

Dynamic Decision Making Laboratory

Carnegie Mellon University

A note from Coty

2012-2013 has been a busy and exciting academic year in the DDMLab!

This year, work continued with our post-doctoral fellows: Noam Ben-Asher (Ben-Gurion University, Israel), Katja Mehlhorn (University of Groningen, Netherlands), Jason Harman (Ohio State University), graduate student Michael Yu, and laboratory manager Hau-yu Wong. We also received a new fellow, Shikhar Kumar (Arizona State University), who worked with us in new grants from the Army Research Laboratories and the Qatar National Research fund. They all contributed in many ways with new ideas, analyses, papers and presentations in conferences and in laboratory meetings. Thanks to all!

Several of our older research grants got renewed, including our grant from the Army Research Office on Cyber-Situation Awareness and our grant from the Defense Threat Reduction Agency on understanding conflict with a socio-cognitive computational approach. Our more recent grants also got off on a great start and will continue for years to come: the National Science Foundation grant to study Decisions from Experience phenomena with Instance-Based Learning models; the Qatar National Research Fund grant to study inferential processing and decisions in relational data sets; and a grant from the Army Research Laboratories' (ARL) Network Science-Collaborative Technologies Alliance (NS-CTA) to study trust and scalable recommendation and information sources.

The fresh news that arrived just on time for this newsletter is a new multimillion dollar, 10-year grant that we obtained from the Army Research Laboratories' Collaborative Research Alliances (ARL-CRA). This is a large effort in collaboration with many other universities: Penn State University, Indiana University, University of California-Davis, and University of California-Riverside. Our goal in the grant titled "Models for Enabling Continuous Reconfigurability of Secure Missions (MACRO)" is to understand and model the risks, human behaviors and motivations, and attacks within Army cyber-missions. Our laboratory will use Instance-Based Learning Theory (IBLT) and experiments with Decisions from Experience (DFE) paradigms to develop models of the cognitive and decision making processes for cyber analysts and attackers.

Our lab continues to be very productive. This year, we have made considerable progress in our understanding of the search process and use of experience during search and how search influences consequential decisions, as demonstrated by publications and many papers in progress.

We organized many important symposia this year and participated in interesting international workshops and conferences. Worth highlighting is the workshop that I organized with Katja Mehlhorn: "Predicting Choice from Exploration" at the 9th Invitational Choice Symposium in Noordwijk, The Netherlands. An exclusive group of researchers contributed to a development of ideas and a synthesis of research regarding exploration and choice. See the picture of our participants!! It was a great and productive experience. A review article is in preparation.

We are looking forward to making 2013-2014 another successful and productive academic year, and we hope that you, all our friends and collaborators from all over the world, will continue supporting our work.

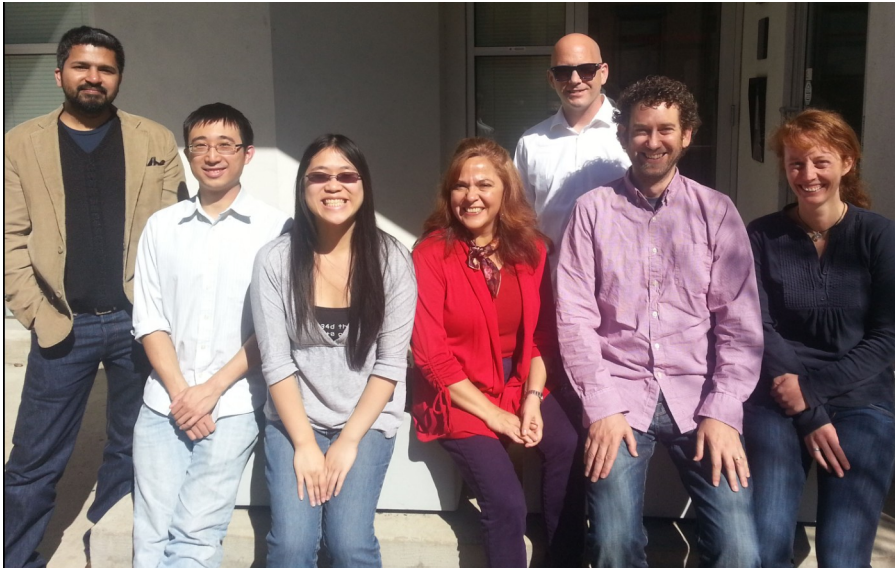
Best regards and our best wishes to all of you!!

Coty Gonzalez
 Founding Director, Dynamic Decision Making Laboratory

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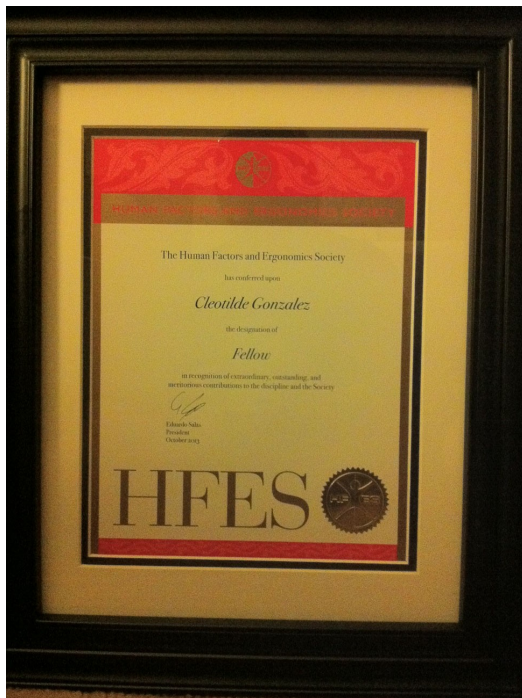




Group photo, September 2013
Left to right: Shikhar, Mike, Hau-yu, Coty, Jason
(standing), Noam, & Katja

News From Our Members

Congratulations to Coty, who was honored as an HFES Elected Society Fellow. She was recognized on October 1, 2013 at this year's International Annual Meeting of the Human Factors and Ergonomics Society in San Diego, CA.



Congratulations to **Shikhar Kumar**, who will be starting as

a Post-Doctoral Fellow in the School of Government and Public Policy at the University of Arizona Tucson. We'd like to thank him for his contribution and to wish him the best in his future endeavors.

This semester, we are going to be joined by two visitors from abroad.

Vincent Becker is a student from the Karlsruhe Institute of Technology, Germany, studying Computer Science. He has completed all of his courses and is going to be working on his Bachelor's thesis during his time at the DDMLab. He is trying to find out if the human performance prediction capabilities of cognitive models can be positively influenced by workload recognition using EEG measurements.

Eric Liang Qi is a doctoral student in Social Medicine and Public Health Management from the Second Military Medical University in Shanghai, China. He will be spending a full year at our lab while he works on his doctoral thesis.

We also have two open post-doctoral fellow positions, with the possibility of an additional position opening up due to recent grant news. [Please see our lab website here for more information about these positions and applying.](#)

New Research

Below is a summary of research highlights during 2012-2013:

From Mike Yu

Collaborating with Muniba Saleem at the University of Michigan-Dearborn, we continued our investigation into the dynamics of trust development. We find that looking at the different components of trust— including beliefs, dispositions, and behaviors— can update differently as a result of experience. Moving forward, we're investigating how experience across several cognitive agents in a network can influence the development of trust at a group/ population-level.

From Noam Ben-Asher

We are examining the connection between information acquisition and decision making as part of social interaction through behavioral game theory. We find that the attention directed to possible outcomes in a description is influenced by the complexity of the social environment and people's desire to maximize the outcomes. We also find behavioral evidence that participants strive to balance between maximizing their own outcomes and preserving fair social interaction at the same time. Furthermore, we were able to model these human behaviors using Instance-Based Learning models.

We also use IBL models to study the decision making processes of cyber attackers and defenders. Using a multi-agent modeling approach, we constructed a cyber warfare environment in which multiple agents are engaged. Another line of research related to cyber security evaluates the role of expertise in the detection of cyber threats. Here, we study the interplay between domain and situated knowledge, and how they affect cyber situation awareness. Situated knowledge is found to be a key component in the detection of cyber threats. In the absence of such knowledge, expert and novice performance in a threat detection task are similar and generally poor. However, detailed feedback during a relatively short period of training improves performance significantly.

From Katja Mehlhorn

Several of our current research projects are aimed at a better understanding of the connection between information search and subsequent consequential choice. We investigate participants' search and choice behavior in a binary choice setting and compare it to predictions from computational models, mainly based on Instance Based Learning Theory (IBLT). In collaboration with Jelmer Borst and Ralph Hertwig, we use those models in model-based fMRI analyses to investigate the neural correlates of search and choice.

In another line of research, we extend current research on the 'description-experience gap,' by exploring the relationship between decisions that are made from description (DFD) and decisions that are made from experience (DFE). Using the classic Asian Disease Problem, we investigate how the framing of a decision problem affects DFD and DFE in different ways. To better understand the cognitive mechanism underlying those differences, we generate and test predictions from Prospect Theory and IBLT.

From Jason Harman

The past year has been very exciting and included several projects exploring basic and applied processes in dynamic decision making. We have completed several experiments exploring the interactions between the decision maker, the environment, and the mode of decision making. These include results that demonstrate the elimination of classic decision making paradoxes when those decisions are made from experience (under review), that explore how humans represent probability in memory and apply those representations to risky choice, and that predict and test changes in decision behavior when a reliable option becomes rare and vice versa.

We have also initiated a collaboration effort with faculty at the University of Calgary Haskayne's School of Business. This work has focused around the ideas of maximization and satisfying. We have explored the relationships between these two decision making styles in decisions from experience, performance on dynamic control tasks, and learning between different types of decision making paradigms.

New Research (Cont'd)

From Shikhar Kumar

Recent work in the field of complex systems has provided us with a new way of studying large interconnected systems—societies, economies, ecological systems, computer networks, etc. Within their larger framework lies network science, which has played a significant role in helping us understand the emergent properties of such systems. Research in this area is fascinating, however, it is disconnected from the world of cognitive psychology. Network science and complexity economics studies focus on the interactions between actors and decision makers and their emergent social and economic phenomena, but they over-simplify the cognitive aspects of the individuals involved.

In order to bridge this gap and to provide a new perspective, we developed a framework to apply the instance-based learning mechanism to a large multi-agent system and developed a system with cognitive agents. We chose a well-known problem, the El Farol Bar Problem, and used IBL mechanism to model the cognitive agents. We showed that the dynamics of the system are sensitively dependent on the agents' cognitive abilities. There is a huge potential for this kind of research and we plan to extend this work in various other domains.

Recent Publications

In the past year, fifteen articles and three book chapters authored by members of the DDMLab and our collaborators were published, including pieces in journals like the *Journal of Experimental Psychology: Human Perception and Performance*, *Behavioral and Brain Sciences*, and *Human Factors*. An additional three journal articles and one book chapter are currently in press.

For a full list of publications, please see the publications page on the laboratory's website at <http://www.hss.cmu.edu/departments/sds/ddmlab/papers.html>.

Conference Proceedings

Lab members also applied to and were accepted into several summer workshops. **Coty** and **Katja** together hosted a symposia, *Predicting choice from exploration*, at the [9th Invitational Choice Symposium in the Netherlands](#) this past summer. **Noam** attended the [Summer 2013 Institute on Bounded Rationality in Psychology and Economics](#) in Berlin, Germany. Here are some papers that appeared in conference proceedings recently:

Gonzalez, C. & Mehlhorn, K. (2013). Life is like a box of chocolates: Experience, emotionality of the context, and framing influences what you're gonna choose. In *Proceedings of the 24th Subjective Probability, Utility, and Decision Making Conference*. Barcelona, Spain.

Ben-Asher, N., Lebiere, C., Oltramari, A., & Gonzalez, C. (2013). Balancing fairness and efficiency in repeated societal interaction. In *Proceedings of the 35th Annual Meeting of the Cognitive Science Society (CogSci 2013)*. Berlin, Germany.

Ben-Asher, N., Dutt, V., & Gonzalez, C. (2013). Accounting for the integration of descriptive and experiential information in a repeated prisoner's dilemma using an instance-based learning model. In *Proceedings of the 22nd Annual Conference on Behavior Representation in Modeling and Simulation (BRiMS 2013)*. Ottawa, Canada.

Gonzalez, C. (2012). From individual decisions from experience to behavioral game theory: Lessons for cybersecurity. Invited panelist to Perspectives from Cognitive Engineering on Cyber Security. In *Proceedings of the Human Factors and Ergonomics Society 56th Annual Meeting. (HFES 2012)*. Boston, MA

Presentations & Invited Talks

Coty gave the following workshops and invited talks during 2012-2013:

Symposia

- October 1, 2013** *Trends in decision making research: How can they change cognitive engineering and decision making in human factors?* 2013 International Annual Meeting of the Human Factors and Ergonomics Society (HFES). San Diego, CA.
Co-chaired with Joachim Meyer. Invited Speakers: Gary Klein, Frank Yates, and Alvin Roth (Nobel Laureate).
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- June 12-16, 2013** *Predicting choice from exploration.* 9th Invitational Choice Symposium. Huis ter Duin, Noordwijk, The Netherlands. With Katja Mehlhorn.
Invited Speakers: Victoria Braithwaite, Klaus Fiedler, Daniel Hausmann, Michael D. Lee, Kate Morgan, Ben Newell, and Peter Todd
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- May 23-26, 2013** *Predicting choice from exploration.* 25th Association for Psychological Science (APS). Washington, D.C. With Katja Mehlhorn.
Invited speakers: Ralph Hertwig, Peter Pirolli, and Jeremy Wolfe

Presentations & Talks

- September 20, 2013** *Dynamic decision making: Learning processes and cognitive challenges.* Forecasting, monitoring, controlling: Dealing with a dynamic world. University College London. London, UK.
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- July 24, 2013** *Cognitive challenges for making decisions in dynamic systems.* Panel on Assessing Systems Thinking Across Skill Levels at the 31st International Conference of the System Dynamics Society. Boston, MA.
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- July 15, 2013** *Decisions from experience in advanced technological systems.* Technical University of Berlin. Berlin, Germany.
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- July 12, 2013** *Dynamics of cooperation with varied information.* 15th International Conference on Social Dilemmas. ETH Zürich, Switzerland.
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- April 9, 2013** *Emergence of cooperation with increased information: Explaining the process with an instance-based learning model.* Center for Adaptive Rationality. Max Planck Institute. Berlin, Germany.
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- April 5, 2013** *Decisions from experience.* School of Psychology at the University of Basel. Basel, Switzerland.
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- February 20, 2013** *Making decisions from experience: Explaining sampling and repeated choice with Instance-Based Learning cognitive models.* Psychology Department at the University of North Carolina, Charlotte.
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- December 12, 2012** *Making decisions from experience in cyber-security.* CyLab Usable Privacy and Security Lab, seminar series. Carnegie Mellon University, Pittsburgh.
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- October 4, 2012** *How do we make risky decisions from experience? An Instance-Based Learning Model explains the process.* International Workshop on Experimental Economics and Finance. Karlsruhe, Germany.