Theory and Tools for Designing Breeding Programs of Animals and Plants

Gregor Gorjanc, Chris Gaynor, Jon Bancic, Daniel Tolhurst

UNE, Armidale
2024-02-05

It’s great to be back!

- I visited Armidale in June 2011!

- I to have studied from the Armidale genetics course materials extensively!

Course instructors

Gregor Gorjanc

Chris Gaynor

Jon Bančič

Daniel Tolhurst

Edinburgh, Scotland, & Great Britain

The Roslin Institute

www.ed.ac.uk/roslin/research

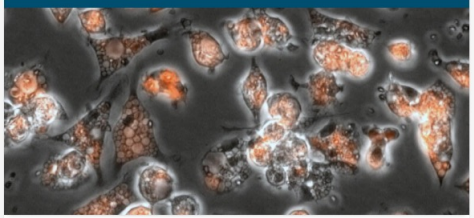
THE UNIVERSITY of EDINBURGH

Biotechnology and Biological Sciences Research Council

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

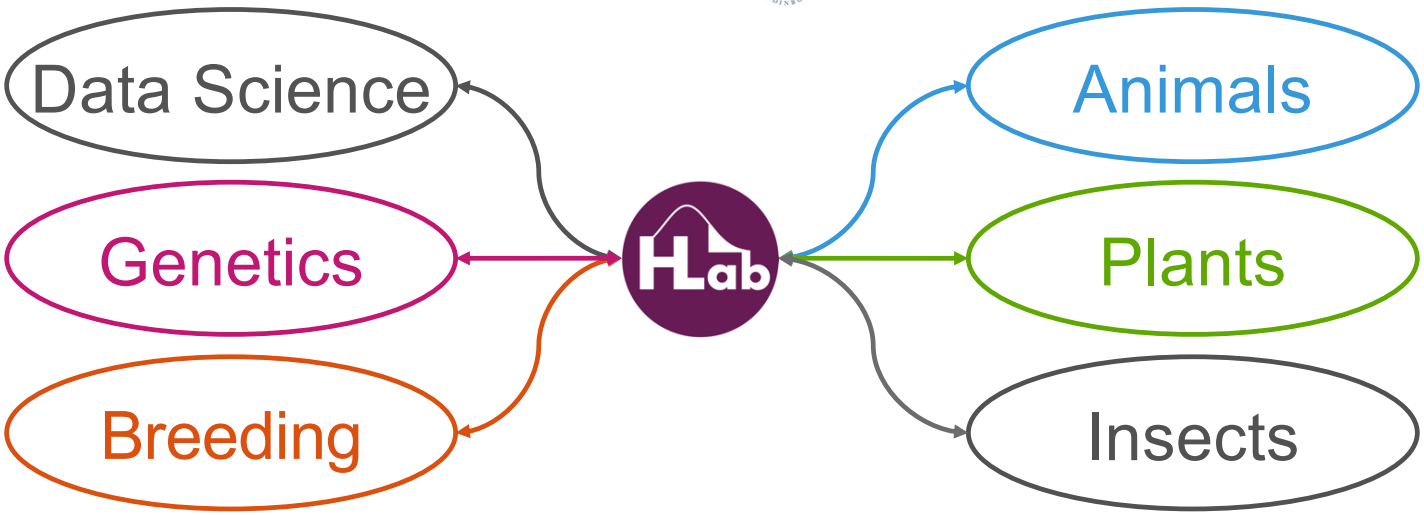
Virology staff list

Clinical Sciences

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

HighlanderLab

We manage and improve populations



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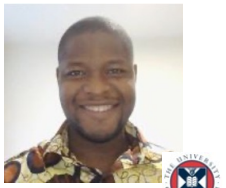
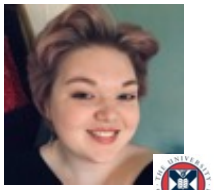




Data Science

Genetics

Breeding

Animals

Plants

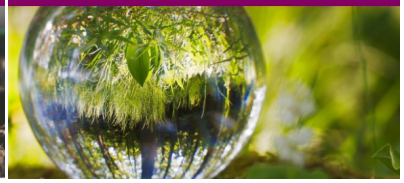
Insects

Our funded projects

www.ed.ac.uk/roslin/highlanderlab/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

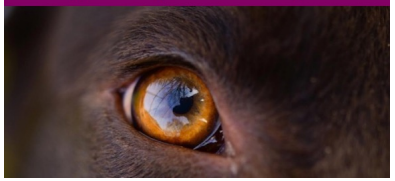
Large-scale modelling of genomic and environmental variation

Genetics and breeding of Taurine-Indicine crossbred dairy cattle

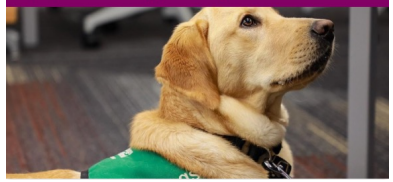
Data-driven breeding of resource efficient cattle

Genomic strategies for optimal crossbreeding in African dairy cattle

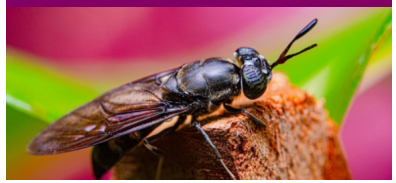
AlleleFetch: Pedigree tracking of alleles causing hereditary disorders in dogs



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



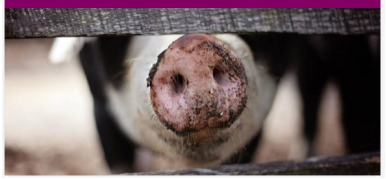
Breeding and genomics of the black soldier fly



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

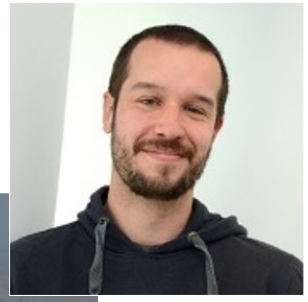


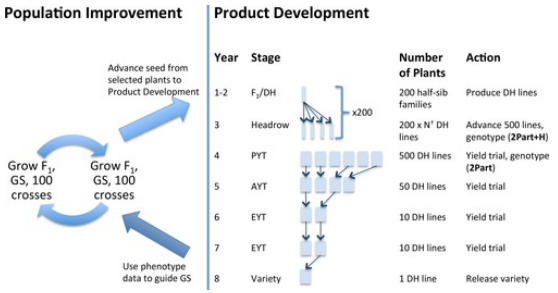
Next EUCARPIA Biometrics meeting!

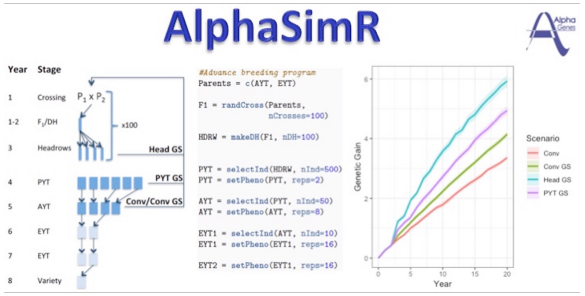
Edinburgh, September 2025

Chris Gaynor

- Oregon State University
  - BS Biochemistry
  - Assistant Breeder
  - MS Crop Science
- Kansas State University
  - PhD Genetics
- University of Edinburgh
  - Post-doc Quant. Gen.
- Bayer
  - Sr Data Scientist
  - Rice/OSR Quant. Gen.







Jon Bančič

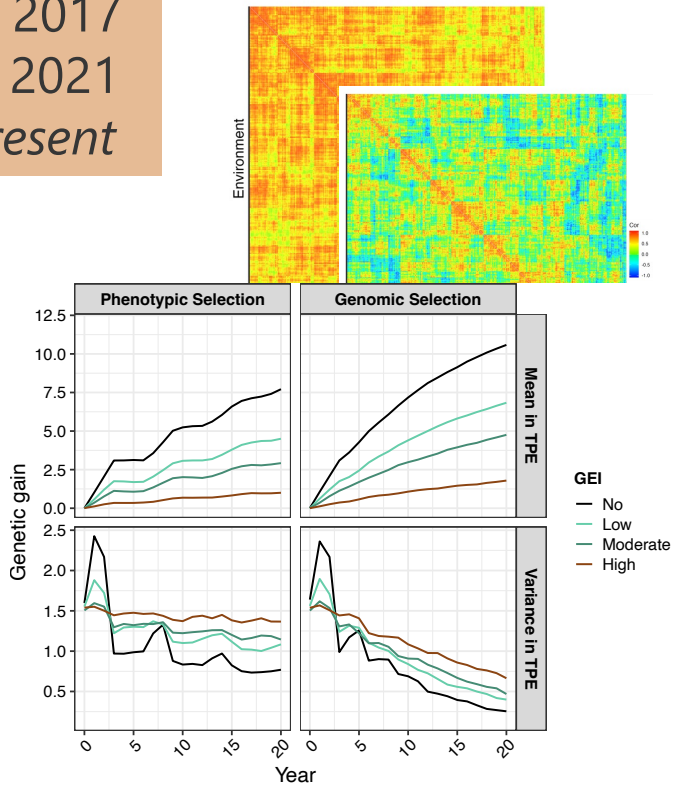
Background

BSc Biology (University of Ljubljana) 2015
MSc Plant Biology (Swedish University of Agricultural Sciences) 2017
PhD Plant breeding and genetics (University of Edinburgh) 2021
Research Fellow (University of Edinburgh) 2022-*present*

Pitch

I apply and develop statistical and quantitative genetics methods to optimize plant breeding programs.

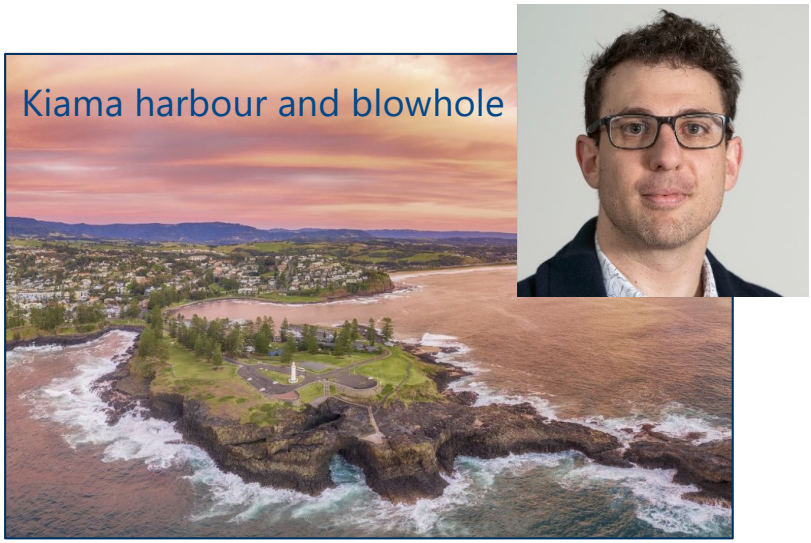
Integration of GxE in plant breeding simulations and developing a two-part transition strategy for hybrid breeding programs.



Daniel Tolhurst

- Originally from Kiama, NSW
- Biometrician by training, Centre of Bioinformatics and Biometrics* (CBB), UOW
- Moved to Edinburgh Dec, 2019
- PhD (submitted) in Genetics and Genomics, The Roslin Institute
- Edinburgh Innovation Fellow ←

"Helping bridge the gap between quantitative genetics, biometrics and practical plant breeding"



Your turn!

Quickly state your:

- NAME
- WORKPLACE
- JOB/POST
- SPECIES you work with

Course roadmap

AlphaSimR

Day 1: Simulation of breeding programmes **BASICS**

Day 2: … Quantitative genetics

Day 3: … Estimation with linear mixed models

Day 4: … Spatial variation & GxE interactions

Day 5: … Ancestral recombination graphs

Day agenda template

- 09:00-10:30 Lectures & Tutorials
- 10:30-11:00 Refreshments break
- 11:00-12:30 Practicals
- 12:30-13:30 Lunch break
- 13:30-15:00 Lectures / Tutorials / Practicals
- 15:00-15:30 Refreshments break
- 15:30-17:00 Practicals

Day 1 agenda

- 09:00-10:30 Introduction to simulation of breeding programs
- 10:30-11:00 Refreshments break
- 11:00-12:30 Intro to AlphaSimR - DNA, phenotypes, & lottery
- 12:30-13:30 Lunch break
- 13:30-15:00 Intro to AlphaSimR - Selection
- 15:00-15:30 Refreshments break
- 15:30-17:00 Intro to AlphaSimR – Breeding programs

Preliminaries

- We will jump between species of animals and plants!
  - Tip: follow chromosomes through a breeding program
- Each presenter is a pro in some areas and we all have specific biases;)
- Ask questions at any time
  - We may defer to later presentations
  - Ask again if your question isn't answered
  - Simple/Silly/Blunt questions are often the best!

Questions?!

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