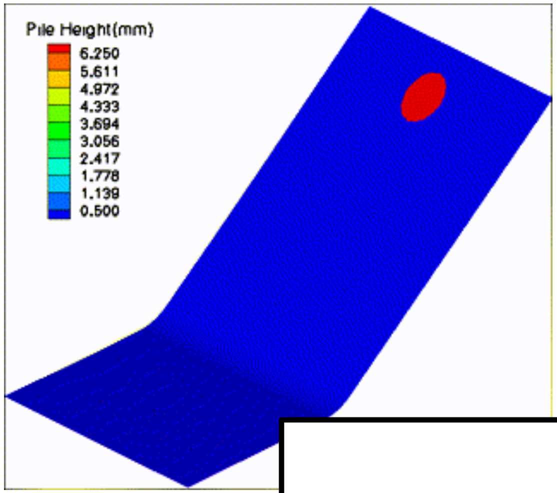

Integrating New Functionality Using Smart Interfaces to Improve Productivity of Legacy Tools

Modernizing Titan2d, Geoflow Simulation Software

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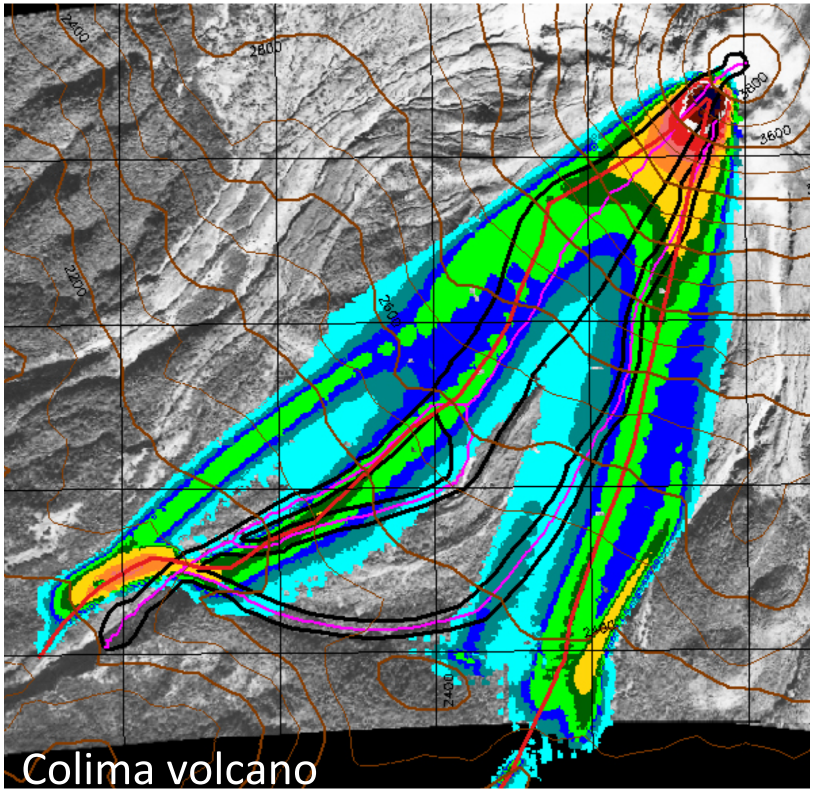
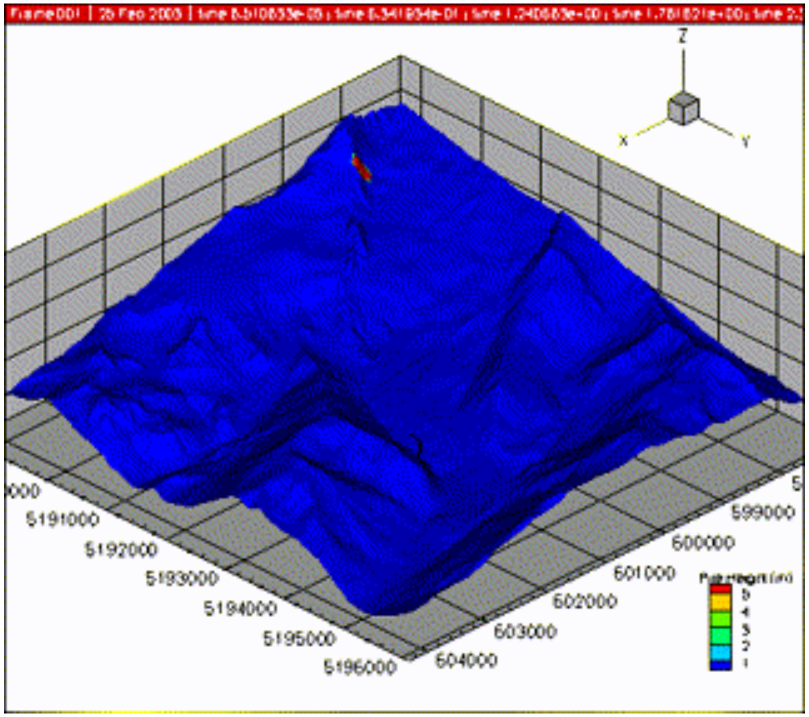
Titan2D - Geoflow Simulation Software



Colima volcano

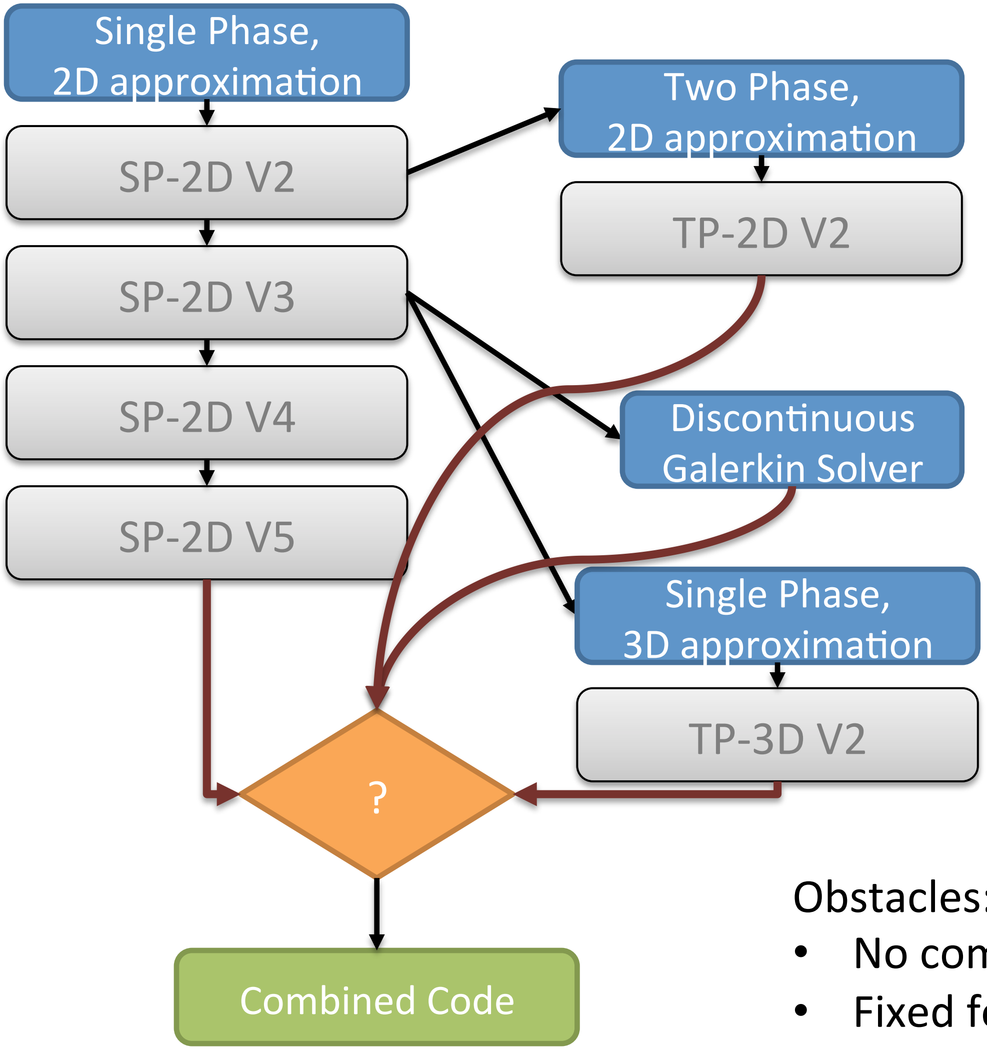
- Modeling of granular flows (geological mass flows such as debris avalanches and landslides) over digital elevation models (DEM)s of natural terrain.
- Risk assessment of hazards due to dry debris flows and avalanches

- Uses adaptive mesh refinement
- MPI Parallel



peak of Little Tahoma in Washington, USA

Forking without Version Control System. Restoring Single Code Base



Historically the code was forked to multiple version each developing new physical approximation or numerical methodology

Common version control system was not used due to:

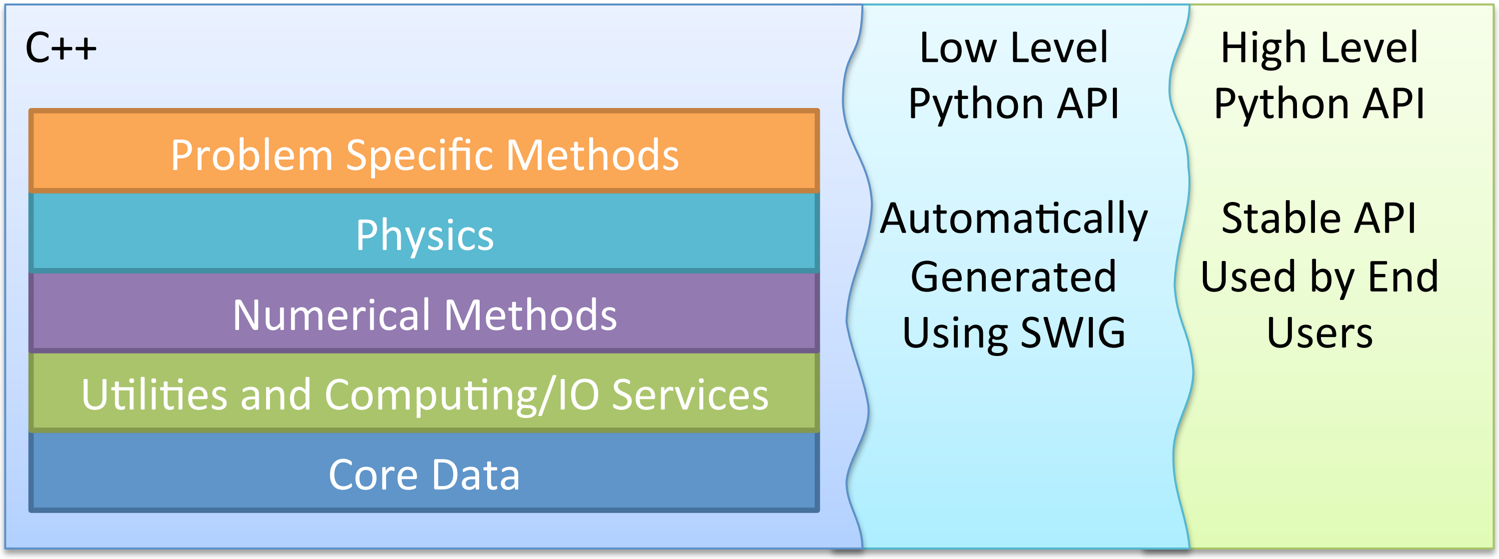
- Complexity of version control system of past
- Immediate research goals

Now we want to merge all forks to benefit from crosspollination of developed physical approximations or numerical methods.

Obstacles:

- No common version control system
- Fixed format of input files
- Many input values set as compilation flags
- Data layout difficult for utilizing modern technologies (vectorization, accellerators, etc.)

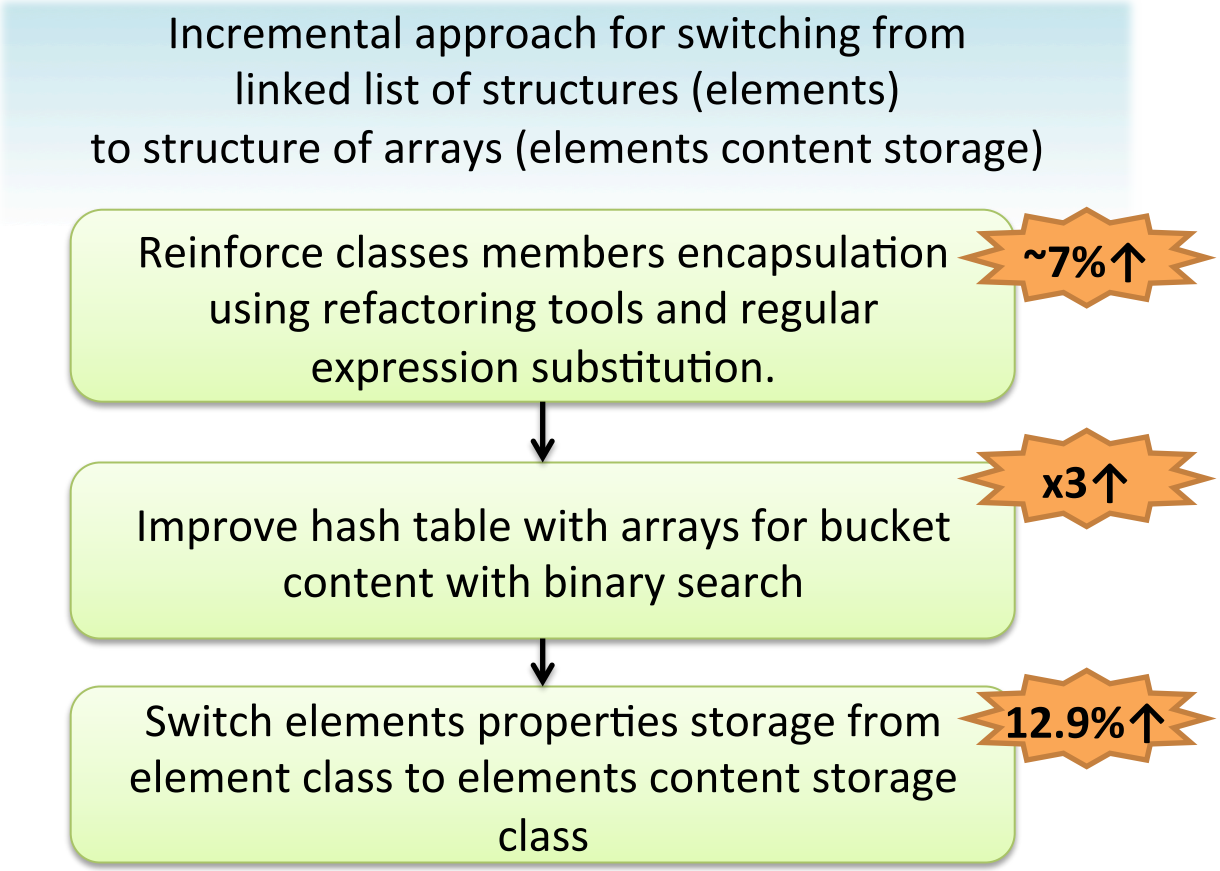
Reinforcing Code Structure



- Over the time code structure separation of was blurred
- Reinforcing the code layout should improve code merging process and performance optimization
- Two levels of python API
    - Automatic low-level generation with SWIG
    - Stable, long-life, high-level Python API
    - Flexibility to setup simulation

Data Layout Redesign

- Majority of modern CPUs and accelerators (GPU, MIC) benefit of usage of simple arrays (due to possible vectorization and memory access patterns).
- Titan2d was utilizing on demand allocated elements, accessed with hash table which uses linked list for buckets content. All elements properties was stored within element class.



Incremental approach for switching from linked list of structures (elements) to structure of arrays (elements content storage)

Reinforce classes members encapsulation using refactoring tools and regular expression substitution.

~7%↑

Improve hash table with arrays for bucket content with binary search

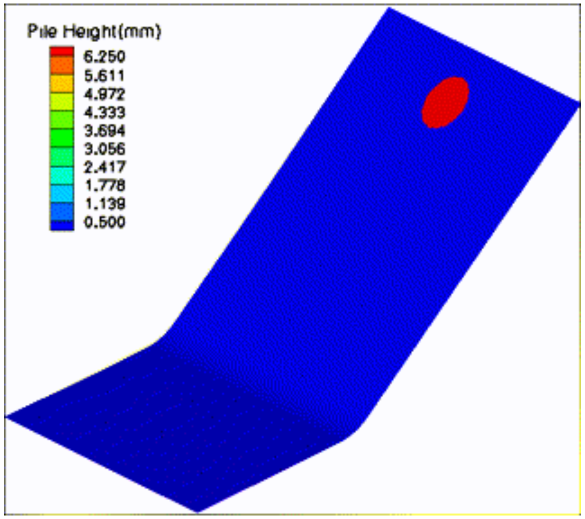
x3↑

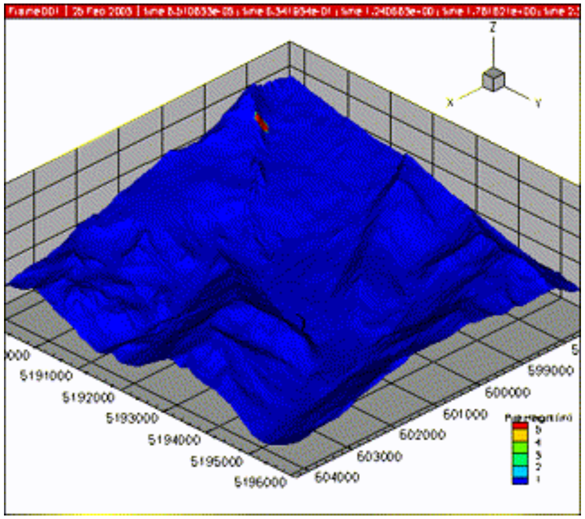
Switch elements properties storage from element class to elements content storage class

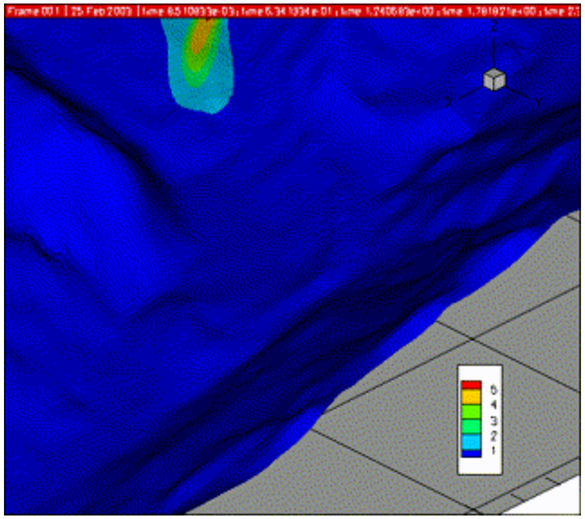
12.9%↑

- With new data layout we can exploit vectorization for further performance improvement
- New data layout simplify facilitation of accelerators (GPU, MIC)

Questions?







Titan2D Web site:

http://www.gmfg.buffalo.edu/

GIT repository:

https://github.com/TITAN2D