Pipelines for NetRexx QuickStart Guide

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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 Start Guide	This guide is meant for an audience that has done some programming and wants to start quickly. It starts with a quick tour of the language, and a section on installing the NetRexx translator and how to run it. 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).
Pipelines for NetRexx QuickStart Guide	The Data Flow oriented companion to NetRexx, with its z/VM CMS Pipelines 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:

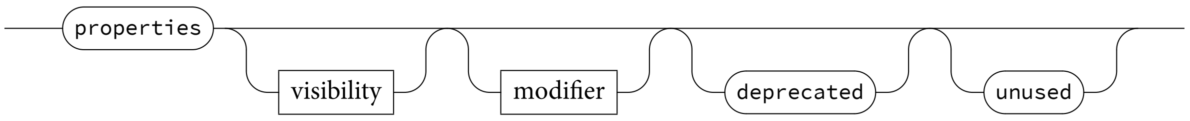
- Body text is in this font
- Examples of language statements are in a **bold** type
- Variables or strings as mentioned in source code, or things that appear on the console, are in a `typewriter` type
- Items that are introduced, or emphasized, are in an *italic* type
- Included program fragments are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



1

Introduction

A Pipeline, or Hartmann Pipeline[1], is a concept that extends and improves pipes as they are known from Unix and other operating systems. The name pipe indicates an interprocess communication mechanism, as well as the programming paradigm it has introduced. Compared to Unix pipes, Hartmann Pipelines offer multiple input- and output streams, more complex pipe topologies, and a lot more.

Pipelines were first implemented on VM/CMS, one of IBM's mainframe operating systems. This version was later adapted to run under MUSIC/SP and TSO/MVS (now z/OS) and has been part of several product configurations. Pipelines are widely used by VM users, in a symbiotic relationship with REXX, the interpreted language that also has its origins on this platform.

Pipes for NetRexx is the implementation of Pipelines for the Java Virtual machine. It is written in NetRexx and pipes and stages can be defined using this language. It can run on every platform that has a JVM (Java Virtual Machine) installed. This portable version of Pipelines was started by Ed Tomlinson in 1997 under the name of *njPipes*, when NetRexx was still very new, and was open sourced in 2011, soon after the NetRexx translator itself. The included stages have always been open source. It was integrated into the NetRexx translator in 2014 and first released with version 3.04.

In version 3.08, there are important improvements that enable pipelines to be run from the command line, and from the NetRexx REPL program *nrws*, the NetRexx Workspace. The pipes compiler has since been renamed *pipc*, while the pipes runner component keeps using the name *pipe*.

[1] `http://en.wikipedia.org/wiki/Hartmann_pipeline`

2

The Pipeline Concept

2.1 What is a Pipeline?

The *pipeline* terminology is a set of metaphores derived from plumbing. Fitting two or more pipe segments together yield a pipeline. Water flows in one direction through the pipeline.

There is a source, which could be a well or a water tower; water is pumped through the pipe into the first segment, then through the other segments until it reaches a tap, and most of it will end up in the sink. A pipeline can be increased in length with more segments of pipe, and this illustrates the modular concept of the pipeline.

When we discuss pipelines in relation to computing we have the same basic structure, but instead of water that passes through the pipeline, data is passed through a series of programs (*stages*) that act as filters.

Data must come from some place and go to some place. Analogous to the well or the water tower there are *device drivers* that act as a source of the data, where the tap or the *sink* represents the place the data is going to, for example to some output device as your terminal window or a file on disk, or a network destination.

Just as water, data in a pipeline flows in one direction, by convention from the left to the right.

2.2 Stage

A program that runs in a pipeline is called a *stage*. A program can run in more than one place in a pipeline - these occurrences function independent of each other.

The pipeline specification is processed by the *pipeline compiler*, and it must be contained in a character string; on the commandline, it needs to be between quotes, while when contained in a file, it needs to be between the delimiters of a NetRexx string. An solid vertical bar | is used as *stage separator*, while other characters can be used as an option when specifiying the local option for the pipe, after the pipe name.[2]

When looking a two adjacent segments in a pipeline, we call the left stage the *producer* and the stage on the right the *consumer*, with the *stage separator* as the connector.

[2]In versions before Pipelines for NetRexx 3.08, the default was the exclamation mark (!)

2.3 Device Driver

A *device driver* reads from a device (for instance a file, the command prompt, a machine console or a network connection) or writes to a device; in some cases it can both read and write. An example of a device drivers are < and > ; these read and write data from and to files.

A pipeline can take data from one input device and write it to a different device. Within the pipeline, data can be modified in almost any way imaginable by the programmer.

The simplest process for the pipeline is to read data from the input side and copy it unmodified to the output side. Figure X shows the currently supported input- and output devices. The pipeline compiler connects these programs; it uses one program for each device and connects them together.

The inherent characteristic of the pipeline is that any program can be connected to any other program because each obtains data and sends data throug a device independent standard interface. This becomes apparent when data can be in-line (specified or generated within the pipeline specification), come in (or be outpur) to devices like disk or tape, or be handled through a network – all these formats can be processed by the same stages.

The pipeline usually processes one record (or line) at a time. The pipeline reads a record for the input, processes it and sends it to the output. It continues until the input source is drained.

3

Running pipelines

There are a number of ways to specify and run a pipeline. A little setup is necessary.

3.1 Configuration

The required configuration is minimal. The NetRexxF.jar (java archive file) needs to be on the classpath environment variable (NetRexxC.jar, which is smaller, will suffice when there is a working javac compiler). Also, the current directory (.) needs to be on the classpath. It is convenient to have aliases or shell scripts defined as abbreviations for the invocation of the pipe, pipc (pipe compiler) and nrc (netrexx compiler) utility programs. Aliases are preferable because some shell processors have idiosyncrasies in the treatment of script arguments. With an alias we can be sure that every NetRexx program sees its arguments the same way.

```
.bash_aliases:
alias pipc=”java org.netrexx.njpipes.pipes.compiler”
alias pipe=”java org.netrexx.njpipes.pipes.runner”
alias nrc=”java org.netrexx.process.\nr{}C”
```

For Windows, the following works:

```
pipe.bat:
@java org.netrexx.njpipes.pipes.runner %*
```

These aliases (or command script (in Windows it is called a batch file) enable you to do the following: To run a pipeline from the commandline, type:

```
pipe 'gen 100 | dup 999 | count words | console'
```

Remember to use double quotes on Windows shells. When the `pipe` alias or command script is not on your path, you can also use:

```
java org.netrexx.njpipes.pipes.runner 'gen 100 | dup 999 | count words | console'
```

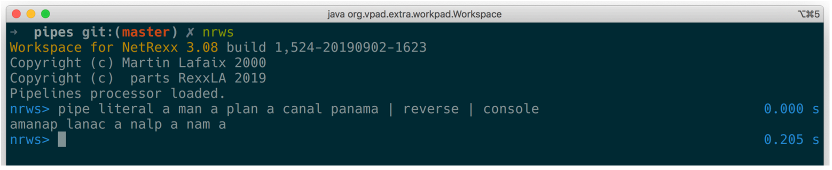
In both cases the answer should be 100000 - you have generated one hundred thousand lines, but fortunately you did not print them, but only counted them. To see them all, you can insert a | console | stage in between the dup and the count stage.

3.2 From the NetRexx Workspace (nrws) with direct execution

The first way is the most straightforward, and highly recognizable for users of CMS Pipelines, as it mimics the way a pipe is run in the CMS 3270 interface. It also yields the best response time, specially when the nrws.input file in your home directory preloads the Pipes subsystem, as in this example:

```
-- preload the pipe machinery for good response on first pipe
pipe literal Pipelines processor loaded. | console
```

This is not magic: we do a Pipe execution (that displays: “Pipe processor loaded”) which loads all necessary classes and leaves them in memory. We can then type this command after the *nrws>* prompt.



```
java org.vpad.extra.workpad.Workspace                                        ⌥⌘5
→  pipes git:(master) ✗ nrws
Workspace for NetRexx 3.08 build 1,524-20190902-1623
Copyright (c) Martin Lafaix 2000
Copyright (c)  parts RexxLA 2019
Pipelines processor loaded.
nrws> pipe literal a man a plan a canal panama | reverse | console          0.000 s
amanap lanac a nalp a nam a
nrws> █                                                                      0.205 s
```

FIGURE 1: Run in the NetRexx Workspace

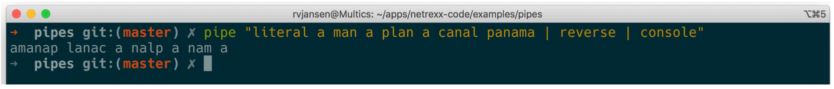
```
pipe literal a man a plan a canal panama | reverse | console
```

Executed this way, the executed class image will not be written to disk. The *timing* option is great for prototyping and performance work.

3.3 From the command line with direct execution

The only difference is that after the PIPE command, the rest of the specification needs to be quoted in the command shells of Linux, Windows and macOS. In CMS, the pipeline specification can also be quoted - in this way, a pipeline specification can be entirely portable. Windows needs double quote, zVM/CMS does not need quotes, but if they are used they need to be double quotes. macOS and Linux can use single or double quotes.

```
pipe "literal a man a plan a canal panama | reverse | console"
```



```
rvjansen@Multics: ~/apps/netrexx-code/examples/pipes                         ⌥⌘5
→  pipes git:(master) ✗ pipe "literal a man a plan a canal panama | reverse | console"
amanap lanac a nalp a nam a
→  pipes git:(master) ✗ █
```

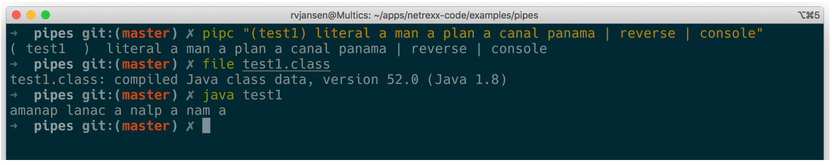
FIGURE 2: Run from the OS command line

Executed this way, the executed class image will not be written to disk.

3.4 Precompiled Pipelines

In this mode, which uses the pipc command (for pipe compiler), a .class file will be persisted to disk. This class can be run as many times as needed, without the overhead of compilation. This would be the right mode for pipes that take different arguments when re-run. The pipe name needs to be specified, and will be the class name. When the class name exists, it will be overwritten.

```
pipc "(test1) literal a man a plan a canal panama | reverse | console"
```



```
→  pipes git:(master) ✗ pipc "(test1) literal a man a plan a canal panama | reverse | console"
( test1  )  literal a man a plan a canal panama | reverse | console
→  pipes git:(master) ✗ file test1.class
test1.class: compiled Java class data, version 52.0 (Java 1.8)
→  pipes git:(master) ✗ java test1
amanap lanac a nalp a nam a
→  pipes git:(master) ✗ █
```

FIGURE 3: Precompile a Pipeline from the OS command line

This will yield a

```
test1.class
```

classfile, which can be executed by the java virtual machine.
The file test1.class can be run with the command:

```
java test1
```

Be sure to leave out the .class suffix when invoking java.

3.5 Compiled from an .njp file

When compiled from a file, the pipe specification must not be quoted. Pipes can be specified in so-called Portrait Mode, which is the standard for more complex pipelines as it is easier to read. An example is:

```
pipe (appendtest)

  gen 100 |
  append gen 50 |
  rexx locate /0/ |
  console
```

Compile from an .njp file with additional stage definitions in NetRexx An example (length1.njp) is:

```
pipe (lengthp) < output.lst | length1 | console

import org.netrexx.njpipes.pipes.
class length1 extends stage final
 method run()
  do
    loop forever
  line = rexx peekto()
  l = line.length
  output(l l.d2x line)
  readto()
    end
  catch StageError
    rc = rc()
  end
  exit(rc*(rc<>12))
```

In this example, the name of the generated pipe is lengthp, while the name of the custom stage is length1. Be sure to invoke the right class, invoking length1 will have the JVM complain about a non-existing main method. This class (lengthp) will be generated by the command:

```
pipc length1
```

note that the .njp suffix is optional when invoking the pipes compiler. When run, it tries to read the contents of the file length.nrx and will put out its lines, prepended by the line length in decimal and hex - because that is what the (in NetRexx) specified homegrown stage does.

4

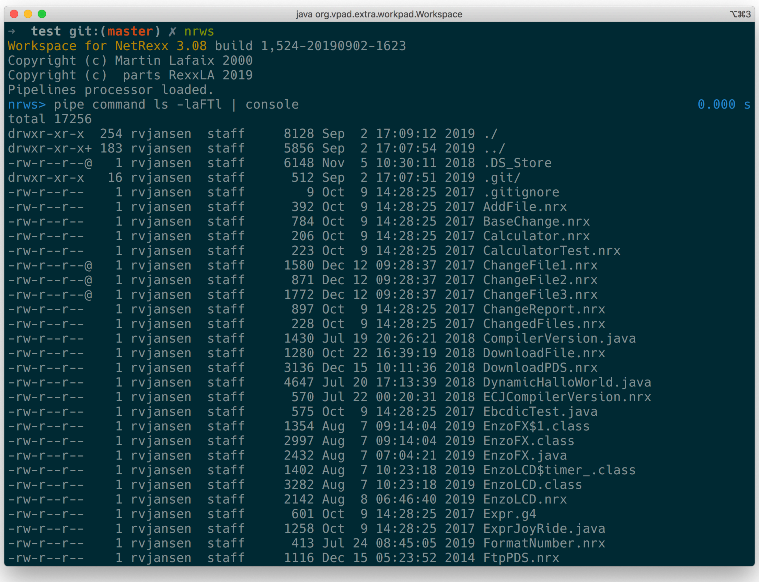
Example Session

Imagine you have landed a job as programmer in an accountants firm, and on your first day there is a question about backups; *the backup process takes too long*. There is an urgent need to identify the files that are produced on this day. You know how to this, of course, it is only some 20 lines of code; use the File() API, fill a collection class (you are thinking of an ArrayList already), or a TreeMap to sort the File object on last modified date already, call an instance of the Calender class, run a comparison - get that compiled and test it a bit - an hour or so would be sufficient. Of course, you need to install the Java compiler, because all machines have Java nowadays, but just not the compiler. But if you want to really impress people, you should type in a command line and be done with it. For this you can use NetRexx pipelines. Fortunately, you emailed the NetRexxF.jar to yourself so you save it on the machine, and you're in business right away; you add it to the classpath. Your first pipeline command should just test the waters. For this chapter, we will use the

```
nrws
```

program. You send a command into the pipeline, and get its output:

```
pipe command ls -laFTl | console
```



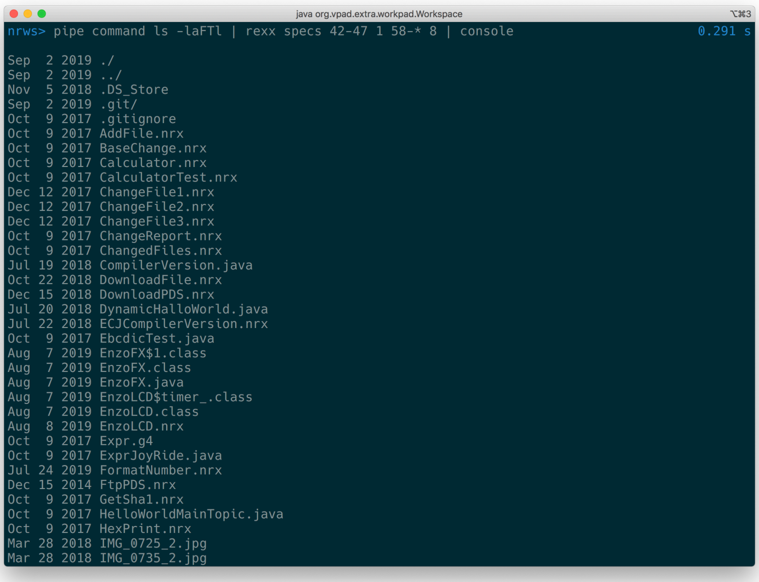
```
→  test git:(master) ✗ nrws
Workspace for NetRexx 3.08 build 1,524-20190902-1623
Copyright (c) Martin Lafaix 2000
Copyright (c)  parts RexxLA 2019
Pipelines processor loaded.
nrws> pipe command ls -laFTl | console                                   0.000 s
total 17256
drwxr-xr-x  254 rvjansen  staff     8128 Sep  2 17:09:12 2019 ./
drwxr-xr-x+ 183 rvjansen  staff     5856 Sep  2 17:07:54 2019 ../
-rw-r--r--@   1 rvjansen  staff     6148 Nov  5 10:30:11 2018 .DS_Store
drwxr-xr-x   16 rvjansen  staff      512 Sep  2 17:07:51 2019 .git/
-rw-r--r--    1 rvjansen  staff        9 Oct  9 14:28:25 2017 .gitignore
-rw-r--r--    1 rvjansen  staff      392 Oct  9 14:28:25 2017 AddFile.nrx
-rw-r--r--    1 rvjansen  staff      784 Oct  9 14:28:25 2017 BaseChange.nrx
-rw-r--r--    1 rvjansen  staff      206 Oct  9 14:28:25 2017 Calculator.nrx
-rw-r--r--    1 rvjansen  staff      223 Oct  9 14:28:25 2017 CalculatorTest.nrx
-rw-r--r--@   1 rvjansen  staff     1580 Dec 12 09:28:37 2017 ChangeFile1.nrx
-rw-r--r--@   1 rvjansen  staff      871 Dec 12 09:28:37 2017 ChangeFile2.nrx
-rw-r--r--@   1 rvjansen  staff     1772 Dec 12 09:28:37 2017 ChangeFile3.nrx
-rw-r--r--    1 rvjansen  staff      897 Oct  9 14:28:25 2017 ChangeReport.nrx
-rw-r--r--    1 rvjansen  staff      228 Oct  9 14:28:25 2017 ChangedFiles.nrx
-rw-r--r--    1 rvjansen  staff     1430 Jul 19 20:26:21 2018 CompilerVersion.java
-rw-r--r--    1 rvjansen  staff     1280 Oct 22 16:39:19 2018 DownloadFile.nrx
-rw-r--r--    1 rvjansen  staff     3136 Dec 15 10:11:36 2018 DownloadPDS.nrx
-rw-r--r--    1 rvjansen  staff     4647 Jul 20 17:13:39 2018 DynamicHalloWorld.java
-rw-r--r--    1 rvjansen  staff      570 Jul 22 00:20:31 2018 ECJCompilerVersion.nrx
-rw-r--r--    1 rvjansen  staff      575 Oct  9 14:28:25 2017 EbcdicTest.java
-rw-r--r--    1 rvjansen  staff     1354 Aug  7 09:14:04 2019 EnzoFX$1.class
-rw-r--r--    1 rvjansen  staff     2997 Aug  7 09:14:04 2019 EnzoFX.class
-rw-r--r--    1 rvjansen  staff     2432 Aug  7 07:04:21 2019 EnzoFX.java
-rw-r--r--    1 rvjansen  staff     1402 Aug  7 10:23:18 2019 EnzoLCD$timer_.class
-rw-r--r--    1 rvjansen  staff     3282 Aug  7 10:23:18 2019 EnzoLCD.class
-rw-r--r--    1 rvjansen  staff     2142 Aug  8 06:46:40 2019 EnzoLCD.nrx
-rw-r--r--    1 rvjansen  staff      601 Oct  9 14:28:25 2017 Expr.g4
-rw-r--r--    1 rvjansen  staff     1258 Oct  9 14:28:25 2017 ExprJoyRide.java
-rw-r--r--    1 rvjansen  staff      413 Jul 24 08:45:05 2019 FormatNumber.nrx
-rw-r--r--    1 rvjansen  staff     1116 Dec 15 05:23:52 2014 FtpPDS.nrx
```

FIGURE 4: example 1

The *ls* command with the flags is the unix way to get a directory listing - for Windows we would use *dir*. In this case, we send the output into the pipeline, but as the last stage (called a pipe 'sink') occurs immediately after that, every line will be echoed on the console. A number of lines like these will be displayed on the console, as in *example 1*.

You see straight away that the relevant info is not in the first columns, and not in consecutive columns; we want to know the date (whether it is today or not) and not the time. So we filter this out of every line with a 'spec' stage, as in *example 2*.

```
pipe command ls -laFTl | rexx specs 42-47 1 58-* 8 | console
```



```
java org.vpad.extra.workpad.Workspace                                  ⌥⌘3
nrws> pipe command ls -laFTl | rexx specs 42-47 1 58-* 8 | console   0.291 s

Sep  2 2019 ./
Sep  2 2019 ../
Nov  5 2018 .DS_Store
Sep  2 2019 .git/
Oct  9 2017 .gitignore
Oct  9 2017 AddFile.nrx
Oct  9 2017 BaseChange.nrx
Oct  9 2017 Calculator.nrx
Oct  9 2017 CalculatorTest.nrx
Dec 12 2017 ChangeFile1.nrx
Dec 12 2017 ChangeFile2.nrx
Dec 12 2017 ChangeFile3.nrx
Oct  9 2017 ChangeReport.nrx
Oct  9 2017 ChangedFiles.nrx
Jul 19 2018 CompilerVersion.java
Oct 22 2018 DownloadFile.nrx
Dec 15 2018 DownloadPDS.nrx
Jul 20 2018 DynamicHalloWorld.java
Jul 22 2018 ECJCompilerVersion.nrx
Oct  9 2017 EbcdicTest.java
Aug  7 2019 EnzoFX$1.class
Aug  7 2019 EnzoFX.class
Aug  7 2019 EnzoFX.java
Aug  7 2019 EnzoLCD$timer_.class
Aug  7 2019 EnzoLCD.class
Aug  8 2019 EnzoLCD.nrx
Oct  9 2017 Expr.g4
Oct  9 2017 ExprJoyRide.java
Jul 24 2019 FormatNumber.nrx
Dec 15 2014 FtpPDS.nrx
Oct  9 2017 GetSha1.nrx
Oct  9 2017 HelloWorldMainTopic.java
Oct  9 2017 HexPrint.nrx
Mar 28 2018 IMG_0725_2.jpg
Mar 28 2018 IMG_0735_2.jpg
```

FIGURE 5: example 2

For the CMS user, the only difference is the rexx cast before specs (which, itself, is exactly the same). This is because the JVM handles in objects, and we need to make sure that the output of this stage is of type Rexx. We can easily sort this without a lot of programming:

```
pipe command ls -laFTl | rexx specs 42-47 1 58-* 8 | sort | console
```

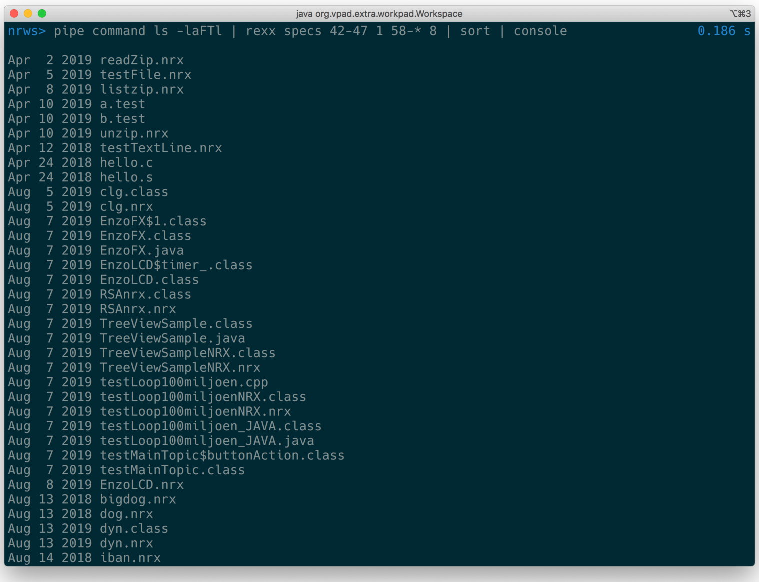
So what now comes out of the pipeline is sorted (see *example 3*). But this is a bit funny, we would like to see chronological order of course, so we switch around some columns with another specs stage:

```
pipe command ls -laFTl | rexx specs 42-47 1 58-* 8 | specs 7-11 1 1-6 7 12-* 12 | sort
      | console
```

which is very near to what we want (see *example 4*. Only thing to do now is to filter on the date. We use the *locate* stage and hardcode the date for now. Let's say it is the 2nd of March, 2019:

```
pipe command ls -laFTl | rexx specs 42-47 1 58-* 8 | specs 7-11 1 1-6
7 12-* 12 | locate /2019 Mar 2/ | sort | console
```

As *example 5* shows, on that day there were only two files produced. Also, because this is a short list now, you can see that Pipelines runs this pipe in 0.157 seconds, because we switched on the time option in *nrws*. Voila, you have impressed the accountants and now



```
nrws> pipe command ls -laFTl | rexx specs 42-47 1 58-* 8 | sort | console         0.186 s

Apr  2 2019 readZip.nrx
Apr  5 2019 testFile.nrx
Apr  8 2019 listzip.nrx
Apr 10 2019 a.test
Apr 10 2019 b.test
Apr 10 2019 unzip.nrx
Apr 12 2018 testTextLine.nrx
Apr 24 2018 hello.c
Apr 24 2018 hello.s
Aug  5 2019 clg.class
Aug  5 2019 clg.nrx
Aug  7 2019 EnzoFX$1.class
Aug  7 2019 EnzoFX.class
Aug  7 2019 EnzoFX.java
Aug  7 2019 EnzoLCD$timer_.class
Aug  7 2019 EnzoLCD.class
Aug  7 2019 RSAnrx.class
Aug  7 2019 RSAnrx.nrx
Aug  7 2019 TreeViewSample.class
Aug  7 2019 TreeViewSample.java
Aug  7 2019 TreeViewSampleNRX.class
Aug  7 2019 TreeViewSampleNRX.nrx
Aug  7 2019 testLoop100miljoen.cpp
Aug  7 2019 testLoop100miljoenNRX.class
Aug  7 2019 testLoop100miljoenNRX.nrx
Aug  7 2019 testLoop100miljoen_JAVA.class
Aug  7 2019 testLoop100miljoen_JAVA.java
Aug  7 2019 testMainTopic$buttonAction.class
Aug  7 2019 testMainTopic.class
Aug  8 2019 EnzoLCD.nrx
Aug 13 2018 bigdog.nrx
Aug 13 2018 dog.nrx
Aug 13 2019 dyn.class
Aug 13 2019 dyn.nrx
Aug 14 2018 iban.nrx
```

FIGURE 6: example 3

they know there is nothing to this programming thing. Be sure to sit on it for a while and not raise the expectations too high. Normally, you would specify your pipeline in a file and use so-called portrait mode: commandtest.njp:

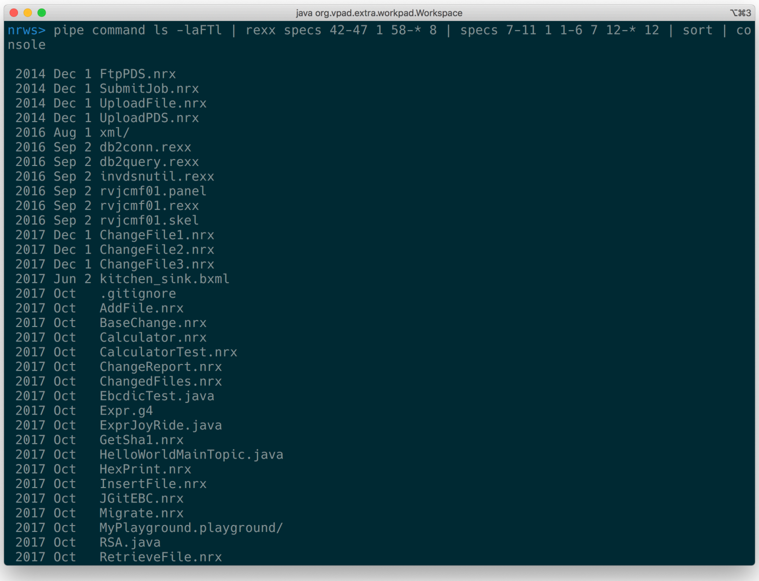
```
pipe (newfiles)
command ls -laFTl |
rexx specs 42-47 1 58-* 8 |
specs 7-11 1 1-6 7 12-* 12 |
sort |
locate /2019 Mar 2/ |
console
```

The filename is different from the generated class file name, on purpose. You could, and would, put different related pipelines in one file. Then we do a:

```
pipe commandtest && java newfiles
```

If you are on Windows, you can run cmd /c instead of the command stage. If your shell cannot find the pipe command, you should make one or alias it, it should call

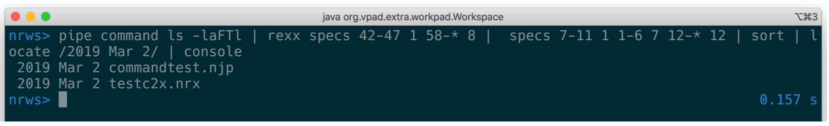
```
java org.netrexx.njpipes.pipes.compiler
```


java org.vpad.extra.workpad.Workspace ⌥⌘3

```
nrws> pipe command ls -laFTl | rexx specs 42-47 1 58-* 8 | specs 7-11 1 1-6 7 12-* 12 | sort | co
nsole

 2014 Dec 1 FtpPDS.nrx
 2014 Dec 1 SubmitJob.nrx
 2014 Dec 1 UploadFile.nrx
 2014 Dec 1 UploadPDS.nrx
 2016 Aug 1 xml/
 2016 Sep 2 db2conn.rexx
 2016 Sep 2 db2query.rexx
 2016 Sep 2 invdsnutil.rexx
 2016 Sep 2 rvjcmf01.panel
 2016 Sep 2 rvjcmf01.rexx
 2016 Sep 2 rvjcmf01.skel
 2017 Dec 1 ChangeFile1.nrx
 2017 Dec 1 ChangeFile2.nrx
 2017 Dec 1 ChangeFile3.nrx
 2017 Jun 2 kitchen_sink.bxml
 2017 Oct   .gitignore
 2017 Oct   AddFile.nrx
 2017 Oct   BaseChange.nrx
 2017 Oct   Calculator.nrx
 2017 Oct   CalculatorTest.nrx
 2017 Oct   ChangeReport.nrx
 2017 Oct   ChangedFiles.nrx
 2017 Oct   EbcdicTest.java
 2017 Oct   Expr.g4
 2017 Oct   ExprJoyRide.java
 2017 Oct   GetSha1.nrx
 2017 Oct   HelloWorldMainTopic.java
 2017 Oct   HexPrint.nrx
 2017 Oct   InsertFile.nrx
 2017 Oct   JGitEBC.nrx
 2017 Oct   Migrate.nrx
 2017 Oct   MyPlayground.playground/
 2017 Oct   RSA.java
 2017 Oct   RetrieveFile.nrx
```

FIGURE 7: example 4


java org.vpad.extra.workpad.Workspace ⌥⌘3

```
nrws> pipe command ls -laFTl | rexx specs 42-47 1 58-* 8 |  specs 7-11 1 1-6 7 12-* 12 | sort | l
ocate /2019 Mar 2/ | console
 2019 Mar 2 commandtest.njp
 2019 Mar 2 testc2x.nrx
nrws>                                                                                      0.157 s
```

FIGURE 8: example 5

5

Write your own Filters

So we have seen in the previous example that it is not too hard to make a simple pipeline out of things called 'device drivers' (such as *command*, for OS commands, '<' for reading files on disk, and *literal*, for inserting literal strings into a pipeline, filters, and sinks. When a filter is not delivered in the standard set of stages, it is very easy to make one yourself in the NetRexx language. The model for this closely follows the way it is done with CMS Pipelines and Classic Rexx. Imagine, for the sake of argument (and a simple example[3]), that you have an assignment to quickly reverse a string.

```
 /* BAGVENDT REXX -- Reverse the contents of lines in the pipeline */
signal on error
 do forever
   'peekto data'
   'output' reverse(data)
   'readto'
end
error: exit RC*(RC<>12)
```

And you would need to remember to call your filetype REXX instead of EXEC. The 'peekto' reads the input but does not actually commit the read yet, so you can read it one more time with knowledge about the contents. The 'output' pushes its argument back into the pipeline. The 'readto' reads and commits the read so the line is really processed and we can go to the next one.

In NetRexx, that would be about the same, but for some small changes incurred by the object oriented model of NetRexx, which you don't have in Classic Rexx. Here peekto(), readto() and output() are method calls on the 'stage' object. This will be imported by the import from org.netrexx.njpipes.pipes. (FILE: bagvendt.nrx)

```
import org.netrexx.njpipes.pipes.
class bagvendt extends stage
method run()
   loop forever
     line = Rexx peekto()
     output(line.reverse())
     readto()
   catch StageError
     rc = rc()
   end
exit(rc*(rc<>12))
```

So that would look fairly familiar, and admittedly, a bit easier for us already well versed in NetRexx. We can test this by building a pipeline and running the filter on its own source:

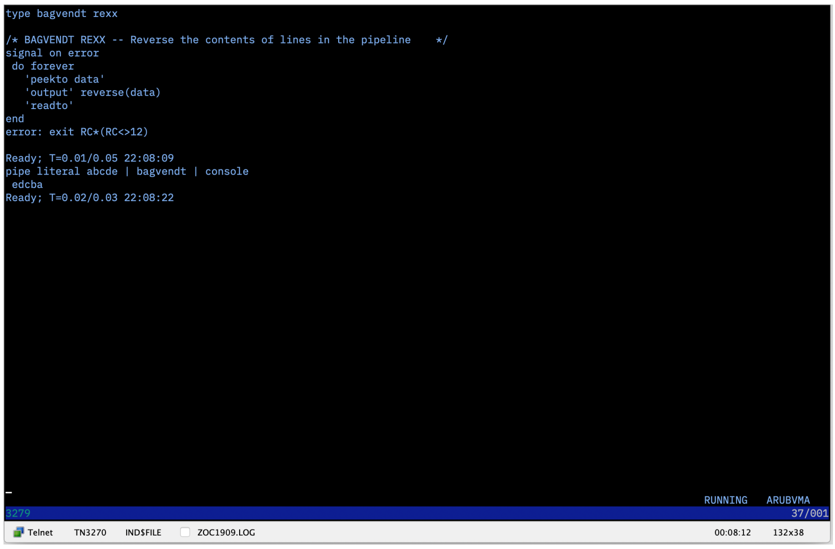
```
pipe "literal abcd | bagvendt | console"
```

[3]From the document CMS Pipelines Explained, by John P. Hartmann

If you have a CMS handy, that would be:

```
pipe literal abcd | bagvendt | console
```

on the first, Classic Rexx version of the filter - but the quoted version also works on CMS.



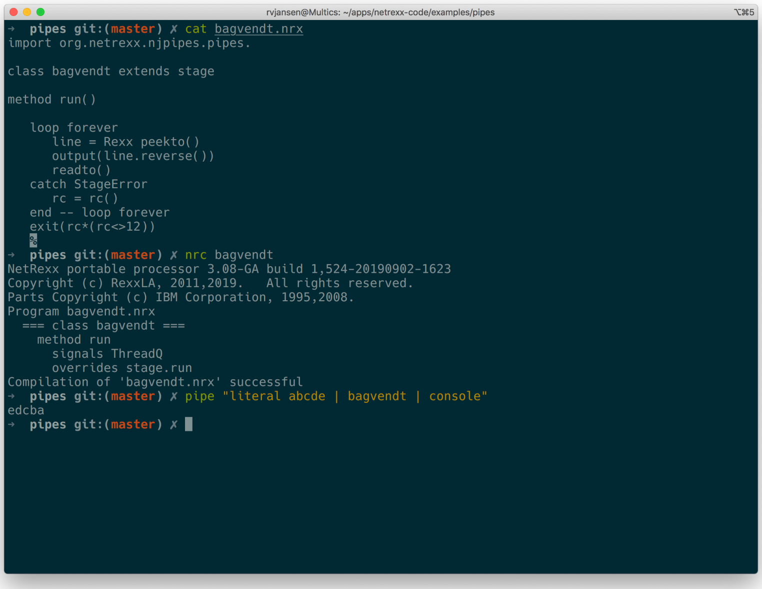
```
type bagvendt rexx

/* BAGVENDT REXX -- Reverse the contents of lines in the pipeline    */
signal on error
 do forever
   'peekto data'
   'output' reverse(data)
   'readto'
end
error: exit RC*(RC<>12)

Ready; T=0.01/0.05 22:08:09
pipe literal abcde | bagvendt | console
 edcba
Ready; T=0.02/0.03 22:08:22
```

```
                                                                                                    RUNNING   ARUBVMA
3279                                                                                                            37/001
```

FIGURE 9: BAGVENDT under VM/CMS



```
→  pipes git:(master) ✗ cat bagvendt.nrx
import org.netrexx.njpipes.pipes.

class bagvendt extends stage

method run()

   loop forever
      line = Rexx peekto()
      output(line.reverse())
      readto()
   catch StageError
      rc = rc()
   end -- loop forever
   exit(rc*(rc<>12))
   %
→  pipes git:(master) ✗ nrc bagvendt
NetRexx portable processor 3.08-GA build 1,524-20190902-1623
Copyright (c) RexxLA, 2011,2019.   All rights reserved.
Parts Copyright (c) IBM Corporation, 1995,2008.
Program bagvendt.nrx
  === class bagvendt ===
    method run
      signals ThreadQ
      overrides stage.run
Compilation of 'bagvendt.nrx' successful
→  pipes git:(master) ✗ pipe "literal abcde | bagvendt | console"
edcba
→  pipes git:(master) ✗ █
```

FIGURE 10: bagvendt.nrx under NetRexx

6

More advanced Pipelines

Admittedly, the examples in the previous chapters could have been done with Unix pipes or at least with incorporation of stream utilities like awk or sed.

To get a good idea of what can be done with Pipelines for NetRexx, look at the tasktest pipe in the examples directory. It [4] implements the shell of a multitasking server - using about eight stages. The file examples/tcptask.njp contains an example of this technique being used.

```
--tasktest.njp

pipe (tasktest stall 2000 -gen)

  literal 0 1 2 3 4 5 6 7 8 9 A B C D E F G H I J K L M N O P Q R S T |
  dup 2 |
  split |             -- supply work for task stage

  ptimer |
a: deal secondary ?   -- send work to task stage requesting work
b: faninany |
  elastic |           -- buffer requests to so no deadlocks
  ptimer |

 a: |
  copy |              -- buffer work so no deadlocks
  task 1 |            -- worker task 1
 b: ?

 a: |
  copy |
  task 2 |            -- worker tast 2...
 b: ?

 a: |
  copy |
  task 3 |
 b:
```

Before discussing this example in-depth, we need to go into some more basic concepts.

[4]using code from Melinda Varians 'Cramming for the Journeyman Plumber Exam' paper

7

Device Drivers

Pipelines for NetRexx contains the following device drivers:

<	read from a fle
>	write to a file (which is overwritten if it exists)
»	append to a file (which is created if it does not exist)
diskr	read from a fle
diskw	write to a file (which is overwritten if it exists)
diska	append to a file (which is created if it does not exist)
diskslow	read, create or append to a file
array	manipulate arrays
arraya	manipulate arrays
arrayr	manipulate arrays
stem	manipulate stems
stema	manipulate stems
stemr	manipulate stems
vector	manipulate vectors
vectora	manipulate vectors
vectorr	manipulate vectors
var	read or set a variable in a NetRexx program
zip	compress a set of files (0 or more) into a zip archive
unzip	decompress a set of files (0 or more) from a zip archive
listzip	list a zip file directory
console	read from, or write to a terminal (window)
hole	destroy data
delay	suspend stream
literal	write the argument string
strliteral	write the argument string
sqlselect	select from any jdbc source
xrange	write a character range

8

Record Selection

Various stages can select records and work on data in the pipeline. These are stages called select, sort, specs, locate, etcetera. For a complete description we refer to the IBM Pipelines documentation.

These are the main selection stages supported in Pipelines for NetRexx:

between	selects records between labels
drop	discard records from the beginning or the end of a file
find	select lines
strfind	select lines
frlabel	select records from the first one with leading string
strfrlabel	select records from the first one with leading string
inside	select records between labels
locate	select records between labels
nfind	select lines using xedit nfind logic
strnfind	select lines using xedit nfind logic
nlocate	select lines without a string
notinside	select records not between labels
outside	select records not between labels
pick	select records that satisfy a relation
take	select records from the beginning or the end of a file
tolabel	select records to the first one with leading string
strtolabel	select records to the first one with leading string
unique	discard or retain duplicate lines

9

Filters

buffer	buffer records
chop	truncate the record
join	join records
pad	expand short records
split	split records relative to a target
change	substitute contents of records
specs	rearrange contents of records
xlate	transliterate contents of records
copy	copy records
count	count lines, words and bytes
dup	duplicate the object
reverse	reverse contents of records
timestamp	prefix date and time to records
append	put output from device driver after data on the primary input
casei	run selection stage in a case-insensitive manner
not	run stages with output streams inverted
prefix	Blocks its primary input and excutes stage supplied as an argument
zone	run selection stage on subset of input record
elastic	buffer sufficient records to prevent stall
fanin	concatenate streams
faninany	copy records from whichever input stream has one
gate	pass records until stopped
juxtapose	preface record with marker
overlay	overlay data from input streams
command	issue a command and write response to pipeline

10

Other Stages

query	check version and level of Pipelines for NetRexx
“– –”	insert comments into a pipeline
comment	insert comments into a pipeline

11

Multi-Stream Pipelines

One of the defining differences with Unix pipes is the possibility to define multi-stream pipelines. The selection stages in the previous chapter all have *secondary streams*. What the selection parameters have discarded, *seem to have discarded*, is in reality not gone. In fact, Pipelines for NetRexx throws very little away during execution.

The way to use the not-selected part of the data through these secondary streams is explained in this chapter; it is this capacity that constitutes the freedom to work with many different streams in one pipeline; where Unix pipes are limited to not very much more than stdin, stdout, stderr – Pipelines for NetRexx enables the user to define as many streams as necessary to accomplish the task at hand in an efficient manner.

Let us look at a simple selection like the following:

```
pipe literal foo bar baz frob frobnitz frobbotzim | split | locate /oo/ |
console
```

```
foo
```

The string that makes it through the selection that is done by the *locate* is 'foo' - it is the only one that is captured by the /oo/ filter.

The rest of the words is not gone, however, and we can use these in further processing by using the secondary stream that *locate* provides.

To prepare for this, we give the secondary stream a name by providing a label for it, we call it, in absence of any creativity, *rest*. Also, we send the selected output, 'foo' into a *hole* stage, where it disappears.

```
pipe literal foo bar baz frob frobnitz frobbotzim | split | rest: locate /oo/ |
hole
```

As predicted, there is no output. To get to the rest of the words, unselected by *locate*, we connect the secondare output stream to a new pipe, using the '?' (the default pipe-end character) like this:

```
pipe literal foo bar baz frob frobnitz frobbotzim | split | rest: locate /oo/ |
hole ? rest: | console
```

The output is now:

```
bar
baz
frob
frobnitz
frobbotzim
```

Instead of sending the original output into a black *hole*, we could have also gone further with it, and, for example, reverse it:

```
pipe literal foo bar baz frob frobnitz frobbotzim | split | rest: locate /oo/ |
reverse | console ? rest: | console
```

The output is now:

```
oof
bar
baz
frob
frobnitz
frobbotzim
```

Likewise, we can specify more filter stages in the second, attached pipeline, and bifurcate the pipeline even further.

```
pipe literal foo bar baz frob frobnitz frobbotzim | split | rest: locate /oo/ |
reverse | console ? rest: | locate /botzim/ | console
```

The output is now:

```
oof
frobbotzim
```

It is good to define and implement secondary streams when you write your own stages.

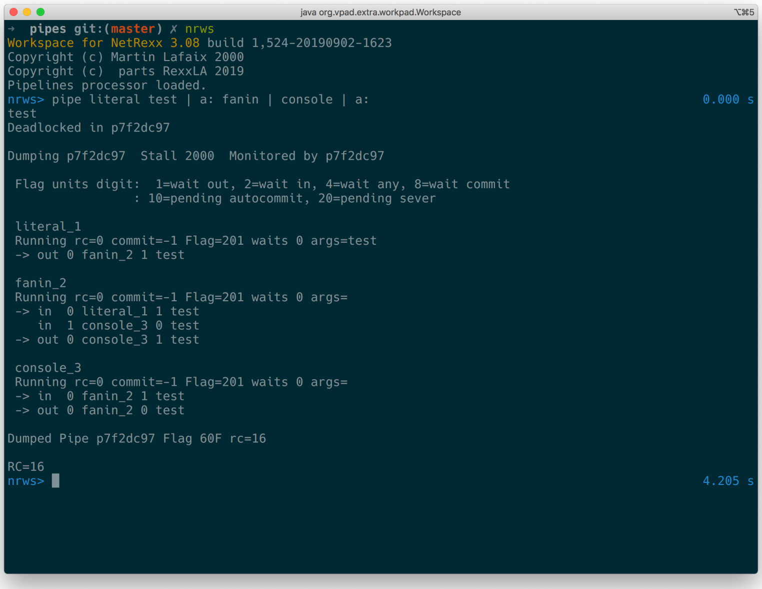
12

Pipeline Stalls

With multistream pipelines a new problem is introduced, which sometimes rears its head - a *Pipeline stall*, also called *deadlock*. This happens when stages wait for input that cannot be delivered, in a way that ensures that it cannot be delivered.

Pipes for NetRexx detects deadlocks and outputs information to allow you to fix the problem. Consider the following session:

```
pipe literal test | a: fanin | console | a:
```



```
→  pipes git:(master) ✗ nrws
Workspace for NetRexx 3.08 build 1,524-20190902-1623
Copyright (c) Martin Lafaix 2000
Copyright (c)  parts RexxLA 2019
Pipelines processor loaded.
nrws> pipe literal test | a: fanin | console | a:                       0.000 s
test
Deadlocked in p7f2dc97

Dumping p7f2dc97  Stall 2000  Monitored by p7f2dc97

 Flag units digit:  1=wait out, 2=wait in, 4=wait any, 8=wait commit
                 : 10=pending autocommit, 20=pending sever

 literal_1
 Running rc=0 commit=-1 Flag=201 waits 0 args=test
 -> out 0 fanin_2 1 test

 fanin_2
 Running rc=0 commit=-1 Flag=201 waits 0 args=
 -> in  0 literal_1 1 test
    in  1 console_3 0 test
 -> out 0 console_3 1 test

 console_3
 Running rc=0 commit=-1 Flag=201 waits 0 args=
 -> in  0 fanin_2 1 test
 -> out 0 fanin_2 0 test

Dumped Pipe p7f2dc97 Flag 60F rc=16

RC=16
nrws>                                                                   4.205 s
```

FIGURE 11: Deadlock detection

We can see that there are three stages in the Running state. None have any return codes set. The Flags tell us that all the stages are waiting for an output to complete.

The '->' show which stream is selected. From this we can see console_3 is trying to output to fanin_2. Unfortunately fanin_2 is waiting for output on stream 0 to complete, it cannot read the data waiting on in stream 1. Hence the stall.

The strings after *Dumping* and *Monitored by* are the autogenerated class names. When you name your pipelines with precompiled pipes, the names you have given them will be displayed here.

When a stream has data being output, there is a boolean flag following the name of the stage the stream is connected to. This tracks the peek state of the object. For an output stream, true means the following stage has peeked at the value. With input streams, the current stage has seen the value when its true.

When a stage is multithreaded, like elastic, you can get flags of 3 or 5. This means that threads are waiting on output and read, or output and any. When using multithreaded stages, only one thread should use output unless it is serialized using protected or syncronized blocks.

When a stage has a pending sever or autocommit flag bits are set too.

13

Differences with CMS Pipelines

The goal of this implementation is to be as close as possible to the the CMS version of Pipelines. A few differences are unavoidable.

- The character set is Unicode and not EBCDIC, as Unicode is the character set of the underlying Java platform
- As shells are different, many 3270 related stages are not implemented
- Pipes need to be quoted on the Windows and Unix command lines; the Workspace for NetRexx (*nrws*) environment is an exception to this rule
- The mainframe is record-oriented in many stages, Pipelines for NetRexx does an approximation of this
- Pipelines on the mainframe is an interpreted language with components as the scanner and the dispatcher; the NetRexx version is compiled to Java .class files by *pipc*, the pipes compiler, and dispatched as threads by the JVM.
- The mainframe pipes dispatcher is not multiprocessor enabled. In Pipelines for NetRexx all tasks (stages) are dispatched over all available processors in parallel.
- The fact that pipes run from NetRexx implies that they can be used in Java source. In previous releases there was more direct support for this; this has lapsed due to changes in the way a java toolchain works. This support can be restored in future releases.
- To put the content of a NetRexx variable in a pipe specification in a NetRexx program, there is a `{}` mechanism. In CMS the pipe would be quoted and you would unquote sections to get a similiar effect.

14

How to use a pipe in a NetRexx program

This shows how to use a pipe in a NetRexx program:

```
class testpipe

  method testpipe(avar=Rexx)

    F = Rexx 'abase'
    T = Rexx 1

    F[0]=5
    F[1]=222
    F[2]=3333
    F[3]=1111
    F[4]=55
    F[5]=444

    pipe (apipe stall 1000 )
      stem F | sort | prefix literal {avar} | console | stem T

    loop i=1 to T[0]
      say 'T['i']='T[i]
    end

  method main(a=String[]) static

    testpipe(Rexx(a))
```

A couple of things can be seen in this example. First that it is simple to pass NetRexx variables to pipes using *stem*. Also look at the phrase `{avar}`. It passes the NetRexx variable's value to the stage at runtime. In CMS the pipe would be quoted and you would unquote sections to get a similiar effect.

Another thing to note is that the pipe extraction program is fairly smart. It detects when pipes takes several lines. As long as there are stages, or the current line ends with a stage-sep or stageend character, or the next line starts with a stagesep or stageend character. It gets added to the pipe.

The arg(), arg(rexx) or arg(null) methods get the arguments passed to a stage or pipe. To get the complete rexx string of an argument use arg(). To get the nth word of a rexx argument use arg(n). When using pipes in netrexx code you can use arg('name') to get the named argument. If the class of the argument is not rexx use arg(null) to get the object.

In .njp files you can use avar phrase actually just shorthand for arg('avar'). The following example shows what has to be done in a stage to access the rexx variables passed by VAR, STEM and OVER. The real over stage is a bit more complete.

```
  -- over.nrx
class over extends stage final

  method run() public
     a = getRexx(arg())
    loop i over a
    output(a[i])
  catch StageError
    rc = rc()
  end

exit(rc*(rc<>12))
```

The getRexx method is passed the name of a string by the pipe. In the previous example it would be passed A and would return an Object pointer to A in testpipe. If you wish to replace a stream this can be done using connectors. For example look at the following fragment:

```
-- examples\calltest.njp
pipe (callt1) literal test | calltest {} | console
```

```
import org.netrexx.njpipes.pipes.

class calltest extends stage final

method run() public

  do
    a = arg()

    callpipe (cp1) gen {a} | *out0:

    loop forever
      line = peekto()
      output(line)
      readto()
    end

  catch StageError
    rc = rc()
  end

exit(rc*(rc<>12))
```

Running the callt1 pipe with an argument of 10 would pass the 10 to calltest via and arg(). Then cp1's gen stage would be passed 'a' which is set to 10. Since gen generate numbers in sequence, the console stage of callt1 would get the numbers from 1 to 10. Now cp1 ends and calltest's output stream is restored and calltest unblocks and reads the the literal's data 'test' and passes it to console.

The use of only works when compiling from .njp files. It will not work from the command line. The njpipes compiler recognizes connectors as labels with the following forms:

```
 *in:
*inN:
*out:
*outN
```

When N is a whole number, the connector connects input or output stream N of the stage with the connector. When the label *in or *out, the connector connects the stages's current input or output stream with the connector. This is used instead of *: due to the way the compiler/preprocessor works. If you do not want the stage to wait for the called pipe to complete you can use addpipe. Here is an example.

```
-- similar to examples\addtest.njp

a = 100
```

```
b = 'some text for literal'

addpipe (linktest) literal {b} | dup {a} | *in0:

loop forever
  line = Rexx readto()
catch StageError
end
```

readto() will get 'some text for literal' one hundred times.

A quick aside. When writing stages remember that njPipes moves objects through pipes. Use 'value = peekto()' instead of 'value = rexx peekto()' when ever possible. Some of the supplied stages pass objects with classes other than rexx and forcing rexx will cause class-CastExceptions. If a stage needs a rexx object try using the rexx stage modifier to attempt to convert the object. Feel free to expand this stage, but please send me the updated version.

Serious stage writers will probably want to take a good look at the methods defined in the NetRexx source package `org.netrexx.process.njpipes.stages`. There you will find various methods for parsing ranges. You will also find the stub for the stageExit compiler exit. It can be used to produce 'on the fly' code at compile time. You can also use it to change the topology of the unprocessed part of the pipe. The major use is to allow implementations of stages like prefix, append or zone. Its also used to produce better performing stages, for an example see specs. The compiler also queries the rexxArg() and stageArg() methods. If your stage expects objects of class Rexx as arguments rexxArg() should return the number of variables expected. If your stage expects a stage for an argument, stageArg() should return the word position of the stage.

15

TCP/IP Networking using Pipes for NetRexx

As the built-in stages all work on data that is dispatched through the pipeline, irrespective of which device driver is used, it is also convenient to do network programming using a set of pipelines.

The *tcplisten* stage can be used as a network device driver, as in CMS, but limited to specification of the port and a timeout value. Below an example of how to implement a sample TCP/IP client/server application.

```
-- one shot tcpip server

pipe (tcpserv stall 60000 debug 0 )
  tcplisten 1958 timeout 15000 | tcpexample

-- one shot tcpip requestor

pipe (tcpreq stall 60000 debug 0 )
  random {} |
  specs *-* 1 ,\n, next |
  tcpclient deblock c localhost 1958 timeout 10000 linger 500 oneresponse |
  rexx to console

-- a single tasking server

options binary
import org.netrexx.njpipes.pipes.
class tcpexample extends stage

method run() public

  loop forever

    peekto()

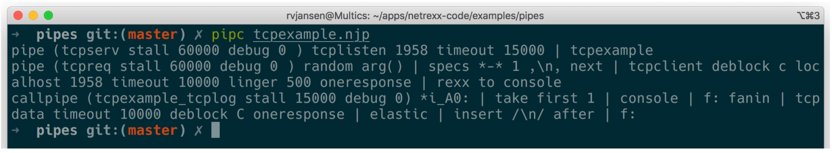
    callpipe (tcplog stall 15000 debug 0)
      *in0: |
      take first 1 |
      console |
    f: fanin |
      tcpdata timeout 10000 deblock C oneresponse |
      elastic |
      insert /\n/ after |
    f:

  catch StageError
    rc = rc()
  end

exit(rc*(rc<>12))
```

This example needs to be compiled with the pipes compiler, see *TCP/IP Client/Server compile*, which yields the classes tcpserv and tcpreq, for the server and the requester component.

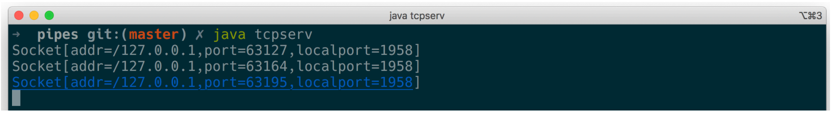
Now we can start the generated pipelines each in their own shell window. As can be seen in *TCP/IP server*, the class keeps waiting on connections on port 1958 - which is



```
rvjansen@Multics: ~/apps/netrexx-code/examples/pipes                    ⌥⌘3
→  pipes git:(master) ✗ pipc tcpexample.njp
pipe (tcpserv stall 60000 debug 0 ) tcplisten 1958 timeout 15000 | tcpexample
pipe (tcpreq stall 60000 debug 0 ) random arg() | specs *-* 1 ,\n, next | tcpclient deblock c loc
alhost 1958 timeout 10000 linger 500 oneresponse | rexx to console
callpipe (tcpexample_tcplog stall 15000 debug 0) *i_A0: | take first 1 | console | f: fanin | tcp
data timeout 10000 deblock C oneresponse | elastic | insert /\n/ after | f:
→  pipes git:(master) ✗
```

FIGURE 12: TCP/IP Client/Server compile

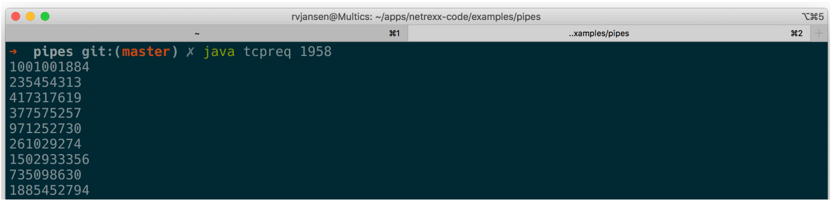
arbitrary, but specified in the pipeline source.



```
java tcpserv                                                            ⌥⌘3
→  pipes git:(master) ✗ java tcpserv
Socket[addr=/127.0.0.1,port=63127,localport=1958]
Socket[addr=/127.0.0.1,port=63164,localport=1958]
Socket[addr=/127.0.0.1,port=63195,localport=1958]
```

FIGURE 13: TCP/IP server

In another window, we can start the *TCP/IP requestor*, which when given port 1958 as argument, connects to the server, and displays a series of random numbers that is sent to it.



```
rvjansen@Multics: ~/apps/netrexx-code/examples/pipes                    ⌥⌘5
~                                  ⌘1   ..xamples/pipes                    ⌘2
→  pipes git:(master) ✗ java tcpreq 1958
1001001884
235454313
417317619
377575257
971252730
261029274
1502933356
735098630
1885452794
```

FIGURE 14: TCP/IP requestor

Note that the stage *tcpexample* from the *tcpserver* pipeline is a custom stage that is written in this tcpexample.njp file.

16

Selecting from databases with Pipelines for NetRexx

Using the built-in *sqlselect* stage you can select data, using SQL, from any jdbc source available.

An `sqlselect.properties` file is needed to define the jdbc parameters like the driver to use, the url of the data source and other arguments, like a password and tracing options, if needed.

The file looks like this:

```
jdbcdriver=org.sqlite.JDBC
url=jdbc:sqlite:flightroute-iata.sqb
```

This is all that is needed for an sqlite database containing flight data. A simple select * can then be done with the following pipeline:

```
pipe literal * from FlightRoute where flight = 'KLM765' | sqlselect | console
```

This yields the following output:

```
FLIGHT--ROUTE--UPDATETIME--
KLM765  AUA-BON-AMS  1494132448
```

Note that from the command line, the quotes around the pipe specification and the literal string in the SQL statement should be opposite, while when the pipeline is issued from the Workspace for NetRexx, the pipeline does not have to be quoted, but the sql string needs double quotes instead of the - for SQL statements- normal single quotes.

17

The Pipes Runner

The pipes compiler is used in both precompiled and directly executed pipelines. When you directly execute a pipeline from the commandline or from the *nrws* NetRexx workspace, the process is optimized to not persist generated NetRexx, Java and Class files to disk before execution, the whole process runs from memory. The Pipes Runner uses the Pipes Compiler for this purpose, and as such misses the options for persistence[5].

The *pipe* command alias start the Pipes Runner, which is a command processor that can execute a pipe from the command line in an OS shell, the OS being Windows, Linux or macOS[6].

A pipe can be run with options prepended within parentheses, like this:

```
pipe '(test1 sep ! stall 2000 debug 63) literal abcde ! console'
```

The following options are available:

pipename	Specify the name of the generated class file. This can be useful for debugging purposes but is not mandatory when running a pipe. An unnamed pipe receives a generated unique name. This option needs to go first.
sep	The default stage separator is the | (pipe) character; this can be overridden with the sep option; a pipe called test1 which uses an exclamation mark as separator character, needs the options (test1 sep !).
debug	The debug option specifies a bitmask for debugging the execution of a pipe; (debug 63), for example, generates a rather complete debugging trail).
end	The default pipe end character is the ' ?' (question mark), which can be overridden here. Note that the backslash, which is an obvious pipe end character for the z/VM 3270 interface, is not a good choice for Windows and Unix shells.
stall	The duration in number of seconds of a pipe stall (or deadlock) detection cycle.

[5]But specifying them will not generate an error
[6]this is a non-exhaustive list of operating systems

18

The Pipes Compiler

The purpose of precompiling a pipeline specification is to produce a .class file for the JVM that can be run independently and on different machines; only the JVM and the NetRexxC.jar or the NetRexxF.jar are required to run a precompiled pipe. A set of precompiled pipes can be shipped as an application.

When precompiling pipes, there are options to save and view the generated NetRexx, Java and JVM Class files. A precompiled pipe has the advantage that it can be executed over and over in an application, without the need to compile it every time; the performance savings are accumulative in this scenario.

The following options can be used on the *pipc* command, in addition to the ones specified in the previous chapter for the Pipes Runner:

-gen	Generate the NetRexx source file. The pipeline needs a name.
-keep	Keep the Java source which is generated from the NetRexx source.

Example:

```
pipe (testpipe -gen -keep)
```

This will generate the NetRexx source as well as keep the java source.

19 Built-in Stages

This section describes the set of built-in stages, i.e. the ones that are delivered with the downloadable open source package. These stages are directly executable from the NetRexxC.jar file or the NetRexxF.jar file (the latter contains a Java compiler for use on JRE-only systems); also, the source of these stages is delivered in the NetRexx source repository. This repository can be checked out at

```
git clone https://git.code.sf.net/p/netrexx/code netrexx-code
```

The source of the stages is in directory

```
netrexx-code/src/org/netrexx/njpipes/stages
```

--	Pipelines for NetRexx only; delegates to comment
<	Implemented as in CMS; delegates to **diskr.**
>	Implemented as in CMS; delegates to **diskw.**
>>	Implemented as in CMS; delegates to **diska.**
?	Not implemented. Help.
3270bfra	Not implemented. Old terminal support.
3270enc	Not implemented. Old terminal support.

abbrev	`>>--ABBREV--+------------------------------------+------------------------><`
	`            +--word--+-----------------------+--+`
	`                     +--number--+------------+-+`
	`                                +--ANYCASE--+`
	Pipes for NetRexx only

aftfst	Not implemented. Open file information
ahelp	Not implemented. Author's help
all	Not implemented. Select all records containing a specified string or strings determined by an expression
apldecode	Not implemented. Old APL language
aplencode	Not implemented. Old APL language
append	`>>--APPEND--string--------------------------------------------------------><`
array	Pipes for NetRexx
arraya	Pipes for NetRexx
arrayr	Pipes for NetRexx
arrayw	Pipes for NetRexx
asatomc	Not implemented. Old printer control
asmcont	Not implemented. Assembler language
asmfind	Not implemented. Assembler language
asmnfind	Not implemented. Assembler language
asmxpnd	Not implemented. Assembler language

between	`>>--BETWEEN--+----------+--/string/--+--/string/--+-----------------------><`
	`             +--ANYcase-+            +--n---------+`

bfs	Not implemented. Read Bit Stream File
bfsdirectory	Not implemented. Read Bit Stream Directory
bfsquery	Not implemented. Read Bit Stream current Directory
bfsreplace	Not implemented. Bit Stream file
bfstate	Not implemented. Read Bit Stream file
bfsxecute	Not implemented. Read Bit Stream file
block	Not implemented. See fblock. Reformat records

buffer	`>>--BUFFER--+--------------------+----------------------------------------><`
	`            +--n--+------------+-+`
	`                  +--/string/--+`

buildscr	Not implemented. Old terminal
casei	`>>--CASEI--stage----------------------------------------------------------><`

change	`                         +--1-*------------+`
	`>>--CHANGE--+---------+--+-----------------+------>`
	`            +-ANYcase-+  +-inputRange------+`
	`                         |    <-------+     |`
	`                         +-(--+-range-+--)-+`
	
	`   >--+-/string1/string2/----+--+-------------+-------------------------><`
	`      +--/string/--/string/--+  +--numorstar--+`

chop

```
                     +--80------+
>>--+--CHOP-----+--+----------+--------------------------------------------><
    +--TRUNCate-+  +--column--+
```

cms

Not implemented. OS dependent.

collate

Not implemented. Match records from 2 streams.

combine

Not implemented. Joins bit-oriented streams.

command

```
>>--COMMAND--+----------+-------------------------------------------------><
             +--string--+
```

-- input stream 0 is for commands

-- input stream 1 is stdin

-- output stream 0 is stdout

-- output stream 1 is the return code

-- output stream 2 is stderr

configure

Not implemented. Create specifications for CMS Pipelines in z/VM.

compare

```
             +-TRINARY-+  (1)           +-PAD SPACE-+
>>--COMPARE--+---------+------------+---+-----------+---------------------><
             +-BINARY--+  (2)       |   +-PAD-Xorc--+
             |                      |
             | <-----------------+  |
             +--ANY DString------+--+   (4) (5)
             +--EQUAL DString----+      (4)
             +--LESS DString-----+  (3) (4)
             +--MORE DString-----+  (3) (4)
             +--NOTEQUAL DString-+      (4)
```

(1) -1 = Primary is shorter/less, 0 = equal, 1 = Secondary is shorter/less

(2) 0 = equal, 1 = not equal

(3) Primary is LESS/shorter (or MORE/longer) than secondary

(4) *DStrings* can use any of the following escapes (or the lowercase) for

the unequal situation:

    \C (count) for the record number,

    \B (byte) for column number

    \P (primary) for the primary stream record
      \S (secondary) for the secondary stream record
      \L (Least) for then stream number that is shortest, -1 if equal
      \M (Most) for the stream number that is longest, -1 if equal

5. Equal or not, this DString precedes any of the others.

Pipes for NetRexx only.

configure

Not implemnted. OS dependent

console

```
>>--+-CONSole--+--+-----------------+-------------------------------------><
    +-TERMinal-+  +--EOF--/string/--+
                  +--NOEOF----------+
```

copy

```
>>--COPY------------------------------------------------------------------><
```

copy from input stream to output without delaying the stream.
See elastic for a more generic way to do this.

count

```
           <--------------------+
>>--COUNT--v--+--CHARACTErs--+--+-----------------------------------------><
              +--WORDS-------+
              +--LINES-------+
              +--MINline-----+
              +--MAXline-----+
```

cp

Not implemented. OS specific.

crc

Not implemented. Compute a checksum

c14to38

Not implemented. Old printer.

dam

Do no pass any objects thru secondary streams until an object appears
on the primary input stream. The primary output stream must not
be connected.

Pipes for NetRexx only.

dateconvert

Not implemented. Timestamp conversion and validation.

deal

```
          +--STOP--ALLEOF-----------------------+
>>--DEAL--+-------------------------------------+-------------------------><
          +--STOP--+--ALLEOF--+-----------------+
          |        +--ANYEOF--+                 |
          |        +--n-------+                 |
          +--SECONDARY--+-----------+-----------+
          |             +--RELEASE--+           |
          +--KEY—inputRange--+---------+--------+
          |                  +--STRIP--+        |
          +--STREAMid--inputRange--+---------+--+
                                   +--STRIP--+
```

Since Java dispatches the stage threads. Deal may not see a sever
immediately, as the severing thread can get multitasked.
This can make options like 'ANYEOF' work in unexpected ways.

deblock

```
             +--FIXED--n--+-------------+-------------------------+
             |            +--PAD--xorc--+                         |
>>--DEBLOCK--+----------------------------------------------------+------->>
             +--+--C----------------+--+-------------+--+--------+
                +--J----------------+  +--TERMINATE--+  +--EOF---+
                +--CRLF-------------+
                +--LINEND xorc------+
                +--STRING--/string/--+
```

?? System.getProperty('line.separator') ??

delay

Not implemented. Wait for clock time

dict

Pipes for NetRexx only.

dicta

dicta

dictw

disk

As in CMS, equivalent to diskr (Pipes for NetRexx Only) or <.

diska

Appends records on its input stream to the end of the supplied file, the
file is created if its does not exist.

diskr

diskslow

diskw

drop

```
          +--FIRST--+  +--1--+
>>--DROP--+---------+--+-----+--+---------+-------------------------------><
          +--LAST---+  +--n--+  +--BYTES--+
                       +--*--+
```

dup

```
         +--1----+
>>--DUP--+-------+---------------------------------------------------------><
         +--n----+
         +--*----+
         +-- -1--+
```

elastic

```
>>--ELASTIC----------------------------------------------------------------><
```

ems
Not implemented. OS specific.

escape
Not implemented. Insert escape characters so special characters are treated a

fanin
```
>>--FANIN--+--------------+-----------------------------------------------><
           |  <---------+ |
           +--+--stream-+-+
```

faninany
```
>>--FANINANY--------------------------------------------------------------><
```

fanout
```
            +--STOP--ALLEOF------+
>>--FANOUT--+--------------------+----------------------------------------><
            +--STOP--+--ANYEOF-+-+
                     +--n------+
```

fblock
```
>>--FBLOCK--number--+--------+--------------------------------------------><
                    +--xorc--+
```

file
As in CMS. Synonym of **disk**

filea
Pipes for NetRexx only. Synonym of **diska**

fileback
Not implemented. Read a CMS file backwards.

filefast
Not implemented. Read or write a CMS file.

filer
Pipes for NetRexx only. Synonym of **diskr**

filerand
Not implemented. Read specific records from a CMS file.

fileslow
Synonym for **diskslow**.

fileupdate
Not implemented. Change records in a CMS file.

filew
Pipes for NetRexx only. Synonym of **diskw**

find
```
>>--+--FIND--+----------+-------------------------------------------------><
             +--string--+
```

fmtfst
Not implemented. OS specific

frlabel
```
>>--+--FRLABEL--+---------+-----------------------------------------------><
                +--string-+
```

frtarget
```
>>--+--FRTARGET----+--stage--+------------+-------------------------------><
    +--FROMTARGet--+         +--operands--+
```

fullscreen
Not implemented. Old terminal.

fullscrq
Not implemented. Old terminal.

fullscrs
Not implemented. Old terminal.

gate
```
>>--GATE--+----------+----------------------------------------------------><
          +--STRICT--+
```

gather
Not implemented. Read records in specified order.

getfiles
```
>>--GETfiles--------------------------------------------------------------><
```

getovers
Input stream 0 should contain rexx objects. The getovers stage will
output will output the index and contents of the stem on stream 0.
If output stream 1 is connected, the root is placed there. Any
severed streams will cause then stage to exit. Passing a non rexx
object will cause the stage to exit with return code 13

Pipes for NetRexx only

getstems
Input stream 0 should contain rexx objects containing stems. The
getstems stage will output the contents of the stem on stream 0.
If output stream 1 is connected, the root is placed there. Any
severed streams will cause then stage to exit. Passing a non rexx
stem object will cause the stage to exit with return code 13

Pipes for NetRexx only.

hash
Pipes for NetRexx only. Synonym of dict

hasha
Pipes for NetRexx only. Synonym of dicta

hashr
Pipes for NetRexx only. Synonym of dictr

hashw
Pipes for NetRexx only.

help

Not implemented. Help for CMS Pipelines.

hole

```
>>--HOLE--------------------------------------------------------------------><
```

hostbyaddr

Not implemented. Resolve IP address to domain and host name.

hostbyname

Not implemented. Resolve domain name to IP address.

hostid

Not implemented. Writes default IP address.

hostname

Not implemented. Writes host name of the TCP/IP system.

iebcopy

Not implemented. OS dependent.

immcmd

Not implemented. OS dependent.

insert

```
                      +--BEFORE--+
>>--INSERT--/string/--+----------+------------------------------------------><
                      +--AFTER---+
```

insert a string into a record. Will be much more efficient than specs especially if the input is a Byte[]

Pipes for NetRexx only.

inside

```
>>--INSIDE--/string1/--+--/string2/--+--------------------------------------><
                       +--n----------+
```

instore

Not implemented. Read records into storage.

ip2socka

Not implemented. Convert IP address to special hex.

ispf

Not implemented. OS dependent.

join

```
          +--1-------------+
>>--JOIN--+----------------+--+-----------+--+---------------+--------------><
          +--n-------------+  +--/string/-+  +-maxlength(1)--+
          +--*-------------+
          +--KEYLENgth--n--+
```

(1) The *maxlength* operand cannot be entered without specifying other operands.

joincont

```
                                        +--TRAILING------+
>>--JOINCONT--+-----------+--+-------+--+----------------+--+---------+-----><
              +--ANYCase--+  +--NOT--+  +--RANGE--range--+  +--ANYof--+
                                        +--LEADING-------+
```

juxtapose

```
>>--JUXTAPOSe---------------------------------------------------------------><
```

ldrtbls

Not implemented. Assembler: precompiled.

listpds

Not implemented. OS dependent.

literal

```
                +--{-object-name-}--+
>>--+-LITERAL---+-----------+-------+---------------------------------------><
                +--string---+
                +--PREFACE--+
```

locate

```
>>--LOCATE--+-----------+--+---------------+--+---------+--+------------+-->
            +--ANYcase--+  +--inputRanges--+  +--ANYof--+  +--/string/--+
```

lookup

in stream 0 are detail records

in stream 1 are master records

in stream 2 adds to masters

in stream 3 delete from masters

out stream 0 are matched records

out stream 1 are unmatched detail records

out stream 2 are unmatched or counted master records

out stream 3 deleted masters

out stream 4 duplicate masters

out stream 5 unmatched master deletes

lookup does not consider an unconnected output stream an error. It does propagate EOFs from output streams.

To increase performance reorder the 'when type=' in method out so the type you use is first in the list and recompile the stage.

```
>>--LOOKUP--+---------+--+-----------+--+-----------+--+----------+----->
            +--COUNT--+  +--ANYCASE--+  +--AUTOADD--+  +--BEFORE--+

   >--+-----------+--+------------+--+-------------+--+--------------+-->
      +--KEYONLY--+  +--SETCOUNT--+  +--INCREMENT--+  +--TRACKCOUNT--+

   >--+---------------------------+---------->
      +--inputRange--+------------+
      +--inputRange--+

   >--+-----------------------------+------------------------------------><
      +--DETAIL MASTER--------------+
      +--DETAIL ALLMASTER PAIRWISE--+
      +--DETAIL ALLMASTER-----------+
      +--DETAIL---------------------+
      +--MASTER DETAIL--------------+
      +--MASTER---------------------+
      +--ALLMASTER DETAIL PAIRWISE--+
      +--ALLMASTER DETAIL-----------+
      +--ALLMASTER------------------+
```

maclib — Not implemented. OS dependent.

mctoasa — Not implemented. Old printer.

mdiskblk — Not implemented. OS dependent.

members — Not implemented. OS dependent.

merge — Not implemented. Merge up to 10 input streams.

nfind

```
>>----NFIND--+----------+-----------------------------------------------><
             +--string--+
```

ninside — Not implemented. Alias for **notinside**.

nlocate

```
>>--NLOCATE--+-----------+--+---------------+--+---------+--+------------+><
             +--ANYcase--+  +--inputRanges--+  +--ANYof--+  +--/string/--+
```

noEofBack — Pipes for NetRexx only. Do not proprogate eof back thru this stage.

nop — Pipes for NetRexx only.

not

```
>>--NOT--stage--+------------+------------------------------------------><
                +--operands--+
```

notinside

```
>>--NOTINSIDE--+--+-----------+--/string/--+--n---------+-----------------><
                  +--ANYcase--+            +--/string/--+
```

notlocate
Not implemented. Alias for **nlocate**.

nucext
Not implemented. OS dependent.

optcdj
Not implemented. Old printer.

outside

```
>>--OUTSIDE--+---------+--/string/--+--n--------+-------------------------><
             +-ANYcase-+            +--/string/-+
```

outstore
Not implemented. Writes records from storage.

over
Pipes for NetRexx only. Extract all the indexes of a rexx variable stem. Like

overlay

```
             +--BLANK--+
>>--OVERlay--+---------+---------------------------------------------------><
             +--SPACE--+
             +--xorc---+
```

overstr
Not implemented. Old printer.

pack
Not implemented. Compacts data

pad

```
         +--Right--+     +--BLANK----+
>>--PAD--+---------+--n--+-----------+------------------------------------><
         +--Left---+     +--SPACE----+
                         +--char-----+
                         +--hexchar--+
```

pause
Not implemented.

pdsdirect
Not implemented. OS dependent.

pick

```
>>--PICK--+-----------+--+----------+--+-------------+--+--==---+--->
          +--ANYcase--+  +-PAD xorc-+  +-inputRanges-+  +--^==--+
                                                        +--<<---+
                                                        +--<<=--+
                                                        +-->>---+
                                                        +-->>=--+


   >--+---------------+---------------------------------------------------><
      +--inputRanges--+
      +--/string/-----+
```

The performance of Pick can be enhanced by reordering the compares in
the comp method to put your compare first.

pipcmd
Not implemented.

pipestop
Not implemented.

predselect
Not implemented. Input to selected output.

preface
Not implemented. Invokes a subroutine/stage then copies records.

prefix
Blocks its primary input and executes stage supplied as an argument. The
output from this stage are put to the primary output stream. When
its compete the primary input is shorted.

Pipes for NetRexx only.

printmc
Not implemented. Old printer.

punch
Not implemented. Old equipment.

qsam
Not implemented. Old equipment.

query
Implemented. Write info about Pipelines.

qsort

reader
Not implemented. Old equipment.

Reverse

```
>>--REVERSE---------------------------------------------------------------><
```

rexx
Not implemented. Run user written compiled stage.

rexxvars
Not implemented. Get info about defined REXX variables.

runpipe	Not implemented.
scm	Not implemented. Clean up comments in REXX and C.
serialize	{class} if class is specified deserialize input to objects of this type other Pipes for NetRexx only. For some reason readObject does not like more than one object network in its examples/sertest.njp
snake	Not implemented. Reformat one or more records into matrices.
socka2ip	Not implemented. Convert special 16-byte hex to IP address.
sort	sort objects: sort {({<Class>} {<size>} {A|D} {IRange} Where <Class> is a sortClass. The default is: Rexx and <size> is the maximum default. Pipes for NetRexx quirks.
sortClass	This is an interface class to allow a generic sort routine to handle objects implemented by sortRexx, which will sort rexx objects. Pipes for NetRexx only.
sortRexx	An implementation for sortClass for rexx objects. Part of the logic to generate sortClass stages is in sort's stageExit. Pipes for NetRexx only.
specs	Massage the data. Selections via start.length start-end, start-* and -from_e These selections can also be prefixed with 'word'. The conversion functions upper, lower, b2x, d2x, x2b and x2d are implemented format options left, right and center. The stop, select, read, readstop, pa work too. The number, TODclock and many other conversion functions are not implemented.

```
>>-SPECs--+----------------------+------------------------------>
          +--STOP--+--ANYEOF--+--+
                   +-n--------+

   +------------------------------------+
   V                                    |
>----+--| Group |-----------------------+---+-----------------------------><
     +--READ--------------------------------+
     +--READSTOP----------------------------+
     +--WRITE-------------------------------+
     +--SELECT--+--streamnum--+-------------+
     |          +--streamid---+             |
     +--PAD--+--char-----+------------------+
     |       +--hexchar--+                  |
     |       +--BLANK----+                  |
     |       +--SPACE----+                  |
     +--+--WORDSEParator---+--+--char-----+-+
        +--WS--------------+  +--hexchar--+
        +--FIELDSEparator--+  +--BLANK----+
        +--FS--------------+  +--SPACE----+
```

Group:

```
|--| Input |--| Conversion |--| Output |--| Alignment |---------|
```

Input:

```
|--+--Words---------wnumberrange----------------+---------------|
   +--Fields---------fnumberrange---------------+
   +--cnumberrange------------------------------+
   +--/string/----------------------------------+
   +--Xhexstring--------------------------------+
   +--Hhexstring--------------------------------+
   +--Bbinstring--------------------------------+
   | -       +--FROM--1-------+ +--BY--1------+  |
   +--RECNO-+----------------+-+-------------+--+
   |  -      +--FROM--fromnum-+ +--BY--bynum--+  |
   +--TODclock----------------------------------+
```

Specs

(cont)

Conversion:

```
|--+---------+--+----------------------+--------------------------|
   +--STRIP--+  +--C2B-----------------+
                +--C2D-----------------+
                +--C2F-----------------+
                +--C2I-----------------+
                +--C2P--+-------------+--+
                |       +------(scale)-+  |
                +--C2V-----------------+
                +--C2X-----------------+
                +--B2C-----------------+
                +--D2C-----------------+
                +--F2C-----------------+
                +--I2C-----------------+
                +--P2C--+-------------+--+
                |       +------(scale)-+  |
                +--V2C-----------------+
                +--X2C-----------------+
                +--f2t-----------------+
```

Output:

```
|--+-Next-+----------+---------+------------------------------------|
   |      |  (1)     |         |
   |      +--------.n-+        |
   +-+-NEXTWord-+-+----------+-+
   | +-NWord----+ |  (1)     | |
   |              +--------.n-+ |
   +-columnrange---------------+
 (1) No blanks allowed
```

Alignment:

```
|--+----------+---------------------------------------------------|
   +--Left----+
   +--Center--+
   +--Right---+
```

spill

Not implemented. Word wrap.

split	`>>--SPLIT--+-----------+--+-------------------+--------------------->`
	`           +--ANYCase--+  +--MINimum--number--+`
	
	`   +--AT-----------------------+           +--BLANK-------------------+`
	`>--+---------------------------+--+-----+--+----------------------------+--><`
	`   +--+----------+--+--BEFORE--+  +-NOT-+  +--| target |--+----------+-+`
	`      +--snumber-+  +--AFTER---+                             +--number--+`
	
	target:
	
	`   |--+--xrange------------------+--|`
	`      +--+--STRing--+--/string/--+`
	`         +--ANYof---+`

sql	Not implemented. OS dependent. See **sqlselect** for Pipes for NetRexx extension.
sqlcodes	Not implemented. OS dependent.
sqlselect	Pipes for NetRexx only. Extension to SQL uses jdbc to select from any jdbc en
stack	Not implemented. OS dependent.
Starmonitor	Not implemented. OS dependent.
starmsg	Not implemented. OS dependent.
starsys	Not implemented. OS dependent.
state	Not implemented. Determine if file(s) exist.
statew	Not implemented. Determine if file(s) exist.
stem	`>>--STEM--stem-------------------------------------------------------------><`
stema	Pipes for NetRexx only. Append to an existing stem, exits if the argument is
stemr	Pipes for NetRexx only.
stemw	Pipes for NetRexx only.
storage	Not implemented.
strasmfind	Not implemented. Assembler.
strasmnfind	Not implemented. Assembler.

strfind	`>>--+--STRFIND--+-----------+--/string/------------------------------------><`
	`                 +--ANYcase--+`

strfrlable	`>>--+--STRFRLABEL--+-----------+--/string/---------------------------------><`
	`                   +--ANYcase--+`

strip	Not implemented. Remove leading / trailing characters.

strliteral	`>>--STRLITERAL--+----------+--+------------+-------------------------------><`
	`                 +--APPEND--+  +--/string/--+`

strnfind	`>>--STRNFIND--+-----------+--/string/--------------------------------------><`
	`               +--ANYcase--+`

strtolabel	`>>--STRTOLABel--+-----------+--/string/------------------------------------><`
	`                 +--ANYcase--+`

strwhilelable	Not implemented. Select consecutive records.
subcom	Not implemented. OS dependent.
synchronize	Not implemented. Synchronizes a multistream pipeline.

take	`+--FIRST--+ +--1--+`
	`>>--TAKE--+---------+----+-----+------------------------------------------><`
	`+--LAST---+ +--n--+`
	`+--*--+`

tape	Not implemented. Old equipment.
timer	

tcpclient	Simple tcpclient implementation. The options implemented are similar to the C linger - wait a bit before terminating the last read (units SECONDS) timeout - wait this long before timing reads out (units MS) deblock - If deblock is omitted a copy stage is used. group - similar to CMS. A delimited string containing a stage is expected. You can use a run of stages, but its is dangerous since you to know the stage sep character being used... greeting - expect a greeting message and discard it nodelay - use the nodelay option keepalive - enable keep alive socket option oneresponse - synchronize cmds/replys
tcpdata	Simple tcpdata implementation. linger - wait a bit before terminating the last read (units SECONDS) timeout - wait this long before timing reads out (units MS) deblock - If deblock is omitted a copy stage is used. group - similar to cms. A delimited string containing a stage is expected. You can use a run of stages, but its is dangerous since you need to know the stage sep character being used... nodelay - use the nodelay option oneresponse - synchronize requests/replies
tcplisten	Simple tcplisten implementation. You can only supply the port and a timeout value, which is ignored unless tcplisten's output stream has been severed, in which case tcplisten terminates. If input stream 0 is connected, tcplisten does a peekto before calling the accept method. The object is consumed after the output of the socket object returns.
timestamp	`                +--8--+` `>>--TIMEstamp--+-----+-----------------------------------------------><` `                +--n--+`
timer	Pipes for NetRexx only. Time pipes
tokenise	`>>--+--TOKENISE--+--/string/--+------------+------------------------------><` `    +--TOKENIZE--+            +--/string/--+`
tolabel	`>>--TOLABel--+----------+-------------------------------------------------><` `             +--string--+`
totarget	`>>--TOTARGet----stage--+------------+-------------------------------------><` `                       +--operands--+`
udp	Not implemented. Read / Write TCP records.

unique

```
                         +--NOPAD------+
>>--UNIQue--+---------+--+-------------+--+----------+------->
            +--COUNT--+  +--PAD--xorc--+  +--ANYcase--+

                             +--LAST------+
   >--+-------------------+--+------------+-------------------------------><
      +--| uniqueRanges |-+  +--SINGLEs---+
                             +--FIRST-----+
                             +--MULTiple--+
                             +--PAIRwise--+

uniqueRanges:
   |--+--inputRange------------------------------+--|
      |     <------------------------------+     |
      +--(----inputRange--+-------------+--+--)--+
                          +--NOPAD------+
                          +--PAD--xorc--+
```

unpack	Not implemented. Uncompress data.
untab	Not implemented. Expand tab characters to blanks for specific columns.
update	Not implemented. Modify a file according to UPDATE control statements. OS dep
uro	Not implemented. Write to old equipment.
var	`>>--VAR--variable-------------------------------------------------------><` **Pipes for NetRexx: this can only read vars**
varload	Not implemented. Set REXX variables.
vchar	Not implemented. Recode data to different number of bits per character.
vectora	Pipes for NetRexx only.
vectorr	Pipes for NetRexx only.
vectorw	Pipes for NetRexx only.
vmc	Not implemented. OS dependent.
whilelabel	Not implemented. Select consecutive records.
xab	Not implemented. Old equipment.
xedit	Not implemented. OS dependent.

xlate

```
<----------------------+

>>--+--XLATE------+--+------------------------+---+-------------------+-+-->
    +--TRANSlate--+  +--inputRange------------+   +-| default-table |-+
                     |  <------------------+  |
                     +----(--inputRange--)-+--+

      <----------------------+
   >---+------------------+--+--------------------------------------------><
       +--xrange--xrange--+



default-table:

   |--+--UPper--------------------------+-------|
      +--LOWer--------------------------+
      +--INput--------------------------+
   {  +--OUTput-------------------------+  }
   {  +--+--TO----+--+------------+--n--+  }
   {     -+--FROM--+  +--CODEPAGE--+        }
   {                                       }
   { Not yet in Pipes for NetRexx                     }
```

xmsg	Not implemented. OS dependent.
xpndhi	Not implemented. Old equipment.
xrange	Not implemented. Create one record of specified range of characters.

zone

```
>>--ZONE--+-----------------------------------------+-->
          +--+--WORDSEParator---+---+--char-----+--+
             +--WS--------------+   +--hexchar--+
             +--FIELDSEparator--+   +--BLANK----+
             +--FS--------------+   +--SPACE----+

   >-+--Words----wnumberrange---+------>
     +--Fields----fnumberrange--+
     +--cnumberrange------------+

   >--+---------+---+-----------+--stage--+------------+------------------><
      +--CASEI--+   +--REVERSE--+         +--operands--+
```

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Appendix A

```
.50  - Released May 30, 1999
        - Fixed a stall occurring when interrupted threads, with the interrupt
          caught by ThreadPool, were reused.
        - Fixed a thread safety problem in ELASTIC
        - Improved the timeout options in TCPDATA and TCPCLIENT, they also
          byte[] instead of strings.  This was done since converting to and
          from strings sometimes scrambles binary data (more research on
          encodings...)
        - Changed DELBLOCK it now handles byte[] to help keep tcpdata and
          tcpclient efficient.  The EOF option was broken, its fixed now.
        - Changed DISKR, DISKW and DISKA to handle byte[] when using streams.
        - Added INSERT which handles byte[].  This should be used instead of
          SPECS to add LF or CR .
        - Changes SERIALIZE to use byte[].
   0.49  - Released May 21, 1999
        - compiled with 1.2.1 and NetRexx 1.148
        - Added preliminary support added to .njp compiler for files containing
          java source!  See the (some what messy) java samples in vectort1.njp,
          overtest.njp and addtest4.njp
        - Added code to generate a dummy .nrx file containing the public class
          in a .java file.  This allows NetRexx to compile class that depend on
          the java source.
        - Modified sort to accept arguements in the same order as CMS
        - Fixed rc logic in drop stage
        - Fixed shortcut code for {n} where n is numeric.
   0.48  - Released May 16, 1999
        - Fixed a (nasty) bug involving reusing pipe objects.
        - Added the reuse() method to the stage class.  To use it override
          it in your stage.  It was added so there was a foolproof way to
          reset a stage when its pipe object is reused.  (doSetup is intended
          for use with dynamic arguements in call or added pipes)
        - Added the cont option and defaulted it to comma.
        - fixed return code logic in some stages and in selectInput/Output
        - Added the Emsg methods
        - Added arguement debug option (128)
        - There are no more final methods
        - Much improved error reporting from stages via new Emsg method
   0.47  - Released Jan 3, 1999
```

```
      - recompiled with 1.1.7A and netrexx 1.148
      - UNIQUE repaired?
      - Added stages to acess java objects easily
        VECTOR, VECTORR, VECTORW, VECTORA for java.util.vector
        ARRAY, ARRAYR, ARRAYW, ARRAYA for Object[]
        HASH, HASHR, HASHW, HASHA for java.util.Hashtable
        DICT, DICTR, DICTW, DICTA for java.util.Dictionary
        The hash stages mostly map directly to DICT stages.  The exception
        is HASHW which uses the clear() method of Hashtable.
      - Modified LITERAL to be able to put any object into a pipe
      - Modified pipe package to store arguements in a hashtable instead of
        a rexx stem - arguements can now be of any class.  Use the arg(null)
        method to get an object arguement.
0.46a - Released Oct 14, 1998
      - recompiled with 1.1.7
      - TCPLISTEN now supports an input stream to be used to pace accepts
0.46  - Released Sept 20, 1998
      - COMMAND, CHANGE, FILE, LOCATE, DROP, LOOKUP, TCPCLIENT, TCPLISTEN
        SQLSELECT, CONSOLE, TCPDATA, NOEOFBACK improved.
      - Jeff improved the testing process with the addition of the COMPARE
        stage, he also upgraded many of the tests.
      - Added the buildtests pipe, it builds a test script to be run with:
        test > output < console.data
      - Unexpected exceptions should no longer hang pipes
0.45  - Released Sept 9, 1998
      * Recompile all your stages.  To fix a commit problem I had to
        change the _stage interface class...
      - tcpclient restart problems with oneresp active fixed.
      - commit now returns the current return code of the pipe.
      - fixed minor errors in tcpclient and diska.
0.44  - Released Sept 8, 1998
      * a recompile of pipes using STEM is required
      - smart DISK, FILE and STEM stages now exist.
      - Made to and from synonoms for in and out in REXX and STRING stages.
      - Added stream option to DISKR and DISKW to read raw streams.
      - Added DISKSLOW and SERIALIZE stages.
      - Now DISK, DISKR, DISKW, DISKA and DISKSLOW have FILE synonyms.
      - Deadlock detection improvements.
      - TCPDATA & TCPCLIENT optimized once again.
      - selectAnyInput could deadlock - fixed.
      - interrupting a pipe now kills it - use this with care (ie. kill -9)
      - Pseudo methods njpRC() and njpObject() are reconized by the pipes
        compiler and return the pipe's RC or object respectivily.
0.43  - Released August 30, 1998
      - Fixed deadlock dection to see commit deadlocks.
      - Added rest of code to handle improved StageError logic.
      - Added stage templates (template*.nrx) in the njpipes directory.
```

```
        - Added a debug flag (64) to trace all StageError rasied by the
          stage class.
0.42    - Not released
        * A recompile of pipes using TCPCLIENT, TCPDATA is required.
        * A recompile of pipes using REXX, STRING, ZONE, CASEI is recommended.
        - Updated the comments in _stage to reflect the possible StageError
          and return codes that can be issued.
        - Added the DEBLOCK stage and reworked TCPDATA, TCPCLIENT & GATE.
        - Improved eofReport processing and added a new option 'either' that
          will trigger a StageError when any stream, input or output, severs.
        - Fixed variable subsitution so multiple variables passed to a stage
          will work.
        - Added the ability to pass thru arguements to callpipe and addpipe.
        - Fixed a problem with some StageExits requiring stage_reset methods.
        - Added a function to utils to help assign smarter name to classes
          generated by StageExits.
        - Added counter method to stage.  use to count external waits so
          deadlock/stall detection is not fooled.
0.41    - Released August 23, 1998
        * removed OBJ2REXX, OBJ2STRING stages, use REXX and STRING stage
          modifiers.
        * pipes using TCPDATA, TCPCLIENT & LOOKUP should be recompiled
        - exhanced REXX stage modifier via an object2rexx improvement in
          pipes/utils.nrx
        - optimized ThreadPool startup times.  No setName and only use
          setPriority when its required.
        - made it possible to optimized stage startup time when arguements
          are static.  See TCPDATA, TCPCLIENT & LOOKUP
        - faq.txt enhanced
0.40    - Released August 14, 1998
        * All pipes MUST be recompiled.  Old pipe class files will stall.
        - OBJ2REXX is depreciated and will be removed, use the REXX stage.
        - added REXX and STRING stages to convert objects entering and leaving
          a stage to rexx or string.  Inorder to avoid nasty class conflicts,
          REXX and STRING are implemented in _rexx and _string.  The compler
          adds the '_' when necessary (any stage can use this feature).
        - fixed an intermitant stall in callpipe (was completing too fast :-)
        - fixed a stall occuring between shortStreams and COMMAND
        - optimized pipe startup time in pipe.class and via the compiler.
        - optimized rc, commit, deadlock, threadpool code
0.39    - Released August 9, 1998
        - WAIT_COMMIT and WAIT_ANY are now used in the call/addpipe logic
        - callpipe was not notifiing its pipe when ending leading to an
          very intermitant hang.
0.38    - Released August 3, 1998
        * All your stages must be recompiled.  Recompile your pipes to
          exploit the pipe & thread pool performance improvements.
```

```
      - fixed and optimized commit logic.
      - implement a pool for pipes to decrease overhead.
      - implement a pool for threads to decrease overhead.
      - compiler fix to proprogate return codes from stageExits (thanks Jeff).
      - signal StageError('...  in all stageExits modified to
        signal StageError(13,'Error - 'pInfo' - ...
      - UNIQUE stage added by Jeff.  It exploits stageExit.
      - COMMAND stage was not starting its threads correctly.
      - SORTs in different pipes could corrupt each other.  Thanks René,
0.37  - Released July 25, 1998
      * A recompile of pipes using SORT is required
      - added NOEOFBACK, TOTARGET and FRTARGET.
      - removed a protected method from dump(), added arg() to the dump
      - upgraded SORT, sortRexx to exploit IRange and stageExit, optimized
        use, and factored the sort algorithm out of sort/sortRexx.
      - multiple sort stages no longer try to share static variables...
      - the compiler just uses the stage name (not args) when naming stages
0.36  - Released July 19, 1998
      * A recompile of ALL pipes with stages using IRANGE is required.
        (CHANGE, DEAL, JOINCONT, LOCATE, LOOKUP, PICK, XLATE & ZONE)
      * pipes using NFIND, NLOCATE, STRNFIND or SORT also need to be
        recompiled
      - Added BuildIRangeExit and other methods to an updated IRange
        class.  Using 'zone range stage ...' will be faster than
        'stage range ...' when the range consists of n.c or n-c (s).
      - NFIND, NLOCATE, STRNFIND implemented via stageExit and NOT
      - Fixed bugs in, JUXTAPOSE, FIND, STRFIND, SORT, COMMAND, CHANGE
      - The compiler was not calling stageExit in the correct order when
        several calls were needed to build the stage.  (zone w1 nfind..)
0.35  - Released July 16, 1998
      - Jeff Hennick pointed out a bugglet that effected LOOKUP, ZONE and
        PICK that could occur with complex ranges, I found another bug in
        strliteral
      - Jeff Hennick updated this doc with information on IRange and DString
0.35  - Released July 15, 1998
      * A recompile of ALL pipes using ZONE, TCPCLIENT, TCPDATA, PREFIX
        and APPEND is required.
      - prefix and append can now be labeled, tcpclient and tcpdata
        now use a stage, instead of a pipe, to group data.
      - added compiler support for negitive stream numbers.  This is
        intended to be used by stageExit.  See append, prefix, tcpdata
        and tcpclient.
      - Redefined rexxArg() and stageArg() to simplify the compiler.
      - selection stages are no longer defined as final.
      - SelectInput(0) and selectOutput(0) are always called by the
        stage implementation so they can be overridden...
      - Reimplemented ZONE using stageExit, added CASEI using the same
```

```
          technique.  In theory NOT could be done the same way but, to
          avoid some recursion problems NOT is staying in the compiler.
        - StageExit modified to allow it to pass back another stage to
          call.  see ZONE, CASEI and NOT.
   0.34 - Released July 11, 1998
        - minor reportEOF(any) logic fix
        - improved command stage, threads used to process stdout and stderr.
          added zone, pad, lookup, pick, upgraded juxtapose, fixed bugs in
          specs & buffer.
        - added pad option to setIRange method
   0.33 - Released July 5, 1998
        - added rexxArg() and stageArg() methods to utils.nrx for use by the
$         compiler to query stages about what they expect their arguments to
          contain.  This allowed the compiler to be simplified.
$       - locate now handles null arguments correctly.  literals now include
          leading blanks.  Thanks for pointing out the problem René.
        - René Jansen contributed the timestamp stage.
        - logic modified to stop output() from getting an EOF when the output
          object has been peeked.  The peek status is also displayed by the
          dump() method and hense by deadlocks.
        - minor specs bug fixes (next.n and nextw.n output specs now work)
        - modified the compiler to invoke stageExit(rexx,rexx) method.  This
          allows stages to generate code and/or change the pipe topology.  See
          specs, append, prefix, change and xnop, in the stages directory.
        - modified StageError in preparation for usage changes.
        - removed the Range class - Jeff's code is better and anything that
          could be done with Range can be done using stageExit.
        - Jeff fixed bugs in change and join and added:
          fblock          joincont        notinside       outside
          inside
   0.32 - Released June 20, 1998
          Jeff updated these stages adding a few new ones too:
          abbrev          between         split           locate
          nlocate         strnfind        strfind         nfind
          find            chop
        - minor docuementation updates
        - the Range class is depreciated and will be removed.  Use the
          replacements Jeff created (see pipes\utils.nrx and stages\).
   0.31 - Released June 17, 1998
        - modified count, drop, take and deal to handle non rexx objects
          when possible
   0.31 - Released June 16, 1998
        - improved eofReport(ANY) logic to trigger when waiting on output
          and a different output stream severs.
        - factored the source for utils.class out of stages so there is
          a class to add (probably static) shared methods for all stages
        - fixed a deadlock that occured between shortStreams and exit
        (severInput)
      - Jeff Hennick updated many stages to work at CMS or near CMS levels.
        append          deal            join            strfrlabel      xlate
        buffer          drop            literal         strliteral
        change          fanin           locate          strtolabel
        console         fanout          split           take
        count           frlabel         strfind         tokenize
        All of Jeff's changes are GNUed.  See CopyLeft.txt in the njpipes
        directory.
0.30  - Released May 24, 1998
      - fixed logic in core classes to post all pending severs and not
        clear them too early either, this corrects a problem seen on
        Multiprocessor machines.
0.29  - www page update (docuemention) May 20
      - deadlock section updated
      - installation verification example corrected!
0.29  - Released May 17, 1998
      - added obj2rexx stage, tolabel stage courtesy of Chuck Moore.
      - enhanced change to support a single range
      - Added setJITCache(Hashtable) method to pipes.  This can be used
        to build a global object cache in programs calling pipes.  The name
        of the Hasttable is passed to pipe/callpipe/addpipe via a cache
        parameter.
      - Added support for reportEof options.  This support is not too
        well tested - some good testcases are needed.
0.28  - Released May 9, 1998
      - Enhanced parsing in specs (word2.1 would work, word 2.1 would not)
      - Fixed COPY for a NT jit bug, fixed locate so NOT LOCATE would
        work, updated LITERAL not to use more than one exit(rc)
      - Fixed a compiler problem that would hit multistreamed pipes using
        append or prefix.
      - Any options not consumed by njp are passed on to nrc
        and java.  Mainly for use from the command line, use with care
        in .njp files...
      - Fixed shortStreams() so it works correctly when shorting streams
        in a stage with multiple streams.
      - Tested all 8 addpipe forms and fixed runtime to work with all
        test cases
      - modified filternjp to accept *in and *out without additional labels
      - reenabled stop() in exit code...
      - added gate, dam, tokenize, juxtapose and courtesy of Chuck Moore,
        frlabel stages
0.27  - Released May 3, 1998
      - Automated the generation of in/outStream calls.  For this to work
        the labels need to be of the form *in0: or *out0: where the '0' is
        replaced by the input or output stream to connect to.
      - Fixed compiler/filter problems with stema
```

```
        - Tighted range checking code in specs, fixed problem with delimited
          ranges.  Specs was compiling the NetRexx EXIT command...
        - Fixed a problem where output was not see that objects were
          consumed when using sipping pipes...
        - Fixed a problem where severing an output stream did not cause the
          stages stacked on the node's outlist to see the sever
        - Fixed a problem where the stage issuing a callpipe was not seeing
          the called pipe end
        - Added debug option to pipes compiler
        - Repaired commit and added commit levels to dump() method
        - Fixed problems with callpipe servering several outputs, unstacking
          the saved stream was selecting it...
        - Modified tcpclient and tcpdata to use a secondary thread to
          recieve the tcpip inputs.
        - Now keep a referenced object for each pipe/stage so the JIT does
          not throw away its work and call/addpipes in loops work faster.
        - in/outStreamState now return -1 when autocommit is enabled and
          the stream is unused.
0.26    - Released April 26, 1998
- Added selection methods to compiler (see getRange in section 4 and
          the locate stage an example#
        - Added the specs stage.  The compiler builds a stage to process the
          specs, reducing overhead.
        - Added tcp/ip stages
        - Fixed problems with severs using addpipe
0.25    - Optimized some stages using jinsight from www.alphaworks.ibm.com.
          This more than doubled the speed of some stages.
        - fixed bugs in fanin, diskw
        - Added netrexx filters to extract pipes, extended the functions
          of .njp files (multiple pipes in a file and .njp files can now
          contain netrexx code with pipe/callpipe/addpipe)
        - fixed a timing bug in deadlock detection.
        - xlate and sqlselect stages contributed by René Jansen added
0.24    - Release Feb 98
        - modified the compiler so the syntax of pipes from the command line
          is the same as pipes from .njp files
        - added the sort stage, the sortClass interface and the sortRexx
          example implementation
        - added the timer stage
0.23    - fixed minor compiler errors (20 Dec 97)
        - not stage modifier added.
        - errors in this page corrected, NT install information added.
        - modified diskr/diskw to use Buffered Streams.
0.22    - second public release
0.21    - enabled auto commit, stages start at a commit level of -2 and
          commit to a level of -1 at the first readto, peekto or output.
          nocommit disables the auto commit.  This feature has not been
```

```
         completely tested (yet).
       - fixed compiler not to call netrexx if one of its pipes deadlocks
0.20   - Upgraded to May version of the NetRexx compiler (Thanks Mike!)
         this changed the compiler interface.  NetRexx from May 10 or
         later is now required.
       - nocommit added to _stages, though its a nop for now
       - modified the compiler class to use the May 10th NetRexx compiler
0.19   - initial public release (4 May 97)
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