

# Sandhi

## Open Source Visual Programming Software

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# Introduction

- Sandhi is a visual programming editor based on GNU Radio
- Basic data structure in sandhi is the flowgraph
- It has been named Sandhi as it means connecting and conveys our idea of connecting various blocks to come up with a robust visual program
- Sandhi is aimed to become a visual programming tool for replacing LabVIEW

# Flowgraph

- Flowgraph represents the connections of the blocks through which a continuous stream of samples flows
- The concept of a flowgraph is an acyclic directional graph:
  - with one or more source blocks (to insert samples into the flowgraph)
  - one or more sink blocks (to terminate or export samples from the flowgraph) and
  - any functional blocks in between.

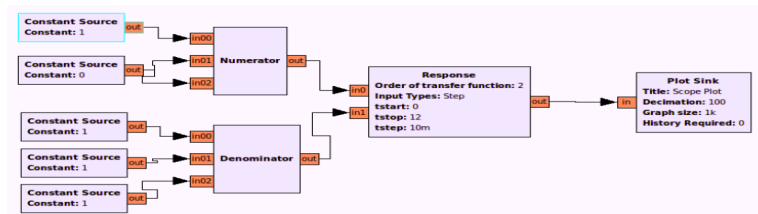


Figure: Flowgraph



# Motivation to develop Sandhi

- Lack of proper open source alternative to LabVIEW.
- Expensive proprietary software.
- Being FOSS, it gives you freedom to modify, share and sell your application without any permission.

# Development of Sandhi

- GNU Radio
- sciscipy
- GRAS

- GNU Radio is a free and open-source software development toolkit that provides signal processing blocks to implement software radios.
- Supposed to be used by the Electrical Engineering community for the purpose of digital signal processing
- It has a rich module of implemented device drivers and thereby supports a range of devices

# Why GNU Radio?

- GNURadio is a very promising visual programming tool as:
  - it make very easy for the developer to abstract his code
  - provides a very easy to use framework to the developer
  - it is open source

- Sciscipy is an Application Programming Interface
- Aimed for Inter Process Communication with scilab when in workspace of Python programming language

## Sample Code:

```
from scilab import Scilab  
sci = Scilab()  
x = sci.rand(20, 20)  
y = x*x.transpose()  
y_inv = sci.inv(y)
```



- GRAS stands for GNU Radio Advanced Scheduler
- It was impossible to implement the feedback with GNU Radio, which uses stock application scheduler

*Note: Application Scheduler is responsible for threading, controlling the data flow and managing the use of the computer resources like processor time to various processes.*

# Blocks in sandhi

- Blocks are the basic building component of flowgraph
- Blocks have the property written in C++ or Python

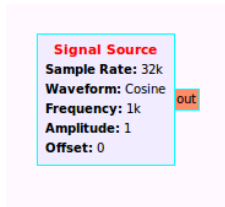


Figure: Source

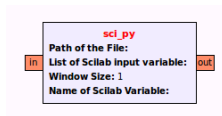


Figure: Process

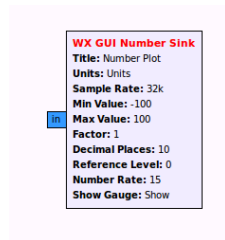


Figure: Sink

# Sandhi GUI

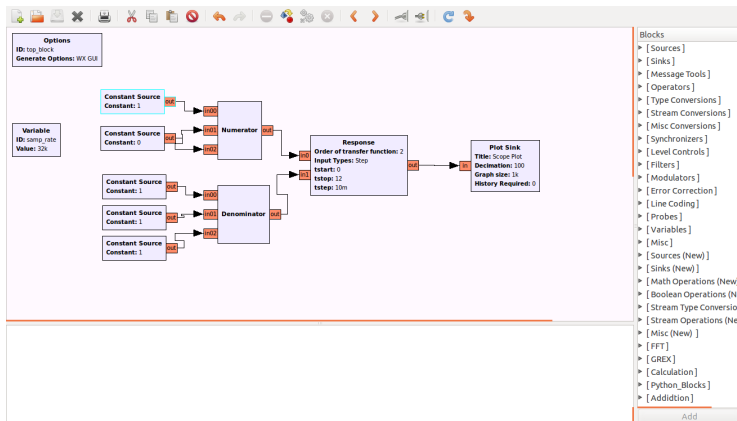
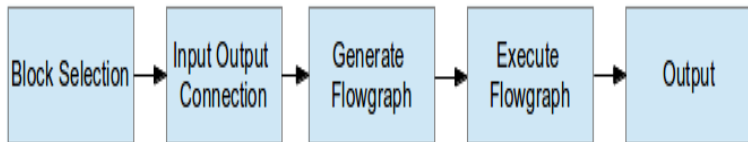


Figure: Sandhi GUI

# How to create a block

- One can create a customized block with knowledge of C++ or Python
- Block developer have access to any library available in Python
- There are two files needed to create a block in sandhi:
  - Functionality written in C++ or Python
  - Properties written in xml file

# Work Flow



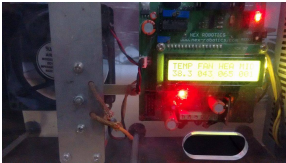
- **Block:** A functional processing unit with inputs and outputs.
- **port:** A single input or output of a block.
- **Source:** A producer of data.
- **Sink:** A consumer of data.

# Features

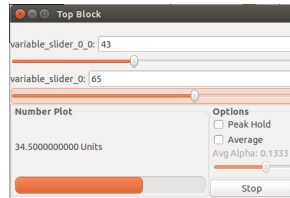
- Applications based on flowgraph can be created in sandhi by connecting blocks as per requirement
- In sandhi user can create their own customized blocks using GNU Radio API
- It is capable of passing any practical types of data between blocks
- User can use scilab script in flowgraph for computation using scipy wrapper
- Flowgraph with feedback can be create using GRAS
- Sandhi provides nice GUI to plot or show data.
- User can also change value in real time using slider.

# Experiments on sandhi: Data Aquisition

- Single Board Heater System(SBHS) can controlled using sandhi
- Using Python serial library, one can set the fan,heat value to SBHS and receive temperature value from SBHS



**Figure:** SBHS setup



**Figure:** Output Window with slider



# Experiments on sandhi: step response of transfer function

- To perform step response the flowgraph is created as follows
- Flowgraph uses *Numerator*, *Denominator*, *Response* and *plot-sink* block
- These blocks has been written in Python and response of system is calculated in scilab using scipy in Response block

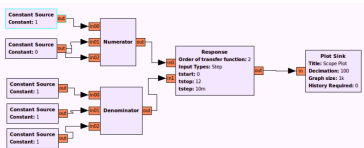


Figure: Flowgraph

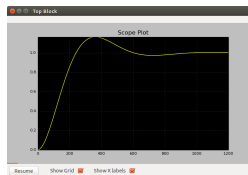
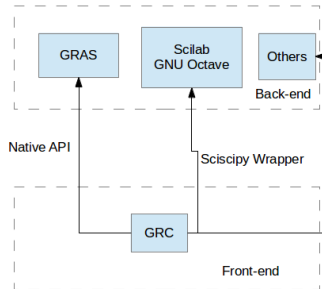


Figure: Output Plot

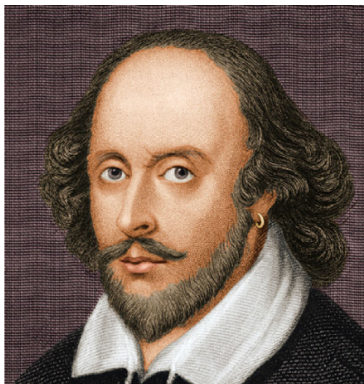


# Architecture



**Figure: Sandhi Architecture**

# Closed Loop System



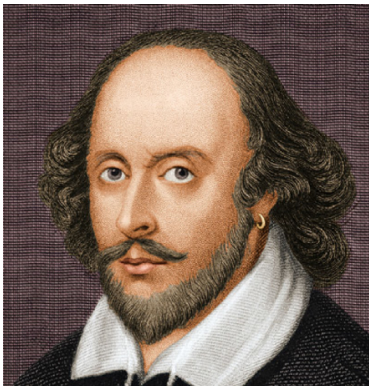
*"Cometh peace and reliability from within,  
and from closed loop system"*  
- W. Shakespeare 1573AD

**Figure:** Ancient Wisdom

# GRAS: GNU Radio Advanced Scheduler

- Written by Josh Blum ([josh@joshknows.com](mailto:josh@joshknows.com))
- It is application scheduler
- Handles how the blocks(computational entity) should be formed, scheduled
- Provides easy API to write our own blocks in Python
- Uses Theron, PMC, Apology etc. libraries

# Being Pythonic



*"Let the code be in Python,  
Speed and GIL is sometimes  
exaggerated"*

**- W. Shakespeare 1573AD**

**Figure:** Really ancient wisdom

```
def work(self, input_items, output_items):  
    # Limit output_items to just the size of window  
    output_items[0][:] = output_items[0][:self.window_size]  
  
    # Check number of input_instances  
    n_input_items = len(input_items)  
  
    # Men Tears were shed here..  
    eval_function = getattr(self.scilab_instance, self.func_name)  
  
    for i in range(n_input_items):  
        output_items[0][i] = eval_function( input_items[i] )
```

**Figure:** Work Function Code snippet

# Ongoing work

- Migrating virtual lab experiments from LABview to Sandhi
- Improving GUI of Sandhi
- Addition of features similar to LabView
- Improving performance of experiments
- Migration of WX blocks to QT
- Testing of existing blocks
- Method to pass Array between blocks
- Data Acquisition using NI DAQs
- Control of sampling rate
- Automatic code generation of blocks

# Contact Us

- If you are interested to contribute please write to us at [contact-sandhi@fossee.in](mailto:contact-sandhi@fossee.in)
- Go through our website [sandhi.fossee.in](http://sandhi.fossee.in)
- You can post your queries on Forums at [forums.fossee.in](http://forums.fossee.in)

THANK YOU