

# NeuroIR 2015 – Neuro-Physiological Methods in IR Research

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## ABSTRACT

This Tutorial+Workshop will discuss opportunities and challenges involved in using neuro-physiological tools/techniques (such as fMRI, fNIRS, EEG, eye-tracking, GSR, HR, and facial expressions) and theories in information retrieval. The hybrid format will engage researchers and students at different levels of expertise, from those who are active in this area to those who are interested and want to learn more. The workshop will combine presentations, discussions and tutorial elements and consist of four segments (tutorial, completed research, work-in-progress, closing panel).

## General Terms

Neuroscience, Experimentation, Measurement.

## Keywords

H. Information Systems. H.3 INFORMATION STORAGE AND RETRIEVAL. H.3.3 Information Search and Retrieval. Subjects: Query formulation; Search process; Retrieval models

## Author Keywords

fMRI, fNIRS, eye-tracking, EEG, GSR, HR.

## 1. MOTIVATION

The progress made in neuroscience in the last two decades allows one to expect that neuroscience (and related fields) will contribute to other disciplines. It has already happened in several social science disciplines, such as economics and marketing – neuroeconomics and neuromarketing have been established over a decade ago. The results from collaboration between behavioral economists and neuroscientists have supported advances in understanding of decision-making and human behavior [1]. More recently, information systems researchers started a new sub-field NeuroIS (Neuro Information Systems – [3]; NeuroIS.org, 2009). Information systems research studies the development and use of information and communication technologies in organizations and society. NeuroIS is “a subfield of information systems literature that relies on neuroscience and neurophysiological theories and tools to better understand the development, use, and impact of information technologies (IT)” [10].

Application of neuro-physiological methods for studying browsing tasks, information selection, and relevance judgment have emerged as critical areas of active research. The broad intersecting theme, among IR researchers and those with strong applied neuroscience background, is development of more robust models for information search – models which go beyond

behavioral data and account for physiological and neurological responses to information as stimuli. This early work by information retrieval researchers resulted in a number of recent publications that appeared at SIGIR, ECIR, and related conferences. Selected recent publications include: [2,4,5,6,7,8,9,11,12,13,14,15].

However, the IR community is still widely unaware of these new methods. We propose the workshop to discuss and exchange experiences among researchers; build a community; plan future work; make others aware of potential usefulness of neuro-physiological methods and their applicability to their research; enable others to read and assess papers that employ such methods.

## 2. THEME AND PURPOSE

The workshop will have three main themes: 1) cases and problems in information retrieval that are particularly amenable to analysis based on neuro-physiological methods (e.g., relevance judgment studies), 2) comparative analysis of neuro-physiological tools and techniques and their applications in information retrieval research (e.g., fMRI versus EEG), and finally, 3) evaluation and statistical analysis methods for incorporating neuro-physiological methods in an IR research study.

For the theme 1 above, we will invite presentations and posters on current IR projects that are utilizing neuro-physiological methods. For theme 2, we will incorporate presentations and demonstrations of neuro-physiological techniques in the workshop. We will invite researchers with strong experience in utilizing portable tools such as eye-trackers and EEGs, encouraging them to bring with them some of these tools. We will also encourage researchers with recent experiences in applying fMRI and fNIRS and other methods based on large imaging instruments to participate. Finally, for theme 3, a certain number of presentations and posters will be sought that place emphasis on metrics, evaluation methods, and statistical techniques associated with neuro-physiological information retrieval data.

## 3. FORMAT AND PLANNED ACTIVITIES

The workshop schedule will combine presentations, discussions and tutorial elements and consist of four segments.

1) Tutorial - will offer guidance on how to start working with neuro-physiological tools in the context of IR. We will introduce and compare several tools, such as EEG, eye-tracking and fMRI, and will discuss best practices and useful tips, which will be helpful to all, not just those new to the area.

2) Completed research - experienced participants will present findings and lessons learned from their own work and will consider how neuro-cognitive and physiological tools, such as fMRI, fNIRS, eye-tracking, EEG, GSR, and analysis of facial expressions could further contribute to IR research questions.

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SIGIR '15, August 09-13, 2015, Santiago, Chile  
ACM 978-1-4503-3621-5/15/08.  
<http://dx.doi.org/10.1145/2766462.2767856>

3) Work-in-progress - participants, and particularly those who are starting out in this area, will present their planned/current work in lightning talks; group discussions will provide feedback and guidance.

4) Closing panel - will discuss future directions and collaborations between workshop participants.

A workshop webpage <https://sites.google.com/site/neuroir2015> will be maintained and added to <http://www.neuroinfoscience.org> website maintained by Jacek Gwizdka.

#### 4. PARTICIPANTS' SELECTION

Selection of papers and posters will be conducted at two levels. Members of the program committee will be assigned responsibilities to conduct the first level review. At least two reviewers will be assigned per paper and at least one member will review each poster. A final review of all papers and posters will be conducted by the four members of the organizing committee. About 15 papers and 12 posters will be selected, and the associated researchers will be invited to attend the workshop. We anticipate a maximum of about 35 participants in this event, but we do not intend to limit participation.

#### 5. ORGANIZERS

**Jacek Gwizdka** is an Assistant Professor and Information eXperience Lab co-director at School of Information at University of Texas, Austin. He studies cognitive aspects of human-information interaction; his research is situated at the intersection of interactive-information retrieval (IIR) and human-computer interaction (HCI). His current projects include application of cognitive psychology to the study of how people evaluate information relevance and neuro-physiological methods to implicit assessment of cognitive load. He also investigates effects of search results presentation and cognitive abilities on information search task performance. Dr. Gwizdka has been affiliated with University of Toronto, Rutgers University and University of Texas at Austin. He conducted research at industrial labs (Xerox PARC, FXPAL, HP Labs). He serves in various roles at international conference committees (e.g., CHIIR, IiX, ASIS&T, ACM SIGCHI and SIGIR) and has co-organized successful workshops at several international conferences, including: IiX (SaL2014), SIGIR (UIIR2009), CSCW (Email'2002). He is as an Associate Editor of *Interacting with Computers* and serves on editorial board of *Information Processing & Management*. More on Dr. Gwizdka's research can be found at: <http://gwizdka.com>

**Joemon M. Jose** is a Professor at the School of Computing Science, University of Glasgow. He is a fellow of the BCS, IET and a chartered information technology professional (CITP), member of the ACM and IEEE. He has a well-established reputation in research on multimedia information retrieval, developing advanced retrieval models, studying the role of emotion in search, personalization and adaptive retrieval. His current research interests include: neurophysiological feedback based systems for IR. He has published over 110 journal and conference articles and leads a team of 6 PhD students and 3 post-doctoral researchers. He was a co-chair of the ICMR 2014, and ECDL 2010 conferences, and had organized numerous conferences and events including AIR 2008, SSMS 2007, AIR 2006, AMR 2005, IRiX 2005 & IRFEST 2005. He was a guest editor for the *Information Processing and Management on Adaptive Retrieval* and a keynote speaker for the RIAO 2010 conference.

**Javed Mostafa.** Javed is the Director of the Carolina Health Informatics Program ([chip.unc.edu](http://chip.unc.edu)) and the Director of the Laboratory of Applied Informatics Research ([lair.unc.edu](http://lair.unc.edu)). His research concentrates on information retrieval problems, particularly related to search and user-system interactions in large-scale document/data repositories. He also serves as the Deputy Director of the Biomedical Informatics Core at the NC Translational & Clinical Sciences Institute ([tracs.unc.edu](http://tracs.unc.edu)) and has current research engagements in biomedical data mining, analysis, visualization, user interface design, and multi-modal human-computer interaction. Javed served as an associate editor for the *ACM Transactions on Information Systems* for eight years. He currently serves on the editorial board of the *Journal of the Association for Information Science & Technology* (<http://www.asis.org/jasist.html>) and he also serves as an associate editor of the *ACM Transactions on Internet Technology* (<http://toit.acm.org/>). Javed is interested in investigating the possible relationship between locations in the brain that specialize in certain activities and information seeking tasks. A related interest is information seeking evaluation methodologies that employ a broad spectrum of biological / physiological methods. Dr. Mostafa has significant experience in organizing research workshops, sponsored by several organizations, including the NSF (2 as PI), ACM DL (2005, 2006, and 2007), and SIGIR (2004).

**Max L. Wilson** is an Assistant Professor in Human-Computer Interaction and Information Retrieval (HCIR) at the University of Nottingham. Max holds a PhD in Human-Computer Interaction from the University of Southampton, and publishes widely in the space between HCI and Information Retrieval, including a book on Search User Interface Design with Morgan Claypool, and a chapter for Ruthven and Kelly's *Interactive IR* textbook. As well as being on conference committees (e.g. CHI 2010-2016, IiX2010-14) and being on the editorial boards for *IP&M* and *IJHCS*, Max has organised several workshops, including the prior EuroHCIR and Searching4Fun workshops. Max's recent work published at ACM CHI2014 and CHI2015 have been on the use of fNIRS brain sensing for measuring mental workload in the prefrontal cortex.

#### 6. PROGRAM COMMITTEE

- Ioannis Arapakis, Yahoo Research, Spain
- Vincent N. Carrasco, Laboratory of Applied Informatics Research, SILS, University of North Carolina at Chapel Hill, USA
- Ashlee Edwards, SILS, University of North Carolina at Chapel Hill, USA
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- Hideo Joho, Faculty of Library, Information and Media Science, University of Tsukuba, Japan
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- Randall Minas, Information Technology Management Dept, Shidler College of Business, University of Hawaii at Manoa, USA
- Yashar Moshfeghi, Computer Science, University of Glasgow, UK
- Heather O'Brien, iSchool, University of British Columbia, Canada

- Luisa Pinto, Computer Science, University of Glasgow, UK
- Frank Pollick, Psychology, University of Glasgow, UK
- University of Glasgow, UK
- Erin Solovey, College of Computing and Informatics, Drexel, USA

## 7. RELATED WORKSHOPS AND PANEL

Two of the workshop organizers (Gwizdka & Mostafa) co-organized a very successful panel session at ASIST 2013 in Montreal entitled “Panel Title: Applications of Neuroimaging in Information Science: Challenges and Opportunities”.

## 8. REFERENCES

1. Camerer, C.F., Loewenstein, G., and Prelec, D. Neuroeconomics: Why Economics Needs Brains. *Scandinavian Journal of Economics* 106, 3 (2004), 555–579.
2. Cole, M.J., Gwizdka, J., Liu, C., Belkin, N.J., and Zhang, X. Inferring user knowledge level from eye movement patterns. *Information Processing & Management* 49, 5 (2013), 1075–1091.
3. Dimoka, A., Pavlou, P.A., and Davis, F. NeuroIS: The Potential of Cognitive Neuroscience for Information Systems Research. *INFORMATION SYSTEMS RESEARCH*, (2010), isre.1100.0284.
4. Eugster, M.J.A., Ruotsalo, T., Spapé, M.M., et al. Predicting Term-relevance from Brain Signals. *Proceedings of the 37th International ACM SIGIR Conference on Research & Development in Information Retrieval*, ACM (2014), 425–434.
5. Gwizdka, J. Looking for Information Relevance In the Brain. *Gmunden Retreat on NeuroIS 2013*, (2013), 14. **BEST PAPER**
6. Gwizdka, J. Characterizing Relevance with Eye-tracking Measures. *Proceedings of the 5th Information Interaction in Context Symposium*, ACM (2014), 58–67.
7. Gwizdka, J. News Stories Relevance Effects on Eye-movements. *Proceedings of the Symposium on Eye Tracking Research and Applications*, ACM (2014), 283–286.
8. Moshfeghi, Y. and Jose, J.M. An effective implicit relevance feedback technique using affective, physiological and behavioural features. *Proceedings of the 36th international ACM SIGIR conference on Research and development in information retrieval*, ACM (2013), 133–142.
9. Moshfeghi, Y., Pinto, L.R., Pollick, F.E., and Jose, J.M. Understanding Relevance: An fMRI Study. In P. Serdyukov, P. Braslavski, S.O. Kuznetsov, et al., eds., *Advances in Information Retrieval*. Springer Berlin Heidelberg, 2013, 14–25. **BEST PAPER.**
10. Riedl, R., Randolph, A., Brocke, J. vom, Léger, P.-M., and Dimoka, A. The Potential of Neuroscience for Human-Computer Interaction Research. *SIGHCI 2010 Proceedings*, (2010).
11. Arapakis, I., Athanasakos, K., and Jose, J.M. A comparison of general vs personalised affective models for the prediction of topical relevance. *SIGIR'2010*, ACM (2010), 371–378.
12. Arapakis, I., Moshfeghi, Y., Joho, H., Ren, R., Hannah, D., and Jose, J.M. Enriching User Profiling with Affective Features for the Improvement of a Multimodal Recommender System. *CIVR'2009*, 29:1–29:8. **BEST STUDENT PAPER.**
13. Lopatovska, I. and Arapakis, I. Theories, methods and current research on emotions in library and information science, information retrieval and human-computer interaction. *IP&M* 47, 4 (2011), 575–592.
14. Maior, H., Pike, M., Sharples, S. and Wilson, M.L. (2015) Examining the Reliability of Using fNIRS in Realistic HCI Settings for Spatial and Verbal Tasks. In: Proc. CHI'15 (accepted).
15. Pike, M. F., Maior, H. A., Porcheron, M., Sharples, S. C., & Wilson, M. L. (2014, April). Measuring the effect of think aloud protocols on workload using fNIRS. In Proc. CHI'14 (pp. 3807-3816). ACM.