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## 1SC4791 – Black swans detection in particle physics and cosmology (Higgs)

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**Department:** DOMINANTE - PHYSIQUE ET NANOTECHNOLOGIES  
**Language of instruction:** ANGLAIS  
**Campus:** CAMPUS DE PARIS - SACLAY  
**Workload (HEE):** 40  
**On-site hours (HPE):** 27,00

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### Description

This Enseignement d'Intégration / Challenge Week is a week-long project where students are grouped in collaborations of about 25, split into 5 teams. The goal of each collaboration is to build an analysis pipeline to arrive at a piece of evidence for the existence of the Higgs boson with Machine Learning, using open data from the CERN ATLAS experiment. The five teams are: Feature Engineering, Boosted Decision Tree, Neural Networks, Statistical analysis, Systematics effects. An elected spokesperson is making sure the collaboration as a whole delivers the expected outcome.

### Quarter number

ST4

### Prerequisites (in terms of CS courses)

Basic knowledge in Particle Physics, Statistical Analysis, Machine Learning, coding in the Machine Learning python ecosystem.

### Syllabus

We provide an introduction to the work to be done on the morning of the first day.

Students are divided into two collaborations and work independently. They are participating in team works and should share workload and tasks, identify difficulties, and brainstorm together. Adjustments on workload and sharing have to be managed within the week to ensure a global collaborative effort.

Regular updates on progress and difficulties encountered have to be provided in order to improve the students' progress. Discussions with teachers happen all along the week. Small daily reports have to be provided. Students work on shared notebooks. We ask for a presentation of the work done and the results obtained by the end of the EI week.

This challenge week ends with a half-day of oral presentations by the students.



### **Class components (lecture, labs, etc.)**

We provide support materials to read and understand. Basic notebooks are also provided. The instruction framework follows practice sessions from which students can draw inspiration to get started. Their work must then go well beyond the framework seen in class and leave room for their personal understanding and initiative.

### **Grading**

The week of the EI ends with a 45' presentation followed by 15' of questions. The presentation is split between 5 randomly selected speakers in addition to the spokesperson. In addition, the collaboration should deliver notebooks with all their computation. The final grade is a combination of the performance of the whole collaboration, the performance of the team, and individual contributions.

### **Resources**

Python Colaboratory notebooks (seen during the main course).

### **Learning outcomes covered on the course**

- Set up standard statistical tools
- Use of machine learning libraries
- Computation of quantities using special relativity
- Numerical data analysis
- Team working
- Work sharing
- Presentation of methods and results

### **Description of the skills acquired at the end of the course**

#### **[C6] Be operational, responsible, and innovative in the digital world:**

- **C6.3** Process data;
- **C6.1** Solve a problem numerically;
- **C6.2** Design software

#### **[C7] know how to convince:**

- **C7.1** Structure your ideas and arguments, be synthetic (assumptions, objectives, expected results, approach, and value created);
- **C7.4** On communication techniques : Master spoken, written, and body language, and master basic communication techniques

#### **[C8] Lead a project, a team :**

- **C8.1** Build the collective to work as a team ;
- **C8.4** Work in project mode by implementing project management methods adapted to the situation

#### **[C1] Analyze, design, and build complex systems with scientific, technological, human, and economic components :**



- **C1.4:** Design: specify, implement and validate all or part of a complex system
- **C1.3:** Solve: solve a problem with a practice of approximation, simulation, and experimentation

**[C2] Develop in-depth skills in an engineering field and in a family of professions**

- **C2.1** Deepen a field of engineering sciences or a scientific discipline