Cognitive Modelling at the UCL Interaction Centre

Christian P. Janssen, Richard M. Young,
Maartje G. A. Ament, Jonathan Back, Duncan P. Brumby, Anna L. Cox, and Justin Grace
[c.janssen, r.m.young, m.ament, j.back, d.brumby, anna.cox, j.grace] @ucl.ac.uk
UCL Interaction Centre, University College London
Gower Street, London WC1E 6BT UK
www.uclic.ucl.ac.uk

UCL Interaction Centre

The UCL Interaction Centre is an interdisciplinary research group with roots in the Psychology and Computer Science Departments of UCL. Research focuses on the cognitive, affective, social and physical aspects of human-computer interaction, including such topics as: sensemaking, information work and digital libraries; design practice; collaborative learning; experiences of novel interaction; and affect, emotion, and subjective experience. In this presentation we will focus on the work of a subset of the researchers, who use and/or develop cognitive models to understand human-computer interaction. This work roughly focuses around three themes: human errors, visual search and strategic adaptation in multitask settings.

Understanding, Predicting and Mitigating Errors

We are interested in the factors that affect the likelihood that people will make slip errors while performing routine procedural tasks. For example, Ament et al. (2009) demonstrated that errors are more likely to occur during specific steps in a task structure, and Li et al. (2008) show how error rates increase with interruptions. Given our understanding of errors, we test methods that are likely to reduce error rates (e.g., Back, Blandford, & Curzon, 2007; Back, Brumby, & Cox, 2010).

Our methodology so far is largely empirical, but strongly based within predictions made by cognitive architectures, in particular the memory for goals model (Altmann & Trafton, 2002). We are planning to increase our modelling work in this domain.

Of particular interest to us are errors made in medical settings. We have recently started a 6-year funded project (CHI+MED, see http://www.chi-med.ac.uk) together with researchers at Queen Mary University, City University and Swansea University. Besides our cognitive science perspective on this area, the CHI+MED project will also study the design and use of devices, in hospital and home settings. The project will work with those who design, purchase, deploy and use devices, to deliver improvements in the design and selection of devices and training users.

Visual Search

A second area of interest is interactive menu search i.e. the activity of searching a novel webpage or menu for a link that will lead to the achievement of a particular search goal. Our work (Brumby & Howes 2008; Cox & Silva 2006; Silva & Cox 2006) explained why people are often seen to select a link without looking at all the items in the list, and also, how people use the mouse pointer to help them complete these tasks as quickly and as efficiently as possible. Our work in this area has assessed predictions made by cognitive models.

Strategic Adaptation in Multitask Settings

A third area of interest is strategic adaptation. Given that goals can sometimes be achieved in multiple ways, how does one decide on a strategy — or more broadly, action sequence — to reach the goal? Can this be understood in terms of the costs of cognitive and motor operators, or for example as maximizing a reward function (e.g., Janssen, Gray, & Schoelles, 2008)?

Of specific interest to us is strategic adaptation in (concurrent) multitask settings, such as dialling a phone number while driving. Here two tasks need to be performed concurrently, and people need to decide when to switch attention between the two. Our efforts so far (e.g., Brumby, Salvucci, & Howes, 2009; Janssen & Brumby, 2009) have used cognitive constraint models (Howes, Lewis, & Vera, 2009) to illustrates how different strategies trade-off performance on each of the tasks.

The longer-term goal of this work is to understand the trade-offs that are made between different strategies in such a way that the underlying principles can be incorporated in a variety of cognitive architectures. Specifically, we are interested in investigating extension of ACT-R and the threaded cognition theory (Salvucci & Taatgen, 2008), with a theory of strategic adaptation.

Acknowledgements

This research was supported by EPSRC grants GR/S67494/01, GR/S67500/01, GR/T28225/01, EP/G059063/1 and EP/G043507/1.

References

Altmann, E. M., & Trafton, J. G. (2002). Memory for goals: An activation-based model. *Cognitive Science*, 26, 39-83.

Ament, M. G. A., Blandford, A., & Cox, A. L. (2009). Different cognitive mechanisms account for different types of procedural steps. In *Proceedings of the 31st Annual Conference of the Cognitive Science Society.*

Back, J., Blandford, A., & Curzon, P. (2007). Recognising erroneous and exploratory interactions. In *Proceedings of the Eleventh IFIP TC13 International Conference on Human-Computer Interaction*.

Back, J., Brumby, D., & Cox, A. L. (2010). Locked-out: Investigating the effectiveness of system lockouts to reduce errors in routine tasks. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York, NY: ACM Press.

Brumby, D.P. & Howes, A. (2008). Strategies for guiding interactive search: An empirical investigation into the consequences of label relevance for assessment and selection. *Human-Computer Interaction, 23*, 1-46.

Brumby, D. P., Salvucci, D. D., & Howes, A. (2009). Focus on driving: How cognitive constraints shape the adaptation of strategy when dialing while driving. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1629-1638). New York, NY: ACM Press.

Cox,A.L., Silva,M. (2006). The role of mouse movements in interactive search. In *Proceedings of the 28th Annual Meeting of the Cognitive Science Society,*(pp. 1156-1161).

Howes, A., Lewis, R. L., & Vera, A. (2009). Rational adaptation under task and processing constraints: Implications for testing theories of cognition and action. *Psychological Review*, 116, 717-751

Janssen, C. P., & Brumby, D. P. (2009). Dual-task strategy adaptation: Do we only interleave at chunk boundaries? In *Proceedings of the 9th International Conference on Cognitive Modeling*. Manchester, UK: University of Manchester.

Janssen, C. P., Gray, W. D., & Schoelles, M. J. (2008). How a modeler's conception of rewards influences a model's behavior: Investigating ACT-R 6's utility learning mechanism. In *Proceedings of the 15th Annual ACT-R Workshop* (pp. 42). Pittsburgh, PA.

Li, S. Y. W., Blandford, A., Cairns, P., & Young, R. M. (2008). The effect of interruptions on postcompletion and other procedural errors: An account based on the activation-based goal memory model. *Journal of Experimental Psychology: Applied*, 14, 314-328.

Salvucci, D. D., & Taatgen, N. A. (2008). Threaded cognition: An integrated theory of concurrent multitasking. *Psychological Review*, 115, 101-130.

Silva,M., Cox,A.L. (2006). Can parafoveal processing explain skipping behaviour in interactive menu search? *Journal of Vision,* 6, 524-524.