Software releases and architecture

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Outline

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Challenges

- Seismic applications are:
  - memory demanding
  - computationally intensive
  - IO intensive
  - we use large-scale-optimization iterative algorithms
- SLIM’s technology is driven by multi-d (d>2) non-separable transforms
- Academic environment calls for
  - code reuse & reproducibility
  - fast learning curves
Programming tools

- In-core computations:
  - **Matlab** and **Java**
  - **C/C++/FORTRAN** for low-level implementations

- Seismic tools for data input/output:
  - Seismic Unix, Delphi, **SegyMAT**, Madagascar (RSF)

- Scripting tools:
  - Unix shells, **SCons**, Python

- Parallelism
  - **MATLAB** and **Java** (for parallel IO)
Hardware

- Desktops (for small-problem prototyping)
- Cluster (for parallel development and computations
  - 288 CPU cores (Intel 2.66 GHz)
  - 16 TB of disk space
  - Funding:
    - contribution to initial purchase (2006)
    - departmental effort to upgrade (2009)
Students typically have already experience with MATLAB programming.

MATLAB introduced the capabilities that allow more efficient algorithm development:

- support for parallel computations
- support for distributed arrays/vectors
- MATLAB interfaces with other low-level languages

Our goal is to isolate students, as much as possible, from low-level programming.
MATLAB addresses our major challenges:
• massive parallel computations
• capability to handle large memory footprint
• faster learning curve (less software to learn)

Unfortunately MATLAB is not free
But there is vast amount of scientific software developed in MATLAB
Development in MATLAB

- There is still need to built or utilize efficient low-level routines and interface them with MATLAB, like:
  - 3D parallel curvelet transform
- Some of the existing MATLAB code is being converted or extended to allow parallel computations, like:
  - SPOT
  - SPGL1
- There is still need to implement utilities for out-of-core processing and data input/output
Development in MATLAB

- Current software projects:
  - SPOT extensions for parallel processing using pSPOT
  - pSPOT: parallel extensions to SPOT
  - both are subjects of the next presentations
Future projects:

- further development of pSPOT
- improvements to interfacing out-of-core data
  - investigating JavaSeis (www.javaseis.org)
  - improvements to RSF-MATLAB interface
- MATLAB implementation of parallel 3D curvelets
- nSPOT: non-linear extensions to SPOT
Programming staff (future)

- We intend to maintain 4 positions to accommodate:
  - part-time senior programmer
  - 2 full-time junior programmers
  - part-time system administrator
- Focus on supporting MATLAB development
Knowledge transfer

- Publications
- Software releases
  - algorithms
  - applications’ demos
- Webinars (monthly/bi-monthly)
  - presentations
  - software demonstrations
  - software tutorials
Past software releases

- **Software Highlights:**
  - [https://wave.eos.ubc.ca/Software/SINBAD/highlights/](https://wave.eos.ubc.ca/Software/SINBAD/highlights/)

- **Software Releases:**
  - [https://wave.eos.ubc.ca/Software/SINBAD/](https://wave.eos.ubc.ca/Software/SINBAD/)

- Accessible only to consortium members
  - (contact hmodzelelewski@eos.ubc.ca for access)
Past software releases
When:

- 1 release in 2006
- 2 releases in 2007
- 1 release in 2008
- 1 release in 2010
Past software releases:

Categories:

- Wavefield reconstruction
- Wavefield separation
- Modelling
- Imaging
- Solvers (ISTc, SPGL1)
- Transforms (Curevelets, Surfacelets, ...)

- see Web Pages for more details
Next software release

• We plan the next release in early 2011
• We intend to unify the software release as much as possible to:
  - clearly separate algorithms from applications
  - package together as many external software packages as possible
  - include automatic dependencies/unit tests
  - streamline installation and implementation of our software in the companies
Next software release

- We plan the next release in early 2011
- The software release will contain the following applications:
  - L1 migration with active contribution from surface-related multiples
  - Compress Sensing of Full-waveform inversion gradients
  - Curvelet Matched Estimation of Primaries via Sparse Inversion
  - Estimation of surface-related primaries with L1 inversion and informed blind deconvolution techniques (update)
  - ...

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Conclusions

We have:

• built a large software framework for seismic-imaging applications.
• implemented new algorithms in this framework.
• build a number of low-level tools to support those algorithms.
• successfully started efforts to introduce MATLAB as our main research and development environment.
We made a huge effort in streamlining/accelerating algorithm development and trying to allow researchers to focus on research rather than software development, and we wish to pursue this goal.

MATLAB offers an efficient alternative so do we are compelled to exploit it and use to our benefit.
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