Kursplan/Course syllabus

Course name: Accelerating climate resilient plant breeding by applying –omics and artificial intelligence (3 ECTS) [No Swedish name]

Number of credits: 3 ECTS

Subject: Biology

Language of education: English

Entry requirements: PhD students interested in handling, interpreting and visualizing large-scale data in the context of relatively uncontrolled environments, e.g. field trials, ecosystems. Some experience of handling and analyzing large datasets in R or similar applications is advantageous but not necessary.

Learning outcomes:

After the completion of the course, the student is expected to be able to:

- Explain how to design trials suitable for representative sampling of plant material for subsequent '-omics' and/or remote sensing data generation.
- Describe a handful of detection techniques of '-omics' data and critically evaluate the suitability and feasibility in selection of appropriate -omics technique(s) for a given biological problem
- Apply various data analysis pipelines and statistics including AI to analyze large-scale data sets
- Demonstrate the integration of phenotyping and '-omics' data through tools such as Cytoscape/mix-omics.
- Discuss the possibilities in using AI to analyse "-omics" data together with other large-scale datasets
- Discuss challenges and future possibilities in this emerging field

Objective and Content:

The last years' rapid technological advancements have enabled genome-scale capturing of biological processes. Analysis of genetic variance and gene expression by Next-generation Sequencing (NGS) as well as protein and metabolite identification by mass spectrometry are today common techniques used in many laboratories. However, combining different types of data and making biological sense out of large datasets remains challenging. The generation of such large datasets - often referred to as '-omics' data - demands partly new considerations for experimental set-ups, sampling, data analysis and visualization. Simultaneously, rapid advancement is undergone within remote sensing and satellite analysis enabling new ways to phenotype plants, which need to be linked to '-omics' and other data. Applying artificial intelligence (AI) to interpret large datasets another possibility, which is rapidly advancing. These methods will have importance in the future development plant breeding and sustainable agriculture and forestry.

This course will provide theoretical and practical aspects to generate and use '-omics' data as well as remote sensing for plant breeding - from sampling to interpreting the results and finding biologically relevant conclusions. The emphasis will be on plant phenomics, genomics, proteomics, metabolomics

and microbiomics. Strategies both in outdoor and controlled environments will be covered. Suitable statistical and visualization methods to deal with the variation in this type of data will be presented. Ways of applying AI for data interpretation will be demonstrated.

The overall goal is to point out the possibilities in using '-omics' and AI for plant breeding but also to highlight possible pitfalls.

Pedagogical form: Lectures, demonstrations, journal club and computer practices. The students will receive scientific publications to read latest two weeks in advance, including the articles for the journal club that should be prepared beforehand.

Examination: Active participation during lectures, demonstrations and computer practicals as well as approved presentation of subject-related article in journal club both orally and in text and computer practical hand-ins. Every missed lesson by the student has to be compensated a written summary addressing the subject area and answering one key question based on the lecture slides and related assigned reading (minimum half an A4 page).

Technical requirements: Own laptop.

Course leader: Erik Alexandersson (erik.alexandersson@slu.se)

Teachers: Kristina Gruden (NIB Slovenia), Dan Jacobson (ORNL), Antoine Harfouche (UNITUS), Ian Dodd (Lancaster University), Rodomiro Ortiz (SLU), Annabel Large (ORNL/SLU), Svane Resjö (SLU), Therese Bengtsson (SLU), Erik Alexandersson (SLU)