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| Università<br>della<br>Svizzera<br>italiana | <b>Institute of<br/>Computing<br/>CI</b> |
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High-Performance Computing Lab

Institute of Computing

Student: Paolo Deidda

Discussed with: FULL NAME

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## Solution for Project 1

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**HPC Lab — Submission Instructions**  
(Please, notice that following instructions are mandatory:  
submissions that don't comply with, won't be considered)

- Assignments must be submitted to iCorsi (i.e. in electronic format).
- Provide source files (e.g. C/C++ files, Matlab). If you are using libraries, please add them in the file. Sources must be organized in directories called:  
*Project\_number\_lastname\_firstname*  
and the file must be called:  
*project\_number\_lastname\_firstname.zip*  
*project\_number\_lastname\_firstname.pdf*
- The TAs will grade your project by reviewing your project write-up, and looking at the implementation you attempted, and benchmarking your code's performance.
- You are allowed to discuss all questions with anyone you like; however: (i) your submission must list anyone you discussed problems with and (ii) you must write up your submission independently.

In this project you will practice memory access optimization, performance-oriented programming, and OpenMP parallelization on the Rosa Cluster .

### 1. Rosa Warm-Up

(5 Points)

1. The **module system** is a utility that allows the user to dynamically manage their software environment on the Rosa HPC cluster and to load different compilers, libraries and applications in order to modify environment variables (like PATH, LD\_LIBRARY\_PATH, MANPATH, etc.) without creating conflicts between different software versions or dependencies.

As reported in the USI resource page the module system provides several commands to manage the environment.

- `module avail` – lists all available modules (on the current system)
- `module list` – lists all currently loaded modules
- `module show` – display information about
- `module load` – loads module
- `module switch` – unloads, loads
- `module rm` – unloads module

- `module purge` – unloads all loaded modules
2. The **Slurm** (Simple Linux Utility for Resource Management) is a job scheduler for Linux clusters. Main features of Slurm are:
- Job scheduling and resource management
  - Framework for starting, executing, and monitoring work (jobs) on a set of allocated nodes
  - Queuing management to handle multiple users and jobs

The two main components are:

- *slurmd*: the daemon that runs on each compute node responsible for launching, monitoring, and terminating jobs
- *slurmctld*: the central management daemon that manages job queues and allocates resources

Main commands:

- `srun`: submit a job for execution
- `sbatch`: submit a batch job
- `squeue`: view the status of jobs in the queue
- `scancel`: cancel a job
- `salloc`: allocate resources for an interactive job

3.

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| <b>2. Performance Characteristics</b>                  | <i>(30 Points)</i> |
| <b>3. Optimize Square Matrix-Matrix Multiplication</b> | <i>(50 Points)</i> |
| <b>4. Quality of the Report</b>                        | <i>(15 Points)</i> |