HPC Project Topics

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23.4.2020

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Educational Goals

- Improve your programming skills by doing a non-trivial project
- Focus on HPC methods

General Requirements

- 300 hours (10 ECTS)
- Can be done in alone or in groups up to 3 people (depending on topic)
- Runs until max. October
- At the end: report (8-10 pages) or presentation (15 min)

Topic 1: Numpy vs Mir

Project Goals

- Compare Mir (D library) and numpy (Python library) for numerical algorithms
- Test case geometric multigrid for Poisson equation
- Software quality norm https://www.iso.org/standard/35733.html
- More information:
- https://github.com/tastyminerals/mir_benchmarks
- https://tastyminerals.github.io/tasty-blog/dlang/2020/03/22/multidimensional_arrays_in_d.html
- https://jackstouffer.com/blog/nd_slice.html
- http://blog.mir.dlang.io/ndslice/algorithm/optimization/2016/12/12/writing-efficient-numerical-code.html
- https://wiki.dlang.org/Timing_Code

Specific Requirements

- Experience with C++ or D
- Experience with software development
- Basic knowledge in numerics

Topic 2: Meta-programming in D

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Project Goals

- Implement simple stencil DSL in D
- Similar to
  - https://pypi.org/project/pystencils/
  - https://www.exastencils.fau.de/
- Test case damped Jacobi method for Poisson equation
- More information:
- http://www.semitwist.com/articles/EfficientAndFlexible/SinglePage/
- https://wiki.dlang.org/User:Quickfur/Compile-time_vs._compile-time
- https://forum.dlang.org/post/rwejilrgpmrlopxmsovq@forum.dlang.org
- https://dlang.org/blog/2017/06/05/compile-time-sort-in-d/
- https://github.com/PhilippeSigaud/D-templates-tutorial/blob/master/D-templates-tutorial.pdf

Specific Requirements

- Experience with Python and C++ or D
- Basic knowledge in compiler technology
- Basic knowledge in numerics

Topic 3: Sparse coding

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Project Goals

- Compare dictionary learning and convolutional dictionary learning methods
- Used for imaging problems like denoising, deblurring or data compression
- Evaluation based on performance and image quality
- General library
  - https://github.com/bwohlberg/sporco
- Specific Implementation
  - https://link.springer.com/article/10.1007%2Fs10851-019-00919-7
  - https://github.com/hollerm/convex_learning

Specific Requirements

- Experience with Python
- Basic knowledge in linear algebra
- Basic knowledge in imaging

Topic 4: Starcraft simulator

Project Goals

- Evaluate Starcraft Learning environment
  - https://github.com/deepmind/pysc2
- Focus on balancing between races
- Builds upon Advanced Programming Techniques project
- Use genetic algorithm for build order optimization
- Replace own simulator by API
- Integrate measure for army strength based on real fights
- Additional Links
  - https://pypi.org/project/sc2simulator/
  - https://deepmind.com/blog/article/AlphaStar-Grandmaster-level-in-StarCraft-II-using-multi-agent-reinforcement-learning

Specific Requirements

- Experience with Python or C++
- Basic knowledge in Starcraft 2
- Previously attended AdvPT is highly recommended

Topic 5: Particle DSL

Project Goals

- Evaluate the parallel particle mesh environment for rigid body dynamics
  - https://wwwdb.inf.tu-dresden.de/misc/rosi_protected/11th_rosi_workshop/Nesrine_Khouzami_poster.pdf
- Software quality norm https://www.iso.org/standard/35733.html
- Test case Brazil nut effect
  - https://en.wikipedia.org/wiki/Granular_convection

Specific Requirements

- Experience with Java and C++
- Basic knowledge in compiler technology
- Basic knowledge in particle dynamics

Preparation for next meeting

What you should do

- Final topic selection and group formation
- Scheduling of project tasks
- Definition of milestones
- Next meeting in 2-3 weeks

Thank you for your Attention!

Questions?

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