Agenda

• Introduction
• Scilab
• Xcos
• Custom Toolbox
• Demo
Introduction

- Numerical computation tool
- Graphical design (Xcos)
- Extendable
  - Toolbox
  - Integration with external tools
  - Programming
- Open source (GPL)

Available at http://www.scilab.org
Introduction: Integration with other tools and hardware

• Extend Scilab with other languages:
  – Java, Python, Tcl Tk, Fortran or C, C++
• Use Scilab from different languages:
  – Java, Python or C, C++
• Integration with other programs:
  – Excel
  – Labview
  – OpenFoam
  – Etc.

More information in https://wiki.scilab.org/Interoperability
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 737183.
Scilab: basic information

• Basic data element: **Matrix**
  
  – everything is a matrix. All real, complex, Boolean, integer, string, and polynomial variables are matrices.

• Variables names case sensitive and only 24 first characters are considered

• Protected variables: %i, %pi, etc.

• High-level interpreted language with variables, flow, functions, primitives.

• High-level functions for 2-D and 3-D data visualization
Scilab: Useful commands

- Help command
  --> help
  --> help <name_of_command>
  --> apropos(keyword)

- Workspace commands:
  --> clc: clear screen
  --> what: show all the primitives
  --> who/whos: show all the variables (with -name show variables starting with <>)
  --> clear: delete all non protected variables
Scilab: Create functions

• Format:

```scilab
function <lhs_arguments>=<function_name><rhs_arguments>
...
Endfunction
```

• Create the function with the editor
  - Save as *.sci file with the name of the function

• Load the function in the command line
  - exec filename.sci

• Genlib to build library from functions (sci files) in given directory
Scripting

• For long code scripts can be used:
  – Files with extension *.sce
  – Load: exec (‘filename.sce’)
  – Can include definition of functions

• Edit with the editor (applications/SciNotes):
  – // for comments
  – F5 to evaluate the script
Load/save data

Variables (environment) *sod

- Save and load commands
- Menu File/Save environment or Load environment

Graphics *.scg

- Any graphic figure can be saved:
  - save() through its identifier as a variable
  - xsave()
  - With figure's menu File/Save
- Load file *.scg: load(..) or xload()
- Several figures may be saved in the same file. Each restored figure gets a new incremented #id, so usually not the original one.
Scilab: Matlab

- 'Comparisons are odious'
- https://wiki.scilab.org/MatlabToScilab
- Conversor available
Scilab: ATOMS

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 737183.
CelestLab/CelestLabX

- Atoms/Domain-specific/Celestlab
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 737183.
Xcos: Palette

- **Standard Palettes and Blocks**
  - Signal processing and signal routing
  - Thermo-hydraulic blocks
  - Mathematical operations, matrix, integer
  - Discrete and continuous system blocks
  - Electrical
  - User defined blocks
  - Annotations: text, LaTeX/MathML
  - Lookup tables
  - Event handling
  - Sinks and sources
  - Port and subsystem
Model building and edition

- Blocks selection from existing palettes (drag and drop)
- Define inputs and connect blocks through lines
- Superblocks management (Sub-diagram embedded in a single superblock for model reuse and simplification)
- All Scilab data types available for signal definition

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 737183.
Model customization

• Simulation parameters definition (solver)

• Signals and blocks parameters adaptation
Example: AntiWindUp PID controller

Source: https://www.scilab.org/pid-anti-windup-schemes (Dew Toodhinda, Scilab Ninja)
Example: AntiWindUp PID controller
Code generation

Create Superblock

Generate code from superblock
Xcos: Custom blocks

• External code (C, C++, Fortran)
• Xcos models (generate code)
• Scilab code
Xcos: Custom blocks

- Install MinGw and its toolbox to be able to compile code (C/C++, Fortran)
- Atoms/Windows Tools/MinGw toolbox
Xcos: Custom Toolbox

- Skeleton structure (contribs in Scilab source code):
  - Etc
  - Help
  - Images
  - Macros: Block definition and Scilab code,
  - Src: Source code.
  - Builder.sce: compilation script.
  - Loader.sce: load toolbox.
**Xcos: Custom Toolbox**

<table>
<thead>
<tr>
<th>Altitude</th>
<th>Declination</th>
<th>Inclination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude</td>
<td>North</td>
<td>East</td>
</tr>
<tr>
<td>Longitude</td>
<td>Down</td>
<td>Total</td>
</tr>
<tr>
<td>Year</td>
<td>secvarD</td>
<td>secvarL</td>
</tr>
<tr>
<td>Months</td>
<td>secvarH</td>
<td></td>
</tr>
<tr>
<td>Day of month</td>
<td>secvarNorth</td>
<td>secvarEast</td>
</tr>
<tr>
<td>Model</td>
<td>secvarDown</td>
<td>secvarTotal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Altitude</th>
<th>He density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude</td>
<td>O density</td>
</tr>
<tr>
<td>Longitude</td>
<td>N2 density</td>
</tr>
<tr>
<td>Year</td>
<td>O2 density</td>
</tr>
<tr>
<td>Day</td>
<td>Ar density</td>
</tr>
<tr>
<td>Seconds</td>
<td>H density</td>
</tr>
<tr>
<td>F10.7 av.</td>
<td>N density</td>
</tr>
<tr>
<td>F10.7</td>
<td>Anomalous O density</td>
</tr>
<tr>
<td>AP (daily)</td>
<td>Exospheric temp</td>
</tr>
<tr>
<td></td>
<td>Temp. at alt.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Altitude</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude</td>
<td>Exospheric temp</td>
</tr>
<tr>
<td>Longitude</td>
<td>Atomic H</td>
</tr>
<tr>
<td>Year</td>
<td>Helium</td>
</tr>
<tr>
<td>Month</td>
<td>Atomic O</td>
</tr>
<tr>
<td>Day</td>
<td>Molecular N</td>
</tr>
<tr>
<td>Hour</td>
<td>Molecular O</td>
</tr>
<tr>
<td>Minute</td>
<td>Atomic N</td>
</tr>
<tr>
<td>Second</td>
<td>Density</td>
</tr>
<tr>
<td></td>
<td>Dens. unc.</td>
</tr>
<tr>
<td></td>
<td>Mean mld mass</td>
</tr>
</tbody>
</table>

**Meridional wind**

**Zonal wind**

**MAGNETIC TORQUE**

**GRAVITY TORQUE**

---

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 737183.
### Links

<table>
<thead>
<tr>
<th>Links of interest</th>
<th>Description</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Download</td>
<td></td>
<td><a href="https://www.scilab.org/download/6.0.2">https://www.scilab.org/download/6.0.2</a></td>
</tr>
<tr>
<td>Tutorials</td>
<td></td>
<td><a href="https://www.scilab.org/tutorials">https://www.scilab.org/tutorials</a></td>
</tr>
<tr>
<td>Wiki</td>
<td></td>
<td><a href="https://wiki.scilab.org/">https://wiki.scilab.org/</a></td>
</tr>
<tr>
<td>Mail lists</td>
<td></td>
<td><a href="https://www.scilab.org/about/community/mailing-lists">https://www.scilab.org/about/community/mailing-lists</a></td>
</tr>
<tr>
<td>Forum</td>
<td></td>
<td><a href="https://scilab.in/forum">https://scilab.in/forum</a></td>
</tr>
<tr>
<td>Books</td>
<td></td>
<td><a href="https://www.scilab.org/about/community/books">https://www.scilab.org/about/community/books</a></td>
</tr>
<tr>
<td>Control Eng.</td>
<td></td>
<td><a href="https://scilabdotninja.wordpress.com/scilab-control-engineering-basics/">https://scilabdotninja.wordpress.com/scilab-control-engineering-basics/</a></td>
</tr>
</tbody>
</table>
Demo
System Modelling and Simulation with SCILAB

David Gonzalez – Valentín Cañas
DEIMOS

Brussels, 28 November 2019