



THE UNIVERSITY  
of EDINBURGH



Biotechnology and  
Biological Sciences  
Research Council



THE ROYAL  
SOCIETY

# Stochastic simulations of breeding programmes

Gregor Gorjanc

Athens, Greece  
2025-01-30



# The Roslin Institute



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of EDINBURGH



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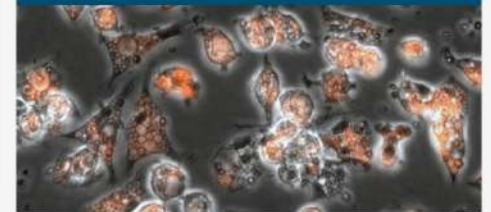
[www.ed.ac.uk/roslin/research](http://www.ed.ac.uk/roslin/research)

## ISP: Genes & Traits for Healthy Animals



This BBSRC-funded Institute Strategic Programme seeks to sustainably enhance animal productivity, efficiency and welfare by dissecting genotype-phenotype relationships and their biological basis.

## ISP: Prevention & Control of Infectious Diseases



This BBSRC-funded Institute Strategic Programme seeks to reduce the burden of infectious diseases of farmed animals and zoonoses.

## Division of Bacteriology

Bacteriology staff list

## Division of Functional Genetics

Functional Genetics staff list

## Division of Epidemiology

Epidemiology staff list

## Division of Genome Biology

Genome Biology staff list

## Division of Immunology

Immunology staff list

## Division of Quantitative Biology

Quantitative Biology staff list

## Division of Translational Bioscience

Translational Bioscience staff list

## Division of Virology

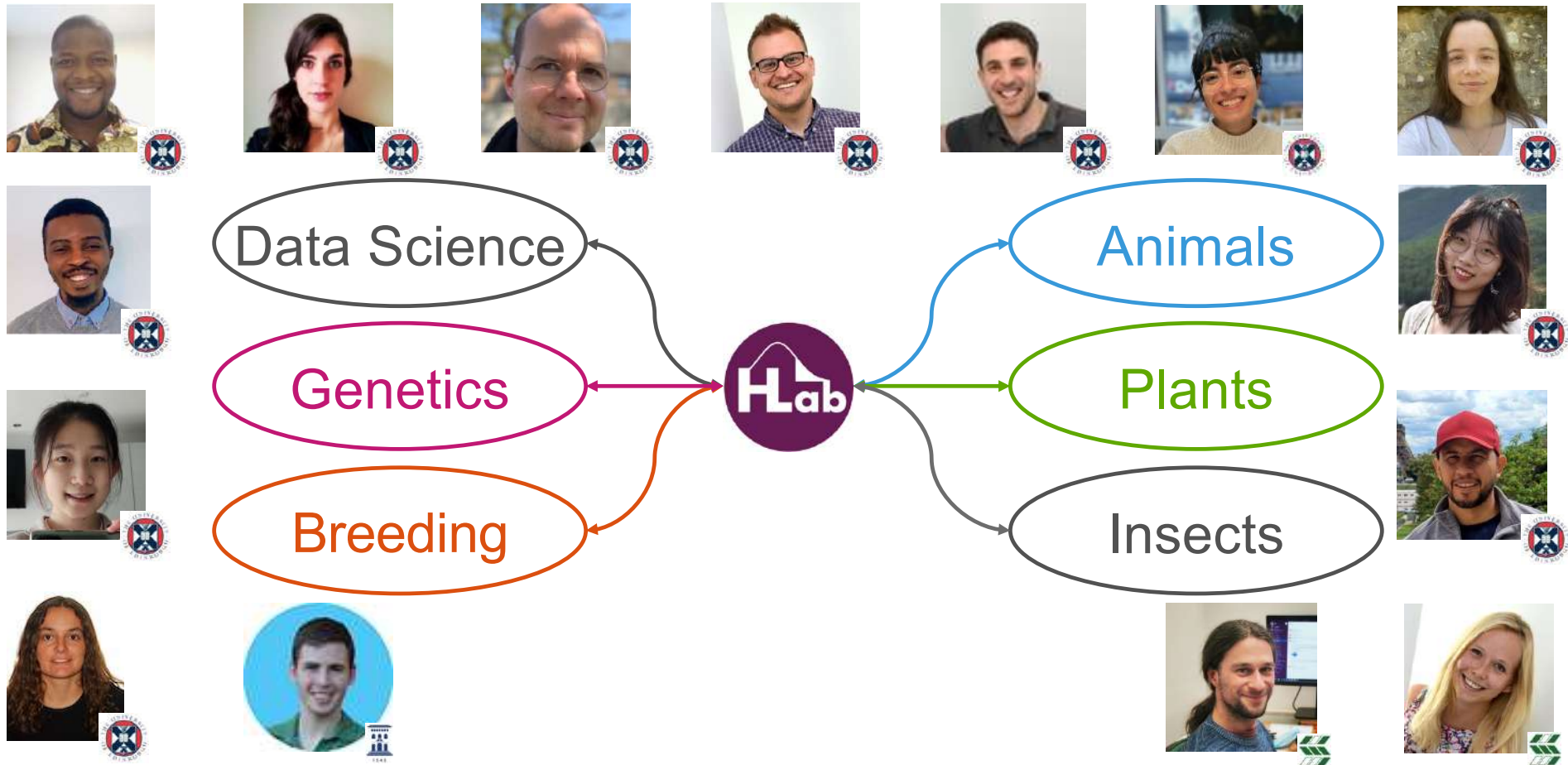
Virology staff list

## Clinical Sciences

Working to improve the lifelong health and welfare of veterinary and human patients.

# HighlanderLab

We manage and improve populations





# Our funded projects

Transition strategy for two-part genomic selection in plant breeding



Genomic prediction in plant breeding using environmental covariates



Analysis of non-additive genetic variance in breeding programmes



Quantifying the drivers of genetic change in plant breeding



GenoForage: Genomic breeding of forages to boost future genetic gains



Large-scale modelling of genomic and environmental variation



Genetics and breeding of Taurine-Indicine crossbred dairy cattle



Data-driven breeding of resource efficient cattle



Genomic strategies for optimal crossbreeding in African dairy cattle



AlleleFetch: Pedigree tracking of alleles causing hereditary disorders in dogs



Born2Guide: Whole-genome sequencing of a population of guide dogs



Breeding and genomics of the black soldier fly



DATA-BEAST - data infrastructure and workflows for an insect genetics operation



Honeybee breeding programmes to improve health and production



Genetics and breeding of global pig breeds in the era of mega-scale genomics



# The aim of this course

- Pitch
  - **Guide on the fundamentals of simulating breeding programs**
  - **~4h introduction to the AlphaSimR package**
- Learning objectives
  - Learn how to **set up and run breeding simulations**.
  - Simulate **DNA, trait genetic architecture, genetic values, and phenotypic values**.
  - Work with **multiple population objects, selecting individuals, and modelling complex breeding programmes**.
  - Evaluate **selection strategies**.

```
for (Year in 1:10) {
  Pop = randCross2(
    males = Sires,
    females = Dams,
    nCrosses = 750,
    nProgeny = 100)

  Dams = selectInd(Pop,
    nInd = 750,
    sex = "F")

  Sires = selectInd(Pop,
    nInd = 25,
    sex = "M")
}
```

```
for (Year in 1:10) {
  Variety = selectInd(EYT, nInd = 1)
  EYT = selectInd(AYT, nInd = 10)
  AYT = selectInd(PYT, nInd = 50)
  PYT = selectInd(HDRW, nInd = 500)
  HDRW = makeDH(F1, nDH = 100)
  Parents = c(EYT, AYT)
  F1 = randCross(Parents, nCrosses = 100)
}
```

Free short online course

## Breeding Programme Modelling with AlphaSimR

<https://www.edx.org/course/breeding-programme-modelling-with-alphasimr>



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THE  
DATA LAB  
value from data



Data-Driven  
Innovation

Part of the Edinburgh & South East Scotland City Region Deal



# Course roadmap

- 14:00-15:00 Introductions (01\_..., 02\_..., & 03\_...)
- 15:00-16:00 DNA, traits, and lottery (04\_..., 05\_..., & 06\_...)
- 16:00-16:30 Coffee / Tea break
- 16:30-18:00
  - Selection (06\_... & 07\_...)
  - Breeding program (09\_..., 10\_..., & 11\_...)

# Preliminaries

- We will jump between lecturing and coding
- Ask questions at any time
  - Your question is in the mind of half of the room that is afraid to ask
  - Ask again if your question isn't answered
  - Simple/Silly/Blunt questions are often the best!
- Code issues
  - Familiarity with R will definitely help, but you can learn on the fly
  - Syntax errors and managing them is part of the learning process
  - Don't give up!



# Preliminaries

- Who has experience with stochastic simulations?
- Who has experience with AlphaSimR?

Questions?!



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