Edinburgh Doctoral College Studentship Projects

Project title: MODEL - Multi-dimensional Outcome moDELling in Prostate Cancer

Supervisory team: *Dr David Noble, Prof Bill Nailon, Prof Duncan McLaren, Dr Archie MacNair*

Lab websites:

https://www.hra.nhs.uk/planning-and-improving-research/application-summaries/research-summaries/the-prosecca-project.

https://www.researchgate.net/profile/Duncan-Mclaren-2

https://www.research.ed.ac.uk/en/persons/bill-nailon

https://www.researchgate.net/profile/Dj-Noble

Research question:

Prostate cancer is the commonest cancer in the UK, but the diagnostic label covers a range of clinical phenotypes. Some cancers are slow-growing, and carry an excellent prognosis, but others present late, with aggressive disease and poor outcomes, and the diagnosis is often made alongside considerable co-morbidity, adding complexity to treatment decision-making. Radiotherapy is an effective curative treatment option for prostate cancer; sometimes curative at the expense of severe long-term toxicity, in some cases insufficiently intense to eradicate disease. Predicting these outcomes is challenging, and treatment protocols remain homogeneous - not personalised to individual patients - because data to nuance decisions is lacking.

In the PROSECCA project, we hypothesise that demographic, disease, comorbidity, radiotherapy imaging/treatment files, and follow up data collated from 15,000 patients treated for prostate cancer across all 5 Scottish radiotherapy centres will uncover the link between clinical phenotype and underlying biology, and improve outcome prediction at the level of the individual patient.

In this PhD project, the candidate will use the PROSECCA data, infrastructure, and collaborations to address the following research questions:

1. Do known clinical, disease and demographic factors predict individual response to radiation therapy?
2. Do advanced image analysis techniques augment these analyses, and improve predictive model performance? (examples in Figures 1&2).
3. Can deep learning techniques be used to detect meta-association between multi-modal predictive variables that further enhance prediction at the individual patient level?

Our objective is to create a clinical decision aid, built on the carefully evaluated performance of developed models for personalising radiotherapy technique and dose. Working with collaborators from the Usher Institute (Prof Ewan Harrison) and the Edinburgh Parallel Computing Centre (Dr George Beckett), we aim to develop both human-driven and machine learning approaches to derive and validate multi-dimensional biomarkers of survival, disease-free survival and life-altering toxicity following radiotherapy for prostate in this unprecedented dataset.

Figure 1: training and validation of prediction models based on radiotherapy dose and imaging data

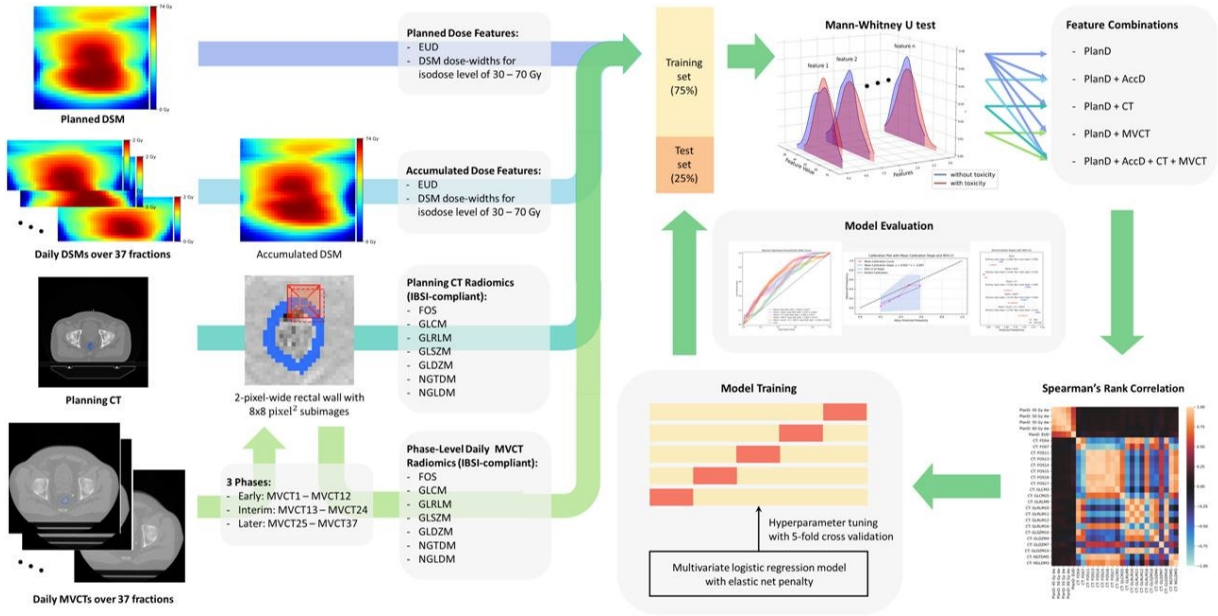

Figure 2: assessment of model performance

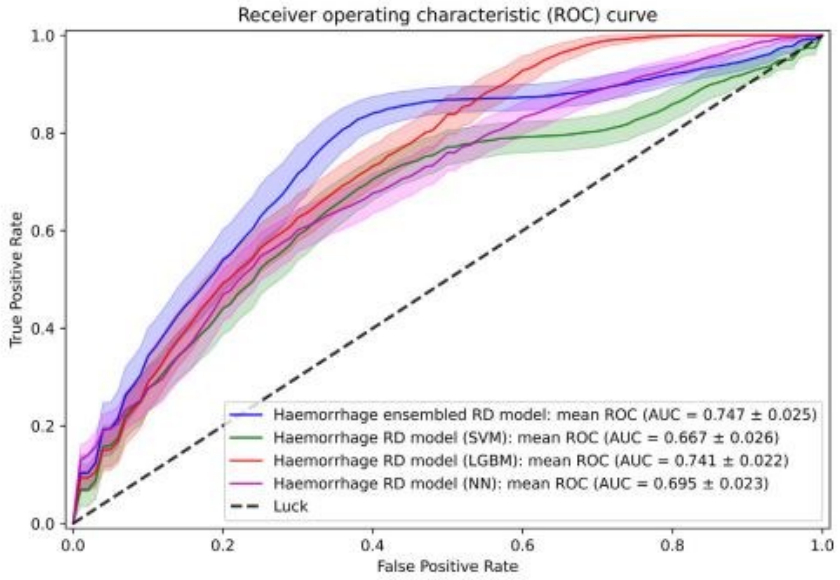

Fig. 2. ROC curves with 95% confidence intervals of the radiomic-dosimetric models and the ensembled radiomic-dosimetric model for grade ≥ 1 haemorrhage prediction.