Meet the Message Paradigm

International Rexx Symposium

May 4th through May 7th 2025, Vienna

I'm sorry that I long ago coined the term "objects" for this topic because it gets many people to focus on the lesser idea. The ***big idea is "messaging".***

Alan Kay (https://en.wikipedia.org/wiki/Alan_Kay)

Developing Business Programming

- Specialisation in **"(Business) Information Systems"**
  - As customary at the time, the *most popular languages* were used to teach beginners: Pascal, BASIC, COBOL, C, PROLOG, Visual Basic Script (VBS) / Applications (VBA), Java, ...
- **Surprise** when experimenting with the Rexx programming language
  - Novices learn ***much faster and more in-depth*** than with popular languages
  - Analysing the **critical success** factors showed that the most important aspect was **the programming language**
- 35 years of **participant observation** (two lectures per semester)
  - Observed difficulties yielded changes in: content, slides, nutshell examples, infrastructure, presentation, ...

Some Historical Bits on Rexx

- Created for IBM mainframes to make programming easier compared to the rather awkward EXEC2
  - **Rexx design goals:** "human centric", "keep the language small", "easy to learn", "easy to understand hence easy to maintain"
  - Rexx is **still instrumental for IBM mainframe operating systems** today!
- Extremely successful in the 80'ies
  - Companies selling Rexx interpreter successfully, **ANSI/INCITS standard** (!)
- Object-oriented successor ("Object Rexx") in the 90'ies
  - **Open-sourced** in 2005 by RexxLA.org – "open object Rexx" (ooRexx)
    - Available for **all major operating systems**
    - Possible to program even MS Windows applications via OLE ...

Fundamental Rexx Concepts, 1

- "Everything is a string"
  - If a string represents a number, one can carry out arithmetic's
- Three instruction types:
  - 1) Assignment
    - Variable name followed by the assignment operator (=) and an expression
  - 2) Keyword instruction
    - Keywords are English words conveying the intent of the keyword instruction, e.g. SAY, DO, IF, LOOP, CALL, PARSE, SELECT, ITERATE, LEAVE, INTERPRET, ...
    - Makes Rexx code legible as if it was pseudo code
  - 3) Commands
    - A string passed to the operating system for execution (as if typed in a window)

Fundamental Rexx Concepts, 2

- White space can be freely used to format code for better legibility
  - Space around operators gets removed
  - White space between symbols will be reduced to a single space serving as abuttal concatenation operator
  - Hence indentations with white space not significant
- Case of symbols irrelevant
  - Rexx uppercases everything outside of quoted strings
  - No (frustrating) casing errors for novices
- Rexx nutshell examples to stress fundamental concepts
  - Illustrate the language
  - Same examples in the popular Python language to allow direct comparisons

Nutshell Example

"Instructions"

```
    /* an assignment instruction:      */
a="hello world"   /* assigns "hello world" to a variable named a  */

    /* a keyword instruction:          */
say a             /* output: hello world */

    /* a command instruction:          */
    /* a command (could be typed into a command line window)          */
"echo Hello World 2" /* execute command                               */
   /* variable RC contains the command's return code, 0 means success */
if rc=0 then say "success!"
        else say "some problem occurred, rc="rc /* show return code   */
```

Output:

```
hello world
Hello World 2
Success!
```

```
# an assignment instruction
a="hello world"     # assigns "hello world" to a variable named a

# no keyword instruction for output, using built-in function print()
print(a)

# no command instruction using module subprocess instead
import subprocess   # import subprocess module
# execute command
completedProcess=subprocess.run("echo Hello World 2", shell=True) # run
rc=completedProcess.returncode  # fetch return code, an int
if rc==0:
    print("found!") # indentation mandatory (forcing a block)
else: # must use + (concatenation operator) with str() function
    print("some problem occurred, rc="+str(rc)) # turn rc into a string
```

Output:

```
hello world
Hello World 2
Success!
```

Concepts Added by ooRexx, 1

- ooRexx has been influenced by SmallTalk including its **message paradigm**
- ooRexx adds *message expressions* and *directive instructions*
- "In ooRexx everything is an *object* (synonyms: *value, instance*)"
  - An object is conceptually regarded as if it was a living thing
  - One can only interact with an object by sending it *messages*
- A *message expression* consists of a *receiver*, the message operator **~** (tilde) and the *message name*, optionally followed by arguments in parentheses
  - The *receiver* will search a method by the name of the received message, invokes it and returns any result to the sender
  - No one can invoke methods directly but the *receiver* (encapsulation)!
  - The *sender* does not need to know anything about implementation details

Nutshell Example

Messages

```
say reverse("olleh")     -- classic Rexx BIF (built-in function)

say "olleh"~reverse      -- message to string object
```

Output:

```
hello
hello
```

```
a="dlrowolleh"     -- assign string to variable
   -- use built-in-functions (BIFs) reverse(), substr()
say substr(reverse(a),1,5) substr(reverse(a),6)

   -- use String methods reverse and substr
say a~reverse~substr(1,5) a~reverse~substr(6)
```

Output:

```
hello world
hello world
```

Concepts Added by ooRexx, 2

- Directive instruction
  - If present then always placed at the end of a program
  - Led in by two consecutive colons (::) serving as an eye catcher
    - Directives can be used to cause ooRexx to create classes with attributes and methods during the setup phase

      ::CLASS name, ::ATTRIBUTE name, ::METHOD name, ...

- Classes with attributes and methods
  - Can be defined with directive instructions or dynamically at runtime
  - Instances get created by sending the class the message new
    - The new method will create the object and before returning it, the newly created object gets the message init sent with the arguments supplied to the new message, if any
      - Hence, defining a method named init will always run at construction time (constructor)

Nutshell Example

Creating A Class with Directives and Dynamically

```
say ".dog:" .dog    -- string value of the class
d=.dog~new          -- create and assign a dog
d~bark              -- let the dog bark
say "d:" d", an instance of:" d~class

::class dog         -- class directive
::method bark       -- method routine directive
  say "wuff!"       -- code to run
```

Output:

```
.dog: The DOG class
wuff!
d: a DOG, an instance of: The DOG class
```

Dynamic creation

```
clz=.object~subclass("DOG")   -- create the dog class
say "clz:" clz -- string value of the class
m  =.method~new("bark", 'say "wuff!"') -- create method
clz~define("bark",m) -- define as instance method for class

d=clz~new      -- create and assign a dog
d~bark         -- let the dog bark
say "d:" d", an instance of:" d~class
```

Output:

```
clz: The DOG class
wuff!
d: a DOG, an instance of: The DOG class
```

Ad Messages, 1

- Quickly familiar, intuitive for novices
- Seeing **objects as living things** makes it easy to accept behaviours and concepts like
  - The new method of a class will send the init message to the newly created object (a method named init is therefore a constructor)
  - An object using the *class hierarchy* to locate the method to invoke (inheritance)
  - *Multiple inheritance* (!) deviating the search carried out by the object
  - Intercepting messages for which no method could be found as the object then sends the unknown message to itself (simply implement a method unknown)
  - The variables self (reference to the object that invoked the method) and super (reference to the immediate superclass) in methods
  - As objects know how to find and invoke methods, the sender does not need to know that (black box) at all, alleviating the (novice) programmer

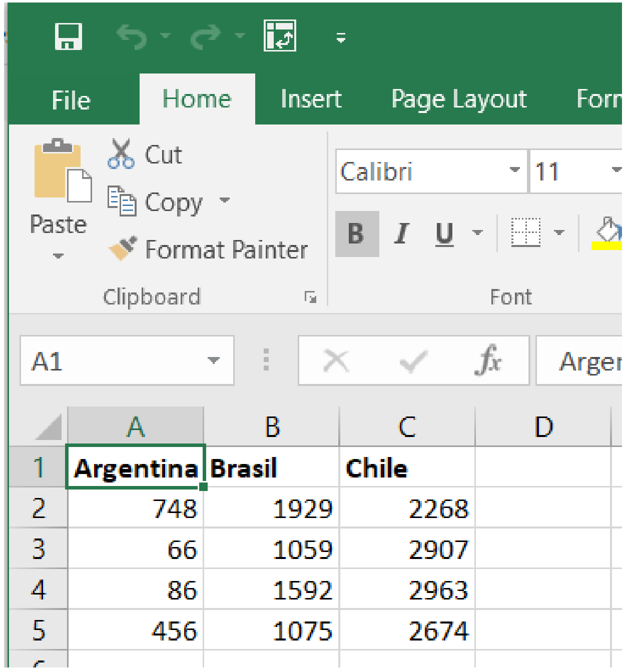
Ad Messages, 2

- Addressing complex software infrastructures can be made easy for message senders (programmers)
  - Create a proxy class in ooRexx for the sender that processes the received messages, marshals the received arguments and unmarshals the return value
- Example Windows and Windows programs
  - ooRexx for Windows has ooRexx classes for Windows support
  - The ooRexx OLEObject class is the proxy class for interacting via OLE (Object Linking and Embedding) with *any* OLE Windows component
    - Its unknown method will intercept all messages for which no method can be found on the ooRexx side, such that it gets forwarded to the proxied Windows object by searching and invoking the appropriate Windows method
    - To exploit this functionality no implementation knowledge of COM or OLE is needed!

Nutshell Example

Programming Excel Using ooRexx Messages

```
excApp = .OLEObject~new("Excel.Application") -- create Excel object
excApp~visible = .true                 -- make Excel visible
sheet  = excApp~Workbooks~Add~Worksheets[1]  -- add and get sheet
    -- set titles from an ooRexx array
titleRange=sheet~range("A1:C1")  -- get title cell range
titleRange~value     = .array~of("Argentina", "Brasil", "Chile")
titleRange~font~bold = .true     -- make font bold
sheet~range("A2:C5")~value = createRows(4)   -- create and assign array
excApp~displayAlerts = .false    -- no alerts (should file exist already)
fileName=directory()"\test.xlsx" -- save in current directory
Say 'fileName:' fileName         -- show fully qualified file name
sheet~SaveAs(fileName)           -- save file (no alerts, see above)
excApp~quit                      -- quit (end) Excel

::routine createRows    -- return two-dimensional array with random data
  use arg items         -- fetch argument
  arr=.array~new        -- create Rexx array
  do i=1 to items       -- create random(min,max) numbers
     arr[i,1] = random(   0,1000)   -- Argentina
     arr[i,2] = random(1001,2000)   -- Brazil
     arr[i,3] = random(2001,3000)   -- Chile
  end
  return arr            -- return two-dimensional Rexx array
```



	A	B	C	D
1	**Argentina**	**Brasil**	**Chile**	
2	748	1929	2268	
3	66	1059	2907	
4	86	1592	2963	
5	456	1075	2674	

Possible Output:

```
fileName: C:\Program Files\JetBrains\IntelliJ IDEA 2023.3.6\jbr\bin\test.xlsx
```

Ad Messages, 3

- Addressing complex software infrastructures can be made easy for message senders (programmers)
  - Create a proxy class in ooRexx for senders that processes the received messages, marshals the received arguments and unmarshals the return value
- Example Java and Java class libraries
  - BSF4ooRexx850 for Windows, macOs and Linux implements an ooRexx-Java bridge
  - Its BSF class is the ooRexx proxy class for interacting with Java
    - Its unknown method will intercept all messages for which no method can be found on the ooRexx side, such that it gets forwarded to the proxied Java object by searching and invoking the appropriate Java method
    - To exploit this functionality no implementation knowledge of BSF4ooRexx850 is needed!

Nutshell Example

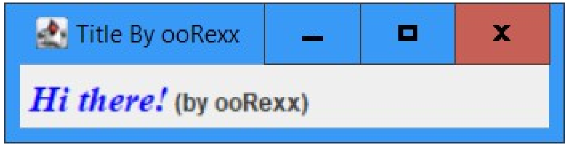
Communicating with Java Objects Using ooRexx Messages

```
dim=.bsf~new("java.awt.Dimension",111,222)
say "dim:         " dim", dim~class:" dim~class
say "dim~toString:" dim~toString -- Java method
    -- use Java fields as if ooRexx attributes
say "dim~width:   " dim~width   -- Java field
say "dim~height:  " dim~height  -- Java field
dim~setSize(333,444) -- Java method
say "dim~toString:" dim~toString -- Java method
    -- use Java fields as if ooRexx attributes
dim~width=555        -- setting Java field
dim~height=666       -- setting Java field
say "dim~toString:" dim~toString -- Java method

::requires "BSF.CLS" -- get ooRexx-Java bridge
```

Output:

```
dim:          java.awt.Dimension@1c4af82c, dim~class: The BSF
class
dim~toString: java.awt.Dimension[width=111,height=222]
dim~width:    111
dim~height:   222
dim~toString: java.awt.Dimension[width=333,height=444]
dim~toString: java.awt.Dimension[width=555,height=666]
```

```
jf  = .bsf~new("javax.swing.JFrame", "Title By ooRexx")  -- create JFrame
style   = 'style="color: blue; font-family: serif; font-size: 18;"'
lblText = '<html><em' style'>&nbsp;Hi there!</em> (by ooRexx) </html>'
lbl = .bsf~new("javax.swing.JLabel", lblText)   -- create JLabel
jf~add(lbl)             -- add JLabel to JFrame
jf~setSize(280,70)      -- set size
jf~setLocation(50,200)  -- set JFrame's location on screen
jf~visible=.true        -- make JFrame visible
jf~toFront              -- place JFrame in front of all windows
say 'Hit <enter> on the keyboard to proceed (end) ...'
parse pull data         -- wait until user presses <enter>

::requires "BSF.CLS"    -- get ooRexx-Java bridge
```



Hi there! (by ooRexx)

Output:

```
Hit <enter> on the keyboard to proceed (end) ...
```

Roundup

- Message paradigm
  - **Easy and intuitive** (easy for novices as well)
  - All important object-oriented concepts can be informally (!) explained and understood (easy to understand for novices as well)
- **Proxy classes** allow **the message paradigm to be extended to other software systems**
  - Windows COM/OLE, proxy class OLEObject (supplied by ooRexx)
  - Java, proxy class BSF (supplied by BSF4ooRexx850)
  - **interestingly, novice students do not care and are not afraid! :-)**
    - They "only" send messages and need not know any implementation details!
    - The supplied nutshell examples allow novices to exploit OLE and Java
      - Windows: MS Excel, MS Word, MS PowerPoint, AOO swriter, LO scalc, ...
      - Java: from (secure!) socket programming to JavaFX GUIs!

Some References

- **Open and free slides** (odp upon request)
  - R. G. Flatscher, “Introduction to Programming with ooRexx and BSF4ooRexx 1. 1-7.” [PDF slides]:
    - <https://wi.wu.ac.at/rgf/wu/lehre/autowin/material/foils/>
  - R. G. Flatscher, “Introduction to Programming with ooRexx and BSF4ooRexx 2. 8-14.” [PDF slides]:
    - <https://wi.wu.ac.at/rgf/wu/lehre/autojava/material/foils/>
- T. Winkler, "Collection of Rexx References". <https://wi.wu.ac.at/rgf/rexx/rexxref/searchref.html>
  - Maintained at: <https://gitlab.com/dylwi/rexx-references>
- R. G. Flatscher and G. Müller, “'Business Programming' – Critical Factors from Zero to Portable GUI Programming in Four Hours,” in 6th BEE-Conference, Plitvice Lakes, Croatia, 2021, pp. 76-82.
  - <https://research.wu.ac.at/files/32933925/2021_BusinessProgramming_BEE2021_accordingToGuidelines.pdf>
- R.G. Flatscher, "Proposing ooRexx and BSF4ooRexx for Teaching Programming and Fundamental Programming Concepts", in 2023 Program Guide ISECON: Information Systems Education Conference, Dallas/Plano, Tx, 2023, pp. 89-102.
  - <https://research.wu.ac.at/files/41301564/ISECON23_Flatscher_Proposing_ooRexx_article.pdf>
- T. Winkler and R. G. Flatscher, “Cognitive Load in Programming Education: Easing the Burden on Beginners with REXX.” In Central European Conference on Information and Intelligent Systems. 2023, pp. 171-178.
  - <https://research.wu.ac.at/files/46150789/CECIIS_CLT_REXX.pdf>

Some Links

- Portable zip archives (no installation needed): ooRexx 5.1.0, oorexxshell, dbusoorexx, bsf4oorexx
  - <https://www.ronyrexx.net/xfer/portable>
    - Note: bsf4oorexx (ooRexx-Java bridge) needs Java installed
- Installation packages
  - ooRexx 5.1.0:
    - <https://sourceforge.net/projects/oorexx/files/oorexx/5.1.0>
  - BSF4ooRexx (ooRexx-Java bridge, needs Java preinstalled):
    - <https://sourceforge.net/projects/bsf4oorexx/files/GA/BSF4ooRexx-850.20240304-GA/>
- Selected seminar papers, Bachelor and Master thesis with ooRexx, BSF4ooRexx, dbusoorexx
  - <https://wi.wu.ac.at/rgf/diplomarbeiten/>
- Non-profit Rexx Language Association (owner of ooRexx):
  - <https://www.RexxLA.org>
- Web page with Rexx related resources maintained by R.G. Flatscher:
  - <https://ronyrexx.net>