The University of Texas, El Paso
Department of Computer Science
CS 5390/4390: Special Topics in Computer Science
Applied Computational Cognitive Modeling
Spring 2022

Course objective: The objective of this course is to understand the human mind and decision-making processes in terms of underlying cognitive processes. Students will learn about the leading computational framework Adaptive Control of Thought—Rational (ACT-R) [1] and Instance Based Learning Theory [2]. Scientists are working with increasingly large quantities of human behavioral data. To better understand and explain the behavioral data, development of computational cognitive modeling has shown promising impact. Cognitive models have been used to model complex cognition across a range of decision-making tasks, including repeated binary-choice decisions [3], multi-choice decisions [4], decision making in teams, dynamic environments such as social dilemmas [5], complex situations of cybersecurity including intrusion detection systems, phishing, and honeypots [6, 7] and cognitive tutors [8, 9].

This course provides students an introduction to the basic methods used to develop and test computational models of cognition. It will answer questions including:

- How to develop cognitive models? How cognitive models are different from other machine learning models?
- To what extent the computational cognitive models could replicate and predict human behavior?
- What does cognitive model explain about human behavior?

In this course, students will provide exposure to various applications of cognitive models in the areas including computer science, psychology, education, and business.

Requirements:

This course will require students to learn the concepts of cognitive modeling and apply to an application of their choice. The assignments and project in this course would require students to develop cognitive model using Python/MATLAB. The models would be analyzed against human data. The model evaluation will be done using measures such as mean square deviation of model predictions and human responses in the task.

References

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2. Gonzalez, C., Lerch, J. F., & Lebiere, C. (2003). Instance-based learning in dynamic decision making. *Cognitive Science*, *27*(4), 591-635.

3. Lejarraga, T., Dutt, V., & Gonzalez, C. (2012). Instance-based learning: A general model of repeated binary choice. *Journal of Behavioral Decision Making*, *25*(2), 143-153.
4. Cranford, E. A., Gonzalez, C., Aggarwal, P., Tambe, M., Cooney, S., & Lebiere, C. (2021). Towards a Cognitive Theory of Cyber Deception. *Cognitive Science*, *45*(7), e13013.
5. Gonzalez, C., & Ben-Asher, N. (2014). Learning to cooperate in the Prisoner's Dilemma: Robustness of Predictions of an Instance-Based Learning Model. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 36, No. 36).
6. Cranford, E. A., Lebiere, C., Rajivan, P., Aggarwal, P., & Gonzalez, C. (2019). Modeling cognitive dynamics in (End)-user response to phishing emails. *Proceedings of the 17th ICCM*.
7. Aggarwal, P., Moisan, F., Gonzalez, C., & Dutt, V. (2020). Learning About the Effects of Alert Uncertainty in Attack and Defend Decisions via Cognitive Modeling. *Human Factors*, 0018720820945425.
8. Anderson, J. R., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned. *The journal of the learning sciences*, *4*(2), 167-207.
9. Nguyen, T. N., & Gonzalez, C. (2021). Theory of Mind From Observation in Cognitive Models and Humans. *Topics in Cognitive Science*.