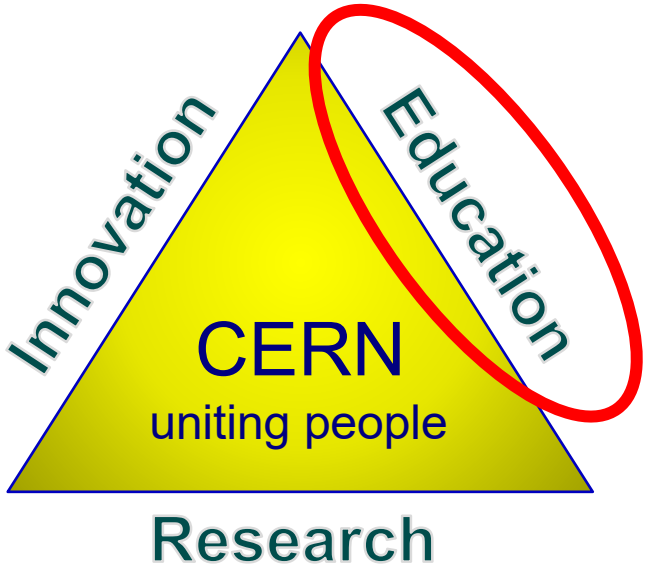

CERN

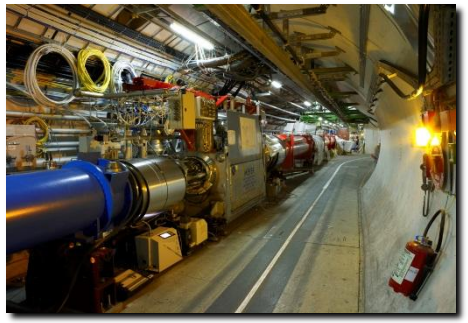
The CERN School of Computing

Alberto Pace, school director

CERN's mission



The CERN School of Computing is here …



Accelerating beams (accelerators)

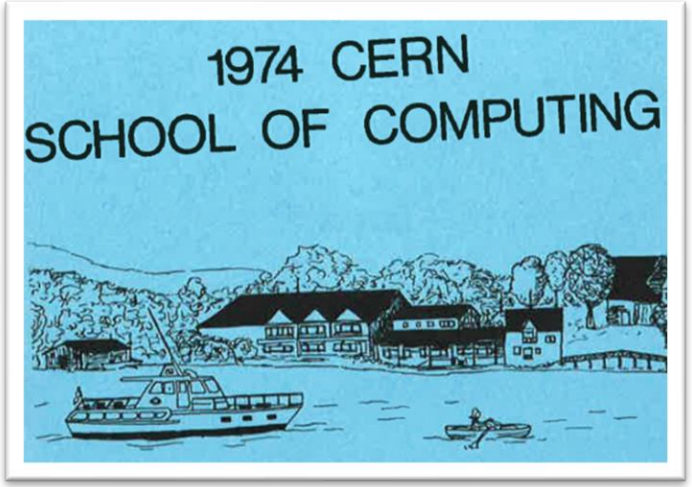
Detecting particles (experiments)

Large-scale computing (Analysis)

Discovery

A school with a long history

- The school was created in 1970, we had 46 editions
- We also had 17 editions of Thematic Schools
- The school has visited 23 countries
  - all member states (except Bulgaria, Slovak Republic) + Croatia, Cyprus, India
- 84+ different nationalities
- 3900+ students have followed the school
- This year we are organizing 7 schools



Mandate and mission

- Create a *common culture* in *scientific computing* among young scientists and engineers involved *in particle physics or other sciences*, as a strategic direction to *promote mobility* and to facilitate the development of large computing-oriented *transnational projects*.
  - http://cern.ch/csc
- Participants come from worldwide laboratories and universities with typically 20 to 30 different nationalities (61 different nationalities in the past 10 years).
  - http://cern.ch/csc/alumni

Bridging science and computing

- The unprecedented technological evolution in computing has profited directly to several scientific research projects, in particular in high energy physics
  - Computing is today the main strategy for many sciences to boost their research productivity
- It is nowadays essential that:
  - Scientists master computing technologies as the main tool for their research
  - Computer scientists understand the scientific domain of the investigation to deliver computing services that meet the needs of the research project

An additional side effect …

- … knowledge transfer of (CERN) skills and (CERN) know-how in computing to academic, national laboratories, research institutes, institutional and industrial circles in Member States and other countries
  - With direct or potential applications up to all spheres of the society (as exemplified with the Web, and the Grid).

The CERN Schools of computing

- The Main School
  - Two weeks, ~ 60 participants *(58 - 82 in last years)*
  - Multiple topics on scientific computing
  - This school: 69 participants
- The Thematic schools
  - Goes more in depth on a particular topic
  - Smaller participation, shorter duration (one week), clear goals
  - This year, three schools 38. 42 participants. One more to come
- (New) Regional Schools
  - Next year in Santiago, Chile (January 2025)
- The School on IT services
- The Inverted school
  - It is frequent to find among students real experts on specific topics, and the cumulated knowledge of the students exceeds the one of lecturers.
  - At the end of each school, we invite students to propose some lectures, and we organize an “inverted” school. *“Where students turn into teachers”*
  - In 2025, the 16th edition had 16 lecturers and hundreds participants

The School Academic Dimension

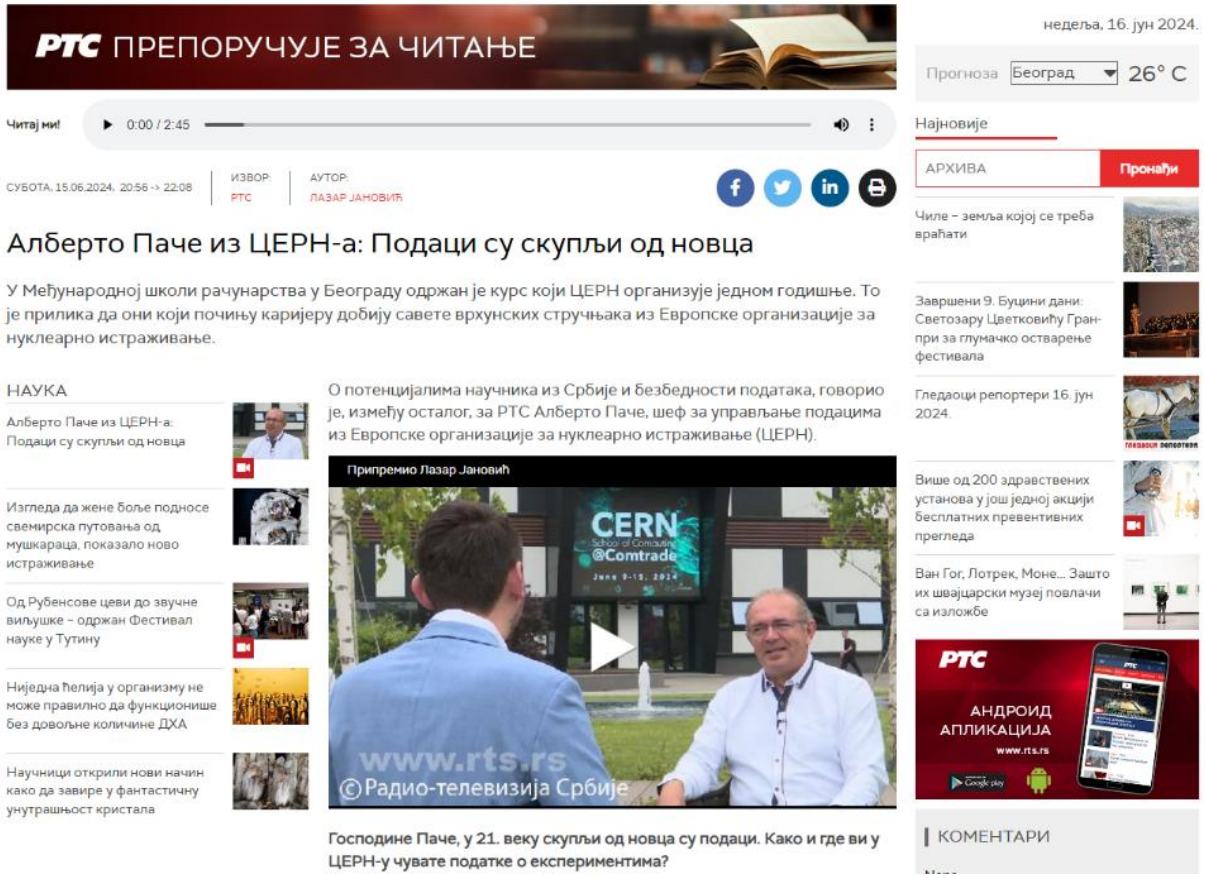
- The school …
  - … is not a conference
  - … is not a place for lecturers to present their work, promote their projects
  - Does not replicate of common training available at home institutes, or in member state's universities
  - Does not delivering "technical training" courses

- Focus on **persistent knowledge**, less notions and knowhow

An outreach opportunity

- For the local organizers


ΚΑΘΗΜΕΡΙΝΗ
ΚΑΒΑΛΑ
ΚΑΘΗΜΕΡΙΝΗ ΕΦΗΜΕΡΙΔΑ ΤΗΣ ΚΑΒΑΛΑΣ
Χρόνος 41ος - Αριθμός Φύλλου 11097 Παρασκευή 11 Σεπτεμβρίου 2015 Τιμή φύλλου 0,50 EURO
Θερινό Σχολειό Ηλεκτρονικής με 75 μεταπτυχιακούς φοιτητές θα διοργανώσει το ΤΕΙ Καβάλας
Μεγάλη διοργάνωση, πολλαπλά τα κέρδη


PTC ПРЕПОРУЧУЈЕ ЗА ЧИТАЊЕ
Читај ми! 0:00 / 2:45
СУБОТА, 15.06.2024. 20:56 -> 22:08 | ИЗВОР: РТС | АУТОР: ЛАЗАР ЈАНОВИЋ
Алберто Пече из ЦЕРН-а: Подаци су скупљи од новца
У Међународној школи рачунарства у Београду одржан је курс који ЦЕРН организује једном годишње. То је прилика да они који почињу каријеру добију савете врхунских стручњака из Европске организације за нуклеарно истраживање.
НАУКА
Алберто Пече из ЦЕРН-а: Подаци су скупљи од новца
Изгледа да жене боље подносе свемирска путовања од мушкараца, показало ново истраживање
Од Рубенсове цеви до звучне виљушке – одржан Фестивал науке у Тутину
Ниједна ћелија у организму не може правилно да функционише без довољне количине ДХА
Научници открили нови начин како да завире у фантастичну унутрашњост кристала
О потенцијалима научника из Србије и безбедности података, говорио је, између осталог, за РТС Алберто Пече, шеф за управљање подацима из Европске организације за нуклеарно истраживање (ЦЕРН).
Припремио Лазар Јановић
CERN School of Computing @Comtrade
www.rts.rs
©Радио-телевизија Србије
Господине Пече, у 21. веку скупљи од новца су подаци. Како и где ви у ЦЕРН-у чувате податке о експериментима?
недеља, 16. јун 2024.
Прогноза Београд 26° C
Најновије
АРХИВА Пронађи
Чиле – земља којој се треба враћати
Завршени 9. Буцини дани: Светозару Цветковићу Гран-при за глумачко остварење фестивала
Гледаоци репортери 16. јун 2024.
Више од 200 здравствених установа у још једној акцији бесплатних превентивних прегледа
Ван Гог, Лотрек, Моне... Зашто их швајцарски музеј повлачи са изложбе
PTC АНДРОИД АПЛИКАЦИЈА www.rts.rs
КОМЕНТАРИ

An outreach opportunity

- For CERN

CERN@DESY public event

1954-2024 JAHRE CERN

18 September 2024

DESY

Overview | Timetable | Speakers | Registration | Getting to DESY | Privacy policy

Have you ever heard of CERN and wondered what the researchers are working on? Or would you like to know more about career opportunities at one of the world's largest research centres?

Join us at the **CERN@DESY public event** on **18 September** to listen to expert presentations on what CERN is doing in general, the computing challenges CERN faces and what opportunities CERN offers for students and early stage professionals.

This public event is part of the CERN School of Computing 2024 which is hosted at DESY. After the presentations, you are cordially invited to stay for a networking reception to continue the discussion and meet the speakers and the students of the CERN School of Computing coming from 32 countries.

Please register for this event by 11 September 23:59.

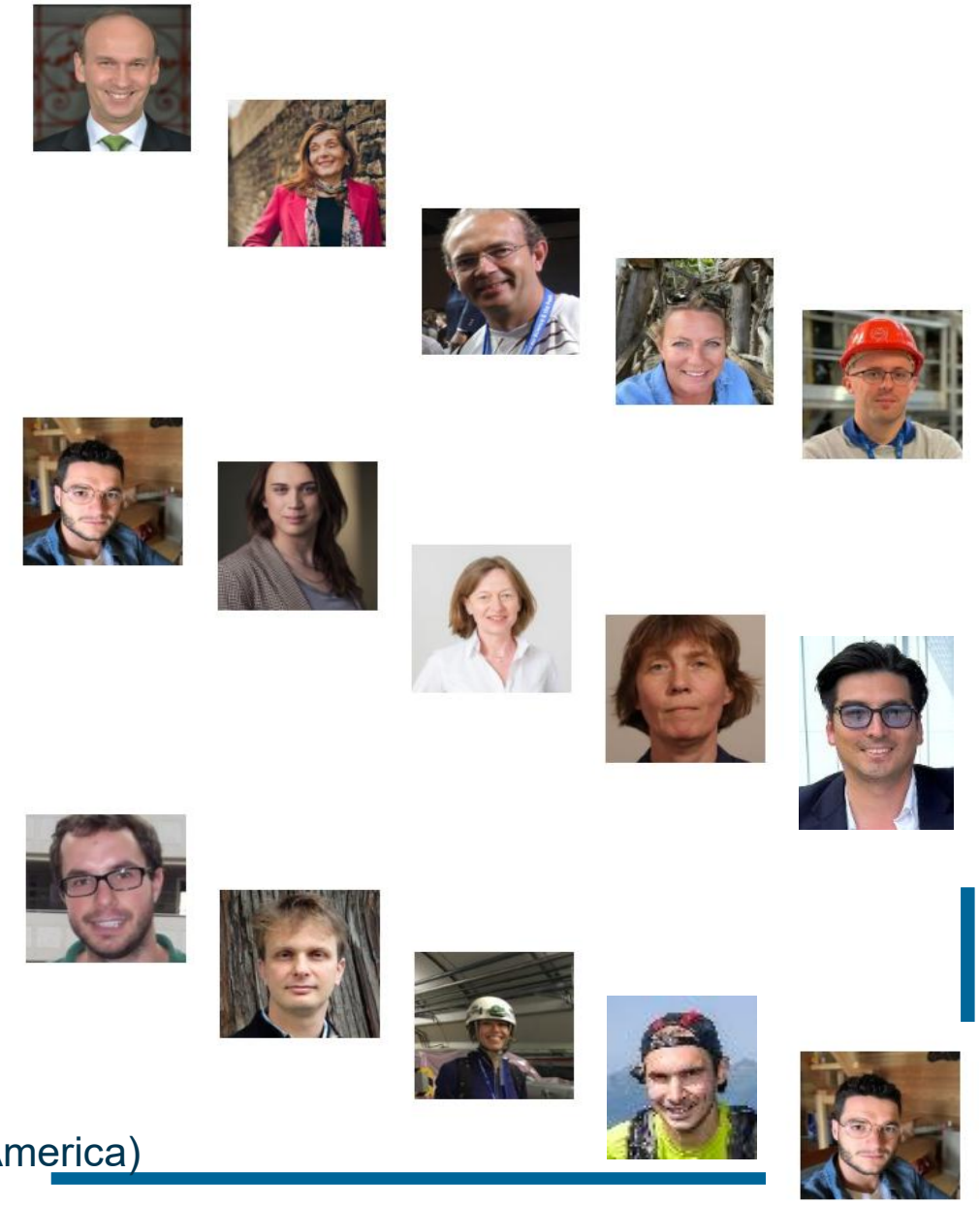
This event will also be available via Zoom (link will be provided later), but physical presence is preferred.

The school governance

- … is discussed at the School Advisory Committee
  - Includes several fulltime university professors from different countries
  - Two meetings per year

The School Advisory Committee

- Chairman: Arnulf Quadt, Georg-August-University of Göttingen
- Ex-officio members:
  - Enrica Porcari, Head of CERN IT department
  - Alberto Pace, School Director
  - Kristina Gunne, School Administrative Manager
  - Andrzej Nowicki, School Technical Manager
- Members:
  - Toni Šćulac, Faculty of Science Split
  - Veronika Zadin, Tartu University
  - Judith Katzy, Berlin Humboldt University
- Members representing the Local Organizing Committee
  - Oxana Smirnova, Lund University
  - Felipe Olivares, Instituto Saphir, Santiago Chile
- Members representing the program committee of the thematic schoo
  - Danilo Piparo, CERN (School heterogeneous computing)
  - Sebastian Lopienski, CERN (School on Computing Security)
  - Verena Kain, CERN (School on Machine Learning)
  - Sebastien Ponce, CERN (School on IT Services)
  - Toni Šćulac, Faculty of Science Split (Regional School in Latin America)



The school core team

Kristina Gunne
Administrator

Andrzej Nowicki
Technical Manager

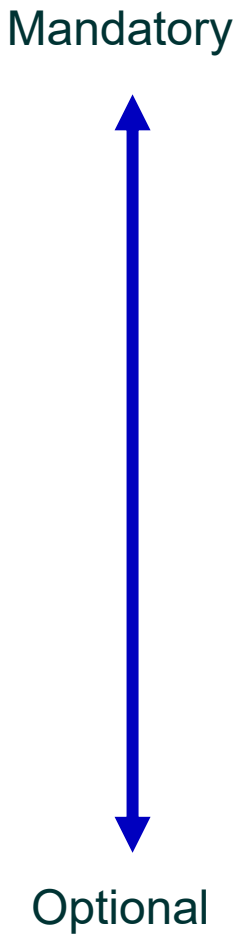
Alberto Pace
Director

The School site is on indico

- https://cern.ch/csc
- https://indico.cern.ch/event/1512761
- Check it regularly for updates

The school learning process

- Learning process
  - Lectures
  - Exercises
  - Exam
- Meet special persons,
  Build trusts with colleagues across the world
  - Lunches, dinners, coffee breaks, evenings
  - Excursions
  - Music events
  - Sport programme



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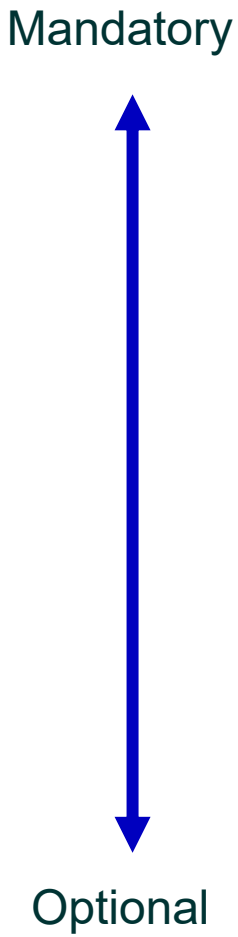
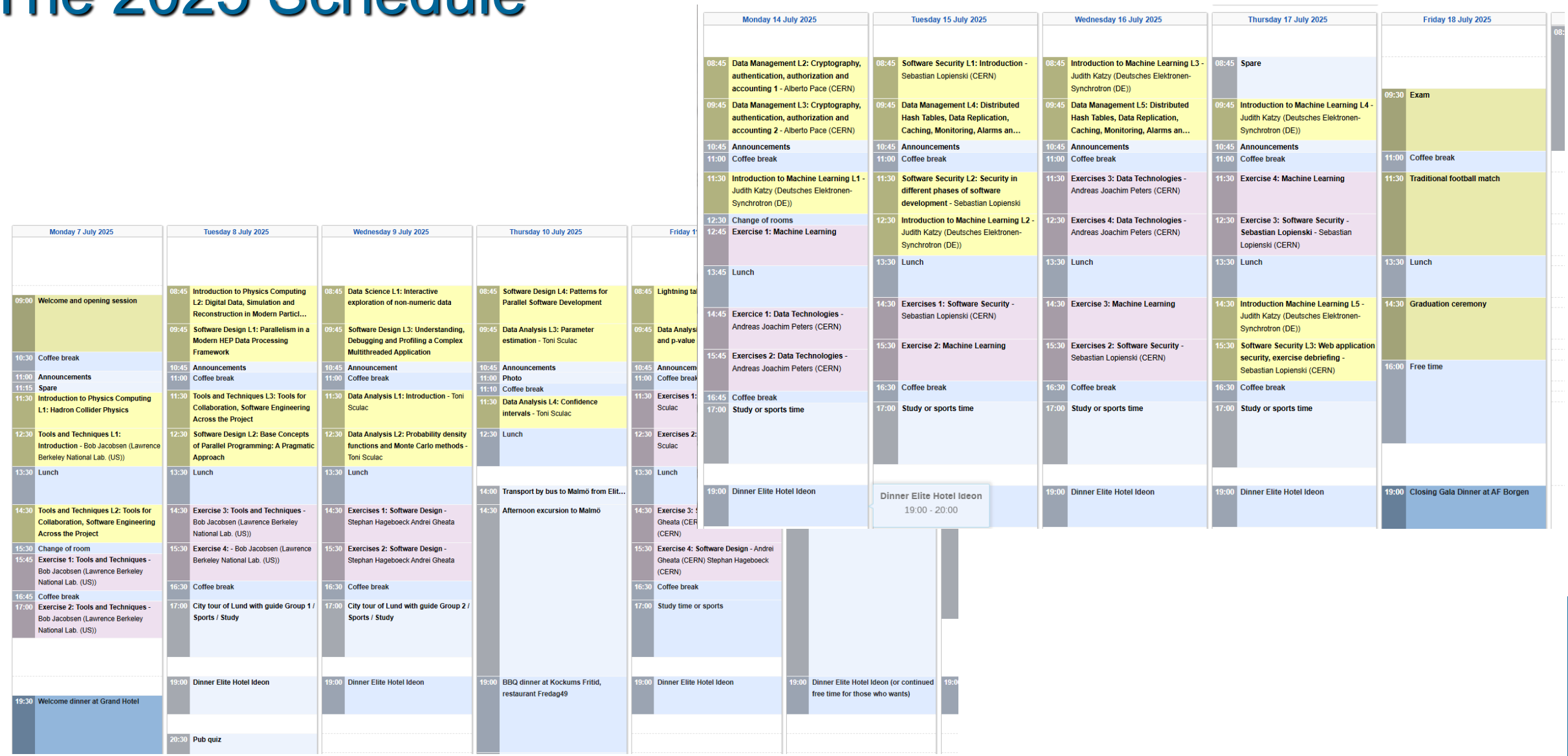


The 2025 academic programme

- Physics Computing
  - Introduction to Physics Computing
  - Data Science and Interactive Data Exploration
  - Data Analysis
  - Introduction to Machine Learning
- Software Engineering
  - Tools and Techniques
  - Software Design in the Many-Cores Era
  - Creating Secure Software
- Data Technologies
  - Data Management
  - Data and Storage Technologies

The 2025 Schedule



Monday 7 July 2025

- 09:00 Welcome and opening session
- 10:30 Coffee break
- 11:00 Announcements
- 11:15 Spare
- 11:30 Introduction to Physics Computing L1: Hadron Collider Physics
- 12:30 Tools and Techniques L1: Introduction - Bob Jacobsen (Lawrence Berkeley National Lab. (US))
- 13:30 Lunch
- 14:30 Tools and Techniques L2: Tools for Collaboration, Software Engineering Across the Project
- 15:30 Change of room
- 15:45 Exercise 1: Tools and Techniques - Bob Jacobsen (Lawrence Berkeley National Lab. (US))
- 16:45 Coffee break
- 17:00 Exercise 2: Tools and Techniques - Bob Jacobsen (Lawrence Berkeley National Lab. (US))
- 19:30 Welcome dinner at Grand Hotel

Tuesday 8 July 2025

- 08:45 Introduction to Physics Computing L2: Digital Data, Simulation and Reconstruction in Modern Particl…
- 09:45 Software Design L1: Parallelism in a Modern HEP Data Processing Framework
- 10:45 Announcements
- 11:00 Coffee break
- 11:30 Tools and Techniques L3: Tools for Collaboration, Software Engineering Across the Project
- 12:30 Software Design L2: Base Concepts of Parallel Programming: A Pragmatic Approach
- 13:30 Lunch
- 14:30 Exercise 3: Tools and Techniques - Bob Jacobsen (Lawrence Berkeley National Lab. (US))
- 15:30 Exercise 4: - Bob Jacobsen (Lawrence Berkeley National Lab. (US))
- 16:30 Coffee break
- 17:00 City tour of Lund with guide Group 1 / Sports / Study
- 19:00 Dinner Elite Hotel Ideon
- 20:30 Pub quiz

Wednesday 9 July 2025

- 08:45 Data Science L1: Interactive exploration of non-numeric data
- 09:45 Software Design L3: Understanding, Debugging and Profiling a Complex Multithreaded Application
- 10:45 Announcement
- 11:00 Coffee break
- 11:30 Data Analysis L1: Introduction - Toni Sculac
- 12:30 Data Analysis L2: Probability density functions and Monte Carlo methods - Toni Sculac
- 13:30 Lunch
- 14:30 Exercises 1: Software Design - Stephan Hageboeck Andrei Gheata
- 15:30 Exercises 2: Software Design - Stephan Hageboeck Andrei Gheata
- 16:30 Coffee break
- 17:00 City tour of Lund with guide Group 2 / Sports / Study
- 19:00 Dinner Elite Hotel Ideon

Thursday 10 July 2025

- 08:45 Software Design L4: Patterns for Parallel Software Development
- 09:45 Data Analysis L3: Parameter estimation - Toni Sculac
- 10:45 Announcements
- 11:00 Photo
- 11:10 Coffee break
- 11:30 Data Analysis L4: Confidence intervals - Toni Sculac
- 12:30 Lunch
- 14:00 Transport by bus to Malmö from Elit…
- 14:30 Afternoon excursion to Malmö
- 19:00 BBQ dinner at Kockums Fritid, restaurant Fredag49

Friday 11

- 08:45 Lightning ta
- 09:45 Data Analysi and p-value
- 10:45 Announcem
- 11:00 Coffee break
- 11:30 Exercises 1: Sculac
- 12:30 Exercises 2: Sculac
- 13:30 Lunch
- 14:30 Exercise 3: Gheata (CER (CERN)
- 15:30 Exercise 4: Software Design - Andrei Gheata (CERN) Stephan Hageboeck (CERN)
- 16:30 Coffee break
- 17:00 Study time or sports
- 19:00 Dinner Elite Hotel Ideon

Monday 14 July 2025

- 08:45 Data Management L2: Cryptography, authentication, authorization and accounting 1 - Alberto Pace (CERN)
- 09:45 Data Management L3: Cryptography, authentication, authorization and accounting 2 - Alberto Pace (CERN)
- 10:45 Announcements
- 11:00 Coffee break
- 11:30 Introduction to Machine Learning L1 - Judith Katzy (Deutsches Elektronen-Synchrotron (DE))
- 12:30 Change of rooms
- 12:45 Exercise 1: Machine Learning
- 13:45 Lunch
- 14:45 Exercice 1: Data Technologies - Andreas Joachim Peters (CERN)
- 15:45 Exercises 2: Data Technologies - Andreas Joachim Peters (CERN)
- 16:45 Coffee break
- 17:00 Study or sports time
- 19:00 Dinner Elite Hotel Ideon

Tuesday 15 July 2025

- 08:45 Software Security L1: Introduction - Sebastian Lopienski (CERN)
- 09:45 Data Management L4: Distributed Hash Tables, Data Replication, Caching, Monitoring, Alarms an…
- 10:45 Announcements
- 11:00 Coffee break
- 11:30 Software Security L2: Security in different phases of software development - Sebastian Lopienski
- 12:30 Introduction to Machine Learning L2 - Judith Katzy (Deutsches Elektronen-Synchrotron (DE))
- 13:30 Lunch
- 14:30 Exercises 1: Software Security - Sebastian Lopienski (CERN)
- 15:30 Exercise 2: Machine Learning
- 16:30 Coffee break
- 17:00 Study or sports time

Dinner Elite Hotel Ideon
19:00 - 20:00

Wednesday 16 July 2025

- 08:45 Introduction to Machine Learning L3 - Judith Katzy (Deutsches Elektronen-Synchrotron (DE))
- 09:45 Data Management L5: Distributed Hash Tables, Data Replication, Caching, Monitoring, Alarms an…
- 10:45 Announcements
- 11:00 Coffee break
- 11:30 Exercises 3: Data Technologies - Andreas Joachim Peters (CERN)
- 12:30 Exercises 4: Data Technologies - Andreas Joachim Peters (CERN)
- 13:30 Lunch
- 14:30 Exercise 3: Machine Learning
- 15:30 Exercises 2: Software Security - Sebastian Lopienski (CERN)
- 16:30 Coffee break
- 17:00 Study or sports time
- 19:00 Dinner Elite Hotel Ideon

Thursday 17 July 2025

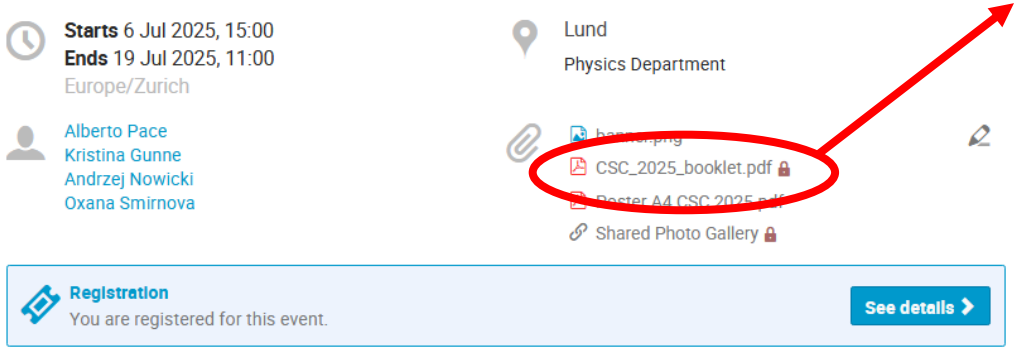
- 08:45 Spare
- 09:45 Introduction to Machine Learning L4 - Judith Katzy (Deutsches Elektronen-Synchrotron (DE))
- 10:45 Announcements
- 11:00 Coffee break
- 11:30 Exercise 4: Machine Learning
- 12:30 Exercise 3: Software Security - Sebastian Lopienski - Sebastian Lopienski (CERN)
- 13:30 Lunch
- 14:30 Introduction Machine Learning L5 - Judith Katzy (Deutsches Elektronen-Synchrotron (DE))
- 15:30 Software Security L3: Web application security, exercise debriefing - Sebastian Lopienski (CERN)
- 16:30 Coffee break
- 17:00 Study or sports time
- 19:00 Dinner Elite Hotel Ideon

Friday 18 July 2025

- 09:30 Exam
- 11:00 Coffee break
- 11:30 Traditional football match
- 13:30 Lunch
- 14:30 Graduation ceremony
- 16:00 Free time
- 19:00 Closing Gala Dinner at AF Borgen

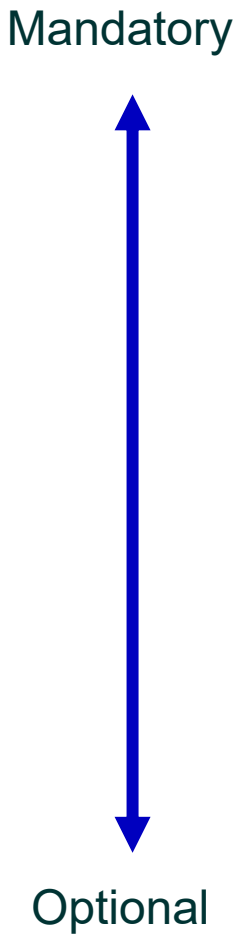
School booklet

- Printed version for those who asked
- Electronic version (PDF) Linked from school main page on Indico
  - https://indico.cern.ch/event/1407896/
- Contains pictures and short biographies of all participants



The school learning process

- Learning process
  - Lectures
  - Exercises
  - Exam
- Meet special persons,
  Build trusts with colleagues across the world
  - Lunches, dinners, coffee breaks, evenings
  - Excursions
  - Music events
  - Sport programme



The School culture in “exercises”

- The school has an entire computing infrastructure for exercises. Remotely accessible to the students
  - The computing infrastructure is provided by the CERN IT department and it is identical to what is used in real analysis at CERN
- You should try to work in pair (2-student teams). If possible:
  - 1 student with physics background
  - 1 student with computing background

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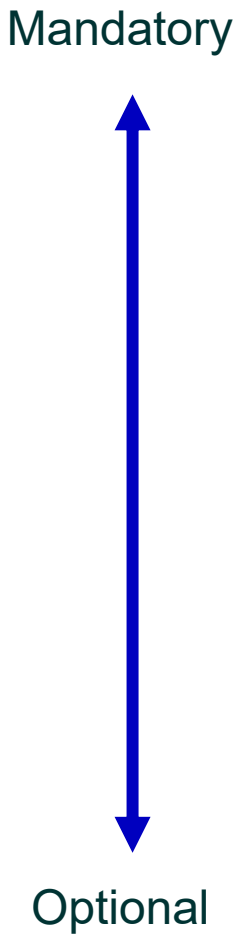

The exam

- A serious and difficult exam, which delivers the diploma and ECTS credits
- ECTS credits from the University of Göttingen
- Evaluate knowledge in two fields
  - Physics
  - Computing

An exam part of the learning process

- The test statistic is usually a single number whose value ...
  - ... reflects an agreement between the data and the hypothesis.
  - ... is equivalent to the mean value of the data sample.
  - ... must be equal to the most probable value of the distribution in question.
  - ... is never larger than the difference between values of variances of two competing hypotheses.

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An exam part of the learning process

- In the process of hypotheses testing, we often define the null and the alternative hypotheses. The most robust final results are obtained for ...
  - ... the acceptance of the alternative hypothesis.
  - ... the rejection of the difference between null and alternative hypothesis.
  - ... the acceptance of the ratio of null and alternative hypothesis.
  - ... the rejection of the null hypothesis.

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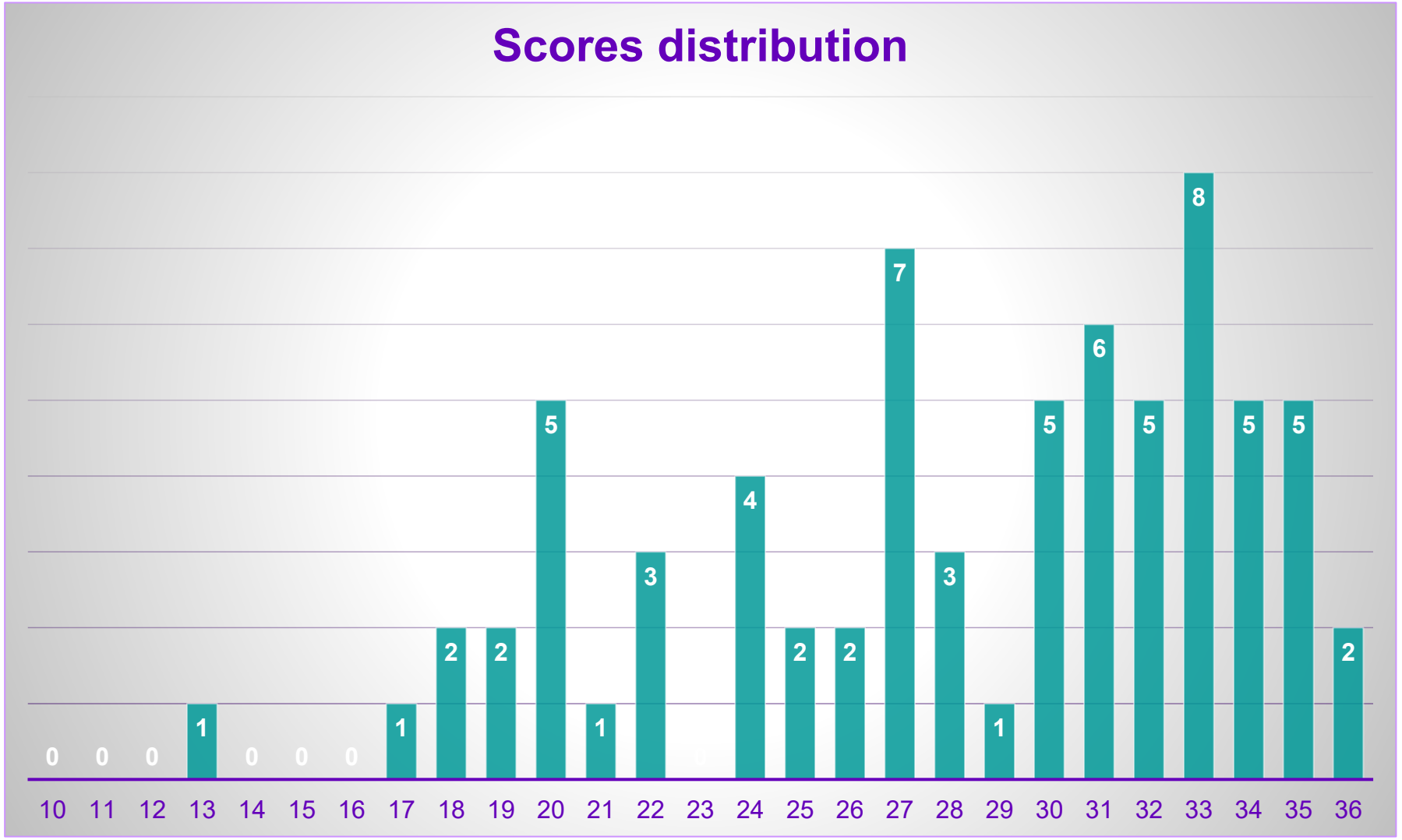
Exam


Scores distribution
0 0 0 1 0 0 0 1 2 2 5 1 3 0 4 2 2 7 3 1 5 6 5 8 5 5 2
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

The school learning process

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- Meet special persons,
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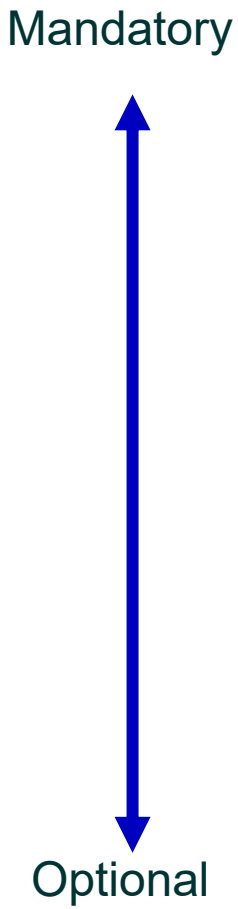
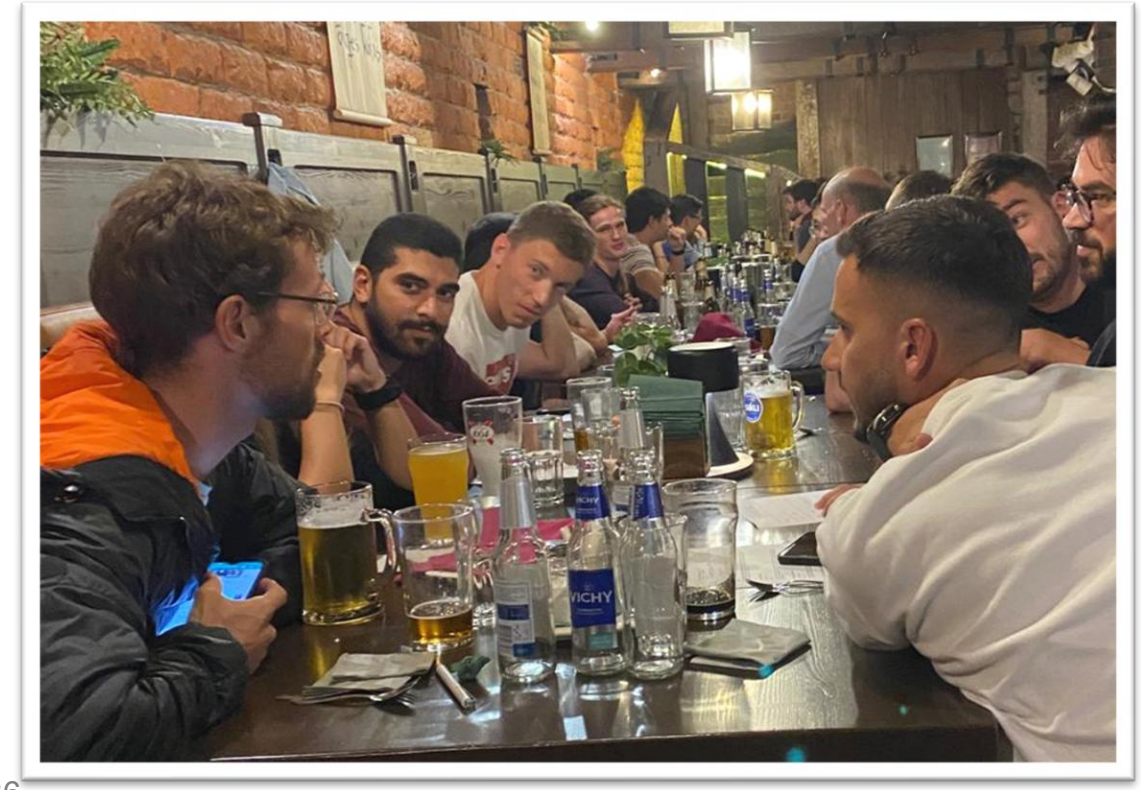
  - Excursions
  - Music events
  - Sport programme
- Provide a work-life balance & additional opportunities for interactions between all participants (students, lecturers and organisers)



Lunch and Dinners

- Mix of Students + lecturers
- Tables of 8 - 12 persons



(Optional) Social programme

- Excursions
  - Culture
  - History
  - Nature

(Optional) Social programme

- Social games

(Optional) Social programme

- Sports
- A couple hours of sports

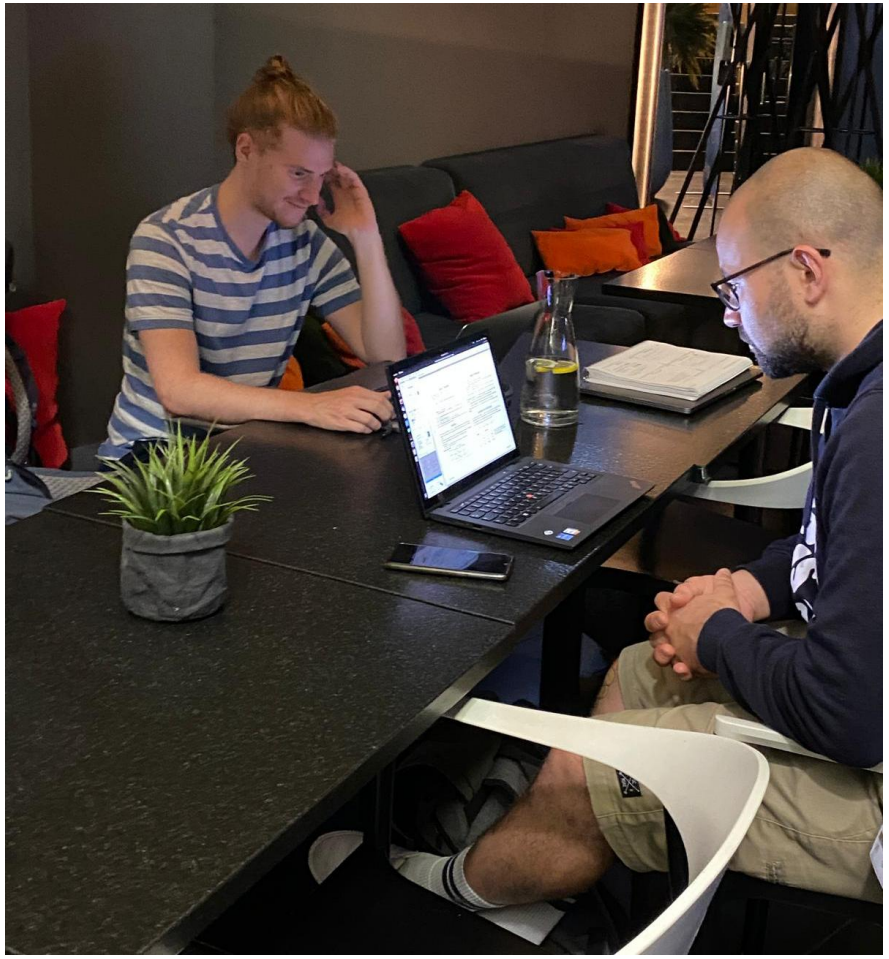
(Optional) Social programme

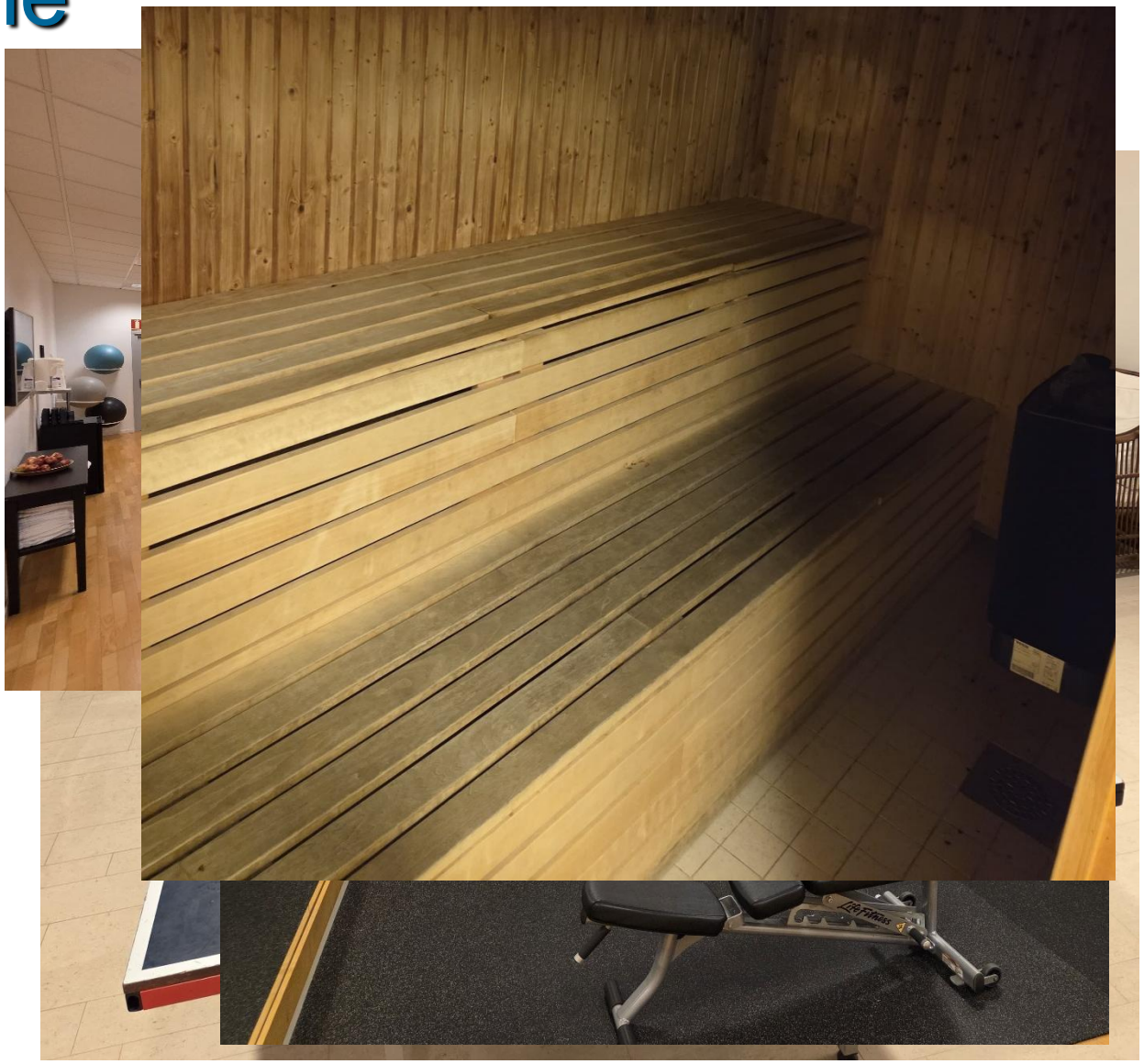
- Music
- Many participants have hidden talents

universal values across cultures

(Optional) Social programme

- Study at the hotel





(Optional) Social programme

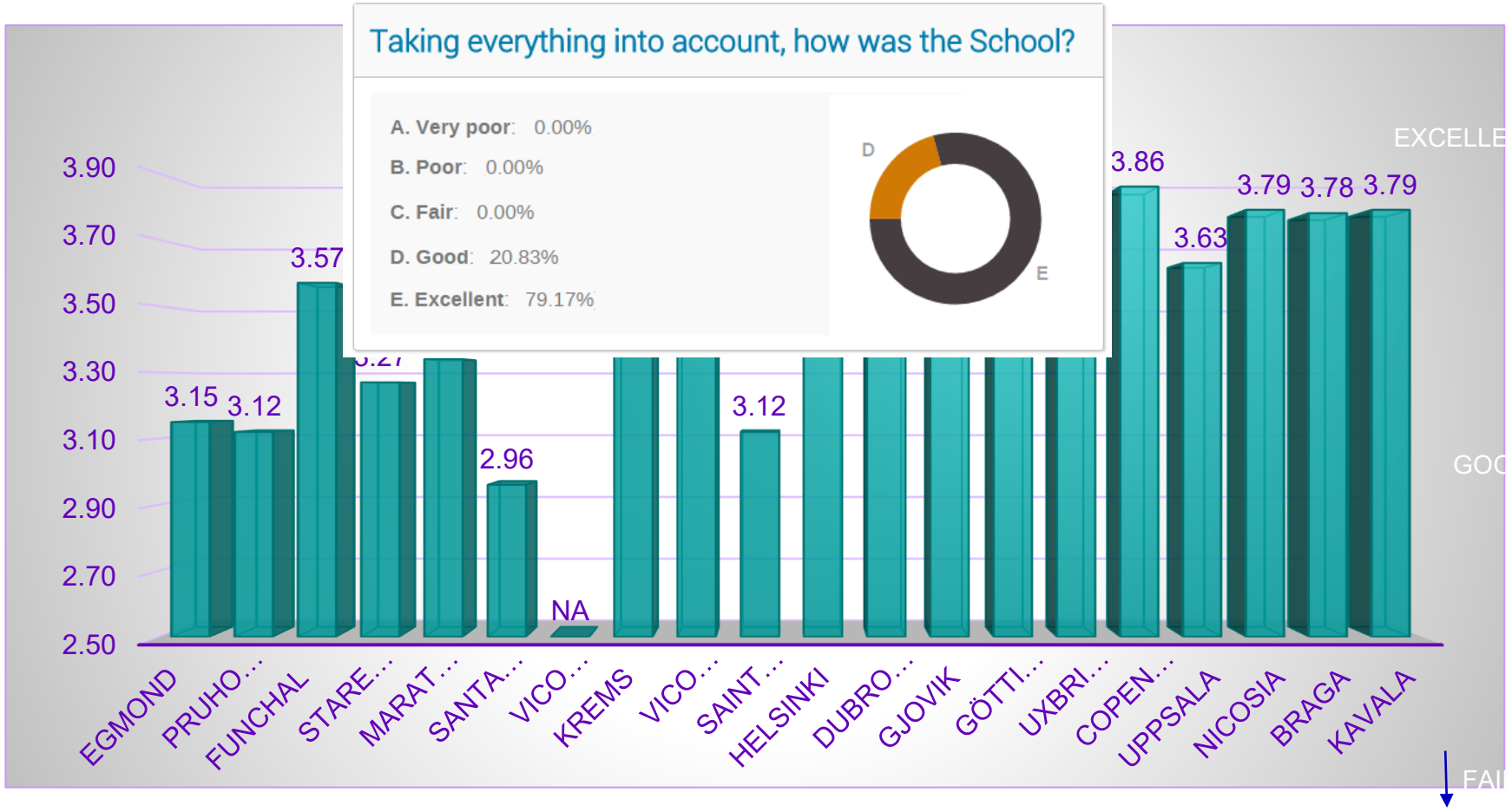
- Farniente

WhatsApp group

- Unofficial communication channel
- We recommend you to join the group
- Autojoin link:

The school evaluation

- We evaluate lectures, lecturers, exercises, activities, food, hotel,…



the participants give the most value to the school !

Why ?

This school numbers

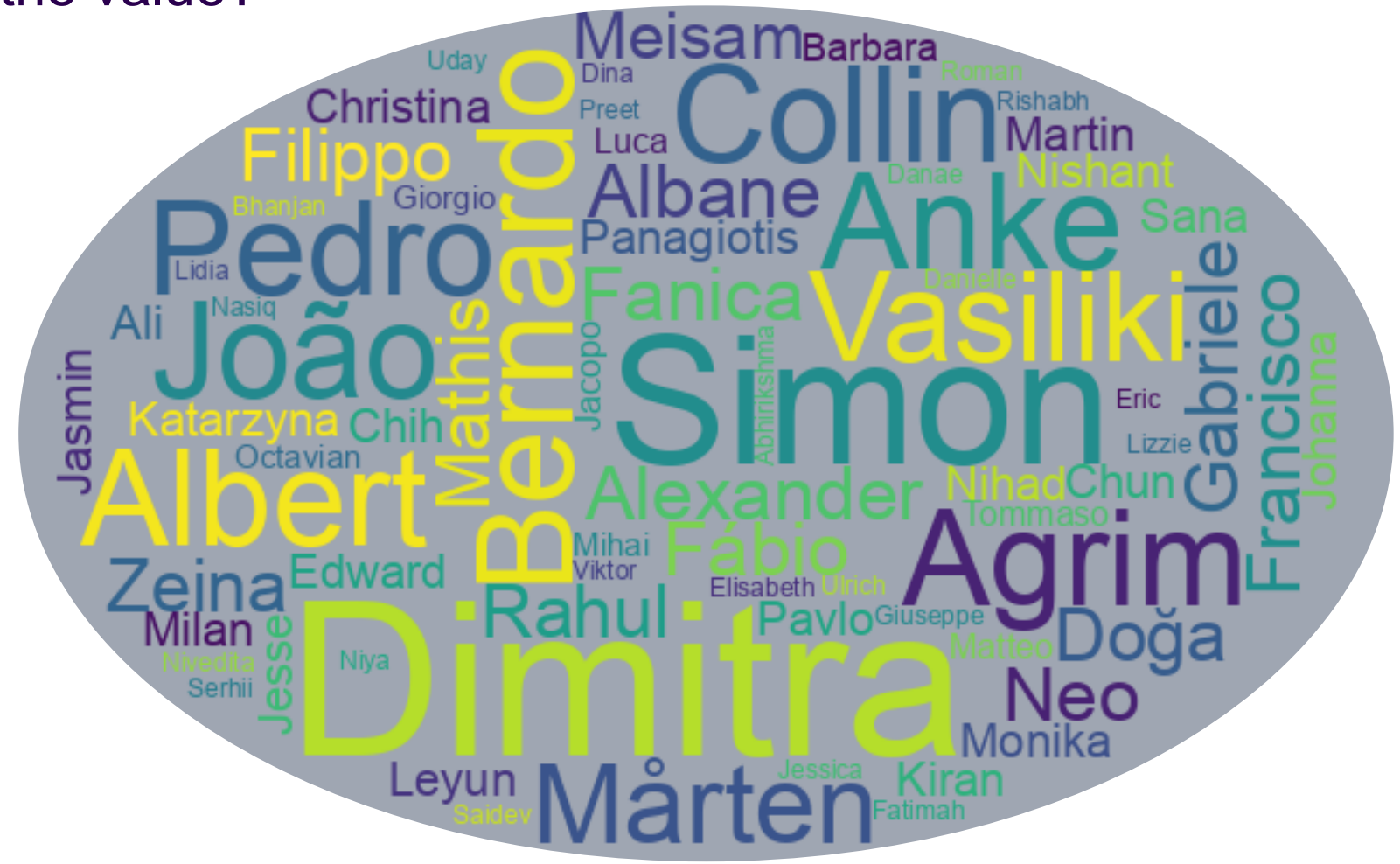
- 130 applicants, 38 nationalities
  - Algeria, Argentina, Austria, Belgium, Bosnia & Herzegovina, Brazil, China, Ethiopia, France, Germany, Greece, India, Iran, Ireland, Italy, Kuwait, Lebanon, Mexico, Morocco, Nepal, Netherlands, Nigeria, Norway, Pakistan, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, Taiwan, Türkiye, Ukraine, United Kingdom, United States
  - 35% female participants (45/130)
- 77 institutes
  - Alfonso X El Sabio University, Alikhanyan National Science Laboratory (AANL), American University of Beirut, Aristotle University of Thessaloniki (GR), BITS Pilani Dubai, Brandenburg University of Technology (BTU) Cottbus-Senftenberg, California Institute of Technology, CERN, Chaitanya Bharathi Institute of Technology, Charles University (CZ), CNRS, CC-IN2P3, Debark University, Deutsches Elektronen-Synchrotron (DE), ESS (European Spallation Source), ETH Zurich (CH), Gebze Tehnical University, Georg August Universitaet Goettingen (DE), Goethe University Frankfurt (DE), Heidelberg University (DE), HEPHY, TU Wien, IBM, Indian Institute of Technology Bhubaneswar, Indian Institute of Technology Roorkee, Institut National des Sciences Appliquées de Lyon, Institute for Research in Fundamental Sciences (IR), ITS - Information Technology School, İzmir Democracy University, Jagiellonian University, LAPP (CNRS), Lund University, Max Planck Institute for Physics, Mohammed 5 University, National and Kapodistrian University of Athens (GR), National Center for Physics, Islamabad, National high school of artificial intelligence, National Institute of Nanotechnology, Turkey, Neils Bohr Institute - University of Copenhagen, Peking University, Rheinisch Westfaelische Tech. Hoch. (DE), Rice University (US), Science and Technology Facilities Council (STFC), Scuola Normale Superiore & INFN Pisa (IT), Serl elmorodj wa elindjazet, Shri G.S Institute of Information Science Technology, Technische Universität Wien (AT), Thapar Institute of Engineering and technology, Thapar University Patiala, Uba, UK Research and Innovation (UKRI), Unesp Sao Paulo Brazil, Universidad Complutense Madrid, Universidad de Málaga, Universidade Federal do Rio Grande do Sul (BR), Universita e INFN Torino (TO), Università La Sapienza di Roma, Universitaet Aachen (DE), Universität Münster (DE), Universitat Oberta de Catalunya, Universite Hassan II, Ain Chock (MA), Université Paris-Saclay (FR), University of Bonn, University of Calgary, University of Constantine 1, University of Ferrara, University of Lagos, University of Lahore, University of Naples Federico II, University of Oslo (NO), University of Petroleum and Energy Studies, University of Sonora, University of Texas at Arlington (US), University of Toronto, University of Wisconsin Madison (US), Vanderbilt University (US), Vienna University of Technology (AT), Vrije Universiteit Brussel (BE), Washington University in St. Louis

This school numbers

- 69 participants selected
- 27 applicant nationalities
  - Austria, Belgium, Bosnia & Herzegovina, China, France, Germany, Greece, India, Iran, Italy, Lebanon, Netherlands, Norway, Pakistan, Poland, Portugal, Romania, Russia, Serbia, Spain, Sweden, Switzerland, Taiwan, Türkiye, Ukraine, United Kingdom, United States
- 35% female participation (24/69)
- 37 institutes
  - Alfonso X El Sabio University, American University of Beirut, Aristotle University of Thessaloniki. Brandenburg University of Technology. CERN, Charles University. CNRS, CC-IN2P3, Deutsches Elektronen-Synchrotron (DESY), ETH Zurich. European Spallation Source (ESS), Georg August University Goettingen. Goethe University Frankfurt, Heidelberg University. HEPHY TU Wien, Indian Institute of Technology Bhubaneswar, Information Technology School ITS (Belgrade), Jagiellonian University, LAPP CNRS, Lund University, Max Planck Institute for Physics, National and Kapodistrian University of Athens. Neils Bohr Institute - University of Copenhagen, Peking University, Rheinisch Westfaelische Tech. Hoch.. Rice University. Science and Technology Facilities Council (STFC), Scuola Normale Superiore & INFN Pisa. Technische Universität Wien, University of Bonn, University of Aachen. University of Ferrara, University of INFN Torino. University of Oslo. University of Wisconsin Madison, Vanderbilt University. Vienna University of Technology. Vrije University Brussel

So, we have quite some diversity …

- But where is the value?



Excerpts from reference letters

- … was among the top students in this course.
- Having supervised . for about two years now, I confidently rank … within the top 10% of PhD students at this stage of their studies at our institution
- … is in the top 10 % of the many PhD students I have encountered.
- At the end of the master… was among the top 5 best students of the class.
- … is one of the best students I have ever met at the B.S. level
- In the final exam, which is arguable the toughest element, … scored maximum points (100%) and received an A+.
- Scholarship awarded to the top 1000 students in the country on the basis of a merit test
- Among all the students I have supervised or collaborated with over the past 15 years of my research, I can confidently rank … in the top 5%
- … consistently stood out for … exceptional mathematical aptitude, sharp analytical thinking, and consistent performance. … ranked in the top 1% of students I have taught over the past five years
- In respect of … research skills, I would rank … in the top 1% of the students I have mentored in the past ten years.

Who are the CSC participants ?

- You are young, diverse, come from many countries, from different institutes …
- You have all an outstanding potential and a passion for both computing and science.
- You will work together one weeks to widen your skills but also establish lifetime links with other participants and research institutes across the world that will be useful throughout your future career.
- This is what gives the highest value to the school

It is a small world …

- All top scientists knows each other very well

CSC 2022, Krakow, Poland

CSC 2023, Tartu, Estonia

CSC 2024 (Hamburg)

Kaare

CSC 2025, Lund, Sweden

tCSC Computing Security, Abington, 6-12 April


CERN