Design and specifications for SLIM's software framework

Road map and progress

SLIM group at UBC EOS

August 2006

About

- Typical approaches to do seismic imaging
- Our way: Python OOP instead of scripting
- SLIM software distribution for SINBAD

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What is typically used?

- Seismic Tools
  - RSF, Seismic Unix, SEP, Delphi
- Higher-level languages like Matlab
- Scripting tools:
  - Unix shells, Perl, Python, etc.
  - Matlab, SCons

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What is the problem?

- Long-learning process - one has to learn a variety of tools and their specific details
  - Cumbersome and slow development using inadequate, often low-level programming tools
  - Implementation details hard-coded into the applications
- Low-level of abstraction and reusability
- Serial code

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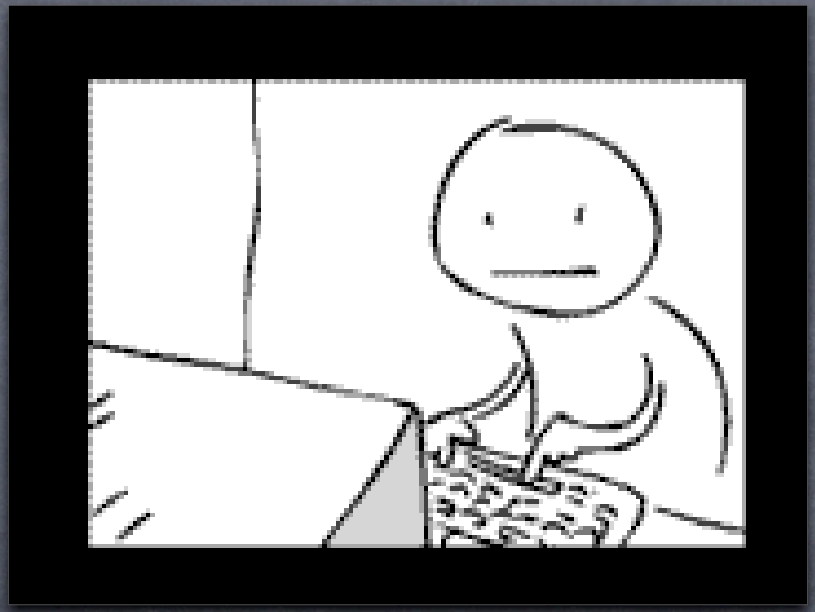

Typical developer / user

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How to avoid the tragedy?

ANAs

An ANA is a numerical algorithm that can be expressed abstractly solely in terms of vectors, vector spaces, and linear operators (i.e. not with direct element access).

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Seismic packages

- Similarities: sffdct2 < in.rsf > out.rsf (RSF)
  - out-of-core UNIX command-line operators
  - operations on UNIX pipes
  - ability to combine operators using UNIX pipes
  - serial
- Differences:
  - data formats

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Where do we go?

- Simplicity: y = A*x +b (Matlab/Mathematica)
  - Abstract Numerical Algorithms (ANA)
    - Vectors / Arrays
    - Operators (Matrices)
- Universality
  - hidden details of abstract objects/algorithms
  - hidden serial-parallel implementation
- Reusability

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How do we get there?
OO Abstraction

- Python object-oriented interface:
  - Abstract Data Types for seismic data
  - Abstract Operators for seismic-tools commands
  - Abstract Numerical Algorithms

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How do we get there? Implementation

- Python wrappers for Python/C++ interfaces to specific seismic-data formats (vectors)
- Python-interface wrapper for specific commands of seismic tools (operators)
- Above implementation details hidden from ANAs and the user
- Choice of serial or parallel algorithm

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"Where do we go" Benefits

- Faster learning curve
- Faster prototyping and development
- Easy implementation of new seismic tools
- Reusability
- Independent of software licenses

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Our tools of choice

- RSF (for seismic tools development)
- Python (for OO ANA/user interface)
  - NumArray for internal arrays
  - PyPar for parallel execution
- PETSc (for distributed overlapping data)

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Software development at SLIM

- Command-line operators (SLIM contribution to RSF)
- SLIMpy
  - OO Python interface to seismic packages
  - parallel algorithms for distributed data
    - involving data communication
    - embarrassingly parallel

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SLIM for SINBAD Software components

- CurveLab extension (CurevLab 2.0)
- Extensions to RSF (rev 1808)
- SLIMpy suite (OO Python interface to command-line based seismic tools)

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SLIMpy components

- core
- ANAs (algorithms)
- Applications
- Demos

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SLIMpy core

- Out-Off-Core objects with RSF support
  - serial
  - parallel
    - window decomposition
    - embarrassingly parallel
- In-Core objects

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SLIMpy core - cont.

- Support for other seismic packages
- Sparse matrix representation
- Differential operators
- Link to external solvers like Trylinos

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SLIMpy ANAs

- blocksolver.py: Primary-multiple separation through a block relaxation
- landweber.py: Generalized Thresholded Landweber
- Conjugate Gradient
- Least SQuares (linear) Regression (LSQR)
- Stage-wise Orthogonal MAtching Pursuit (STOMP)

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SLIMpy ANAs

- Ground Roll Prediction and Removal Through Morphological Component Analysis
- New detection-estimation Scheme:
  - Detection with Sparse spike De-convolution
  - Estimation with Image Appearance Manifolds (IAM)
- Seismic image recovery
  - Diagonal approximation of migration operator
- Wave-atom transform

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SLIMpy applications

- dnoise.py: 2D de-noising using Landweber method
- interpolation.py: 2D/3D interpolation using a sparsity constraint in a transform domain
- pm_separation.py: primary-multiple separation
- pm_separation_noise.py: primary-multiple separation with de-noising

All of above are included in SLIMpy demos

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Software distribution

- https://wave.eos.ubc.ca/Software/SINBAD/
  - SSL protected data transfer
  - Access for either:
    - users with password
    - designated IPs

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WARNING:

YOU are the beta tester

- SLIMpy is actively developed
- released version is only alpha tested
- there is a number of SLIMpy features that are under development
- only parts of the code that are used in ANAs , apps, and demos are tested

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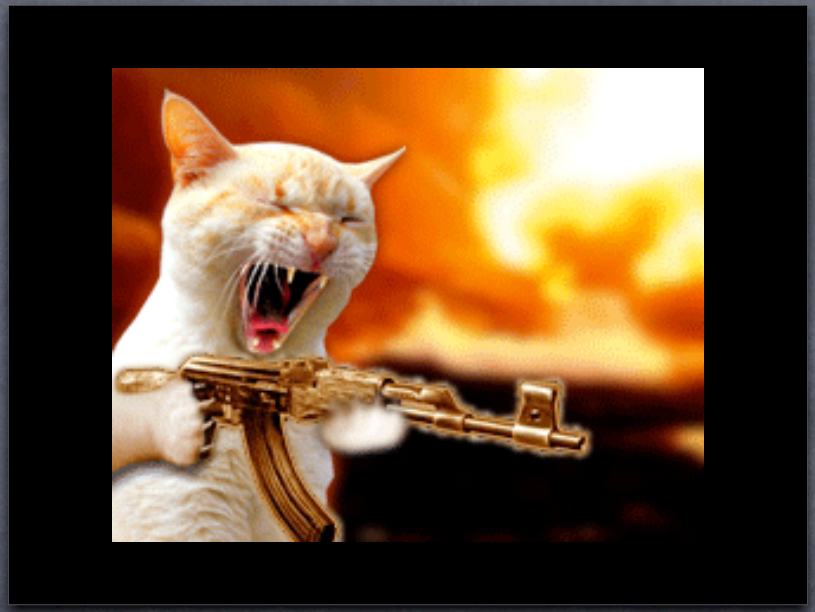
If you ever feel like that:



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Software support

- Mailing lists:
  - SLIM2RSF-user:
    - http://slim.eos.ubc.ca/mailman/listinfo/slim2rsf-user
  - SLIMpy-user
    - http://slim.eos.ubc.ca/mailman/listinfo/slimpy-user

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Summary

- SLIM software development paths:
  - new algorithms for seismic imaging
  - command-line based seismic tools
  - SLIMpy
- SLIM software distribution for SINBAD memebers

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