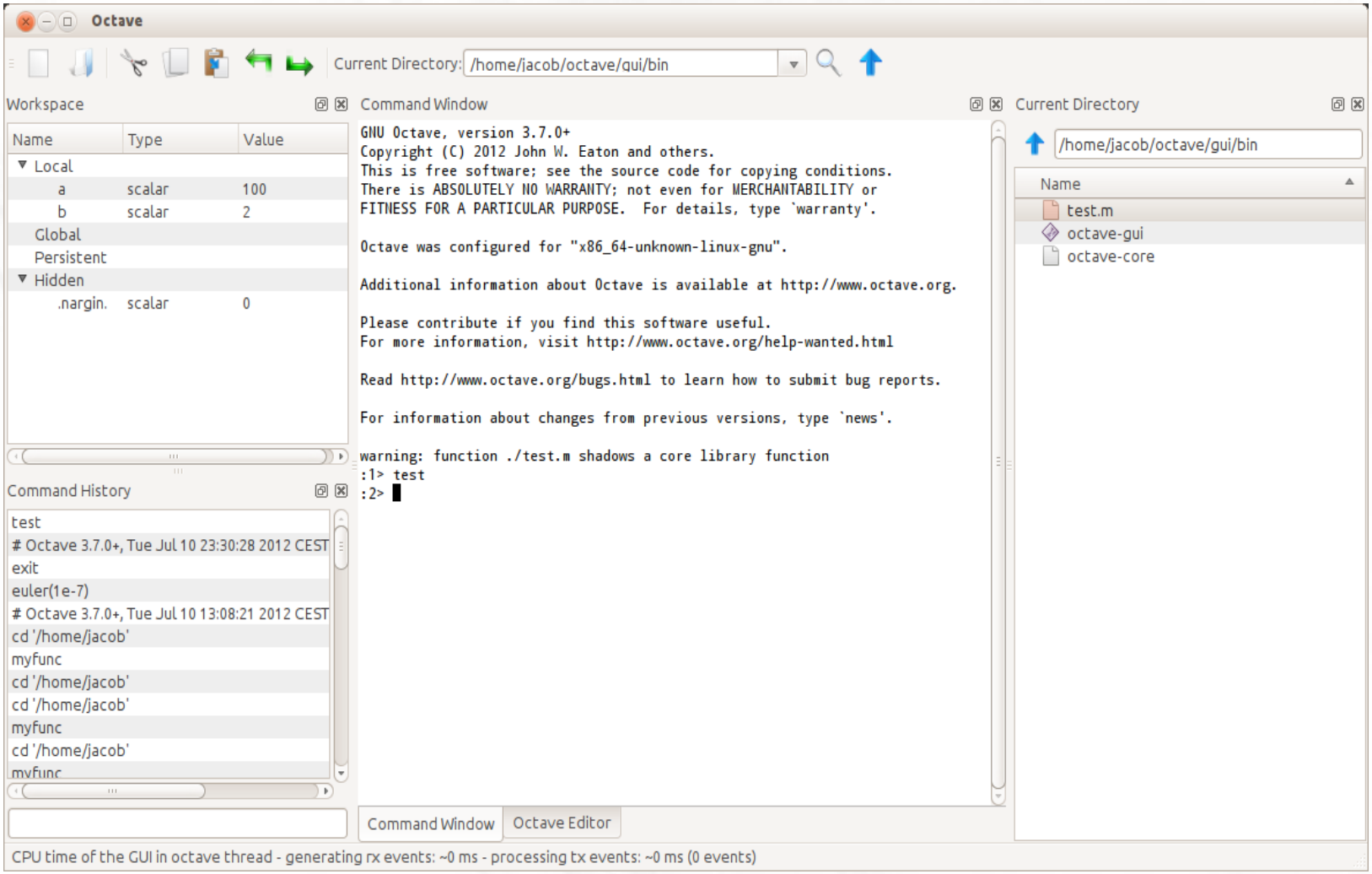
The Octave GUI



What makes a good GUI?

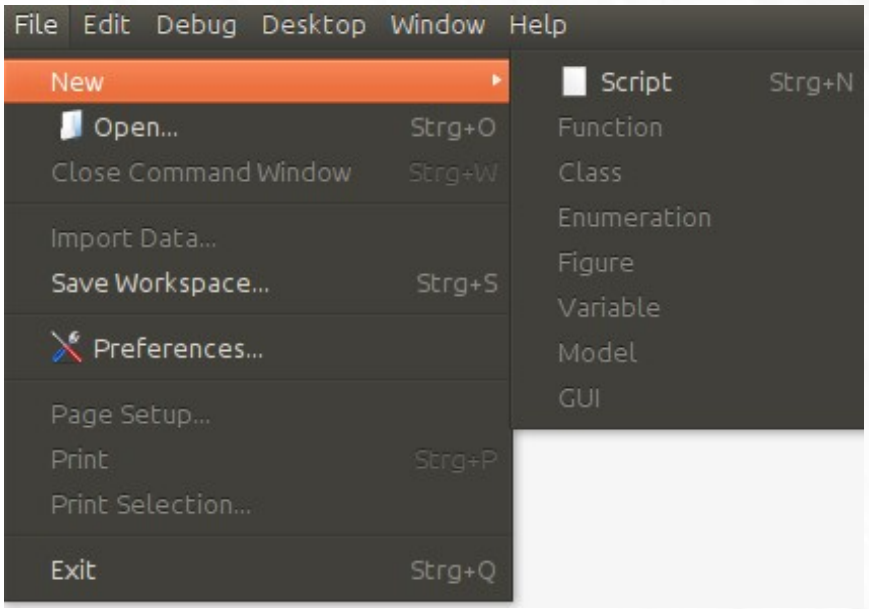
- Requirements for a GUI are summarized in the EN ISO 9241 standard, which includes:
- Suitability
- Must be self-descriptive
- Accessibility (different means to perform a certain task)
- Adaptability
- Must meet the user's expectations

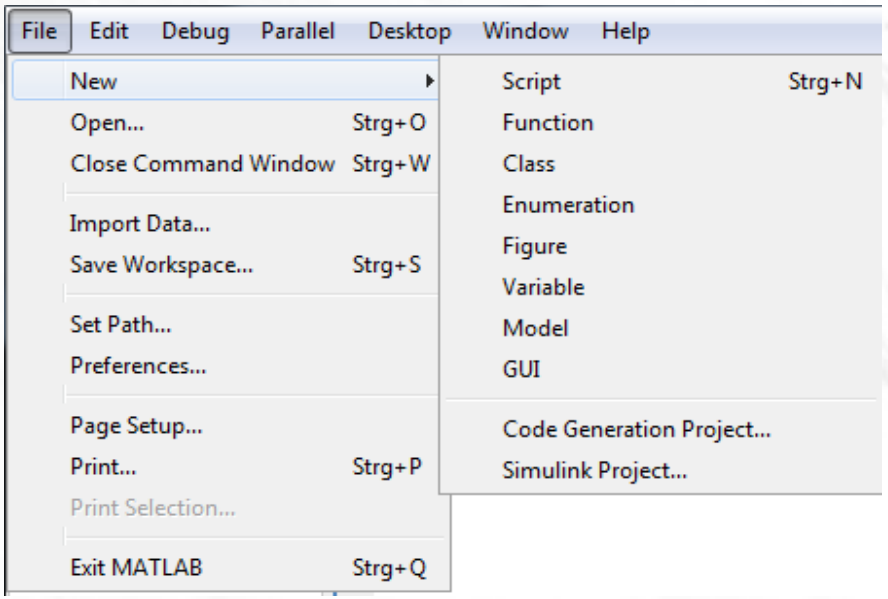
=> There is no **absolute measure** to determine whether a GUI is well-done or not. Whether the design of a GUI is good or not heavily depends on the target audience.

Taken from: http://www.ssw.com.au/

Design goals for the Octave GUI

- Provide an visual environment that is similar to that of MATLAB. Keep care of menu structure, shortcuts, naming conventions.
- Extend the visual environment whereever it makes sense to do that (for example: *History search*)





What is Qt?

- Qt is an *application development framework*
- An application development framework is a set of classes that helps developers to create feature-rich applications faster by providing common functionality on a very abstract level
- It is common to use application development frameworks in software development today
- Qt is free software licensed under the GPL

Design features of Qt

- Very high abstraction level
- Aim for platform-independency
- Suited for high-performance, multimedia applications
- Easy to learn, just a few repetitive concepts („learned it once, learned it all“)
- Very good documentation, integrated into the QtCreator IDE

Basic Concepts: QObject

- Much like in Java, Qt introduces a basic object classes for all non-trivial data structures: QObject
- By default, each instance of a QObject is unique, it cannot be copied
- Each QObject can benefit from a language extension Qt provides, called *signals and slots*

Basic Concepts: QObject

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Basic Concepts: Signals and Slots

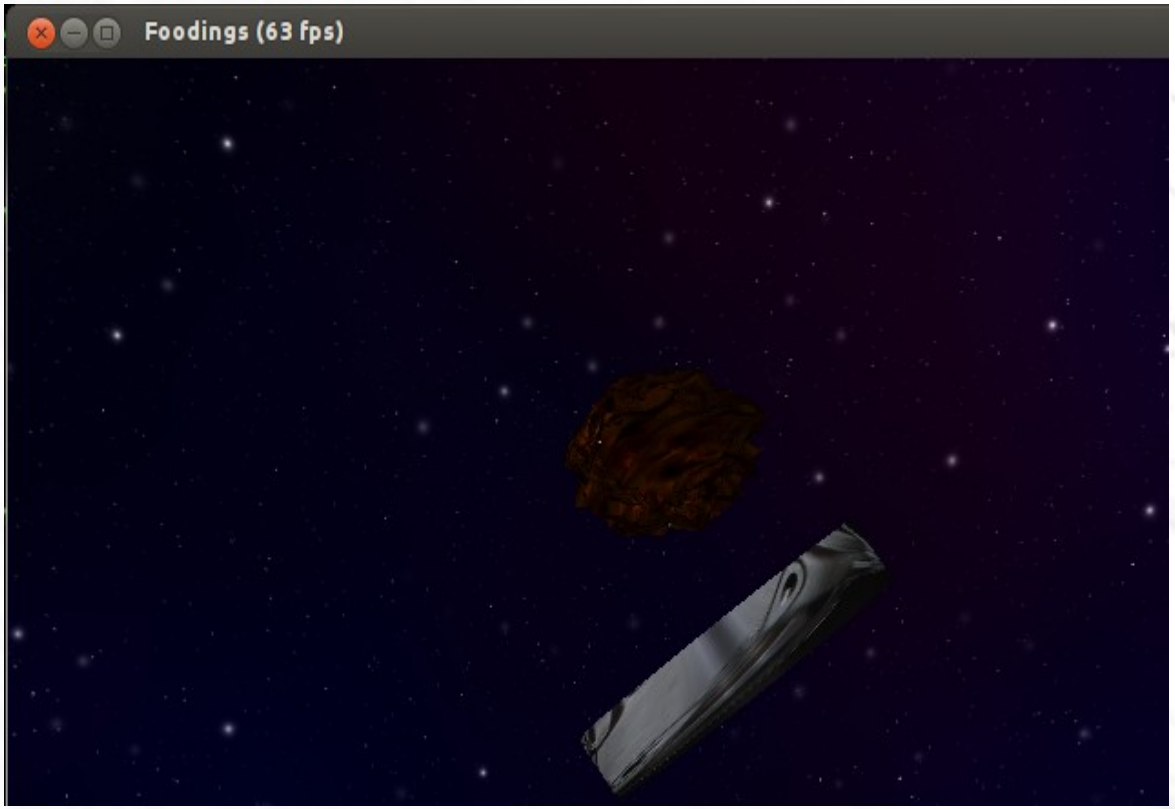
- In order to provide loose coupling of objects (that's a desirable feature in object-oriented programming), QObject can communicate via signals and slots
- Each QObject can *emit signals,* however, it does not have any knowledge about who listens to the signal and if it has an effect at all
  → „Fire and forget“
- Each QObject can offer slots. Slots can be connected and disconnected to signals **at runtime**, without the need of telling the QObjects about that

Basic Concepts: QWidgets

- QWidget derives from QObject
- Widget = „Visual Gagdet“
- QWidgets are usually used for displaying visual elements. All visual elements have to have QWidget as a base class
- QWidgets can be „stacked“ one into another by explicitly stating a hierarchy via the *parent*-parameter in the QWidget-constructor
- Once a parent has been assigned to a QWidget, the parent cares for cleaning up memory (ie. deleting child widgets will lead to a segfault)
- QWidget without a parent are top-level-widgets. The user has to take for cleaning up memory.

Basic Concepts: Neatless integration of OpenGL

- With QGLWidget, Qt integrates OpenGL neatlessly. Qt can manage several OpenGL displays at the same time.



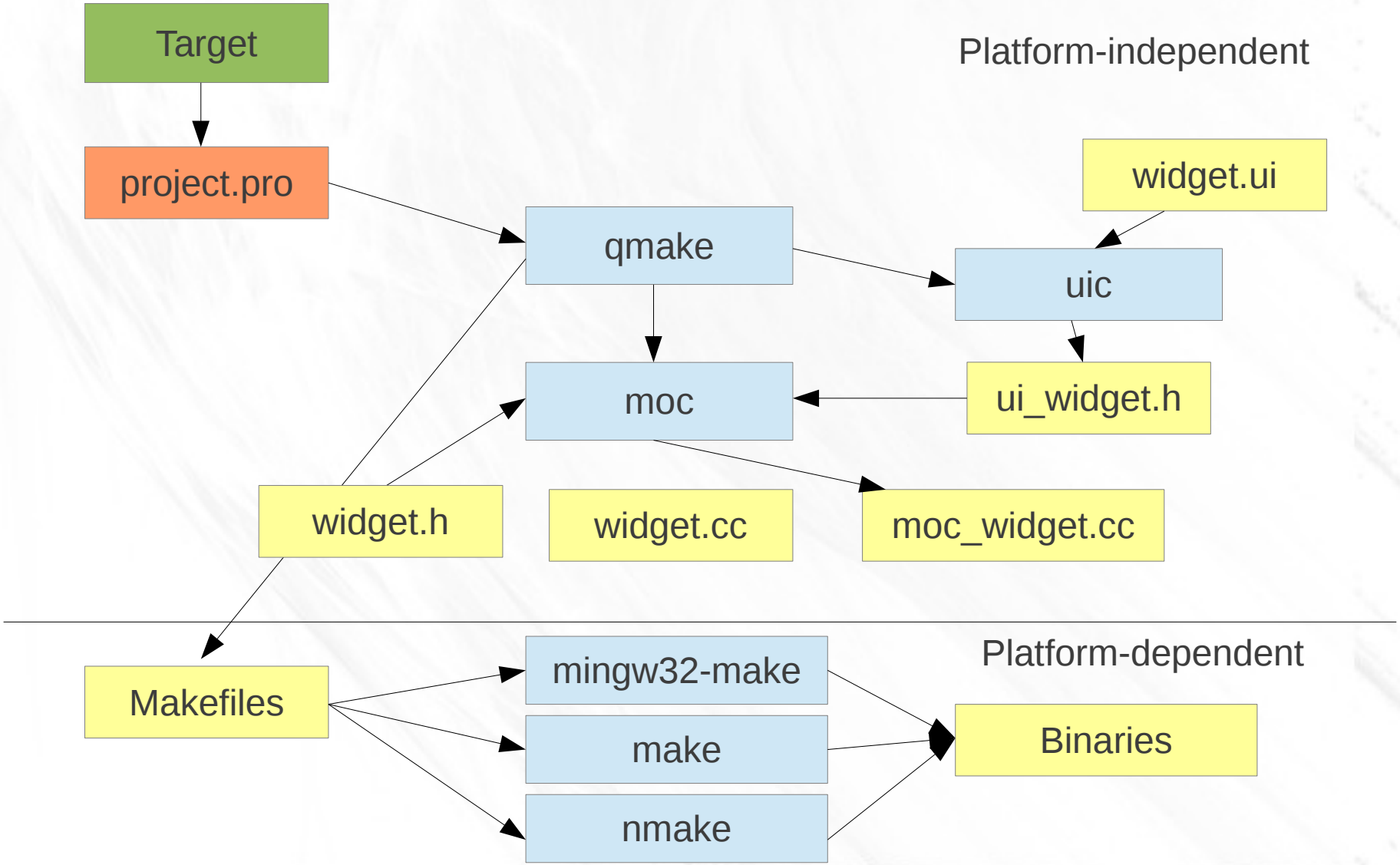
Basic Concepts: Layouting and Styling

- QWidgets can be aligned in horizontal and vertical layouts
- The actual size size is determined by the size policy of each QWidget
- Layouts can be cascaded to provide any widget layout that is desired
- QWidgets can be styled like webpages with regular CSS

Basic Concepts: Qt Devel Tools

- qmake: Reads a *.pro-project file and generates makefiles for various „targets“ (platforms). qmake is able to generate project files for other IDEs, like for example Visual Studio.
- moc: Meta-Object-Compiler. This tool is used to parse source files containing QObjects in order to generate glue code for the signals and slots system.
- uic: User-Interface-Compiler. Reads XML-user interface definitions and creates C++ source code.
- lupdate: Part of Qt's language translation system. Updates the language files by parsing the sources for the tr (..) macro.
- lrelease: Compiles language files that can be shipped with and loaded by Qt applications.

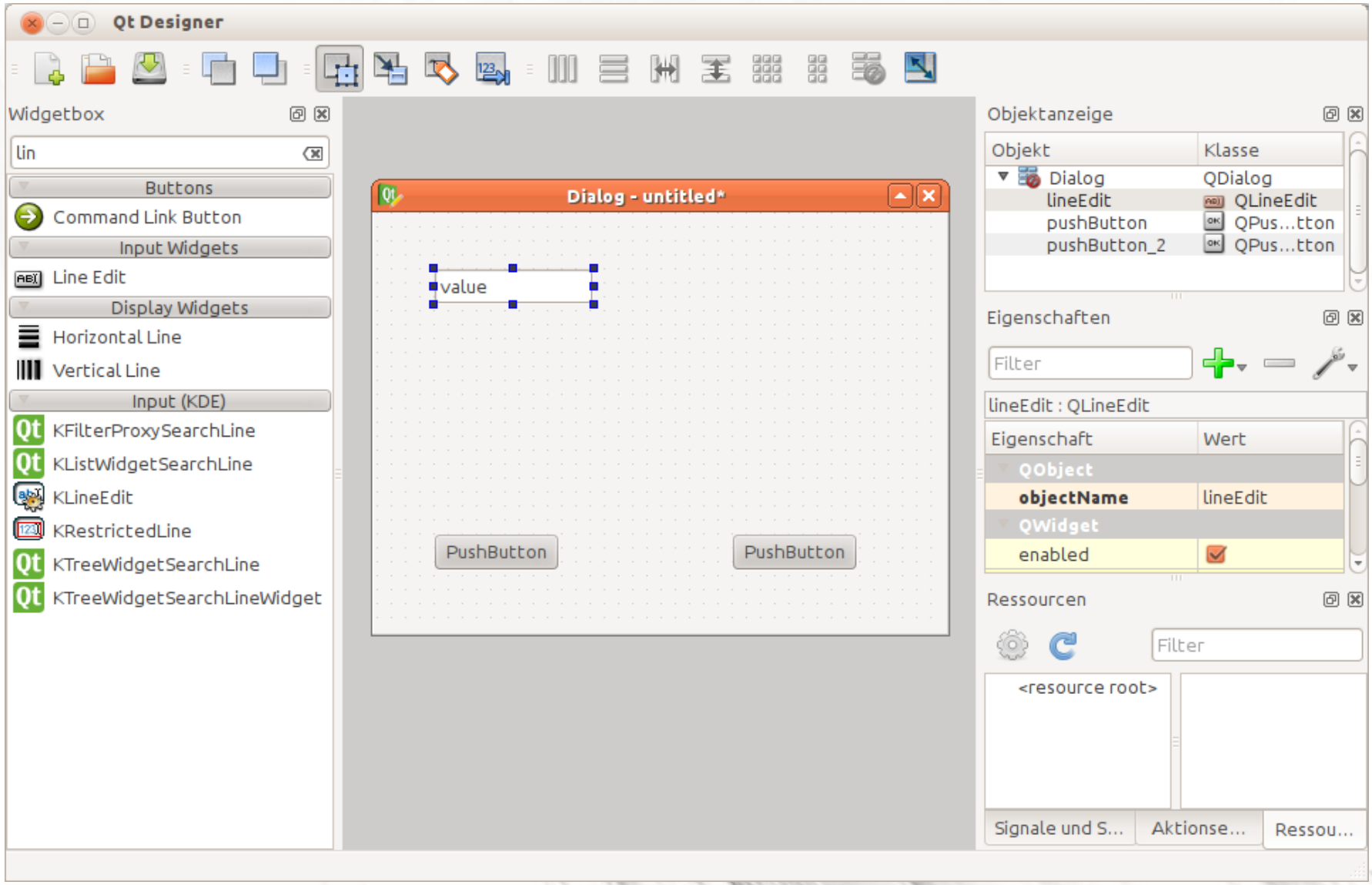
Minimal Qt Build Process



Designing a GUI with Qt

- Qt offers a WYSIWYG editor for designing GUIs: QtDesigner
- Qt offers a pretty neat system for layouts and size policies
- Once a GUI has been designed, it will store the result in an XML-format file (.ui-file)
- The uic-tool generates header files, these will contain a widget class that can be subclassed and extended with C++ code
- => **Combining the best of two worlds**: *Code generation* for designing purposes, *writing code* in order to write detailed GUI logic and implementing extended features.
  => Code generation and writing code do not interfere.

QtDesigner


Qt Designer
Widgetbox
lin
Buttons
Command Link Button
Input Widgets
Line Edit
Display Widgets
Horizontal Line
Vertical Line
Input (KDE)
KFilterProxySearchLine
KListWidgetSearchLine
KLineEdit
KRestrictedLine
KTreeWidgetSearchLine
KTreeWidgetSearchLineWidget
Dialog - untitled*
value
PushButton
PushButton
Objektanzeige
Objekt
Klasse
Dialog
QDialog
lineEdit
QLineEdit
pushButton
QPus...tton
pushButton_2
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Eigenschaften
Filter
lineEdit : QLineEdit
Eigenschaft
Wert
QObject
objectName
lineEdit
QWidget
enabled
Ressourcen
Filter
<resource root>
Signale und S...
Aktionse...
Ressou...

Localization

- Qt has built-in localization support. Within Qt, all user interface strings have to be surrounded with *tr(...)*
- With the qupdate-command the language input files for the specified languages will be updated.
- QtLinguist can be used for translators to do translation within an easy to learn IDE.
- With qrelease the language files get compiled into distributable „language packages“ that can be loaded by Qt applications.

  There has already been a few translations for the GNU Octave GUI.

GNU Octave and thread-safety

- Problem: GNU Octave itself is not thread-safe, but applications with GUIs have to be multithreaded in order to keep the GUI responsive.
- Solution 1: Make GNU Octave threadsafe.

  + Often, GNU Octave can benefit heavily from systems that are able to execute multiple threads in parallel in hardware

  + Applying a GUI would be easy

  - Nearly impossible to achieve due to lots of global state in GNU Octave

  - Performance decrease for tasks that cannot be parallelized or hardware that does not support multiple threads in hardware

GNU Octave and thread-safety

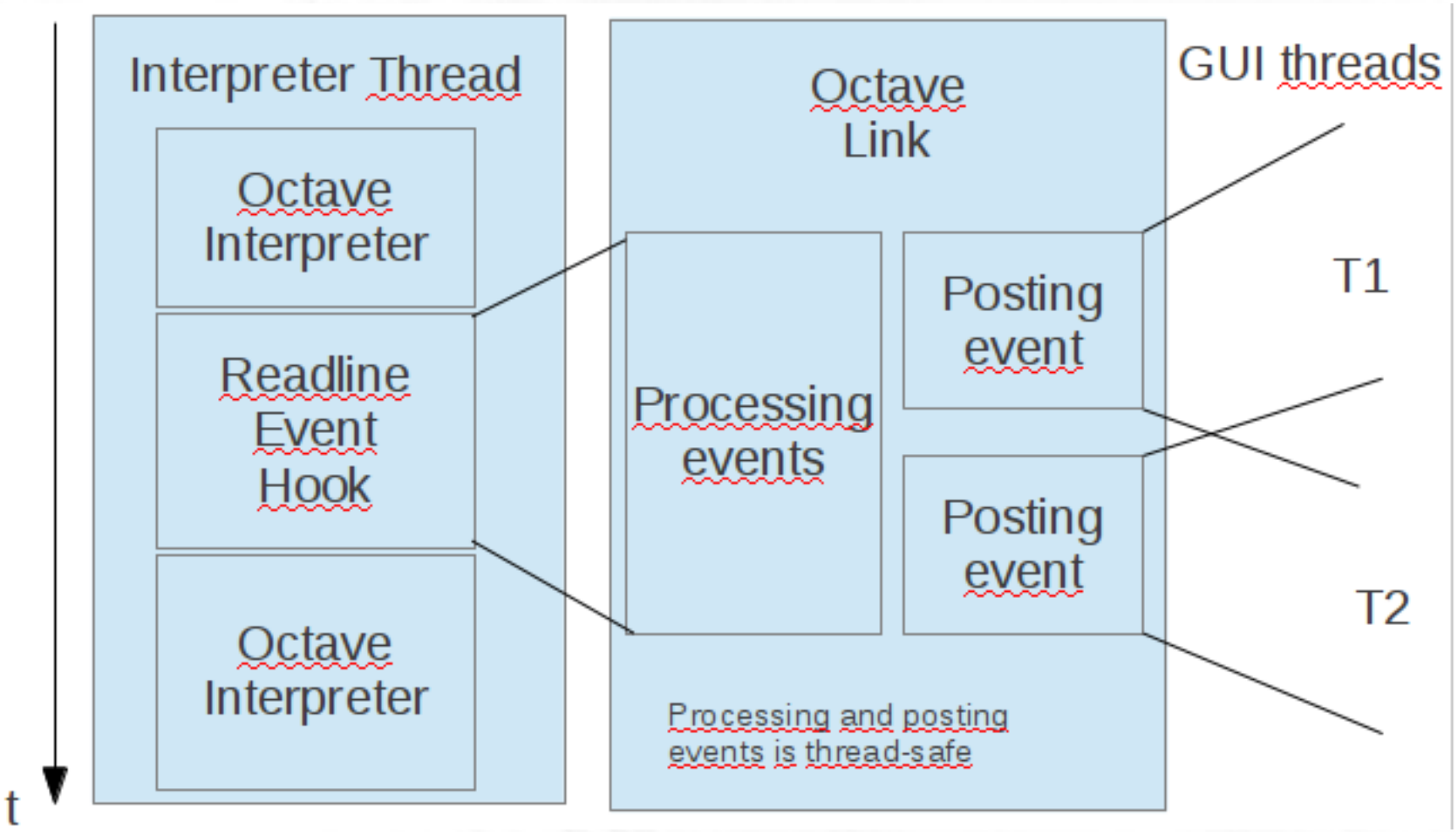
- Problem: GNU Octave itself is not thread-safe, but applications with GUIs have to be multithreaded in order to keep the GUI responsive.
- Solution 2: Serialize communication between GNU Octave and other threads.

  + Minimal-invasive approach, no modification of former GNU Octave code

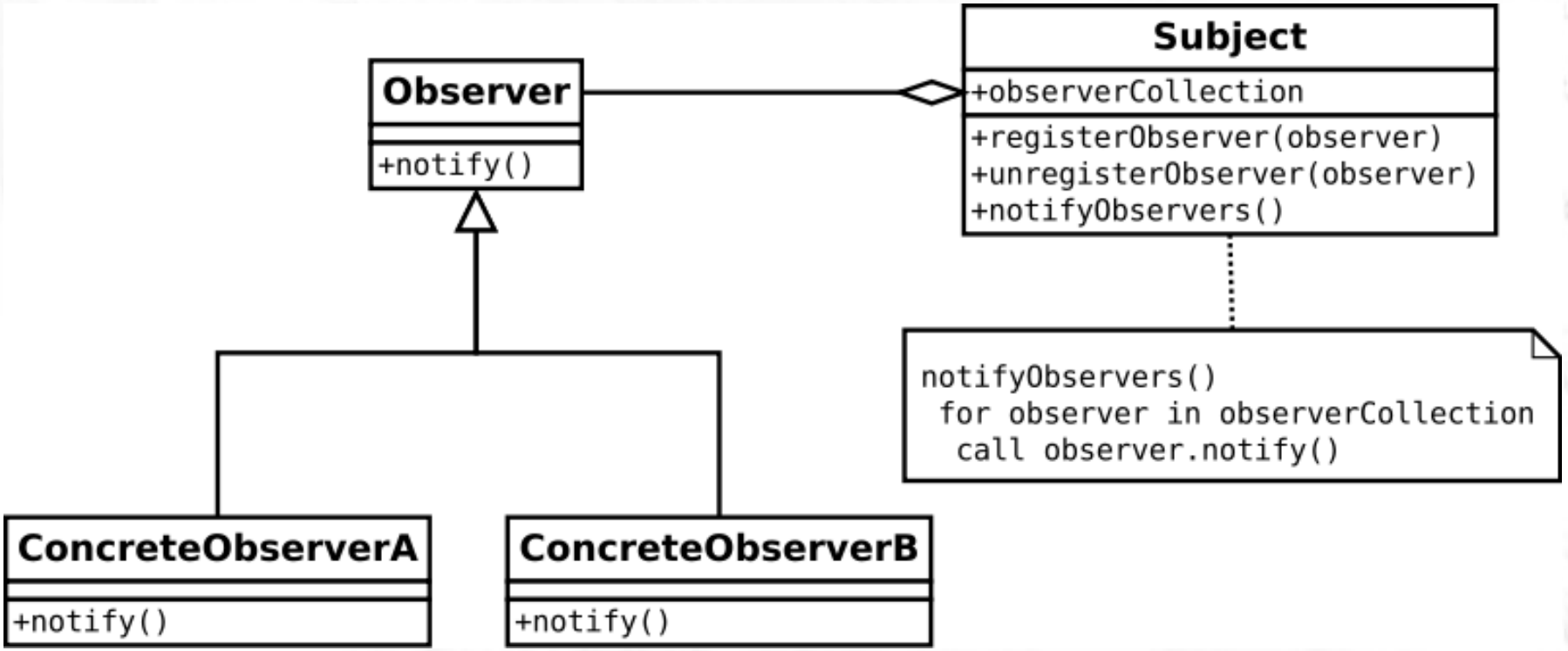
  + Easy to implement and understand

  - Performance decrease for all tasks, since additional time in the GNU Octave thread will be spent. *Possible solution → Use the GUI for interactive research and code development. Once this has been done, use the GNU Octave CLI version to run your scripts on a larger scale.*

Event-based communication



Events implemented with Observer-Pattern



Source: http://en.wikipedia.org/wiki/File:Observer.svg

Integrating the command line

- Former GUIs implemented a pipe-based communication by launching GNU Octave as a subprocess.

  Disadvantages:

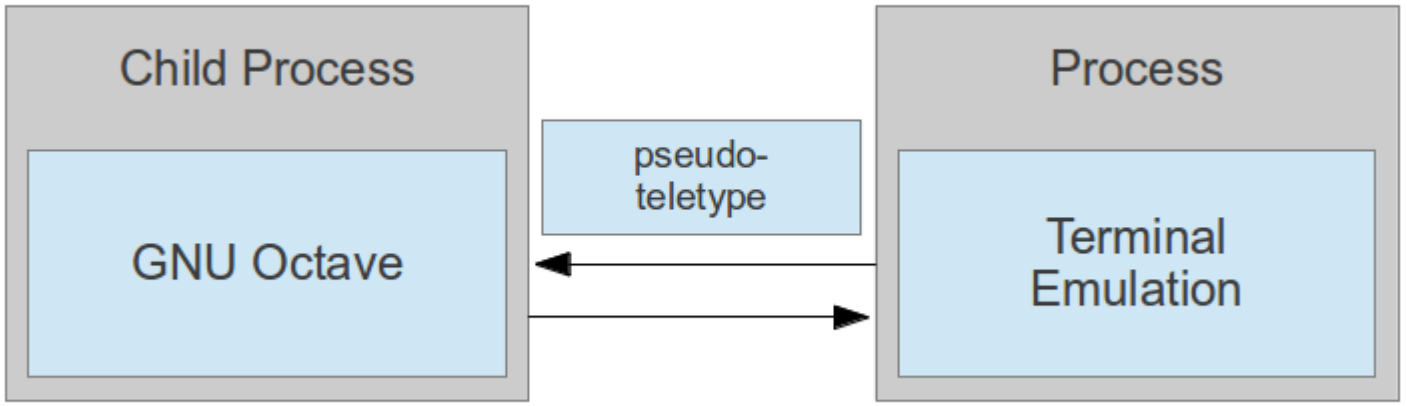
- The GUI has to parse GNU Octave's output and generate input → slow and error-prone
- The GUI has no access to internal data → limited functionality
- The GUI has to reimplement basically all functionality that is already given by readline

GNU Octave GUI's approach

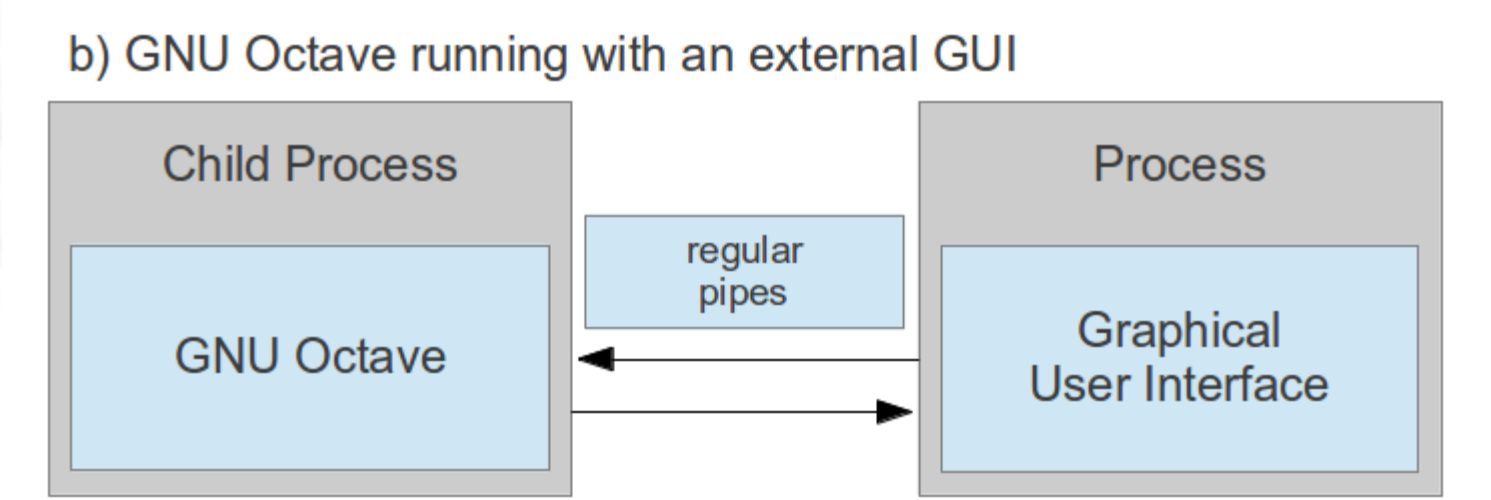
- Based on code from KDE's Konsole: Full terminal emulation. On Windows: Console2 approach.
- Theoretically, offers the same functionality as GNU Octave run in a terminal window, with no compromises on functionality
- John Swensen first came up with this idea in his GTK+/Qt *OctaveDE.*

Different ways of running octave

a) GNU Octave running in a terminal emulation

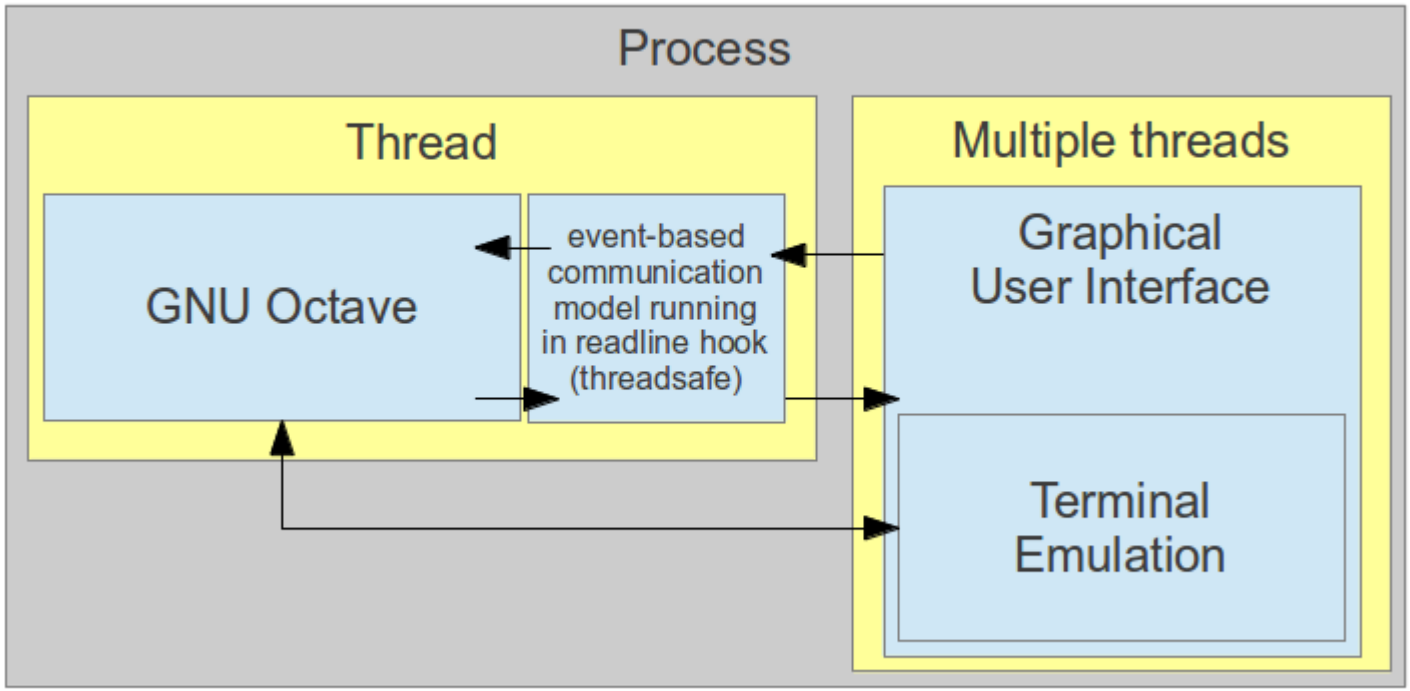


Different ways of running octave



Different ways of running octave

c) GNU Octave running with GUI



Integrated Editor

- Using QScintilla2 as as powerful editor widget
- QScintilla2 is free software licensed under the GPL
- Offers all the standard comfort of an editor:
  Marker lines, line numbers, code folding, current line highlighting, syntax highlighting, auto-indent, code-completion
- For further Information see:

  http://www.riverbankcomputing.co.uk/software/qscintilla/

Debugging Interface

- Neatless integration of GNU Octave's debugger. It is possible to set breakpoints at the margin in the editor.
- Stepping through the code can be done with the usual F10/F11/F12 and F5 commands.
- While debugging, it is possible to track the current state of the workspace.

Thank you for your attention!