The Python Interface to Antelope

New Mexico Tech

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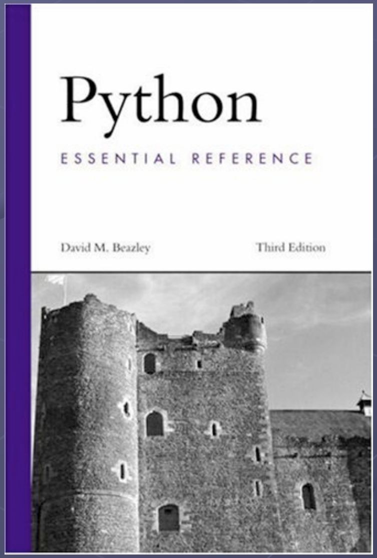
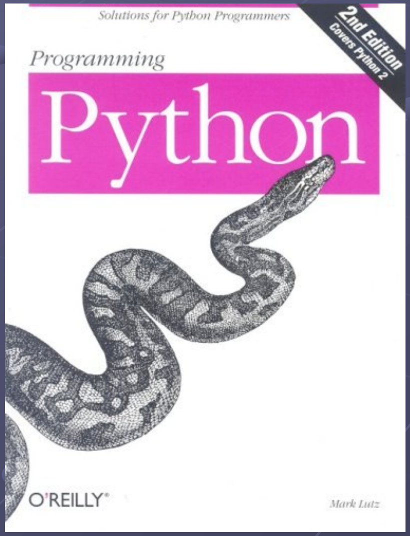
Acknowlegments

- PASSCAL authors who shared their beginnings
- Bob Busby and IRIS
- BRTT
- Frank Vernon, Rob Newman, Alex Clemesha (Array Network Facility)
- Ole Nielsen, Duncan Gray, Nariman Habili, Phil Cummins, Spiro Spiliopoulos (Geoscience Australia)

Antelope Python Interface

- Python: Object-oriented scripting language
  - http://www.python.org
  - Dynamic
  - Powerful
  - Extensible
  - Fast





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Antelope Programming

Create your own:

•Acquisition Programs
•Real-time Processes
•Utility programs
•Database applications
•Scientific projects
•GUI Interfaces
•Etc…

- BRTT Interfaces
  - C
  - Perl
  - TCL/Tk
  - Command-line
- Contributed Interfaces
  - Matlab
  - PHP
  - Java

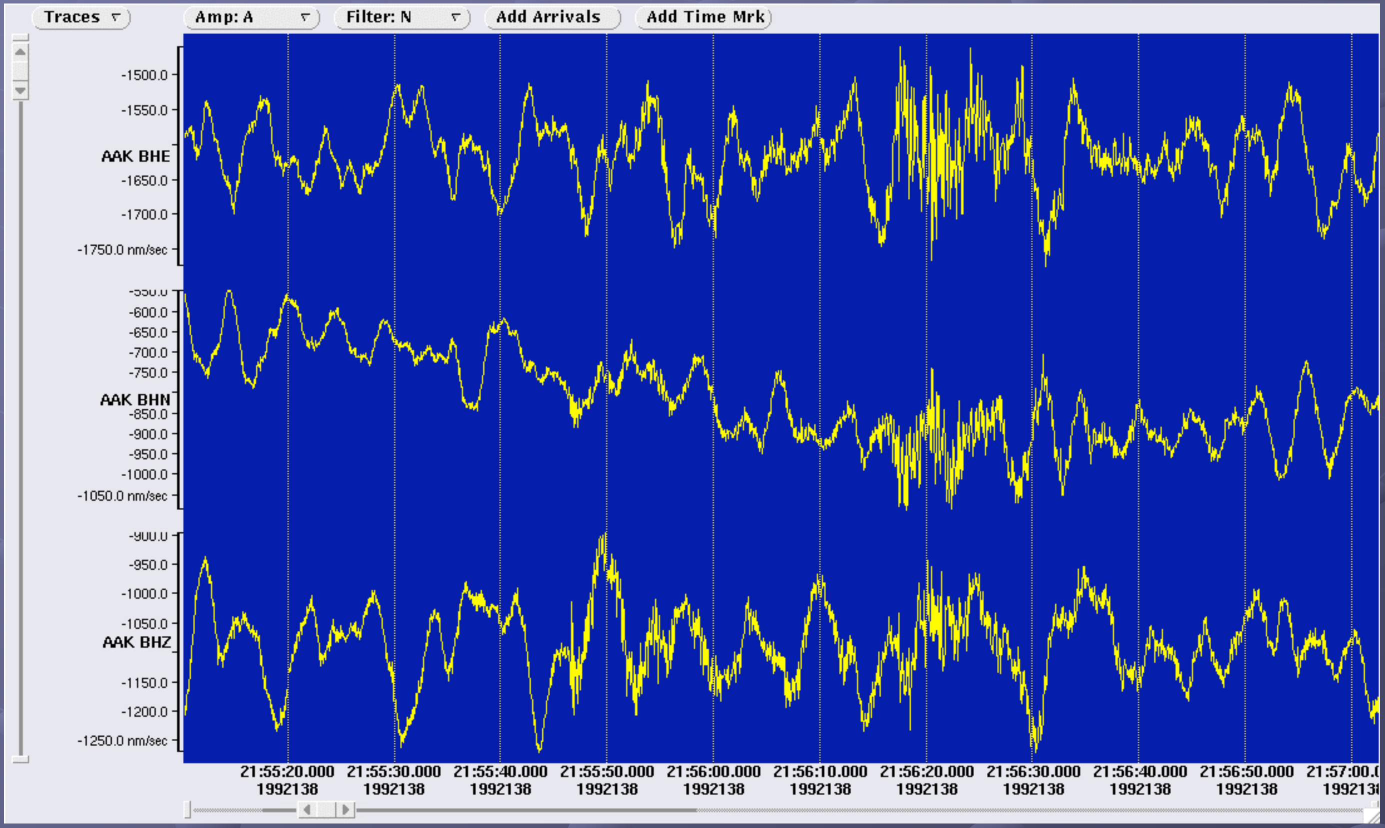
“About Python”

- Scripting language
- Created by Guido van Rossum, 1990’s
- http://www.python.org/about:
  - Very clear, readable syntax
  - Strong introspection capabilities
  - Intuitive object orientation
  - Natural expression of procedural code
  - Full modularity, supporting hierarchical packages
  - Exception-based error handling
  - Very high level dynamic data types
  - Extensive standard libraries and third-party modules for virtually every task
  - Extensions and modules easily written in C, C++ (or Java for Jython, or .NET languages for IronPython)
  - Embeddable within applications as a scripting interface

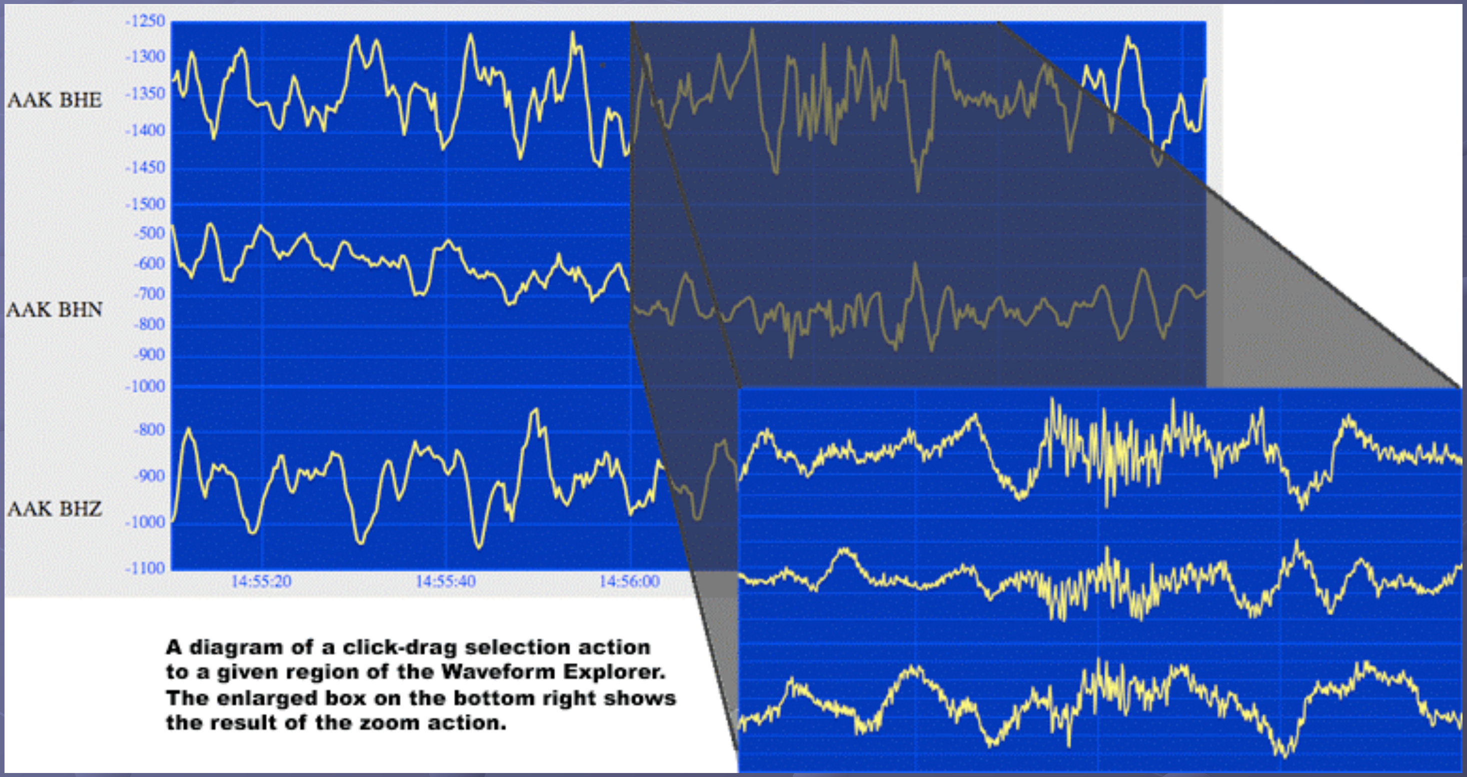
Why another Interface?

- Specific problem: Web-based waveform plotting
  - EarthScope Array Network Facility support (esp. field personnel)
  - Responsive web GUI
  - Interactive
  - Flexible and Extensible
  - Fastest robust path: accessibility of database data in Python
    - Powerful web capabilities
    - Matplotlib
    - Personnel experience

Model: dbpick emulation



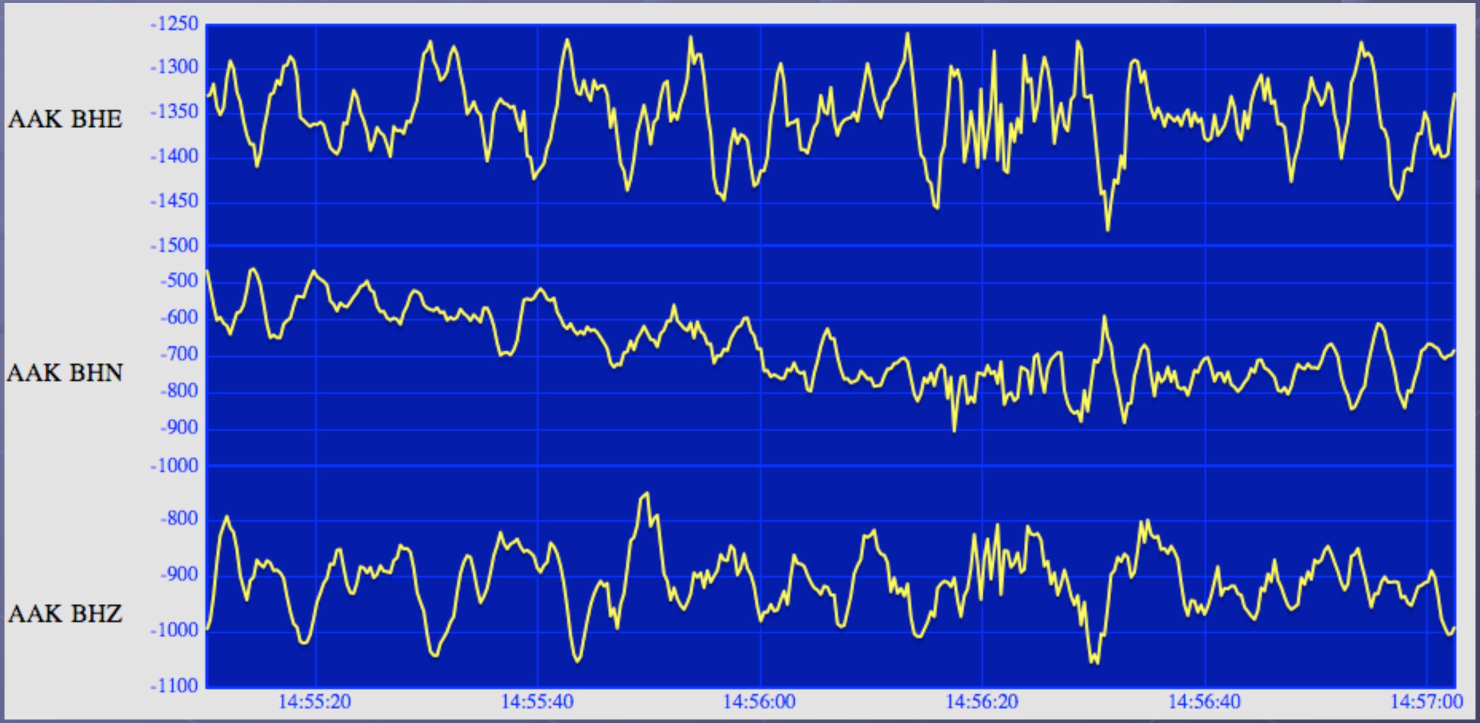
Web-based Interactive Waveform Display (Python)



A diagram of a click-drag selection action to a given region of the Waveform Explorer. The enlarged box on the bottom right shows the result of the zoom action.

development prototype courtesy
Alex Clemesha, UCSD

Waveform Explorer single-station focus



development prototype courtesy
Alex Clemesha, UCSD

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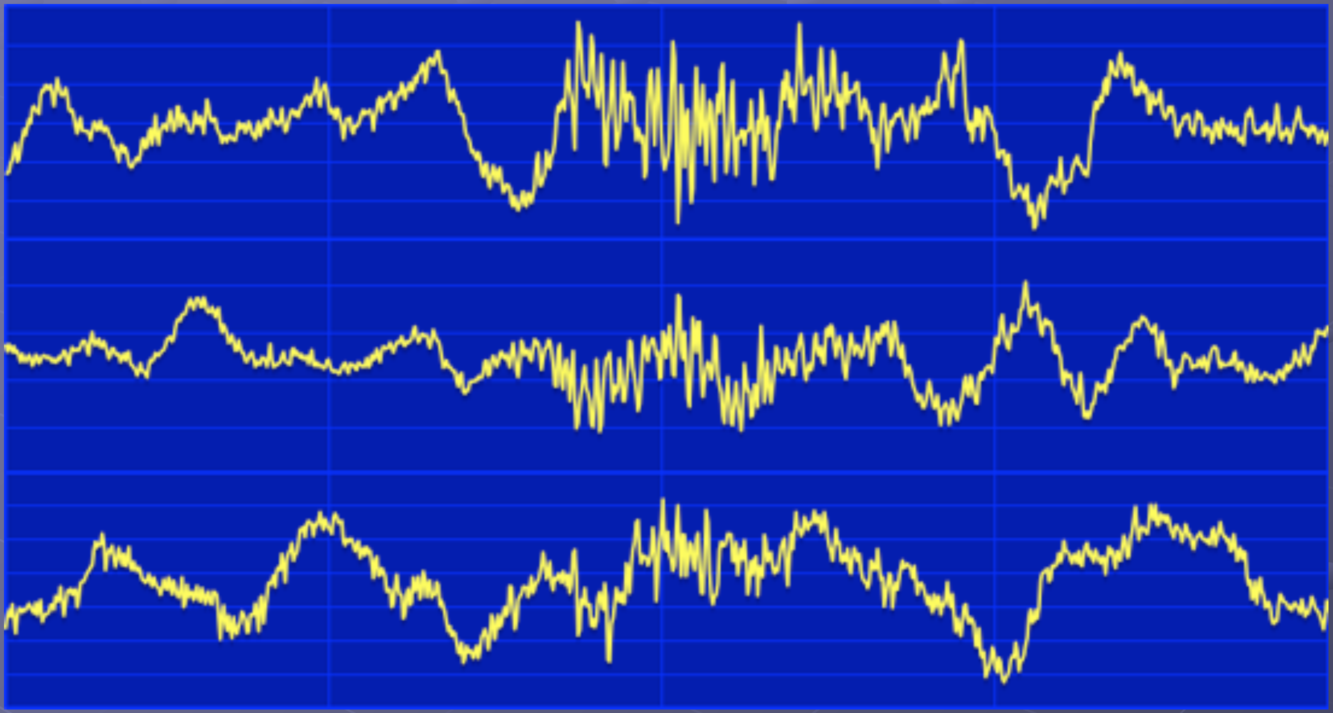
Waveform Explorer interactive zoom



development prototype courtesy
Alex Clemesha, UCSD

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Waveform server current status

- *dbwfserver* executable, in Antelope contributed-code repository
- Project now under leadership of Rob Newman (and Alex Clemesha, Juan Reyes) of UCSD group

Python Interface Characteristics

- Fairly uniform ‘look and feel’ across languages for Antelope APIs
  - Database pointers
  - Familiar functions
- Behaviors natural to each language
  - E.g. perl arrays / hashes, Matlab matrices
- Other interfaces implement subset of full C API
- Easy to do something quick; hard to do robustly, thoroughly, and faithful to language and API without glitches

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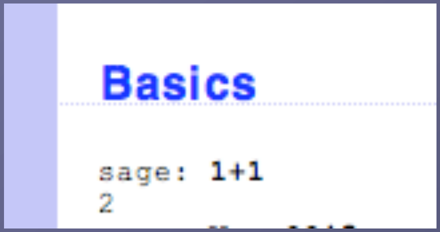
Approach

- Pyrex ?
  - Requires a separate ‘pyrex’ compiler
- SWIG (Simplified Wrapper and Interface Generator) ?
  - Requires external ‘swig’ tool to process interface files
  - Creates code hard to hand-tune
- Ctypes ?
  - Forces user to understand lots of the C interface
- “The hard way”
  - Properly balance C / Script interface boundary
  - Exact features of Antelope API (C)
  - “Look and Feel” of Python (Python wrappers)

First Efforts

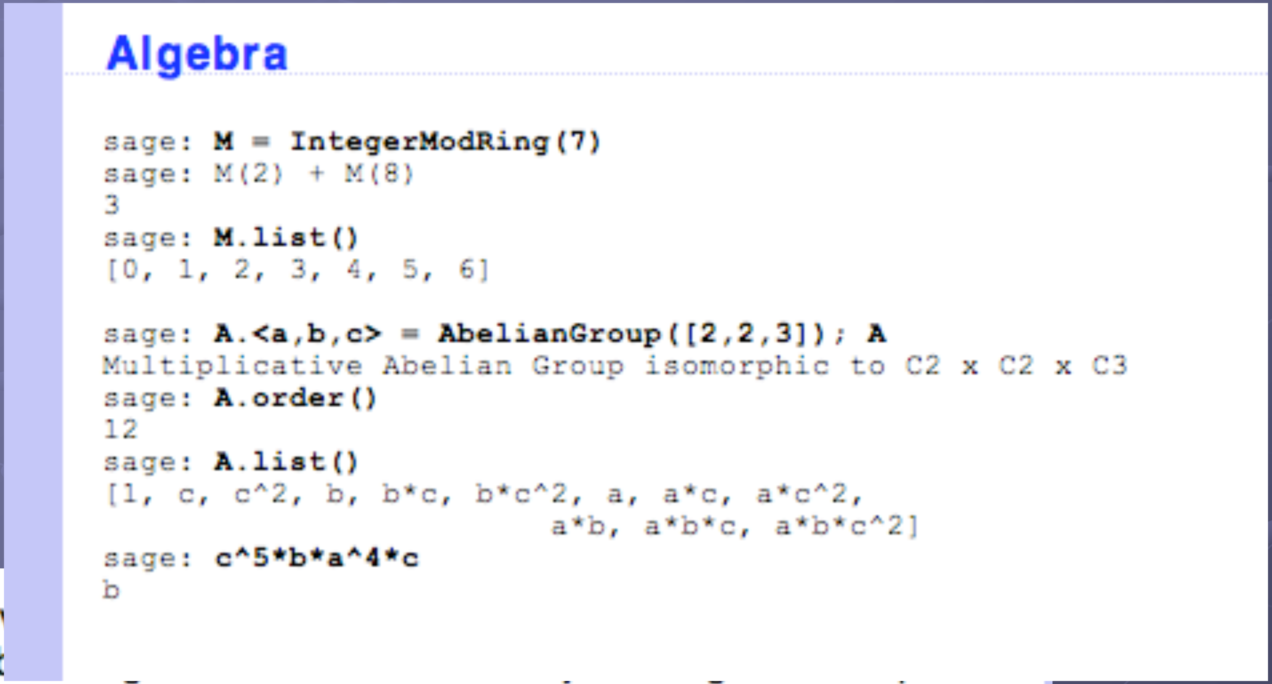
- SAGE
  - http://www.sagemath.org
  - Open-source Mathematics Software System
  - Built around a python interpreter
  - Large software collection, includes many Python packages esp. Matplotlib

SAGE examples



Basics

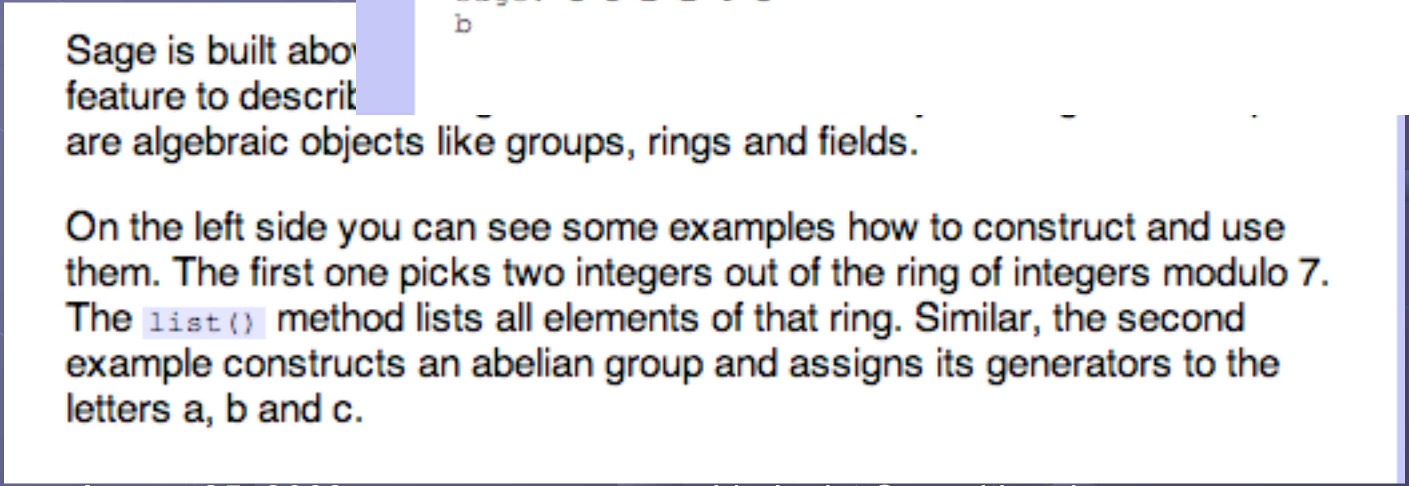
```
sage: 1+1
2
```



Algebra

```
sage: M = IntegerModRing(7)
sage: M(2) + M(8)
3
sage: M.list()
[0, 1, 2, 3, 4, 5, 6]

sage: A.<a,b,c> = AbelianGroup([2,2,3]); A
Multiplicative Abelian Group isomorphic to C2 x C2 x C3
sage: A.order()
12
sage: A.list()
[1, c, c^2, b, b*c, b*c^2, a, a*c, a*c^2,
                        a*b, a*b*c, a*b*c^2]
sage: c^5*b*a^4*c
b
```



Sage is built abo
feature to describ
are algebraic objects like groups, rings and fields.

On the left side you can see some examples how to construct and use them. The first one picks two integers out of the ring of integers modulo 7. The `list()` method lists all elements of that ring. Similar, the second example constructs an abelian group and assigns its generators to the letters a, b and c.

…Includes matplotlib

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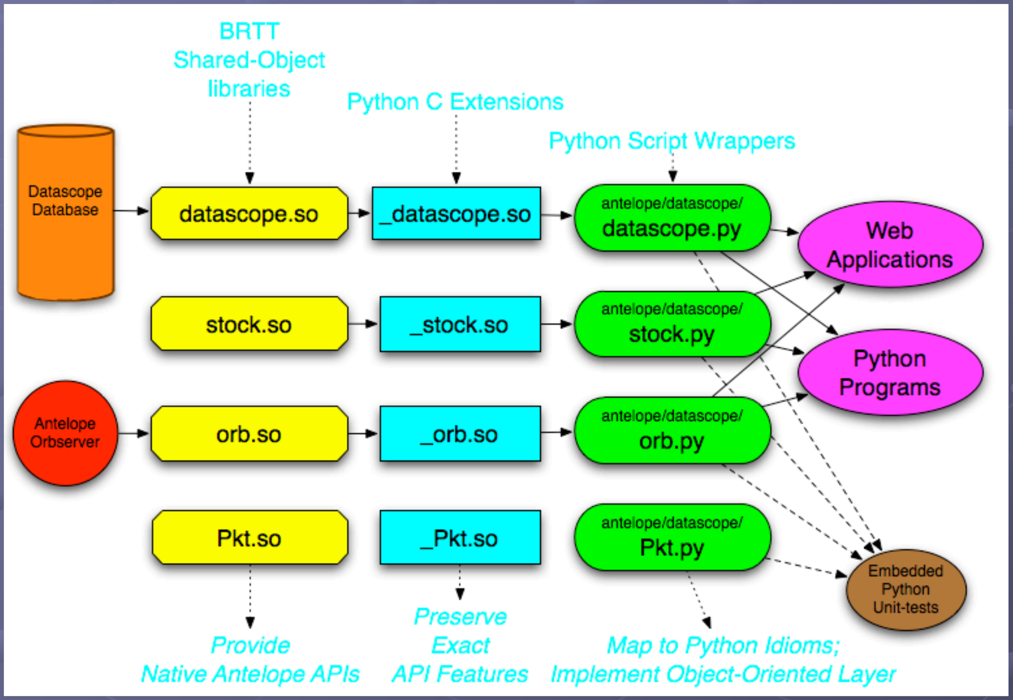
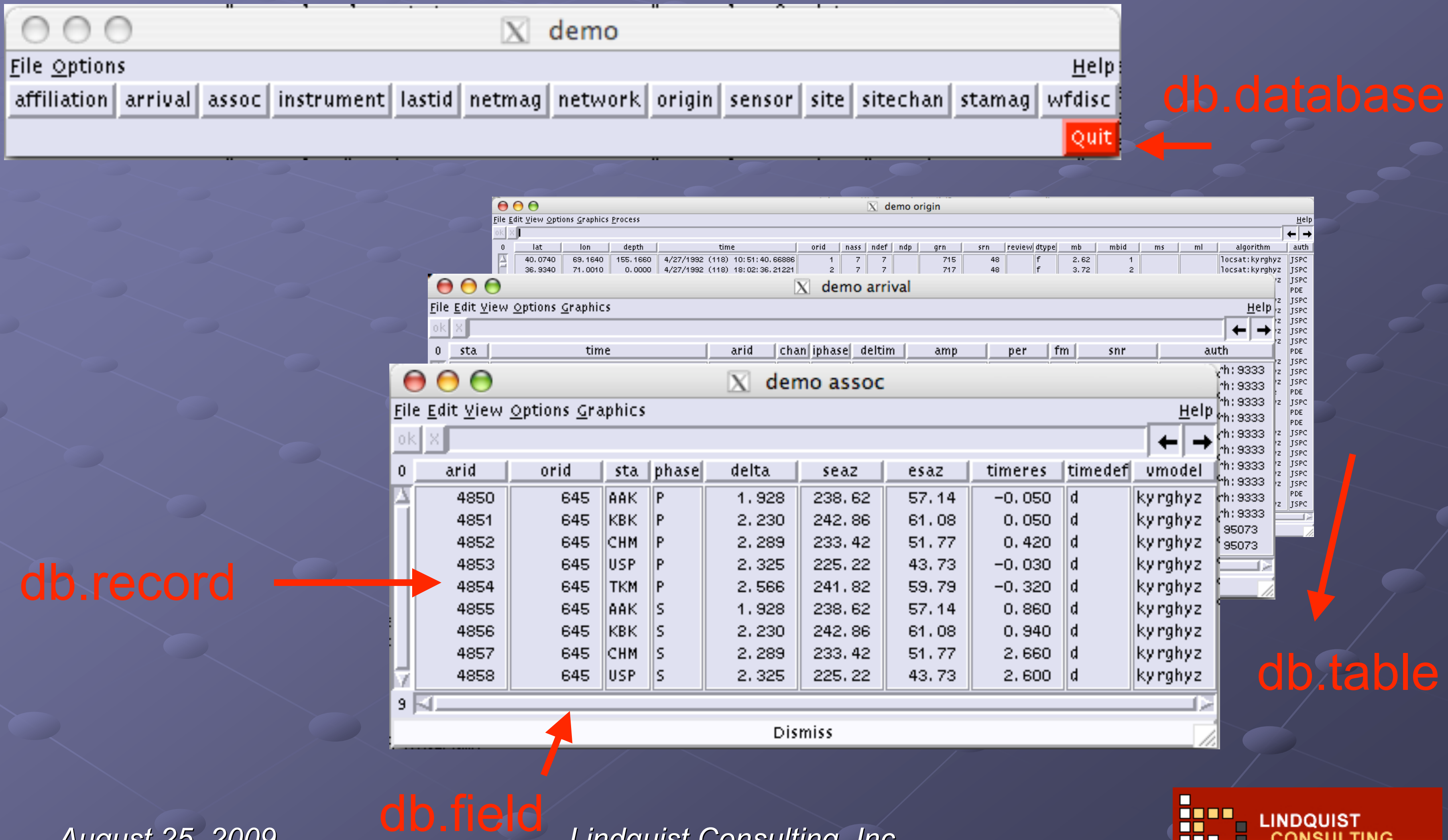
Python Interface Architecture


BRTT Shared-Object libraries
Python C Extensions
Python Script Wrappers
Datascope Database
datascope.so
_datascope.so
antelope/datascope/ datascope.py
Web Applications
stock.so
_stock.so
antelope/datascope/ stock.py
Python Programs
Antelope Orbserver
orb.so
_orb.so
antelope/datascope/ orb.py
Pkt.so
_Pkt.so
antelope/datascope/ Pkt.py
Embedded Python Unit-tests
Provide Native Antelope APIs
Preserve Exact API Features
Map to Python Idioms; Implement Object-Oriented Layer

Switching to Python

- Design class hierarchies
- Code indentation has syntactic meaning
- Quit putting semicolons everywhere

Datascope Database Pointers



lat	lon	depth	time	orid	nass	ndef	ndp	grn	srn	review	dtype	mb	mbid	ms	ml	algorithm	auth
40.0740	69.1640	155.1660	4/27/1992 (118) 10:51:40.66886	1	7	7		715	48		f	2.62	1			locsat:kyrghyz	JSPC
36.9340	71.0010	0.0000	4/27/1992 (118) 18:02:36.21221	2	7	7		717	48		f	3.72	2			locsat:kyrghyz	JSPC

sta	time	arid	chan	iphase	deltim	amp	per	fm	snr	auth

arid	orid	sta	phase	delta	seaz	esaz	timeres	timedef	vmodel
4850	645	AAK	P	1.928	238.62	57.14	-0.050	d	kyrghyz
4851	645	KBK	P	2.230	242.86	61.08	0.050	d	kyrghyz
4852	645	CHM	P	2.289	233.42	51.77	0.420	d	kyrghyz
4853	645	USP	P	2.325	225.22	43.73	-0.030	d	kyrghyz
4854	645	TKM	P	2.566	241.82	59.79	-0.320	d	kyrghyz
4855	645	AAK	S	1.928	238.62	57.14	0.860	d	kyrghyz
4856	645	KBK	S	2.230	242.86	61.08	0.940	d	kyrghyz
4857	645	CHM	S	2.289	233.42	51.77	2.660	d	kyrghyz
4858	645	USP	S	2.325	225.22	43.73	2.600	d	kyrghyz

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Python Database pointers

- Full-fledged Python ‘Type’ (sub-class of list) and Object
- Addressable attribute fields
  - db.record
  - Familiar to Matlab and C coders
- Implements sequence abstraction, subclasses Python lists
  - db[3]
  - Familiar to Perl coders
- Implements Python dictionary access
  - db[‘record’]
  - Familiar to Python coders

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Example function call: dbsubset of origin table

- C:
  - sprintf(expr, “orid == 645”);
  - db = dbsubset(db, expr, 0);
- Perl:
  - @db = dbsubset(@db, “orid == 645”);
- TCL/Tk:
  - set db [dbsubset $db ‘orid == 645’]
- Shell:
  - dbsubset demo.origin ‘orid == 645’
- Matlab:
  - db = dbsubset(db, ‘orid == 645’);
- PHP:
  - $db = dbsubset($db, ‘orid == 645’);

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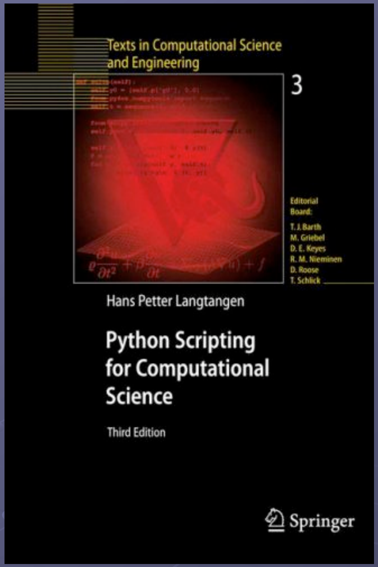
Python Method calls

- Procedural (class) methods
  - dbsubset(db, ‘orid == 645’)
- OO (instance) methods
  - db.subset(‘orid == 645’)
- Basic calls with familiar arguments
  - datascope.dblookup(db,’’,’origin’,’’,’’)
- Enhanced calls with Python idioms
  - dblookup(db, table=‘origin’)

Other advantages


Texts in Computational Science and Engineering

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Editorial Board: T. J. Barth, M. Griebel, D. E. Keyes, R. M. Nieminen, D. Roose, T. Schlick

Hans Petter Langtangen

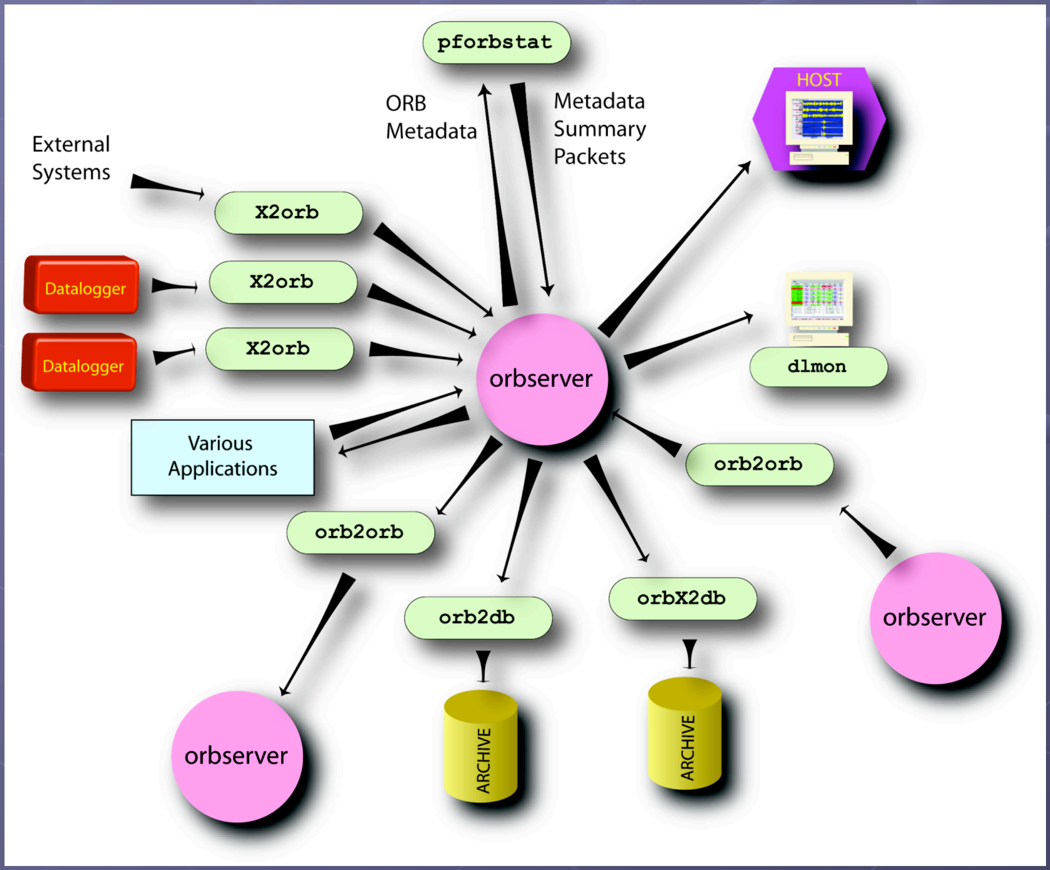
Python Scripting for Computational Science

Third Edition

Springer

- Lots of people use Python
- Scientific, Math, Computer-science and Graphics capabilities
- Object-oriented programming accessibility
  - Complementary to C++
  - Antelope object support in Python should surpass that in PHP, Perl
- unit testing capability
- It's fun

Pforbstat connectivity monitoring



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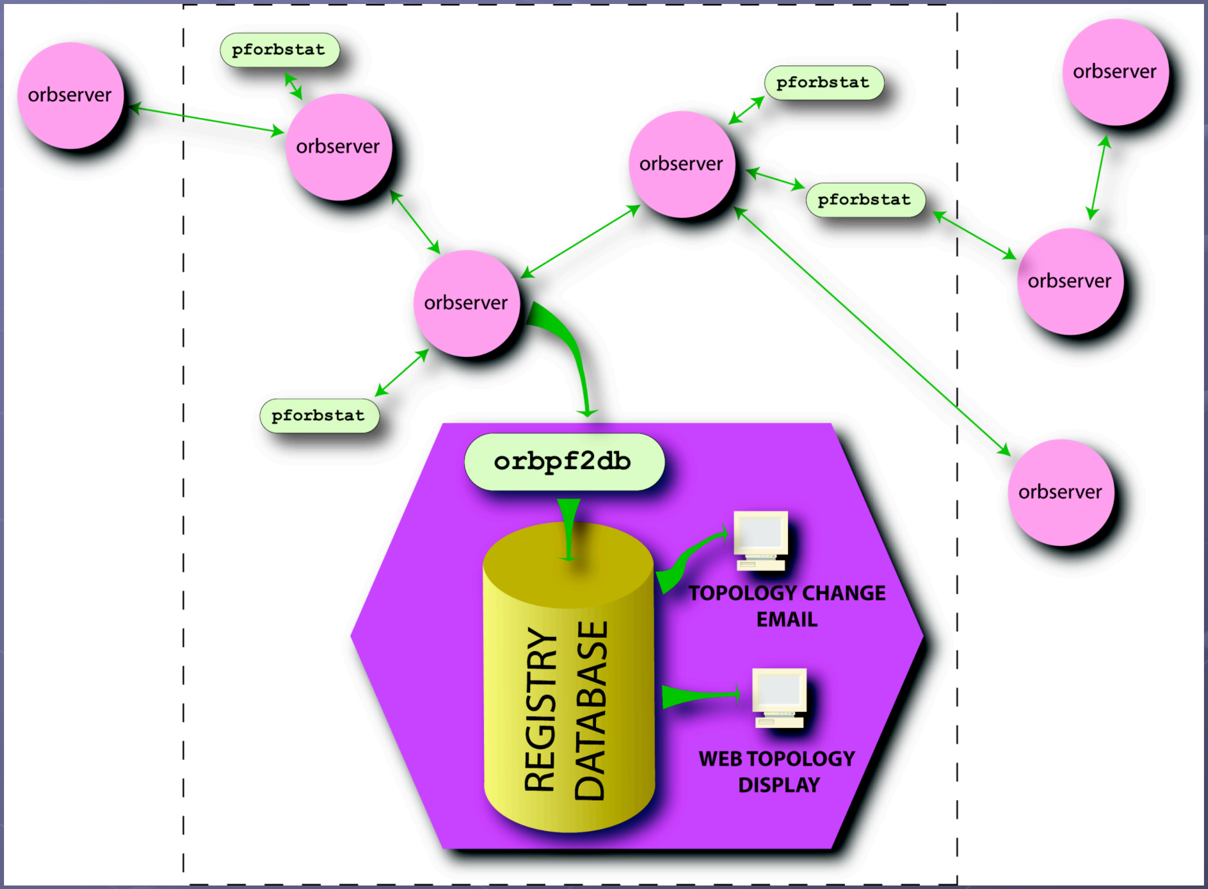
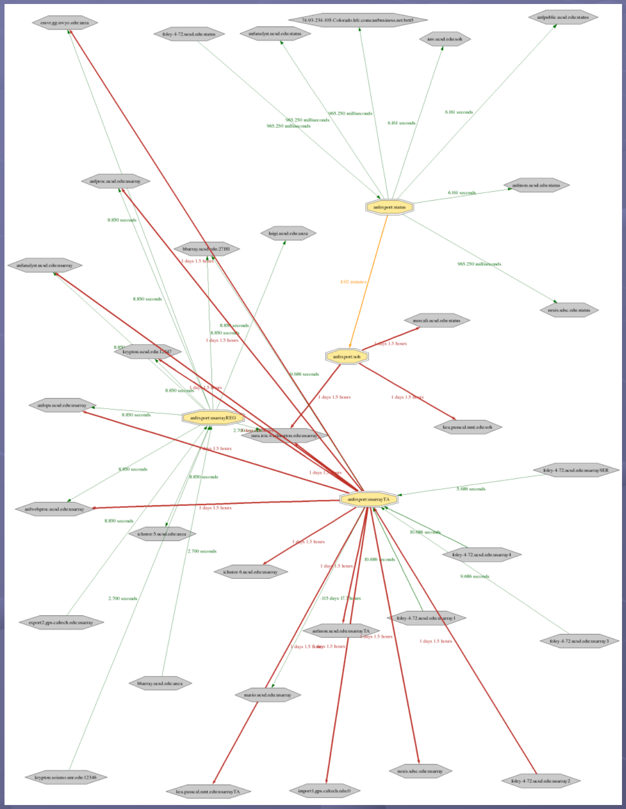
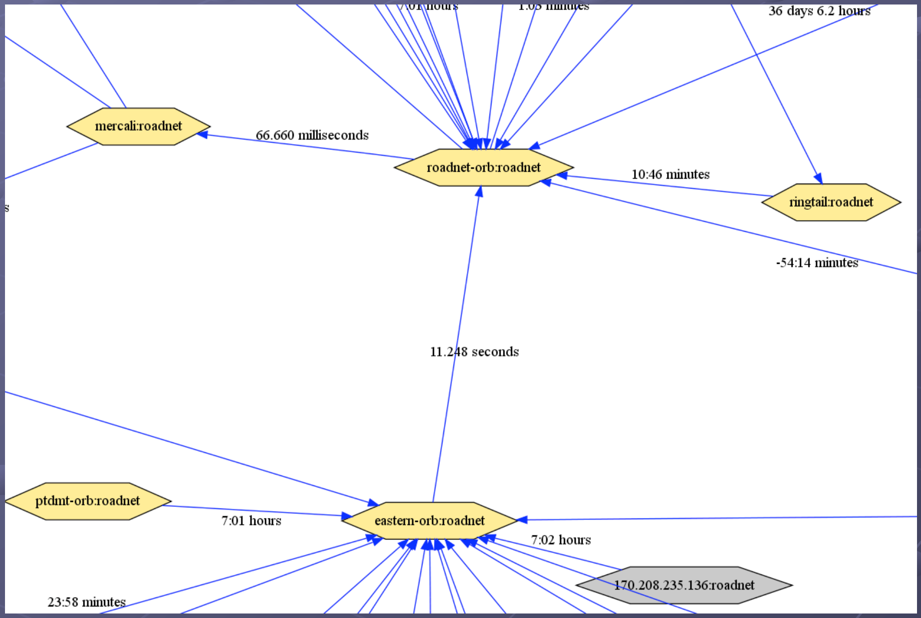
Pforbstat network overview



Directed-graph analysis of data-flow: 'orbtopo'





Current status

- Datascope interface solidified
  - Includes trace-library commands
  - Includes response-file support
- Libstock interface
  - Basic time handling
  - Parameter files
- Orb interface just finished
  - All normal orb interactions
  - Packet unstuffing through separate Pkt module
- 155 unit tests
  - Python unittest module
  - Also serve as examples of each command in use

Future Directions

- Newly established interface
- Watch for problems
- Watch for opportunities