1SC4693 – Estimate the output of an offshore wind farm

Instructors: Loïc Queval
Department: DOMINANTE - ENERGIE
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 27,00

Description

The goal of the EI is to estimate the production of an offshore wind farm. We will consider several factors, such as the variability of the wind, the wake effect, the parameters of the energy conversion chaine, the cabling and the costs.

Quarter number

ST4

Prerequisites (in terms of CS courses)

none

Syllabus

The students are divided into 12 groups of 3 students (= 36) who work in "competition". The goal is to design an offshore wind farm by taking into account certain technic and economic constraints. The input data is a set of weather data and the parameters of the conversion chain (measured in TL for some). The constraints are the geographic boundaries of the park, the point of connection to the power grid and the size of the cables. The students have to determine the optimal number of turbines, their location and estimate the park's production.

Grading

At the end of the week, each group presents their analysis. The optimized park data for each group is used by the supervising team to evaluate the work of each group.

Course support, bibliography

none

Resources

Classroom (100 pers) reconfigurable with videoprojection and WiFi.

Learning outcomes covered on the course

- Assess the wind energy ressource of a given site.
- Master the various steps of the energy conversion from wind energy to electric energy.
- Understand the difficulties related to the integration of this production mean to the electrical grid.
- Evaluate the levelized cost of wind energy.

Description of the skills acquired at the end of the course

- C1.1 - Study a problem in its entirety, the situation as a whole. Identify, formulate and analyze a problem in its scientific, economic and human dimensions.
- C1.2 - Use and develop adapted models, choose the right modeling scale and simplifying assumptions relevant to the problem.
- C1.3 - Solve the problem with a practice of approximation, simulation and experimentation.
- C2.5 - Master the skills of one of the core trades of the engineer (junior level).
- C3.1 - Be proactive, take initiative, get involved.

ST4 – 47 – BLACK SWANS DETECTION IN PARTICLE PHYSICS AND COSMOLOGY

Major: PNT (Physics and Nanotechnology)

Teaching language: English
Campus: Paris-Saclay

Engineering problem statement:

Particle Physics and Observational Cosmology are fields which have significantly progressed in recent years, substantially improving our understanding of the Universe and its content. This research requires considerable human, scientific and technological efforts to detect rare events and/or of very low intensity, thus difficult to detect. The simple observation of those sparse events can however greatly change our understanding paradigm. They are therefore called "*Black Swans*", a metaphor remembering the fragility of our system of thoughts where a single rare event can potentially largely change our posterior understandings. In order to get a real scientific meaning, these measurements have to be reported with an acute awareness of their limitations (statistical and systematical uncertainties).

From an economic perspective, Particle Physics and Observational Cosmology data are collected thanks to several tens of millions to billion dollars facilities. These high costs lead scientists to maximally exploit these data. Engineering designs behind these activities are often far beyond the scientific goal alone. They require optimising data storage, memory allocation, CPU usage and algorithms *etc.*

These fundamental research efforts have always required complex data analysis rationales. The quick growth of the Internet giants (GAFA, BATX) has considerably accelerated Artificial Intelligence (AI) revival. Scientists have recently sought to incorporate these developments back in their data analyses. These algorithms gradually become new standards for the exploitation of considerable amounts of data from Particle Physics facilities and astrophysical observatories.

This course addresses Fundamental Physics issues as well as a some of the scientific rationales used by this community to analyse the data of the most recent instruments (LHC, Planck, SDSS, …). It is focused on giving students a view on technical activities in this intense field of research.

Prerequisite

First semester Statistical and probability course. Computer programming skills: Python (Anaconda), GitHub.

Context and challenge modules: these modules will give to the engineering students a first sight with nowadays scientific context in Particle Physics and Cosmology. It will also lead to point out needs and challenges of these research fields in Big Data, High Performance Computing (HPC), High Throughput Computing (HTC) and Artificial Intelligence. Beyond scientific and technological facets, social and economic aspects will be addressed, among which funding of fundamental research.

Specific course (60 HEE): Data Analysis in Particle Physics and Cosmology

- **Short description:** This course will give a short overview of modern Particle Physics and Cosmology research through data analyses. The objective is to give to students a synthetic and technical view of research activities which exploit data from the most recent instruments (such as LHC, Planck, SDSS…). However, the technics and skills introduced in this course could largely serve a wider scope for data analysis technics since many former PhD students in Particle Physics and Cosmology have also secured Data Scientist positions in private companies.

Challenge week: Black Swans detection in Particle Physics and Cosmology.

- **Industrial partner:** CNRS/CEA
- **Location:** Paris-Saclay Campus
- **Short description:** Application of signal processing, statistical analysis and machine learning methods to the analysis of Particle Physics and Cosmology experimental data.

  The students will be divided into two groups, one working on a Particle Physics problem (Higgs group), the other on Cosmology (Cosmology group). The organisation of the two groups will be very similar, the differences will be indicated when necessary.

  - Higgs group. The activities will involve searching for Higgs bosons in data provided by the ATLAS collaboration (LHC). The data sample contains Higgs bosons but also distortions of experimental origins. The goal is to find a maximum of Higgs bosons using different techniques, robust to experimental distortions.
  - Cosmology group. The working frame will be an end-to-end analysis of public data from the three main probes of contemporary Observational Cosmology: Type Ia Supernovæ (SNIa), Cosmic Microwave Background (CMB) and Baryon Acoustic Oscillations (BAO). The goal is to obtain constraints on the ΛCDM cosmological model by a Bayesian approach based on the Markov Chain Monte Carlo technique with each probe and to combine them.

The learning objectives are: consistency checks, performance evaluations and optimisation of machine learning methods, of image and catalogs analysis, output results combination, treatment of statistical and systematical uncertainties and scientific interpretation.