Department of Information Systems and Operations Management

Proposing ooRexx and BSF4ooRexx for Teaching Programming and Fundamental Programming Concepts

(ISECON23, 2023-03-31)

"Business Programming"

Basics, Commands, Parsing, ...	Messages, Directives, Classes, ...	Windows (COM/OLE), MS Office, ...	GUIs (awt, swing, JavaFX), Client/Server (Sockets), AOO/LO, Jsoup, XML SAX, JDOR Rexx commands, ...

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Overview

- WU (acronym from "*W*irtschafts*u*niversität")
- Background of developing "Business Programming" for decades
- Introducing important critical success factor (programming language)
  - REXX: concepts and nutshell example
  - ooRexx: concepts and nutshell examples
  - BSF4ooRexx: concepts and nutshell examples
- Roundup
- Links
- Addendum (Rexx vis-à-vis Python)

WU (Business Administration University)

- Based in Vienna, Austria
  - One of the few imperial cities in Europe (located at the "heart of Europe")
- Founded 1898 as a "World Trade High School" (celebrating 125 years)
- Appr. 20,000 students
  - One of the largest universities of its kind
  - Appr. 15,000 Bachelor, 4,200 Master, and 800 Doctoral/PhD
- Information Systems (IS) Department
  - One of eleven departments at WU
  - Currently seven institutes, in alphabetic order
    - "Data, Process and Knowledge Management", "Digital Ecosystems", "Distributed Ledgers and Token Economy", "Information Management and Control", "Information Systems and New Media", "Information Systems and Society", "Production Management"

Background: "Business Programming"

- Personal challenge of more than 35 years
  - Question: "is it possible to teach interested novice students programming in a single semester such that the students become able to program MS Office?"
  - Evolved over appr. 120 lectures (two lectures each semester)
    - Each lecture's installment got systematically analyzed
    - Observing and analyzing student's problems understanding taught concepts
    - Constantly reworking focus areas, slides, nutshell examples accordingly
    - Experimenting with various programming languages (VBA, VBS, Java, REXX/ooRexx)
  - As of 2023
    - BA students learn in a *four hour lecture (8 ECTS)* in a *single semester (four months)*
      - Fundamentals of programming
      - Windows and MS Office programming via COM/OLE
      - Platform independent programming of GUIs, client/server, OpenOffice/LibreOffice, ...
  - Key success factor: programming language ooRexx and BSF4ooRexx

REXX, 1

- Mike F. Cowlishaw (IBM)
- IBM released REXX 1979 as a product
  - Became IBM's SAA strategic procedural language in the 80's
- Design of REXX
  - Explicitly human oriented as opposed to the cryptic EXEC 2 it should replace
    - Goal: easy to learn and easy to maintain
  - Principles
    - Typeless language (everything is a string, including numbers)
    - Caseless (everything outside of quotes will be uppercased before processing)
    - No reserved keywords
    - Whitespace can be freely used for formatting instructions for better legibility and better comprehension
      - Multiple whitespace characters between symbols will be reduced to a single whitespace

REXX, 2

- Only three instruction types
  - Assignment instruction
    - Variable name, followed by the equal sign (**=**), followed by an expression
  - Keyword instruction
    - Keywords are English words that convey their meaning
      - Makes Rexx programs look like pseudo code
    - Starts with one of the defined keyword instructions like call, if, loop, ...
  - Command instruction
    - Anything else (an expression evaluating to a string)
      - Or explicitly using the address keyword instruction which allows one to target the environment the command should get sent to
    - By default the command gets sent to the operating system for execution and the command's ***r***eturn ***c***ode is made directly available to Rexx via the variable named **RC**

REXX, 3

- A Rexx program demonstrating the three instruction types

```
a="Hello, world"     /* assignment          */

do i=1 to 3          /* a loop              */
   say "... round #" i":" a
End

   /* command, will have a return code     */
"copy file1.txt file1.txt.bkp"
if rc<>0 then  /* variable RC set by REXX */
   SAY "Command's return code:" rc
```

Assuming that the file *file1.txt* does not exist such that the copy command will issue the error message "The system cannot find the file specified." in the command line window

Output:

```
... round # 1: Hello, world
... round # 2: Hello, world
... round # 3: Hello, world
The system cannot find the file specified.
Command's return code: 1
```

ooRexx, 1

- Object-oriented successor for REXX developed by IBM
  - IBM released "Object REXX" 1994 with the operating system "OS/2 Warp"
  - 2004 source code handed over to the non-profit SIG "Rexx Language Assoc."
  - RexxLA.org released "open object Rexx (ooRexx) version 3.0" in 2005
- Design of ooRexx
  - Goals
    - Keep human oriented design principle
    - Run REXX programs unchanged
  - Influenced by SmallTalk
    - Message paradigm (the tilde character **~** is an explicit message operator in ooRexx)
      - Alan Kay (Wikipedia): *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".*
      - Simplifies programming as object's implementation is encapsulated (and becomes irrelevant)

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ooRexx, 2

- The message paradigm abstracts from the implementation
  - A programmer conceptually communicates with an object (as if it was a living thing) by sending it a message
    - No need to have any knowledge about the implementation of a method routine
  - The object will search for a method routine by the name of the received message, invokes it (supplying any arguments received with the message) and returns any result to the caller
    - If a method routine is not found in the object's class it will search its superclass up to the root class (thereby realizing inheritance): the first found method routine will be executed by the object
    - Should the object not be able to find the method routine the error message "Object does not understand message" gets raised
- Introduces the *directive* instruction type
  - Placed at the end of a program, led in with two colons **::** followed by one of
    - ANNOTATE, ATTRIBUTE, CLASS, CONSTANT, METHOD, OPTIONS, REQUIRES, RESOURCE, ROUTINE
  - Processed by the interpreter after the *syntax checking phase*, thereby setting up the program's environment (*setup phase*) before it gets executed (*execution phase*)

ooRexx, 3
Directives and Messages

```
p1=.person~new("Albert Einstein", 45000)  -- create a new person:  person1
say "p1:" p1~name p1~salary               -- show person1's attribute values

p2=.person~new("Mary Withanyname", 35000) -- create a new person:  person2
say "p2:" p2~name p2~salary               -- show person2's attribute values

p1~increaseSalary(10000)                  -- increase salary of person1
say "p1:" p1~name p1~salary               -- show person1's attribute values

p2~name="Mary Withaspecificname"          -- change the name of person2
p2~salary=45500                           -- change the salary of person2
say "p2:" p2~name p2~salary               -- show person2's attribute values
say "total of salaries:" p1~salary + p2~salary

::class Person              -- define name of class
::attribute name            -- define attribute "name"
::attribute salary          -- define attribute "salary"

::method init               -- define constructor (a method routine)
  expose name salary        -- establish direct access to attributes
  use arg name, salary      -- fetch and store arguments in attributes

::method increaseSalary     -- define method routine
  expose salary             -- establish direct access to attribute "salary"
  use arg increase          -- fetch argument
  salary=salary+increase    -- increase value of salary attribute
```

Output:

```
p1: Albert Einstein 45000
p2: Mary Withanyname 35000
p1: Albert Einstein 55000
p2: Mary Withaspecificname 45500
total of salaries: 100500
```


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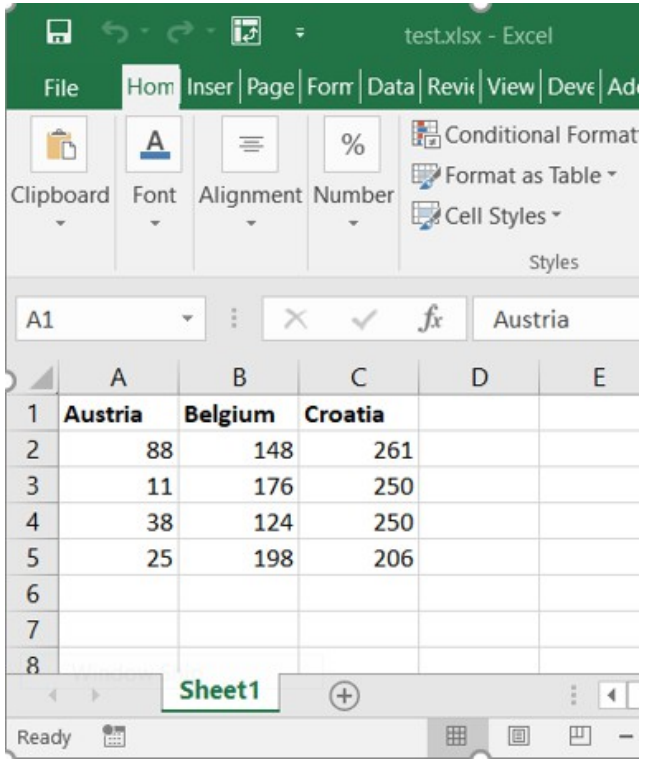
ooRexx, 4
Messages to MS Excel (Windows)

```
excApp = .OLEObject~new("Excel.Application")
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("Austria", "Belgium", "Croatia")
titleRange~font~bold = .true          -- use bold font for titles
sheet~range("A2:C5")~value = createRows(4)   -- create and assign array
excApp~displayAlerts = .false         -- no alerts (should file exists 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    -- create two-dimensional array with arbitrary data
  use arg items=5                 -- fetch argument, default, if omitted: 5
  arr=.array~new                  -- create Rexx array
  do i=1 to items                 -- create random(min,max) numbers
     arr[i,1] = random( 0 ,100 )     -- Austria
     arr[i,2] = random(101,200 )     -- Belgium
     arr[i,3] = random(201,300)      -- Croatia
  end
  return arr              -- return two-dimensional Rexx array
```

Output:




```
fileName: C:\Users\rony\test.xlsx
```

BSF4ooRexx, 1

- Bidirectional bridge between ooRexx and Java
  - In development since 2000, latest version: BSF4ooRexx850
    - Minimum Java version: 8, minimum ooRexx version: 5.0
    - Includes a Rexx command handler for Java2D named "JDOR" (**J**ava2**D** for **oo****R**exx)
      - Simplifies using Java2D considerably using Rexx commands
  - No need to know any implementation details
- Design of BSF4ooRexx
  - Goals
    - Keep REXX' human oriented design principle
      - ooRexx programmers need not know implementation details
        - Camouflage Java objects as ooRexx objects that understand messages
      - Allow Java programmers to send ooRexx objects messages from Java
    - Make all Java functionality available to ooRexx in a platform independent manner

BSF4ooRexx, 2

- Prerequisites
  - Installation
    - Java 8 or later (Oracle) or OpenJDK 8 (open-source version) or later
      - Hint: use the installation packages with the JavaFX GUI modules ("FX" or "full" in name)
    - ooRexx 5.0 or later
    - BSF4ooRexx or BSF4ooRexx850 installed
  - ooRexx programs
    - Get the camouflaging support by requiring the ooRexx package named BSF.CLS

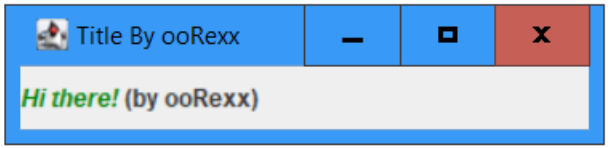
```
::requires BSF.CLS -- get ooRexx-Java bridge
```

BSF4ooRexx, 3
Messages to Java Objects

```
jf = .bsf~new("javax.swing.JFrame", "Title By ooRexx")  -- create JFrame
lblText = '<html><em style="color: green;">Hi there!</em> (by ooRexx)</html>'
lbl= .bsf~new("javax.swing.JLabel", lblText)    -- create JLabel
jf~add(lbl)                -- add label
jf~setSize(300,70)         -- set size
jf~setLocation(50,200)     -- set location
jf~visible=.true           -- make visible
jf~toFront                 -- place frame in front of all windows
say 'Hit <enter> to proceed (end) ...'
parse pull data            -- wait until user presses <enter> on the keyboard

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

Output:

```
E:\rony\Vortraege\2023\isecon23\work>rexx code_4_ooRexx_1.rex
Hit <enter> to proceed (end) ...
```



BSF4ooRexx, 4

- Java2D
  - Powerful 2D graphics
  - Used for drawing light-weight javax.swing classes
  - Used for Java games and business graphics of any kind
  - ...
- Example
  - Java code to create a Java2D graphic
  - Equivalent ooRexx code to create the same Java2D graphic
    - Rexx JDOR commands make this considerably easier
      - WU students immediately take advantage of it after the first Java related lecture!

BSF4ooRexx, 5
Java2D (Java *AffineTransformDemo*)

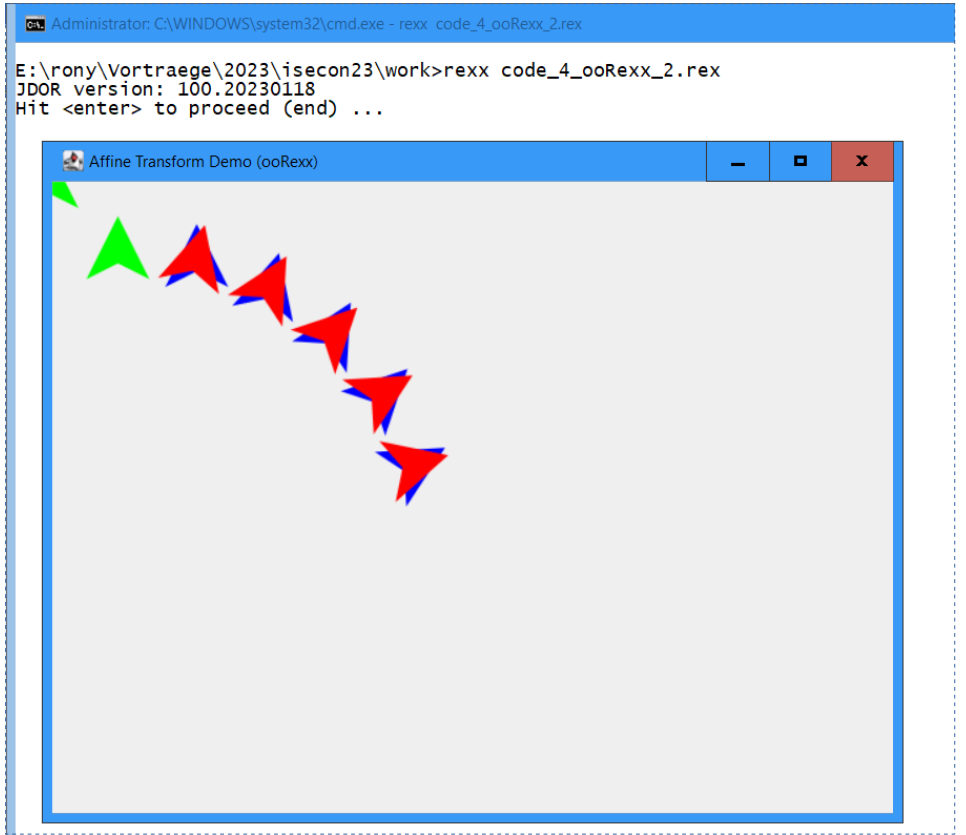
```
import java.awt.*;
import java.awt.geom.AffineTransform;
import javax.swing.*;

/** Test applying affine transform on vector graphics */
@SuppressWarnings("serial")
public class AffineTransformDemo extends JPanel {
   // Named-constants for dimensions
   public static final int CANVAS_WIDTH = 640;
   public static final int CANVAS_HEIGHT = 480;
   public static final String TITLE = "Affine Transform Demo";

   // Define an arrow shape using a polygon centered at (0, 0)
   int[] polygonXs = { -20, 0, +20, 0};
   int[] polygonYs = { 20, 10, 20, -20};
   Shape shape = new Polygon(polygonXs, polygonYs, polygonXs.length);
   double x = 50.0, y = 50.0;  // (x, y) position of this Shape

   /** Constructor to set up the GUI components */
   public AffineTransformDemo() {
      setPreferredSize(new Dimension(CANVAS_WIDTH, CANVAS_HEIGHT));
   }

   /** Custom painting codes on this JPanel */
   @Override
   public void paintComponent(Graphics g) {
      super.paintComponent(g);    // paint background
      setBackground(Color.WHITE);
      Graphics2D g2d = (Graphics2D)g;

      // Save the current transform of the graphics contexts.
      AffineTransform saveTransform = g2d.getTransform();
      // Create a identity affine transform, and apply to the Graphics2D context
      AffineTransform identity = new AffineTransform();
      g2d.setTransform(identity);
// … continued …
```

```
// … continued …
      // Paint Shape (with identity transform), centered at (0, 0) as defined.
      g2d.setColor(Color.GREEN);
      g2d.fill(shape);
      // Translate to the initial (x, y) position, scale, and paint
      g2d.translate(x, y);
      g2d.scale(1.2, 1.2);
      g2d.fill(shape);

      // Try more transforms
      for (int i = 0; i < 5; ++i) {
         g2d.translate(50.0, 5.0);  // translates by (50, 5)
         g2d.setColor(Color.BLUE);
         g2d.fill(shape);
         g2d.rotate(Math.toRadians(15.0)); // rotates about transformed origin
         g2d.setColor(Color.RED);
         g2d.fill(shape);
      }
      // Restore original transform before returning
      g2d.setTransform(saveTransform);
   }

   /** The Entry main method */
   public static void main(String[] args) {
      // Run the GUI codes on the Event-Dispatching thread for thread safety
      SwingUtilities.invokeLater(new Runnable() {
         @Override
         public void run() {
            JFrame frame = new JFrame(TITLE);
            frame.setContentPane(new AffineTransformDemo());
            frame.pack();
            frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
            frame.setLocationRelativeTo(null); // center the application window
            frame.setVisible(true);
         }
      });
   }
}
```

BSF4ooRexx, 6
Java2D (JDOR: Rexx Commands)

```
   -- create a JDOR Rexx command handler
jdh=.bsf~new("org.oorexx.handlers.jdor.JavaDrawingHandler")
say "JDOR version:" jdh~version     -- show version
call BsfCommandHandler "add", "jdor", jdh -- add as a Rexx command handler
address jdor -- set default environment from operating system to JDOR

newImage 640 480           -- create new image
winShow                    -- show image in a window
winTitle "Affine Transform Demo (ooRexx)" -- set window's title

   -- could use Rexx variables denoting the respective Java arrays instead
polygonXs="(-20,0,+20,0)"  -- define four x coordinates
polygonYs="(20,10,20,-20)" -- define four y coordinates
shape myP polygon polygonXs polygonYs 4   -- create polygon shape
color green                -- set color to green
fillShape myP              -- fill (and show) the polygon shape
translate 50 50            -- move origin (x=x+50, y=y+50)
scale 1.2 1.2              -- increase the polygon shape sizes by 20%
fillShape myP              -- fill (and show) the polygon shape

do 5                       -- repeat five times
   translate 50 5          -- move origin (x=x+50, y=y+5)
   color blue              -- set color to blue
   fillShape myP           -- fill (and show) the polygone shape
   rotate 15               -- rotate by 15°
   color red               -- set color to red
   fillShape myP           -- fill (and show) the polygone shape
end

say 'Hit <enter> to proceed (end) ...'
parse pull data         -- wait until user presses <enter> on the keyboard

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

Output (AffineTransformDemo: Java and ooRexx):



Roundup

- "Business Programming"
  - Four weekly contact hours for one semester (four months)
  - 8 ECTS, total net teaching load 200 hours
  - *Novices* get empowered by being able to learn programming
    - At the middle of the semester (after two months), after seven installments
      - Fundamental programming concepts, programming Windows (COM/OLE) and MS Office, AOO/LO
    - At the end of the semester (after four months), after seven installments
      - Programming exploiting all of Java camouflaged as ooRexx
        - GUI (awt, swing, JavaFX)
        - Client/server socket programming including SSL/TLS
        - Interacting with web servers (curl, Jsoup)
        - Using Java APIs: Apache OpenOffice (AOO)/LibreOffice (LO)
- Critical success factor "programming language"
  - ooRexx with BSF4ooRexx (making all of Java/OpenJDK available, camouflaged as ooRexx)
  - All needed software is free and open-source

Links (As of 2023-03-20)

- **WU (English)**: https://www.wu.ac.at/en/the-university/about-wu/facts-figures/studierende/
  - **Business Programming 1 (BP1)**: first half of semester (two months)
    - Syllabus (German use e.g. Google translate, deepl.com) 2023: http://wi.wu.ac.at/rgf/wu/lehre/autowin/2023sBP1/BP1-autowin-2023s-uebersicht.pdf
    - Slides (English): https://wi.wu.ac.at/rgf/wu/lehre/autowin/material/foils/
  - **Business Programming 2 (BP2)**: second half of semester (two months)
    - Syllabus (German use e.g. Google translate, deepl.com) 2023: http://wi.wu.ac.at/rgf/wu/lehre/autojava/2023sBP2/BP2-autojava-2023s-uebersicht.pdf
    - Slides (English): https://wi.wu.ac.at/rgf/wu/lehre/autojava/material/foils/
  - **Some seminar papers, Bachelor and Master thesis with ooRexx, BSF4ooRexx**: https://wi.wu.ac.at/rgf/diplomarbeiten/
- **Software**
  - **ooRexx** 5.1: https://sourceforge.net/projects/oorexx/files/oorexx/5.1.0beta/
  - **Java/OpenJDK** *with* JavaFX modules, e.g. https://www.azul.com/downloads/?package=jdk#zulu
  - **BSF4ooRexx850**: https://sourceforge.net/projects/bsf4oorexx/files/beta/20221004/
- Hock-Chuan, Chua: *"Java Game Programming: 2D Graphics, Java2D and Images"*; *AffineTransformDemo*: https://www3.ntu.edu.sg/home/ehchua/programming/java/J8b_Game_2DGraphics.html#zz-2.2
- REXX history (initial specification): https://speleotrove.com/rexxhist/REXinitspec-1979.pdf

Addendum (Rexx vis-à-vis Python)

- Rexx and Python programs
  - Instructions
  - Block, selections, multiple selections
  - Parsing strings
- Possible assessment question
  - What concepts need to be explained and understood (by novices) for the Rexx solution and for the feature equivilent Python solution?

Rexx and Python, 1 (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 Windows command (could be typed into a command line window)    */
"dir a.txt"       /* command: list the file a.txt                       */
   /* variable RC contains the command's return code, 0 means success   */
if rc=0 then say "found!"
        else say "some problem occurred, rc="rc /* show return code     */
```

```
# 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("dir a.txt", shell=True) # run command
rc=completedProcess.returncode  # fetch return code, an int
if rc==0:
    print("found!") # indentation mandatory (forcing a block)
else:
    print("some problem occurred, rc="+str(rc)) # turn rc into a string
```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Rexx and Python, 2
(Blocks, Selection, Multiple Selections)

```rexx
max=5             /* number of repetitions   */
loop a=1 to max   /* loop block              */
   select         /* nested block # 1        */
      when a=1 then say a": first round"
      when a=2 then say a": second round"
      when a=3 then say a": third round"
      otherwise say "(a="a")"
   end
   if a=max then
   do             /* nested block # 2        */
      say "-> a=max"
      say "-> last round!"
      say "-> loop will end"
   end
end
/* output of the above program will be:
   1: first round
   2: second round
   3: third round
   (a=4)
   (a=5)
   -> a=max
   -> last round!
   -> loop will end
*/
```

```python
max=5       # number of repetitions
for a in range(1,max+1): # loop with range() function, must add 1 to max
    match a:    # must be indented, "match" needs Python 3.10 or higher
        case 1: print(str(a)+": first round")   # nested block # 1
        case 2: print(str(a)+": second round")  # nested block # 1
        case 3: print(str(a)+": third round")   # nested block # 1
        case _: print("(a="+str(a)+")")  # default, nested block # 1

    if a==max:  # must be indented
        print("-> a==max")          # nested block # 2
        print("-> last round!")     # nested block # 2
        print("-> loop will end")   # nested block # 2



""" output of the above program will be:
    1: first round
    2: second round
    3: third round
    (a=4)
    (a=5)
    -> a==max
    -> last round!
    -> loop will end
"""
```

Rexx and Python, 3 (Parsing Strings)

```
text = " John     Doe   Vienna Austria"
parse var text firstName lastName city country
say "first name:" firstName", last name:" lastName", city:"
city

text = "Mary Doe Tokyo Japan"
parse var text firstName lastName city .   /* ignore
country */
say "first name:" firstName", last name:" lastName", city:"
city

/* output of the above program will be:
   first name: John, last name: Doe, city: Vienna
   first name: Mary, last name: Doe, city: Tokyo
*/
```

```
text      = " John     Doe   Vienna Austria"
words     = text.split()    # create list of words
firstName = words[0]        # assign to variable
lastName  = words[1]        # assign to variable
city  = words[2]        # assign to variable
print("first name:",firstName+",","last
name:",lastName+",","city:",city)

text  = "Mary Doe Tokyo Japan"
words = text.split()    # create list of words
# assign multiple elements in a single statement
firstName, lastName, city = [words[i] for i in (0, 1, 2)]
print("first name:",firstName+",","last
name:",lastName+",","city:",city)

""" output of the above program will be:
    first name: John, last name: Doe, city: Vienna
    first name: Mary, last name: Doe, city: Tokyo
"""
```


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