GEOMIN 2015
4th International Seminar on
Geology for the Mining Industry

Acceleration of GSLIB package using multi-core and many-core processors

Oscar Peredo and Julián M. Ortiz

ALGES Lab, Advanced Mining Technology Center, Universidad de Chile

ALGES
ADVANCED LABORATORY FOR GEOSTATISTICAL SUPERCOMPUTING

amtc
ADVANCED MINING TECHNOLOGY CENTER

www.gecamin.com/geomin

Universidad Católica del Norte
ver más allá

GECAMIN
Conferences for Mining

ALGES

Research & Technology

Development

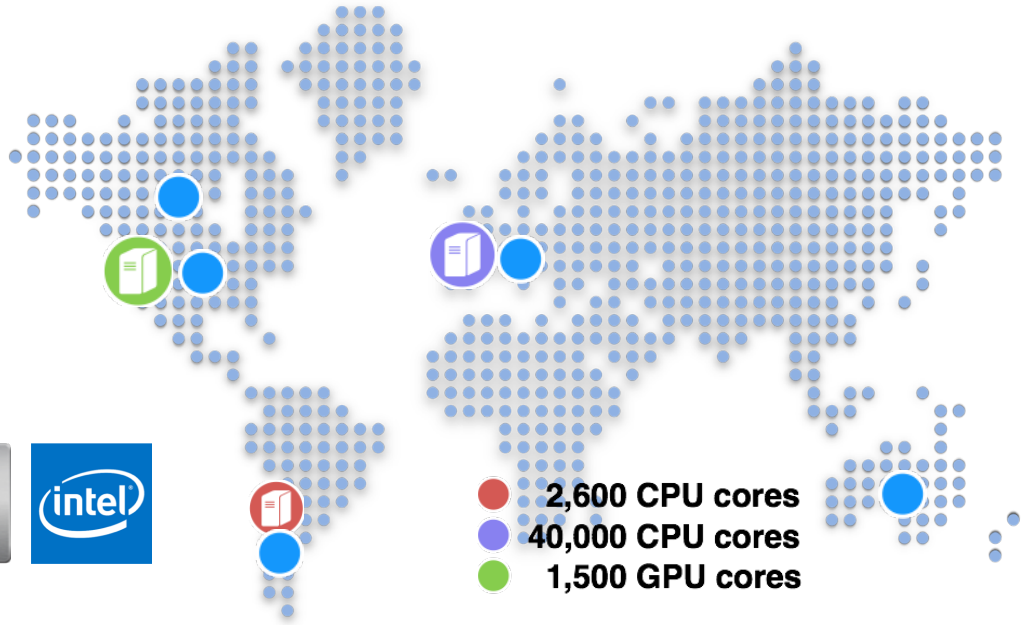
Supercomputing

98 international publications
- Geostatistics
- Parallel computing
- Stochastic simulation
- Software development

2 software licenses: U-Fo, U-Mine

38 graduates

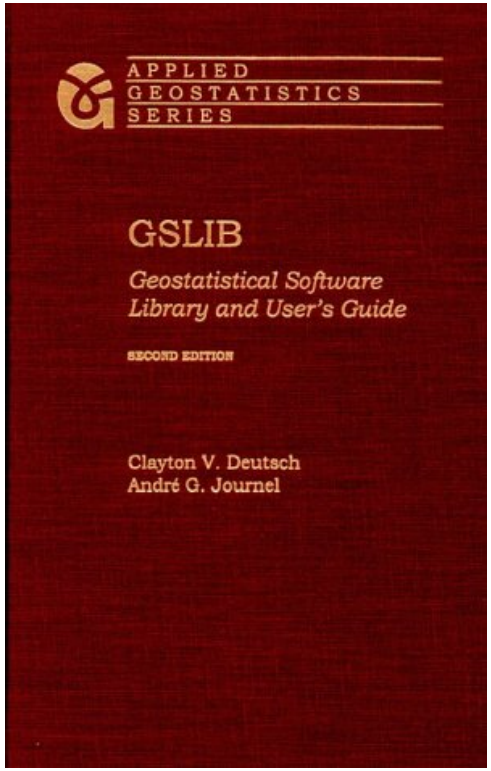
Teaching and training at U. Chile
- Resource evaluation
- Mining and Supercomputing
- Advanced Programming



http://www.alges.cl

GSLIB: Geostatistical Library package

- Open-source software package used by the geostatistical community for more than 30 years
- Developed by Deutsch & Journel at Stanford
- Implemented in Fortran 77/90 (Windows, Linux, Mac)
- Widely used by academics, researchers and practitioners.



Why accelerating the GSLIB?

- Some resource evaluation processes can take too many time to complete, making cumbersome the work for geologists and geostatisticians.

- Example:
  - Sequential indicator simulation (`sisim`)
  - 6 categories (lithologies), 108000 samples
  - Simulation grid of 16 million nodes
  - Time to obtain 1 simulation in a 2.2GHz CPU:
    - **80 minutes = 1 hour + 20 minutes**
  - Time to obtain 100 simulations in a 2.2GHz CPU:
    - **8000 minutes** = **5 days + 14 hours**

How can we accelerate the GSLIB?

Two alternatives:

- Alternative 1: Improved algorithms and methods.
- Alternative 2: Improved usage of computational resources in validated algorithms.

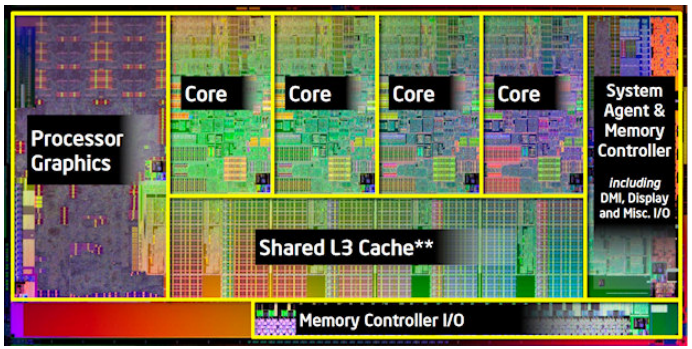
How can we accelerate the GSLIB?

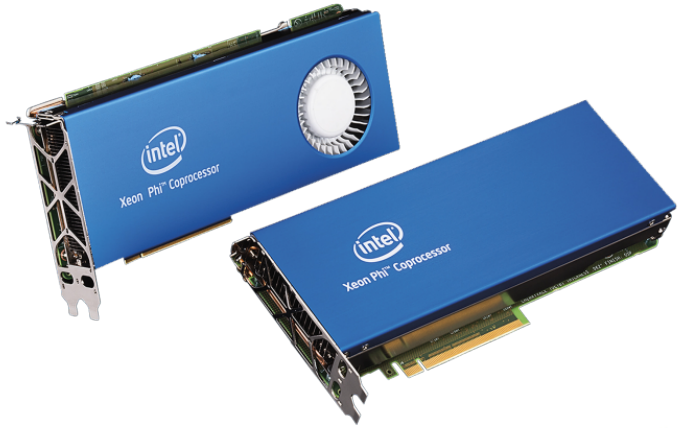
Two alternatives:

- Alternative 1: Improved algorithms and methods.
- **Alternative 2: Improved usage of computational resources in validated algorithms.**

Multi-core / Many-core technologies

- **Multi-core**: general purpose CPU with 4 to 20 cores of compute (Intel Core i7, AMD Opteron).
- **Many-core**: hardware devices with hundreds to thousands of compute cores (Nvidia Tesla, Intel Xeon Phi).

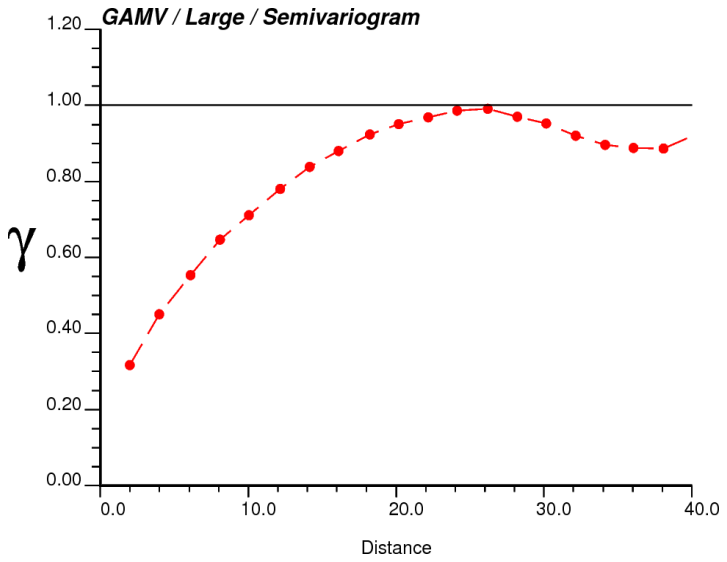




Case studies

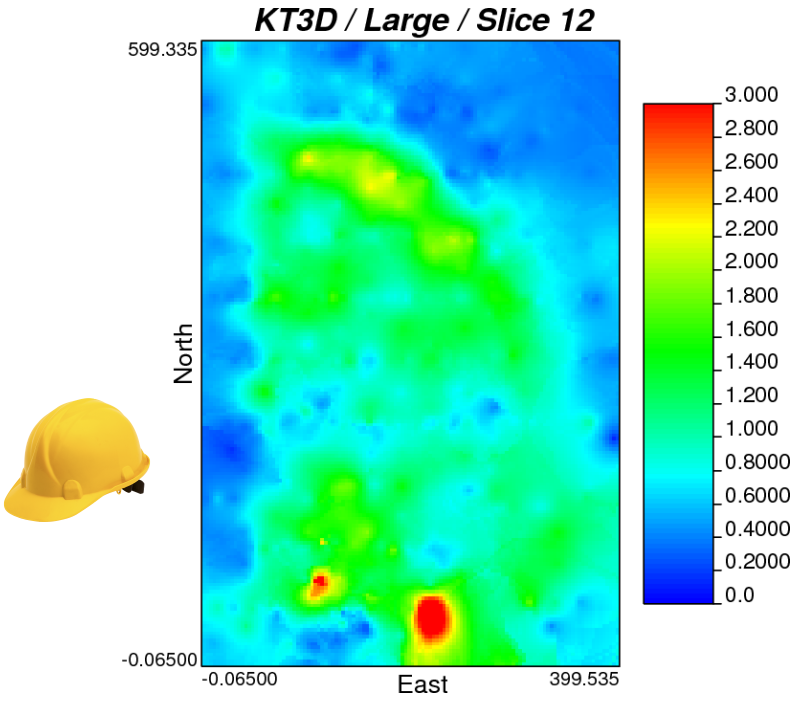
Variogram calculation

- Problem:
  - Traditional semi-variogram using 1 million 3D-located points of standardized Gaussian random field values (synthetic irregular dataset).
- Single-core: **35 min**
- Multi-core:
  - 16-cores CPUs: **35 sec (60x)**
- Many-core:
  - Nvidia Tesla c2075: **43 sec (48x)**
  - Intel Xeon Phi: **20 sec (105x)**



Kriging estimation

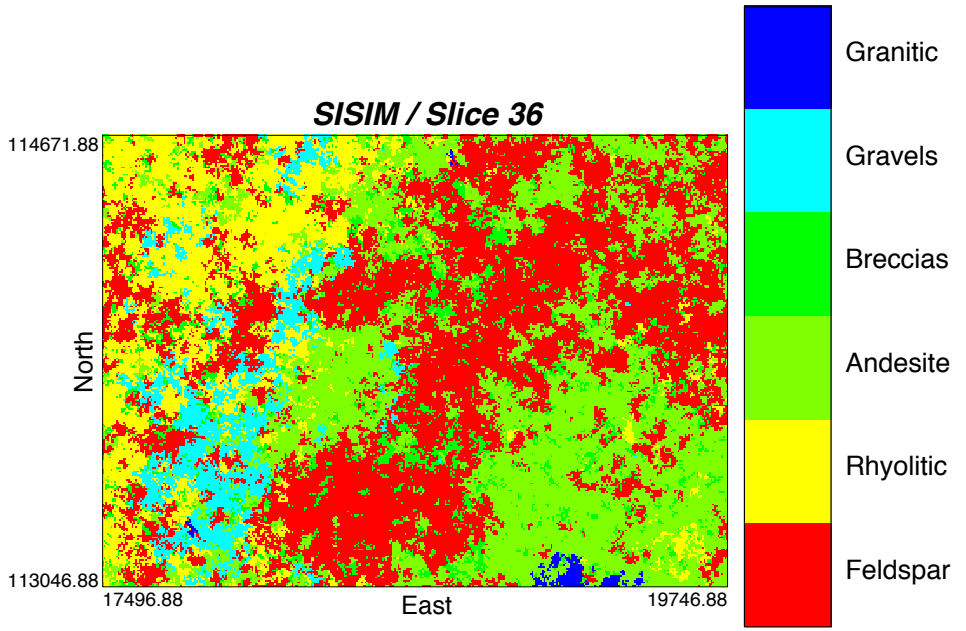
- Problem:
  - Simple kriging with 2376 drillhole copper grade samples in a grid of 12.4 million nodes (Rio Blanco – Los Bronces porphyry copper deposit)
- Single-core: **16 min**
- Multi-core:
  - 16-cores CPUs: **1.5 min (11x)**
- Many-core:
  - Nvidia Tesla c2075: not finished
  - Intel Xeon Phi: **3.5 min (4.6x)**



Sequential indicator simulation

- Problem:
  - SISIM 1 realization with 103650 drillhole copper grade samples in a grid of 15.7 million nodes (Escondida norte porphyry copper deposit)
- Single-core: **1 hour 20 min**
- Multi-core:
  - 16-cores CPUs:

    9.5 min (8.6x)
- Many-core:
  - not enough memory ☹



Conclusions

- New hardware technologies can be used combined with the legacy GSLIB package.
- Multi-core and many-core devices allow geologists and geostatisticians to accelerate the exploratory data analysis, estimation and simulation of mineral resources.
- Not all applications can benefit from these technologies: memory restrictions and challenging programming.

Where can I download the code?

- Currently, the code is being refactored to be readable and well-documented.
- Website:

  http://gslib.alges.cl/

- Check the website or contact the author if you are interested in the accelerated package (open-source, as the original GSLIB).
- We can help you and your organization to adopt these new technologies.

Thanks for your attention

Contact: Oscar Peredo
Email: operedo@alges.cl

Check out also
(A21) U-Fo: Software for Resource Estimation
in Prescence of Faults and Folds, 11:30am Ballroom B today