



Can We Migrate Our Analysis Routines
to Python?

HWIS[®]

Introduction

- Can we migrate our analysis routines to Python?
 - MATLAB is powerful, but it's expensive.
 - Capable open-source alternatives exist and are thriving.
- Recent developments in scientific Python libraries have made migration from MATLAB to Python possible and attractive.
- The IADS Group uses multiple MATLAB licenses.

Dominance of MATLAB

- MATLAB is the standard language for engineering analysis.
- No need to be a programmer to solve engineering problems.
- Used for collaboration and development of analysis routines.
- MATLAB is required for study in an engineering curriculum
 - ECE 309 (CSUN), “Numerical Methods in Electrical Engineering”, is now taught using MATLAB. It was taught using Pascal in the 1980s...

Dependence on MATLAB

- IADS uses MATLAB to prototype new analysis routines.
- IADS uses MATLAB to test and maintain data export and import.
- IADS uses a set of MATLAB scripts to test Autospectrum and PSD results for Every Release.
- IADS is dependent upon MATLAB.



Problems with Dependency

- Budget constraints mean fewer licenses and toolboxes are available.
- MATLAB version changes force retest of data interfaces.
- Retest requires an active license.
- Test Scripts are unusable without a license.
- Having no backup plan in place is risky.

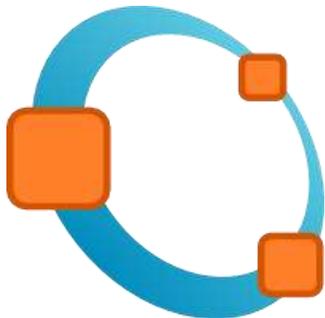


Requirements for a Replacement

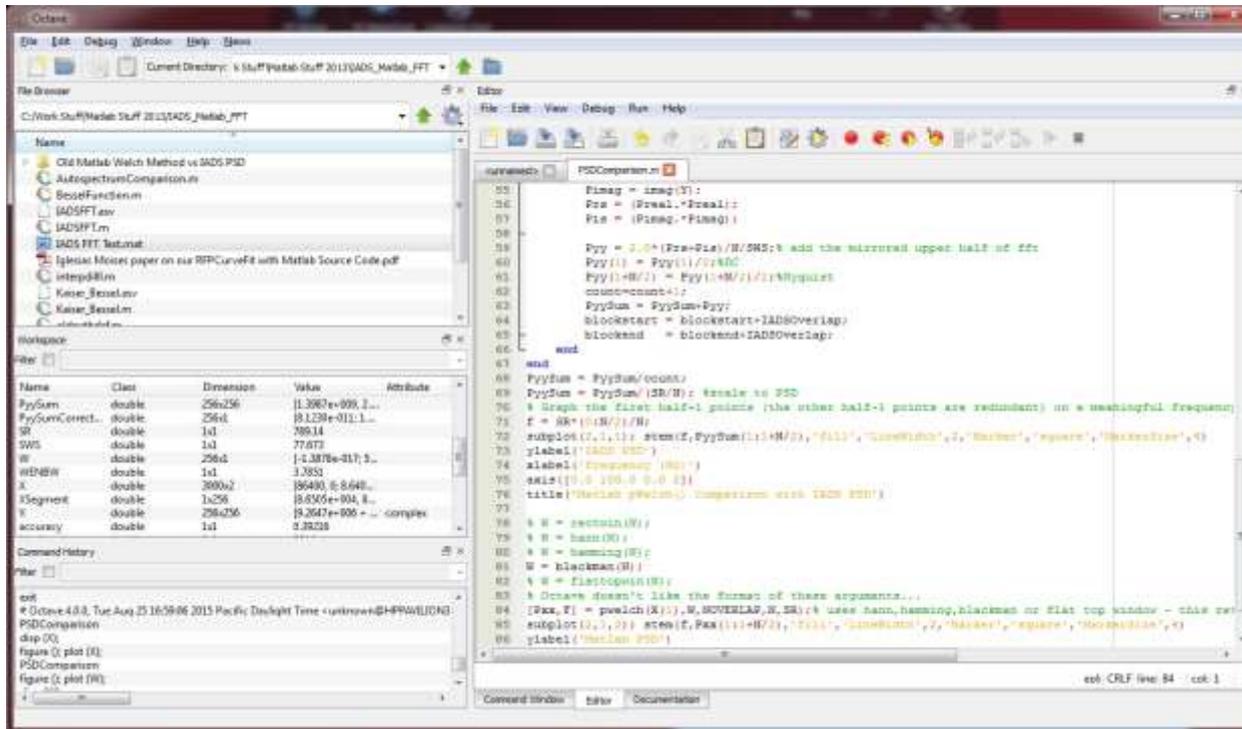
- Should have broad industry acceptance.
- Should have scientific libraries that mimic functionality that is commonly used in MATLAB by the flight test community.
- Should have similar syntax.
- Total MATLAB functionality is not necessary for our purposes, but it would be nice for going forward.
- Should be relatively free of periodic licensing hassles.

Open-Source Alternatives

- A Google search brings these up:
 - GNU Octave
 - Scilab & Xcos
 - Python/NumPy/SciPy



Gnu Octave



The screenshot displays the Gnu Octave environment. The main editor window shows a script named 'PSDComparison.m' with the following code:

```
50 Finag = imag(Y);
51 Pxx = (Real.*Finag);
52 Pyy = (Imag.*Finag);
53
54 Pyy = 2.0*(Pxx-Pyy)/N/SWS; % add the mirrored upper half of fxx
55 Pyy(1) = Pyy(1)/2; %DC
56 Pyy(1+N/2) = Pyy(1+N/2)/2; %Nyquist
57 count=count+1;
58 PyySum = PyySum+Pyy;
59 blockstart = blockstart+IADSOverlap;
60 blockend = blockend+IADSOverlap;
61
62
63 end
64
65 PyySum = PyySum/count;
66 PyySum = PyySum/(SR/N); %scale to PSD
67 % Graph the first half-1 points (the other half-1 points are redundant) on a meaningful frequency
68 f = SR*(0:N/2)/N;
69 subplot(2,1,1); stem(f,PyySum(1:1+N/2),'fill','ColorIndex',2,'Marker','square','MaxSize',4)
70 ylabel('IADS PSD')
71 xlabel('Frequency [Hz]')
72 axis([0 100 0 0.0 1])
73 title('Matlab vWelm01 Comparison with IADS PSD')
74
75 % W = spectrum(N);
76 % W = hamd(N);
77 % W = hamming(N);
78 % W = blackman(N);
79 % W = flatopdm(N);
80 % Octave doesn't like the format of these arguments...
81 [Pxx,P] = pwelch(X(1),W,SWS,IADSOverlap,N,SR); % use hann,hamming,blackman or flat top window - this re
82 subplot(2,1,2); stem(f,Pxx(1:1+N/2),'fill','ColorIndex',2,'Marker','square','MaxSize',4)
83 ylabel('Matlab PSD')
```

The workspace window shows the following table:

Name	Class	Dimension	Value	Attribute
PyySum	double	256x256	1.3967e+000, 1...	
PyySumCorrect	double	256d	18.1231e+011, 1...	
SR	double	1x1	200.14	
SWS	double	1x1	77.673	
W	double	256d	[-1.3876e-017, 3...	
WENBW	double	1x1	3.3831	
N	double	2000x2	16440, 0.844...	
IADSOverlap	double	1x256	8.6305e+004, 8...	
count	double	256x256	19.3647e+000 +... complex	
accuracy	double	1x1	0.8238	

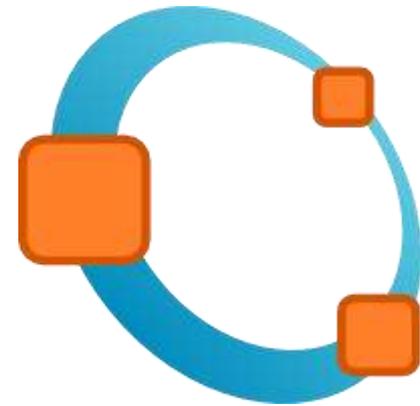
The Command History window shows the following commands:

```
exit
# Octave 4.0.0, Tue Aug 25 16:59:06 2015 Pacific Daylight Time - cyntony@SH-FRW@UIC
PSDComparison
stop OO
figure (1), plot (X)
PSDComparison
figure (1), plot (W)
```

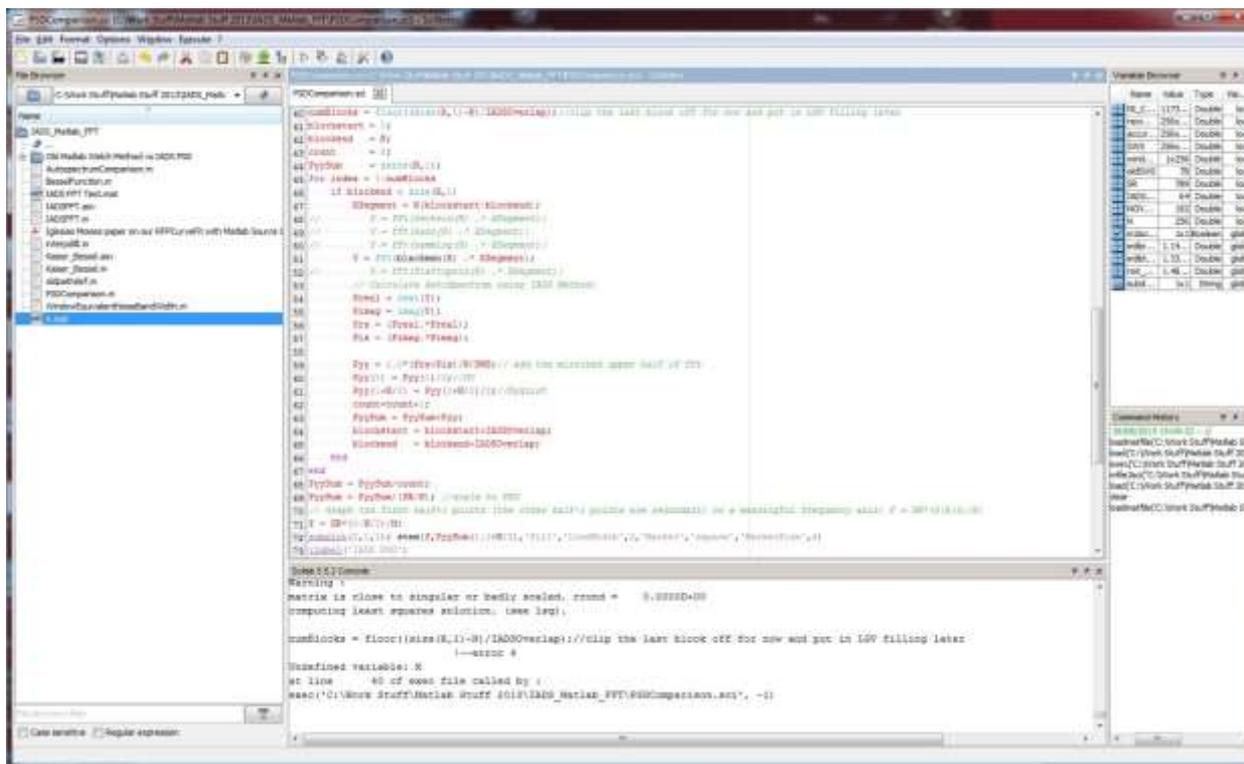
Octave's Modern Development Environment

Gnu Octave

- IADS Team evaluated Octave right after MATLAB was in use.
 - User Interface was cumbersome.
 - Windows installation package wasn't comprehensive.
- Modern Octave install with IDE warrants another evaluation.
- MATLAB and Octave are basically dialects.
 - MATLAB script can be dropped right in.
 - Some library manipulation necessary?



SciLab and Xcos



SciLab's Modern Development Environment

Scilab and Xcos

- IADS Team also tried Scilab right after MATLAB was in use.
 - User Interface was cumbersome.
 - Windows installation package wasn't comprehensive.
 - Syntax different enough to cause initial difficulty.
- Modern Octave install with IDE plus Simulink alternative Xcos warrants another evaluation.



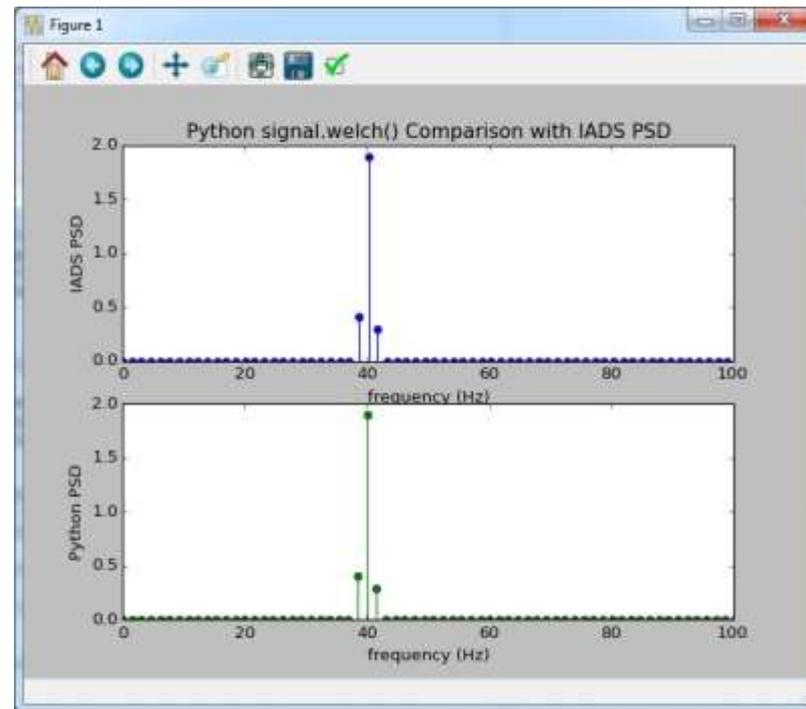
Python/SciPy/Matplotlib

- Anaconda install is comprehensive – Spyder IDE intuitive.
- Can be installed free on any Windows PC.
- Syntax different enough to cause initial difficulty like SciLab.
- Wide array of available libraries is incentive to push forward.
- Plots from Matplotlib look good.
- Wide industry acceptance is hard to ignore.
- Python also functions as a general-purpose programming language.



Practical Results with Python

- Working PSD and Autospectrum test script
- Working RFP Curve Fit test script
- Bessel Filter added to IADS using SciPy for test
- Collaboration with users that do not have MATLAB is possible
- IADS Group can trim MATLAB Subscription down to one License for data interface testing.



Python Downsides

- Must translate scripts for collaboration with MATLAB users.
- There is no Simulink “clone” in Python yet.
- Requires learning new syntax and array/matrix constructs.
- Requires translation of existing MATLAB-based tools.
- Not all MATLAB functions are supported in SciPy.
 - SciPy’s documentation lists everything available
 - New development is happening constantly.

Conclusions

- Python/SciPy are sufficient for the IADS Group to replace the MATLAB analytical capabilities used presently.
- Total elimination of MATLAB licenses is not possible or necessary for the IADS Group.
- Some combination of the open-source applications presented here may possibly completely replace MATLAB for many should the need arise.
- Python/SciPy Octave and SciLab are now serious, professional engineering analysis tools.

Contact Information

For further information regarding IADS contact:

Patrick Mattingly
Vice President
SYMVIONICS, Inc.
(661) 273-7003 x206
E-mail: pmattingly@symvionics.com

Commercially available product. Numerous contracting options are available to procure IADS, including GSA contracting vehicles.

**For more information about SYMVIONICS,
see our web site www.symvionics.com, or contact:**

Richard A. Weeks
Executive Vice President
SYMVIONICS, Inc.
(626) 585-0115
E-mail: rweeks@symvionics.com

IADS®