CentraleSupélec

Feedback from a data center for education at CentraleSupélec engineering school

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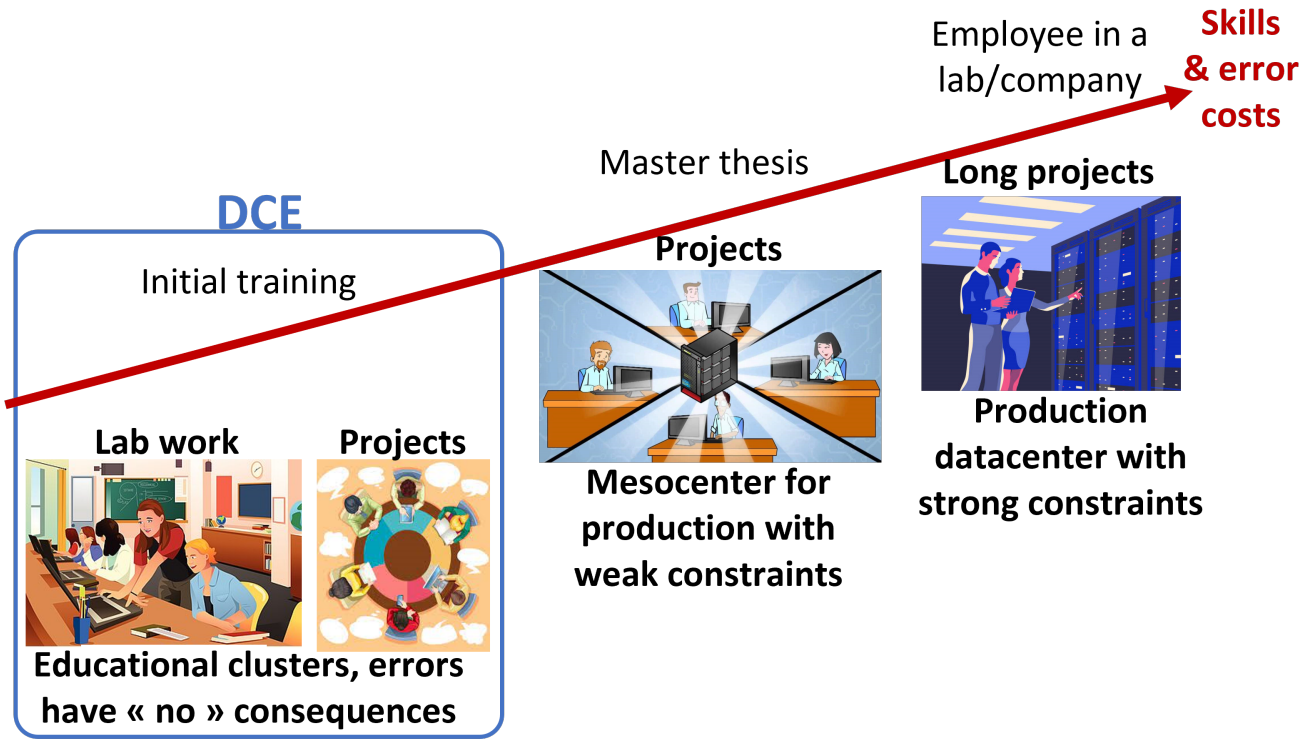
IPDPS - Edupar Workshop 2022

Motivations



For teaching, for beginners

- powerfull shared computing resources

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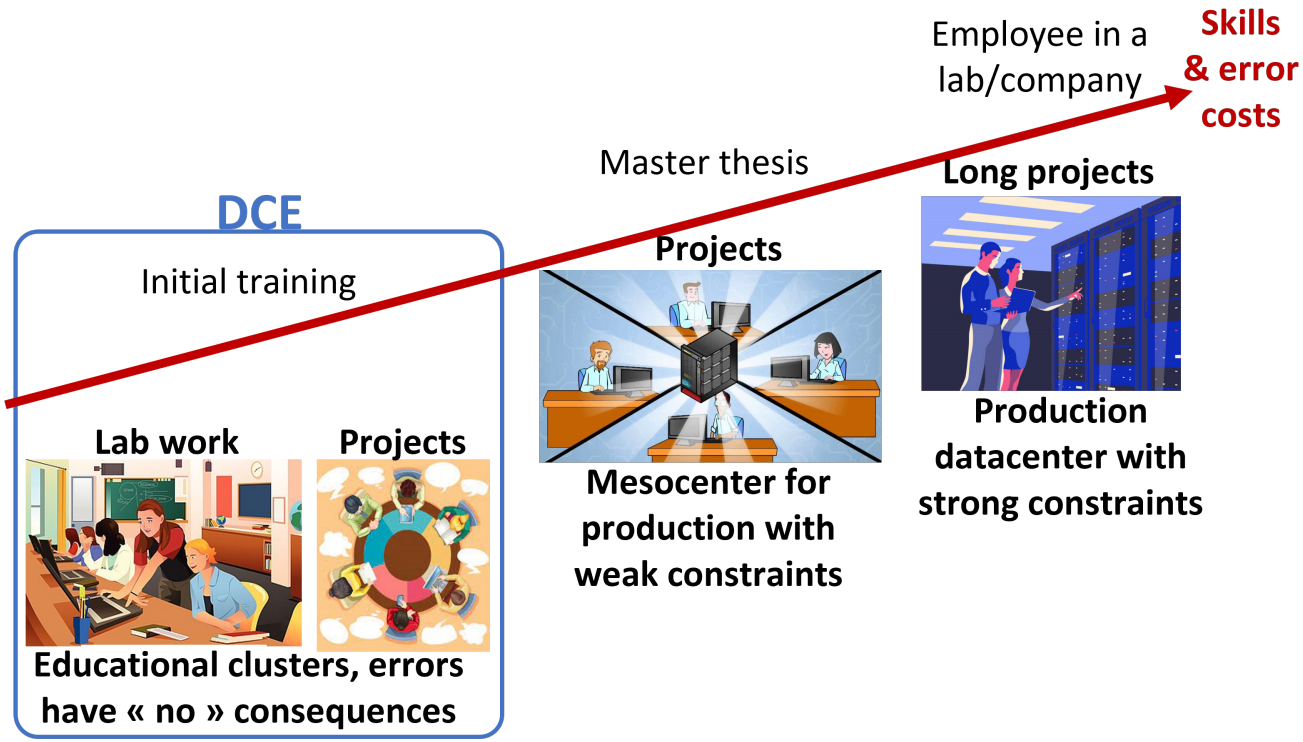

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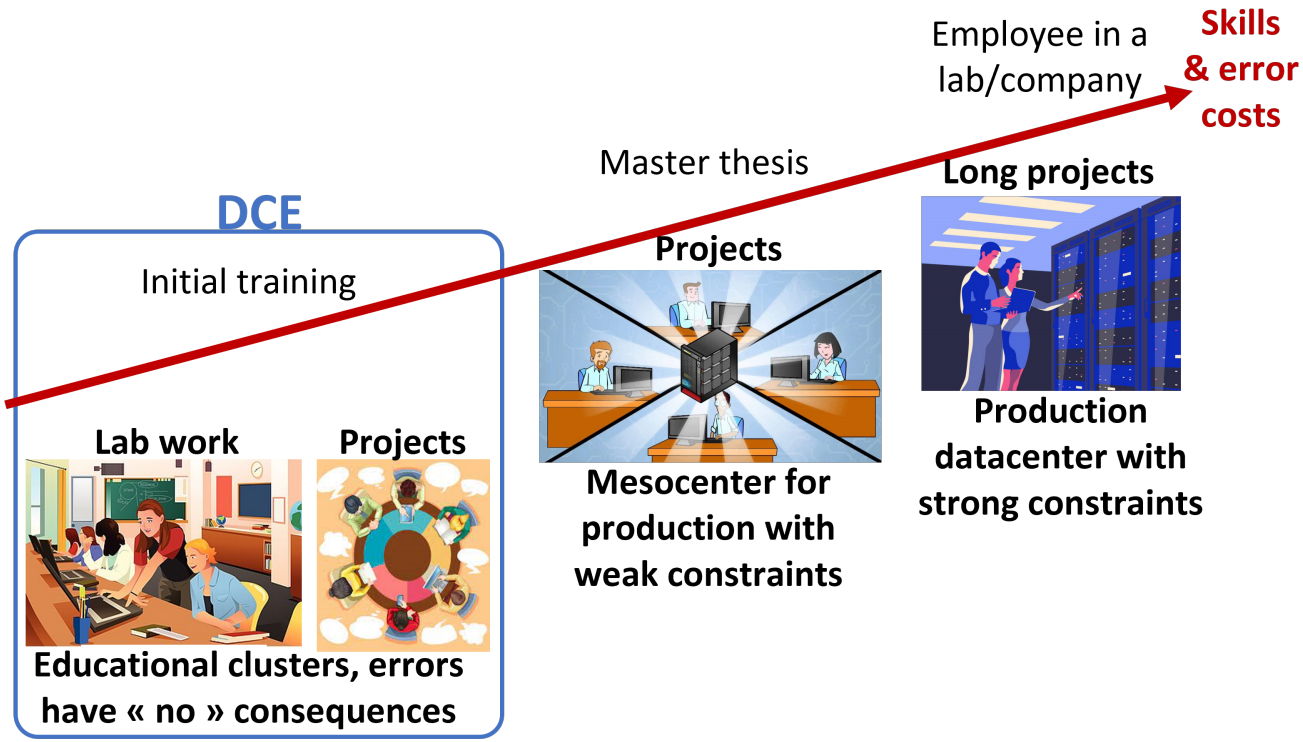

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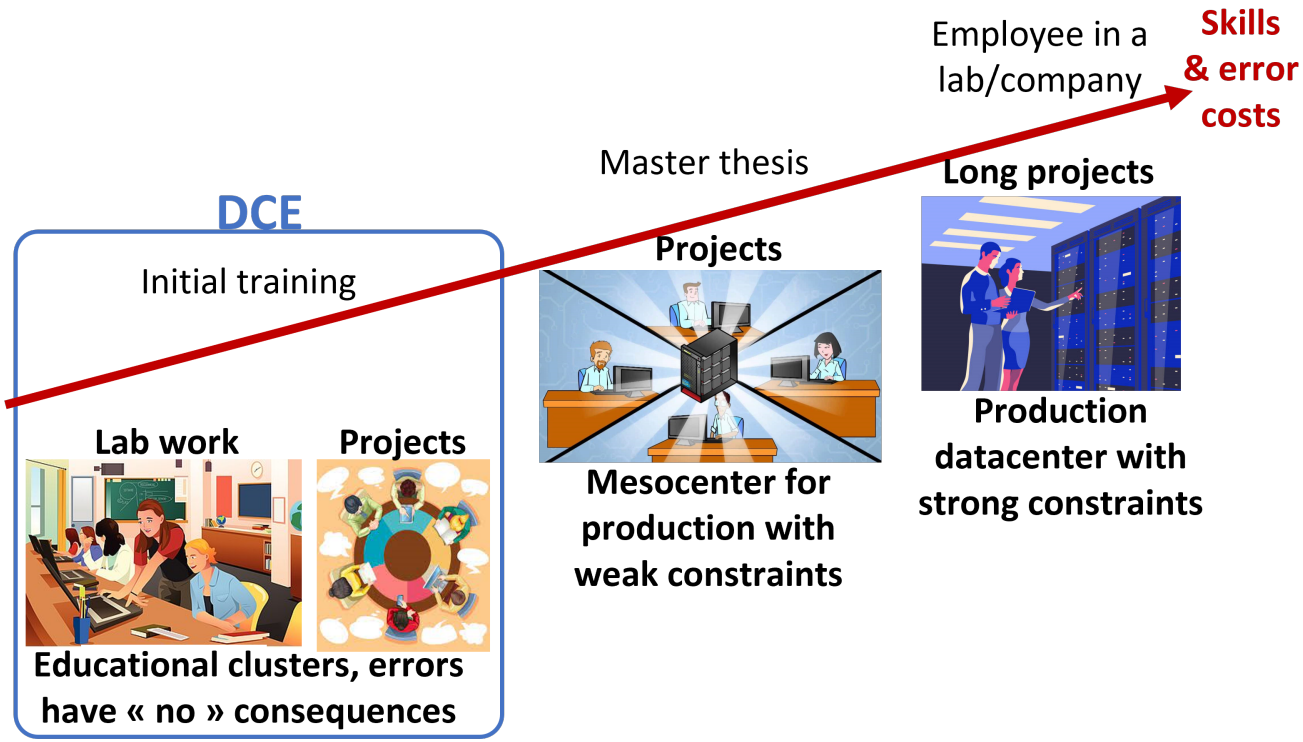
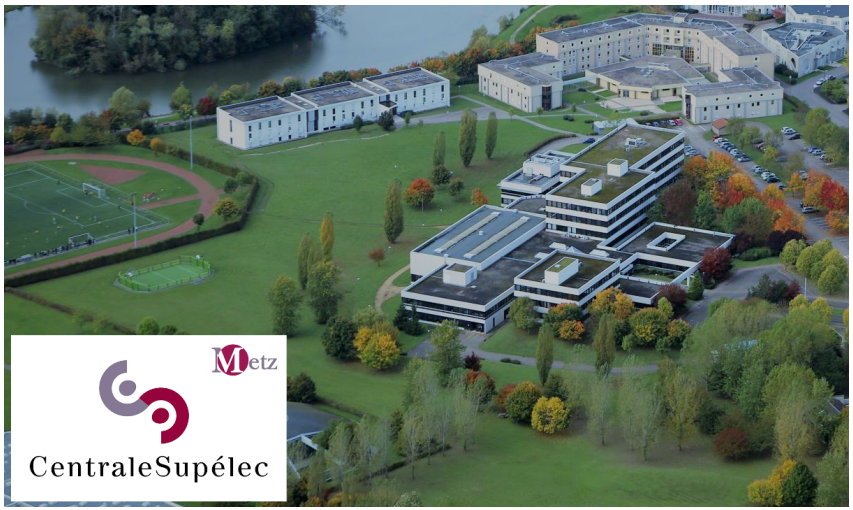


For teaching, for beginners

- powerfull shared computing resources
- no bill to the end users
- errors without consequences
- access as simple and ergonomic as possible

Where is the Data Center for Education (DCE)



What is the Data Center for Education (DCE)

CPU clusters

- Kyle : 68 × 16 physical cores, 64 GB
- Sarah : 32 × 8 physical cores, 32 GB

Eth 10Gb/s

AVX, AVX2, AVX-512

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- Cameron : 17 GPU servers (1080)
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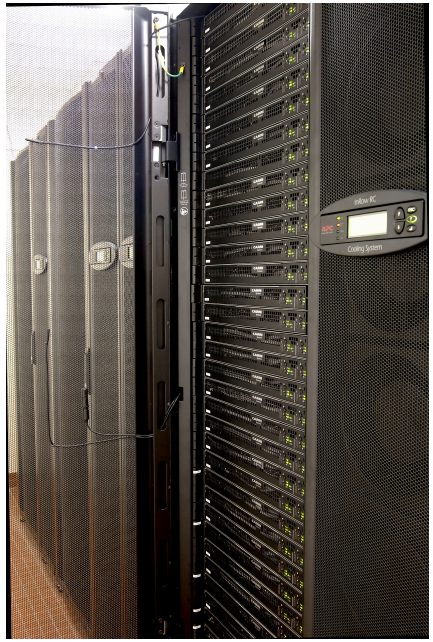

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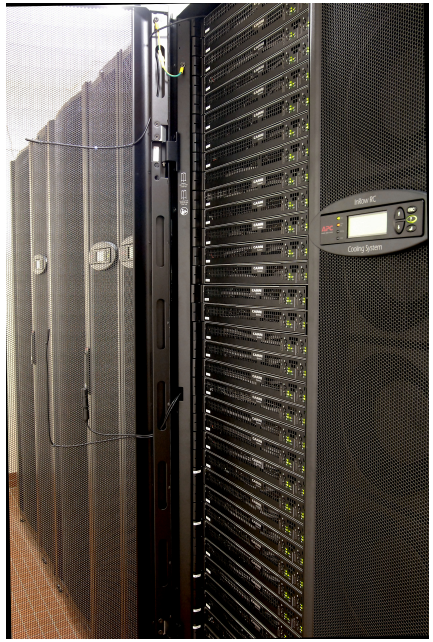

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Admin machines

1(+1)×Gateway, 1(+1) frontal SLURM, NFS server + 1 storage bay

Software environment

Administration

- ressources are scheduled with **slurm**
- the installations are synchronized with **ansible**
- the nodes are monitored with **Zabbix**
- labs are planed on website `www.dce-cs.fr`
- users access the nodes with home made software dcejs

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Teaching

- Hadoop / Spark pre-installed distributed servers (on Sarah)
- Intel OneAPI, gcc, python, OpenMP, OpenMPI, OpenBLAS, CUDA, cublas, cudnn, ...
- Tensorflow, PyTorch, pandas, numpy, scikit-learn
- Robot Operating System (ROS) ecosystem

Custom envs. with conda (soon with module/singularity)

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Hardware costs

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Total estimated : ~~182~~ $222MWh/y$ ($\approx 25K€$)
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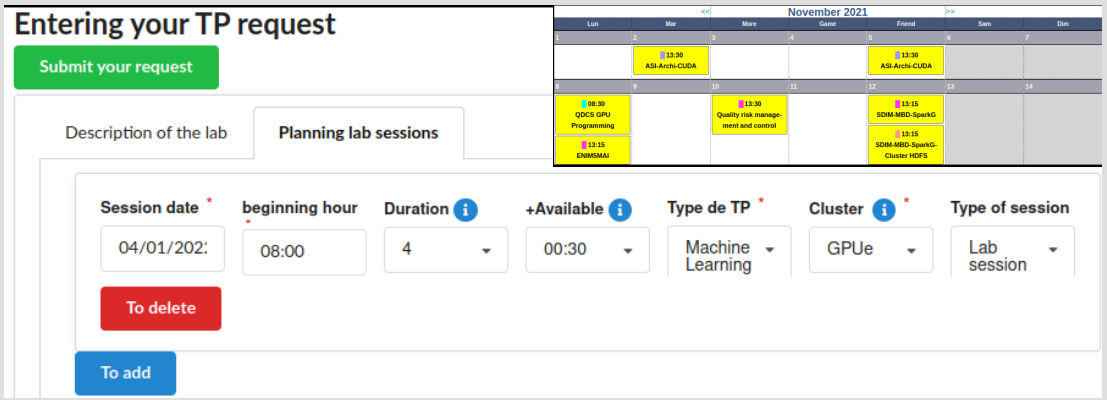
Humans

3 engineers (40%, 5%, 5%) and 2 professors (10%, 5%)
$\approx$ 7.8 (french-)man months/year

Using the DCE

Planning and accessing the DCE

Registering a lab



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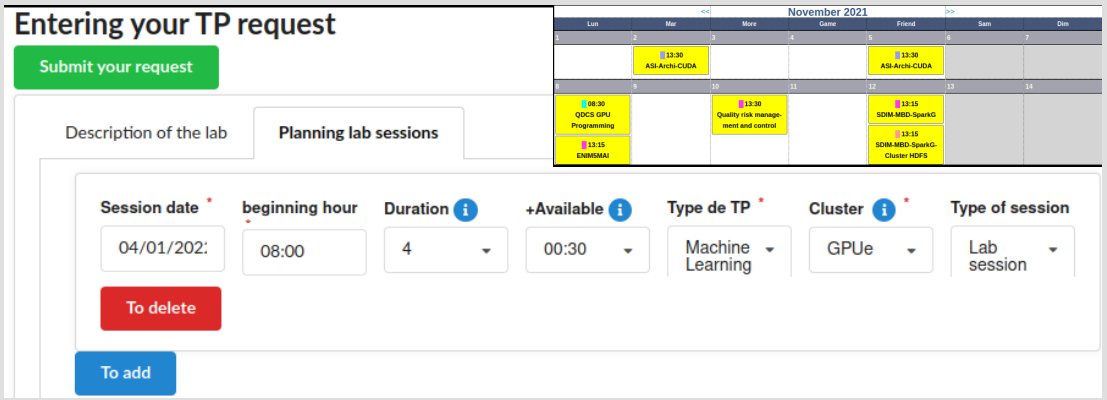

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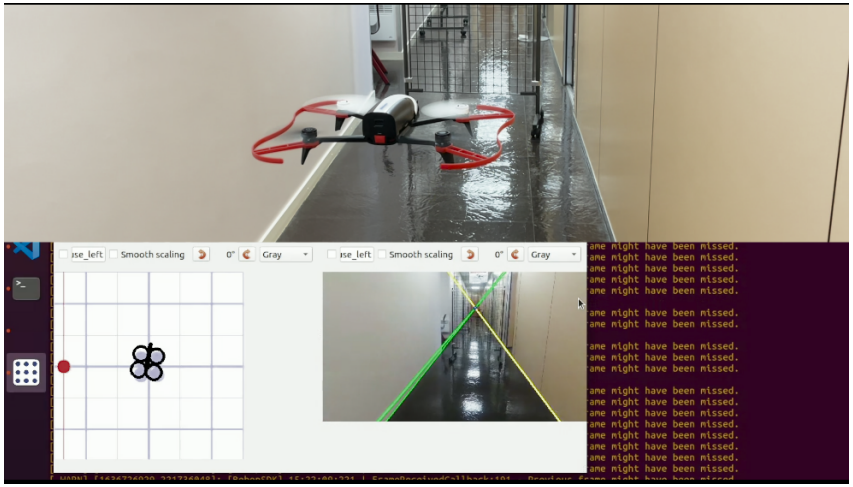
Co-hosting labs and projects

Partition	Max time	# nodes	Purpose
gpu_tp_resa	4h30	34	Scheduled lab works
gpu_tp	2h	34	Lab works live coding
gpu_prod_night	12h	16	Batch jobs, night& weekends
gpu_inter	2h	42	Project live coding
gpu_prod_long	48h	17	Long batch jobs

Description of the use case

The students experiment algorithms on robotic platforms:

- written in ROS with multiple interacting processes,
- computationnally intensive processes (MonteCarto / Particle filters for SLAM, planning and navigation, Gazebo simulator),
- requires an interactive session

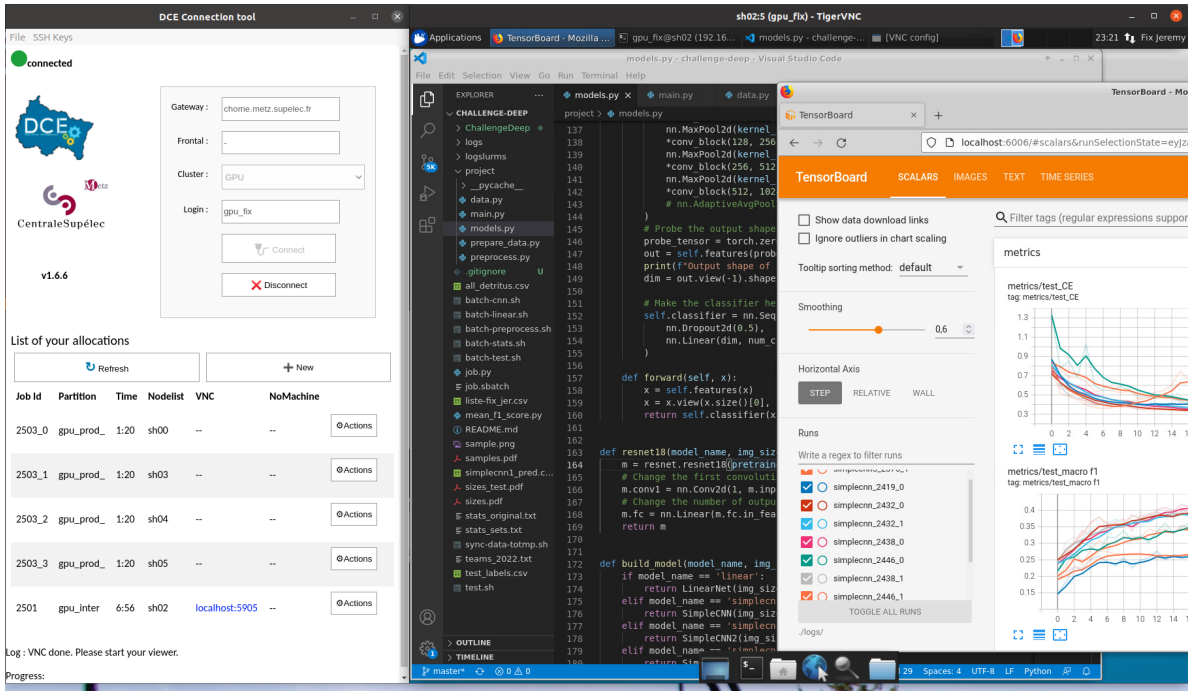


Also labs with on-site platforms during Covid-19.

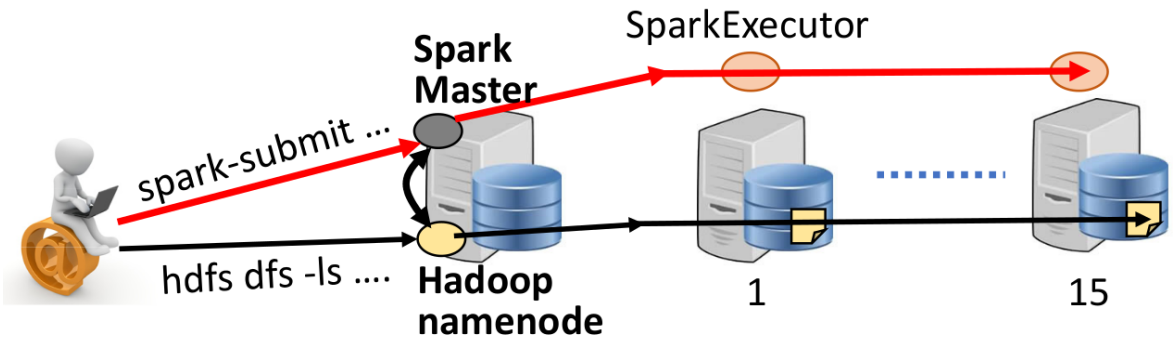
Description of the use case

The student train deep neural networks (pytorch/tensorflow):

- during ML labs, or projects/challenges (see Kaggle 3MD4040)
- both interactive and batch mode (long running jobs)

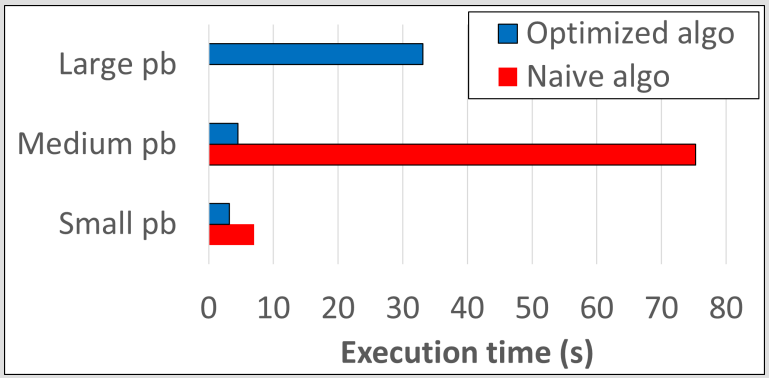


III. Distributed Hadoop/Spark on CPU cluster[1/2]



Description of the use case

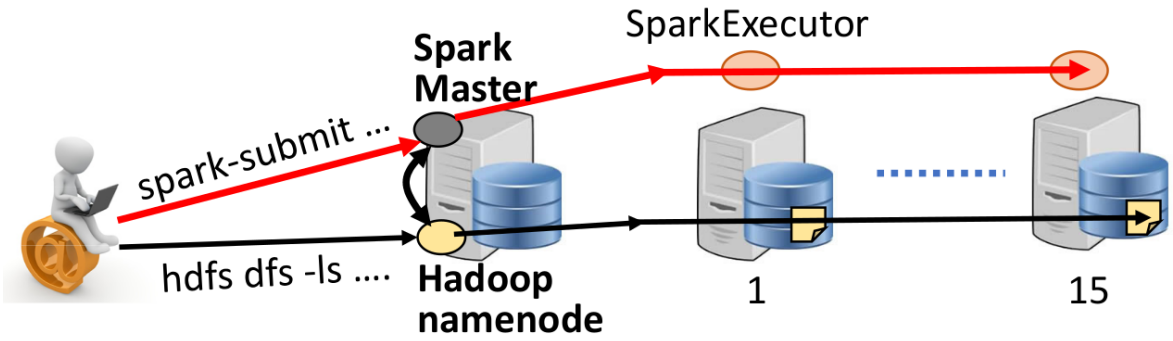
Design of a Map-Reduce with limited network traffic



Bad algorithms on real distributed systems ⇒ huge network cost

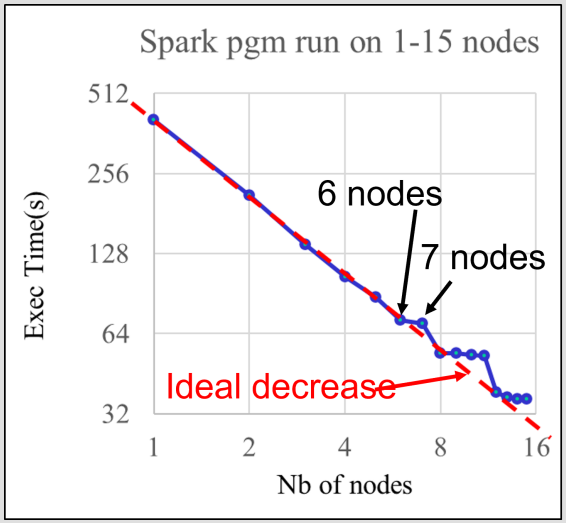
Teaching use cases

III. Distributed Hadoop/Spark on CPU cluster[2/2]

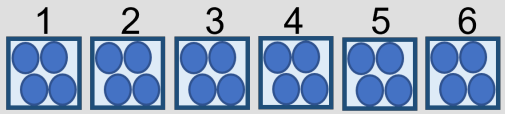


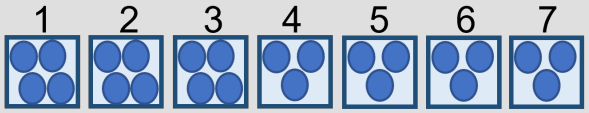
Description of the use case

Observe load balancing impact on speedup of Spark programs.



Ex: Load balancing of a **24-task** Spark pgm:





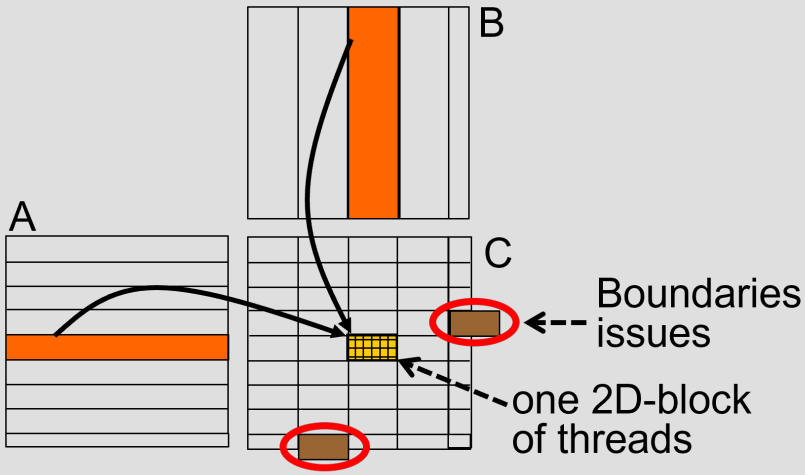
T(7 nodes) = T(6 nodes) = T(4 tasks)

Description of the use case

First steps with CUDA on GPU: dense matrix product

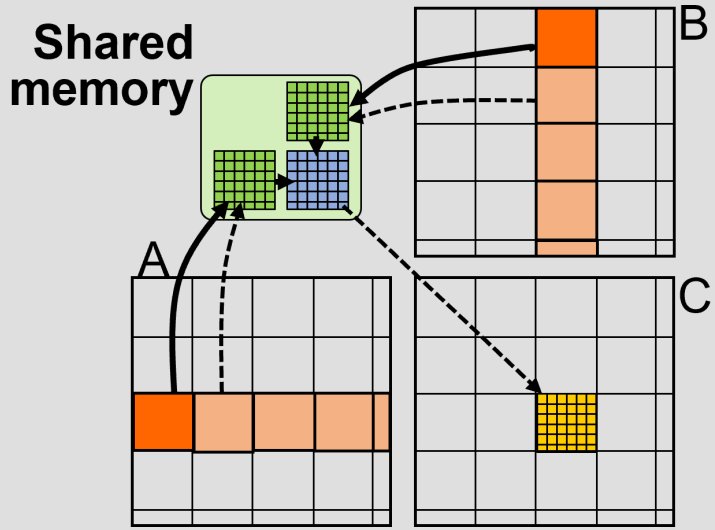
Issues:

- Grid of blocks of threads
- First CUDA kernels
- Coalescent mem. accesses



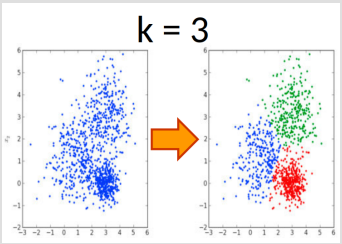
Issues:

- Use the shared memory
- Increase the coalescence
- Decrease the number of global memory accesses



Description of the HPDA use case

K-means clustering on GPU with CUDA

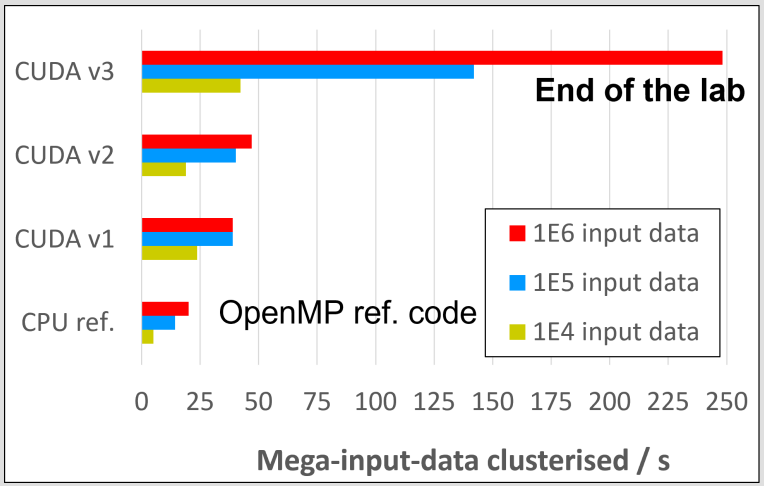


Issues adressed:

- Coalescence
- Shared memory
- Reduction
- Atomic functions

Lab: Design the right data structures and associated computations to obtain optimized kernels ... many combinations exist !

After 2 lab sessions :



Many CUDA optimizations succeed.

Questions

Thank you for your attention !

We are gratefull for the support of

More details on
`https://dce.pages.centralesupelec.fr/`.

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