Course Package

Applied Physics – Q3

Name module	Applied Physics – Q3
Educational programme	MSc Applied Physics
Period	Second semester (Quartile 3)
Study load	15 ECTS

Applied Physics			
Quartile 1	**Quartile 2**	**Quartile 3**	**Quartile 4**
		Machine Learning **202100224** (5 EC)	
		Computational Physics **202100223** (5 EC)	
		Remote Control of Experiments **202100225** (5EC)	

Suitable for: 3rd year student (or completed) the Bachelor of (Applied) Physics.

Required preliminary knowledge on bachelor level: Python programming skills required.

202100224 - **Machine Learning**

Machine Learning (ML) and Artificial Intelligence (AI) are fast expanding topics in mathematics (e.g., statistics, control), computer science, robotics, engineering and science in general. In the field of computational physics and chemistry ML is on the rise to learn simple models based on data produced by numerically solving complex equations on supercomputers.
This course will give you an overview on ML (and a little AI) and will let you learn the concepts in a 'hands-on' manner.
(1) We start with

- 'programming in Python'. Do not worry if you have never programmed in Python: you will get Jupyter notebooks from level 0 up to the level that is required. Of course, you should have some affinity with programming;
- a little 'probability theory'. Algorithms can be analyzed, but methods in ML and AI look pretty ad hoc, especially when it comes to neural networks (deep learning). Statisticians claim that ML is in fact statistics.

(2) The first few weeks we treat the basic ML topics on supervised, unsupervised and reinforcement learning. This leads to methods for classification, clustering, linear and nonlinear regression, searching (so a little AI as well);

(3) In the second half of the course you will do a project: you can choose 'whatever' you like. This can be;

Please note: these packages are not fixed. They serve as an example of what you are able to select. It may be possible for you to make changes if you would like to do so.
The modules are tentative and subject to change. Please check the website regularly.

- building a neural network for some application,
- getting a deeper understanding of why certain algorithms (do not) work,
- joining in to a Kaggle competition problem,
- making a world champion (well, a very good) backgammon player,
- etc.

In any case, before you start on your project you should prepare a short project proposal (max. 1 A4) in which you write what you want to do, how you are going to do it and why you think this is the right strategy.

202100223 - **Computational Physics**

The Computational Physics course will illustrate through guided practical sessions how one solves physics problems on the computer. For a number of selected topics, the student will set up a computational "experiment". He/she will develop an appropriate computational strategy for each given problem, implement the needed numerical techniques, analyze the results and the correctness of the model regarding the chosen computational parameters, and describe/interpret the physical phenomena.

Subjects in 2.5 EC Computational Physics part:

- Excitons – Numerical solution of the radial Schrödinger equation,
- Magnetism, Ising model – Monte Carlo simulations.

Additional Subjects for the expansion to the 5.0 EC Computational Physics:

- Wave propagation – Transmission of electron waves through (resonant) tunneling devices,
- Non-linear and linear physics problems – Poisson-Boltzmann equation, eigenvalue problems, molecular Rotations,
- Diffusion – Brownian motion, random walks.

202100225 - **Remote Control of Experiments**

The content of this course is currently being developed. Please check our website for updates.

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