Jacqueline Kory – NSF GRFP 2011 Application Materials – Past Research Experience

In my freshman year of college, one of my professors, Dr. Ken Livingston, invited me to participate in Vassar's Undergraduate Research Summer Institute (URSI) – ten full-time weeks of research. Usually, students have to apply for this opportunity and relatively few are selected. Ken had singled me out regardless. The project was to test and refine a novel learning algorithm for mobile robots [1]. One other student and I implemented the algorithm as a partially recursive neural network with the ability to grow new nodes and connections while learning in real time. Testing was done with two simulated robots in Microsoft Robotics Studio. I was primarily in charge of writing smaller portions of the code and running the simulations, since at the time, I was new both to programming and to the theory behind the project. The experience opened my eyes to one possible direction I could take my studies in cognitive science. I returned the next summer for a second URSI session, working on the same project. I independently ported our work to the real world on an actual robot, and incorporated visual input in the form of optical flow information and colored object tracking. Although adding vision was not as successful as was hoped, I understood the worth of the endeavor – we wanted a more general algorithm that could learn patterns across multiple sensory modalities and be more able to deal with different contexts. Each summer concluded with poster presentations at the URSI research symposium.

So far, my knowledge of types of cognitive science research was limited. I sought opportunities to broaden my experience. During my semester abroad at the University of Sydney, I interned one day a week at the Brain and Mind Research Institute. I learned how to configure, retrieve, and score actigraphic data for the Youth Mental Health project in the Chronobiology and Sleep Group. This data can determine sleep and activity patterns and is used to diagnose mental health issues. I independently analyzed a subset of the actigraphy data, trying to determine the range of average activity counts per minute for different groups of people, and gave a 20-minute presentation of the results for the Youth Mental Health group. On my return to Vassar, I investigated the stability of first impressions and their revisions across the Big Five personality dimensions, designing and implementing pilot behavioral and EEG studies with the fourteen students in my research methods course. We got an unusual result – we saw a peak in the EEG that is normally seen during the re-evaluation of syntactic anomalies. Our participants were re-evaluating their impressions of other people. Another student and I wanted to know whether the result would hold up with replication. If it did, the peak could potentially be used in completely new ways, as a measure in studies of social processing as well as neurolinguistics. The two of us reran the EEG study, but our results were inconclusive and have not yet been published. The experience convinced me that I did, in fact, want to pursue a research career.

All of my experience up to this point was at academic institutions. I wanted to explore other options, so I applied for summer internships in industry and government labs. I spent the summer of 2009 at NASA Langley Research Center, working with eight fellow undergraduates under the mentorship of Mr. Garry Qualls. Our team's goal was to establish an autonomous vehicle facility to allow complex, multi-vehicle tests to be run both indoors and outdoors. I wrote and integrated software in C, C++, and Java for a flight management system, navigation controllers, GPS simulators, real-time visual data displays, data parsers, and the commercial motion capture system that was used for vehicle localization. I kept the team organized and helped develop a simple demonstration of the facility with a quadcopter that tracked and followed a ground vehicle, which my lab presented at the NASA Langley Aeronautics Student Forum in August 2010. Even before then, NASA engineers and scientists were coming to us to ask if they could use the facility, saying it would be greatly beneficial for testing their new technologies.

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I returned to Vassar at the end of the summer stoked for my year-long senior thesis. Drawing from my diverse interests – communication, emotion, artificial agents, adaptive behavior – I designed a study to investigate the effects of an artificial emotion-like system on group behavior in swarms of simple mobile robots in a predator-prey scenario. I developed a behavior-based control architecture for a single predator and a group of prey; the prey could also communicate via affect-motivated signals about the location of the predator. I implemented the architecture on simulated robots in Microsoft Robotics Studio. Using a genetic algorithm, I let populations of prey evolve over time; in later generations, the prey agents began to utilize alarm signaling and displayed "fear" contagion, with more group members surviving than in groups of prey without the emotion-like system. These results suggested that emotion plays a key role in generating adaptive, context-dependent behavior, supporting recent studies on the topic (e.g., [2], [3]). Incorporating emotion-like systems into artificial agents could improve the agents' abilities to deal with uncertain situations. I am currently preparing a paper for the publication of my results, and in my graduate work, I plan to explore this topic further.

After graduation from Vassar, I drove south to NASA Goddard Space Flight Center to lead a software team in the Engineering Boot Camp. The goal of my project, LIDAR-Assisted Robotic Group Exploration, was to assemble a networked team of autonomous robots to be used for three-dimensional terrain mapping, high-resolution imaging, and sample collection in unexplored territories. The software developed in this proof-of-concept project could be transportable from our test vehicles to actual flight vehicles, which could be sent anywhere from disaster zones on Earth to asteroids and moons beyond. My team consisted of four software developers, all college seniors or graduate students. The whole Boot Camp included about sixty students from more than five countries. Partway through the summer, my team was joined by collaborators from Brazil. We were advised by numerous NASA engineers and professors from the University of Maryland College Park. I kept everyone organized and on task, writing detailed documentation and coordinating with the hardware team who dealt with the electronics and mechanics of the robots. My team developed object recognition, mapping, path planning, and multi-robot coordination software in C++ and C# using the Robot Operating System (ROS) for a group of customized worker-bots, which allowed for autonomous control between infrequent contacts with human monitors. We presented demonstrations to the public at NASA Wallops Flight Facility visitor's center and at NASA Goddard Space Flight Center's visitor's center in July 2011.

Presently, I am working full-time in Professor Sidney D'Mello's Emotions Lab in the Institute of Intelligent Systems at the University of Memphis. My goal is to gain a deeper understanding of emotions research, since I plan to continue work in this vein during my graduate career. I am involved on projects for two large NSF grants on how cognitive disequilibrium and confusion interact with learning, which utilize intelligent tutoring systems and are focused on building better educational tools. I am also lead researcher on a project on mind wandering during reading. Mind wandering is correlated with poorer memory for the text and poorer reading comprehension overall, so the goal is to be able to both detect and predict when a reader is mind wandering so we can intervene either during or before the zoning out episode to increase reading comprehension. I have written software to interface with eye trackers and galvanic skin response sensors, developed stimulus sets, and am currently coordinating data collection. Several papers for academic journals are anticipated as a result.

References

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