Department of Computer Science

HPC CF

University of Reading

Toward a Globally Acknowledged and Free HPC Certification

Julian Kunkel (+ HPC Certification Forum)

https://hpc-certification.org

Archer Seminar

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Outline

Challenges for HPC Training

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- Not all users possess the right level of training
  - Inefficient usage of systems, frustration, lost potential
  - Good training saves compute time and costs!
- Diverse user background and goals
  - Science is the goal, HPC is the vehicle
  - Need to run an application to complete the PhD
- Learning is not easy
  - Users need to understand beneficial knowledge for tasks
  - There exist various different training material
  - Teaching of different data centers is hard to compare
- Data center have difficulties to verify the skills of users

The HPC Certification Forum

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Goals

- Fine-grained standardizing HPC knowledge representation
  - What competences exist, how are they defined?
  - Puzzle of competences for everyone (practitioners, students, admins)
  - Supporting navigation and role-specific knowledge maps
- Establishing international certificates attesting knowledge
- Supporting an ecosystem around the HPC competences

Scope of the forum

- Central authority for competence representation, certification, and support
- Purposeful limitations of the forum:
  - We do not compete with content providers
  - We do not create a curriculum (university/centers responsibility)

The HPC Certification Forum

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Organization Details

- An independent international body
- Organized into
  - Steering board (elected)
  - Full members (with voting rights)
    - Contributors to the project (e.g., 1-2 hours per month)
  - Associate members (anyone and any institution)
  - Collaboration with e.g., SIGHPC Education Chapter

Responsibilities

- Curating and maintaining the **Competence Standard**
- Providing tools and ecosystem around the competences

Governance

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We have governance rules splitting responsibility across roles

Steering Board

- General chair: Julian Kunkel (University of Reading)
- Skill-tree curator: Kai Himstedt (University of Hamburg)
- Topic curators:
  - HPC Knowledge: Lev Lafayette (University of Melbourne)
  - Performance Engineering: Anja Gerbes (University of Frankfurt)
  - Sofware Development: Roberto Villegas-Diaz (South Dakota State University)
  - Administration: Sudeep Banerjee (Indian Institute of Technology Gandhinagar)
- Other topics are jointly managed by the board
- Examination curator: Christian Meesters (University of Mainz)
- Publicity chair: Weronika Filinger

Organization

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Organization of the members

- Webpage is the central hub (https://www.hpc-certification.org)
- Mailinglists (news, members, board)
- Monthly public meetings on our Slack channel
- Annual general assembly (form of a BoF at ISC or workshop)

Data handling

- Everything* is developed/available in the open GitHub (https://github.com/HPC-certification-forum)
- Exception are examination questions

Outline

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Classification of Competences == Skills

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- A **skill** defines background, objectives, learning outcomes
- The **skill tree** organizes the competences as hierarchical skills
- Certificates bundle several skills into attestable unit

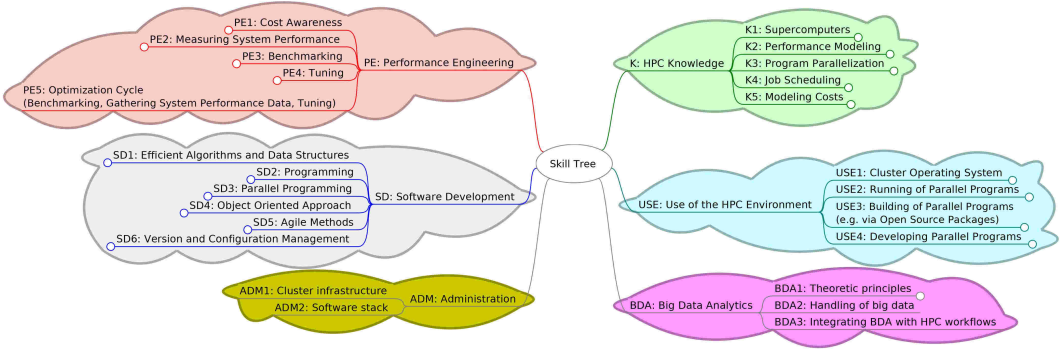

Figure: Top-levels of the skill tree (Initial ADM and BDA branches)

Example High-Level Skill (Excerpt)

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- Name: SLURM Workload manager
- Id: USE4.2.2-B
- Background: SLURM is a widely used open-source workload manager providing various advanced features.
- Aim:
  - comprehend and describe the basic architecture of SLURM and its tools
  - use relevant tools to run and monitor (parallel) applications

Learning outcomes (these must be examinable)

- run interactive jobs with salloc, a batch job with sbatch
- explain the architecture of SLURM, i.e., the role of slurmd, srun
- explain the function of the tools: sacct, sbatch, salloc, ...
- explain time limits and the benefit of a backfill scheduler
- *see https://www.hpc-certification.org/wiki/*

Classification of HPC Competences

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- Granularity of skill descriptions
  - Too fine $\Rightarrow$ content of a skill is predefined at leaf level
  - Too coarse $\Rightarrow$ no help for structuring the material
  - Guiding principle: leaf node should be coverable in 1-4 hour lecture/workshop
- Organization of HPC skills
  - Skills are typically depending on sub-skills $\Rightarrow$ tree structure
  - References to skills are possible; still skills are building blocks for various tasks
  - One skill can have multiple instances for different skill levels (basic, ..., expert)
- Verification of skill tree and certification approach
  - Feedback by the HPC community/practitioners justify the approaches

Further Considerations

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- Certificate definition
  - Bundles a set of useful skills together
  - A users' HPC qualification is certified by successful exams
  - Testing a single (fine-grained) skill may be too easy with a cheat sheet
- Separation of **skill**, **certificates** and **content provider**
  - Similar to the concept of a high school graduation exam
  - Learning material can be provided by different institutions
  - Teachers can put badges on material: this "trains skills X, Y, Z"
- External information can be linked to the skills providing different **views**
  - Suitability for a user role (Tester, Builder, Developer)
  - Suitability for a scientific domain (Chemistry, Physics, ...)
  - View: purpose-specific representation / coloring / content
    - Groups/institutions can derive a new skill tree with their own emphasis
    - What should people know to effectively work in your environment?

Status / Previous Activities

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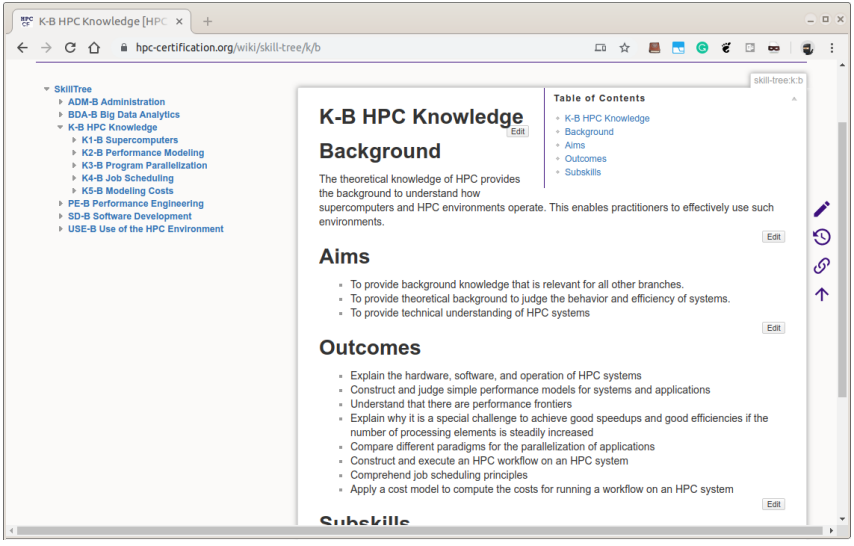
- The development version of the Competence Standard is online
- Released technical representations of the HPC skills
  - Markdown (embedded in a Wiki)
- Released JavaScript for visualization of skill tree (demo)
  - Enables views: adjustable/embedable in your webpage
- Developed prototype for exam process and framework
- Developed various processes
- Designed seal of endorsement
- Engaged with various stakeholders (e.g., SIGHPC Edu)
- Conducted survey to verify the skill tree (more to come!)

All our developments are under open licenses (except the exam questions)

Wiki for Skills



Contribution to the Skill-Tree High-Level Editing

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How can members contribute?

- Webpage with Markdown version controlled in Git
  - https://www.hpc-certification.org/wiki/skill-tree/b
  - GitHub: https://github.com/HPC-certification-forum/skill-tree
    - Pull requests, reviews, comments, ...
- Editing a MindMap, the structure of Skills
  - Synchronized with the skill tree in Git
  - Uses the OpenSource tool Freemind
- Discussion on our Slack
- Details in our videos on YouTube: https://www.youtube.com/playlist?list=PL4b682pSp7MQbdhhvwisrPo7PjYya26_g

Outline

Certification: Assessment Prototype

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1. User takes multiple-choice test online (any time!)
   - A combination of JavaScript and a web service
   - System selects number of questions randomly from a pool
     - The questions are managed with rigorous license agreement
   - System draws 4-5 responses from 10 possible responses (some randomized)
2. Choices are submitted to the web server
3. *Approval* of the result
4. Automatic creation of certificate and returned by email
   - Permanent computer-verifiable proof that skill is created
     - Return a text version with GPG signature
     - Return a link that can be verified on hpc-certification.org

- Privacy: minimize information stored on servers, keep some for statistics
- Includes some measure to prevent cheating and brute forcing (e.g., delay)

Certification: Certificate

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Text representation

```
-----BEGIN PGP SIGNED MESSAGE-----
Hash: SHA512
HPC Certification Forum Certificate
This text confirms that "Jane Doe" has
successfully obtained the certificate
"HPC driving license" (id: 1) at 02/2019.
Verification URL: https://hpc-certification.org/[...]
-----BEGIN PGP SIGNATURE-----
[...]
-----END PGP SIGNATURE-----
```

Certificate

Outline

Outlook and Expected Benefits

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HPC practitioners

- Increase motivation to participate as the certificates are recognized in a CV
- Validate knowledge via tests
- Browse relevant competences
- Identify recommended and required skills related to certain tasks
- Understand and compare teaching offers across sites

Data centers

- Increase sharing of teaching materials
- Simplifies documentation of taught skills
- Identify missing teaching activities
- Tailor skill-representation specifically to users
- Correlate lack of skills with efficient use

Summary

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HPC Certification Program

- Effort to standardize representation/certification of relevant HPC skills
  - Hierarchical definition of skills for practitioners
  - Building blocks that can be cherry-picked for different tasks
  - It's goal is **NOT** to provide content or a linear curriculum
- Perspective for data centers
  - Use statistics and machine learning to direct users to right skills
  - Make certain skills a mandatory requirement?
- Customizable representation and navigation for data centers/domains
  - Interactive viewer to browse skills and related content
  - We will use the viewer to link good content to the skills, too!
- Visit us and join our Slack/mailing lists: `https://hpc-certification.org`