What research do we do?

We study learning and decisions from experience in situations involving repeated, interdependent decisions in dynamic environments.

- How does experience influence our decisions?
- What kinds of experiences would produce better decisions and better adaptation?
- How does experience transfer to new situations?

We also study humans making decisions in a wide range of real-world decision contexts that we bring to the laboratory in the form of dynamic simulations (MicroWorlds or DMGames).

- How do operators of complex industrial plants make dynamic allocation of limited resources?
- How luggage screeners at the airport can be more successful at detecting possible threatening targets?
- How cyber-security analysts may improve their detection of cyber-attacks?

Our driving theory is the Instance-Based Learning Theory (IBLT), which in essence proposes that **people make choices from experience and according to what has led to the best outcomes in similar situations in the past**. The process involve:

- Retrieve memories (*instances*) that resemble the current situation
- Filter memories according to their maximum experienced expected value (utility or *blended value*)
- Evaluate and store new instances reflecting each possible option in the decision situation (instances are triplets: situation-decision-utility)
- Select the option with the maximum blended value

People of DDMLab

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Dynamic Decision Making Laboratory

The Dynamic Decision Making Laboratory (DDMLab) was founded in 2002 by Dr. Cleotilde Gonzalez to investigate decision making in complex dynamic environments. Such environments are characterized by the need for people to make multiple, interdependent, real-time decisions in reaction to both external changes, as well as the effects of their past decisions.

At the DDMLab, we seek to build models and methods that help explain, predict, and draw recommendations for improving decision making in dynamic environments. We use multiple research methods, but notably, we rely on laboratory experiments where we collect human behavior using dynamic simulations (Decision Making Games) and on computational cognitive models based on Instance-Based Learning Theory (IBLT) and the ACT-R cognitive architecture to understand and predict such behavior.

Practical applications of our research extend from front-end system design activities to back-end training and decision-support. On the front-end, we can provide principled guidance and empirical support for the design of systems that exploit DDM strengths. On the back-end, we can help decision makers exploit system strengths. In this respect, DDM theory and methods are particularly suited for the design of training interventions. But the closely related activity of decision support design is no stretch for the skill set our multidisciplinary team provides.

The laboratory consists of post-doctoral fellows, research-programmers, doctoral students and research assistants. Lab members come from different fields, including Behavioral Decision Research, Psychology, and Computer Science.

The DDMLab is part of the Social and Decision Sciences Department at Carnegie Mellon University.

http://www.cmu.edu/ddmlab/

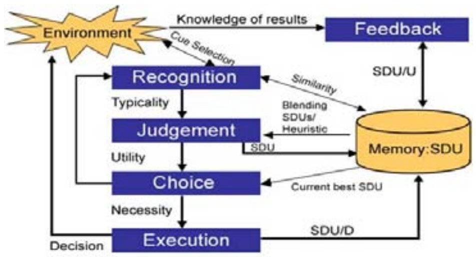
How do we do research?

We use a research approach involving laboratory experiments and cognitive computational models. We study human behavior by observing and collecting human performance in a dynamic task, and develop cognitive models that reproduce that behavior and predict new unobserved behavior within the same task.

Decision Making Games (MicroWorlds)
Our main laboratory's research tasks are interactive computer simulations that represent decision making situations. They are environments characterized by the need for people to make multiple, interdependent, real-time decisions in reaction to both external changes and to the effects of their past decisions.

We have created DMGames in many diverse contexts, including examples for dynamic resource allocation, medical diagnosis, supply chain management, climate change and CO_2 accumulation, as well as other generic choice and control tasks.

IBL Models and the IBLTool
Many cognitive models based on IBLT have been developed, please see the inside of brochure for more about IBLT.



The Instance-Based Learning Tool (IBLTool) is an effort to make our theoretical approach to modeling more accessible for psychologists that are not modelers. Our goal is to make IBLT:

- Shareable by bringing the theory closer to the users, and making it more accessible;
- Generalizable by making it possible to use the theory on different and a diverse set of tasks;
- Understandable by making it easier to implement and use;
- Communicable by making the tool interact more easily and in a more standard way with tasks; and
- Usable by abstracting the specifics of the implementation of the theory away from any specific programming language.

Basic Research Program

Dynamics of choice

In every-day life, we often make choices from experience in at least two ways:

Decisions from sampling: where experience is acquired by exploring an environment without significant consequences, before consequential decisions are made.

Consequential repeated decisions: where we cannot sample the options, but rather learn while making choices from past choices, perceiving the outcomes, and adjusting our decisions to the consequences.

We study how decisions are made from experience during and after repeated choices. Using IBL models, we study the cognitive processes by which these decisions are made, and we are able to make predictions regarding human decisions from experience in novel conditions of choice.

- What learning processes take place during sampling and repeated consequential decisions?
- How do these processes change when decisions are interrelated over time? When feedbacks are delayed? When decisions are time-dependent?
- How do we address consequential and sampling decisions when the "environment" involves other individuals?

Dynamics of control

In the real world, we often need to keep a system "under control." These systems can be anything from blood sugar level in diabetics to someone's bank account. Using simple representations of "accumulation" systems which need to be controlled, we study how people make decisions regarding the inflows that increase the accumulation and the outflows that decrease it over time.

Despite the ubiquity of these systems, research often demonstrates the frailty and fallibility of human performance in these tasks.

- How do people make decisions in dynamic stock management tasks?
- Why do people perform so poorly at control tasks?
- How can judgments of accumulation be improved?
- What are the effects of feedback complexity and delay?

Applied Research Program

Application to Human Factors and Cognitive Engineering

We apply the theoretical knowledge developed in our basic research program to applications concerning important problems that affect our society and human life.

Human detection of cyber-attacks: Understanding how defender and adversarial behaviors influence accurate and timely detection of cyber attacks. Models of human behavior can help predict the influence of adversarial behaviors on a defender's cyber attack detection.

Understanding conflict with a socio-cognitive computational approach: We aim at developing general theoretical models of the socio-cognitive factors that influence conflict across and within teams; namely those that lead to conflict between two constituencies and those that lead to conflict resolution.

Trust and scalable recommendation systems: We study the dynamics of trust among people and systems, particularly its development through experiential interactions. Our research will have an impact on how recommender systems are designed, which aim at providing a more intelligent and proactive information service according to the learning preferences of web users.

Human perception & control of climate change: We study how humans make judgments regarding CO_2 accumulation; how we influence it through emissions decisions; how we perceive changes in it through experience; and how we can increase awareness of its dynamics in this context.

Visual search and adaptation: We study how different characteristics of human memory, such as: frequency, recency, spacing, and similarity influence the way humans make target search decisions. We determine best ways to train individuals in order to improve their search in novel situations.