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Anatomy of a GUI (Graphical User Interface)

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2018 International Rexx Symposium

Overview

- Interaction with users
- Windows dependent interactions
- Platform independent interactions
  - BSF4ooRexx
  - Platform independent class BSF.Dialog
- Anatomy of a GUI
  - Using awt and swing
  - Using JavaFX
- Roundup and outlook

Interaction with Users, 1

- From time to time input from users is needed
  - Fetch input data to be processed
  - Display and allow input for desired choices
- Sometimes the user needs to be informed
  - About conditions that have occurred
  - Progress a longer running function takes
- Command-line Rexx
  - SAY statements for outputs
  - PARSE PULL statements for inputs

Interaction with Users, 2

- Rexx programs that use SAY and PARSE PULL statements execute in a single thread
- Getting input halts execution of the Rexx program until the user pressed enter
  - No need to synchronize the Rexx program with the user input

Windows Dependent Interactions

- ooDialog
  - Windows only GUI solution
  - Originally with a development environment
    - Included a user interface builder
- Open Object Rexx version
  - Without development environment
    - For leagal reasons IBM could not opensource it
  - Instead manually creating Windows resource files
    - Possible to use some resource editor programs
  - Outdated, no active development, yet still feasible

Platform Independent Interactions

- BSF4ooRexx
  - ooRexx Java bridge
  - Java: *"compile once, run everywhere"*
    - Truly enables platform independence
    - BSF4ooRexx exists for Windows, Linux, MacOSX, AIX, s390x
    - All BSF4ooRexx samples run unchanged on all those platforms
    - Opens access to Java GUI classes and infrastructure!
      - java.awt (abstract windows toolkit) package
      - javax.swing package
      - javafx package plus SceneBuilder to create GUIs interactively

BSF.CLS – Class BSF.DIALOG, 1

- Class BSF.DIALOG defines class methods to create *blocking* popup windows on all operating systems
  - messageBox
    - Informs the user, can be also a warning or error
  - dialogBox
    - Allows the user to chose which button to click
  - inputBox
    - Allows the user to supply input to the program
  - Waits until user pressed a button or picked a choice
    - Comparable to using PARSE PULL, just much more versatile!
    - Cf. samples/1-020_demo.BSF.dialog.rxj

BSF.CLS – Class BSF.DIALOG, 2

```
say "Demonstrating .bsf.dialog~messageBox(...):"
/* arguments: message, title, messageType */
.bsf.dialog~messageBox("This is an informal message")
.bsf.dialog~messageBox("This is an informal message", "A title text")
.bsf.dialog~messageBox("This is an informal message", "A title text", "info")
.bsf.dialog~messageBox("This is an error message",    "A title text", "error")
say "---"

say "Demonstrating .bsf.dialog~dialogBox(...):"
/* arguments: message, title, messageType, optionType, icon, textOfButtons, defaultButton */
res=.bsf.dialog~dialogBox("Shall we delete?", , "question",  "YesNoCancel")
say "dialogBox: you picked button #" res

txtButtons=.list~of("Tickle Alice", "Tickle Berta", "Tickle Cindy")
defButton ="Tickle Berta"
res=.bsf.dialog~dialogBox("Please pick a button", , "question", , , txtButtons, defButton)
say "dialogBox: you picked button #" res
say "---"

say "Demonstrating .bsf.dialog~inputBox(...):"
/* arguments: message, title, messageType, icon, textOfOptions, defaultValue */
res=.bsf.dialog~inputBox("Enter something!")
say "inputBox: you entered" pp(res)

txtOptions=.list~of("Tickle Alice", "Tickle Berta", "Tickle Cindy")
defaultTxtOption="Tickle Berta"
res=.bsf.dialog~inputBox("Pick something!", "Choice Dialog", "plain", , txtOptions,
defaultTxtOption)
say "inputBox: you picked" pp(res)

::requires BSF.CLS
```

Anatomy of a GUI, 1

- If a GUI element gets created, then
  - The GUI subsystem creates an own "GUI Thread" !
  - Interaction with GUI elements/objects is only allowed on the "GUI Thread"
    - Otherwise the GUI hangs, the program blocks!
    - The user cannot interact with the program anymore!
- Usually
  - One supplies a callback method that will be invoked on the "GUI Thread"
  - Then it is safe to interact with all GUI elements

Anatomy of a GUI, 2

- Interacting with GUI elements/objects from another Rexx thread
  - Usually a service function/method from the GUI management is needed to be used instead
  - One needs to register the need for a callback on the GUI thread
  - The next time the GUI thread is used by the GUI management the registered callbacks get carried out on the "GUI Thread"

Anatomy of a GUI, 3

- Graphical subsystems in operating systems
  - Windows
  - Linux
  - MacOSX
- Programming environment with "GUI Thread"
  - Windows GUIs including ooDialog
- Java packages available on all operating systems
  - java.awt, javax.swing and javafx GUIs

GUI With Synchronisation Needs, 1

- If "GUI Thread" totally independent of others
  - Need to synchronize with "GUI Thread"!
  - Otherwise the Rexx program ends, tearing down the GUI
  - Java packages java.awt, javax.swing
- ooRexx multi-threading to the rescue! ;)
  - Setup the GUI
    - User will become able to interact immediately
  - Block the main Rexx program by calling a blocking method after setup, waiting for the GUI to close
  - Define a callback for the GUI event that indicates that Window closes, that releases the blocked method
    - Blocked main Rexx program will be able to continue its work

GUI With Synchronisation Needs, 2

- A simple "helloWorld.rxj" example
  - Creates a window with a title (a "Frame")
    - Closing it should end the Rexx program via a callback
  - Creates a button with a text
    - Clicking it should end the Rexx program via a callback
  - After creating the GUI and displaying the frame
    - The Rexx program waits/blocks until the frame gets closed or the button clicked
  - There is an ooRexx class defined that will
    - Allow blocking
    - Defines the necessary callback methods

GUI With Synchronisation Needs, 3a

```
   -- The Rexx class implements blocking and the methods for the Java callbacks
   -- "actionPerformed" (ActionListener) and "windowClosing" (WindowListener)
::class RexxCloseAppEventHandler

::method init                   -- Rexx constructor method
  expose lock
  lock=.true                    -- if set to .false, then release block

::method waitForExit            -- method blocks until attribute is set to .true
  expose lock
  guard on when lock=.false     -- clever ooRexx way to block! :)

::method actionPerformed        -- event method (from ActionListener)
  expose lock
  lock=.false                   -- indicate that the app should close

::method unknown                -- intercept unhandled events, do nothing

::method windowClosing          -- event method (from WindowListener)
  expose lock
  lock=.false                   -- indicate that the app should close
```

GUI With Synchronisation Needs, 3b

```
    -- create instance/value of our Rexx class
rexxCloseEH =.RexxCloseAppEventHandler~new   -- Rexx event handler
```

```
   -- Create Java RexxProxy for the Rexx event handler
javaCloseEH=BsfCreateRexxProxy(rexxCloseEH, , - /* Rexx object to box  */
           "java.awt.event.ActionListener",  - /* actionPerformed     */
           "java.awt.event.WindowListener" )   /* windowClosing       */
```

```
    -- create a Java awt window with a title
window=.bsf~new("java.awt.Frame", 'Hello World!')
window~addWindowListener(javaCloseEH)       -- register event handler
```

```
    -- create a Java awt window with a title
button=.bsf~new("java.awt.Button", 'Press Me !')
button~addActionListener(javaCloseEH)       -- register event handler
```

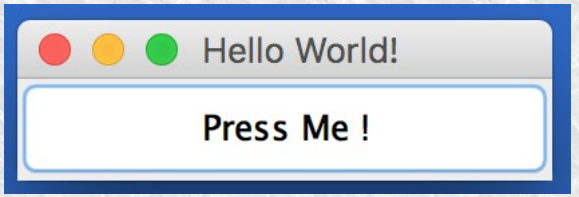
```
    -- prepare window and show it, using cascading messages (two twiddles '~')
window ~~add(button) ~~pack ~~setSize(200,60) ~~setVisible(.true) ~~toFront
```

```
rexxCloseEH~waitForExit -- blocks until user closes the Window (Frame)
```

```
::REQUIRES BSF.CLS      -- get the Java support
```

GUI With Synchronisation Needs, 3c

```
    -- create instance/value of our Rexx class
rexxCloseEH =.RexxCloseAppEventHandler~new   -- Rexx event handler

   -- Create Java RexxProxy for the Rexx event handler
javaCloseEH=BsfCreateRexxProxy(rexxCloseEH, , - /* Rexx object to box  */
           "java.awt.event.ActionListener",  - /* actionPerformed     */
           "java.awt.event.WindowListener" )   /* windowClosing       */

    -- create a Java awt window with a title
window=.bsf~new("java.awt.Frame", 'Hello World!')
window~addWindowListener(javaCloseEH)       -- register event handler

    -- create a Java awt window with a title
button=.bsf~new("java.awt.Button", 'Press Me !')
button~addActionListener(javaCloseEH)       -- register event handler

    -- prepare window and show it, using cascading messages (two twiddles '~')
window ~~add(button) ~~pack ~~setSize(200,60) ~~setVisible(.true) ~~toFront

rexxCloseEH~waitForExit -- blocks until user closes the Window (Frame)

::REQUIRES BSF.CLS      -- get the Java support

/* ---------------------------------------------------------------------- */
   -- The Rexx class implements blocking and the methods for the Java callbacks
   -- "actionPerformed" (ActionListener) and "windowClosing" (WindowListener)
::class RexxCloseAppEventHandler

::method init               -- Rexx constructor method
  expose lock
  lock=.true                -- if set to .false, then release block

::method waitForExit        -- method blocks until attribute is set to .true
  expose lock
  guard on when lock=.false -- clever ooRexx way to block! :)

::method actionPerformed    -- event method (from ActionListener)
  expose lock
  lock=.false               -- indicate that the app should close

::method unknown            -- intercept unhandled events, do nothing

::method windowClosing      -- event method (from WindowListener)
  expose lock
  lock=.false               -- indicate that the app should close
```



GUI Without Synchronisation Needs, 1

- JavaFX
  - Creating GUI with *SceneBuilder*
    - GUI stored in FXML file
  - Creating a Rexx program
    - Need to extend/subclass javafx.application.Application
    - Implement its method start
    - Run the launch method
    - JavaFX will block that application object until the user closes the GUI!

GUI Without Synchronisation Needs, 2a

```
rxApp=.RexxApplication~new -- create Rexx object that will control the FXML set up
jrxApp=BSFCreateRexxProxy(rxApp, ,"javafx.application.Application")
jrxApp~launch(jrxApp~getClass, .nil)    -- launch the application, invokes "start"

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

-- Rexx class implements "javafx.application.Application" abstract method "start"
::class RexxApplication -- implements the abstract class "javafx.application.Application"

::method start          -- Rexx method "start" implements the abstract method
  use arg primaryStage  -- fetch the primary stage (window)
  primaryStage~setTitle("Hello JavaFX from ooRexx! (Green Version)")

   -- create an URL for the FMXLDocument.fxml file (hence the protocol "file:")
  fxmlUrl=.bsf~new("java.net.URL", "file:fxml_01.fxml")
   -- use FXMLLoader to load the FXML and create the GUI graph from its definitions:
  rootNode=bsf.loadClass("javafx.fxml.FXMLLoader")~load(fxmlUrl)

  scene=.bsf~new("javafx.scene.Scene", rootNode)    -- create a scene
  primaryStage~setScene(scene)  -- set the stage to our scene
  primaryStage~show             -- show the stage (and thereby our scene)
```

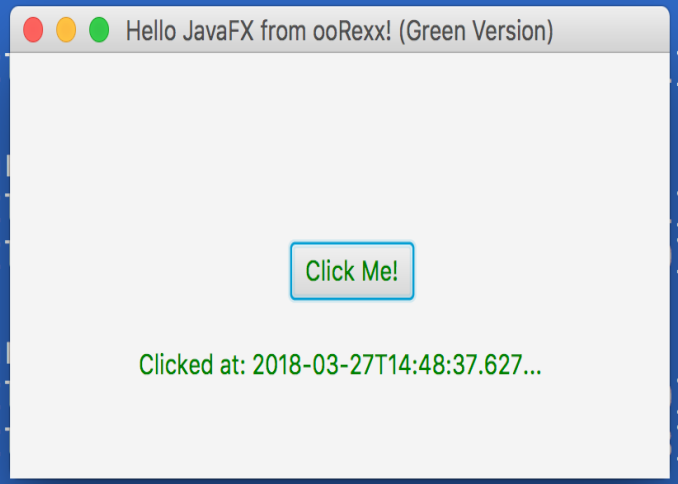
GUI Without Synchronisation Needs, 2b

```
<?xml version="1.0" encoding="UTF-8"?>

<?import javafx.scene.control.Button?>
<?import javafx.scene.control.Label?>
<?import javafx.scene.layout.AnchorPane?>

<!-- use the Java scripting engine named 'rexx' in this file -->
<?language rexx?>

<AnchorPane id="AnchorPane" prefHeight="200" prefWidth="400"
            xmlns:fx="http://javafx.com/fxml/1">
    <!-- Rexx buttonClicked callback -->
    <fx:script source="fxml_01_controller.rex" />

    <children>
        <Button fx:id="idButton1" layoutX="170.0" layoutY="89.0"
                        onAction="slotDir=arg(arg()); call buttonClicked slotDir;"
                        text="Click Me!" textFill="GREEN" />

        <Label fx:id="idLabel1" alignment="CENTER" contentDisplay="CENTER"
                                layoutX="76.0"     layoutY="138.0"
                                minHeight="16"     minWidth="49"
                                prefHeight="16.0"  prefWidth="248.0"
                                textFill="GREEN" />
    </children>
</AnchorPane>
```

GUI Without Synchronisation Needs, 2c

```
::routine buttonClicked public
  slotDir=arg(arg())  -- note: last argument is the slotDir argument from BSF4ooRexx
  now=.dateTime~new -- time of invocation
  say now": arrived in routine 'buttonClicked' ..."

  /* @get(idLabel1) */
  say '... current value of label='pp(idLabel1~getText)
  idLabel1~text="Clicked at:" now          -- set text property
  say '...     new value of label='pp(idLabel1~getText)
  say
```

```
ronymac2014:code rony$ rexxj.sh fxml_01.rex
REXXout>2018-03-27T14:48:24.646971: arrived in routine 'buttonClicked' ...
REXXout>... current value of label=[]
REXXout>...     new value of label=[C
REXXout>
REXXout>2018-03-27T14:48:28.443930: ar
REXXout>... current value of label=[C
REXXout>...     new value of label=[C
REXXout>
REXXout>2018-03-27T14:48:30.251728: ar
REXXout>... current value of label=[C
REXXout>...     new value of label=[C
REXXout>
REXXout>2018-03-27T14:48:37.627544: arrived in routine 'buttonClicked' ...
REXXout>... current value of label=[Clicked at: 2018-03-27T14:48:30.251728]
REXXout>...     new value of label=[Clicked at: 2018-03-27T14:48:37.627544]
REXXout>
```



Updates to GUI From Another Thread, 1

- Possible to have Rexx threads in parallel
  - Long running operations
  - Need to give user feedback about progress
  - Desire to use the GUI to inform the user
  - Updating a GUI element from a Rexx thread
    - Hangs the GUI and as a result
    - Hangs the application for the user
  - Proper way
    - Inform the GUI to call back on the "GUI Thread" later
    - Depends on the GUI system one uses

Updates to GUI From Another Thread, 2

- JavaFX
  - Own GUI mangagement
  - "GUI Thread" dubbed "JavaFX Application Thread"
    - Too long of a term
  - "javafx.application.Platform"
    - Class method runLater(Runnable)
    - Allows to have the Runnable code executed on the "GUI Thread" later
- Students, even skilled and informed were not able to properly use this class
  - Need to find a more "human centric" solution

Updates to GUI From Another Thread, 3

- BSF4ooRexx
  - Class FXGuiThread methods
    - IsGuiThread
      - Returns .tru/.false
    - runLater(GUI_object, message, …)
      - Returns GUIMessage object
    - runLaterLatest(GUI_object, message, …)
      - Returns GUIMessage object
  - Class GUIMessage
    - Modelled after ooRexx class Message
      - Can directly use its documentation
    - Possible to wait on message to have executed

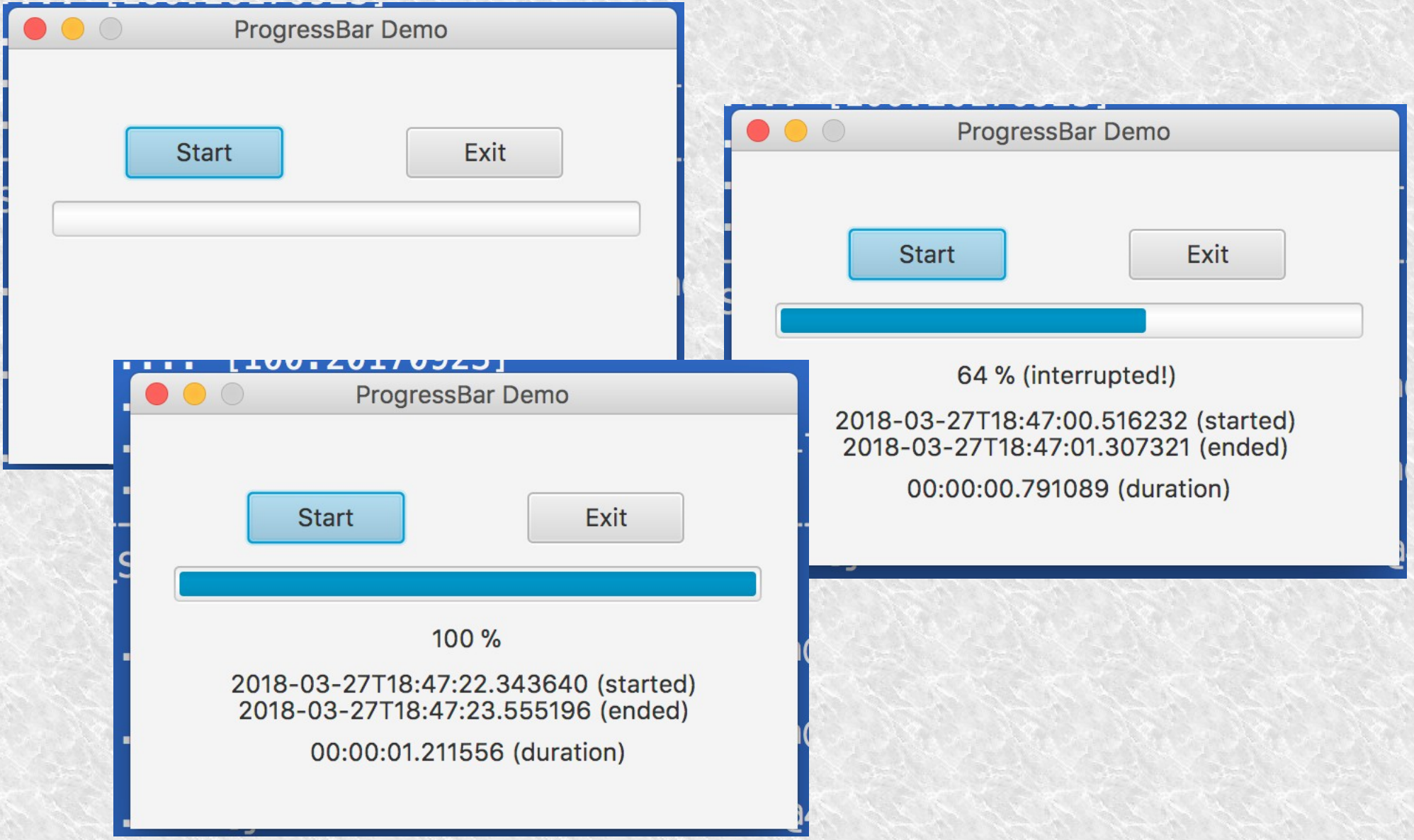
Updates to GUI From Another Thread, 4

- samples/JavaFX/fxml_06
  - GUI progress bar sample
  - GUI progress indicator gets updated from a worker Rexx thread
  - As the user may interrupt the Rexx thread at any time via the GUI the worker thread needs to learn about it
    - Need to create a communication protocol!
    - Cf. class Action in fxml_pb_controller.rex
    - Communication via Rexx can be done without problems between the "GUI Thread" and the Rexx worker thread

Updates From Rexx Worker Thread, 1

```
::requires "BSF.CLS"

::class Worker public

::method go
  use arg clzAction  -- get class object

  reply     -- return to caller, keep working on a separate thread
  fxml=.my.app~fxml_pb.fxml  -- get the corresponding FXML Rexx directory
  pb        =fxml~idProgressBar
  lblCurrent=fxml~idLabelCurrent

  do i=1 to 100 while clzAction~state="running"
     -- update GUI controls on the "JavaFX Application Thread"
    d=box("Double",i/100)
    .FXGuiThread~runLaterLatest(pb, "setProgress", "individual", d)
    .FXGuiThread~runLaterLatest(lblCurrent, "setText", "indiv" , i "%")

     -- instead of sleeping, do the real work here!  <-- <-- <--
    call SysSleep 0.01    -- sleep 1/100 of a second
  end
   -- we need to send the message on the "JavaFX Application Thread"
  msg=.FXGuiThread~runLater(clzAction, "setIdle")
  res=msg~result  -- this blocks until message was executed
```

Updates From Rexx Worker Thread, 2



Roundup and Outlook

- Creating cross-operating system GUIs easy
- Possible problem
  - Interacting with GUI element from a non "GUI Thread"
    - Hangs the GUI, hangs the user interface!
  - Solution for JavaFX applications
    - Rexx class FXGuiThread
    - Easy to use
    - Makes it easy to create bullet-proof Rexx-GUI applications!