Teaching on Demand: an HPC Experience

Rocío Carratalá-Sáez
Sergio Iserte
Sandra Catalán
rcarrata@uji.es
siserte@uji.es
scatalan@ucm.es
What is HPC?
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 now
What is HPC?

HPC is now
HPC is now

HPC is now

HPC is now

<table>
<thead>
<tr>
<th>Computer Science (CS) Year</th>
<th># Subjects</th>
<th># HPC Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>2nd</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>3rd</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>4th</td>
<td>26</td>
<td>2</td>
</tr>
</tbody>
</table>

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 -
“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”

<table>
<thead>
<tr>
<th></th>
<th>CS</th>
<th>Other Engineering (OE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicants</td>
<td>15 (58%)</td>
<td>11 (42%)</td>
</tr>
<tr>
<td>Selected</td>
<td>12 (60%)</td>
<td>8 (40%)</td>
</tr>
<tr>
<td>Attendants</td>
<td>12 (67%)</td>
<td>6 (33%)</td>
</tr>
</tbody>
</table>


“Keep it simple and focus on what matters. Don’t let yourself be overwhelmed.”
- Confucius -
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, Marenstrum 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, Marenosum 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, Marenstrum 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, Marenostrom 4
  - Top500 (Linpack)
- Raspberry Pi 3 Model B+
- Visit to our “supercomputer” Tintorrum
2nd Part: User guide based (5h - 6h)

- Hardware setup

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
<th>Individual Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry Pi 3 Model B+</td>
<td>4</td>
<td>29,47€</td>
</tr>
<tr>
<td>USB Hub (4 port)</td>
<td>1</td>
<td>11,99€</td>
</tr>
<tr>
<td>USB 2.0 wire</td>
<td>4</td>
<td>0,94€</td>
</tr>
<tr>
<td>Micro SD Class 10 (16GB)</td>
<td>4</td>
<td>7,77€</td>
</tr>
<tr>
<td>Switch Ethernet (5 ports)</td>
<td>1</td>
<td>16,50€</td>
</tr>
<tr>
<td>Ethernet wire</td>
<td>4</td>
<td>1,14€</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>185,77€</strong></td>
</tr>
</tbody>
</table>
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 install nfs-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!)
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