Curriculum Vitae
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Research positions

December 2015 – present, CoEDL postdoctoral fellow: In December 2015, I started working as a post-doctoral fellow in the Centre of Excellence for the Dynamics of Language (CoEDL) node at the University of Queensland. The goal of CoEDL is to "transform the science of language." As part of the technology thread within CoEDL, my primary role was to lead the software development side of the OPAL project, which aimed to develop a child-sized social robot, Opie, for interacting with children. In this project I have: i) developed software systems to enable the robot to be used with children, ii) helped to design studies, iii) helped to run studies, iv) been involved in developing robot prototypes, v) co-written publications (with Gautier Durantin and Janet Wiles), and vi) helped with data analysis. The project successfully developed multiple prototypes that were constantly tried with children in psychology labs and public areas. In addition to working on the OPAL project, I have also worked on the Lingodroids project, iRat project and social moments project while in this position. For the Lingodroids project, I have used Opie to pilot naming games with children in the domain of colour, to see how children would respond in this type of interaction. I successfully ran the study (with Kristyn Hensby and Marie Boden) and the results were published as an abstract.

For the social moments project, I (with Gautier Durantin) have successfully written software for, facilitated and analysed a study around communication using tele-operated motion. The project has resulted in a conference paper that is still under review.

The position has led to two journal publications, one as first author, one conference publication, and four peer-reviewed abstracts. I also have three additional conference papers, two as first author, which are currently under review. In addition to these publications, several unpublished datasets are still under analysis.

Education

2011 – 2016, Ph.D. candidate: In January, 2016, I received my Ph.D. for my thesis entitled "Evolving spatial and temporal lexicons across different cognitive architectures". I received positive reports from both thesis reviewers. My Ph.D. supervisors were Prof. Janet Wiles and Dr. David Ball.

My Ph.D. research forms part of the Lingodroids project, a project that investigates practical robot language learning. The Lingodroids are small mobile robots that are currently based on UQ's iRat rat-animat robot platform, with state-of-the-art robot mapping system RatSLAM to allow robots to represent and name locations in space and time. These names can then be used to refer to a space and later time to perform useful tasks. My PhD studied three facets of robot language learning: i) how robots could learn words for time, ii) how robots with different sensors and mapping systems could learn words for space, and iii) how robots could resolve their uncertainty between words and meanings. I have collaborated on eight publications during my candidature and as first author on five.

2005 – 2010, Bachelor of Engineering and Information Technology: I completed bachelors of both engineering (electrical) and information technology at the University of Queensland, graduating on the 17th December, 2010 with honours IIB and a GPA of 5.

I submitted my undergraduate thesis in 2009 on connecting a mobile robot to a web server using wireless connections to allow people on the Internet to control the robot.

Within engineering: I completed advanced electives in signal processing, control systems, power electronics design and embedded programming. Within information technology: I completed advanced electives in algorithms and data structures, machine learning and network and operating systems.

Research projects

The OPAL project (July 2015 – present): The OPAL project aims to build a child-sized robot for interacting with children. In this project I was responsible for managing the software side of the robot. The project presented a number of challenges: i) the cross-disciplinary team included roboticists, psychologists, interaction designers, and educational outreach officers, ii) significant engineering challenges around the construction of the robot, and around the distributed software systems, and iii) the requirement for extremely safe operation of the robot. A number of prototypes of the Opie robot were developed, with the flagship Opie robot consisting of moving arms and a moving head. The flagship robot was successfully internally demoed in February, 2017, and first trialed with children in August, 2017. The project has resulted in one journal paper, four abstracts, and there is one conference paper under review. Different prototypes of the robot have been trialled with over 200 children. The project is online at (`http://www.itee.uq.edu.au/cis/opal`).

Social moments (July 2015 – present): Social moments are (typically short time-scale) events that convey a social meaning. I (with Janet Wiles and Gautier Durantin) have implemented a study to capture social moments by restricting communication modalities. This study uses two iRat robots and requires participants to communicate through motion in order to pass through an intersection. The motion of the participants can be captured by recording the speed of the robots, the positions of the robots, and the user input from joysticks. In addition to helping to design the study, I wrote the majority of the software to implement the study and helped with data analysis.

iRat (July 2015 – present): The iRat is a rat-sized robot designed for neuroscience studies, that was designed and built at UQ, and is also part of collaboration with the University of California, San Diego (UCSD). My contributions to this platform are the creation of software drivers and standard robotics interfaces (ROS) to allow offboard control. I have also been responsible for maintaining the iRat platform for use in rat–iRat studies, where the iRat is used to stimulate or teach a rat. In 2017, a second iteration of the iRat robot was developed in the course of a five-week period. This iteration of the iRat, with its external tracking system, is the first fully autonomous version of the iRat.

   The original iRat has resulted in two conference papers and the new iRat has resulted in an additional conference paper. The project is online at (`http://www.itee.uq.edu.au/cis/irat`).

Lingodroids (2011 – 2015): The Lingodroids Project investigates robots autonomously evolving languages for space and time through conversations. My contributions to this project are the exploration of words for time and exploring robots with different embodiment and cognitive capabilities. I also rewrote the Lingodroids processes so that they could be run on the new iRat robot platform. These contributions resulted in the publication of two journal papers and two conference papers. The project is online at (`https://www.lingodroids.org`).

OpenRatSLAM (2011 – 2013): OpenRatSLAM is an open-source version of mapping system RatSLAM that was originally adapted for iRat studies. The original code was expanded to use standard robotics (ROS) interfaces, multiple processes and a generally improved architecture. This project has resulted in a journal paper and a freely available implementation of OpenRatSLAM hosted on Github (`https://github.com/davidmball/ratslam`).

RatSLAM Telerobot (2008 – 2011): The RatSLAM telerobot was a project to allow users to interact with a robot from within a web browser. My contributions were the creation of a module for Apache that could communicate with the robots and the creation of a Flash front-end to provide images and mapping information to users online. The project combined research code written in C++ with a C++ Apache module and Flash front-end written in ActionScript. The thesis project was demonstrated at the university's ITEE expo. This project formed my undergraduate thesis and resulted in a conference paper. The project was demonstrated live at both the UQ ITEE expo, and at the Australian Conference on Robotics and Automation.

Research interests

My research interests encompass social robotics for both humans and other animals. I am particularly interested in the engineering side of social robots - how to develop social abilities for robots, but also in the psychology of how humans respond to social robots. I am also interested in communication aspects of human-robot interaction, particularly the links between a word and its meaning as understood by a human and a

robot, and the importance of symbol grounding for a robot in helping to understand words where meaning depends on the environment.

Technical skill - Programming languages and software tools

Fluent with: C/C++, Python, Linux, g++/gcc, CMake, Robot Operating System (ROS)

Competent with: LaTeX, Lua, Javascript, MATLAB/Octave, Julia, Java, SQL, ActionScript/HaXe, Android Studio, Git

Competent with: Assembly, OpenGL/GLSL, Lisp/Scheme, Rust

Technical skill - Electrical

Familiarity with: Analysis and design of electrical circuitry, LTSpice

Publications (selected)

Heath, S., Ramirez-Brinez, C. A., Arnold, J., Olsson, O., Taufatofua, J., Pounds, P. and Wiles, J. (2018) PiRat: An autonomous framework for studying social behaviour in rats and robots. In *Proceedings of the International Conference on Intelligent Robots and Systems*

Taufatofua, J., Heath, S., Ramirez-Brinez, C. A., Sommer, K., Durantin, G., Kong, W., and Wiles, J. (2018) Designing for robust movement in a child-friendly robot. In *Proceedings of the International Conference on Intelligent Robots and Systems*

Quinn, L. K., Schuster, L. P., Aguilar-Rivera, M., Arnold, J., Ball, D., Gygi, E., Heath, S., Holt, J., Lee, D. J., Taufatofua, J., Wiles, J. and Chiba, A. A. (2018) "When rats rescue robots." Animal Behavior and Cognition 5, no. 4: 368-379.

Heath S., Durantin G., Boden M., Hensby K., Taufatofua J., Olsson O., Weigel J., Pounds P. and Wiles J. (2017) Spatiotemporal aspects of engagement during dialogic storytelling child–robot Interaction. In Mutlu, B. (Ed.) *Frontiers in Robotics and AI*

Heath S., Durantin G., Boden M., Hensby K., Taufatofua J., Olsson O., Weigel J., Pounds P. and Wiles J. (2017) Spatiotemporal aspects of engagement during dialogic storytelling child–robot Interaction. In Mutlu, B. (Ed.) *Frontiers in Robotics and AI*

Durantin, G., Heath, S. and Wiles., J. (2017) Social moments: A perspective on interaction for social robotics, In Mutlu, B. (Ed.) *Frontiers in Robotics and AI*

Heath, S., Ball., D. and Wiles, J. (2015) Lingodroids: Cross-situational learning for episodic elements, In Cangelosi, A. (Ed.). *IEEE Transactions on Autonomous Mental Development*

Heath, S., Ball., D., Schulz, R. and Wiles, J. (2013) Communication between Lingodroids with different cognitive capabilities, In Parker, L. (Ed.). *Proceedings of the 2013 International Conference on Robotics and Automation*, Karlsruhe, Germany

Ball, D., Heath, S., Wiles, J., Wyeth, G., Corke, P. and Milford, M. (2013) OpenRatSLAM: an open source brain-based SLAM system, In Pantofaru, C., Chitta, S., Gerkey, B., Rusu, R., Smart, W. D. and Vaughan, R. (Eds.). *Autonomous Robots*, 34(3):149-176

Heath, S., Schulz, R., Ball, D. and Wiles, J. (2012). Long Summer Days: Grounding words in the temporal cycles of real world events. In Harris, Jr., F. C., Krichmar, J., Siegelmann, H. and Wagatsuma, H. (Eds.). *IEEE Transactions on Autonomous Mental Development*, 4(3):192-203

Heath, S., Schulz, R., Ball, D. and Wiles, J. (2012). Lingodroids: Learning terms for time. In Parker, L. (Ed.). *Proceedings of the 2012 International Conference on Robotics and Automation*. Saint Paul, MN, USA.

Heath, S., Cummings, A., Wiles, J. and Ball, D. (2011). A rat in the browser. In Drummond, T. and Li, W. H. (Eds.). *Proceedings of the 2011 Australian Conference on Robotics and Automation*. Melbourne, Australia.

All publications: I have a total of 20 peer-reviewed publications, including 6 journal publications, and 4 publications in international robotics conferences ICRA and IROS. The full list of publications is available on Google Scholar (see `https://scholar.google.com.au/citations?user=QwnKIG0AAAA`).

Grants

CoEDL transdisciplinary and innovation grant "Learning language with a robot in the school classroom," 2018: I received a transdisciplinary and innovation grant entitled "Learning language with a robot in the school classroom." The aim of the grant application is for funding to study how Opie can be integrated into a lesson plan and used as a teaching aid within a Brisbane-based indigenous school. The grant application was awarded $AU 14,170 in funds.

CoEDL transdisciplinary and innovation grant "Building a social robot for language teaching and preservation in remote areas of the Northern Territory," 2017: I was involved in a grant led by Dr. Gautier Durantin, entitled "Building a social robot for language teaching and preservation in remote areas of the Northern Territory." The aim of the grant was to get funding for taking one of the Opie robots to a remote indigenous community, Ngukurr, in the Northern Territory, Australia. The grant application was awarded $AU 17,957.10 in funds.

Teaching

2018, CSSE2002 – Programming in the large: I (with Dr. Jessica Korte) co-lectured, designed assignments, and co-marked for the subject *CSSE2002 – Programming in the large* at the University of Queensland in semester 2, 2018. The course had over 400 enrolments.

2018, DECO3500 – Social and mobile technology: I gave two guest lectures for the subject DECO3500 – Social and mobile technology at the University of Queensland in semester 1, 2018.

2009 – 2012, Tutoring: I tutored subjects *Artificial intelligence* (2012), *Advanced control and robotics* (2011), *Introduction to programming* (2009), *Signal and image processing II* (2009) and *Advanced information technology project* (2009) at the University of Queensland.

Media

Courier Mail (Brisbane): Opie appeared in the local the Courier Mail blog as part of an article on automation. Burgess, M. (2017). Robots, automation, artificial intelligence not as scary for workers as they seem. `http://www.couriermail.com.au/business/work/robots-automation-artificial-intelligence-not-as-scary-for-workers-as-they-seem/news-story/38bcd6f730f0f8b36815d91d60bea8d1?nk=4f8628e1640f134d86a48b90544e665e-152272612`

IEEE Spectrum: Lingodroids has appeared in an article by Evan Ackerman in the IEEE Spectrum blog Automation. The article is based on a talk I gave at the International Conference on Robotics and Automation. Ackerman, E. (2012). Lingodroids robots invent new words for time. `http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/lingodroid-robots-invent-new-words-for-time`

ABC News: The iRat appeared in the ABC news after a demo given by Prof. Janet Wiles and me at the World Conference on Computational Intelligence. Berkman, K. (2012). AI expo underway in Brisbane. `http://www.abc.net.au/news/2012-06-15/ai-expo-underway-in-brisbane/4074056`

Community Outreach

Queensland state library: Prof. Janet Wiles and I gave a Lingodroids talk and demo in June, 2013, at the Queensland state library in their *Clever Convention* series.

Sherwood state school: Dr. Dan Angus and I gave an iRat demo to grade 2 students at Sherwood State School in Brisbane. A video of the event was posted online at `http://vimeo.com/29238207`.