



Material from the training school on Population and breeding programme simulation

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This course demonstrates how to simulate populations and breeding programmes with the software AlphaSimR (Gaynor et al., 2021).

The course consists of three parts:

- 1) Introduction to the course, AlphaSimR, and simulations
- 2) Simulate DNA and phenotypes (traits)
- 3) Selection simulation and response to selection
- 4) Simulating a breeding programme

Each part consisted of a lecture in a pdf file accompanied by a practical part in an R markdown script (Rmd). The material also includes two papers on simulating insect populations (honeybees and black soldier fly).

1. Introduction to the course, simulation, and AlphaSimR

Introduction to course introduces the lecturer and his teams, and offers some additional resources. Introduction to simulation of breeding programmes provides an overview of the tools and stochastic simulation, what is possible to simulate with the current tools, and showcases different types of breeding programmes. The material (lectures and practical) for this part is found in the folder 1_Introduction.

2. Simulate DNA and phenotypes (traits)

The second lecture explains the principle of inheritance, as well as how to simulate DNA, genomes, and inheritance patterns. It then goes on and explains how to add the simulation of a trait, a phenotype, to the simulation of the genome alone. Last, it links the two and touches upon the variability within/between families. The material can be found in the folder 2_Simulating_DNA_and_phenotypes (one lecture pdf, two practicals on simulating DNA and simulating traits, and two corresponding PDFs offering additional material).

3. Selection simulation and response to selection

The third part upgrades the simulation of genomes and phenotypes by introducing the idea of selection. It first explains the response of selection, its effect on the variance, it revisits the breeder's equation (introduced in the Crash course on Quantitative genetics) and its components. It then demonstrates how to simulate selection on a single trait in a simulated population. The material for this part can be found in the folder 3_Selection_response, a lecture, practical (Rmd), and a corresponding PDF with additional material.

4. Simulating breeding programmes

Lastly, the course ties all introduced concepts in a simulation of a breeding programme. Simulating a breeding programme is a complex task that includes simulating individuals with their genomes and phenotypes, as well as selecting best individuals and a continuous and usually overlapping manner. This lecture offers the logic behind simulating a breeding programme as well as a step-by-step instructions on how to build the simulation and the crucial questions that need to be answered before doing so. It also introduces measures one would usually quantify in a simulation and offers examples of simulated breeding programmes for different (plant and animal) species. The material can be found in 4_Breeding_programme, a lecture, a practical (Rmd) as well as additional reads explaining the simulation of plant and animal breeding programme (there is also a scheme of a beef breeding programme).