Dynamic Decision Making Laboratory

ISSUE 11 FALL 2019

Carnegie Mellon University

Annual Summary from Coty—Founding Director, DDMLab

Inside this issue:

Dear Friends and Collaborators:

It is hard to believe that another academic year has come to an end (2018-2019). In this year's newsletter we reflect on the research activities of the DDMLab during this year, while we start the new academic year (2019-2020). Thank you for letting us update you!

We are grateful for the support provided by our current research sponsors. This year, we continued the work sponsored by the **Army Research Office (ARO)**, Network Sciences program. This grant has helped us in developing new algorithms and cognitive models that expand our understanding of how group and network behavior emerges from individual learning, and how networks form from individual interactions. We also have continued the work sponsored by the **ARO's Multidisciplinary University Research Initiative (MURI)** program on Cyberdeception. This program has resulted in important advances to algorithms for defense and dynamic and personalized deception strategies. Our collaborations with researchers at University of Southern California now at Harvard University, and University of Texas at El Paso, have helped advance new signaling algorithms that are applied to cybersecurity but can be applied to other security problems. We also continue to be part of an exciting long-term research program with the **Army Research Laboratories (ARL).** This program on cybersecurity is a Collaborative Research Alliance (CRA) that allows us to interact and develop new collaborations with many other universities and organizations. We continue to maintain an active research program on socio-cognitive aspects of cybersecurity including; decision making on defenders, attackers, and end-users and developing cognitive models that can capture those processes. Finally, we are also grateful for the support from the **Defense Advanced Research Projects Agency (DARPA)**. In the SocialSim program, we collaborate with Christian Lebiere in the development of cognitive models that capture phenomena in large scale data sets including tweeter, telegram, and others.

This year we concluded the work sponsored by the **National Science Foundation (NSF),** Decision, Risk and Management Science program, which helped in advancing cognitive models that account for decision making based on experience and description. There are a few manuscripts still under preparation or review as part of our work on this grant, which we plan to conclude in the near future.

It is also exciting to announce our participation in a new **DARPA** program: **Artificial Social Intelligence for Successful Teams (ASIST)**. In this program we will develop foundational Artificial Intelligence theory that demonstrate effective human-machine collaboration. Our research will be performed by an interdisciplinary, women-only team of Co-PIs from Carnegie Mellon: Anita Woolley, Henny Admoni, and myself. Stay tuned for exciting news from this program!

Many publications emerged this past year. Perhaps due to our increased collaborations with Computer Scientists, many of our publications appeared in prestigious

interdisciplinary conferences including: the International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS, 2019); The International Joint Conference on Artificial Intelligence (IJCAI-19); The International Conference on Cognitive Science (CogSci, 2019), and many others.

This year we participated in a number of invited lectures and plenary talks. These included: an invited talk at the Workshop on decisions from experience, Universidad Nacional Autonoma de Mexico. Psychology Department, Mexico City, Mexico. Computational Security in Compromised Environments (C3E) meeting in Atlanta, GA.; the participation in the Past President's Forum at the Human Factors and Ergonomics Society (HFES 2018) Meeting in Philadelphia, PA; an invited talk at NYU Abu Dhabi, and an invited talk at the Reinforcement Learning and Decision Making (RLDM) conference in McGill University in Montreal, CA.

Two keynote or plenary talks lectures are especially noticeable:

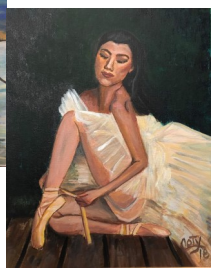
- 2018 November 29. *Human Failure in Stock and Flow Problems: An Updated Review*. **Plenary talk**. I Congreso Iberoamericano de Soluciones Sistemicas y Transformacion Organizacional (I CISSTO, 2018). November 28-30. San Lorenzo de El Escorial. Madrid, Spain.

  Thank you German Dugarte and Maribel Sanchez-Segura for the great adventure at El Escorial!!

- 2019 July 10. *Moments@Work: Advancing Sensitivity to Diversity through Experiential Learning*. Development Symposium. Women in Mathematical Psychology Development Symposium. Thank you Leslie Blaha for the invitation!

Another highlight of this academic year was a workshop organized by my friend Mirta Galesic at the **Santa Fe Institute**. I love the interdisciplinary and relaxed research environment of the SFI!

Teaching was a good experience during the Spring 2019 Semester. I think I found a way to teach the mix of concepts on decisions from experience, behavioral science with microworlds, cognitive modeling, and system dynamics concepts and models all in one course, while making it practical and useful to the students. I think students enjoyed the experience of playing games in the classroom while learning concepts of dynamic systems. Here are my students playing The Beer Game.



Finally, to end on a personal note, I continue to enjoy biking and painting on my weekends (when I can!). These pictures show some of my favorite paintings from this year. I used water colors and acrylics.

I hope you enjoy this newsletter. Thank you so much for reading our update, and thank you so much for contributing to our efforts in so many ways!! We look forward to a new year full of interesting research, surprises and new adventures. ***Let's all work to make this a better world!!***

2019

News From Our Members

Farewells

Many good people left my lab during this year. Each of them deserve special mention: Ph.D. students Cristobal de La Maza and David Hagmann defended their dissertation successfully this year, and they moved on to work on new challenging adventures. Pegah Fakhari ended her position as a Post-doctoral fellow in December 2018, and moved to California. German Dugarte returned as a visitor to my lab during summer 2019, and we certainly enjoyed having him here again! Qiao Shen supported our work for diversity and inclusion and our game development of *Moments@Work* a game designed to raise awareness and to influence the state of diversity at Carnegie Mellon University.

But I want to particularly highlight Orsi Kovacs, our lab manager until August 2019. Orsi's contributions to the lab are invaluable. She redesigned our web page recently, and maintained the lab running in an impeccable way. Most importantly, Orsi really cared about us and the lab success. We will miss her.

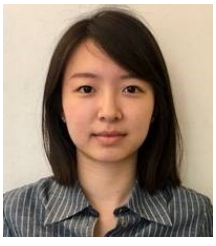
Orsi Kovacs is taking her talents, skills, and work ethic to California.

Germán Lenin Dugarte Peña visited us until August 2019. He has returned to Spain to work for Universidad Carlos III de Madrid, research group SEL-PROMISE.

Dr. Christobal De La Maza returned to Chile to become the Head of Division Environment and Climate Change at the Ministry of Energy.

Dr. David Hagmann accepted a position as a Taubman Fellow at the Harvard Kennedy School of Government.

Dr. Pegah Fakhari moved to California and is a senior data scientist in the renewable energy market.



Qiao Shen is an undergraduate student at Carnegie Mellon University, double majoring in Economics and Statistics and Psychology.

News From Our Members

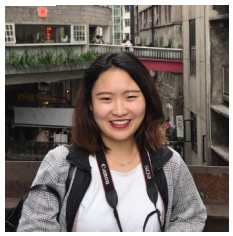
Welcome New Members

Jeffrey Flagg obtained his Bachelor's and Master's Degree in Psychology at the University of Pittsburgh. His research interests include information sharing, online privacy concerns, newcomers to groups, and social exclusion. He has previously managed the Privacy Economics Experiments (PEEX) Lab based at the Heinz College, and he is now supporting the management of the DDMLab in its daily operation and development.

Hanshu Zhang received her Ph.D. and M.S. degree in Human Factors and Industrial/Organization Psychology from Wright State University. Her previous research includes cognitive modeling, perception, and visual search. At the DDMLab, she is working on studies involving sequential decision making and deception concepts, applied to the cybersecurity research..

Thuy-Ngoc Nguyen received her Ph.D. in Computer Science from the Free University of Bozen-Bolzano (UNIBZ), Italy for her research on supporting group decision making process with recommendation techniques. Prior to UNIBZ, she completed her master's and bachelor's at Vietnam National University-HoChiMinh City University of Science and HoChiMinh City University of Education, respectively. Her research interests include (group) recommender systems and their applications, human computer interaction, and user modeling.

Alison Butler received her Bachelor's degree in Neuroscience and Economics from the Ohio State University in 2016. Afterwards, she began studying as an MD/PhD student in the Medical Scientist Training Program at University of Pittsburgh School of Medicine and Carnegie Mellon University. She is working on a project examining how people think about end-of-life scenarios and form preferences surrounding end-of-life care.


Undergraduate students Max Yeh, Peijie He, and Max Gamerman joined the DDMLab for the Fall semester. Max Yeh is currently a Junior in the department of Social and Decision Sciences pursing a Bachelor's Degree in Decision Science and a minor in Business Administration. Peijie He is currently a senior majoring in Decision Science with a double major in Economics and Statistics. Max Gamerman is a third-year student studying Behavioral Economics, Policy, and Organizations with a minor in Humanities Analytics.

Research Updates from Lab Members During 2018-2019

From Palvi Aggarwal

I joined the lab a year ago and started working on cybersecurity projects in collaboration with various universities. I worked on different projects that deal with various levels of complexity and realism to solve cybersecurity problems. In the first project, we investigated how signaling could be helpful in reducing cyber-attacks. We found that a combination of truthful and deceptive signals for both protected and not-protected nodes would be helpful to decrease the overall attacks. Furthermore, we developed cognitive models to predict the attacker's behavior in the presence of signaling. We found that the optimal algorithms of protection and signaling were unable to reduce the attacker's actions. To exploit attackers learning, we developed adaptive and personalized signaling algorithms. This work is accepted for publication in ICCM-2019 and HICSS-2020 conferences.

In another project, we enhanced the functionality of the HackIT tool which was part of my Ph.D. work. The HackIT tool was made capable of creating flexible network sizes, configurations, different deception strategies, and conduct multi-player experiments. I presented this work in Women in Cyber Security (WiCys-2019) conference and Applied Human Factors and Ergonomics (AHFE-2019) conference. Using the additional features in HackIT, we have been working on identifying different scanning strategies that attackers use before launching an attack. We have developed scenarios and will start the data collection soon. Next, we have been working on a real-time testbed for cybersecurity research called CyberVAN. We developed various masking scenarios in CyberVAN. The objective here is to identify which masking strategy would be able to reduce attackers' utility. We are currently running pilots and start the full data collection soon. In addition to the above projects, I have also been working on making IBL model for the network of agents, developing effective training for phishing and optimal allocation of honeypots in the network.

From Hanshu Zhang

I joined DDM lab as a postdoctoral researcher this August. Currently, I am working on three projects. The first project I am wrapping up is the deception game that was initiated by Fred Moisan. For this deception project, we are exploring how different payoff perceptions motivate decision makers to lie about the information that is less beneficial for them. In addition to the payoff matrix manipulation, we also include a measurement of social preference to test whether "niceness" has an impact on deception behavior.

The other two projects that I am involved with are the paper rock scissor game and box game with Palvi Aggarwal. Both projects examine how decision makers learn from previous experience, and how that biases them in future sequential choices.

From Korosh Mahmoodi

During the past year, I developed an agent based model, called Living Algorithm (LA), to show how collective intelligence can emerge from self-interest of the interacting individuals. The main ingredient of the LA is a new mechanism for decision making, Self-Interest-Based Imitation/Trust which is combination of reinforcement learning and Imitation/Trust.

Research Updates Continued

We also introduced a new mechanism for connection between the agents, Self-Interest-Based Connection, which leads to the emergence of a complex dynamic network. This model has been presented in the ACM Collective Intelligence 2019 conference as well as in the 41st Annual Meeting of the Cognitive Science Society.

To examine the prediction of the LA about emergence of mutual cooperation we designed an experiment and ran it on human participants. We found that the results of the experiment are in agreement with that of the model. A new IBL model is being compared to the LA.

Finally, I showed that the emerged behavior by LA is adaptive and robust: when the environment of the emerged group changes the agents reorganize their trust network and their connections in order to increase their own payoffs in the new conditions; and doing so the payoff of the whole group moves towards its optimum value.

FROM KULDEEP SINGH

I joined the DDMLab last year and was fascinated by the phishing studies conducted by Prashanth Rajivan. The previous study focused on crafting effective phishing emails. I started working on this project from the end user perspective. In this project, we are investigating how to train people and prepare them against phishing emails. To achieve this objective, we developed a phishing training tool. We ran a human experiment with the help of the phishing training tool. Results show that participants receiving higher frequency of phishing emails had a higher hit rate, but also higher false alarm rate at detecting phishing emails at post-training, compared to participants encountering lower frequency levels during training. Furthermore, we are working on other cognitive parameters such as incentive structure and feedback to improve the quality of training. This work is accepted for publication in HFES-2019.

In another project, we are working on collaborative multiplayer attacker and defender game. In this project, we are investigating, how multiple defenders can take advantage of information sharing against cyber-attacks by learning the behavioural aspect of an attacker in the network. The information sharing idea includes two aspects: first, with whom one can share the information and the other is how much information one can share with other collaborative defenders. I am also working on another project where we are developing two player cooperation games and using IBL models to predict human behaviour.

FROM ERIN MCCORMICK

This past year I proposed my dissertation, which has two components, and am currently working on the proposed studies for the second component. The first component of my dissertation investigates human adaptation to continuous, gradual, exogenous changes in the probabilities and payoff values of choice outcomes in decisions from experience. This work is part of a manuscript with Coty and Sam Cheyette, former lab member and current graduate student at UC Berkeley. We find that a previously neglected factor in dynamic choice environments (the direction or trend of change) influences the success of adapting in such dynamic environments, in conditions of both partial and full feedback about outcomes.

The second part of my dissertation proposes to investigate how decision makers adapt to time constraints on their decision process (work advised by Coty and Stephen Broomell, another faculty member in the Social and Decision Sciences). This project seeks to systematically test whether certain changes in the decision process should and do allow decision makers to adapt to constraints on how long they have to make their decisions, and is anticipated to have implications for testing theories and predicting how decision processes change under time constraints.

FROM DAVID HAGMANN

In January, I defended my dissertation and began a Postdoctoral Fellowship at the Kennedy School of Government. My research in the past year has focused on the desire to avoid information about taxes and information that threatens to undermine cherished political beliefs. In one ongoing project, my coauthors and I find that people who share their own experience ("personal narrative") rather than data and statistics are viewed more favorably by their audience. We are testing whether this in turn makes people more receptive to the information and opens them to being persuaded. Although I'm excited by the new research opportunities in Boston, I also miss the wonderful DDMLab group and our memorable lunch conversations. It's a small world, so I'm looking forward to catching up at the next conference!

Research Updates Continued

From Germán Lenin Dugarte Peña

This year, during the summer, I visited the DDMLab for the second time. My main activity was focused on finishing the writing process of my PhD dissertation. I submitted the final document to my academic program in August, which was accepted. My public defense was scheduled for September 27th, 2019.

Having Coty as co-advisor, I centered my days here on improving the implementation of an IBL-model using the Netlogo simulation tool. This Netlogo model simulates "decisions" and the process of "learning from such decisions" in the context of software solutions implementation, providing a valuable input for real "smart" decision making. This model is also connected to a knowledge management module representing how such decisions would affect organizational knowledge assets.

In another project, I started collaborating the DDMLab by building a simulation model of an academic network collaborations dynamics. The main goal of this model is to represent the collaborations among academics considering factors affecting such collaborations, such as: academic position, gender, race, tendency to collaborate with others, h-index, etc.

After a wonderful 3.5 months experience of which I'm sincerely grateful, I returned to Spain to work for Universidad Carlos III de Madrid, research group SEL-PROMISE (Processes and Information Technologies for the Governance of Intelligent Organizations). I keep with me excellent memories and a willingness to collaborate with the DDMLab in the future.

From Don Morrison

Among the projects this past year was building an online version of Moments@Work, a game aimed at raising awareness and increasing sensitivity to diversity and inclusion issues, developed with support from the office of the Vice Provost for Faculty. This was built using node.js and Ajax, allows a human to play against three simulated opponents, which can be configured to have different “personalities,” and facilitates gather data when running the game as part of an experiment. In the future we may expand it to allow multiple human participants and/or more sophisticated simulated opponents.

A new version of PyIBL is approaching public release, including bug fixes and improved APIs, easier access to the internals of the IBL process to facilitate more complex models, and a flexible interface to allow delayed feedback. We’ve also moved all of our online experiments and our download page to an in-house server which allows greater flexibility than the ISP we had been using, and are working to move the last vestiges of our presence on the ISP to the in-house server.

From Orsi Kovacs

In the past year, as a lab manager, I contributed to projects by supporting the full research cycle with preparing IRB protocols, testing experiments, and managing data collection. I streamlined and optimized processes in the lab to facilitate participant management and I developed experimental design protocols to help transfer knowledge between post-doctoral fellows and researchers. I managed and migrated the lab’s website to the new domain under https://www.cmu.edu/dietrich/sds/ddmlab/.

I implemented the deception box game in Qualtrics using custom JavaScript for the cybersecurity project that aims to explore the optimal use of deceptive signals in cybersecurity. In the Moments@work project that studies the effects of experiential learning on reducing biases in the workplace, I was working together with Coty, Geoff Kaufman, Kevin Jarbo, Don, and Qiao on experiment implementation, testing and data collection. In the End-of-life project with Coty, we studied how individual and cultural differences influence the type of end-of-life treatment decisions people make, and how comfortable they feel to make such decisions.

From Pegah Fakhari

At the DDM lab, the main focus of my research was to investigate computational and cognitive mechanisms involved in human decision making from experience. Specifically, (1) how people exploit their learning strategies to make optimal choices, (2) how people apply different sources of information to execute the best actions (description based decisions vs. experience based decisions).

Dr. Fakhari works as a senior data scientist in renewable energy market.

Research Updates Continued

From Jeffrey Flagg

I started with the DDMLab in July of 2019. I was very grateful to have Orsi here to help guide me through my first month of training. Her encyclopedic knowledge of lab procures, dedication to the work, and positive attitude made it obvious why she was such a well liked member of the team. She will definitely be missed!

I obtained my Bachelor's and Master's Degree in Psychology at the University of Pittsburgh. I previously managed the Privacy Economics Experiments (PEEX) Lab based at the Heinz College. I'm also grateful for my time working with Dr. Alessandro Acquisti and his team.

At the DDMLab, I have been assisting in preparing IRB protocols, testing materials, and running experiments. In addition, I have been maintaining the DDMLab website and procedural documents, preparing our Newsletter, and integrating myself into all aspects of our daily operation. I'm looking forward to working with Coty and the rest of our wonderful lab members.

From Alison Butler

I started working with Coty this past summer on a project related to end-of-life decision making. We are interested in the question of how people make decisions when they cannot necessarily obtain personal experience with the choices involved -- such as decisions about what type of medical care people would want when they were near the end of life, or what type of interpersonal treatment they would desire if they were dying. We have been analyzing experimental data collected by a previous lab member, Nalyn Sriwattanakomen, that asked participants to answer a series of end-of-life scenario questions from a questionnaire called the Five Wishes (developed by the organization Aging with Dignity). The Five Wishes questionnaire is a living will designed to encompass personal, emotional, and spiritual needs, as well as medical wishes and designation of a health care agent decision maker.

Currently, we are exploring whether certain demographic characteristics (i.e. age, level of financial stability, and acts of preparation for old age, among other items) can predict participants' comfort with answering questions in the Five Wishes, as well as which demographics correlate with emotions such as fear and sadness when answering questions in the Five Wishes. This work will shed light on how clinicians and other healthcare professionals can identify emotional and social difficulties involved in completing a living will or advanced directive, so that they are better equipped to help patients take the initial steps in completing documents like the Five Wishes well in advance of actual end-of-life settings.

From Thuy-Ngoc Nguyen

I will be joining the Dynamic Decision Making Lab as a postdoc fellow this October. In the lab, I will be working on a project about human-machine teaming. Specifically, my main research work will revolve around developing a computational Socio-Cognitive architecture that can be used to model the emergence of individual human behavior and collective behavior at the team level.

Orsi's farewell dinner!

Recent Publications

In the past year, we published several journal articles and articles in conference proceedings authored by members of the DDMLab and our collaborators.

For a full list of publications, please see the publications page on the laboratory's website at https://www.cmu.edu/dietrich/sds/ddmlab/publications.html

Some Recent Publications in Conference Proceedings (available upon request:)

Cooney, S., Vayanos P., Nguyen T. H., Gonzalez, C., Lebiere, C., Cranford E. A., Tambe, M. (2019). Warning Time: Optimizing Strategies Signaling for Security Against Boundedly Rational Adversaries. Proceedings of the 18th International Conference on Autonomous Agents and Multi Agents Systems. AAMAS, 2019. May 13-17, 2019, Montreal, CA.

Cranford, E. A., Gonzalez, C., Aggarwal, P., Cooney, S., Tambe, M., Lebiere, C. (2019). Towards personalized deceptive signaling for cyber defense using cognitive models. In Proceedings of the 17th Annual Meeting of the International Conference on Cognitive Modelling (in press). Montreal, CA.

Gutierrez, M., Cerny, J., Bosansky, B., Kiekintveld, C., Ben-Ahser, N., & Gonzalez, C. (2019). Evaluating Models of Human Behavior in an Adversarial Multi-Armed Bandit Problem. 41th Annual Meeting of the Cognitive Science Society (CogSci 2019). July 24-27, 2019, Montreal, Canada. 394 – 400.

Mahmoodi, K. & Gonzalez, C. (2019). Emergence of Collective Cooperation from Selfish-Imitation and Selfish-Attachment. 41th Annual Meeting of the Cognitive Science Society (CogSci 2019). July 24-27, 2019, Montreal, Canada. 2254 – 2260.

Sing, K., Aggarwal, P., Rajivan, P., & Gonzalez, C. (2019). Training to Detect Phishing Emails: Effects of the Frequency of Experienced Emails. Human Factors and Ergonomics Society's 2019 International Annual Meeting (HFES 2019). October 28-November 1, Seattle, WA.

Highlighted Projects and Events

Moments@Work– Given our involvement with Diversity and inclusion at the level of the university, we have developed a game called Moments@Work, There is a computer and a card version of the game. We study the power of experiential learning on reducing biases and increasing sensitivity about the challenges that women and minority groups confront in the workplace. This year, the game was used in hiring committees, in a meeting with the Deans, the College of Engineering and other places around campus, and in the Mathematical Psychology conference, the development consortium of this year's conference in Montreal, CA.

Army Research Laboratories Bootcamp—This year we hosted the annual bootcamp of the Army Research Laboratories' Collaborative Research Alliance on Cybersecurity at Carnegie Mellon. It was fun research and hard work with great collaborators.

PyIBL—This year we developed a new improved version of our mini-architecture to build IBL cognitive models in Python. This is about to be released. Check our Downloads page: https://www.cmu.edu/dietrich/sds/ddmlab/downloads.html#py-ibl

Adventures During 2018 - 2019

In a farewell event for David Hagmann, we got trapped in a typical Pittsburgh apartment… Erin and David did their best to get us out on time, but we couldn't make it!

Bicycles and white water rafting!! Yes, you need to pass a fitness test to be part of the lab!

Adventures in Niagara Falls.

Dynamic Decision Making Laboratory

Winthrop Lab
4609 Winthrop Street, 1st Floor
Pittsburgh, PA 15213
e-mail: ddmlab(at)andrew.cmu.edu
Phone: 412-268-9547
412-268-8439

Thank you for your interest in our 2019 Newsletter!

Keep up with us on our webpage or follow us on Facebook LinkedIn or Twitter