NeuroIR 2015 – SIGIR 2015 Workshop on Neuro-Physiological Methods in IR Research

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Abstract: The first international workshop on Neuro-Physiological (NP) Methods in Information Retrieval Research took place at SIGIR 2015 in Santiago, Chile on August 13, 2015. The workshop included a mixture of short introductions to selected NP methods, paper presentations and a panel discussion by invited scholars. Each session included significant time allotted to open discussions among the participants. The high attendance and the lively discussions demonstrated significant interest in the use of NP methods in information retrieval research. The panel and discussions pointed out many advantages of using these methods as a data source complementary to traditional measures but also potentially offering deeper insights into humans interacting with information. Significant challenges, such as the lack of baseline data and reference tasks, and a need to collaborate with neuroscientists, were also noted. Overall, the NP-methods were found to be very promising and worth continued research efforts.

1 Introduction

The progress made in neuroscience in the last two decades allows one to expect that neuroscience 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. More recently, information systems researchers started a new sub-field NeuroIS (Neuro Information Systems [3]). Information systems research studies the development and use of information and communication technologies in organizations and society. NeuroIS is a subfield of information systems that employs neuroscience and neurophysiological theories and tools to better understand the development, use, and impact of information technologies [15].

Application of neuro-physiological methods for studying search and browsing tasks, and relevance judgment has emerged as an important area 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, 5–8, 11, 12]. This work has already received a significant recognition as three of these early publications [1, 7, 11] were recognized as a best paper or poster. However, the wider IR community is still mostly unaware of these new methods. The workshop was organized to bridge this gap.

2 Purpose

The objectives of the workshop were to:

- introduce neuro-physiological methods to IR researchers (and serve as a mini-tutorial);
- make IR researchers aware of potential usefulness of neuro-physiological (NP) methods and their applicability to IR research;
- enable IR researchers to read and assess papers that employ NP methods;
- promote discussion and exchange of experiences among researchers;
- build a community and map out future work.

3 Structure of the Workshop

The workshop was chaired by Jacek Gwizdka from the School of Information at the University of Texas at Austin, and workshop co-organizer. The workshop combined presentations with interactive discussion sessions. It started with participant introductions and ten lightning talks given by authors of papers accepted to the workshop[1]. Next, the workshop session switched to a tutorial mode and four introductions to NP modalities were given by experienced researchers. Each introduction was followed by a discussion. Next, three selected papers were presented by one of their authors. Workshop ended with a panel session.

4 Introductions to Neuro-physiological Modalities

Ioannis Arapakis introduced several physiological modalities, including electro-dermal activity (EDA) and heart-rate variability (HRV) and presented use cases focused on affective and emotional aspects of human information interaction. Jacek Gwizdka introduced eye-tracking and its derived measures. He emphasized the promise for inferring constructs of interest to IR from dynamic changes in pupil dilation. The usefulness of eye-tracking in IR was illustrated by examples from his research [6, 9]. Javed Mostafa and Vincent Carrasco introduced EEG and fMRI, respectively. They illustrated these modalities with their own research framework [13].

[1] Full list of papers accepted to the workshop is available online on the workshop website. See: http://neuroir.org

5 Paper Presentations

Tukka Ruotsalo presented "Predicting Relevance of Text from Neuro-Physiology" [4]. On an example of two case studies he showed the possibilities for detecting relevance using NP-signals, such as, electro-encephalography (EEG), electro-dermal activity (EDA), and electromyography (EMG). Dawei Song presented "EEG Based Emotion Identification Using Unsupervised Deep Feature Learning" [10]. The discussed work focused on using Deep Belief Network in automatic feature extraction from raw EEG signals in order to assess user's emotional states and use them in implicit relevance feedback. Ioannis Arapakis presented "On Human Information Processing in Information Retrieval" [14]. In this, somewhat provocative, talk, he proposed that the application of psychological knowledge to information retrieval research will not only be beneficial for IR, but, thanks to large scale testing grounds provided by IR, it will also be useful for evaluating psychological hypotheses about human information processing.

6 Panel Discussion

6.1 Background on the Panel & Panelists

After the paper presentation session, a panel discussion was held as the concluding event of the workshop. Three senior scholars in the information retrieval field were invited to participate in the panel. Representing industry, a highly reputable and established information retrieval scholar, Sue Dumais participated as a panel member. Another panel member was Diane Kelly, Professor at the University of North Carolina Chapel Hill's iSchool, where she conducts research on human-information interactions. A third member was Paul Kantor, Distinguished Professor (Emeritus) of Information Science, at Rutgers University. Paul has a wide-ranging set of research contributions in information retrieval, covering both theoretical and empirical work. The panel was moderated by Javed Mostafa, Professor of Information Science at the University of North Carolina at Chapel Hill and co-organizer of the workshop. The scope of the panel topics consisted of three specific dimensions. Panelists were asked to consider the primary drivers and advantages for integrating neuro-physiological (NP) approaches in information retrieval research. Specific areas of further development and advances in applying NP approaches in IR research comprised the second dimension. The last dimension was challenges and barriers associated with using NP approaches in IR research.

6.2 Summary of Points Discussed

Information retrieval has become ubiquitous and pervasive to a point that we need to rely on different tools and methods to scrutinize and study user behavior at a more granular level. A panelist noted that NP methods are likely powerful enough to elicit subtle clues and signals that other methods are not capable of. It was pointed out that NP methods may identify signals that are not expressible verbally or through actions. Methods utilizing eye fixation durations, pupil dilation, skin conductance response, and even facial expressions can reveal additional information that may complement other sources of analyzing user behavior in a powerful way. It may even be possible that such sources of NP evidence and others may reveal "deep signals" that are less noisy and more immune from external influences such as the person conducting the

experiment. Some panelists observed that by utilizing portable, less intrusive and sometimes inexpensive NP measurement tools (e.g., wireless EEG headsets) it may be possible to study search behavior in more realistic settings and increase the validity of the derived data and observations. Information retrieval studies that deal with mobile devices may require the use of such easy to use NP measurement tools. A participant pointed out that such NP tools and capabilities are beginning to be built into some mobile devices such as Apple's iWatch. In general, there were a lot of enthusiasms for exploring different types of NP measurement tools and in a wider variety of search contexts. A participant also commented about the possibility of exploring the utility of NP methods across different age groups (e.g., children vs. elderly).

A significant amount of discussion time was dedicated to various limitations associated with NP methods and ways of overcoming some of them. A panelist stated that the major problem associated with reported results is that typically a large number of tool-oriented parameters and settings require adjustments before experiments and these parameter-level information are omitted in publications. The omission is seen as a major barrier for other researchers to replicate the experiments or to even understand the reported NP results deeply. Another participant stated that although there are potentially advantages to be gained by combining multiple NP modalities in conducting search experiments, relating results from one modality with another should be conducted carefully, with due attention paid to what the individual modalities are "tuned" to measure and if they are set up to measure the same thing (e.g., Are they measuring cognitive load? Or, are they merely measuring interest or attention?). Another challenge mentioned in connection with the complexity of theories underlying NP tools was a need to collaborate, or at least consult with neuroscientists and other specialists. It should be noted that individual modalities such as eye-tracking, EEG, and fMRI are relatively new ways of measuring human responses during searching and no norms, baselines, or ranges of expected responses have yet been established. Therefore, comparison of responses across modalities becomes even more difficult to make. At the end of the session, all the panelists expressed their concern that it is difficult for most experts in IR to evaluate NP-based IR papers as there is a lack of awareness of critical NP methods and their appropriate applications. As a way to overcome this barrier it was suggested that a paper should be written targeted to the broad IR community that can be used as a guide to evaluate the rigor and appropriateness of NP-oriented contributions in the IR field. Finally, development of a standard set of search tasks and baseline results that can be used across different NP methods was seen as a useful way to advance this emerging area. Some participants mentioned that a TREC track on NP-IR (trec.nist.gov) should be seriously considered by the research community.

7 Conclusions

This was the first workshop on Neuro-Physiological Methods in IR Research. The intensity of interest in the workshop, as represented in the number of paper submissions and in the number of workshop participants, marks the growing research engagements in NeuroIR within the IR community. We believe that this area has a high potential for contributing to IR by enriching it with new ways for collecting data that can yield new and complementary measures and enable researchers to contribute at theoretical level as well as at applied level. We trust that the interest in the area will not only continue beyond the workshop, but also increase as more colleagues become aware of these methods and start using them.

In support of continued conversations, a Neuro-IR mailing list has been created; to subscribe send email with subject line: `SUB neuro_ir-list to:` sympa@utlists.utexas.edu . The workshop's website is at: http://neuroir.org.

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