

PhD Project Proposal

ECIT Interdisciplinary PhD Programme

Proposed Project Title: Meaningful Object Processing in Mind and Machine

Principal Supervisor(s): Barry Devereaux, Neil Robertson

Project Description: The ability to derive meaning from vision – to understand what we see around us – is a fundamental function of the human brain, with as many as 50% of the neurons making up the human cortex being involved in visual processing. Human visual cortex has a hierarchical organization, with early stages of the hierarchy being involved in processing low-level visual detail, and higher levels of cortex being involved in semantics – i.e., representing the overall meaning of the object being viewed (for example, recognising that a particular object is a cup, that it has a handle that can be grasped, that it can be used for drinking, and so on).

In contrast, a standard computer vision task is to correctly classify images (e.g. ImageNet; Deng et al 2009). Typically, models such as deep convolutional neural networks are trained to classify the object in the image as belonging to one of a number of categories (e.g. TIGER, CUP, EAGLE), or to segment the image into areas with different classes of content (i.e. semantic segmentation – labelling each location of the image as a particular category). However, labelled classes or labelled regions do not convey the rich meaning of what is in the image. To more faithfully represent human object vision requires a model that maps visual input onto meaningful semantic representations of what is viewed.

In this project we will investigate meaningful object recognition in an integrated way, by combining vision with conceptual knowledge about objects. Building on existing work (e.g. Devereux et al 2018; Pereira et al 2016; Jozwik et al 2016), we will combine distributional models of concept meaning (e.g. fasttext; GloVe) with human derived property knowledge of concepts (Devereux et al 2014; Sommerauer & Fokkens 2018) and state-of-the-art hierarchical and dynamic neural network architectures for computer vision (e.g. Simonyan & Zisserman, 2014; Spoerer et al 2018; Nayebi et al 2018). Furthermore, large scale fMRI neuroimaging datasets will also be used to further refine the model and to evaluate the quality of its visuo-semantic representations. Our goal is to go beyond the state of the art in terms of the quality of the semantic representation of object concepts, compared with existing word embedding approaches.

Objectives

- Develop, train and evaluate neural network architectures that combine vision with detailed semantics in an effective and neurobiologically-informed framework.
- Evaluate the quality of the resulting models against a variety of existing intrinsic and extrinsic validation benchmarks.
- Further refine the models with neuroimaging data, through regularization and co-training.

Academic Requirements:

Students entering the programme will normally be required to have a 2.1 BSc/BEng in Computer Science, Electrical and Electronic Engineering, or a maths based engineering or physical science degree, or equivalent qualification recognised by the University. Students holding an appropriate MEng or MSc (Software conversion) will normally be required to have a 2.1 or commendation (distinction) respectively. Furthermore, additional criteria may be applied. All applicants must have significant mathematical and programming experience.

GENERAL INFORMATION:

This 4 year PhD studentship, potentially funded by the Department for Employment and Learning (DEL), commences on 1 October 2019.

Eligibility for both fees and maintenance depends on the applicants being either an ordinary UK resident or those EU residents who have lived permanently in the UK for the 3 years immediately preceding the start of the studentship. Non UK residents who hold EU residency may also apply but if successful may receive fees only.

Applicants should apply electronically through the Queen's online application portal at: <https://dap.qub.ac.uk/portal/>

Deadline for applications: Friday 1 March 2019

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