PhD Project Advertisement

Project title: A novel Bayesian methodology to estimate unobserved traits of cattle for AI-assisted precision feeding
Project No: FBS2024-050-Kyriazakis-qc

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Project description:

The traditional method of feeding livestock is to feed them in a group according to the requirements of the 'average' individual. This means that some individuals of the group receive less nutrients than they require, with adverse consequences on their health and welfare, whereas some others are fed above their requirements, meaning that the excess nutrients pollute the environment. Recent advances in AI-assisted technology now allows individuals to be identified and to be fed differently whilst they are still in their group.

In order to feed individuals according to their needs, information on number of trais is required, but some are difficult to measure. For a growing animal key traits include their maximum capacity for growth and at what stage they are in their growth trajectory right now (degree of maturity). We propose that these individual traits can be inferred from other traits that are measured routinely on farms, such as bodyweight and food intake, by means of AI. The hypothesis is that the approach will lead to better estimates of individual animal nutrient requirements which, in turn, will enhance heir health and welfrae, as well as tthe resilience and sustainability of UK livestock production.

Our starting point will be the recent statistical model proposed by Kyriazakis and Filipe (2019, doi:10.3389/fgene.2019.00727), which suggests that the distribution of difficult to measure (unbserved) traits, such as growth potential or body composition, can be estimated via observed (measured) traits, using an Approximate Bayesian Computation (ABC) approach. The method has yet to be tested and validated on empirical data, and we proposed to do this on a large database of Northern Irish beef cattle for the first time in the world.

1. The student will interrogate a large database of several thousand beef cattle owned our Industry sponsor (Agri-Food and Biosciences Institute, AFBI), which record serial measurements of individual trais from birth to slaughter. Because part of the database has been collected for research purposes, it contains measurements which are not routinely recorded in commercial populations.
2. The student will estimate the empirical average and distribution of individual (unobserved) traits characterising growth potential and degree of maturity in individuals of the sub-population, through the application of the ABC approach based on the principles of inverse modelling, using the traits measured routinely.
3. The database will contain additional unobserved traits for some individuals within the population of beef cattle, such as body composition at slaughter. Formal statistical diagnostics will be carried out to assess the biological plausibility of the estimates of the values of the unobserved traits for each individual within the population, including comparisons when the numbers of measured traits change. Formal statistical comparisons of the distributions of the biological values of the unobserved traits will be made against the actual measurements of these traits on a subset of individuals (validation), i.e., the individuals where such measurements were recorded.
4. The nutrient requirements of the individuals within the population will be estimated along their growth trajectory. Energy and protein requirements will be estimated in the first instance and their mean values for the population will be compared against the values of the average individual as estimated by the recently updated feed tables for UK beef cattle (Feed into Beef). These tables are currently used as the guidelines by the beef cattle Industry.

5. Finally, the consequences of feeding strategies where targeting the nutrient requirements for the average individual against feeding the individuals within a population will be quantified through computer simulations in terms of nutrient excretion, environmental impact and profitability for farmers. This will lead to strategies for precision management of beef cattle, which enhance animal health, welfare and performance, whilst minimising pollution.

Training opportunities:

This is a cross disciplinary project where the training opportunities will be adapted to the skills and expertise of the student appointed. A student with mathematics/ statistics or data science background will be directed to attend modules of the courses in Animal Nutrition and Management at QUB. Additional training will be offered by AFBI, the CASE partner for the project, on data collection processes, database management and on the simulation models used as the starting point of the project.

Alternatively, a student with a biological/ agriclutural background will be trained on modules provided by the MSc in Data Analytics (QUB), especially in Bayesian statistics and analysis. Additional training will be provided by courses provided at Cranfield on introduction of stochasticity in mathematical models and simulation modelling. The student will spend a period specifically for this purpose at Cranfield to acquire such novel skills.

In both cases the candidate will acquire a rare combination of technical, scientific, and hands-on skills that are highly valued in both industry and academia. The student will also benefit from association with AFBI, who will provide access to Northern Ireland Farm Animal Biobank, supplement the cost of the research and provide the student with unique opportunities of industry placement.

Student profile:

This project will be suitable for candidates who have an upper second-class degree in a related field (e.g., animal science, veterinary, data analytics, data science, mathematics or statistics), and who is interested in the application of novel statistical/ AI methods and data analysis to a biological problem. The ideal candidate will have strong problem solving and statistical skills. They will be highly motivated to learn the state-of-the-art in statistical methodology and data analytics and be ready to adapt and modify these techniques to the project's biological context.

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2023/24 this is £18,622 and it will increase slightly each year at rate set by UKRI.

Equality Diversity and Inclusion:

The FoodBioSystems DTP is committed to equality, diversity and inclusion (EDI), to building a doctoral researcher(DR) and staff body that reflects the diversity of society, and to encourage applications from under-represented and disadvantaged groups. Our actions to promote diversity and inclusion are detailed on the FoodBioSystems DTP website.

In accordance with UKRI guidelines, our studentships are offered on a part time basis in addition to full time registration. The minimum registration is 50% FT and the studentship end date will be extended to reflect the part-time registration.

References:

JAN Filipe, I Kyriazakis (2019). Bayesian, likelihood-free modelling of phenotypic plasticity and variability in individuals and populations. Frontiers in Genetics 10, 727

For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.