PhD Project Advertisement

Project title: GrainQuest – using Artifical Intelligence and high resolution multimodal imaging to dissect the developmental and genetic basis of seed composition
Project No: FBS2023-14-Doonan-aq
Lead supervisor: John Doonan, IBERS, Aberystwyth University
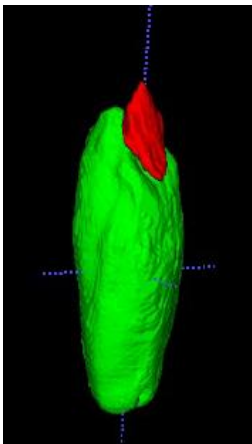
Email: john.doonan@aber.ac.uk
Co-supervisors:
Simon Cameron, Queen's University Belfast, Chuan Lu, Aberystwyth University

Project description:

Cereal grains provide a large portion of our food, either for direct consumption or indirectly via brewing or animal feed.

Composition varies between and within varieties and is affected by environmental stress. Composition largely determines end use and value to the producer. The grain is a composite structure, with three genetically distinct individuals, the embryo, endosperm and maternal protective tissues. Loss of spatial / developmental information during typical destructive compositional analysis means we don't fully understand how composition is controlled. This project aims to develop automated non-destructive tools, combining state of the art imaging with spatial molecular analyses, genetics and deep learning (AI) to model (see Fig for example AI model – embryo in red, endosperm in green) and extract novel information that could be used for crop improvement and understanding the effect of climate change on grain quality.

The project is based on the exciting development of novel methods to image and dissect tissues in QUB (iKnife) and Aberystwyth (CT and hyperspectral scanning). The challenge is to combine these different data streams and extract meaningful information in a systematic manner that useful to researchers, breeders and agriculture.

Training opportunities:

In this interdisciplinarian project, the student will work with plant geneticists at Aberystwyth, medical biochemists at Queens, Belfast and computer scientists in Aberystwyth Computer Science Dept. You will learn a range of specialist bio-medical imaging skills, including the use of high resolution cameras and microscopes, and innovative metabolite analysis equipment, and combine this with computer vision skills to apply deep-learning algorisms to co-register (line up) different datastreams, explore and exploit the data. Also, Aberystwyth University retains a strong public-good plant breeding program, so you will have the opportunity to work closely with breeders and be trained in crop genetics, including specialist software for QTL analysis and GWAS. Plant Breeding has been identified as a major skill-gap in the UK and has excellent career opportunities, particularly when combined with new ways of collecting and handling large datasets. Collaborative supervision from the QUB provides training opportunities in advanced biomolecular science and there will be the opportunity to visit other centers working on grain biodiversity, such as John Innes. There may also be opportunities to spend time at other major plant phenotyping centres in Europe, Australia or North America, particularly Canada where we have a collaboration with the synchrotron at Saskatoon.

Student profile:

We are looking for highly motivated candidates who should have (or expect to achieve) a minimum of a 2.1 Honours degree in a relevant subject area related to biological sciences, computer science or agriculture, with an interest in working across disciplines. Applicants with a minimum of a 2.2 Honours degree will be considered providing they have a Masters degree or significant relevant outputs/experience, such as publications.

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2022/23 this will be £17,668 and this 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:

Vaqas, B Cameron, SJ et al (2019) The iKnife: Development and Clinical Applications of Rapid Evaporative Ionization Mass Spectrometry. In "The Handbook of Metabolic Phenotyping" Eds: John C. Lindon, Jeremy K. Nicholson, Elaine Holmes. Elsevier, pp 219-236, ISBN 9780128122938,

Hughes et al. (2019) μCT trait analysis reveals morphometric differences between domesticated temperate small grain cereals and their wild relatives. Plant J. 99:98-111. doi: 10.1111/tpj.14312.

Hamidinekoo, et al., (2020) DeepPod: A Convolutional Neural Network Based Quantification of Fruit Number in Arabidopsis. GigaScience 9 (3), giaa012

Adamski et al. (2021) Ectopic expression of *Triticum polonicum VRT-A2* underlies elongated glumes and grains in hexaploid wheat in a dosage-dependent manner The Plant Cell 33 (7), 2296-2319

Google Scholar link for Doonan Lab. https://scholar.google.com/citations?user=6KcPHw8AAAAJ&hl=en
Google Scholar link for Cameron Lab https://scholar.google.com/citations?hl=en&user=wFrYc8AAAAAJ
Google Scholar link for Lu Lab
https://scholar.google.com/citations?hl=en&user=tvY6seQAAAAJ&view_op=list_works&sortby=pubdate
National Plant Phenomics Centre Website: https://www.plant-phenomics.ac.uk/

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