Talk To Me:
Inter-Program Communication for Brain Data Analysis

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Preamble

Brain imaging analysis produces a great amount of image data. Navigating and examining data at various analysis stages is important given the complexity of the analysis, numerous sources of artifacts, and software differences.

We present new tools that automate AFNI and SUMA's[1] data rendering capabilities. This allows users and developers to drive AFNI's extensive data navigation with relatively little, if any, overhead. These tools, along with the adoption of NIfTI-1[2] format, further facilitate data processing across multiple applications.

Other programs can drive AFNI / SUMA graphical interface using two modes:

- Scripted commands on command-line or in matlab ("Hands-OFF Mode").
- C function calls ("Hands-ON Mode") with the C API provided with AFNI's source code.

Sample Applications Include:

- Automate repeated sequences of GUI interactions which quickly become tedious with large numbers of data sets.
- Pinpoint origins of failure in complex iterative methods such as surface-based filtering, warping or skull-stripping. Automated recording of scenes can be easily done for later video viewing.
- Detect subject motion or scanner-induced artifacts promptly with real-time imaging setups.

Hands-OFF Mode

Applications communicate with AFNI via a program called 'plugout_drive' which sends a series of commands and associated data to AFNI for execution.

+ Program called via "system" function (shell invocation)
+ No need to manage sockets or format and transmit commands
+ User Interaction with AFNI/SUMA GUI is uninterrupted

Matlab

Excerpts from: Test_TellAfni.m
(Distributed with AFNI's matlab library)

```
cs(1) = NewCs('open_window', '', 'axialimage', 'keypress=" "');
cs(2) = NewCs('OPEN_PANEL', '', 'Define_Overlay');
cs(3) = NewCs('Set_Function', 'A', 'ARzs_CW_avvr.DEL');
cs(4) = NewCs('SET_DICOM_XYZ', '', '-6 86 -3');
cs(5) = NewCs('SET_SUBBRICKS', '', '-1 0 2');
cs(6) = NewCs('SET_THRESHNEW','', 1e-9, '*p');
err = TellAfni(cs);
```

plugout_drive

Sample commands (out of 40+ options, See README.driver for complete list):
OPEN_GRAPH_1D
OPEN_PANEL
SAVE_JPEG
SET_ANATOMY
SET_DICOM_XYZ
SET_FUNCTION
SET_SUBBRICKS
SET_THRESHOLD

Shell Script

Sample command:

```
plugout_drive -com "SET_ANATOMY A ARZSspgrax.nii" \
              -com "SET_FUNCTION A ARzs_CW_avvr.nii" \
              -com "SET_ANATOMY B ${pref_brwp}" -quit
```

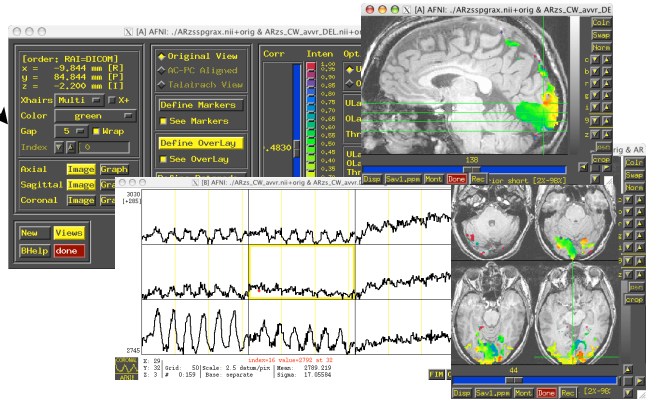


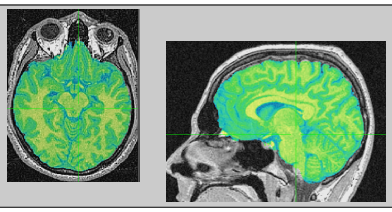
Figure 1: Time-series, anatomical, and functional data displays created using a series of Matlab[3] function calls [4]. Similar sequences could be generated from command line or from other programs via C-style system calls.

CSH Script loop to cycle over numerous data sets , setup new background, foreground, and turn video mode in axial view:

```
while ($cnt < 300)
      plugout_drive     -com "SWITCH_UNDERLAY  A ${WithSkull[$cnt]}"
                        -com "SWITCH_OVERLAY A ${WithNoSkull[$cnt]}"
                        -com 'OPEN_WINDOW A coronalimage opacity=0.5'
                        -com 'OPEN_WINDOW A axialimage keypress=v opacity=0.4'
                        -quit
      echo "Enter new number or hit enter for next brain:"
      set ans = $< && set cnt = `expr $cnt + $ans`
end
```

Set underlay to brain with skull dataset and overlay to the skull-stripped brain

Open Coronal and Axial images, set overlay opacity and start video mode in axial window



Hands-ON Mode

The hands-on mode requires applications to establish one or two way communications and to format and transmit commands to AFNI. There are two ways for achieving this:

1- commands are simple ASCII strings but do not allow for practical transmission of large image datasets.
2- commands and data are transmitted using XML-formatted data elements [5]

To make use of the faster and tighter communication control offered by the hands-on mode, programs must link with AFNI's C-libraries.

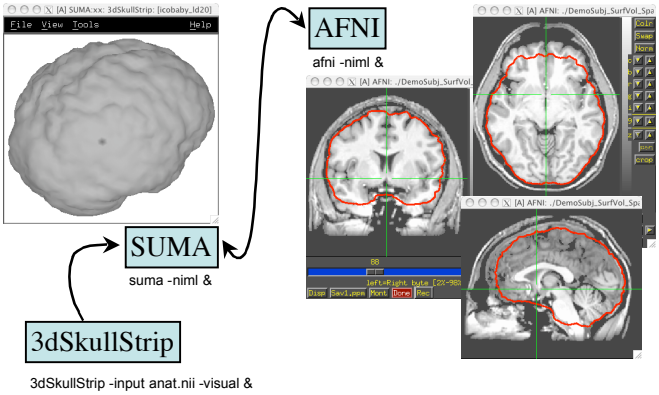


Figure 2: Hands-on communication between AFNI/SUMA/3dSkullStrip.
With each iteration, 3dSkullStrip sends a new surface to SUMA, which displays it and sends it in turn to AFNI. Surface and contours shown here are from an intermediate iteration.
In general, all communications can be bi-directional and different applications can communicate with the same program.

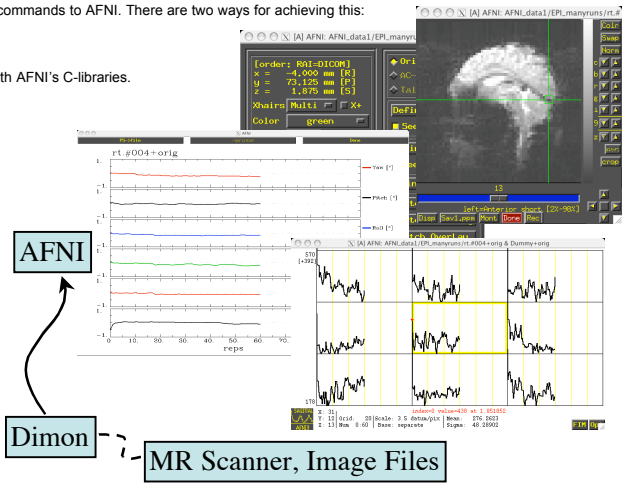


Figure 3: Hands-ON communication illustrated with real-time EPI time series viewing, volume registration and correlation analysis (not illustrated).
The program Dimon monitors file directories where the scanner deposits newly reconstructed images in DICOM format. Dimon sends each new volume to AFNI's real-time interface for further processing.
The program **rtfeedme** serves as a template for communicating new volumes to AFNI for the purposes of real-time imaging.

References

[1] Cox, RW. et.al. (1997). *NMR in Biomedicine* 10(4-5):171-178.
[2] http://nifti.nimh.nih.gov/nifti-1/
[3] The MathWorks, Inc.
[4] AFNI Matlab library: http://afni.nimh.nih.gov/afni/matlab
[5] afni.nimh.nih.gov/afni/doc/misc/NIML_documentation/NIML_manual

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Software Implementation

The proposed methods have been implemented and included with the distribution of AFNI and SUMA http://afni.nimh.nih.gov

See also: Poster Mon. AM #451 by R. W. Cox et al.
Poster Tue. PM #428 by P. Christidis et al.