02614

High-Performance Computing

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Course curriculum

Three modules:

- Serial tuning (week 1)
- Parallel computing with OpenMP (week 2)
- GPU computing with CUDA (week 3)

- Three projects – one per week

Course Overview – Topics

- Hardware basics: CPU, caches, memory
- Tuning of sequential programs
- Compilers, Debuggers, Analysis Tools
- Libraries
- Parallel computers – multi-core, SMP, clusters GPGPUs, etc
- Parallel Programming with OpenMP
- GPU computing with CUDA (and OpenCL)

Practicalities – I

- Lectures, exercises, project work, etc:
  - "*Every day*", 9 – 17
  - on-line lectures (Zoom)
  - on-line help during labs (more details later)
- Teachers (week 1 + 2):
  - Bernd Dammann <beda@dtu.dk>
  - Morten, Anders, Asbjørn & Marcus
  - members of the HPC team (Sebastian, Andrea, Hans-Henrik)

Practicalities – I (cont'd)

- more participants (week 2):
  - students from course 41391 will join us for week 2
- more teachers (week 3):
  - Hans-Henrik Sørensen <hhbs@dtu.dk>
  - Morten, Anders, Asbjørn & Marcus
  - members of the HPC team (Sebastian, Andrea, Bernd)

Practicalities – II

- Lecture notes:
  - will be made available on DTU Inside
- Exercises:
  - material on DTU Inside
  - access to DTU Linux computers via SSH or ThinLinc
- On-line updates:
  - last minutes info will be published on ~~Piazza~~ Redmine (or DTU Inside)
  - discussions on ~~Piazza~~ Redmine

Practicalities – III

Literature:

- Part I – Serial Tuning:
  - "Introduction to High-Performance Scientific Computing" by Victor Eijkhout, U of Texas and TACC – on-line available as PDF http://tinyurl.com/EijkhoutHPC
  - "Introduction to High Performance Computing for Scientists and Engineers", by G. Hager & G. Wellein, CRC Press (on-line via DTU Library), Chapters 1-8 relevant for this course
  - other relevant references will be made available during the course

Practicalities – III (cont'd)

Literature:

- Part II – OpenMP:
  - on-line references and articles
  - "Using OpenMP – portable shared memory parallel programming" by B. Chapman, G. Jost and R. van der Pas, MIT Press (2008)
  - "Using OpenMP – The Next Step" by R. van der Pas, E. Stotzer and C. Terboven, MIT Press (2017) (via DTU Library)
  - "The OpenMP Common Core" by T.G. Mattson, Y. He, and A.E. Koniges, MIT Press (2019)
  - Hager & Wellein (see week 1)

Practicalities – III (cont'd)

Literature:

- Part III – CUDA:
  - on-line references and articles
  - "CUDA by example", by J. Sanders & E. Kandrot, Addison-Wesley (2011)
  - "Programming Massively Parallel Processors", by David B. Kirk & Wen-mei W. Hwu, Morgan Kaufmann (2010)

Practicalities – IV

- Three assignments:
  - Groupwork: 3-4 students/group
    - Note: 1 student is NOT a group!
  - Assignment I: Serial tuning
    - deadline: Friday, January 8, 16:00 (!!)
  - Assignment II: OpenMP
    - deadline: Friday, Jan 15, midnight
  - Assignment III: GPU computing
    - deadline: Friday, Jan 22, midnight

Practicalities – IVa

- "Individualized reports":
  - each assignment has four sub-tasks
  - when handing in the reports, each group member has to take main responsibilty for one sub-task
  - this should be documented in an addendum to the report (we provide a template)
  - But ... remember: all group members should contribute equally to the work, and should know about all parts of the assignment!

Practicalities – V

Requirements for this course:

- Knowledge of at least one of these programming languages: C/C++ (or Fortran)
- Note: Python or MATLAB are not enough!
- Basic understanding of numerical computations
- The will to "play" with new tools and to explore new fields on your own.
- To be able to document what you have done.

Practicalities – VI

Computer usage:

- You are encouraged to use the DTU computer systems – at least for your “production runs”
- Especially needed in weeks 2 and 3, but make your first steps in week 1, already!
- Well defined environment – that is known to work
- Same environment for everybody
- Don't waste time to “roll your own”

Practicalities – VII

Lab exercises & projects:

- Please do the labs! They are the foundations for the projects/assignments
- Read the assignments carefully – and follow the instructions
- We do experiments, and our lab is the computer
- Describe your findings in a well written report – see the 'Assignment Guide' on DTU Inside

Practicalities – Group work

How to work in groups?

- You should work in groups of 3-4 students
- How you do this is up to you
  - choose your favourite online tool
    - Zoom, Teams, or Discord
  - or sit together (following the Corano rules!)
  - or ...
- Note: students are **not** allowed to enter buildings on DTU Campus!

Practicalities – Getting help

How to get help online?

- We have set up a ticket system with a queue
- Send us an e-mail: 02614@hpc.dtu.dk
  - short info about your problem (optional)
  - provide a link to your group's online session (mandatory) – this can be Zoom, Teams or Discord
  - one of us will join your session when it is your turn
- This is (almost) the same help we can provide when coming to your table on campus ...