Skilled Performance & Training
Fall 2017

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CRN 49011 COGS-6960-01
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<table>
<thead>
<tr>
<th>Instructor: Wayne Gray</th>
<th>Individual Session with Instructor: tbd</th>
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<tr>
<td>Phone: 518.276.3315</td>
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Check the instructor’s website to make sure that the version of the syllabus you are using is the most recent version available:
http://homepages.rpi.edu/~grayw/courses/syllabi/j%20Fa2017/

This is a graduate level course. Junior or Senior undergraduates may sign up with consent of the instructor.

Description We focus on the acquisition and performance of skilled tasks within a cognitive science framework. For our purposes, “skilled performance” includes aspects of human perception, motor behavior, memory, and decision-making, as well as the discovery or invention, by individual performers, of new methods of task performance. Examples of the skilled tasks to which we aspire to explain include action video games, medical diagnosis, surgery, driving a car, juggling, and any other situation where “even hesitating requires a decision to hesitate.” Our emphasis will be on the basic research and theories which shed light on skilled performance and which might be use to guide training. The syllabus may change during the semester with new readings being added and old ones pruned. Keep your eye on: http://homepages.rpi.edu/~grayw/courses/syllabi/jFa2017/ for more information.
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Week 1  [09/01] ORIENTATION AND PROJECT ERNESTINE

Optional Reading:


Lecture: The Précis of Project Ernestine: An Overview of the Validation of GOMS (Gray & John, 1993)

Week 2  [09/08] WHAT IS SKILLED PERFORMANCE?

All read and respond to:


Paper presentations:


Week 3  [09/15] DO STUDIES OF SIMPLE SKILLS GENERALIZE TO COMPLEX ONES?

All read and respond to:


Paper presentations:


*Not yet claimed*


**Week 4  [09/22] THE POWER LAW OF LEARNING**

All read and write response papers to:


Paper presentations:

- SPECIAL PRESENTATION: Sean will walk us through section 5 of Newell & Rosenbloom


**Week 5  [09/29] SOFT CONSTRAINTS**


All read and write response papers to:

Paper presentations:


**Week 6 [10/06] FORGETTING & SPACING**

All read and write response papers to:


Paper presentations:


**Week 7 [10/13] PLATEAUS, DIPS, & LEAPS AND THE POWER LAW**

Lecture: Milliseconds Matter: An introduction to microstrategies and to their use in describing and predicting interactive behavior (Gray & Boehm-Davis, 2000)

All read and write response papers to:


Paper presentations:

Not yet claimed:


**Abstract:** Learning curves of 190 women operators in trimming, covering, and hemming operations in knitting mills showed an early sharp rise, negative acceleration, plateaus, and a point beyond which little improvement occurred. Those who left the company were found to be less proficient in trimming and hemming than those who remained at work. The reliabilities of production records were not high; reasons for this are advanced. Early proficiency is not a very good measure for prediction of later proficiency. Speed of learning in each operation is closely related to average hourly output. (PsycINFO Database Record (c) 2016 APA, all rights reserved).

**Week 8 [10/27 – Class Meets at 10:00 AM] REPEALING THE POWER LAW**

All read and write response papers to:


Paper presentations:


**Week 9 [11/03] THE IMPORTANCE OF INFO REDUCTION IN SKILL ACQUISITION**

All read and write response papers to:


Paper presentations:


Not yet claimed:


Abstract: Ignoring irrelevant visual information aids efficient interaction with task environments. We studied how people, after practice, start to ignore the irrelevant aspects of stimuli. For this we focused on how information reduction transfers to rarely practised and novel stimuli. In Experiment 1, we compared competing mathematical models on how people cease to fixate on irrelevant parts of stimuli. Information reduction occurred at the same rate for frequent, infrequent, and novel stimuli. Once acquired with some stimuli, it was applied to all. In Experiment 2, simplification of task processing also occurred in a once-for-all manner when spatial regularities were ruled out so that people could not rely on learning which screen position is irrelevant. Apparently, changes in eye movements were an effect of a once-for-all strategy change rather than a cause of it. Overall, the results suggest that participants incidentally acquired knowledge about regularities in the task material and then decided to voluntarily apply it for efficient task processing. Such decisions should be incorporated into accounts of information reduction and other theories of strategy change in skill acquisition.

Week 10  [11/10 – Class Meets at 10:00 AM] EXPERTISE

All read and write response papers to:


Paper presentations:


Not yet claimed:

Abstract: Expert chess players, specialized in different openings, recalled positions and solved problems within and outside their area of specialization. While their general expertise was at a similar level, players performed better with stimuli from their area of specialization. The effect of specialization on both recall and problem solving was strong enough to override general expertise—players remembering positions and solving problems from their area of specialization performed at around the level of players 1 standard deviation (SD) above them in general skill. Their problem-solving strategy also changed depending on whether the problem was within their area of specialization. When it was, they searched more in depth and less in breadth; with problems outside their area of specialization, the reverse. The knowledge that comes from familiarity with a problem area is more important than general purpose strategies in determining how an expert will tackle it. These results demonstrate the link in experts between problem solving and memory of specific experiences and indicate that the search for context-independent general purpose problem-solving strategies to teach to future experts is unlikely to be successful.


Abstract: [from the Introduction] This chapter reports findings from an investigation of the capabilities of an expert problem solver who not only solves different randomly generated instantiations of the notoriously difficult Rubik’s Cube puzzle with invariant success, but also does so with striking speed and surprising flexibility. This inquiry starts by describing this expert’s performance, followed by the results of efforts to identify the cognitive structures and processes that produce the performance, and findings from explorations of the flexibility of his skill. This inquiry closes by relating the findings to theoretical mechanisms prior research has identified as pillars of exceptional performance, particularly tenets of Skilled Memory Theory (Chase and Ericsson, 1982; Ericsson & Staszewski, 1989), as well as problem-solving expertise (Anzai & Simon, 1979; Chi, Feltovich, & Glaser, 1981; Larkin, McDermott, Simon, & Simon, 1980) and flexibility issues related to automaticity and transfer (Kimball & Holyoak, 2000; Lewandowsky & Thomas, 2009).

Miscellaneous Readings


**Week 11 [11/17] BLUNDERS**

All read and write response papers to:


Paper presentations:

Not yet claimed:


**Abstract**: Inferences about structured patterns in human decision making have been drawn from medium-scale simulated competitions with human subjects. The concepts analyzed in these studies include level-k thinking, satisficing, and other human error tendencies. These concepts can be mapped via a natural depth of search metric into the domain of chess, where copious data is available from hundreds of thousands of games by players of a wide range of precisely known skill levels in real competitions. The games are analyzed by strong chess programs to produce authoritative utility values for move decision options by progressive deepening of search. Our experiments show a significant relationship between the formulations of level-k thinking and the skill level of players. Notably, the players are distinguished solely on moves where they erred-according to the average depth level at which their errors are exposed by the authoritative analysis. Our results also indicate that the decisions are often independent of tail assumptions on higher-order beliefs. Further, we observe changes in this relationship in different contexts, such as minimal versus acute time pressure. We try to relate satisficing to insufficient level of reasoning and answer numerically the question, why do humans blunder?


**Abstract**: Rapid chess provides an unparalleled laboratory to understand decision making in a natural environment. In a chess game, players choose consecutively around 40 moves in a finite time budget. The goodness of each choice can be determined quantitatively since current chess algorithms estimate precisely the value of a position. Web-based chess produces vast amounts of data, millions of decisions per day, incommensurable with traditional psychological experiments. We generated a database of response times and position value in rapid chess games. We measured robust emergent statistical observables: 1) Response time (RT) distributions are long-tailed and show qualitatively distinct forms at different stages of the game, 2) RT of successive moves are highly correlated both for intra- and inter-player moves. These findings have theoretical implications since they deny two basic assumptions of sequential decision making algorithms: RTs are not stationary and can not be generated by a state function. Our results also have practical implications. First, we characterized the capacity of blunders and score fluctuations to predict a player strength, which

Abstract: An increasing number of domains are providing us with detailed trace data on human decisions in settings where we can evaluate the quality of these decisions via an algorithm. Motivated by this development, an emerging line of work has begun to consider whether we can characterize and predict the kinds of decisions where people are likely to make errors. To investigate what a general framework for human error prediction might look like, we focus on a model system with a rich history in the behavioral sciences: the decisions made by chess players as they select moves in a game. We carry out our analysis at a large scale, employing datasets with several million recorded games, and using chess tablebases to acquire a form of ground truth for a subset of chess positions that have been completely solved by computers but remain challenging even for the best players in the world. We organize our analysis around three categories of features that we argue are present in most settings where the analysis of human error is applicable: the skill of the decision-maker, the time available to make the decision, and the inherent difficulty of the decision. We identify rich structure in all three of these categories of features, and find strong evidence that in our domain, features describing the inherent difficulty of an instance are significantly more powerful than features based on skill or time.

Week 12  [12/01] THE EYES HAVE IT!

All read and write response papers to:


Paper presentations:


Week 13  [12/08] THE THEORY OF EVENT CODING (TEC)

All read and write response papers to:


Paper presentations: Pages 876-910 contain 28, 1000 word responses to the Hommel paper. Pick 2 of the 3 I have assigned you. Note that there are 4 “EXTRAS”. If you like you can talk about one of those.

In case, I will ask you to talk about each one of your two papers for 3 min (maximum).

- Sean Barton
  - Thierry Chaminade
  - Eric Chown
  - Paul Cisek
- Jacki Berry
  - Jorn Diedrichsen
  - Hubert Dinse
  - Bruno Galantucci
- Ropa Deng
  - Robert Hartsuiker
  - Julian Hochberg
  - Jason Ivanoff
- Josh Eaton
  - J. Scott Jordan
  - Nam-Gyoon Kim
  - Wilfried Kunde
- Johannes Kruse
  - Lane, Cheng, & Gobet
  - Nachshon Meiran
  - Oade
- Roussel Rahman
  - Belardinelli
  - Oriet & Stevanovski
  - Zacks
- Matt Sangster
  - Proctor
  - Richardson & Michaels
  - Rosenbaum
- Catherine Sibert
  - Sanders
  - Shaw & Wagman
  - Vogt & Hecht
- EXTRAS
  - Westwood & Goodale
  - Wolters & Raffone
  - Pisella
  - Kunde
Week 14  [12/15] TEC2

All read and write response papers to:


Paper presentations:

- Roussel will present: Frank, D. J. & Macnamara, B. N. (2017). Does the acquisition of spatial skill involve a shift from algorithm to memory retrieval?. *Journal of Experimental Psychology: Learning, Memory, and Cognition*


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90 REQUIREMENTS

90.1 PreRequisites

Permission of the instructor. This is a graduate research seminar in the Cognitive Science Department. However, all interested undergraduates and interested graduate students from other departments are encouraged to contact the instructor to discuss their participation in the seminar. Responsibilities and assignments for undergraduates will be discussed and agreed on, in writing, by the student and the instructor.

90.2 About the Instructor

Professor Gray has been a member of the Cognitive Science Department at RPI since the Fall of 2002. For details on his research interests and activities see his homepage.

90.3 Activities

Reading, Writing, Presenting, Discussing

- Group discussion.

  - The most important contribution each person can make is to our discussions of the readings. I believe a seminar course in which everyone actively participates can be the most productive and educational forum in grad school (often for the instructor as well). Bringing together the various backgrounds and training of everyone in the room generally leads to a much richer perspective than would otherwise be possible. There is a lot of individual variability in tendency to speak up in this type of environment, but it is critical to an academic career to be comfortable doing so. You
cannot succeed in this field without a willingness (and desire) to share your ideas in the face of criticism, and this is perhaps the best context to practice. If you are someone who has no qualms about dominating a debate, this is also a good place to practice restraint and listening.

- Students (graduate and undergraduate) will take a turn leading a discussion of each week’s core assigned readings. Advanced preparation for this includes the Response Paper for that week’s readings.

- **Response Papers**
  - For each week students will be asked to write short, one-page, “response papers”. Each response paper will be on one of that week’s assigned readings.
  - Unless explicitly told otherwise, response papers will always be due by 5pm the day before class meets. This will enable me sufficient time to read your papers, to integrate the various themes that different students identify, and to gage the difficulties (if any) the class had understanding the paper.

- **Paper presentations.**
  - Most weeks will feature a group discussion of all or parts of our current group readings, followed by one to three detailed presentations on research papers assigned by the instructor as relevant to that week’s topic. Generally, just one student will read and present each research paper. There will be 1-3 presentations per week, one each by 1-3 different students. The number of presentations per student will be inversely proportional to class size (which is topped at 10 students). Longer or survey papers may be divided among several students.

In general, each presentation should be 20-25 minutes long and structured as though you were presenting your own work at a conference. A useful strategy is to copy key figures and tables out of each article and supplement with (scant) text stating the major points. Focus on summarizing the research, as the authors present it (including motivation, background, methods, results, and conclusions), but also allow us to hear your voice as well – however, be sure we know when the author is speaking and when you are speaking.

- **Undergraduate presentations.**

  * As this is a communication intensive course, I will be asking our undergraduates (if any) to also do presentations. These will be fewer in number than the graduate student assignments; however, I will encourage each undergraduate to prepare her/his presentation a week in advance, in time for it to be delivered in a practice session to me or to one of the senior graduate students. This extra meeting is intended as a “practice” session to get you comfortable with this type of presentation.

### 91 Grading Policy

- **Examinations** – none
• Group Discussion
  – 35% Grad Students; 45% Undergrads
  – For active participation in all discussions on all weeks in which the seminar is held. Exceptions due to professional travel or other activities need to be discussed with the instructor ahead of time.

• Response Papers
  – 35% Grad Students; 45% Undergrads
  – Prior to each week’s meeting, one or more readings will be assign and, for each reading, all students are expected to write a short, one-page Response Paper. The Response Paper should not merely summarize or outline the assigned reading but should reflect your thoughts on the author’s arguments, the strength of evidence, alternative hypotheses, implications, and so on.
  – Response papers are due to the Instructor by 5:00 pm the day before the seminar.

• Presentations
  – 35% Grad Students; 15% Undergrads
  – Throughout the semester, an average of one or two students each week will be asked to present the findings of a published research paper, assigned by the instructor. The presentation should be in the range of 20-30min. The student should assume the role of the paper’s author and present the case made by the author in her paper. Use of figures, tables, and headings from the paper is encouraged, as well as original visualizations created by the student, as appropriate. The student may also step out of their role as “surrogate author” for various “meta” comments on the material but should, generally, maintain and represent the case made by the original author in her paper.

• Yes. I expect 105% out of you!

92 Honors Policy

• My expectation is that all of the work you do for me in this class will be the work of one individual. Exceptions to this rule will be broadcast to the class by email.

• As you will all find out, I explicitly encourage you to engage in public (using email and other media to broadcast a message to the entire) or private (one-to-one) discourse regarding the readings and topics raised in this class. Study groups are encouraged.

• If any of you have any questions regarding current situations or future situations, remember that I am your first contact on this. Please come and see me.
References


This document contains 57 references.