SC19
Denver, CO | hpc is now.

EduHPC-19
Workshop on Education for High Performance Computing

Teaching on Demand: an HPC Experience

Rocío Carratalá-Sáez — **rcarrata@uji.es**
Sergio Iserte — siserte@uji.es
Sandra Catalán — scatalan@ucm.es

UNIVERSITAT JAUME I

UNIVERSIDAD COMPLUTENSE MADRID

What is HPC?

HPC transforms

HPC transforms

HPC matters

HPC transforms

HPC matters

HPC connects

HPC transforms

HPC matters

HPC connects

HPC inspires

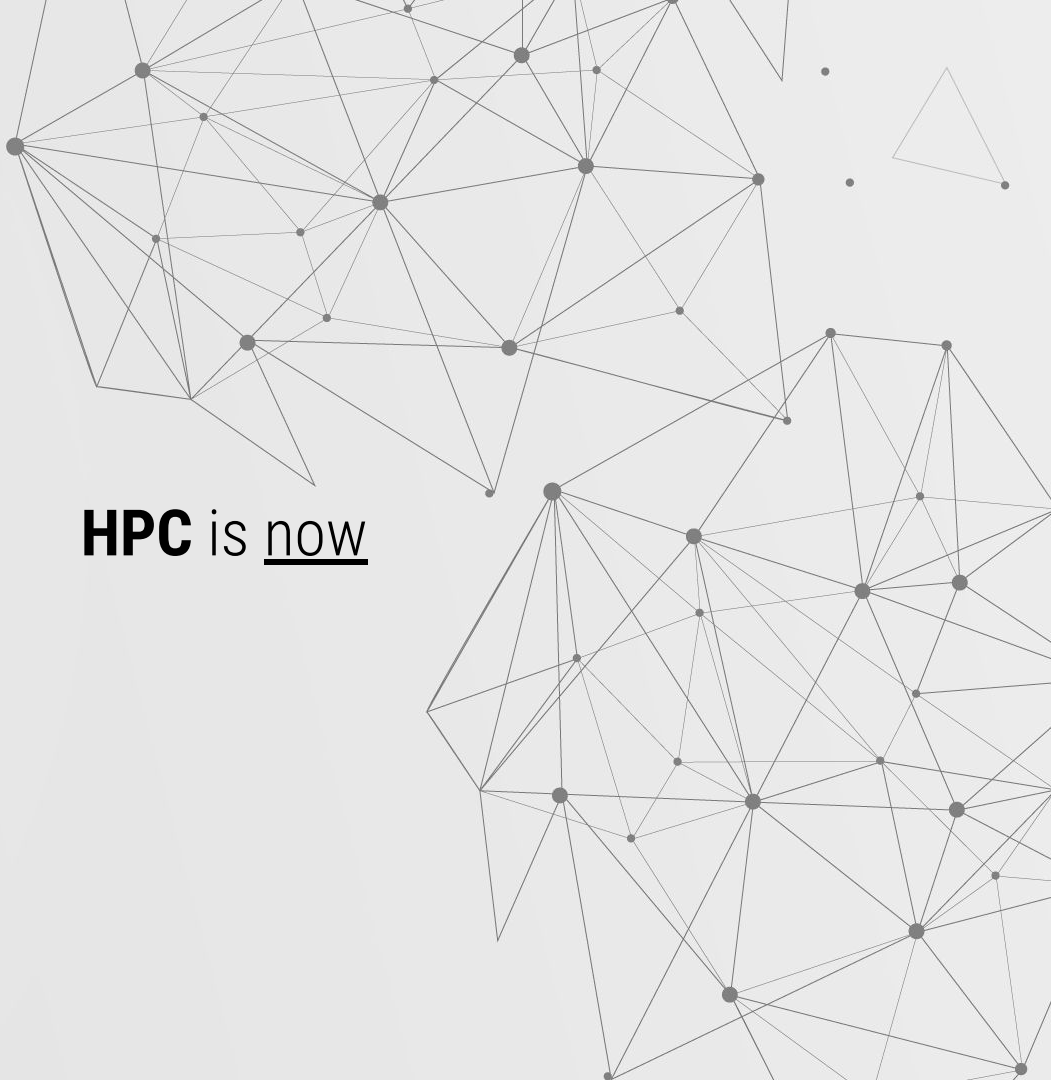
HPC transforms

HPC matters

HPC connects

HPC inspires

HPC is <u>now</u>



HPC is now

What is HPC?

HPC is now

Source of the picture: https://www.ornl.gov/news/ornl-launches-summit-supercomputer

HPC is <u>now</u>

Source of the picture: https://www.ornl.gov/news/ornl-launches-summit-supercomputer

HPC is now

Computer Science (CS) Year	# Subjects	# HPC Subjects
1st	10	2
2nd	10	3
3rd	15	4
4th	26	2

UNIVERSITAT JAUME I

< 13%

Source of the picture: https://www.ornl.gov/news/ornl-launches-summit-supercomputer

Motivation: HPC is now

Reasons to “do something” for HPC and for our Computer Science (CS) students

- HPC society interest and need is increasing (possibly needed in future jobs)
- There exists a lack of HPC related content among CS syllabus (<13%)
- HPC self-learning is complicated

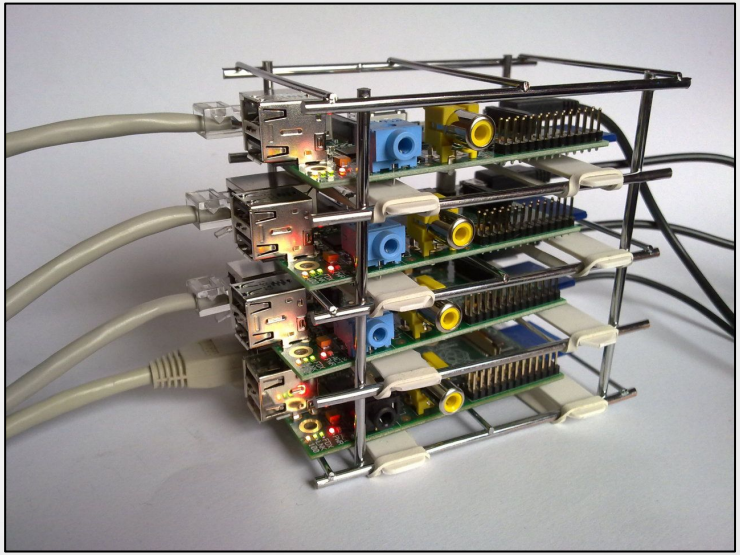
Our concerns while designing the course

- There exists a lack of HPC knowledge among Engineering students (in general)
- Are students motivated to learn?

“Keep it simple and focus on what matters. Don't let yourself be overwhelmed.”

- Confucius -

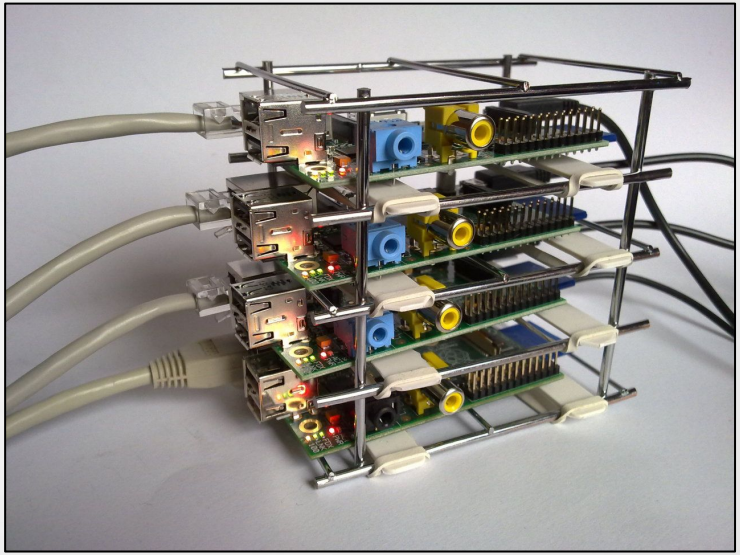
“Build your own supercomputer with Raspberry Pi”



“Keep it simple and focus on what matters.
Don't let yourself be overwhelmed.”
- Confucius -

Source of the picture:
http://raspberrywebserver.com/raspberrypicluster/raspberry-pi-cluster.html

“Build your own supercomputer with Raspberry Pi”



	CS	Other Engineering (OE)
Applicants	15 (58%)	11 (42%)
Selected	12 (60%)	8 (40%)
Attendants	12 (67%)	6 (33%)

“Keep it simple and focus on what matters. Don't let yourself be overwhelmed.”

- Confucius -

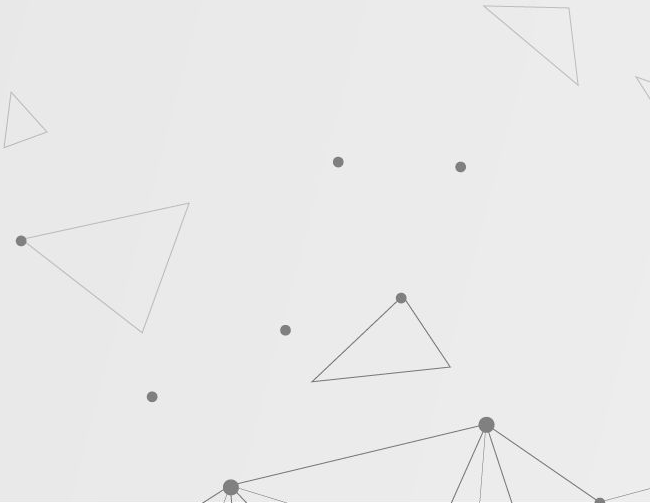
Source of the picture:
http://raspberrywebserver.com/raspberrypicluster/raspberry-pi-cluster.html

Objectives of the course

- 1) Provide the students with general **HPC knowledge**
- 2) HPC does **not only** mean “**huge computers** that belong to huge **companies**”
- 3) Understand the **needs** (both in terms of hardware and software) of an HPC supercomputer
- 4) Recognize current **applications** where HPC is necessary
- **5) Enjoy** the learning process and avoid classical lessons pressure feelings

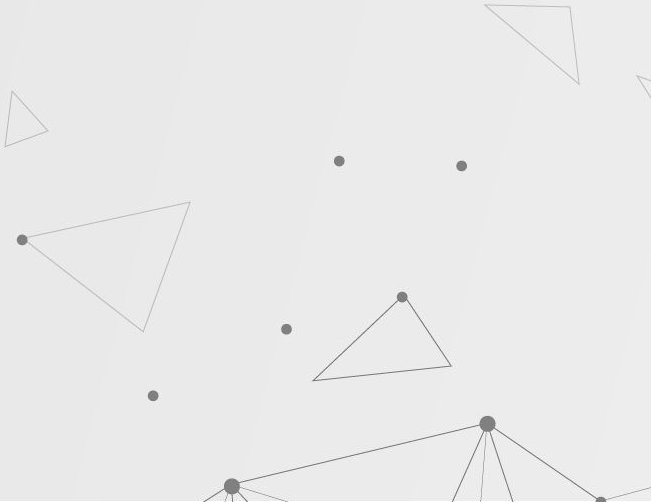
Schedule of the course (10h)

- 1st Part: Theoretical introduction (1h) *[Objectives 1, 2, 4 - HPC knowledge and applications]*
- 2nd Part: User guide based (5h - 6h) *[Objectives 3, 4 - HPC needs and applications]*
    - Hardware setup
    - Cluster configuration
    - HPC applications
- 3rd Part: Learning on demand (4h - 3h) *[Objective 5 - enjoy]*
    - Performance and frequency tools
    - Creating a larger cluster



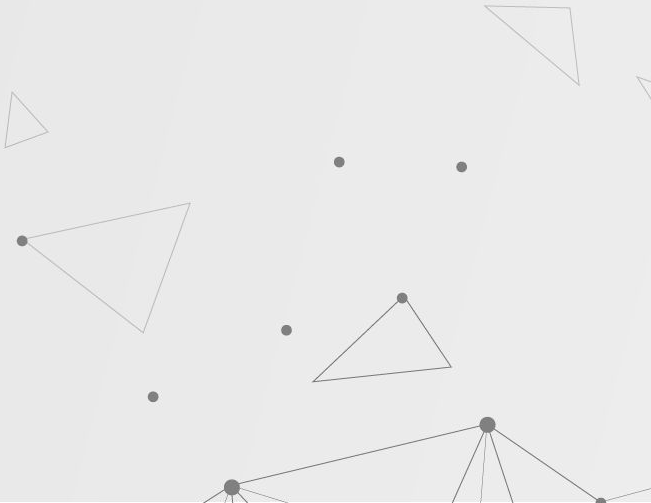
1st Part: Theoretical introduction (1h)

- HPC?
  - What is it (from the HW and the SW point of view)
  - Everyday life applications
  - Impact and need in research and companies



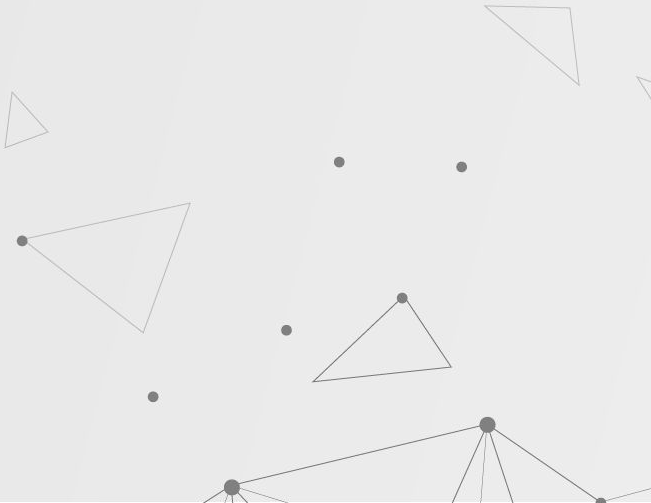
1st Part: Theoretical introduction (1h)

- HPC?
  - What is it (from the HW and the SW point of view)
  - Everyday life applications
  - Impact and need in research and companies
- Supercomputer
  - Summit, Marenostrum 4



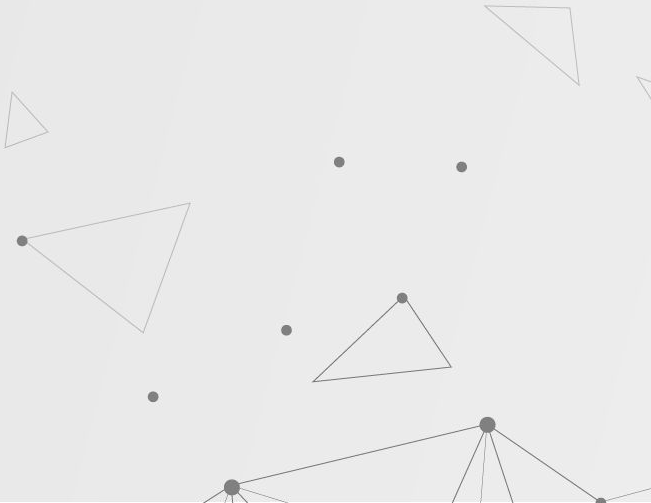
1st Part: Theoretical introduction (1h)

- HPC?
  - What is it (from the HW and the SW point of view)
  - Everyday life applications
  - Impact and need in research and companies
- Supercomputer
  - Summit, Marenostrum 4
  - Top500 (Linpack)



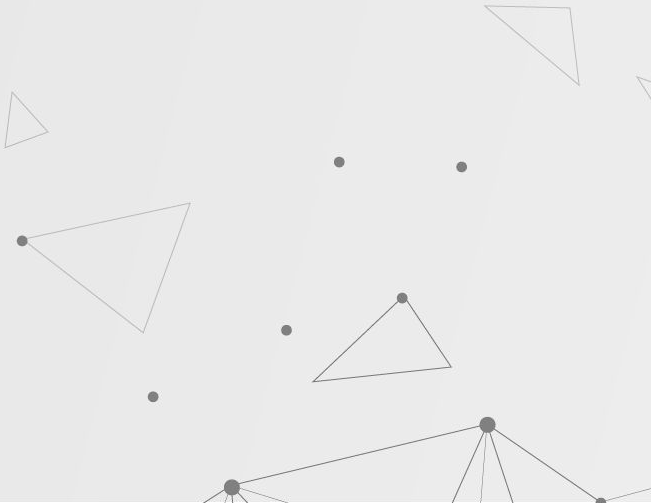
1st Part: Theoretical introduction (1h)

- HPC?
  - What is it (from the HW and the SW point of view)
  - Everyday life applications
  - Impact and need in research and companies
- Supercomputer
  - Summit, Marenostrum 4
  - Top500 (Linpack)
- Raspberry Pi 3 Model B+



1st Part: Theoretical introduction (1h)

- HPC?
  - What is it (from the HW and the SW point of view)
  - Everyday life applications
  - Impact and need in research and companies
- Supercomputer
  - Summit, Marenostrum 4
  - Top500 (Linpack)
- Raspberry Pi 3 Model B+
- Visit to our “supercomputer” Tintorrum



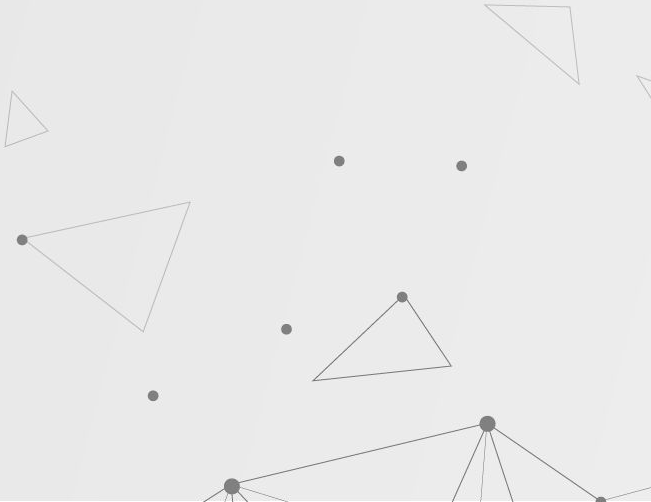
2nd Part: User guide based (5h - 6h)

- Hardware setup

Component	Quantity	Individual Price
Raspberry Pi 3 Model B+	4	29,47€
USB Hub (4 port)	1	11,99€
USB 2.0 wire	4	0,94€
Micro SD Class 10 (16GB)	4	7,77€
Switch Ethernet (5 ports)	1	16,50€
Ethernet wire	4	1,14€
	TOTAL	**185,77€**

2nd Part: User guide based (5h - 6h)

- Hardware setup
- Cluster configuration
    - Installing the Operating System (Raspbian OS, kernel version 4.9, March 2018)



2nd Part: User guide based (5h - 6h)

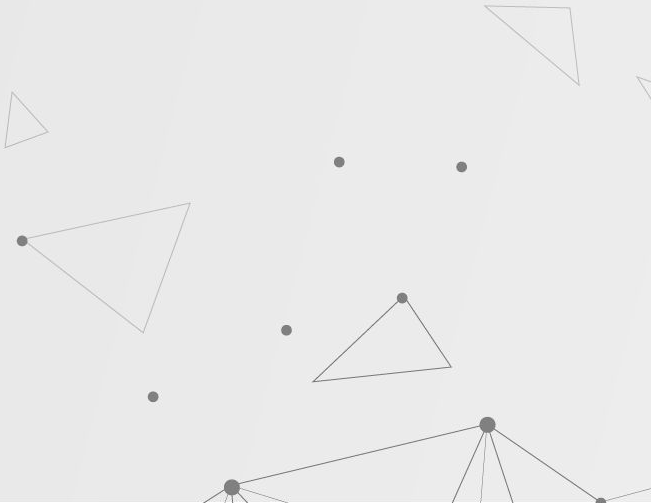
- Hardware setup
- Cluster configuration
  - Installing the Operating System (Raspbian OS, kernel version 4.9, March 2018)
  - Network configuration
    - All nodes: assign hostname to each node, enable SSH, configure DHCP
    - Main node:
      - enable 8.8.8.8 in DHCP configuration, configure default gateway
      - specify /etc/hosts list
      - Generate SSH keys and copy the id and the hosts list to the other nodes

2nd Part: User guide based (5h - 6h)

- Hardware setup
- Cluster configuration
  - Installing the Operating System (Raspbian OS, kernel version 4.9, March 2018)
  - Network configuration
  - Configure the Network File System (NFS)
    - `sudo apt-get installnfs-kernel-server`
    - Create `/SHARED` directory and edit `/etc/exports` to enable mounting
    - (from the remaining nodes) Modify the file etc/fstab by adding `node1:/SHARED /SHARED nfs` and then mount

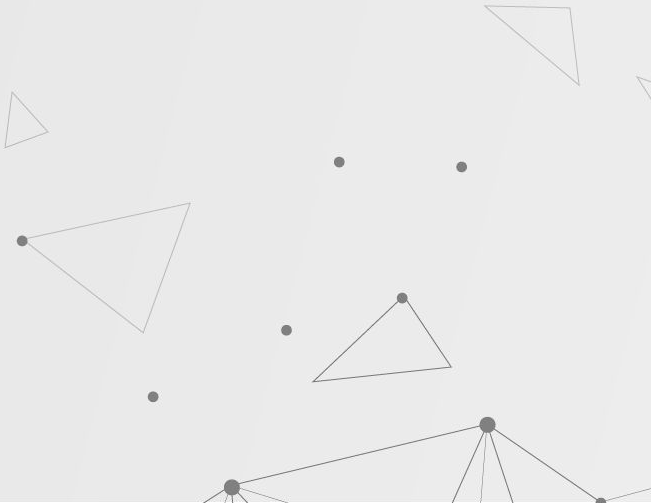
2nd Part: User guide based (5h - 6h)

- Hardware setup
- Cluster configuration
  - Installing the Operating System (Raspbian OS, kernel version 4.9, March 2018)
  - Network configuration
  - Configure the Network File System (NFS)
- HPC applications and tools
  - Install OpenMPI, MPICH
  - Install LAMMPS
  - Install LINPACK (optional)



3rd Part: Learning on demand (around 3h)

- Students express their interest and preferences
  - Performance and frequency analysis
    - Threads usage limits
    - OpenMP vs. MPI vs. OpenMP + MPI
    - Cooling vs. not cooling
    - Modifying frequency
  - Creating a larger cluster

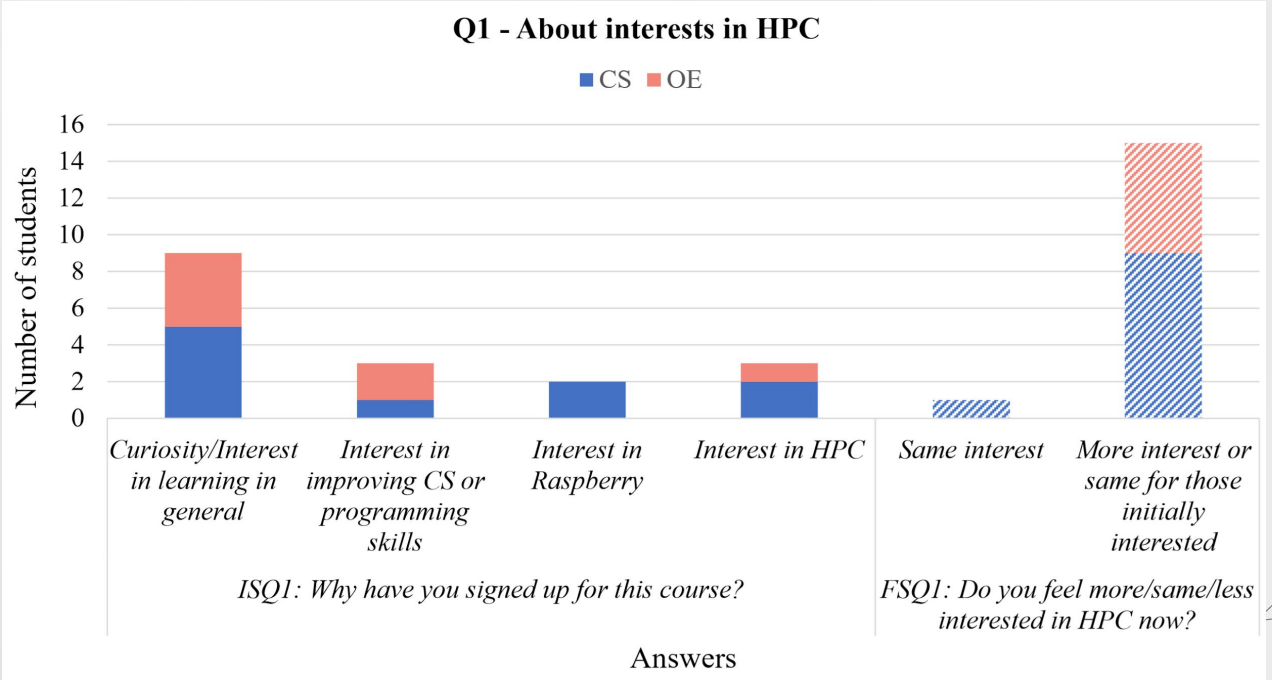


Data collection and evaluation

- Initial survey (IS) *[18 answers]*
  - ISQ1: Why have you signed up for this course?
  - ISQ2: Do you think that HPC has influence on your day to day? If so, how?
  - ISQ3: How would you define HPC?
  - ISQ4: What do you think about supercomputers?
- Final survey (FS) *[16 answers]*
  - FSQ1: Do you feel more/same/less interested in HPC now?
  - FSQ2: Do you think that HPC has an influence on your day to day? If so, how?
  - FSQ3: How would you define HPC?
  - FSQ4: What do you think about supercomputers?

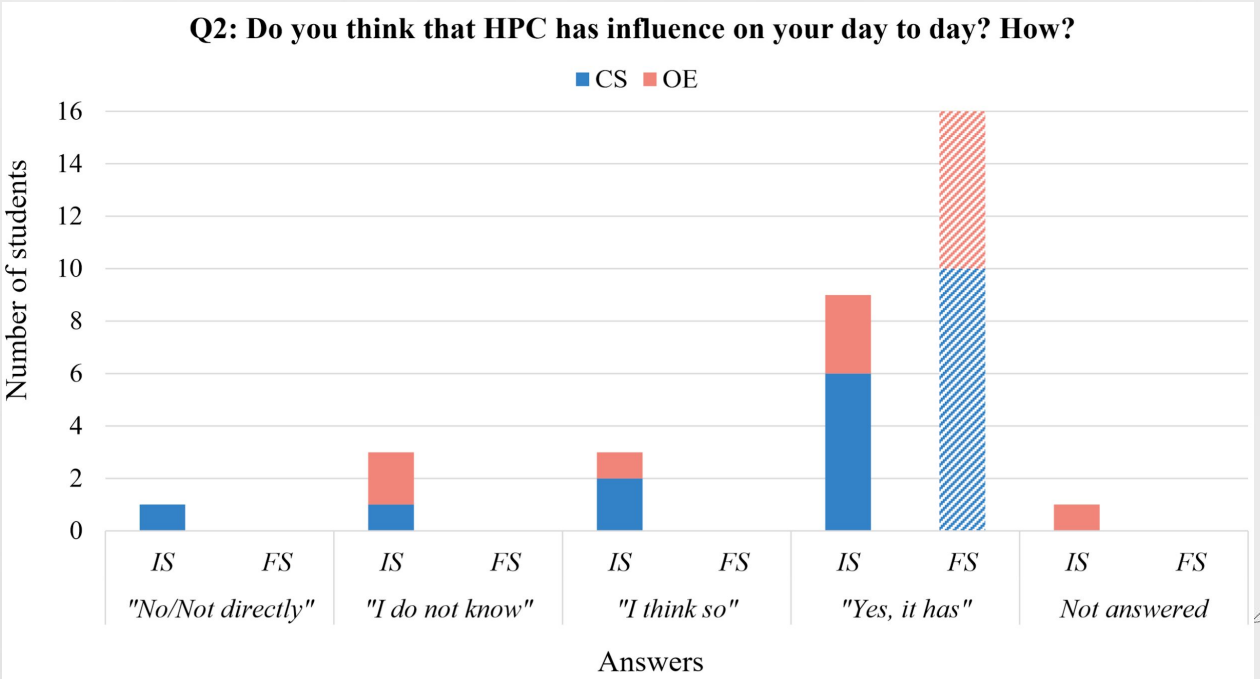
Targeted flaws conclusions, discussion and lessons learnt

- Students are clearly motivated to learn (IS) || Their interest in HPC has increased (FS)



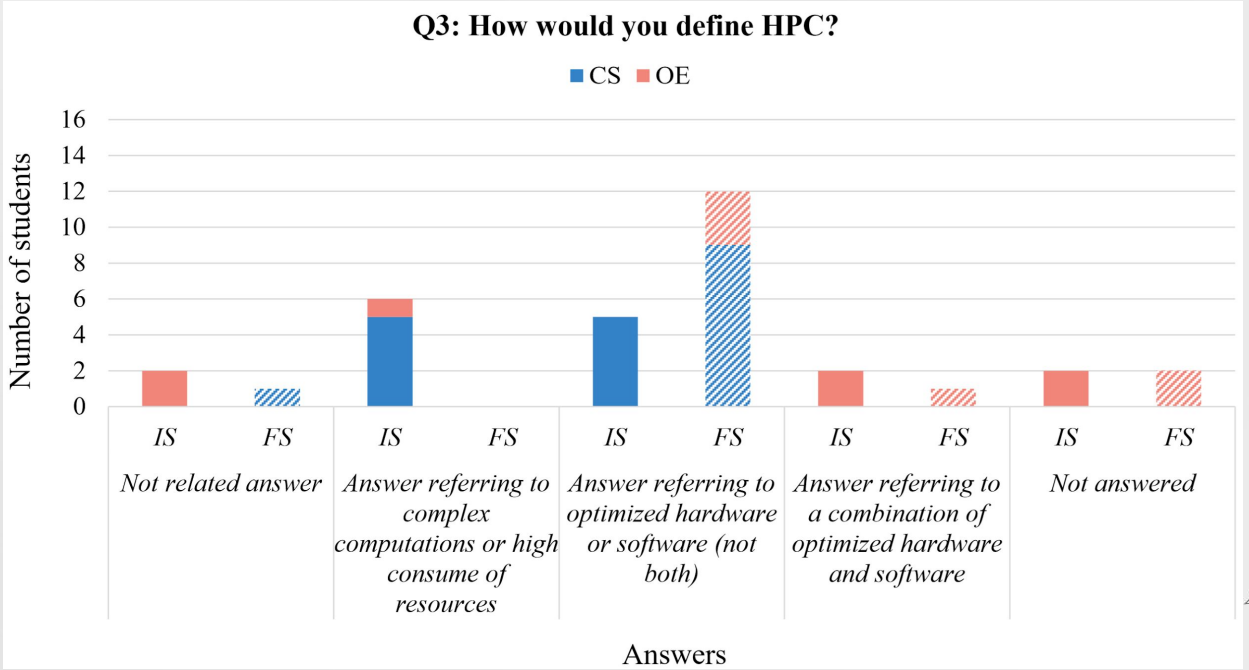
Targeted flaws conclusions, discussion and lessons learnt

- Students have learnt that HPC has impact in their everyday life



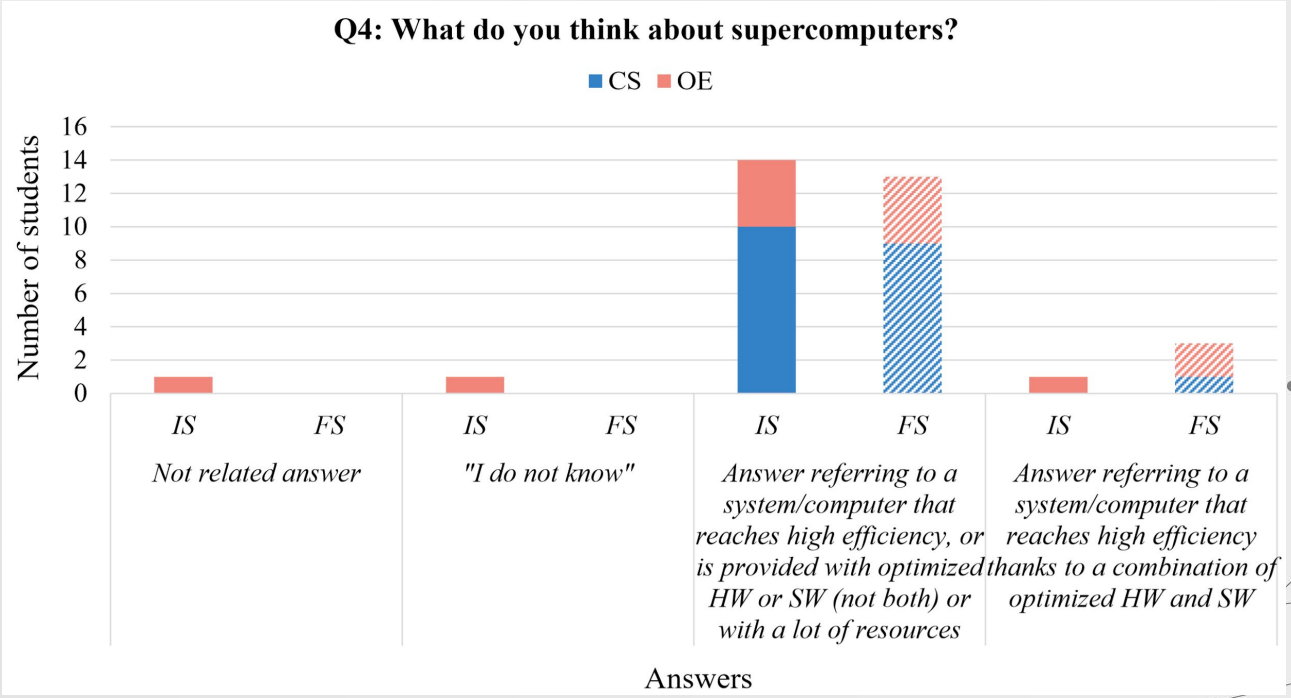
Targeted flaws conclusions, discussion and lessons learnt

- HPC knowledge has increased among students



Targeted flaws conclusions, discussion and lessons learnt

- HPC knowledge has increased among students



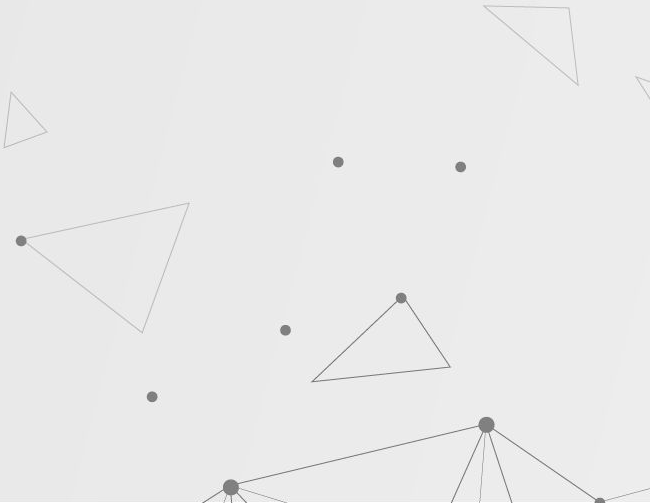
Targeted flaws conclusions, discussion and lessons learnt

- Students are clearly motivated to learn (ISQ1)
- Their interest in HPC has increased (FSQ1)
- Students have learnt that HPC has impact in their everyday life (Q2)
- HPC knowledge has increased among students (Q3, Q4)

- Raspberry Pi components provide sufficient flexibility and versatility
- The approach and programming of the course are appropriate to establish basic knowledge about HPC and motivate students

Future work

- 2nd edition of the course (already happened last Saturday 9th)
- Include a small competition (look for external fundings) - Student Cluster Competition
- Include Slurm installation and usage
- Extend HPC applications set adjusted to the different students interests
- Improve surveys (thanks to the reviewers!)



SC19
Denver, CO | hpc is now.

EduHPC-19
Workshop on Education for High Performance Computing

“Teaching on Demand: an HPC Experience”

THANKS FOR YOUR ATTENTION

AND ALSO FOR THE REVIEWS

rociocarratalasaez/BuildYourOwnSupercomputer

Rocío Carratalá-Sáez
rcarrata@uji.es

Sergio Iserte
siserte@uji.es

Sandra Catalán
scatalan@ucm.es