WIRTSCHAFTS UNIVERSITÄT WIEN VIENNA UNIVERSITY OF ECONOMICS AND BUSINESS

EQUIS ACCREDITED AACSB ACCREDITED ASSOCIATION OF MBAS ACCREDITED

ePub^{WU} Institutional Repository

Rony G. Flatscher

JavaFX for ooRexx – Creating Powerful Portable GUIs for ooRexx

Article (Published)
(Refereed)

Original Citation:

Flatscher, Rony G.

(2017)

JavaFX for ooRexx – Creating Powerful Portable GUIs for ooRexx.

The Proceedings of the Rexx Symposium for Developers and Users.

pp. 1-43. ISSN 1534-8954

This version is available at: https://epub.wu.ac.at/7451/
Available in ePub^{WU}: October 2021

License: Creative Commons: Attribution 4.0 International (CC BY 4.0)

ePub^{WU}, the institutional repository of the WU Vienna University of Economics and Business, is provided by the University Library and the IT-Services. The aim is to enable open access to the scholarly output of the WU.

This document is the publisher-created published version. It is a verbatim copy of the publisher version.

http://epub.wu.ac.at/

JavaFX for ooRexx – Creating Powerful Portable GUIs for ooRexx

Rony G. Flatscher (Rony.Flatscher@wu.ac.at), WU Vienna
"The 2017 International Rexx Symposium", Amsterdam, The Netherlands
April 9[9h] – 12th, 2017

Abstract. The powerful "*JavaFX*" GUI classes together with their support of the *javax.script* framework and the availability of a graphical GUI builder ("*SceneBuilder*") make it possible for the latest version of BSF4ooRexx (a Rexx-Java bridge) with its *RexxScript* implementation to use Rexx scripts as GUI handlers out of the box. It becomes therefore also possible to create and control the most complex GUIs for and from Rexx applications, which will be able to run unchanged on Windows, Linux and MacOSX. This article explains the core concepts of *JavaFX* and how to take advantage of them from ooRexx. Working stand-alone nutshell examples will demonstrate how *JavaFX* can be controlled by and employed for ooRexx.

1 Introduction

This article first introduces briefly the history of the Java GUI[1] frameworks *awt*, *swing* and *JavaFX* which allow the creation of GUI applications that are portable among Windows, Linux and MacOSX. It then explains the core concepts *JavaFX* defines and which need to be understood to become able to exploit this powerful Java framework, which will be demonstrated with appropriate ooRexx nutshell programs. As *JavaFX* includes the possibility to define the most complex GUIs with the help of XML encoded ("*FXML*") files, that can be created and edited with a portable tool named *SceneBuilder*, BSF4ooRexx with its *RexxScript* [1] and *RexxScript annotation* [1] adds support that eases the exploitation of this infrastructure from Rexx. Small nutshell examples will demonstrate how easy it is for ooRexx applications to take advantage of *JavaFX* and *FXML*.

2 Brief History

Already the first version of Java 1.0 included a founding, portable GUI framework named "abstract window toolkit (*awt*)" organized in the Java package *java.awt* [2] in 1996, more than 20 years ago. The Java classes allowed for creating portable GUI applications that could be run unchanged on all supported operating systems

1 GUI is the acronym for "graphical user interface".

like Windows or OS/2 then. Operating system dependent differences[2] in the GUI area were abstracted away by the Java implementation of this portable GUI framework.

Two years later (1998) with the next version of Java, 1.2, an additional GUI framework got introduced organized in the Java package *javax.swing*. [3] These GUI classes were implemented and drawn in Java following the GUI concepts used for the *awt* GUI classes and allowed among other things to "skin"[3] the GUI classes at run time or to format GUI classes using the then popular HTML style attributes.

In 2008 a stand-alone new Java package named *JavaFX* got introduced with a proper scripting language named "*JavaFX Script (FX)*", which was removed later with the release of *JavaFX* 2.0 in 2011. *JavaFX* was meant as a full replacement for the *java.awt* and *javax.swing* packages. With an update to Java 1.7/7 it was added to the Java runtime environment (JRE), with the release of Java 1.8/8 (2014) its name was changed to "*JavaFX 8*". *JavaFX* is supposed to ease the creation and maintenance of complex GUI applications on all Java supported devices, from very small portable devices to the most powerful computers with large screens.

3 JavaFX

This section introduces the JavaFX concepts and demonstrates how to take advantage of them from ooRexx using BSF4ooRexx.

3.1 Concepts

JavaFX introduces a new package named "javafx". [5] The entire GUI system is organized around the idiom of a theater with one or more stages, where on each *stage* a particular *scene* gets played. Each *scene* is managed by a controller program, that can be implemented in Java or in any *javax.script* language.

---

2 The OS/2 GUI origin of the coordinate "0,0" was the lower left corner of the screen, whereas in Windows and many other operating systems that coordinate was defined to be the upper left corner of the screen. Yet, the Java GUI origin of "0,0" was defined to be the upper left-hand corner and the necessary OS/2-dependent mappings would be done transparently by the java.*awt* classes, relieving the programmers from handling such differences.

3 The layout of the visible *swing* GUI classes can be changed at run time, taking advantage of the package *javax.swing.plaf* which allows for this flexible behaviour ("PLAF" is an acronym for "pluggable look and feel"). [4] In this sense the look, the "skin" of the visible GUI classes can be modified at run time, changing the look and feel of a Java application at will.

3.1.1 JavaFX Interface Class "Property"

Many *JavaFX* GUI classes take advantage of the j*avafx.beans.property.Property* [6] interface class for defining their properties. Interacting with such properties eases the definition and the coding of GUI applications. Therefore there are numerous *JavaFX* implementations for properties of different types available that get employed in various *JavaFX* GUI classes. They are documented in the Javadocs for the interface *Property* [6] where the Javadocs list all classes implementing that particular interface class.

Some *JavaFX* properties can be bound to each other, such that changes in a bound property get reflected in the other property.

Code 1 below demonstrates how one can use BSF4ooRexx to import the JavaFX class *SimpleIntegerProperty* [7] into Rexx for creating two such objects, one (*num1*) representing the integer value *1*, the other (*num2*) the integer value *2*. Using the *add* method inherited from *IntegerExpression* [8] to add the two integer properties yields another property that is named *sum*, which binds the two operands *num1* and *num2*.

As long as the current value of the *sum* property (an *IntegerBinding*) is not fetched either with the methods *getValue* or *get*, its *toString* method indicates that the addition has not yet been evaluated, outputting therefore the string value "*IntegerBinding [invalid]*" as can be seen from the output in Output 1 below. The

```
  -- import the Java class, allow it to be used like an ooRexx class thereafter
sipClz=bsf.import("javafx.beans.property.SimpleIntegerProperty")
num1 = sipClz~new(1)
say "num1:" num1 "|" num1~toString "|" num1~getValue
num2 = sipClz~new(2)
say "num2:" num2 "|" num2~toString "|" num2~getValue
say
sum=num1~add(num2)
say "sum: " sum
say "sum: " sum~toString "|" sum~getValue "|" sum~toString
say "---"
say "num1:" num1~getValue "num2:" num2~getValue "-> sum:" sum~getValue
say "setting 'num1=2' ..."
num1~set(2)
say "num1:" num1~get      "num2:" num2~get      "-> sum:" sum~get
say "setting 'num2=3' ..."
num2~set(3)
say "num1:" num1~getValue "num2:" num2~getValue "-> sum:" sum~getValue

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

Code 1: Using bound SimpleIntegerProperty objects.

```
num1: javafx.beans.property.SimpleIntegerProperty@67c3bb | IntegerProperty [value: 1] | 1
num2: javafx.beans.property.SimpleIntegerProperty@19bb37 | IntegerProperty [value: 2] | 2

sum:  javafx.beans.binding.Bindings$15@1d10166
sum:  IntegerBinding [invalid] | 3 | IntegerBinding [value: 3]
---
num1: 1 num2: 2 -> sum: 3
setting 'num1=2' ...
num1: 2 num2: 2 -> sum: 4
setting 'num2=3' ...
num1: 2 num2: 3 -> sum: 5
```

Output 1: Output of executing Code 1, above.

effect of requesting the current value of *sum* in the same statement, displays the result value *3* and following that expression the invocation of its *toString* method will change the string to "*IntegerBinding [value: 3]*".

After the three dashes the current values of *num1*, *num2* and *sum* get displayed. From now on, whenever *num1* or *num2* get changed and the value of *sum* gets queried, the result of the additions of the two bound operands *num1* and *num2* will be displayed. Output 1 displays the output of running the Rexx program in Code 1.

3.1.2 The "*JavaFX Application Thread*"

The creation of and interaction with *JavaFX* GUI objects must be carried out in the *JavaFX Application Thread* only, otherwise the application may not be responsive to user input anymore and as a result hangs. *JavaFX* reports GUI events by calling event handlers on this *JavaFX Application Thread*, such that it is always safe for event handlers to directly interact with the *JavaFX* GUI objects. [4]

In the case that an application needs to directly communicate with the *JavaFX* GUI objects it is able to do so by employing the *runLater* method (with a *java.lang.Runnable* as an argument) of the *JavaFX* class *javafx.application.Platform* [12], which will make sure that the *Runnable* object gets invoked on the *JavaFX Application Thread*.[5]

4 This corresponds to the event dispatch handler [9] that has been documented with tutorials of how to use the swing [10] and awt [11] frameworks.

5 For an easy BSF4ooRexx solution for this problem see chapter "B Addendum: The Classes FXGuiThread and GUIMessage" on page 35.

3.1.3 JavaFX Stages and JavaFX Scenes

A *JavaFX* application creates one or more windows of type *javafx.stageStage* [13] which can be displayed on the host's GUI. Each stage can be used to display a *javafx.stage.Scene* [14] which is a container for a graph of GUI nodes, that are usually instances of one of the *JavaFX* GUI classes from packages that start with the package name *javafx.scene*. [15]. An application may define multiple scene objects and use them to display them in stage objects.

The creation of and interaction with stages and scenes needs to be carried out on the *JavaFX Application Thread*.

3.1.4 DOM and CSS

The fundamental data structure of *JavaFX* GUIs is a scene that is composed of a (hierarchical) tree of GUI objects of type *javafx.scene.Node*[6]. Each node is assigned to a specific scene object and may have a unique *id* and an individual *style* for rendering[7] it.

Comparable to using DOM [18] traversing HTML [19], the creation of a GUI for a scene will traverse the hierarchic scene graph node by node rendering each node using CSS[8] rules.

Any programmer familiar with the web technologies HTML, DOM and CSS can readily apply her knowledge when devising and creating *JavaFX* applications!

3.1.5 JavaFX Abstract Class "Application"

Each *JavaFX* application must extend the abstract class *javafx.application.Application* [23] and implement the method *start* that sets up the initial GUI by creating and setting a scene to the supplied stage. The *launch* method will first invoke the method *init*, then create the *JavaFX Application Thread* and a stage object, which will be passed as the sole argument to the *start* method, which executes on the *JavaFX Application Thread*. Therefore it is safe to create and interact with *JavaFX* stage and scene objects in this *start* method.

---

6 All *JavaFX* GUI classes in a scene have the *javafx.scene.Node* class as one of their supertypes.

7 When rendering the user interface *JavaFX* employs the open source "WebKit" engine at the time of writing. This rendering engine gets used e.g. in Apple's Safari web browsers.

8 Cf. the world wide web consortium homepage [20]. *JavaFX* defines a subset of CSS attributes and values in [21].

```
/* modelled after
https://docs.oracle.com/javase/8/javafx/api/javafx/application/Application.html
*/

myRexxApp=.myApp~new     -- create an instance of the Rexx class
   -- extend the Java abstract class with the "myRexxApp" object
jrxApp=BSFCreateRexxProxy(myRexxApp, ,"javafx.application.Application")
jrxApp~launch(jrxApp~getClass, .nil)    -- launch the Application

::class MyApp       -- the Rexx class used to extend the Java class
::method start      -- implementing the abstract Java method "start"
  use arg stage     -- fetch the stage object to use for a scene to show
      -- create a circle object (will be black)
  circ =.bsf~new("javafx.scene.shape.Circle", 40, 40, 30)
      -- create a group and add the circle to it
  root =.bsf~new("javafx.scene.Group")
  root~getChildren~add(circ)   -- add the circle to the group
      -- create a scene assign it the group as the root node
  scene=.bsf~new("javafx.scene.Scene", root, 400, 300)
      -- interact with the stage
  stage~title="My JavaFX Application from Rexx"
  stage~scene=scene   -- assign the scene
  stage~show          -- show the stage (window)

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

Code 2: A simple JavaFX Rexx application modelled after the example in [23].

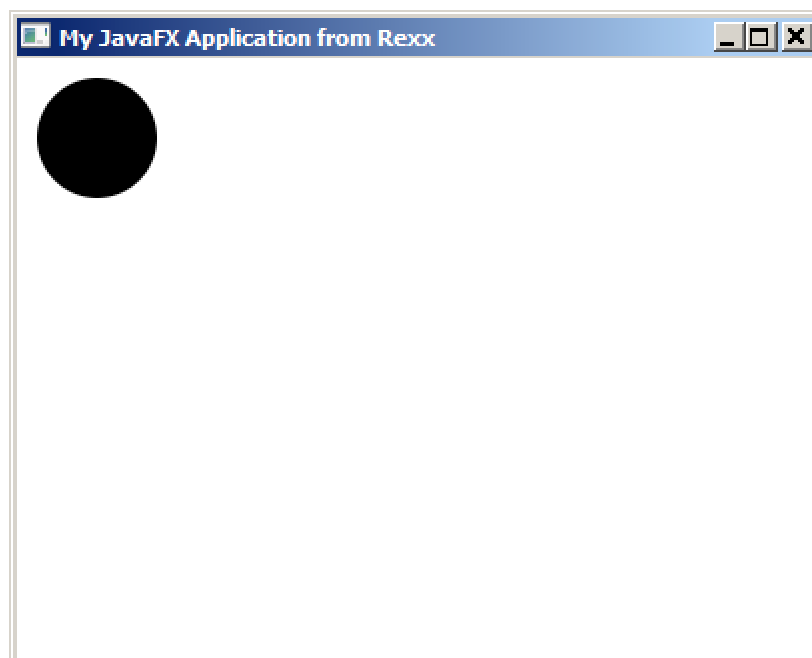


Figure 1: JavaFX application created by Code 2 above.

BSF4ooRexx' external Rexx function named *BsfCreateRexxProxy()*[9] [24] allows for

9 The first argument is the Rexx object implementing the abstract Java methods, the second argument is optional and may be any Rexx object (if given it will get added to the *slotDir* argument under the name *USERDATA*), the third argument is the fully qualified Java interface or abstract class name that defines the type of the returned Java object.

```
myRexxApp=.myApp~new     -- create an instance of the Rexx class
   -- extend the Java abstract class with the "myRexxApp" object
jrxApp=BSFCreateRexxProxy(myRexxApp, ,"javafx.application.Application")

signal on syntax          -- if an error occurs, jump to label "SYNTAX:" below
jrxApp~launch(jrxApp~getClass, .nil)    -- launch the Application
exit

syntax:                   -- syntax condition handling routine
  co=condition("object")-- get condition object
  say ppCondition2(co)  -- show all error information including nested Java exceptions

::requires "rgf_util2.rex" -- get all utility routines from this package

::class MyApp        -- the Rexx class used to extend the Java class
::method start       -- implementing the abstract Java method "start"
  use arg stage     -- fetch the stage object to use for a scene to show
      -- create a circle object (will be black)
  circ =.bsf~new("javafx.scene.shape.Circle", 40, 40, 30)
      -- create a group and add the circle to it
  root =.bsf~new("javafx.scene.Group")
  root~getChildren~add(circ)   -- add the circle to the group
      -- create a scene assign it the group as the root node
  scene=.bsf~new("javafx.scene.Scene", root, 400, 300)
      -- interact with the stage
  stage~title="My JavaFX Application from Rexx"
  stage~scene=scene    -- assign the scene
  stage~show           -- show the stage (window)

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

Code 3: A simple JavaFX Rexx application with a Rexx syntax condition handler.

creating a Java object from a Rexx object, that implements the abstract methods of a Java interface or abstract classes in Rexx. The resulting Java object can then be used as an argument wherever a Java type of the interface or abstract class is required. If the abstract method gets invoked on the Java side this will cause a Rexx message of the abstract method's name to be sent to the Rexx object. Any Java arguments are passed as Rexx arguments, where BSF4ooRexx will always add a trailing "*slotDir*" argument[10] of type *Slot.Argument*[11] which is a Rexx directory containing additional, context related information for the invoked Rexx method.

Code 2 above shows a Rexx program modelled after the presented example in [23][12] which will create a simple JavaFX GUI application as depicted in Figure 11.

10 As the *slotDir* argument is always the last argument one can fetch it with the built-in function *arg()* as well, e.g. "*slotDir=arg(arg())*", where *arg()* returns the actual number of arguments which is then used to fetch last supplied Rexx argument.

11 A Rexx programmer can therefore always test whether the last supplied argument was sent by the invoker or was added by BSF4ooRexx by testing: slotDir~isA(.Slot.Argument).

12 Please note that the Java example uses the circle shape object as the sole argument for the constructor of the *JavaFX Group* class which will cause the Java compiler to pick the *varargs* version. Instead the Rexx version gets the group's children collection and adds the JavaFX *Circle* shape object to it. Alternatively, the Rexx program could have created a Java array of type

Note, if there are errors in the *start* method of the Rexx class then it may be the case that the original source of the error on the *JavaFX* side is not displayed, rather the Java exception that got returned and which may nest the original Java exception. In such a case one needs to iterate over the nested Java exceptions using the *getCause* method and get the description of the bottom Java exception with the *toString* method.

With BSF4ooRexx the Rexx utility package, *rgf_util2.rex* [25], gets distributed which eases displaying such a chain of nested Java exceptions by employing the public method *ppCondition2()* which expects an ooRexx condition object[13] as its sole argument. *ppCondition2()* will display all nested Java exceptions such that a Rexx programmer can find out the root cause of any error that may be created in the aforementioned *start* method. Code 3 highlights the necessary changes of Code 2 to output all nested Java exceptions in case such an exception occurs.

3.1.6 Model View Controller (MVC) Pattern

As we have seen we are able to create JavaFX applications quite easily. However so far we are not able to react upon events that are created by the GUI. For example in Code 2 above the GUI would not react if we would click into its area. The reason is that we have not set up any code that would react to such events.

Like in the *awt* and *swing* frameworks the *JavaFX* framework wsa created with the "model-view-controller (MVC)" [26] pattern in mind. The model component of an application would set up the application and use one ore more view components for presentation to the user, which can have controller components assigned to which events can be redirected.

In the Java *awt* and *swing* GUI frameworks the view components like GUI controls would communicate events to controllers by allowing listeners to be registered. Depending on the listener type the GUI component would then invoke the corresponding event method in the supplied controller's listener object.

The *JavaFX* framework takes a different, simpler approach: it defines event

Node with a size of one, store the *Circle* shape object in it and use the Java array as the argument for the *Group* constructor which would then cause the *varargs* version to be picked.

13 If a Rexx condition gets raised the condition handler can use the built-in function *CONDITION('Object')* to retrieve the condition object, which is a Rexx directory that includes all condition relevant information.

properties for its view components that expect an object that implements the interface *javafx.event.EventHandler*. Whenever the GUI component triggers an event, the appropriate property will invoke its *EventHandler*'s *handle* method, supplying an event object that may contain additional information about the event.

3.1.7 Creating a Simple JavaFX GUI Dialog Application with ooRexx

This section introduces a simple *JavaFX* GUI application in ooRexx which creates a colored *javafx.scene.control.Label* and a colored *javafx.scene.control.Button*. The Rexx code is depicted in Code 4 below: it defines two Rexx classes:

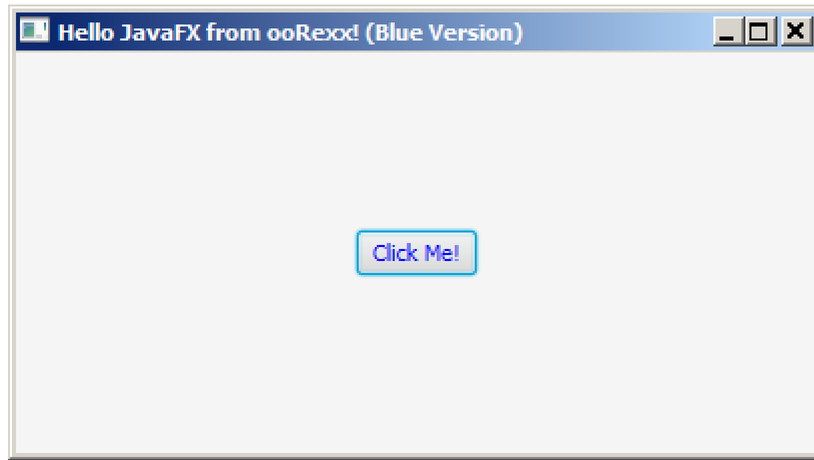
- *RexxApplication*: this class is used to implement the abstract Java method start as a Rexx method, which creates a *JavaFX Label* and a *Button* object, which get sized, positioned and styled, e.g. with a blue text color. The *Button* object will get an instance of the *RexxButtonHandler* assigned as its action handler. The Rexx object will be wrapped up as a Java Rexx proxy defining it to implement all methods of the *javafx.event.EventHandler* interface, i.e. in this case the single method named *handle*. Each time the button gets pressed it will invoke the method *handle*. The *RexxApplication* object will be wrapped up as a Java Rexx proxy that extends the abstract *javafx.application.Application* class such that it becomes possible to send it the *launch* message which will cause the *start* method to be invoked in the Rexx object.
- *RexxButtonHandler*: this class implements the *javafx.event.EventHandler* interface, i.e. the method named *handle* in Rexx. When an instance of this class gets created a *JavaFX Label* object needs to be supplied, which is stored in the attribute named *label* and directly accessed in the *handle* method. As event handler methods get always invoked in the *JavaFX Application Thread*, it is safe to directly interact with any *JavaFX* GUI object in this case with the label object.

Studying the *RexxApplication start* method it is interesting to learn that there are quite many aspects that need attention and configuration when creating, sizing, styling and positioning GUI controls.

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

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

-- Rexx class defines "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! (Blue Version)")

  -- get Java class objects to ease access to their constants (static fields)
  colorClz=bsf.loadClass("javafx.scene.paint.Color") -- JavaFX colors
  cdClz=bsf.loadClass("javafx.scene.control.ContentDisplay") -- ContentDisplay constants
  alClz=bsf.loadClass("javafx.geometry.Pos")       -- alignment constants (an Enum class)

  root=.bsf~new("javafx.scene.layout.AnchorPane") -- create the root node
  root~prefHeight=200            -- or: root~setPrefHeight(200)
  root~prefWidth=400             -- or: root~setPrefWidth(400)
      -- define the Label
  lbl=.bsf~new("javafx.scene.control.Label")
  lbl~textFill=colorClz~BLUE     -- or: lbl~setTextFill(colorClz~BLUE)
  lbl~setLayoutX(76)             -- or: lbl~layoutX=76
  lbl~setLayoutY(138)            -- or: lbl~layoutY=138
  lbl~prefHeight="16.0"          -- or: lbl~setPrefHeight("16.0")
  lbl~prefWidth="248.0"          -- or: lbl~setPrefWidth("248.0")
  lbl~contentDisplay=cdClz~CENTER        -- or: lbl~setContentDisplay (cdClz~CENTER)
  lbl~alignment=alClz~valueOf("CENTER") -- or: lbl~setAlignment(alClz~valueOf("CENTER"))
      -- define and add the Button, assign values as if we deal with Rexx attributes
  btn=.bsf~new("javafx.scene.control.Button")
  btn~textFill=colorClz~BLUE     -- or: btn~setTextFill(colorClz~BLUE)
  btn~layoutX=170                -- or: btn~setLayoutX(170)
  btn~layoutY=89                 -- or: btn~setLayoutY(89)
  btn~text="Click Me!"           -- or: btn~setText("Click Me!")
      -- create a Rexx ButtonHandler, wrap it up as a Java RexxProxy
  rh=.RexxButtonHandler~new(lbl)-- create Rexx object, supply it the label "lbl"
  jrh=BSFCreateRexxProxy(rh, ,"javafx.event.EventHandler")
  btn~setOnAction(jrh)           -- forwards "handle" message to Rexx object
      -- add the button and label to the AnchorPane object
  root~getChildren~~add(btn)~~add(lbl)
      -- put the scene on the stage
  primaryStage~setScene(.bsf~new("javafx.scene.Scene", root))
  primaryStage~show -- show the stage (window) with the scene

   -- Rexx class which handles the button presses
::class RexxButtonHandler   -- implements "javafx.event.EventHandler" interface
::method init        -- Rexx constructor method
  expose label       -- allow direct access to ooRexx attribute
  use arg label      -- save reference to javafx.scene.control.Label

::method handle      -- will be invoked by the Java side
  expose label       -- allow direct access to ooRexx attribute, not used in this example
  -- use arg event, slotDir    -- expected arguments
  now=.dateTime~new -- time of invocation
  say now": arrived in method 'handle' ..."
  say '... current value of label='pp(label~getText)
  label~text="Clicked at:" now         -- set text property
  say '...     new value of label='pp(label~getText)
  say
```

Code 4: A simple JavaFX GUI application in ooRexx ("javafx_01.rex").

Running the *JavaFX* dialog application and pressing the button two times, yields



```
2017-10-31T18:40:06.558000: arrived in method 'handle' ...
... current value of label=[]
...     new value of label=[Clicked at: 2017-10-31T18:40:06.558000]

2017-10-31T18:40:38.104000: arrived in method 'handle' ...
... current value of label=[Clicked at: 2017-10-31T18:40:06.558000]
...     new value of label=[Clicked at: 2017-10-31T18:40:38.104000]
```

Figure 2: The JavaFX initial dialog and changes by two button presses.

the dialogs and the console output as depicted in Figure 2 above.

3.2 Defining Scenes in FXML (FX Markup Language)

The *JavaFX* framework allows the definition of GUIs in a declarative manner using the "FX Markup Language (FXML)" and saving them in a file. FXML mandates a well formed XML markup, but describes the elements and properties informally in [27]. There is neither a DTD (document type definition) nor a XSD (XML schema definition) for FXML, because elements representing *JavaFX* compliant controls should always be usable in FXML files in the case that either *JavaFX* creates new controls over time or third party *JavaFX* controls (e.g. [28]) get employed.

Code 5 below depicts an FXML file that defines a *JavaFX* dialog that is comparable to the example in the section "3.1.7 Creating a Simple JavaFX GUI Dialog Application with ooRexx" above, with the exception that the *textFill* property in the label and button controls is defined to be green (instead of blue).

As can be seen from that example there are XML *import* processing instructions (PI)[14] that fully qualify the *javafx.scene* classes that needs to be imported in order to process the elements (unqualified Java class names) defined in the XML file. The attributes/properties defined for the elements will be used to set the values of the *JavaFX* properties by the same name.

The processing instruction *language* defines a *javax.script* scripting language to be used for executing any programs defined in an *fx:script* element or programming statements in event handler. Code 5 below defines "rexx" as the scripting language.

3.2.1 SceneBuilder

There exists a tool, *SceneBuilder*, that allows one to create *JavaFX* GUIs interactively with drag and drop [31] and set the attributes of available properties, as well as definitions relevant for the layout and code related information for controllers[15]. It is possible to add third party *JavaFX* controls to *SceneBuilder*.

Although developed and maintained by Oracle, free installation packages of

14 A processing instruction starts with the charactesr "*<?*" followed by the instruction and ends with "*?>*", cf. [29], [30].

15 *SceneBuilder* directly supports controllers implemented in Java.

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

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

<!-- the processing instruction (PI) defines the Java script engine named 'rexx'
     to be used for executing code in this FXML file: running "fxml_01_controller.rex"
     and the code in the 'onAction' event attribute for the Button element -->
<?language rexx?>

<AnchorPane id="AnchorPane" prefHeight="200" prefWidth="400"
            xmlns:fx="http://javafx.com/fxml/1">

    <!-- call Rexx program, its public routine "buttonClicked" is known afterwards -->
    <fx:script source="fxml_01_controller.rex" />

    <children>
        <!-- the Rexx code in the 'onAction' attribute will be invoked by JavaFX;
             note: last argument is the slotDir argument from BSF4ooRexx
        -->
        <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>
```

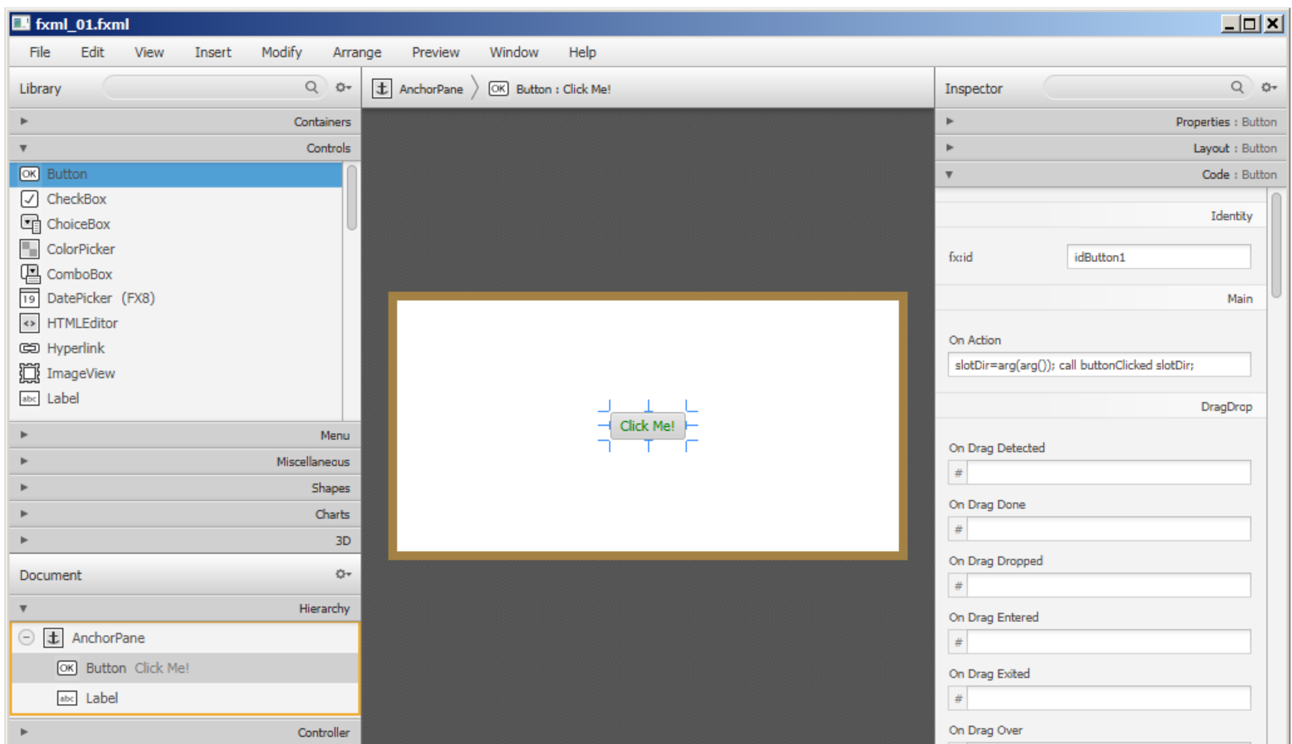
Code 5: FXML definitions ("fxml_01.fxml").

SceneBuilder are usually provided for download by other companies such as Gluon [32].

3.2.2 The JavaFX "FXMLLoader" Class

When graphical user interface definitions get stored in FXML files, one needs to use the *javafx.fxml.FXMLLoader* class to load (process) that FXML file.

The loading process will carry out processing instructions as they come along, load and maintain stylesheets, create and build the *JavaFX* node objects from the element definitions, setting the properties to the defined values, setting event handlers defined in the attributes/properties in the FXML elements that start with the string "*on*", eventually builds a hierarchy from all of the nested element definitions and finally returns the root node object of the resulting tree.



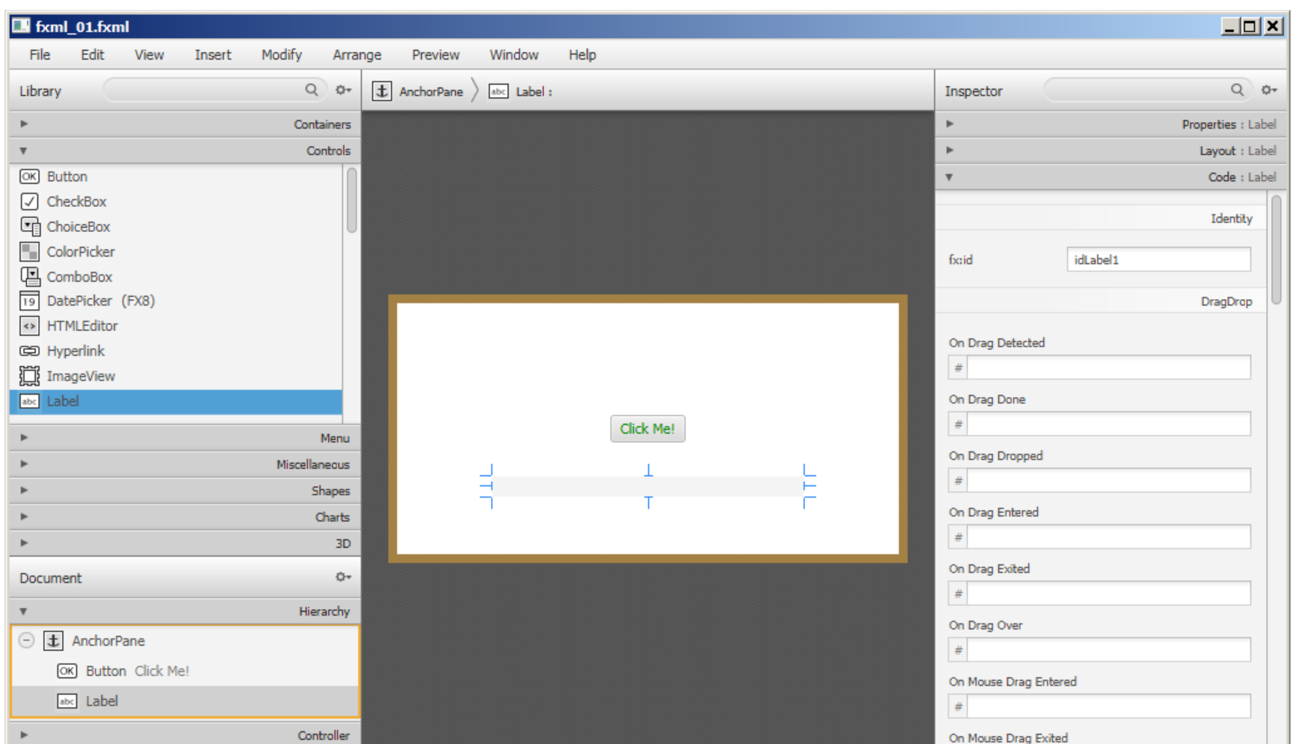


Figure 3: SceneBuilder displaying Code 5 above, highlighting the Button (note the Rexx code in the "onAction" property labeled "On Action") and the Label controls.

3.2.2.1 Defining FXML Controller that Are Implemented in Rexx

For each FXML file one is able to define a controller that may react to events in *JavaFX* GUI objects. The *SceneBuilder* by default supports controllers written in

```
/* This routine will be called from the Rexx code defined in the Button element in
   with the fx:id="button" the "onAction" attribute in the FXML Button definition */
::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' ..."
  /* RexxScript annotation fetches "label" from ScriptContext
     and makes it available as the Rexx variable "LABEL":  */
  /* @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
```

Code 6: The Rexx controller ("fxml_01_controller.rex").

Java. However, using the *language* processing instruction one can use any *javax.script* programming language for programming the controller, in the case of Rexx, ooRexx the name of the *javax.script* defined language is one of "*rexx*", "*Rexx*", "*oorexx*", "*ooRexx*", "*orexx*", and "*oRexx*". The FXML file in Code 5 above uses "*rexx*".

Any *fx:script* definitions or event handler statements get carried out using the *javax.script* infrastructure [1]. The way *JavaFX* instruments this infrastructure is very basic: there is only one *javax.script* language that can be set per FXML file[16] and the arguments supplied to the event handlers are not supplied directly, but indirectly via the *ScriptContext*. bindings, such that the *event* argument will be stored in its *ENGINE_SCOPE* bindings. All *JavaFX* objects that got created for FXML elements with an *fx:id* attribute right before a *fx:script* defined program gets executed will be made available in the *ScriptContext GLOBAL_SCOPE* bindings.[17]

Rexx programmers can use so called *@get RexxScript* annotations [1] in their Rexx code to fetch such *JavaFX* objects from the *ScriptContext* bindings and make them available as local Rexx variables by the same name. Code 6 above demonstrates this fetching with the line "*/* @get(idLabel1) */*", where afterwards

16 The *FXMLLoader* creates one separate instance of the *RexxScriptEngine* class for each FXML file and uses that instance to execute the Rexx programs in that FXML file. If an application consists of multiple FXML files, then there will be multiple *RexxScriptEngine* instances.

17 This behaviour is exploited in some of the BSF4ooRexx JavaFX samples by adding a *<fx:script source="put_FXID_objects_into.my.app.rex" />* element right before the closing tag of the root element in the FXML file. The Rexx program will then have access to all JavaFX objects with a *fx:id* value and stores them in the Rexx global *.environment* in a directory named *MY.APP*, which gets a directory entry by named after the FXML file. That directory will then be used to store each JavaFX object indexed by its *fx:id* value.

the *Label* object can be referenced with the local Rexx variable named "*idLabel1*".

If a Rexx handler gets invoked by *JavaFX*, BSF4ooRexx will always supply a trailing argument, the "*slotDir*" argument, which is a Rexx directory of type *Slot.Argument* that in the case of such a *RexxScript* invocation will contain an entry *SCRIPTCONTEXT* which allows one to directly interact with it.

Unlike ooRexx, a *RexxScriptEngine* instance will make all public classes and public routines always available to code that gets executed afterwards. This way after *FXMLLoader* executed the *fx:script* program "*FXML_01_controller.rex*" while processing the FXML file depicted in Code 5 above its public routine "*buttonClicked*" is available when the Rexx event handler code is run for the *Button* element's event handler stored with the *onAction* property.[18]

Any invocation of an event handler will be carried out on the *JavaFX Application Thread*, such that it is safe to interact with any GUI elements from the event handling code.

3.2.2.2 Special Processing of "text" Attribute Values

The *FXMLLoader* analyzes the value of *text* attributes in FXML files and depending on the existence of an optional prefix character supplies the following services:

- *$* prefix character:
  - if the remaining text is actually enclosed in curly brackets, then it gets extracted and taken as the name of an attribute that is used to lookup the *ScriptContext* bindings. The resulting value will be used to fill in the *text* property. Each time the value of this attribute changes in the *ScriptContext* bindings will cause the *text* property to be updated to reflect that change. Example: "*${currentTime}*"
  - If the remaining text is not enclosed in curly brackets, then the name is taken as the name of an attribute that gets used to lookup the *Script-Context* bindings once at loading time. The resulting value will be used to fill in the *text* property. Example: "*$startupTime*"

18 Please note, that for RexxScript annotations to work, it is important that the routine or method gets the *slotDir* (or alternatively the *ScriptContext*) object as its last argument.

- *%* prefix character, if the *FXMLLoader* is used with the load method that accepts a *java.util.ResourceBundle* [34] [19] object as its second argument. A *ResourceBundle* allows among other things the *java.util.Locale* [36] dependent translation of *name=value* pairs that are stored in locale (language and region) dependent *properties* text files. In this case the remaining text is taken as the name that will be used to lookup the *properties* file and return its value. To put it in another way: this feature makes it easy to internationalize the GUI by making sure that the *text* values use the strings that are defined in a particular *Locale*. To support different languages on the GUI then becomes a task of defining the user interface text in *properties* files created for those languages. Example: "*%clickMe*".

3.2.3 Creating a Simple JavaFX GUI Application with FXML in ooRexx

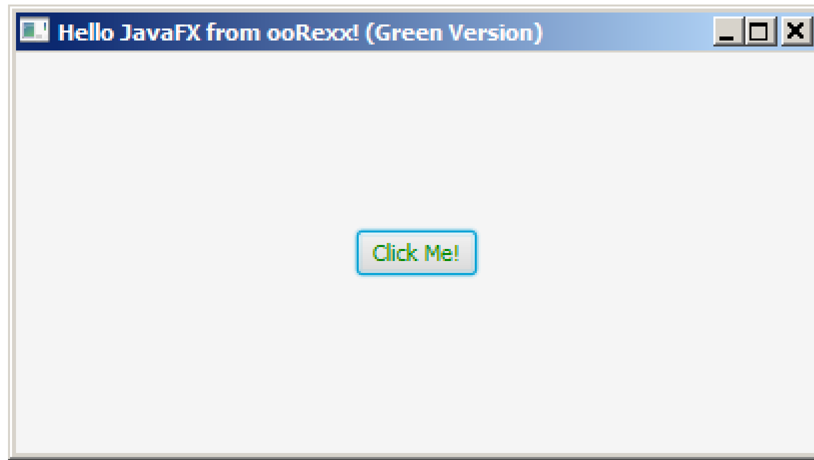
In this section the *JavaFX* GUI application that got introduced in "3.1.7 Creating a Simple JavaFX GUI Dialog Application with ooRexx" on page 9 above gets broken up into three different files:

- *fxml_01.fxml*: this is the FXML file that fully defines the GUI and is depicted in Code 5 on page 13 above.
- *fxml_01_controller.rex*: this is the Rexx controller that defines the public *buttonClicked* routine that updates the *Label* object, outputs debug

```
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 defines "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 for our document
  primaryStage~setScene(scene)   -- set the stage to our scene
  primaryStage~show              -- show the stage (and thereby our scene)
```

Code 7: A simple JavaFX GUI application with FXML in ooRexx ("fxml_01.rex").

19 Cf. the tutorial at [35].



```
REXXout>2017-10-31T19:02:11.047000: arrived in routine 'buttonClicked' ...
REXXout>... current value of label=[]
REXXout>...     new value of label=[Clicked at: 2017-10-31T19:02:11.047000]
REXXout>
REXXout>2017-10-31T19:02:29.911000: arrived in routine 'buttonClicked' ...
REXXout>... current value of label=[Clicked at: 2017-10-31T19:02:11.047000]
REXXout>...     new value of label=[Clicked at: 2017-10-31T19:02:29.911000]
REXXout>
```

Figure 4: The JavaFX initial dialog and changes by two button presses.

information on the console and is shown in Code 6 on page 15 above. As this Rexx program gets executed by a *RexxScriptEngine* the ooRexx *.output* monitor will prefix the output with the string "*REXXout>*" [1] to allow Rexx output to be easily distinguishable from Java output.

- *fxml_02.rex*: this is the main Rexx program, which is depicted in Code 7 above. Comparing this program with the one in Code 4 on page 10 above it is immediately clear that it is much simpler, because the GUI definition and the controller for it got removed. It employs the *FXMLLoader* class to load the FXML file and set it up, creates a *Scene* with it that gets displayed on the *primaryStage*. It is interesting to note, that *FXMLLoader* expects a *java.net.URL* object that denotes the FXML file.

Comparing the GUIs in Figure 2 on page 11 with Figure 4 on page 18 they look alike with the exception of the title and the *textFill* color. Also the console output differs, as in the FXML case a *RexxScriptEngine* gets created for executing the controller's statements which will automatically cause the prefix "*REXXout>*" to be prepended to the output of each *SAY* statement.

Considering that creating a GUI, placing and styling elements in it is much easier done interactively than in code, the solution exploiting the JavaFX FXML feature becomes preferable. In addition, whenever the GUI needs changes in placing and styling there is no need to change the program at all, making maintaining GUIs less time-consuming, less error-prone, in short: much cheaper!

3.2.4 A More Advanced JavaFX GUI Application with FXML in ooRexx

As *JavaFX* allows CSS to be employed for layouting and formatting of GUI elements, this section will demonstrate employing CSS. In addition the application will take advantage of *FXMLLoader*'s special processing of text properties that start with the characters *$* and *%* as introduced in section 3.2.2.2, Special Processing of "text" Attribute Values, on page 16 above. The resulting application will not be aesthetically beautiful, however, it should demonstrate the effects.

The application is comprised of the following files:

- *bsf4oorexx_032.png*: the image (32 by 32 pixels) used as a tile for the application's background in the *fxml_02.css* rule for the class "*root*", cf.

Figure 5: The 32x32 images "oorexx_032.png" and "bsf4oorexx_032.png" .

```
! "fxml_02_en.properties"
! This is the English (en) translation for two terms.
!
! the following key is used in the idLabelYear: text="%year"
year = Year->
! the following key is used in the idButton: text="%clickMe"
clickMe = Click Me!
```

```
! "fxml_02_de.properties"
! This is the German (de) translation for two terms.
!
! the following key is used in the idLabelYear: text="%year"
year = Jahr->
! the following key is used in the idButton: text="%clickMe"
clickMe = Drück mich!
```

Code 8: The properties files "fxml_02_en.properties" and "fxml_02_de.properties".

Figure 6: The GUI in English and in German, values from the properties files.

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

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

<!-- processing instruction (PI) defines the Java script engine named 'rexx'
     to be used to execute programs (fx:script or in event attributes) -->
<?language rexx?>

<AnchorPane id="AnchorPane" fx:id="idRoot" prefHeight="240.0" prefWidth="480.0"
            styleClass="root" stylesheets="@fxml_02.css"
            xmlns:fx="http://javafx.com/fxml/1">

    <!-- defines entries for ScriptContext bindings, public routine 'klickButton' -->
    <fx:script source="fxml_02_controller.rex" />

    <children>
        <Label fx:id="idLabelRexxStarted" alignment="CENTER" layoutX="50.0"
               layoutY="26.0"                minHeight="16" minWidth="69"
               prefHeight="16.0" prefWidth="380.0" styleClass="rexxStarted"
               stylesheets="@fxml_02.css" text="$rexxStarted" />

        <Button fx:id="idButton" layoutX="210.0" layoutY="137.0" onAction=
                  "slotDir=arg(arg()) /* last argument added by BSF4ooRexx */;
                   say ' /// onAction eventHandler calling routine ''klickButton'' \\\';
                   call klickButton slotDir /* now process the event */; "
            text="%clickMe" />

        <Label fx:id="idLabelYear" layoutX="50.0" layoutY="175.0" minHeight="16"
               minWidth="20" style="-fx-background-color:palegoldenrod;" text="%year" />

        <Label fx:id="idLabel" layoutX="95.0" layoutY="175.0" minHeight="16"
               minWidth="49" prefHeight="16.0" prefWidth="335.0"
               style="-fx-background-color: honeydew;" />

        <Label fx:id="idLabelRexxInfo" alignment="CENTER" layoutX="50.0" layoutY="200.0"
               minHeight="16.0" minWidth="49.0" prefHeight="16.0" prefWidth="380.0"
               style="-fx-background-color: skyblue; -fx-cursor: wait;
                      -fx-font-family: serif; -fx-font-weight: lighter;"
               text="${rexxInfo}" />
    </children>
</AnchorPane>
```

Code 9: FXML definitions ("fxml_02.fxml").

Figure 5 above,

- *fxml_02.rex*: the Rexx program depicted in Code 12 on page 24 below will take an argument from the user from the command line and if the string is "*de*" ("de" for "<u>de</u>utsch", which simply means "German") then GUI should be translated into German. To do so the *RexxApplication* class gets instantiated with the supplied argument that gets stored in the attribute named "*locale*" which will be accessed later in the *start* method in order to set up the *ResourceBundle* for the desired language. The language bundle is then supplied to the respective *FXMLLoader load* method and automatically

```
/* Java-FX CSS definitions, cf. <http://docs.oracle.com/javafx/2/get_started/css.htm>,
   especially: <https://docs.oracle.com/javafx/2/api/javafx/scene/doc-files/cssref.html>
*/

/* define the background of the scene, will be applied to AnchorPane: */
.root {
     -fx-background-image: url("bsf4oorexx_032.png");
     -fx-background-color: LightGoldenRodYellow;
}

/* this will style the Label elements */
.label {
    -fx-font-size: 11px;
    -fx-font-weight: bold;
    -fx-text-fill: #333333;
    -fx-effect: dropshadow( gaussian , rgba(255,255,255,0.5) , 0,0,0,1 );
    -fx-border-color: red;
    -fx-border-radius: 3px;
    -fx-border-style: dashed;
    -fx-border-width: 1px;
}

/* this will style the Button element: */
.button {
    -fx-text-fill: royalblue;
    -fx-font-weight: 900;
}

/* this will apply alpha (fourth value) to get the background to shine thru the
   label with the styleClass="rexxStarted" */
.rexxStarted {
     -fx-background-color: rgb(253, 245, 230, 0.75) ;
     -fx-text-fill: royalblue;
}
```

Code 10: The CSS definitions ("fxml_02.css").

translates all text values that start with the special character *%*. This allows for the easy creation of internationalizable JavaFX applications!

- *fxml_02.fxml*: the GUI definition, which uses *style* attributes for individual stylings and a *styleClass* attribute from one of the styles in the *stylesheets* attribute, cf. Code 9 above; note: the Rexx code in the *onAction* attribute of the *idButton* spans multiple lines and is enclosed in double quotes, but the *FXMLLoader* and the *SceneBuilder* will fetch it as one single line, therefore it is necessary to end each Rexx statement with a semicolon. Also, if there are multiple Rexx statements, then one must not use the line comment "--" (two consecutive dashes), because after creating one line out of the Rexx statements everything after the line comment will be ignored by Rexx!

Studying the FXML element definitions shows that the style attribute is used to individually style the *Node* objects. The *idRoot* and *idLabelRexxStarted*

```
slotDir=arg(arg())      -- last argument is the slotDir argument, added by BSF4ooRexx
started=.dateTime~new   -- get current date and time
parse source s          -- get the source information and show it
say "just arrived at" pp(started)": parse source ->" pp(s)

sc=slotDir~scriptContext -- get the ScriptContext entry from slotDir
   -- add the attribute "rexxStarted" to the ScriptContext's GLOBAL_SCOPE Bindings
sc~setAttribute("rexxStarted", "Rexx started at:" started~string, sc~global_scope)
parse version v         -- get Rexx version, display it in the "rexxInfo" label
sc~setAttribute("rexxInfo", "Rexx version:" v, sc~global_scope)
   -- set attribute at ENGINE_SCOPE (visible for this script engine only):
sc~setAttribute("title", "--> -> >", sc~engine_scope)
   -- set attribute at global scope (visible for all script engines):
sc~setAttribute("count", "1", sc~global_scope)

/* --------------------------------------------------------------------------------- */
/* This routine will be called from the Rexx code defined with the "onAction" event
   attribute; cf.    the JavaFX control with the id "idButton" in the fxml_02.fxml    */
::routine klickButton public
    use arg slotDir                         -- fetch the slotDir argument
    scriptContext=slotDir~scriptContext -- get the slotDir entry
    /* @get( idLabel count title ) */

    rexxInfo="Updated from public Rexx routine 'klickButton'."
    if count//2=0 then rexxInfo=rexxInfo~reverse    -- if even, reverse the current text
    /* @set( rexxInfo ) */   -- update the "rexxInfo" attribute, will auto update label

    /* show the currently defined attributes in the default ScriptContext's scopes   */
    say "getting all attributes from all ScriptContext's scopes..."
    do sc over .array~of(100, 200)
        say "ScriptContext scope:" pp(sc) pp(iif(sc=100,'ENGINE','GLOBAL')"_SCOPE")":"
        bin=scriptContext~getBindings(sc)
        if bin=.nil then iterate -- inexistent scope
        keys=bin~keySet           -- get kay values
        it=keys~makearray         -- get the keys as a Rexx array
        do key over it~sortWith(.CaselessComparator~new) -- sort keys caselessly
           val=bin~get(key)       -- fetch the key's value
           str=" " pp(key)~left(31,".") pp(val)
           if key="location" then str=str "~toString="pp(val~toString)
           say str
        end
        if sc=100 then say "-"~copies(86); else say "="~copies(86)
    end
      -- change the text of idLabel
    idLabel~setText(title .dateTime~new~string "(count #" count")")
    count+=1              -- increase counter
    /* @set(count) */     -- save it in the ScriptContext bindings
    say
```

Code 11: The Rexx controller ("fxml_02_controller.rex").

define a *styleClass* attribute whose value is used to lookup a class definition in the stylesheets listed in the *stylesheets* attribute which controls the rendering of these nodes. Figure 7 on page 25 below shows how the *SceneBuilder* displays this FXML file.

- *fxml_02.css*: the CSS definitions for the GUI (see Code 10 above), that is e.g. responsible for the tiled background using the image "*bsf4oorexx_032.png*" (*.root*), or for applying transparency to the *idLabelRexxStarted* label such

```
   /* usage: fxml_02.rex [de] ... "de" will cause fxml_02_de.properties to be used */
parse arg locale .

   -- create Rexx object that will control the FXML set up with or without local
if locale<>"" then rxApp=.rexxApplication~new(locale)
              else rxApp=.rexxApplication~new

   -- instantiate the abstract JavaFX class, abstract "start" method implemented in Rexx
jrxApp=BsfCreateRexxProxy(rxApp,,"javafx.application.Application")
   -- launch the application, which will invoke the methdos "init" followed by "start"
jrxApp~launch(jrxApp~getClass, .nil)     -- need to use this version of launch in order to work
say center(" after jrxApp~launch ", 70, "-")

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

/* implements the abstract method "start" of javafx.application.Application */
::class RexxApplication

::method init   -- constructor to fetch the locale ("de": "fxml_01_de.properties")
  expose locale -- get direct access to attribute
  use strict arg locale="en"    -- if omitted use "fxml_01_en.properties"

   /* loads the FXML file (doing translations), sets up a scene for it and shows it */
::method start  -- implementation in Rexx
  expose locale -- get direct access to attribute
  use arg stage -- we get the stage to use for our UI

   -- create a file URL for fxml_02.fxml file (hence the protocol "file:")
  fxmlUrl=.bsf~new("java.net.URL", "file:fxml_02.fxml")
  jLocale=.bsf~new("java.util.Locale", locale)  -- get the desired Locale
  jRB=bsf.importClass("java.util.ResourceBundle")~getBundle("fxml_02", jLocale)

  rootNode=bsf.loadClass("javafx.fxml.FXMLLoader")~load(fxmlUrl, jRB)
  scene=.bsf~new("javafx.scene.Scene", rootNode)     -- create a scene from the tree
  stage~setScene(scene)      -- set our scene on stage
  stage~title="A Crazy FXML Rexx Application"    -- set the title for the stage
  img=.bsf~new("javafx.scene.image.Image", "oorexx_032.png")     -- create Image
  stage~getIcons~add(img)    -- use image as the application icon
  stage~show                 -- show the stage with the scene
```

Code 12: A simple JavaFX GUI application with FXML in ooRexx ("fxml_02.rex").

that the tiled background shines through that label's background.

- *fxml_02_controller.rex*: the controller (see Code 11 above): when first executed by the *FXMLLoader* the "prolog" part of the program will create four attributes in the *ScriptContext* bindings that are being referred to in the FXML elements, "*rexxStarted*" and "*rexxInfo*", as well as two entries, "*title*" and "*count*" that are used in the *klickButton* routine, whenever an *onAction* event triggers.

  The *klickButton* routine uses *RexxScript* annotations for getting and setting attributes from/in the *ScriptContext* bindings. The *count* value from the *ScriptContext* bindings gets fetched, increased and written back. If the *count* value is even then the value for the "*rexxInfo*" attribute will be reversed and automatically cause the *idLabelRexxInfo Node* to update. As it

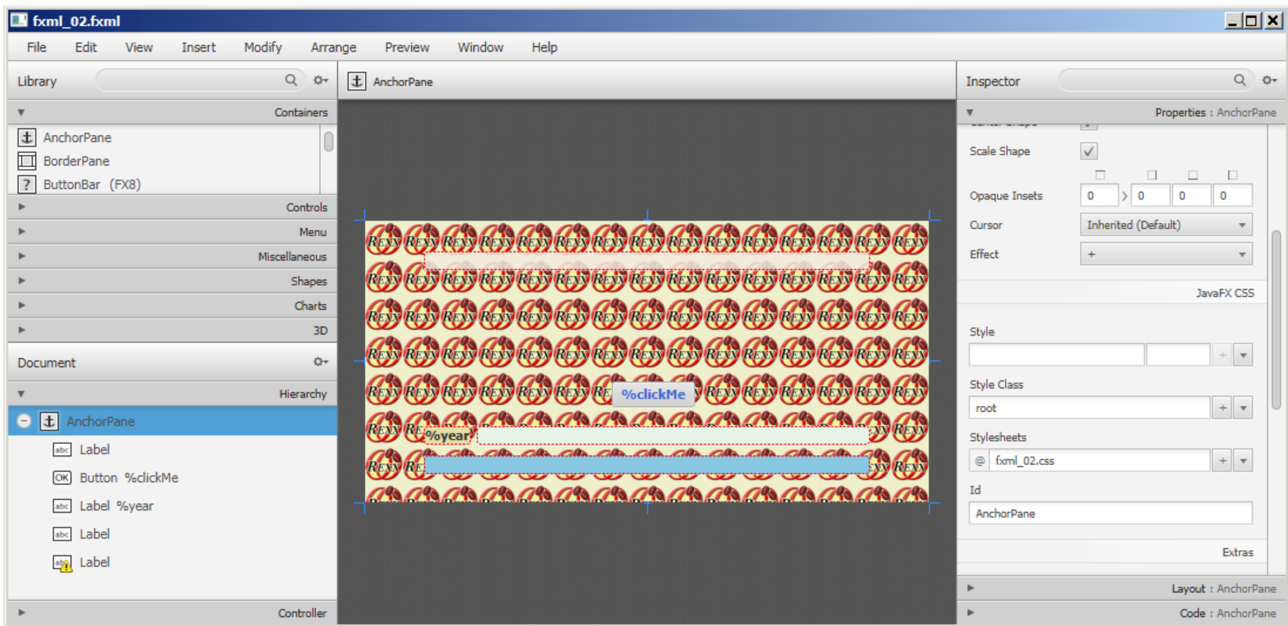


Figure 7: SceneBuilder editing "fxml_02.fxml" (Code 9 on page 21 above).

is interesting to see the content of the *ScriptContext* bindings on each invocation, the *ENGINE_SCOPE* and *GLOBAL_SCOPE* bindings will get queried for their keys which then get sorted caselessly and displayed with their current values.

- *fxml_02_en_properties*, *fxml_02_de.properties*: text files that contain the English ("en") and German ("de") translations for the *idLabelYear* text value "*%year*" (de: "*year = Jahr->*", en: "*year = Year->*") and the *idButton* text value "*%clickMe*" (de: "*clickMe = Drück mich!*", en: "*clickMe = Click Me!*") used in *fxml_02.fxml*, cf. Code 8 on page 20 above,
- *oorexx_032.png*: the image (32 by 32 pixels) used as the application icon, cf Figure 5 on page 20 above.

Running the Rexx program *fxml_02.rex* as depicted in Code 12 on page 24 above, will create a little dialog that changes with every click of the button as shown in Figure 8 on page 26 below, yielding the output displayed in Output 2 on page 27 below.

As can be seen in the output the filename supplied to the *parse source* keyword statement is not *fxml_02_controller.rex*. The reason is that in *JavaFX* 8 at the time

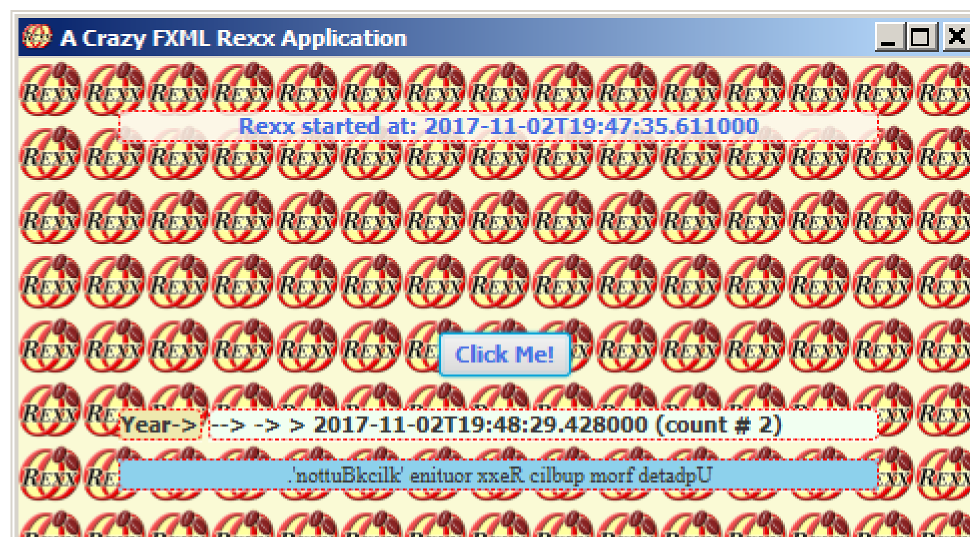


Figure 8: Running "fxml_02.rex" and clicking twice (GUIs).

```
E:\fxml_02>rexx fxml_02.rex
REXXout>just arrived at [2017-11-02T19:47:35.611000]: parse source -> [WindowsNT SUBROUTINE
rexx_invoked_via_[fxml_02.fxml]_at_2017_11_02T18_47_35_584Z.rex]
REXXout> /// onAction eventHandler calling routine 'klickButton' \\\
REXXout>getting all attributes from all ScriptContext's scopes...
REXXout>ScriptContext scope: [100] [ENGINE_SCOPE]:
REXXout>  [event]...................... [javafx.event.ActionEvent@10c0221]
REXXout>  [javax.script.engine]......... [Open Object Rexx (ooRexx)]
REXXout>  [javax.script.engine_version].. [100.20170923]
REXXout>  [javax.script.language]........ [ooRexx]
REXXout>  [javax.script.language_version] [REXX-ooRexx_5.0.0(MT)_32-bit 6.05 19 Oct 2017]
REXXout>  [javax.script.name]........... [Rexx]
REXXout>  [title]...................... [--> -> >]
REXXout>--------------------------------------------------------------------------------------
REXXout>ScriptContext scope: [200] [GLOBAL_SCOPE]:
REXXout>  [count]...................... [1]
REXXout>  [idButton]................... [javafx.scene.control.Button@1c62fae]
REXXout>  [idLabel].................... [javafx.scene.control.Label@12e9675]
REXXout>  [idLabelRexxInfo]............ [javafx.scene.control.Label@15a1ca1]
REXXout>  [idLabelRexxStarted]......... [javafx.scene.control.Label@7683c9]
REXXout>  [idLabelYear]................ [javafx.scene.control.Label@137e560]
REXXout>  [idRoot]..................... [javafx.scene.layout.AnchorPane@100fa1b]
REXXout>  [location]................... [java.net.URL@1a9d3d7] ~toString=[file:fxml_02.fxml]
REXXout>  [resources].................. [java.util.PropertyResourceBundle@14e2f70]
REXXout>  [rexxInfo]................... [Updated from public Rexx routine 'klickButton'.]
REXXout>  [rexxStarted]................ [Rexx started at: 2017-11-02T19:47:35.611000]
REXXout>======================================================================================
REXXout>
REXXout> /// onAction eventHandler calling routine 'klickButton' \\\
REXXout>getting all attributes from all ScriptContext's scopes...
REXXout>ScriptContext scope: [100] [ENGINE_SCOPE]:
REXXout>  [event]...................... [javafx.event.ActionEvent@117e598]
REXXout>  [javax.script.engine]......... [Open Object Rexx (ooRexx)]
REXXout>  [javax.script.engine_version].. [100.20170923]
REXXout>  [javax.script.language]........ [ooRexx]
REXXout>  [javax.script.language_version] [REXX-ooRexx_5.0.0(MT)_32-bit 6.05 19 Oct 2017]
REXXout>  [javax.script.name]........... [Rexx]
REXXout>  [title]...................... [--> -> >]
REXXout>--------------------------------------------------------------------------------------
REXXout>ScriptContext scope: [200] [GLOBAL_SCOPE]:
REXXout>  [count]...................... [2]
REXXout>  [idButton]................... [javafx.scene.control.Button@1c62fae]
REXXout>  [idLabel].................... [javafx.scene.control.Label@12e9675]
REXXout>  [idLabelRexxInfo]............ [javafx.scene.control.Label@15a1ca1]
REXXout>  [idLabelRexxStarted]......... [javafx.scene.control.Label@7683c9]
REXXout>  [idLabelYear]................ [javafx.scene.control.Label@137e560]
REXXout>  [idRoot]..................... [javafx.scene.layout.AnchorPane@100fa1b]
REXXout>  [location]................... [java.net.URL@1a9d3d7] ~toString=[file:fxml_02.fxml]
REXXout>  [resources].................. [java.util.PropertyResourceBundle@14e2f70]
REXXout>  [rexxInfo]................... [.'nottuBkcilk' enituor xxeR cilbup morf detadpU]
REXXout>  [rexxStarted]................ [Rexx started at: 2017-11-02T19:47:35.611000]
REXXout>======================================================================================
REXXout>
------------------------ after jrxApp~launch ------------------------
```

Output 2: Output of running "fxml_02.rex" and clicking twice (console output).

of writing unfortunately the *FXMLLoader* does not store the filename *fxml_02_controller.rex* under the name *javax.script.filename* in the *ScriptContext ENGINE_SCOPE* bindings that is given in the *src* attribute of the *fx:script* element in *fxml_02.fxml* in Code 9 on page 21 above. As a result the *RexxScriptEngine* will create an artificial filename and if it guesses that the Rexx program got executed via *FXMLLoader* then it supplies the name given in the *location* attribute in the

GLOBAL_SCOPE ScriptContext bindings to ease debugging in multi FXML file scenarios.[20]

Studying the three dialogs and the corresponding output one can see that the counter gets maintained in the *ScriptContext*'s *GLOBAL_SCOPE* bindings.

The *event* object of the *JavaFX* event which causes the *onAction* handler to run that eventually invokes the public routine *klickButton* is contained in the *ScriptContext*'s *GLOBAL_SCOPE* bindings and changes after each button click.

It may be interesting to note, that the FXML file's name is supplied in the attribute *location* which gets stored together with those *JavaFX* GUI objects that have a defined *fx:id* attribute value with the *ScriptContext*'s *GLOBAL_SCOPE* bindings.

3.2.5 A Rather Complex JavaFX GUI Application in ooRexx

When *JavaFX* was introduced Sun (later bought by Oracle) created a set of tutorials to teach the new concepts, among them a little FXML application for an address book in *JavaFX* 2 [37] which later got updated to reflect *JavaFX* 8 [38]. A Swiss technical writer, Marco Jakob, rewrote the address book example and demonstrates among other things how easy *JavaFX* CSS formatting can be applied as well as using a *JavaFX* bar chart control.[39]

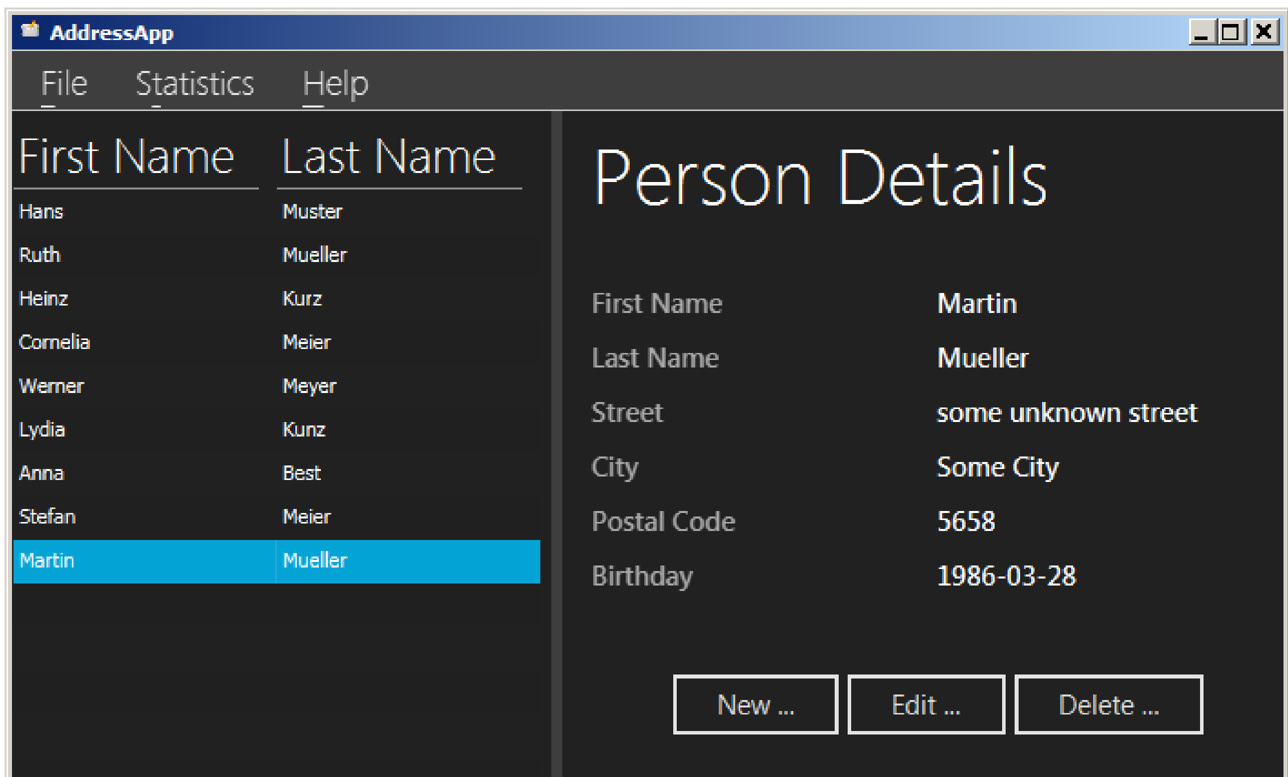
BSF4ooRexx comes with quite a few FXML examples in ooRexx, that demonstrate how Rexx can be used to take advantage of *JavaFX* and FXML. Among these samples there is one stored in "*bsf4oorexx/samples/JavaFX/fxml_99*"[21]. This ooRexx application implements [39] and in addition adds a printing feature. Unlike [39] the address book data gets stored in and read from a JSON[22] file. Giving the functionality of the the application and the GUIs it is astounding that it only takes approximately 1,270 lines of ooRexx code to implement it.

---

20 The *FXMLLoader* class should use the *fx:script* element's *source* attribute value as the filename and add an entry named *javax.script.filename* into the *ENGINE_SCOPE ScriptContext* bindings to allow script engines to supply that value to the programs that the *ScriptEngine* executes.

21 One can navigate there with an explorer, if one chooses the *BSF4ooRexx* menu item named "*Samples*", then double-clicks on the file *index.html*, then double-clicks the links "*JavaFX*" and "*fxml_99*". All directories in the *samples* subdirectory contain an *index.html* file that briefly explains all samples and allows one to navigate via links to its subdirectories (or parent directory).

22 The ooRexx package *json-rgf.cls* is based on ooRexx 5 *json.cls*, but stores the data in a legible ("human centric") format.



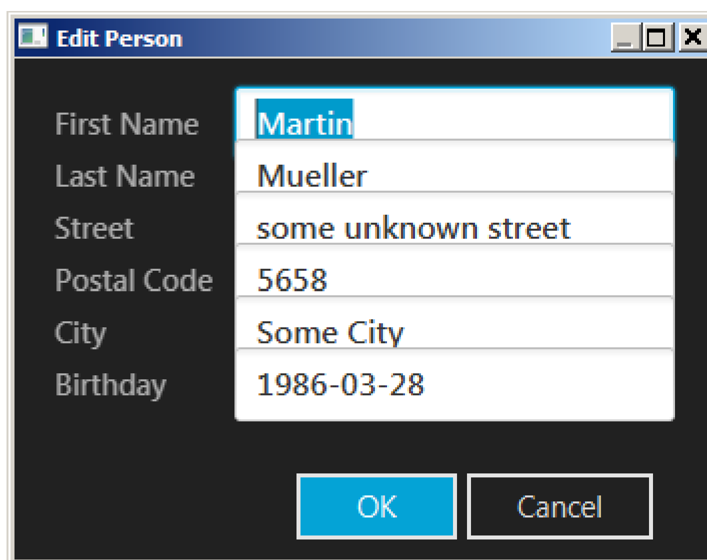


Figure 9: Running "MainApp.rex", overview (TableView) and edit windows.

In this case all GUI controllers are stored in the *MainApp.rex* program (package), each implemented as an ooRexx class. Besides demonstrating this possibility it also allows one to compare the Rexx solution with the Java solution in [39].

As the *JavaFX TableView* control maintains the data it displays it is necessary to create the ooRexx *Person* class such that the *JavaFX TableView* control can interact with it. This is done by defining the attributes as *JavaFX* properties. Each

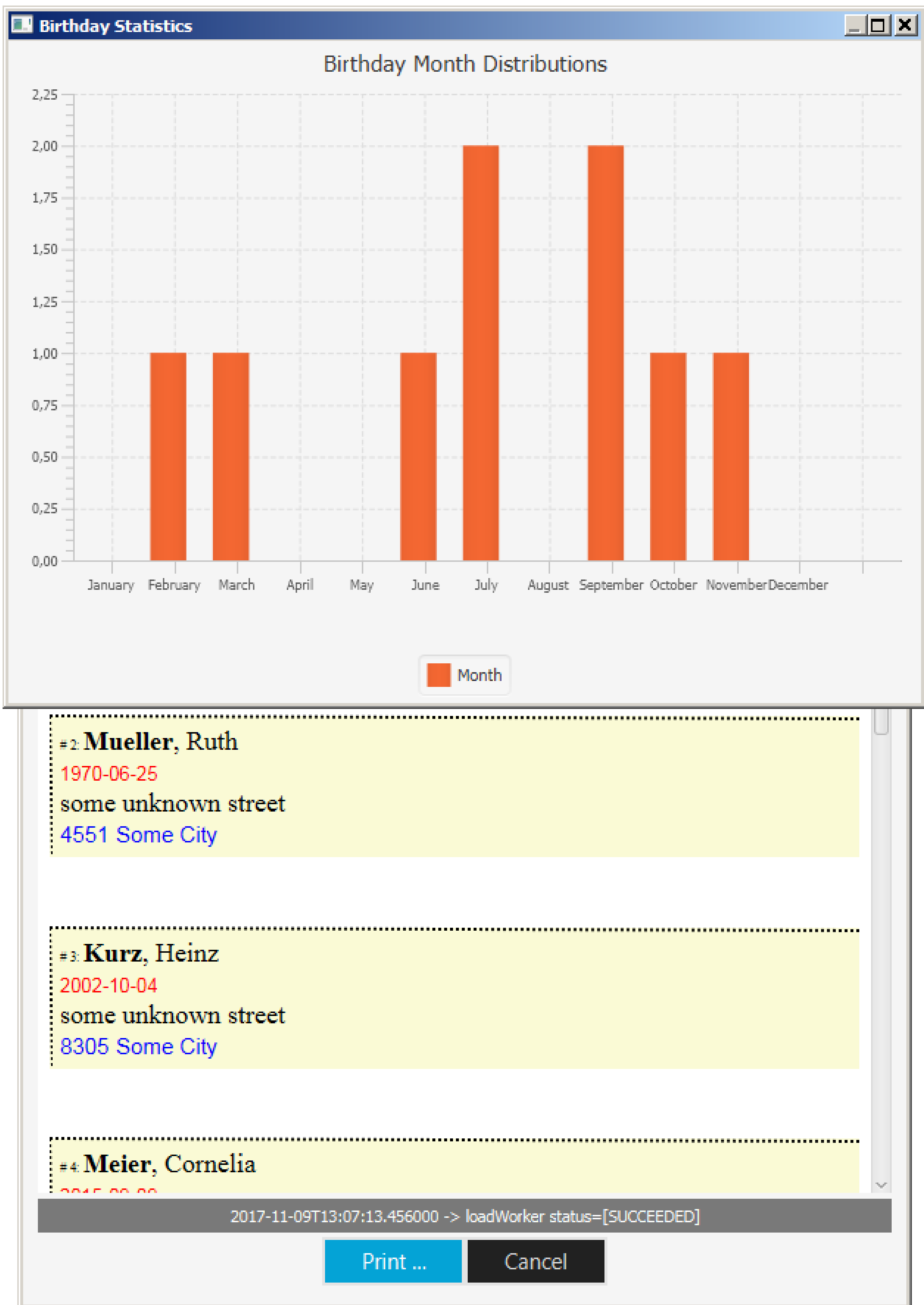


Figure 10: Running "MainApp.rex", statistics and print preview windows.

person is then added to an *arrayObservableList* received from the *JavaFX* utility class *javafx.collections.FXCollections*, which is the *ObservableList* that the *TableView* uses for the GUI. In addition to the tutorial in [39] the ooRexx solution also demonstrates how a double-click on a cell will be used to open the edit window.

The added print demonstration takes advantage of the *javafx.scene.web.-WebView*[23] class which renders the print data supplied as HTML marked up text according to the defined style sheet, which intentionally does not use the original dark theme.

4 Roundup and Outlook

This article introduced *JavaFX*, its concepts and its core features, and demonstrates them with ooRexx programs that exploit the ooRexx-Java-bridge BSF4ooRexx. The presented ooRexx programs are part of the BSF4ooRexx distribution and can be found in its *samples/JavaFX* subdirectories.

One challenge when developing ooRexx *JavaFX* applications is the mapping of Java concepts into ooRexx. The JavaFX ooRexx sample programs help in understanding the principles that get applied. In essence one needs to find out which Java and JavaFX interface classes are needed and then implement those interfaces in ooRexx classes and wrap up its instances with the external Rexx function *BsfCreateRexxProxy()* which is implemented in BSF4ooRexx. The resulting Java object, encapsulating a Rexx object, is then supplied as the Java object for call-backs to the appropriate Java methods, ultimately causing the appropriate Rexx method to run.

JavaFX Java applications can be stored in a Java archive (filetype "*.jar*", a form of a zip archive) and can be directly started with the "*java -jar*" variant of running Java applications. The Java developer kit's *javapackager* [43] utility is used for creating such self-running Java archives. It would great, if such a utility could be conceived for running JavaFX applications that are implemented in any *javax.script* scripting language, such as BSF4ooRexx' *RexxScript*. [1]

23 This class actually uses the *WebEngine* [42] class to realize the core of a web browser!

A References

[1] Flatscher R.G.: "'RexxScript' – Rexx Scripts Hosted and Evaluated by Java (Package javax.script)", in: Proceedings of the "The 2017 International Rexx Symposium", Amsterdam, The Netherlands, April 9th – 12th, 2017. URL (as of 2017-10-31): http://www.rexxla.org/events/2017/presentations/201704-RexxScript-Article.pdf

[2] Javadocs for the Java package *java.awt* (as of 2017-04-04): https://docs.oracle.com/javase/8/docs/api/java/awt/package-summary.html

[3] Javadocs for the Java package javax.swing (as of 2017-04-04): https://docs.oracle.com/javase/8/docs/api/javax/swing/package-summary.html

[4] Java tutorial "Modifying the Look and Feel" (as of 2017-04-04): https://docs.oracle.com/javase/tutorial/uiswing/lookandfeel/index.html

[5] Javadocs for JavaFX 8 (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/toc.htm

[6] Javadocs for *javafx.beans.property.Property* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/beans/property/Property.html

[7] Javadocs for *javafx.beans.property.SimpleIntegerProperty* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/beans/property/SimpleIntegerProperty.html

[8] Javadocs for *javafx.beans.binding.IntegerExpression* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/beans/binding/IntegerExpression.html

[9] Java tutorial "JavaFX: Handling Events" (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/events-tutorial/title.htm

[10] Java tutorial "Lesson: Concurrency in Swing" (as of 2017-04-04): https://docs.oracle.com/javase/tutorial/uiswing/concurrency/index.html

[11] Java documentation "AWT Threading Issues" (as of 2017-04-04): https://docs.oracle.com/javase/8/docs/api/java/awt/doc-files/AWTThreadIssues.html

[12] Javadocs for *javafx.application.Platform* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/application/Platform.html

[13] Javadocs for *javafx.stage.Stage* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/stage/Stage.html

[14] Javadocs for *javafx.stage.Scene* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/stage/Stage.html

[15] Javadocs for the package *javafx.scene* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/scene/package-summary.html

[16] Javadocs for *javafx.stage.Node* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/scene/Node.html

[17] Javadocs for *javafx.stage.Node* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/scene/Node.html

[18] World Wide Web Consortium "Document Object Model (DOM)" (as of 2017-10-30): https://www.w3.org/DOM/

[19] World Wide Web Consortium "Hypertext Markup Language (HTML)" (as of 2017-10-30): https://www.w3.org/html/

[20] World Wide Web Consortium "Cascading Style Sheets (CSS)" (as of 2017-10-30): https://www.w3.org/Style/CSS/

[21] "JavaFX CSS Reference Guide" (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/scene/doc-files/cssref.html

[22] Homepage "WebKit" (as of 2017-10-30): https://webkit.org/

[23] Javadocs for *javafx.application.Application* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/application/Application.html

[24] Flatscher R.G.: "The 2009 Edition of BSF4Rexx Part I and II", slides (as of 2017-04-04): http://www.rexxla.org/events/2009/presentations/01_Monday/Mon_Session_3/

[25] Flatscher R.G.: 'The ooRexx Package "rgf_util2.rex"', in: Proceedings of the “The 2009 International Rexx Symposium”, Chilworth, England, Great Britain, May 18th – May 21st 2009. URL (as of 2017-04-01): http://www.rexxla.org/events/2009/presentations/04_Thursday/Thu_Session_2/

[26] Wikipedia "Model-view-controller (MVC)" (as of 2017-04-04): https://en.wikipedia.org/wiki/Model%E2%80%93view%E2%80%93controller

[27] Java documentation "Introduction to FXML" (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/fxml/doc-files/introduction_to_fxml.html

[28] WWW-Site "ControlsFX Features" (as of 2017-04-04): http://fxexperience.com/controlsfx/features/

[29] World Wide Web Consortium "Extensible Markup Language (XML) 1.0 (Fifth Edition)" (as of 2017-04-04): https://www.w3.org/TR/xml/

[30] Wikipedia "Processing Instruction" (as of 2017-04-04): *https://en.wikipedia.org/wiki/Processing_Instruction*

[31] Java documentation "JavaFX Scene Builder: Getting Started with JavaFX Scene Builder" (as of 2017-04-04): https://docs.oracle.com/javase/8/scene-builder-2/get-started-tutorial/index.html

[32] Gluon's download page for their *SceneBuilder* distribution (as of 2017-04-04): http://gluonhq.com/products/scene-builder/

[33] Javadocs for *javafx.fxml.FXMLLoader* (as of 2017-04-04): https://docs.oracle.com/javase/8/javafx/api/javafx/fxml/FXMLLoader.html

[34] Javadocs for *java.util.ResourceBundle* (as of 2017-04-04):
https://docs.oracle.com/javase/8/docs/api/java/util/ResourceBundle.html

[35] Java tutorial "Isolating Locale-Specific Data" (as of 2017-04-04):
https://docs.oracle.com/javase/tutorial/i18n/resbundle/index.html

[36] Javadocs for *java.util.Locale* (as of 2017-04-04):
https://docs.oracle.com/javase/8/docs/api/java/util/Locale.html

[37] JavaFX 2 tutorial "Mastering FXML", "4 Creating an Address Book with FXML" (as of 2017-11-09): https://docs.oracle.com/javafx/2/fxml_get_started/fxml_tutorial_intermediate.htm

[38] JavaFX 8 tutorial "JavaFX: Mastering FXML", "3 Creating an Address Book with FXML" (as of 2017-11-09): https://docs.oracle.com/javase/8/javafx/fxml-tutorial/fxml_tutorial_intermediate.htm

[39] Jakob M.: "JavaFX 8 Tutorial" (as of 2017-11-09):
http://code.makery.ch/library/javafx-8-tutorial/

[40] Javadocs for *javafx.collections.FXCollections* (as of 2017-11-09):
https://docs.oracle.com/javase/8/javafx/api/javafx/collections/FXCollections.html

[41] Javadocs for *javafx.scene.web.WebView* (as of 2017-11-09):
https://docs.oracle.com/javase/8/javafx/api/javafx/scene/web/WebView.html

[42] Javadocs for *javafx.scene.web.WebEngine* (as of 2017-11-09):
https://docs.oracle.com/javase/8/javafx/api/javafx/scene/web/WebEngine.html

[43] Java documentation "*javapackager*", formerly known as "*javafxpackager*" (as of 2017-11-09): https://docs.oracle.com/javase/8/docs/technotes/tools/unix/javafxpackager.html

B Addendum: The Classes FXGuiThread and GUIMessage

The BSF4ooRexx package *BSF.CLS* implements two public ooRexx classes that ease interaction with JavaFX GUIs from threads that are not the "*JavaFX Application Thread*" (cf.)[24], "*FXGuiThread*" and "*GUIMessage*".

The public *GUIMessage* class is modelled after ooRexx' fundamental class *Message*, the documentation of which, therefore, applies to *GUIMessage*. This class gets employed by the *FXGuiThread* class, which in some of its methods returns an instance of this class for the Rexx programmer to become able to interrogate the current state of the *messageName* and any *result* the sending of the message yielded.

The public *FXGuiThread* class with its public class methods *runLater* and *runLaterLatest* allows for sending messages later, on the "*JavaFX Application Thread*". Both methods expect the following arguments:

- the *target* (receiver) object (usually some JavaFX object),
- the *messageName*,
- optionally, if arguments should be supplied:
    - "*I*" for "*individual*", followed by a comma-separated list of arguments,
    - "*A*" for "*array*", followed by an ooRexx *Array* argument that contains the arguments

The class methods *runLater* and *runLaterLatest* use the GUIMessage class to create the message that will be sent later on the "*JavaFX Application Thread*". This makes it straight-forward and easy for ooRexx programmers to make sure that any message they send to ooRexx objects will be sent on the GUI thread, from where updating *JavaFX* GUIs is safe.

runLater will append the *GUIMessage* object to the queue of messages to be sent later. *runLaterLatest* will do the same, but will remove all *GUIMessage* objects that have the same *target* and *messageName* from the queue, and append its *GUIMessage* object to it, which will be the "latest" incarnation of that intended *GUIMessage*.

24 Cf. 3.1.2, 'The "JavaFX Application Thread"' on page 4.

```
rxApp=.rexxApplication~new
   -- instantiate the abstract JavaFX class, abstract "start" method implemented in Rexx
jrxApp=BsfCreateRexxProxy(rxApp,,"javafx.application.Application")
   -- launch the application, which will invoke the methdos "init" followed by "start"

signal on syntax  -- intercept syntax conditions
jrxApp~launch(jrxApp~getClass, .nil)     -- launch the application
say center(" after jrxApp~launch ", 70, "-")
exit

   -- in case something goes foul, use "ppCondition2()" to show all Java exception causes
syntax:
  co=condition('object')
  say "--- oops, something went wrong while executing 'fxml_pb.rex':"
  say ppCondition2(co)

::requires "rgf_util2.rex" -- get access to public routine ppCondition2()


::requires "BSF.CLS"    -- get Java support
::requires "worker.rex" -- get access to the Worker class

/* implements the abstract method "start" of javafx.application.Application */
::class RexxApplication

   /* loads the FXML file, sets up a scene and shows it on the stage */
::method start  -- implementation in Rexx
  expose locale -- get direct access to attribute
  use arg stage -- we get the stage to use for our UI

  fxmlUrl=.bsf~new("java.net.URL", "file:fxml_pb.fxml")
  rootNode=bsf.loadClass("javafx.fxml.FXMLLoader")~load(fxmlUrl)
  scene=.bsf~new("javafx.scene.Scene", rootNode)    -- create a scene from the tree

      -- .my.app (.environment~my.app) created by "put_FXID_objects_into.my.app.rex"
      -- which gets invoked by FXMLLoader when it processes the FXML file "fxml_pb.fxml"
      -- make a worker instance available via .my.app~worker
  .my.app~worker=.worker~new

  stage~setScene(scene)    -- set our scene on stage
  stage~title="ProgressBar Demo"    -- set the title for the stage
  stage~resizable=.false   -- make sure we cannot resize
  stage~show               -- show the stage with the scene
```

Code 13: A nutshell JavaFX GUI application with a progress bar ("fxml_pb.rex").

The nutshell example in this section demonstrates how a Rexx program is able to update GUI controls using the class *FXGuiThread*'s *runLater* or *runLaterLatest* class methods.

The little application consists of:

- *fxml_pb.rex* (Code 13 above): the main program which loads the FXML file *fxml_pb.fxml*, creates an instance of the Rexx class *Worker* (defined in *worker.rex*) and saves it in the *.my.app* directory (created by *put_FXID_objects_into.my.app.rex* below) for later use in the controller program (*fxml_pb_controller.rex*),

```
/* called by FXMLLoader on the "FX Application Thread" */

/* initialize JavaFX objects, define public routines for event handling */
fxml=.my.app~fxml_pb.fxml   -- get the corresponding FXML Rexx directory

   -- clear label fields
fxml~idLabelCurrent ~text=""
fxml~idLabelStart   ~text=""
fxml~idLabelEnd     ~text=""
fxml~idLabelDuration~text=""

::routine onActionButtonStart public   -- toggle button, start
--  slotDir=arg(arg())      -- supplied by BSF4ooRexx, not needed, but available
  if .my.app~fxml_pb.fxml~idButtonStart~text="Start" then
     .action~setRunning
  else
     .action~setStop

::routine onActionButtonExit  public   -- exit the application
  bsf.loadClass("javafx.application.Platform")~exit


/* This class allows communication of state with the worker and
   updating the GUI. Therefore its methods must be invoked on
   the "JavaFX Application Thread".
*/
::class Action        public
::attribute state     class    -- states: "idle", "running", "stop"
::method init         class
  expose state
  state="idle"                 -- initialize to "idle"

::method setRunning  class    -- invoked by pressing "Start" button, starts worker
  expose state
  if state<>"idle" then return   -- worker runs already

  fxml=.my.app~fxml_pb.fxml       -- get access to JavaFX controls
  fxml~idButtonStart~disable=.true  -- do not let user interact with this control
  state="running"

  fxml~idButtonExit~disable=.true
  fxml~idLabelEnd~text     =""
  fxml~idLabelDuration~text=""
  fxml~idLabelCurrent~text =""

  now=.dateTime~new
  .my.app~fxml_pb.fxml~startedAt=now   -- save Rexx object
  fxml~idLabelStart~text    = now "(started)"
  fxml~idButtonStart~text="Stop"

   -- start worker object, supply this class object
  .my.app~worker~go(self)          -- supply this class object
  fxml~idButtonStart~disable=.false -- allow interaction again

      … continued on next page …
```

Code 14: Progress bar controller program, part 1 of 2 ("fxml_pb_controller.rex").

- *fxml_pb.fxml* (Code 16 on page 39 below): the FXML file defining the *JavaFX* GUI,
- *put_FXID_objects_into.my.app.rex* (Code 16 on page 39 below): a utility Rexx program invoked at the end of *fxml_pb.fxml* which will store all

```
    … continued from previous page …

::method setStop  class       -- invoked by pressing "Stop" button, stops worker
  expose state
  if state<>'running' then return  -- not running, cannot stop

  fxml=.my.app~fxml_pb.fxml          -- get access to JavaFX controls
  fxml~idButtonStart~disable=.true  -- do not let user interact with this control

  state="stop"                       -- worker will stop and invoke "setIdle" method
  fxml~idButtonStart~text="Stopping..."
  now=.dateTime~new
  fxml~stoppedAt=now    -- save Rexx object


::method setIdle  class       -- invoked by worker on "JavaFX Application Thread"
  expose state
  if wordpos(state,'running stop')=0 then return   -- not running, nor stopping, ignore

  fxml=.my.app~fxml_pb.fxml          -- get access to JavaFX controls
  fxml~idButtonStart~disable=.true  -- do not let user interact with this control

  now=.dateTime~new
  fxml~stoppedAt=now -- save Rexx object

  now                =.dateTime~new
  fxml~idLabelEnd~text=now "(ended)"
  duration           =now - .my.app~fxml_pb.fxml~startedAt
  fxml~idLabelDuration~text=duration "(duration)"
  if state='stop' then      -- indicate user stopped
  do
     current=fxml~idLabelCurrent~text
     fxml~idLabelCurrent~text=current "(interrupted!)"
  end

  state="idle"                       -- communicate we can be started again
  fxml~idButtonStart~text="Start"
  fxml~idButtonStart~disable=.false -- allow interaction again
  fxml~idButtonExit~disable=.false
```

Code 15: Progress bar controller program, part 2 of 2 ("fxml_pb_controller.rex").

JavaFX objects with an *fx:id* value in the *.environment~my.app* directory: the utility will create this entry, if it is not yet defined; it then creates a new directory, stores all *fx:id JavaFX* objects in it, and saves it under the name of the FXML file in *.my.app* (*fxml_pb.fxml*). If an entry *.my.app~bDebug* is set to *.true*, then this utility will also list all the *ScriptContext* scopes and dump the corresponding bindings to *.output*.

- *fxml_pb_controller.rex* (Code 14 on page 37 above and Code 15 above): a Rexx program invoked at the end of *fxml_pb.fxml* that initializes the GUI; and upon return its public routines *onActionButtonStart* and *onActionButtonExit* become available.

```
parse source . . thisProg
thisProg=filespec("Name", thisProg)

   -- make sure global Rexx .environment has an entry MY.APP (a Rexx directory)
if \.environment~hasEntry("my.app") then          -- not there?
   .environment~setEntry("my.app", .directory~new) -- create it!

bDebug=(.my.app~bDebug=.true)     -- set debug mode
if bDebug then say .dateTime~new " ==> ---> arrived in Rexx program" pp(thisProg) "..."

slotDir=arg(arg())  -- get slotDir argument (BSF4ooRexx adds this as the last argument)
scriptContext=slotDir~scriptContext   -- get entry "SCRIPTCONTEXT"

GLOBAL_SCOPE=200
   -- "location" will have the URL for the FXML-file
url=scriptContext~getAttribute("location",GLOBAL_SCOPE)
fxmlFileName=filespec("name",url~getFile) -- make sure we only use the filename portion
dir2obj =.directory~new           -- will contain all GLOBAL_SCOPE entries
.my.app~setEntry(fxmlFileName,dir2obj) -- add to .My.APP

bindings=scriptContext~getBindings(GLOBAL_SCOPE)
keys=bindings~keySet~makearray    -- get the kay values as a Rexx array
do key over keys
   val=bindings~get(key)          -- fetch the key's value
   dir2obj ~setEntry(key,val)     -- save it in our directory
end

if bDebug then
do
   say "all GLOBAL_SCOPE attributes now available via:" pp(".MY.App~"fxmlFileName)
   say
      -- show all the currently defined attributes in all ScriptContext's scopes
   say "getting all attributes from all ScriptContext's scopes..."
   dir=.directory~new    -- known constant names
   dir[100]="ENGINE_SCOPE"
   dir[200]="GLOBAL_SCOPE"
   arr=scriptContext~getScopes~makearray  -- get all scopes, turn them into a Rexx array
   do sc over arr                          --
       str="ScriptContext scope" pp(sc)
       if dir~hasEntry(sc) then str=str "("dir~entry(sc)")"
       say str", available attributes:"
       say
       bin=scriptContext~getBindings(sc)
       if bin=.nil then iterate  -- inexistent scope
       keys=bin~keySet           -- get kay values
       it=keys~makearray         -- get the keys as a Rexx array
       do key over it~sortWith(.CaselessComparator~new)  -- sort caselessly
          val=bin~get(key)       -- fetch the key's value
          str=""
          if val~isA(.bsf) then str="~toString:" pp(val~toString)
          say "   " pp(key)~left(35,".") pp(val) str
       end
       if sc<>arr~lastItem then say "-"~copies(89)
                           else say "="~copies(89)
   end
end

if bDebug then
do
   say .dateTime~new " <== <--- returning from program" pp(thisProg) "."
   say
end
```

Code 16: Utility program "put_FXID_objects_into.my.app.rex".

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

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

<!-- define the script language for this FXML file -->
<?language rexx?>

<AnchorPane maxHeight="-Infinity" maxWidth="-Infinity" minHeight="-Infinity"
            minWidth="-Infinity" prefHeight="219.0" prefWidth="353.0"
            xmlns="http://javafx.com/javafx/8.0.65" xmlns:fx="http://javafx.com/fxml/1">

   <children>
      <Button fx:id="idButtonStart" defaultButton="true" layoutX="62.0" layoutY="41.0"
              mnemonicParsing="false" prefHeight="22.0" prefWidth="83.0"
              onAction="call onActionButtonStart arg(arg())" text="Start" />

      <Button fx:id="idButtonExit" cancelButton="true" layoutX="210.0" layoutY="41.0"
              mnemonicParsing="false" prefHeight="22.0" prefWidth="83.0"
              onAction="call onActionButtonExit arg(arg())" text="Exit" />

      <ProgressBar fx:id="idProgressBar" layoutX="23.0" layoutY="80.0" prefHeight="17.0"
                   prefWidth="311.0" progress="0.0" />

      <Label fx:id="idLabelCurrent" contentDisplay="CENTER" layoutX="22.0"
             layoutY="110.0" prefHeight="14.0" prefWidth="311.0"
             style="-fx-alignment: center;" text="lblCurrent" />

      <Label fx:id="idLabelStart" contentDisplay="CENTER" layoutX="21.0" layoutY="134.0"
             prefHeight="14.0" prefWidth="311.0" style="-fx-alignment: center;"
             text="lblStart" />

      <Label fx:id="idLabelEnd" layoutX="21.0" layoutY="148.0" prefHeight="14.0"
             prefWidth="311.0" style="-fx-alignment: center;" text="lblEnd" />

      <Label fx:id="idLabelDuration" layoutX="23.0" layoutY="170.0" prefHeight="14.0"
             prefWidth="311.0" style="-fx-alignment: center;" text="lblDuration" />
   </children>

   <!-- save all fx:id objects in ".environment~my.app~fxml_pb.fxml" -->
   <fx:script source="put_FXID_objects_into.my.app.rex" />

   <!-- run controller (initializes GUI, defines public routines and class) -->
   <fx:script source="fxml_pb_controller.rex" />
</AnchorPane>
```

Code 17: FXML definitions ("fxml_pb.fxml").

- public routine *onActionButtonStart*: this routine will check the text of the button, if it is set to "*Start*" then the class *Action*'s class method *setRunning* gets invoked (this will send the *go* message to *.my.app~worker*, supplying the *Action* class object as an argument to allow direct access to it), else the message *setStop* will be sent, which signals the worker via the *Action*'s class attribute *state* the change, causing the worker to prematurely leave the worker's loop.

```
::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

   -- real work would be done in the loop, such that updates to the
   -- progress bar need to be possible from there, hence runLater[Latest]
  do i=1 to 100 while clzAction~state="running"
     -- real work would go here

     -- update GUI controls on the "JavaFX Application Thread"
    .FXGuiThread~runLaterLatest(pb, "setProgress", "individual", box("Double",i/100))
    .FXGuiThread~runLaterLatest(lblCurrent, "setText", "i", i "%")
    call SysSleep 0.01
  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
  return
```

Code 18: Updating the GUI with runLater[Latest] ("worker.rex").

- public routine *onActionButtonExit*: this routine will invoke the *exit* method of the *javafx.application.Platform* class, which will cause *JavaFX* to be shut down and cause the blocked *start* method in the class *RexxApplication* (*fxml_pb.rex*) to continue (and to return), allowing the main Rexx program to end gracefully.
- public class *Action*: this class defines the class attribute named *state* and three class methods that manage the GUI:
  - *setRunning*: initializes the GUI, disables the *idButtonExit* button, renames the text of *idButtonStart* to "*Stop*", changes the class attribute *state* to "*running*" and finally sends the *go* message to the *.my.app~worker* to start the work,
  - *setStop*: changes the class attribute *state* to "*stop*" to signal the worker that the user wishes to stop the program and changes the text of *idButtonStart* to "*Stopping...*",
  - *SetIdle*: updates the GUI, changes the class attribute *state* to "*idle*", renames *idButtonStart* back to the original value "*Start*" and re-enables the *idButtonExit* button.

- *worker.rex* (Code 18 on page 41 above): this program defines the class *Worker* and its *go* method that will receive the *Action* class object and start

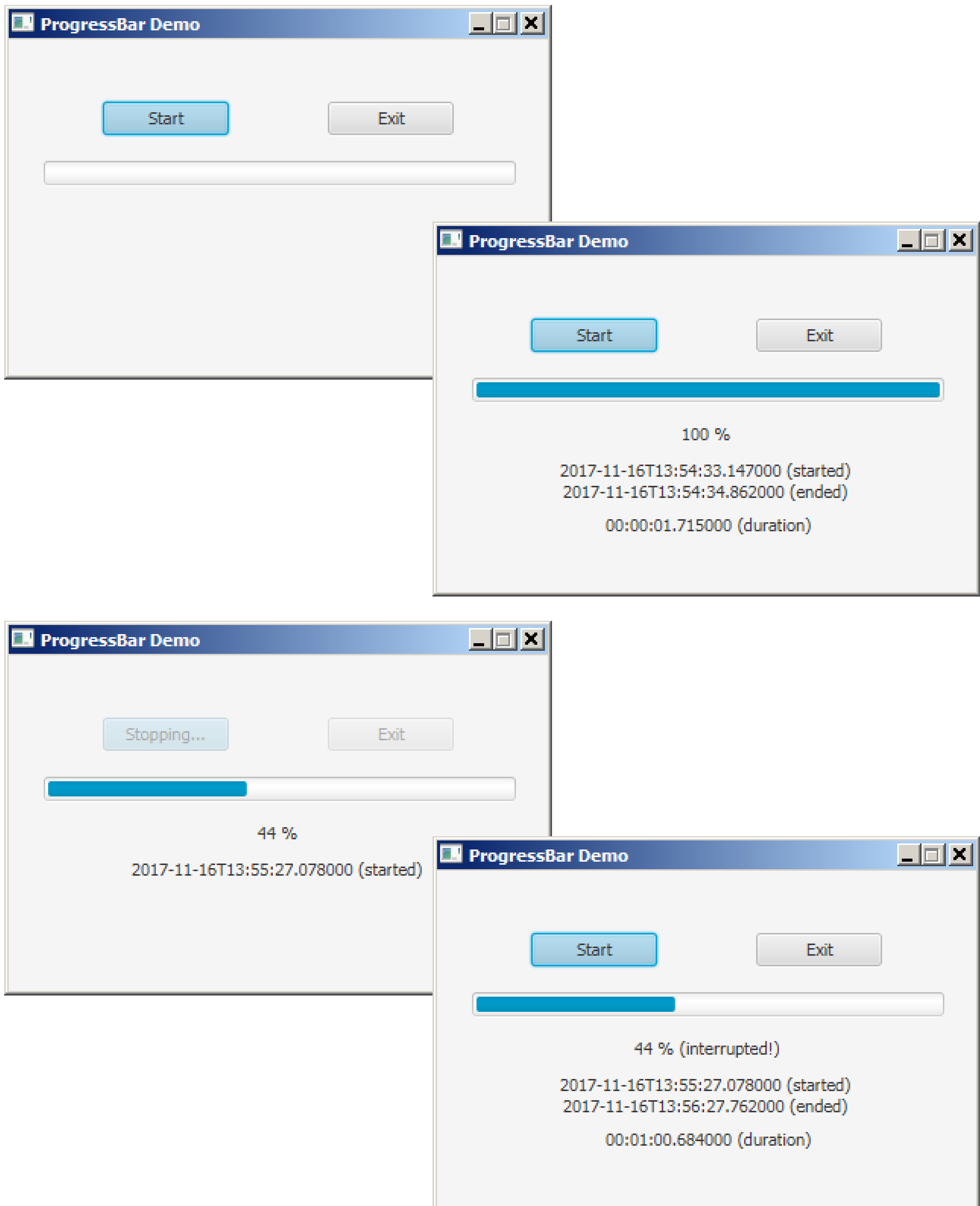


Figure 11: ProgressBar GUI screenshots.

the work after receiving the *go* message from the GUI controller (*fxml_pb_controller.rex*). It will loop 100 times and update the GUI controls *idProgressBar* and *idLabelCurrent* using *runLaterLatest* to set the values in the "*JavaFX Application Thread*" later. The loop can be terminated prematurely, if the *Action*'s class attribute *state* changes its value to anything else from "*running*". After the loop the *Action*'s class method *setIdle* will be invoked on the "*JavaFX Application Thread*" with *runLater* and this time the resulting *GUIMessage* object will be fetched and assigned to the variable *msg*. Sending *msg* the message *result* will block, until the message object for sending *setIdle* was run later.

Figure 11 on page 42 above displays the GUI in four different states:

- before starting the worker,
- after running the worker,
- while interrupting a running worker in the middle of its work, and
- after interrupting a running worker in the middle of its work.