Issue 8

Fall 2016

Dynamic Decision Making Laboratory

Carnegie Mellon University

A Note from Coty

Dear Friends and Collaborators: Here is an update about another year of work at the DDMLab. As usual, every year is filled with exciting news in grants, papers and, most importantly, the people that bring our lab good news!! So here we go.

Inside this issue:

Our research activities continue to be supported by many organizations. During the 2015-2016 academic year, The **Army Research Laboratory (ARL)** funded our applied work on trust, recommendations, and network science. In collaboration with many colleagues, we worked on expanding our understanding of first impressions and trust, cognitive modeling of social dilemmas, and the effects of information sharing in network-based operations. **ARL** also funded our work on the socio-cognitive aspects of Cybersecurity. Under a large Cybersecurity Collaborative Research Alliance (CRA), I continue to lead the socio-cognitive work. With this grant, we addressed basic psychological issues of attack detection and agility using behavioral game theory to study attacker-defender interactions. The **National Science Foundation (NSF)** funded our work on decisions from experience, where we have advanced both empirical and theoretical work using instance-based learning theory and computational models. In an effort to bring applied and basic research together, we have been working on expanding and scaling up work on decisions from experience to work on pairs and larger groups. A grant from **NSF** that started last year has funded new research to expand theoretical frameworks of experiential and descriptive information, and the dynamic aspects of choice. We have started to work in these new directions this year. In other good news, the **Laura and John Arnold Foundation** greenlighted our research on memory effects for the evaluation of eyewitness lineup procedures, as part of a collaboration with the Statistics department at Carnegie Mellon and the Center for Excellence in Forensic Science. We will investigate order, similarity, and other learning effects in eyewitness lineups using experiments and cognitive models.

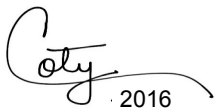
Our research publications this year encompassed various themes at the DDMLab. First, for **dynamics of control**, we highlight three papers that came out last year: Fischer & Gonzalez in *Cognitive Science*; Weinhardt et al. in the *Journal of Operations Management*; and Newell et al. in *Topics in Cognitive Science*. All three of these manuscripts aim at advancing our understanding about how people reason about stock-flow relationships and highlight the implications of stock-flow failure in naturalistic problems such as CO_2 accumulation. Second, for **dynamics of choice**, we highlight at least two papers in *Decision* and *Cognitive Science*, which examine the exploration-exploitation tradeoff and the process of search and consequential choice under uncertainty. Third, for **psychological factors in applied settings** such as cybersecurity and network science, we advanced our theoretical understanding of the factors involved in modeling human behavior in cyber defense by using cognitive models as decision aids and investigating the effect of information availability of teams and command decision making. Relatedly, under our cybersecurity project, we started new collaborations on developing security models and algorithms that plan defender actions by investigating adversary behavior. We have run a set of studies that collected human data in opportunistic security games to understand and analyze adversarial behavior. Our results delineate categories of adversaries based on their attack strategies and exploration-exploitation dynamics.

This past summer, our lab was well represented in a number of conferences. In the Foundations of Utility and Risk (**FUR 2016**) conference at the University of Warwick, we had a number of papers by Michael Yu, Fred Moisan, David Hagmann, and Cristobal de la Masa (see picture on the right during the dinner at the Warwick castle). I was invited to a keynote address as part of an Ambiguity and Learning round table.

At the International Conference on Cognitive Modeling (**ICCM 2016**) at Penn State University, we were also well represented with presentations by Michael Yu, Yassi Abbasi (USC), and our collaborator Christian Lebiere (picture shows Yassi and Cristobal paddling along the lake during the conference dinner.

Finally, we took part in the **ACT-R 2016 post-graduate school** in Lancaster, PA, with a presentation on reflections on unresolved psychological problems for cognitive architecture. Here are some pictures from these meetings.

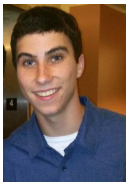
On a personal note, 2015-2016 was a *teaching year.* Teaching several new courses while keeping up the research program was challenging. I taught an intermediate course in statistics for Masters students at Heinz College, CMU; a new dynamic decisions undergraduate course in SDS, CMU; and two short courses during the summer: one at the TELECOM Ecole de Management in Paris (see picture on the right), and one on the 4th Summer School on Decisions from Experience at University of Warwick.



In closing, I want to thank all of you, the collaborators and friends of the DDMLab from all over the world!!! Thank you for contributing to our efforts with new ideas and your support. Enjoy the newsletter!!!

News From Our Members

Farewell



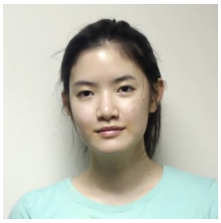
Sam Cheyette was our summer student intern and research assistant. After working at DDMLab for a year, Sam graduated from CMU and went on to graduate school at the University of Rochester!

Dr. Michael Yu, May 2014-2016. Ph.D. Social and Decision Sciences, Carnegie Mellon University. Dr. Yu took a Research Associate position at the Engineering and Public Policy department, Carnegie Mellon University.

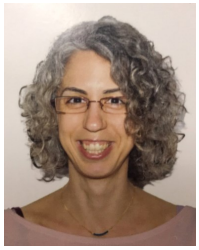
Dr. Frederic Moisan, February 2014 December, 2015, Ph.D. Computer Science and Economics, University of Toulouse (IRIT and TSE), Toulouse, France. Dr. Moisan took a Researcher position at the Faculty of Economics, University of Cambridge, UK.

Dr. Emmanouil Konstantinidis, October 2014-October 2015. Ph.D. in Cognitive Science, University College London, London, UK. Dr. Konstantinidis took a Post-doctoral fellow position at the school of Psychology at University of New South Wales, Australia.

Welcome New Members



Nalyn Sriwattanakomen was our visiting student from Washington & Jefferson College. After graduating this year, Nalyn joined the DDMLab as a full-time Research Associate.



Efrat Aharonov completed her Ph.D. in the department of Psychology at Ben-Gurion University of Negev, Israel. Prior to joining the DDMLab, Efrat was a post-doctoral fellow at The Technion, Israel. She just joined us in September as a postdoctoral fellow!

Jeff Chrabaszcz completed his Ph.D. in Neuroscience and Cognitive Science at the University of Maryland, College Park. He also joined us this year as a postdoctoral fellow!

Beginning of 2016-2017 year party

Research during 2015-2016

From Jeffrey Chrabaszcz

I have spent my first month in the DDMLab developing three different projects. The first investigates how individuals integrate information from descriptions and experience. Though we know that people tend to overweight rare outcomes from description and underweight the same rare outcomes when relying on experience, we do not yet have a good understanding of how descriptions and experiences are combined to produce decisions, or how this process plays out over time.

The second project focuses on how multi-attribute learning influences choice behavior. The environment often contains probabilistic cues relevant to a decision. Existing studies suggest that assuming limited memory improves correspondence between computational models and human performance. I plan to use Instance-Based Learning Theory to explore how probabilistic cues influence choice behavior.

Finally, Bayesian methods and multilevel modeling offer an opportunity to both improve modeling accuracy and quantify individuals differences in a variety of cognitive models. I am currently developing a Bayesian implementation of IBL that allows us to simultaneously estimate and aggregate subject-varying parameters. This model will allow us to make more efficient use of data when fitting IBL models and increase the types of data that can be modeled with IBLT.

From Cristobal De La Maza Guzman

People have difficulty understanding how risks accumulate over time and often using heuristics to simplify their task. We examined the effect of these heuristics in both judgments and choices regarding cumulative flood risks. We recruited 997 respondents from Amazon's Mechanical Turk, requesting a series of cumulative risk judgments and choices about flood insurance policies facing varying cumulative flood risks. Respondents were also randomly assigned to receive information about the correct cumulative probability for a 1% annual risk. From their judgments, we found that respondents' cumulative risk judgments could be represented by a bimodal distribution, with a group that severely underestimated the risk and a group that moderately overestimated the risk. Correct cumulative risk information improved the accuracy of these judgments. From their choices, we observed that individuals who underestimated the risk in their judgments tended to be more risk-seeking than individuals who overestimated the risk. The results show that judgment errors about cumulative risk have an important impact on choices, possibly exposing the public to harm they would not accept had they been fully informed. Nevertheless, a large proportion of individuals who over- or underestimated the cumulative risks made choices consistent with expected utility maximization, suggesting that judgment studies alone exaggerate the need for corrective action. Finally, we proposed a model to account for subjective cumulative risk judgments when modeling human risky choices.

New Research (Cont'd)

From David Hagmann

In the past year, I have continued joint work with Coty on decisions from experience. We have progressed on my Master's thesis, in which we show that delaying outcome feedback can close the description-experience gap. I have presented the paper at multiple conferences (ESA, SJDM, FUR, and the Yale Whitebox Graduate Student Conference, among others), and we are preparing the manuscript for resubmission now. We have further explored decisions between two risky options, each of which with multiple outcomes. This work is ongoing, as our results conflict with some of our prior expectations and prior research on decisions between a safe option with a guaranteed outcome and a risky option with two outcomes.

In other work, I have co-authored a report for the Behavioral Science and Policy Association on applications of behavioral economics to health policy. The report is expected to be published in the December issue of the Behavioral Science & Policy journal. A review paper on "Information Avoidance," with two co-authors from the Social and Decision Sciences department, has been accepted at the Journal of Economic Literature. We organize work from economics and psychologies showing that people sometimes actively avoid information when it threatens their existing beliefs, even when it could help them make better decisions. I am extending this work in my dissertation, which explores the implications of utility from beliefs for persuasion. I argue that when people have motivated reasons to maintain their beliefs, persuasion is most effective not when it provides more information, but when it takes an indirect path that bypasses the receiver's mental defenses.

From Fei Lu

I started working with Coty on a project aimed at investigating how proximity or relevant previous experiences influence people's end-of-life decisions. I am also working on designing a board game to study opportunistic security strategies. Our student intern Andrei Marculescu started working on it during the summer and provided valuable suggestions. Now I am trying to make it an applicable two-player board game that will be used to teach relevant concepts of dynamics of behavior in security games.

I also manage various protocols in the lab such as new IRB applications, experimentation, and Amazon Mechanical Turk. I am also currently investigating platforms to run studies with multiple players online.

From Erin McCormick

This past year, I have been primarily working on a project with Coty and Sam Cheyette (recently graduated from CMU and starting graduate study at the University of Rochester) about adaptation to exogenous change when making decisions from experience. The project is an extension of Coty's work with Jason Harman and Manos Konstantinidis. Two experiments ask participants to make choices between uncertain options (probabilistic lotteries) that change in some way over time: the probability of receiving the high outcome or the value of that high outcome. This specific project seeks to examine the effect of varying levels of feedback about the outcomes of participants' choices, and the impact of different directions of change on adaptation to that change. The investigation of changing outcome values, in addition to changing outcome probabilities, contributes to our understanding of the conditions amenable to change detection and successful adaptation, and the conditions that make adaptation difficult.

From Nalyn Sriwattanakomen

Before joining the lab as a full-time research associate, I worked on the NEXCEL project in collaboration with Iliano Cervesato at Carnegie Mellon Qatar. We developed a feedback program that aims at helping people construct recursive rules in a Datalog-like language.

In a new project with Coty and Jeff, I am revisiting an experiment performed by former lab members that examined the relationship between people's ability to make judgments about the areas in a stock-flow graph and their ability to answer questions related to accumulation. In the near future, we hope to investigate stock-flow failure in more naturalistic settings.

Finally, I have been collaborating with Coty and Fei on a new project that studies how people make end-of-life decisions for themselves. We're currently designing a survey that will identify demographic, emotional, experiential, and cognitive factors that make a person more or less likely to preemptively opt for certain types of treatment in the event of their incapacitation.

From Don Morrison

Development of PyIBL, our library of reusable Python code to quickly and easily create Instance-Based Learning models, continues. The latest released version is available at <http://pyibl.ddmlab.com>. We've used PyIBL on a variety of projects. Recent examples include: modeling adversarial behavior in an opportunistic security game, with Yasaman Dehghani Abbasi of the University of Southern California and Noam Ben-Asher; modeling behavior in Erin McCormick's change detection task; and modeling behavior in a network game with Alex Yahja of the University of Illinois.

New Research (Cont'd)

From Mike Yu

Over the last year we worked on a few great projects involving trust and social dynamics. The project on trust and early information was presented at both ESA and FUR, where we got some great feedback that is leading into a third study that investigates the robustness of our interventions over time.

The project on learning and the Prisoner's Dilemma was accepted and presented at ICCM. In addition, we started a few new projects with Fred Moisan, both of which consider social value orientation. In the one case, we examined how SVO interacts with incentives to deceive and found that even people with high SVO can be tempted to be misleading. In another project, we examined how SVO interacts with both deterministic and probabilistic recommender systems in a Chicken Game -- finding that people who prefer fairness tend to do *poorly* when recommendations are made using a fair coin toss.

We've also made progress in some of our follow-up work from the CPC tournament, developing a paper with Sabrina Lin at IBM on how cognitive models can inform and improve machine learning algorithms designed for predicting human behavior; and on work with Dan Veksler at DCS Corps and ARL in studying how cognitive models perform relative to traditional game theoretic solutions in adversarial games.

From Prashanth Rajivan

I joined DDMLab in mid-December 2015 as winter was setting in! I am working primarily on the psycho-social aspects of the cybersecurity project where my interest lies.

I began by helping Coty complete the security event learning and classification project handed over to me by Manos and Coty. In collaboration with Manos, Noam, and Coty, I completed data analysis for the project and prepared the manuscript describing the findings. The manuscript was submitted for publication at the HFES conference 2016 and was accepted for presentation. So my journey at DDMLab started with a bang!

Meanwhile, I began working on two projects. First, I have been working on a cyber defense teamwork behavior evaluation scale called OATS (Objective Assessment of Teamwork in Security). Using this scale, we collected team process evaluations of teams participating in two separate cyber defense events: MACCDC and CyberShield. This work is in collaboration with Norbou Buchler at ARL and is currently being analyzed and written up for publication in the Journal of Computers and Security. Second, I have been developing a study on deception and creativity in the phishing context from an adversarial behavior perspective. Adversarial behavior is the least studied human factor in cybersecurity. This project is moving steadily towards the data collection phase.

I am also working with Coty on designing new projects on attack attributions (using website defacement Zone-H data) in collaboration with Char Sample at ARL and a behavioral game theoretic project in the Internet privacy context. Finally, I was also able to publish a couple of my older work at HAISA and SOUPS this year. It has definitely been an exciting, intellectually stimulating, and productive 8 months so far at the DDMLab. Looking forward to more such productive years!

Some Recent Publications

All our journal manuscripts and book chapters can be found on our lab web site:

http://www.hss.cmu.edu/departments/sds/ddmlab/papers.html

In the past year, more than ten articles authored by members of the DDMLab and our collaborators were published in various journals such as *Human Factors; Decision*; *Journal of Operations Management; Cognitive Science; Journal of Dynamic Decision Making; Frontiers in Psychology;* and *Journal of Cognitive Engineering and Decision Making*.

In addition, many papers were published in conference proceedings.

Some recent publications in conference proceedings:

Yu, M. & Gonzalez, C. (2016). Learning the dynamics of Prisoner's Dilemma: Lessons from modeling and simulation. 14th International Conference on Cognitive Modeling (ICCM 2016). August 4-6, 2016, Pennsylvania State University, University Park, PA.

Lebiere, C., Morrison, D., Abdelzaher, T., Hu, Shaohan, Gonzalez, C. Buchler, N., Veksler V. D. (2016). Cognitive Models of Prediction as Decision Aids. 14th International Conference on Cognitive Modeling (ICCM 2016). August 4-6, 2016, Pennsylvania State University, University Park, PA.

Abbasi, Y. D., Ben-Asher, N., Gonzalez, C., Kar, D., Morrison, D., Sintov, N., Tambe, M. (2016). Adversaries Wising Up: Heterogeneity and Dynamics of Behavior. 14th International Conference on Cognitive Modeling (ICCM 2016). August 4-6, 2016, Pennsylvania State University, University Park, PA.

Abbasi, Y. D., Ben-Asher, N., Gonzalez, C., Kar, D., Morrison, D., Sintov, N., Tambe, M. (2016). Know your Adversary: Insights for a Better Adversarial Behavioral Model. 38th Annual Meeting of the Cognitive Science Society (CogSci 2016). August 10-13, 2016, Philadelphia, PA.

Abbasi, Y. D., Ben-Asher, N., Gonzalez, C., Kar, D., Morrison, D., Sintov, N., Tambe, M. (2016). Categorizing Adversary Rationality Based on Attack Patterns in an Opportunistic Security Game. Security and Multi-agent Systems (SecMAS) Workshop. International Conference on Autonomous Agents and MultiAgent Systems (AAMAS 2016).

Cheyette, S., Konstantinidis, E., Harman, J.L., Gonzalez, C., (2016). Choice adaptation to increasing and decreasing event probabilitiesl. 38th Annual Meeting of the Cognitive Science Society (CogSci 2016). August 10- 13, 2016, Philadelphia, PA.

Ben-Asher, N., Oltramari, A., Erbacher, R., & Gonzalez, C. (2015). Ontology-based Adaptive Systems of Cyber Defense. 10th International Conference on "Semantic Technology for Intelligence, Defense, and Security (STIDS 2015), November 18-20. Fairfax, VA. Best paper award.

Presentations & Invited Talks

Some recent invited talks:

2016 August 24. *How to get funding: a personal view*. 2016 Incoming Faculty Orientation. Carnegie Mellon University. Pittsburgh, PA, USA.
2016 August 8. *Reflections on unresolved psychological problems for a cognitive architecture*. ACT-R 2016 Post-Graduate Summer School. Lancaster, PA, USA.
2016 July 29. *Games, Game-Theory, and the Science of Cybersecurity*. Panel on Cognitive and Behavioral Modeling for Military Functions. First international conference in Virtual Reality and Simulation. Part of the 7th International Conference on Applied Human Factors and Ergonomics. Orlando, FA, USA.
2016 July 29. *Cognitive Models in Cybersecurity*. Panel on The Risk/Utility Tradeoff in Cybersecutiy. Second International Conference on Human Factors in Cybersecurity. Part of the 7th International Conference on Applied Human Factors and Ergonomics. Orlando, FA, USA.
2016 June 27. *Information and Decisions: Description and Experience Come Together.* Plenary roundtable on Dynamics and Ambiguity. Foundations of Utility and Risk (FUR) conference. Hosted by the interdisciplinary behavioural science group at the University of Warwick. Coventry, UK.
2016 February 4. *Behavioral Game Theory and Cyber Security*. USC/ARO Workshop on Cyber-Physical Security: Challenges and Approaches. University of Southern California. Los Angeles, CA.
2016 January 13. *Dynamic Decision Making: Learning Processes and Cognitive Challenges*. Cognitive Science Brownbag, Learning Research and Development Center (LRDC), University of Pittsburgh.