96082 – Computer Science for High Energy Physics – Modules 1, 2, 3
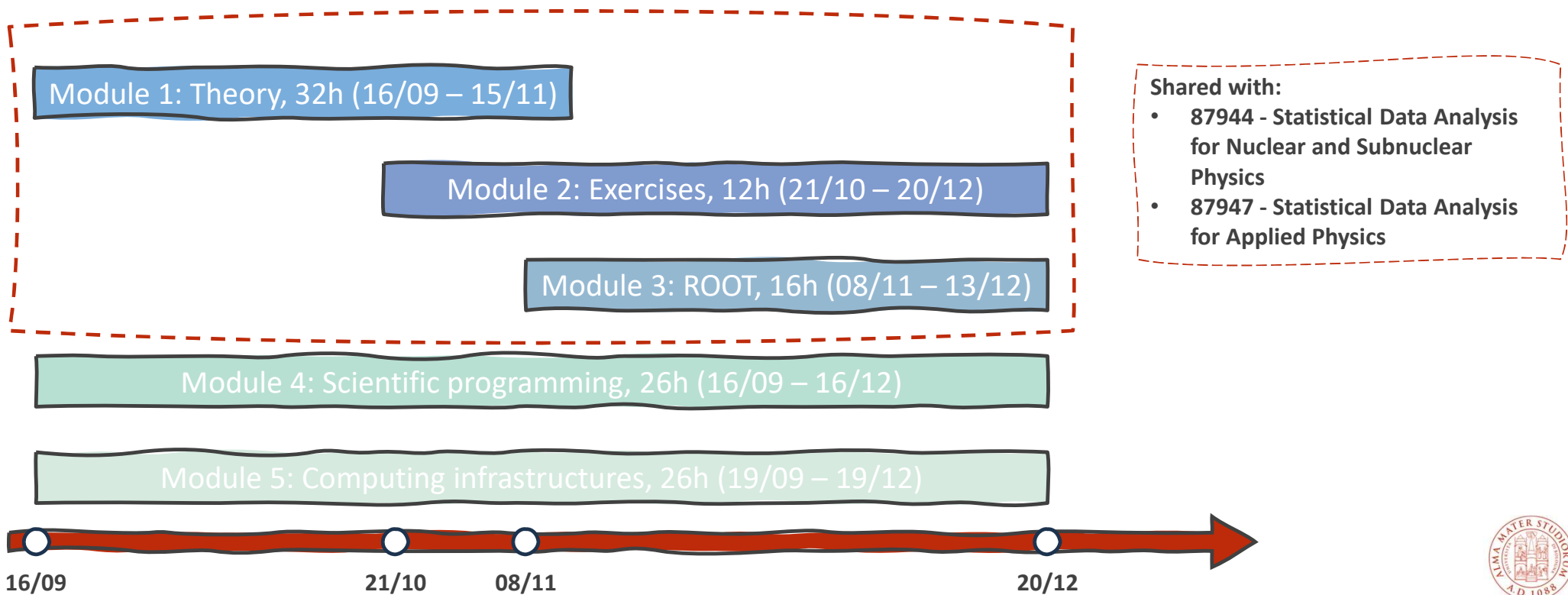
Luca Clissa

Department of Physics and Astronomy «Augusto Righi»

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Course structure

- 5 modules, 12 Credits
- 3 modules shared with degrees in Nuclear and Subnuclear Physics, Applied Physics

Module 1: Theory, 32h (16/09 – 15/11)

Module 2: Exercises, 12h (21/10 – 20/12)

Module 3: ROOT, 16h (08/11 – 13/12)

Module 4: Scientific programming, 26h (16/09 – 16/12)

Module 5: Computing infrastructures, 26h (19/09 – 19/12)

Shared with:
- **87944 - Statistical Data Analysis for Nuclear and Subnuclear Physics**
- **87947 - Statistical Data Analysis for Applied Physics**

16/09   21/10   08/11   20/12

Module 1: Theory

Lecturer: Luca Clissa

Researcher @ Unibo & INFN

Research on Deep Learning and Artificial Intelligence in ATLAS experiment:

- Deep Learning methods for point clouds
- Computer Vision for cell recognition
- Quantum Machine Learning

Program:

- Fundamentals of probability and statistics
- Random variables and probability distributions
- Parameter estimation
- Statistical inference and hypothesis testing

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Module 2: Exercises and complements

Lecturer: Matteo Negrini

Researcher @ INFN

Research on Physics and Computing in ATLAS:

- Top quark
- Software development

Program:

- Exercises: e.g. parameter estimation, computing probabilities, hypothesis testing…
- Monte Carlo
- Unfolding
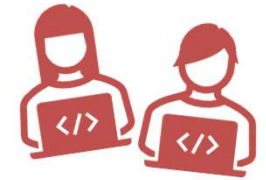
Module 3: ROOT laboratories

Lecturer: Gabriele Sirri

Senior Researcher @ INFN

Experimental physicist in DUNE experiment:

- Neutrinos
- Dark universe

Program:

- **Practical** intro to advanced statistical tools (as user): Roofit, RooStats, TMVA, RooUnFold
- 4 labs: lecture (2h) + tutorial (2h)
- Tutorial solutions as homework for next lecture (**mandatory for written exam**)
- PC: personal or lab

Pre-requisites:

- ROOT Installation [1] + check Roofit/RooStats/TMVA work
- C++ basics: namespaces, classes, **inheritance**, pointers, references, passing by value VS by reference, **pointers VS references**; (Python also accepted)
- Basic ROOT (macros + root files) [2, 3]

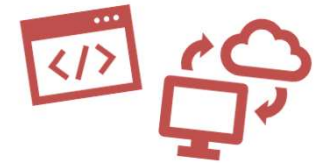**Check slides for more info!!**

Module 4 & 5:

Lecturers:

Francesco Giacomini, Researcher @ INFN

Andrea Chierici, Researcher @ INFN

Research on:

- Middleware for distributed computing: authentication, authorization and data management; efficient coding

- HPC, Cloud computing Data center management

Program:

- C++ for scientific programming
- Memory management
- Software engineering
- Computing infrastructures
- HPC, Cloud/Fog/Edge computing

More details on Monday's lecture!

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Exam structure: modules 1, 2, 3

Written exam (+ optional oral)

- 1/3 theory questions
- 1/3 one exercise
- 1/3 lab: comment a code snippet
  → **4 lab tutorials mandatory for taking written test**
- oral session is optional:
  +/-3 variation of written test score

6 sittings in A.Y. 2024/25

- 3 in winter session
- 2 in summer session
- 1 in September

See you on Monday!