BU STUDENTSHIPS 2020

PROJECT DESCRIPTION

PROJECT DETAILS
PROJECT TITLE
Understanding and Developing Commonsense Reasoning In Conversational AI via Natural Language Processing *Part of the Doctoral Training Centre - Centre for Digital Entertainment – Intelligent Virtual Personal Assistant (Intel-PA)*
DOCTORAL TRAINING CENTRE SUMMARY
The Intelligent Virtual Personal Assistant consists of three landmark components that enable Intel-PA to perform human-like communications with real humans. These are: sensible conversations; appropriate body gestures and facial expressions; and ability to detect the motion and emotions of the human user. By performing such human-like functions, Intel-PA will be able to play a huge role in assisting the mankind in countless applications, such as healthcare, training, education, marketing and decision making, to name but a few. Taking healthcare as an example, we all are aware of the acute pressure the NHS is under and it usually takes a long wait even to see our GP. If some/most of the GP's tasks can be undertaken by Intel-PA, it will not only save the NHS a huge budget, but also significantly shorten the waiting time. In addition to the role of a GP assistant, in healthcare alone there are many other applications where Intel-PA can play an important assisting role. Research in this area is still at a very early stage. The aim of this research is to investigate and create novel algorithms and techniques leading to the development of the three landmark components of Intel-PA. The initial six projects will define the research focus for the six PhD students. Working as a multidisciplinary team of researchers and supervisors, we will demonstrate the research by developing an Intelligent Neur-Assistant, an AI-powered conversational animated avatar that can have a plausible initial consultation with a patient with neurological conditions by integrating these six projects. All students will have to contribute to the overall objectives of the research with each of them concentrating on an individual research project.
PROJECT SUMMARY
In the last decade, with Machine Learning development, Natural Language Processing(NLP) witnessed many breakthroughs and countless successful applications. Conversational artificial intelligence(AI), as an important research field of NLP, also gains many research interests [1,2]. Research in Conversational AI studies techniques to enable AI engages in natural conversational interactions with humans. However, most existing conversational AIs only work on context information with pre-defined actions and cannot understand the user intents and reactions [2]. Commonsense reasoning in conversational AI is believed to be the key to solve this problem. Bringing commonsense into Conversational AI understanding, inference and generation is considered to be the next breakthrough in NLP [3]. The RTE challenges[4] are the early stage commonsense related tasks for textual entailment. In recent years, Event2Mind from Rashkin et al.[5] and SWAG from Zellers et al.[6] are two crucial models that integrate commonsense reasoning into NLP. Conversational AI is well addressed by Khatri et al.[2] from both industrial and academic research fields, but how commonsense can efficiently collect and contribute to conversational AI remains a challenge. Previous commonsense reasoning research primarily focused on coreference resolution, textual entailment and plausible inference. There is a gap to make commonsense reasoning to work in conversational AI and it is difficult for the AI to detect intent and response with different commonsense backgrounds. This research project aims to bring an in-depth understanding of commonsense reasoning, investigate how commonsense can help build conversational AI with natural responses to different user's intent, and model aspects of commonsense inference via NPL and deep learning framework. The project will try to apply commonsense inference for domain applications such as healthcare, education and marketing. The experiment will include creating conversational AI with a range of commonsense knowledge to interact with real humans. Therefore, this project will pursue three mutually supportive research and development paths: 1) advancing the theoretical frontiers of common sense reasoning in conversational AI; 2) building user satisfaction modules to improve engagement via evaluation; 3) developing and producing practical applications **References** 1. Yan, R. (2018, July). " Chitty-Chitty-Chat Bot": Deep Learning for Conversational AI. In IJCAI (Vol. 18, pp.

5520-5526).
2. Khatri, C., Venkatesh, A., Hedayatnia, B., Gabriel, R., Ram, A., & Prasad, R. (2018). Alexa Prize—State of the Art in Conversational AI. AI Magazine, 39(3), 40-55.
3. Davis, E., & Marcus, G. (2015). Commonsense reasoning and commonsense knowledge in artificial intelligence. Communications of the ACM, 58(9), 92-103.
4. Dagan, I., Glickman, O., & Magnini, B. (2005, April). The pascal recognising textual entailment challenge. In Machine Learning Challenges Workshop (pp. 177-190). Springer, Berlin, Heidelberg.
5. Rashkin, H., Sap, M., Allaway, E., Smith, N. A., & Choi, Y. (2018). Event2mind: Commonsense inference on events, intents, and reactions. arXiv preprint arXiv:1805.06939.
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ACADEMIC IMPACT

Intel-PA is concerned with the research and interaction of three cross-disciplinary but complementary research subjects, which are computer animation and visualisation; computer vision; and conversational AI. They each have their own research challenges. Their inter-connection will further bring in new challenges and research questions. Our mission here in terms of academic research is to find solutions to these challenges.

The overarching research together with the individual PhD projects will lead to the formulation of many new algorithms. It will advance the state-of the-art of a number of research topics including the generation of plausible body and facial motions in real-time; tracking and detecting human body movements and facial expressions; natural language understanding and synthesis; expert systems and machine learning; conversational artificial intelligence.

The research outcomes will be published in peer-reviewed journals and conferences, which will inspire other researchers for further investigations of relevant or similar topics. The research achievements will be scalable and applicable to other related research undertakings in computer animation, computer vision and conversational AI. The supervising academics can reuse the developed methods, computer programing codes and databases and can either continue with this work or apply them to relevant, but different research questions.

The research outputs will benefit REF2021 and future REFs.

SOCIETAL IMPACT

Intel-PA represents a new generation of virtual humans who can 'think' intelligently; 'understand' and participate in human conversations; 'see' the bodily actions of the human user; and enact appropriate body gestures and facial expressions. It will be a true Intelligent Virtual Human when it is fully developed. By initiating this hugely exciting research direction, Intel-PA can perform many human-like tasks having impactful effects on many aspects of the society.

In healthcare, it can assist the medical practitioners to collect data, have an initial consultation with the patient, generate preliminary diagnosis, suggest a range of treatment options. It can also perform many training tasks for different healthcare workers, such as nurses and clinic psychologists. Similarly, the other sectors will benefit from the functions of Intel-PA, such as in education, marketing, training and many more.

This new technology, once developed, will benefit the UN sustainable development goal of Good Health and Well-being (Goal 3). As Intel-PA will help significantly enhance the proficiency and productivity due to improved communication, training and decision making, it will benefit Goal 8: Decent Work and Economic Growth; and Goal 9: Industry, Innovation and Infrastructure.

DEVELOPMENT OPPORTUNITIES

One of the important aspects of our DTC is that all students will belong to one centre and have the same overall aim of research. We will arrange regular group supervision meetings where all students and supervisors are required to attend. All students will therefore benefit by understanding the global picture of the project; getting advice from all supervising academics; and seeing the progress of their fellow students.

For their individual projects, each student will be supported by their own supervisors on a weekly basis. They will be guided to research on the technical elements relevant to their investigation. In the same time, they will be exposed to the knowledge and practice of the applicable applications.

The training courses from the Doctoral College, such as research methodology, academic writing and presentation, research ethics, project management, career development, will help the students develop their research skills in a wide context.

Students will be provided some additional research training opportunities from our current Centre for Digital Entertainment will include: participating in CDE organised events (for technical and soft skills) and attending prestigious conferences and high-profile public engagement activities (e.g. the annual CDE research showcase at the British Film Institute, London https://youtu.be/WmEL2f6jK5s and the 2018 CDE showcase at the Digital Catapult London https://youtu.be/XOF0By9Wssw). CDE delivered the 2018 EPSRC funded Digital Economy Network Summer School (DEN SS) with 110 doctoral students from ten UK Universities attending http://www.digital-entertainment.org/research-impact/den-summer-school-2018-inspire-programme-develop/

SUPERVISORY TEAM	
First Supervisor	Prof Wen Tang
Additional Supervisors	Prof Jian Jun Zhang
Recent publications by supervisors relevant to this project	1. Gao, Q. H., Wan, T.R., Tang, W. Chen, L (2017): A Stable and Accurate Marker-less Augmented Reality Registration Method. 2017 International Conference on CYBERWORLDS, Chester, UK, 20 Sep 2017 - 22 Sep 2017 2. Chen, L., Tang, W. Wan, T.R., John, W. N.(2020): Self-supervised monocular image depth learning and confidence estimation. Neurocomputing, vol 381, PP 272-281 Elsevier 3. Chen, L, Tang, W., John, NW, Wan, TR., Zhang, JJ (2020): Context-Aware Mixed Reality: A Learning-Based Framework for Semantic-Level Interaction. Computer Graphics Forum 39 (1), 484-496 4. Deng, S., Jiang, N., Chang, J., Guo, S. and Zhang, J., 2017. Understanding the impact of multimodal interaction using gaze informed mid-air gesture control in 3D virtual objects manipulation. International Journal of Human Computer Studies, 105, 68-80. 5. Feng. Y., Ji, M., Xiao, J., Yang, X., Zhang, J., Zhuang, Y., Li, X. (2015). Mining Spatial-Temporal Patterns and Structural Sparsity for Human Motion Data Denoising, Cybernetics, IEEE Transactions on. 6. Hu, W., Wang, Z., Liu, S., Yang, X., Yu, G. and Zhang, J., 2017, Motion Capture Data Completion via Truncated Nuclear Norm Regularization, in IEEE Signal Processing Letters, vol. PP, no. 99, pp. 1-1. 7. Liu, F., Southern, R., Guo, S., Yang, X., and Zhang, J., 2013. Motion adaptation with motor invariant theory. Cybernetics, IEEE Transactions on, 43(3):1131 – 1145. 8. Liu, S., Wang, Z., Yang, X., Zhang, J., 2017, Realtime Dynamic 3D Facial Reconstruction for Monocular Video In-The-Wild, The IEEE International Conference on Computer Vision (ICCV), 2017, pp. 777-785. 9. Nie, Y., Chang, J., Chaudhry, E., Guo, S., Smart, A. and Zhang, J., 2018. Semantic modeling of indoor scenes with support inference from a single photograph. Computer Animation and Virtual Worlds, 29 (3-4). 10. Nie, Y., Tang, Z., Liu, F., Chang, J. and Zhang, J., 2018. A data-driven dynamics simulation framework for railway vehicles. Vehicle System Dynamics, 56 (3), 406-427.

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17. Yang, X., Chang, J., Southern, R., and Zhang, J., 2013. Automatic cage construction for
18. Zheng, J., Qiu, H., Sheng, W., Yang, X., Yu, H., 2018. Kernel group sparse representation classifier via structural and non-convex constraints, Neurocomputing, Vol.296, pp.1-11.
19. Zheng, J., Lu, C., Yu, H., Wang, W., and Chen, S., 2018. Iterative Reconstrained Low-Rank Representation via Weighted Nonconvex Regularizer, IEEE Access, Vol.6, pp.51693-51707.

INFORMAL ENQUIRIES

Please contact the lead supervisor on the following email for informal enquiries: jchang@bournemouth.ac.uk

ELIGIBILITY CRITERIA

The BU PhD Studentships are open to UK, EU and International students.

Candidates for a PhD Studentship should demonstrate outstanding qualities and be motivated to complete a PhD in 4 years and must demonstrate:

- outstanding academic potential as measured normally by either a 1st class honours degree (or equivalent Grade Point Average (GPA) or a Master's degree with distinction or equivalent
- an IELTS (Academic) score of 6.5 minimum (with a minimum 6.0 in each component, or equivalent) for candidates for whom English is not their first language and this must be evidenced at point of application.

ADDITIONAL ELIGIBILITY CRITERIA

An ideal candidate should have a background in computer science, mathematics, engineering or a similar subject. Strong mathematical and computer programming skills are essential.

HOW TO APPLY

Please complete the online application form by **31/10/2021**.

Further information on the application process can be found at: www.bournemouth.ac.uk/studentships