the rest, and nowadays Swing is a valid way of producing a rich client user interface.

For esthetical reasons, it is best to research a bit in the third party look-and-feel libraries that can be obtained. Swing can be made to look beautiful, but it takes some care and the defaults are not helping.

15.3.1 Creating NetRexx Swing interfaces with NetBeans

15.4 Web Frameworks

15.4.1 JSF

16

Network Programming

16.1 Using Uniform Resource Locators (URL)

16.2 TCP/IP Socket I/O

16.3 RMI: Remote Method Interface

17

Database Connectivity with JDBC

For interfacing with Relational Database Management Systems (RDBMS) NetRexx uses the Java Data Base Connectivity (JDBC) model. This means that all important database systems, for which a JDBC driver has been made available, can be used from your NetRexx program. This is a large bonus when we compare this to the other open source scripting languages, that have been made go by with specific, nonstandard solutions and special drivers. In contrast, NetRexx programs can be made compatible with most database systems that use standard SQL, and, with some planning and care, can switch database implementations at will.

Listing 17.1: A JDBC Query example

```
/* jdbc\JdbcQry.nrx

   This NetRexx program demonstrate DB2 query using the JDBC API.
   Usage: Java JdbcQry [<DB-URL>] [<userprefix>] */

import java.sql.

parse arg url prefix                    -- process arguments
if url = '' then
   url = 'jdbc:db2:sample'
else do                                 -- check for correct URL
     parse url p1 ':' p2 ':' rest
     if p1 \= 'jdbc' | p2 \= 'db2' | rest = '' then do
        say 'Usage: java JdbcQry [<DB-URL>] [<userprefix>]'
        exit 8
     end
end
if prefix = '' then prefix = 'userid'

do                                      -- loading DB2 support
  say 'Loading DB2 driver classes...'
  Class.forName('COM.ibm.db2.jdbc.app.DB2Driver').newInstance()
  -- Class.forName('COM.ibm.db2.jdbc.net.DB2Driver').newInstance()
catch e1 = Exception
  say 'The DB2 driver classes could not be found and loaded !'
  say 'Exception (' e1 ') caught : \n' e1.getMessage()
  exit 1
end                                     -- end : loading DB2 support

do                                      -- connecting to DB2 host
  say 'Connecting to:' url
  jdbcCon = Connection DriverManager.getConnection(url, 'userid', 'password')
catch e2 = SQLException
  say 'SQLException(s) caught while connecting !'
  loop while (e2 \= null)
     say 'SQLState:' e2.getSQLState()
     say 'Message: ' e2.getMessage()
     say 'Vendor:  ' e2.getErrorCode()
     say
     e2 = e2.getNextException()
   end
   exit 1
```

```
43 end                                  -- end : connecting to DB2 host
44
45 do                                   -- get list of departments with the managers
46   say 'Creating query...'
47   query = 'SELECT deptno, deptname, lastname, firstnme' -
48             'FROM' prefix'.DEPARTMENT dep,' prefix'.EMPLOYEE emp'-
49             'WHERE dep.mgrno=emp.empno ORDER BY dep.deptno'
50   stmt = Statement jdbcCon.createStatement()
51   say 'Executing query:'
52   loop i=0 to (query.length()-1)%75
53      say '    ' query.substr(i*75+1,75)
54   end
55   rs = ResultSet stmt.executeQuery(query)
56   say 'Results:'
57   loop row=0 while rs.next()
58      say rs.getString('deptno') rs.getString('deptname') -
59      'is directed by' rs.getString('lastname') rs.getString('firstnme')
60   end
61   rs.close()                        -- close the ResultSet
62   stmt.close()                      -- close the Statement
63   jdbcCon.close()                   -- close the Connection
64   say 'Retrieved' row 'departments.'
65 catch e3 = SQLException
66   say 'SQLException(s) caught !'
67   loop while (e3 \= null)
68      say 'SQLState:' e3.getSQLState()
69      say 'Message: ' e3.getMessage()
70      say 'Vendor:  ' e3.getErrorCode()
71      say
72      e3 = e3.getNextException()
73    end
74 end                                  -- end: get list of departments
```

The first peculiarity of JDBC is the way the driver class is loaded. When most classes are 'pulled in' by the translator, a JDBC driver traditionally is loaded through the reflection API. This happens in line 22 with the `Class.forName` call. This implies that the library containing this class must be on the classpath.

In line 32 we connect to the database using a url and a userid/password combination. This is an easy way to do and test, but for most serious applications we do not want plaintext userids and passwords in the sourcecode, so most of the time we would store the connection info in a file that we store in encrypted form, or we use facilities of J2EE containers that can provide data sources that take care of this, while at the same time decoupling your application source from the infrastructure that it will run on.

In line 47 the query is composed by filling in variables in a Rexx string and making a `Statement` out of it, in line 50. In line 55, the `Statement` is executed, which yields a `ResultSet`. This has a *cursor* that moves forward with each `next` call. The `next` call returns *true* as longs as there are rows from the resultset to return.

The `ResultSet` interface implements *getter* methods for all JDBC Types. In the above example, all returned results are of type `String`.

Listing 17.2: A JDBC Update example

```
1  /* jdbc\JdbcUpd.nrx
2
3     This NetRexx program demonstrate DB2 update using the JDBC API.
4     Usage: Java JdbcUpd [<DB-URL>] [<userprefix>] [U] */
5
6  import java.sql.
7
8  parse arg url prefix lowup            -- process arguments
9  if url = '' then
10    url = 'jdbc:db2:sample'
11 else do                               -- check for correct URL
12       parse url p1 ':' p2 ':' rest
13       if p1 \= 'jdbc' | p2 \= 'db2' | rest = '' then do
```

```
14          say 'Usage: java JdbcUpd [<DB-URL>] [<userprefix>] [U]'
15          exit 8
16       end
17   end
18   if prefix = '' then prefix = 'userid'
19   if lowup \= 'U' then lowup = 'L'
20
21   do                                    -- loading DB2 support
22     say 'Loading DB2 driver classes...'
23     Class.forName('COM.ibm.db2.jdbc.app.DB2Driver').newInstance()
24     -- Class.forName('COM.ibm.db2.jdbc.net.DB2Driver').newInstance()
25   catch e1 = Exception
26     say 'The DB2 driver classes could not be found and loaded !'
27     say 'Exception (' e1 ') caught : \n' e1.getMessage()
28     exit 1
29   end                                   -- end : loading DB2 support
30
31   do                                    -- connecting to DB2 host
32     say 'Connecting to:' url
33     jdbcCon = Connection DriverManager.getConnection(url, 'userid', 'password')
34   catch e2 = SQLException
35     say 'SQLException(s) caught while connecting !'
36     loop while (e2 \= null)
37        say 'SQLState:' e2.getSQLState()
38        say 'Message: ' e2.getMessage()
39        say 'Vendor:  ' e2.getErrorCode()
40        say
41        e2 = e2.getNextException()
42      end
43      exit 1
44   end                                   -- end : connecting to DB2 host
45
46   do                                    -- retrieve employee, update firstname
47
48     say 'Preparing update...'                          -- prepare UPDATE
49     updateQ = 'UPDATE' prefix'.EMPLOYEE SET firstnme = ? WHERE empno = ?'
50     updateStmt = PreparedStatement jdbcCon.prepareStatement(updateQ)
51     say 'Creating query...'                            -- create SELECT
52     query = 'SELECT firstnme, lastname, empno FROM' prefix'.EMPLOYEE'
53     stmt = Statement jdbcCon.createStatement()
54     rs = ResultSet stmt.executeQuery(query)            -- execute select
55
56     loop row=0 while rs.next()                         -- loop employees
57       firstname = String rs.getString('firstnme')
58       if lowup = 'U' then firstname = firstname.toUpperCase()
59       else do
60          dChar = firstname.charAt(0)
61          firstname = dChar || firstname.substring(1).toLowerCase()
62       end
63       updateStmt.setString(1, firstname)               -- parms for update
64       updateStmt.setString(2, rs.getString('empno'))
65       say 'Updating' rs.getString('lastname') firstname ': \0'
66       say updateStmt.executeUpdate() 'row(s) updated'  -- execute update
67     end
68
69     rs.close()                          -- close the ResultSet
70     stmt.close()                        -- close the Statement
71     updateStmt.close()                  -- close the PreparedStatement
72     jdbcCon.close()                     -- close the Connection
73     say 'Updated' row 'employees.'
74   catch e3 = SQLException
75     say 'SQLException(s) caught !'
76     loop while (e3 \= null)
77        say 'SQLState:' e3.getSQLState()
78        say 'Message: ' e3.getMessage()
79        say 'Vendor:  ' e3.getErrorCode()
80        say
81        e3 = e3.getNextException()
82      end
83   end                                   -- end: empoyees
```

For database updates, we connect using the driver in the same way (line 23) and now prepare the statement used for the database update (line 50). In this example,

we loop through the cursor of a select statement and update the row in line 66. The `executeUpdate` method of `PreparedStatement` returns the number of updated rows as an indication of success.

From JDBC 2.0 on, cursors are updateable (and scrollable, so they can move back and forth), so we would not have to go through this effort - but it is a valid example of an update statement.

18

Threads

19

WebSphere MQ

WebSphere MQ (also and maybe better known as MQ Series) is IBM's messaging and queing middleware, in use at a great many financial institutions and other companies. It has, from a programming point of view, two API's: JMS (Java Messaging Services), a generic messaging API for the Java world, and MQI, which is older and proprietary to IBM's product. The below examples show the MQI; other examples might show JMS applications.

This is the sample Java application for MQI, translated (and a lot shorter) to NetRexx.

Listing 19.1: MQ Sample

```
import com.ibm.mq.MQException
import com.ibm.mq.MQGetMessageOptions
import com.ibm.mq.MQMessage
import com.ibm.mq.MQPutMessageOptions
import com.ibm.mq.MQQueue
import com.ibm.mq.MQQueueManager
import com.ibm.mq.constants.MQConstants

class MQSample
properties private

  qManager = "rjtestqm";
  qName = "SYSTEM.DEFAULT.LOCAL.QUEUE"

  method main(args=String[]) static binary
    m = MQSample()
    do
      say "Connecting to queue manager: " m.qManager
      qMgr = MQQueueManager(m.qManager)

      openOptions = MQConstants.MQOO_INPUT_AS_Q_DEF | MQConstants.MQOO_OUTPUT

      say "Accessing queue: " m.qName
      queue = qMgr.accessQueue(m.qName, openOptions)

      msg = MQMessage()
      msg.writeUTF("Hello, World!")

      pmo = MQPutMessageOptions()

      say "Sending a message..."
      queue.put(msg, pmo)

      rcvMessage = MQMessage()

      gmo = MQGetMessageOptions()

      say "...and getting the message back again"
      queue.get(rcvMessage, gmo)

      msgText = rcvMessage.readUTF()
      say "The message is: " msgText

      say "Closing the queue"
```

```
45        queue.close()
46
47        say "Disconnecting from the Queue Manager"
48        qMgr.disconnect()
49        say "Done!"
50      catch ex=MQException
51        say "A WebSphere MQ Error occured : Completion Code " ex.completionCode "Reason
              Code " ex.reasonCode
52      catch ex2=java.io.IOException
53        say "An IOException occured whilst writing to the message buffer: " ex2
54      end
```

This sample connects to the Queue Manager (called *rjtestqm*) in *bindings mode*, as opposed to *client mode*. Bindings mode is only a connection possibility for client programs that are running in the same OS image as the Queue Manager, on the server. Note that the application connects (line 19), accesses a queue (line 23), puts a message (line 32), gets it back (line 39) closes the queue (line 45) and disconnects (line 48) all without checking returncodes: the exceptionhandler takes care of this, and all irregulaties will be reported from the catch MQException block starting at line 50).

The main method does in this case not follow the canonical form, but has 'binary' as an extra option. Option binary can be defined on the command line as an option to the translator, as a program option, as a class option and as a method option. Here the smallest scope is chosen. There is a good reason to make this method a binary method: accessing a queue in MQ Series requires some options that are set using a mask of binary flags - this works, in current NetRexx versions, only in binary mode, because the operators have other semantics in nobinary mode.

Listing 19.2: MQ Message Reader

```
1  import com.ibm.mq.
2
3  class MessageReader
4    properties private
5
6    qManager = "rjtestqm";
7    qName    = "TESTQUEUE1"
8
9    method main(args=String[]) static binary
10
11     m = MessageReader()
12     do
13       MQEnvironment.hostname = 'localhost'
14       MQEnvironment.port     = int 1414
15       MQEnvironment.channel  = 'CHANNEL1'
16
17       -- exit assignment
18       exits          = TimeoutChannelExit()
19       MQEnvironment.channelReceiveExit = exits
20       MQEnvironment.channelSendExit = exits
21       MQEnvironment.channelSecurityExit   = exits
22
23       say "Connecting to QM: " m.qManager
24       qMgr = MQQueueManager(m.qManager)
25
26       openOptions = MQConstants.MQOO_INPUT_AS_Q_DEF
27
28       say "Accessing Queue : " m.qName
29       queue = qMgr.accessQueue(m.qName, openOptions)
30
31       gmo = MQGetMessageOptions() -- essential here is that we have MQGMO_WAIT;
             otherwise we cannot timeout
32       gmo.Options = MQConstants.MQGMO_WAIT | MQConstants.MQGMO_FAIL_IF_QUIESCING |
             MQConstants.MQGMO_SYNCPOINT
33       gmo.WaitInterval = MQConstants.MQWI_UNLIMITED
34
35       loop forever
36     rcvMessage = MQMessage()
```

```
37    queue.get(rcvMessage, gmo)
38    msgText = rcvMessage.readUTF()
39    say "Got a message; the message is: " msgText
40    say
41       end
42
43     catch ex=MQException
44       say "A WebSphere MQ Error occured : Completion Code " ex.completionCode "Reason
             Code " ex.reasonCode
45       say "Closing the queue"
46       queue.close()
47       say "Disconnecting from the Queue Manager"
48       qMgr.disconnect()
49       say "Done!"
50     end
```

In contrast to the previous sample the MessageReader sample only has one import statement. This is always hotly debated in project teams, one school likes the succinctness of including only the top level import, and only goes deeper when there is ambiguity detected; another school spells out the all imports to the bitter end.

The MessageReader sample connects to another queue, called TESTQUEUE1 (specified in line 7) but here we connect in *client mode*, as indicated by lines 13-15 which specify an MQEnvironment. (Other options are using an MQSERVER environment variable or a *Channel Definition Table*.

This program is also uncommon in that it uses `MQConstants.MQGMO_WAIT` as an option instead of being triggered as a process by a message on a trigger queue. Using this option means that the program waits (stays active, not really busy polling but depending on an OS event) until a new message arrives, which will be processed immediately.

In lines 18-21 a *Channel Exit* is specified. This exit is show in the following example.

Listing 19.3: MQ Java Channel Exit

```
1  import com.ibm.mq.
2  import java.nio.
3
4  class TimeoutChannelExit implements WMQSendExit, WMQReceiveExit, WMQSecurityExit
5
6    properties
7
8    tTask = WatchdogTimer
9    t = java.util.Timer
10   timeout = long
11   initialized = boolean
12
13   method TimeoutChannelExit()
14     say "TimeoutChannelExit Constructor Called"
15     t = java.util.Timer()
16     timeout = long 15000
17
18   method channelReceiveExit(channelExitParms=MQCXP, –
19              channelDefinition=MQCD, –
20              agentBuffer=ByteBuffer) returns ByteBuffer
21     do
22       this.tTask.cancel() –– cancel the timer task whenever a message is read
23     catch NullPointerException –– but catch the null pointer the first time
24     end
25     this.tTask = WatchdogTimer()
26     this.t.schedule(this.tTask,this.timeout)
27     return agentBuffer
28
29   method channelSecurityExit(channelExitParms=MQCXP, –
30               channelDefinition=MQCD, –
31               agentBuffer=ByteBuffer) returns ByteBuffer
32     return agentBuffer
33
34   method channelSendExit(channelExitParms=MQCXP, –
35           channelDefinition=MQCD, –
```

```
36            agentBuffer=ByteBuffer) returns ByteBuffer
37      return agentBuffer
```

Listing 19.4: WatchdogTimer

```
1  class WatchdogTimer extends TimerTask
2
3    method WatchdogTimer()
4    method run()
5      say  'WATCHDOG TIMER TIMEOUT: HPOpenView Alert Issued' Date()
```

MQ Series has traditional channel exits (programs that can look at the message contents before the application gets to it). In the MQI Java environment there is something akin to this functionality, but a Java channel exit for MQ Series has to be defined in the application, as shown in the previous example. The function of this particular exit is to implement a *Watchdog timer* - on a separate thread, as shown in the sample that follows the sample channel exit. The timer threatens here to have issues a HP OpenView alert, but that part has been left out.

This particular sample has been designed to do something that is hard to do: signal the operations department when something does NOT happen - here the assumption is that there is a payment going over the queue at least once every 20 minutes - when that does not happen, an alert is issued. With every message that goes through, the timer thread is reset, and only when it is allowed to time out, action is undertaken.

20

Component Based Programming: Beans

21

Using the NetRexxA API

As described elsewhere, the simplest way to use the NetRexx interpreter is to use the command interface (NetRexxC) with the *-exec* or *-arg* flags. There is a also a more direct way to use the interpreter when calling it from another NetRexx (or Java) program, as described here. This way is called the *NetRexxA Application Programming Interface* (API).
The *NetRexxA* class is in the same package as the translator (that is, *org.netrexx.process*), and comprises a constructor and two methods. To interpret a NetRexx program (or, in general, call arbitrary methods on interpreted classes), the following steps are necessary:

1. Construct the interpreter object by invoking the constructor *NetRexxA()*. At this point, the environment's classpath is inspected and known compiled packages and extensions are identified.
2. Decide on the program(s) which are to be interpreted, and invoke the NetRexxA *parse* method to parse the programs. This parsing carries out syntax and other static checks on the programs specified, and prepares them for interpretation. A stub class is created and loaded for each class parsed, which allows access to the classes through the JVM reflection mechanisms.
3. At this point, the classes in the programs are ready for use. To invoke a method on one, or construct an instance of a class, or array, etc., the Java reflection API (in *java.lang* and *java.lang.reflect*) is used in the usual way, working on the *Class* objects created by the interpreter. To locate these *Class* objects, the API's *getClassObject* method must be used.

Once step 2 has been completed, any combination or repetition of using the classes is allowed. At any time (provided that all methods invoked in step 3 have returned) a new or edited set of source files can be parsed as described in step 2, and after that, the new set of class objects can be located and used. Note that operation is undefined if any attempt is made to use a class object that was located before the most recent call to the *parse* method.
Here's a simple example, a program that invokes the *main* method of the *hello.nrx* program's class:

Listing 21.1: Try the NetRexxA interface

```
options binary
import org.netrexx.process.NetRexxA

interpreter=NetRexxA()              -- make interpreter

files=['hello.nrx']                 -- a file to interpret
flags=['nocrossref', 'verbose0']    -- flags, for example
```

```
interpreter.parse(files, flags)    -- parse the file(s), using the flags

helloClass=interpreter.getClassObject(null, 'hello') -- find the hello Class

-- find the 'main' method; it takes an array of Strings as its argument
classes=[interpreter.getClassObject('java.lang', 'String', 1)]
mainMethod=helloClass.getMethod('main', classes)

-- now invoke it, with a null instance (it is static) and an empty String array
values=[Object String[0]]

loop for 10    -- let's call it ten times, for fun...
  mainMethod.invoke(null, values)
end
```

Compiling and running (or interpreting!) this example program will illustrate some important points, especially if a **trace all** instruction is added near the top. First, the performance of the interpreter (or indeed the compiler) is dominated by JVM and other start-up costs; constructing the interpreter is expensive as the classpath has to be searched for duplicate classes, etc. Similarly, the first call to the parse method is slow because of the time taken to load, verify, and JIT-compile the classes that comprise the interpreter. After that point, however, only newly-referenced classes require loading, and execution will be very much faster.
The remainder of this section describes the constructor and the two methods of the NetRexxA class in more detail.

21.1 The NetRexxA constructor

Listing 21.2: Constructor

```
NetRexxA()
```

This constructor takes no arguments and builds an interpeter object. This process includes checking the classpath and other libraries known to the JVM and identifying classes and packages which are available.

21.2 The parse method

Listing 21.3: parse

```
parse(files=String[], flags=String[]) returns boolean
```

The parse method takes two arrays of Strings. The first array contains a list of one or more file specifications, one in each element of the array; these specify the files that are to be parsed and made ready for interpretation.
The second array is a list of zero or more option words; these may be any option words understood by the interpreter (but excluding those known only to the NetRexxC command interface, such as *time*). [6] The parse method prefixes the *nojava* flag automatically, to prevent *.java* files being created inadvertently. In the example, *nocrossref* is supplied to stop a cross-reference file being written, and *verbose0* is added to prevent the logo and other progress displays appearing.
The *parse* method returns a boolean value; this will be 1 (true) if the parsing completed without errors, or 0 (false) otherwise. Normally a program using the API should test this

[6] Note that the option words are not prefixed with a -.

result an take appropriate action; it will not be possible to interpret a program or class whose parsing failed with an error.

21.3 The getClassObject method

Listing 21.4: getClassObject

```
1 getClassObject(package=String, name=String [,dimension=int]) returns Class
```

This method lets you obtain a Class object (an object of type *java.lang.Class*) representing a class (or array) known to the interpreter, including those newly parsed by a parse instruction.
The first argument, *package*, specifies the package name (for example, *com.ibm.math*). For a class which is not in a package, *null* should be used (not the empty string, *''*).
The second argument, *name*, specifies the class name (for example, *BigDecimal*). For a minor (inner) class, this may have more than one part, separated by dots.
The third, optional, argument, specifies the number of dimensions of the requested class object. If greater than zero, the returned class object will describe an array with the specified number of dimensions. This argument defaults to the value 0.
An example of using the *dimension* argument is shown above where the *java.lang.String[]* array Class object is requested.
Once a Class object has been retrieved from the interpreter it may be used with the Java reflection API as usual. The Class objects returned are only valid until the parse method is next invoked.

22

Interfacing to Open Object Rexx

22.1 BSF4ooRexx

23

NetRexx Tools

23.1 Editor support

This chapter lists editors that have plugin support for NetRexx , ranging from syntax coloring to full IDE support (specified), and Rexx friendly editors, that are extensible using Rexx as a macro language (which can be the first step to provide NetRexx editing support).

23.1.1 JVM - All Platforms

JEdit	Full support for NetRexx source code editing, to be found at `http://www.jedit.org`.
NetRexxDE	A revisions with additions of the NetRexx plugin for jEdit, moving to a full IDE for NetRexx . `http://kenai.com/projects/netrexx-misc`
Eclipse	Eclipse has a NetRexx plugin that provides a complete IDE environment for the development of NetRexx programs (in alpha release) by Bill Fenlason. The project is situated at SourceForge (`http://eclipsenetrexx.sourceforge.net/`).

23.1.2 Linux

Emacs	netrexx-mode.el (in the NetRexx package in the `tools` directory) runs on GNU Emacs, which is installed by default on most Linux developer distributions.
vim	vi with extensions

23.1.3 MS Windows

Emacs	netrexx-mode.el (in the NetRexx package in the `tools` directory) runs on GNU Emacs for Windows. `http://www.gnu.org/software/emacs/windows/faq.html`.
vim	vi with extensions

23.1.4 MacOSX

Aquamacs	A version of Emacs that is integrated with the MacOSX Aqua look and feel. (`http://www.aquamacs.org`). NetRexx mode is included in the NetRexx package in the `tools` directory.
Emacs	netrexx-mode.el (in the NetRexx package) runs on GNU Emacs for MacOSX. `http://www.gnu.org/software/emacs`.
Vim	Vi with extensions

23.2 Java to Nrx (java2nrx)

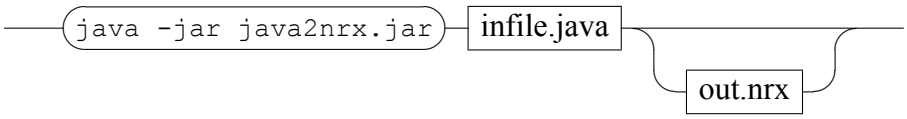
When working on a piece of Java code, or an example written in the language, sometimes it would be good if we could see the source in NetRexx to make it more readable. This is exactly what *java2nrx* by Marc Remes does. It has a Java 1.5 parser and an Abstract Syntax Tree that delivers a translation to NetRexx, to the extend of what is currently supported under NetRexx.

At the moment it is to be found at `http://kenai.org/NetRexx/contrib/java2nrx`

It is started by the `java2nrx.sh` script; for convenience, place `java2nrx.sh` and `java2nrx.jar` in the same directory. NetRexxC and java must be available on the path.

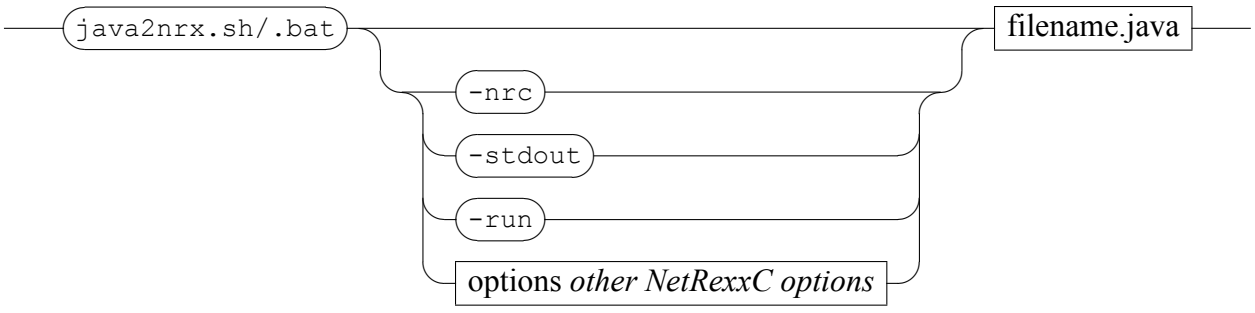
Usage:

java2nrx



Alternatively:

java2nrx



-nrc runs NetRexxC compiler on output nrx file

-stdout prints NetRexx file on stdout

-run runs generated translated NetRexx output file

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ISBN 978-90-819090-0-6