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APPLICATION FOR ETHICS REVIEW OF RESEARCH INVOLVING HUMAN PARTICIPANTS

Please remember to PRINT AND SIGN the form and forward with all attachments to the Office of Research Ethics, Needles Hall, Room 1024.

Question G3 is incomplete. Please provide a location (G-Anonymity).
Question G3 has not been answered, please indicate the data storage location (G-Anonymity).

A. GENERAL INFORMATION

1. Title of Project: A framework for hybrid machine and human computation for the accurate and scalable analysis of human clinical EEG recordings

2. a) Principal and Co-Investigator(s)

NEW As of May 1, 2013, all UW faculty and staff listed as investigation must complete the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Tutorial, 2nd Ed. (TCPS2) prior to submitting an ethics application. The tutorial takes at least three hours; it has start and stop features.

Name	Department	Ext:	e-mail:
Edith Law (faculty)	Computer Science, School of	35751	edith.law@uwaterloo.ca

2. b) Collaborator(s)

NEW As of May 1, 2013, all UW faculty and staff listed as investigation must complete the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Tutorial, 2nd Ed. (TCPS2) prior to submitting an ethics application. The tutorial takes at least three hours; it has start and stop features.

Name	Department	Ext:	e-mail:

3. Faculty Supervisor(s)

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Name	Department	Ext:	e-mail:

4. Student Investigator(s)

Name	Department	Ext:	e-mail:	Local Phone #:
William Callaghan	Computer Science, School of	N/A	wrcallag@uwaterloo.ca	519-860-7493
Josh Bradshaw	Systems Design Engineering	N/A	jabradsha@uwaterloo.ca	905 531 1056

5. Level of Project: Faculty Research **Specify Course:**

Research Project/Course Status: New Project\Course

6. Funding Status (If Industry funded and a clinical trial involving a drug or natural product or is medical device testing, then Appendix B is to be completed):

Is this project currently funded? Yes

- If Yes, provide Name of Sponsor and include the title of the grant/contract: CIHR : A framework for hybrid machine and human computation for the accurate and scalable analysis of human clinical EEG recordings

- If No, is funding being sought OR if Yes, is additional funding being sought? No
- Period of Funding: April 1, 2015 - April 1, 2018

7. Does this research involve another institution or site? Yes
If Yes, what other institutions or sites are involved:
Harvard University, McGill University, University of Toronto, Sunnybrook Health Sciences Center

8. Has this proposal, or a version of it, been submitted to any other Research Ethics Board/Institutional Review Board? No

9. For Undergraduate and Graduate Research:

Has this proposal received approval of a Department Committee? Not Dept. Req.

10. a) Indicate the anticipated commencement date for this project: 8/1/2015

b) Indicate the anticipated completion date for this project: 8/1/2019

11. Conflict of interest: Appendix B is attached to the application if there are any potential, perceived, or actual financial or non-financial conflicts of interest by members of the research team in undertaking the proposed research.

B. SUMMARY OF PROPOSED RESEARCH

1. Purpose and Rationale for Proposed Research

a. Describe the purpose (objectives) and rationale of the proposed project and include any hypothesis(es)/research questions to be investigated. For a non-clinical study summarize the proposed research using the headings: Purpose, Aim or Hypothesis, and Justification for the Study. For a clinical trial/medical device testing summarize the research proposal using the following headings: Purpose, Hypothesis, Justification, and Objectives.
Where available, provide a copy of a research proposal. For a clinical trial/medical device testing a research proposal is required:
Purpose:

Electroencephalography (EEG) is a key tool in the diagnosis of epilepsy and sleep disorders. In current practice, EEG recordings are visually analyzed by specialist technicians and physicians. However, this is a slow process and dependent on the availability of these expert annotators. This limits EEG as a diagnostic medical tool in smaller communities. Even in larger centers, the time consuming nature of human EEG analysis can lead to backlogs and significant delays in

diagnosis and treatment. Thus, there is a need for rapid, scalable, cost-efficient, accurate EEG interpretation that is not heavily dependent on the time of highly trained specialists. These limitations have motivated efforts to develop fully automated algorithms for the interpretation of human EEG signals. Unfortunately, to date, these approaches have had limited success, in part because many aspects of EEG interpretation are fundamentally image classification problems that while straightforward for trained humans, are difficult to fully automate.

The purpose of this research is to design a framework for hybrid machine and human computation to achieve accurate and scalable analysis of human clinical EEG recordings in both resource-rich and resource-poor health settings.

Hypotheses:
Our hypotheses are:
- Our hybrid approach, combining non-expert, expert and machine contributions, can produce comparative quality annotations but at a much lower cost.
- The crowd-generated annotations would help EEG specialists make more informed decisions about their classification
- Interfaces can be constructed in such a way that non-experts can feel a sense of engagement while performing EEG analysis tasks.

Justification for the study:
Approximately 250,000 Canadians, suffer from epilepsy [18]. Meanwhile, the prevalence of sleep apnea, the most common sleep disorder, has been estimated at 2-4% in adults [20]. EEG is key to the diagnosis of epilepsy, sleep disorders, and other neurological diseases. A large center such as the Toronto Western Hospital can perform over 12,500 EEGs annually. EEG and other tests for epilepsy are estimated to account for >21% of the direct costs of caring for epilepsy patients [18]. Visual interpretation of EEG by trained specialists has the drawbacks of being slow, expensive, and inefficient. Furthermore, these drawbacks make it difficult to provide EEG-based diagnostics in smaller communities in Canada and internationally.

Our project will address these needs by producing two prototype systems - one for conventional EEG data from large Canadian hospitals, and one integrated with the smartphone EEG recording system developed by the Bhutan Epilepsy Project for use in rural and remote settings by healthcare professionals without EEG training. For large Canadian hospitals, there will be several benefits:

1) Timeliness. The use of automated algorithms to prune EEG records will reduce the human input needed to review each record. Meanwhile, careful task decomposition may allow much of the required human input to be provided by available non-EEG trained health care workers. Specialists may be called upon to provide input only on ambiguous cases, thus allowing a large proportion of records to be screened in near real-time without specialist input.

2) Accuracy. By decreasing the hours of recording requiring human review, and allowing for parallel review of ambiguous features by multiple experts, the proposed system will minimize errors due to lapses in vigilance, and improve accuracy especially in ambiguous cases.

3) Cost Efficiency. Specialist labour is the main cost associated with EEGs. By decreasing the need for this, our system should decrease EEG costs.

4) Capacity. By decreasing the amount of specialist labour needed to interpret each EEG, a single specialist will be able to review a much larger number of EEGs. For smaller Canadian communities the overriding benefit with be the capacity to obtain EEG recordings locally without transferring patients or relying on outside experts, reducing costs, and allowing more rapid diagnosis and treatment.

Objectives:
The objectives of this research are:

1. Develop a general set of algorithms to decompose EEG analysis into micro-tasks, and integrate the responses of non-expert and expert human processors with automated algorithms to solve EEG-related clinical problems.
2. Develop a general framework to compare these algorithms against fully automated approaches and specialist analyses, and an iterative approach to improve these algorithms.
3. Apply the algorithms to the interpretation of clinical EEGs from Canadian hospitals.
4. Integrate these algorithms with EEG smartphone-based recording device developed by the Bhutan Epilepsy Project to allow recording and interpretation of EEGs in remote settings.
5. New understanding about the medical EEG analysis tasks themselves

The outcomes of this work will include two prototype systems freely available for general use by health care organizations – one for analyzing conventional EEG data from large Canadian hospitals, and one integrated with the smartphone EEG recording system developed by the Bhutan Epilepsy Project for use in rural and remote settings by health care professionals (e.g., nurses) without EEG training. For Canadian hospitals, the benefits will include improved robustness, speed, and efficiency of EEG interpretation, resulting in more timely and accurate diagnosis of epilepsy, sleep disorders and other neurological conditions, as well as more efficient utilization of scarce specialist resources. For more remote regions in Canada and internationally, the integrated smartphone-based version will provide access to accurate, scalable, cost- and time-efficient local EEG diagnosis, with minimal need for outside EEG specialists.

b. In lay language, provide a one paragraph (approximately 100 words) summary of the project including purpose, the anticipated potential benefits, and basic procedures used.
Electroencephalography (EEG – the measurement of human brain activity using electrodes on the scalp) is a key tool in the diagnosis of epilepsy. It is also a key step in the diagnosis of sleep disorders. Right now, interpretation of EEGs is dependent on specialized neurologists. This limits access to EEG services in smaller communities. Even in large communities, the laborious nature of EEG interpretation and the heavy reliance on specialists imposes substantial costs on the health care system, and can delay diagnosis and treatment. In this research, we will design a series of experiments that involves understand how non-experts and experts classify EEG data, when their capabilities are augmented by automated algorithms and novel interfaces. Benefits will include improved timeliness and accuracy of epilepsy and sleep disorder diagnosis, accompanied by reduced costs. For more remote regions in Canada and elsewhere, our smartphone-integrated device will provide local access to accurate and cost-efficient EEG diagnosis avoiding the need to travel to larger centers.

C. DETAILS OF STUDY

1. Methodology/Procedures

a. Indicate all of the procedures that will be used. Append to form 101 a copy of all materials to be used in this study.

Computer-administered task(s) or survey(s) Some are standardized.
Interview(s) (in person)
Interview(s) (by telephone)
Audio-recording
Video-recording

b. Provide a detailed, sequential description of the procedures to be used in this study. For studies involving multiple procedures or sessions, provide a flow chart. Where applicable, this section also should give the research design (e.g., cross-over design, repeated measures design).
Experiment 0: Expert Identification of Sleep Spindles in Adult EEG

Experts in EEG analysis will be presented with anonymized EEG samples from the Sunnybrook health science center's neurology lab. The experts will be video taped while they attempt to identify sleep spindles in the EEG traces. Throughout this process, the experts will be encouraged to describe the thought process that they use to analyze EEG recordings in detail. We will ask the experts clarifying questions throughout the process as required. We will pay the experts fifty dollars per hour in renumeration, and the task will last one to two hours depending on scheduling and availability. The consent form, data release forms and task template are attached to this application.

Experiment 1: Non-Expert Identification of Sleep Spindles

Online participants will to to identify sleep spindles through an online tutorial, based on the instruction sheet created by Warby et al. Next, the participants will be asked to identify sleep spindles in twenty short sections of EEG recordings from the DREAMS sleep spindle database. Each section will contain at least one sleep spindle. The participant will identify the spindles by clicking on them, and then pressing submit. After the participant submits each section, the answers will be presented complete with explanatory notes to help them improve throughout the task. Additionally, participants may choose to review the instructions at any time without penalty. The participant will be paid a base rate of five dollars for completion of the task, plus a bonus of up to five dollars based on how many spindles they managed to correctly identify. The bonus payment is intended to encourage the online participants to spend more time on the tutorial, and to be careful throughout the task. The tutorial, consent form and design mock-ups of the interface are attached to this application.

c. Will this study involve the administration/use of any drug, medical device, biologic, or natural health product? No

d. Will you be using or processing any biological materials such as human blood, tissue, cells or bodily fluids in the proposed research?
No

2. Participants Involved in the Study

a. Indicate who will be recruited as potential participants in this study.
Non-UW Participants:
Adults

b. Describe the potential participants in this study including group affiliation, gender, age range and any other special characteristics. Describe distinct or common characteristics of the potential participants or a group (e.g., a group with a particular health condition) that are relevant to recruitment and/or procedures. Provide justification for exclusion based on culture, language, gender, race, ethnicity, age or disability. For example, if a gender or sub-group (i.e., pregnant and/or breastfeeding women) is to be excluded, provide a justification for the exclusion.

Experiment 0: Experts in EEG analysis will be recruited from the Neurology labs of Sunnybrook

health science center. If more experts are required, they will be recruited from other neurology labs affiliated with the University of Toronto.

Experiment 1: Participants will be recruited and participate via Amazon's Mechanical Turk online marketplace. In order to participate in the marketplace (and thus in the study), the employees must be adults ages eighteen years or older capable of providing banking information for Amazon deposits. In addition, it can be assumed that all participants have at least rudimentary familiarity with computers and web tools. Finally, to ensure that the participants possess the relatively high level of literacy and implicit cultural understanding required to read and understand the instructions, the study will be limited to American participants, and we will only accept participants who have not been reported for cheating or unacceptable work quality by other employers.

c. How many participants are expected to be involved in this study? For a clinical trial, medical device testing, or study with procedures that pose greater than minimal risk, sample size determination information is to be provided.

Experiment 0: 2-5 expert participants Experiment 1: Up to 50 participants

3. Recruitment Process and Study Location

a. From what source(s) will the potential participants be recruited?
Businesses, industries
Amazon Mechanical Turk

b. Describe how and by whom the potential participants will be recruited. Provide a copy of any materials to be used for recruitment (e.g. posters(s), flyers, cards, advertisement(s), letter(s), telephone, email, and other verbal scripts).
Experiment 0: Experts will be recruited by our collaborator Dr. Andrew Lim from the Sunnybrook Health Sciences Center neurology lab. Experiment 1: Potential participants will be recruited via the Amazon Mechanical Turk marketplace. Tasks within each condition of the survey are exposed through a search interface on the marketplace. A task is shown with a title and description. Users of Mechanical Turk can sort tasks by posting date, remuneration amount, time allotted, keyword search, and otherwise. Only American users will be able to complete the tasks for this study. A sample of a task posting as it would be seen by a potential user is attached. Remuneration and study time are exposed in a separate field of the task posting.

c. Where will the study take place? Off campus: Experiment 0 will take place at Sunnybrook Health Sciences Center

4. Remuneration for Participants
Will participants receive remuneration (financial, in-kind, or otherwise) for participation? Yes
If Yes, provide details:
Experiment 0: Experts will be paid fifty dollars per hour in remuneration. This is less than or equivalent to their normal professional hourly rate. Experiment 1: Participants will be paid a base rate of five dollars for the completion of twenty question task, with a possible performance bonus of up to five dollars based on how many sleep spindles they correctly identify. The bonus pay is intended to incentivize the participants to spend time and attention during the tutorial and spindle identification task.

5. Feedback to Participants

Describe the plans for provision of study feedback and attach a copy of the feedback letter to be used. Wherever possible, written feedback should be provided to study participants including a statement of appreciation, details about the purpose and predictions of the study, restatement of the provisions for

confidentiality and security of data, an indication of when a study report will be available and how to obtain a copy, contact information for the researchers, and the ethics review and clearance statement.
Experiment 0: The participants will be given the opportunity to provide study feedback verbally at the end of the task, and they will be provided with a form containing the contact information of all of the researchers involved so that they can contact us regarding results or any other concerns.
Experiment 1: Feedback will collected using the last page of the web task. The feedback page is attached to this application.

D. POTENTIAL BENEFITS FROM THE STUDY

1. Identify and describe any known or anticipated direct benefits to the participants from their involvement in the project.
Experiment 0: No direct benefits

Experiment 1: No direct benefits

2.Identify and describe any known or anticipated benefits to the scientific community/society from the conduct of this study.
Experiment 0: This task will contribute to building an anonymized dataset of gold standard sleep spindle annotations. This dataset will be extremely invaluable to researchers attempting to build automatic classifiers for sleep spindles.

Experiment 1: This study will contribute to a better understanding of human-computer interaction, specifically improving our understanding of incentive mechanisms for motivating participation on crowdsourcing platforms. Additionally, it will contribute to a better understanding of how effective non-experts can be at EEG analysis when provided with only basic instructions.

E. POTENTIAL RISKS TO PARTICIPANTS FROM THE STUDY

1. For each procedure used in this study, describe any known or anticipated risks/stressors to the participants. Consider physiological, psychological, emotional, social, economic risks/stressors. A study–specific current health status form must be included when physiological assessments are used and the associated risk(s) to participants is minimal or greater.
No known or anticipated risks
Experiment 0: No risks beyond those assumed by the professionals while doing their normal jobs.
Experiment 1: No risks to the online participants beyond those they encounter while using the Amazon Turk online platform on a daily basis.

2. Describe the procedures or safeguards in place to protect the physical and psychological health of the participants in light of the risks/stressors identified in E1.
No risks to the physical or psychological health of the participants are anticipated.

F. INFORMED CONSENT PROCESS

1. What process will be used to inform the potential participants about the study details and to obtain their consent for participation?
Information letter with written consent form
Online participants will give their consent using an online form

2. If written consent cannot be obtained from the potential participants, provide a justification for this.

3. Does this study involve persons who cannot give their own consent (e.g. minors)? No

G. ANONYMITY OF PARTICIPANTS AND CONFIDENTIALITY OF DATA

1. Provide a detailed explanation of the procedures to be used to ensure anonymity of participants and confidentiality of data both during the research and in the release of the findings.
Experiment 0: The video recordings will only be reviewed by members of the CrowdEEG research team. The annotations produced by the experts will be completely anonymized using the CrowdEEG annotation interface, which will store no information about the expert who completed the annotations. Experiment 1: The data w

2. Describe the procedures for securing written records, video/audio tapes, questionnaires and recordings. Identify (i) whether the data collected will be linked with any other dataset and identify the linking dataset and (ii) whether the data will be sent outside of the institution where it is collected or if data will be received from other sites. For the latter, are the data de-identified, anonymized, or anonymous?
Experiment 0: The video recordings of the experts will be stored in an encrypted format in a locked lab in the David R. Cheriton School of Computer science. Experiment 1: The data will be stored with only password protected computers. All data collected will be electronic. The data will not be linked with any other data set. While the data will not leave the institution, participant responses are first sent through Amazon's Mechanical Turk service and servers before it will be received by researchers, and Amazon has access to de-identified information about each participant recruited through its service. However, it is stated in the Mechanical Turk terms of service (section 3b) that all intellectual property rights regarding the participants' responses are ceded to the requester (in this case UW researchers). Thus, while Amazon has access to the information and can link it to participants, it is outside of their legal rights to do so without permission from the researchers.

3. Indicate how long the data will be securely stored and the method to be used for final disposition of the data.
Audio/Video Recordings
Erasing of audio/video recordings after 5 year(s).
Electronic Data
Erasing of electronic data after 8 year(s).

4. Are there conditions under which anonymity of participants or confidentiality of data cannot be guaranteed?
Yes

If Yes, please provide details:
While the data will not leave the institution, participant responses are first sent through Amazon's Mechanical Turk service and servers before it will be received by researchers, and Amazon has access to de-identified information about each participant recruited through its service. However, it is stated in the Mechanical Turk terms of service (section 3b) that all intellectual property rights regarding the participants' responses are ceded to the requester (in this case UW researchers). Thus, while Amazon has access to the information and can link it to participants, it is outside of their legal rights to do so without permission from the researchers.

H. PARTIAL DISCLOSURE AND DECEPTION

1. Will this study involve the use of partial disclosure or deception? Partial disclosure involves withholding or omitting information about the specific purpose or objectives of the research study or other aspects of the research. Deception occurs when an investigator gives false information or intentionally misleads participants about one or more aspects of the research study. No

Researchers must ensure that all supporting materials/documentation for their applications are submitted with the signed, hard copies of the ORE form 101/101A. Note, materials shown below in bold are normally required as part of the ORE application package. The inclusion of other materials depends on the specific type of projects.

Protocol Involves a Drug, Medical Device, Biologic, or Natural Health Product

If the study procedures include administering or using a drug, medical device, biologic, or natural health product that has been or has not been approved for marketing in Canada then the researcher is to complete Appendix A. Appendix A is to be attached to each of the one copy of the application that are submitted to the ORE. Information concerning studies involving a drug, biologic, natural health product, or medical devices can be found on the ORE website.

Please **check** below all appendices that are attached as part of your application package:

- Information Letter and Consent Form(s)*. Used in studies involving interaction with participants (e.g. interviews, testing, etc.)
- Information/Cover Letter(s)*. Used in studies involving surveys or questionnaires.
- Data Collection Materials: A copy of all survey(s), questionnaire(s), interview questions, interview themes/sample questions for open-ended interviews, focus group questions, or any standardized tests.
- Feedback letter *
- Debriefing Letter: Required for all studies involving deception.

* Refer to sample letters.

NOTE: The submission of incomplete application packages will increase the duration of the ethics review process.

To avoid common errors/omissions, and to minimize the potential for required revisions, applicants should ensure that their application and attachments are consistent with the *Checklist For Ethics Review of Human Research Application*

Please note the submission of incomplete packages may result in delays in receiving full ethics clearance. We suggest reviewing your application with the Checklist For Ethics Review of Human Research Applications to minimize any required revisions and avoid common errors/omissions.

INVESTIGATORS' AGREEMENT

I have read the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, 2nd Edition (TCPS2) and agree to comply with the principles and articles outlined in the TCPS2. In the case of student research, as Faculty Supervisor, my signature indicates that I have read and approved this application and the thesis proposal, deem the project to be valid and worthwhile, and agree to provide the necessary supervision of the student.

NEW As of May 1, 2013, all UW faculty and staff listed as investigators must complete the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Tutorial, 2nd Ed. (TCPS2) prior to submitting an ethics application. Each investigator is to indicate they have completed the TCPS2 tutorial. If there are more than two investigators, please attach a page with the names of each additional investigator along with their TCPS2 tutorial completion information.

Print and Signature of Principal Investigator/Supervisor **Date**

Completed TCPS2 tutorial:
___YES ___NO ___ In progress

Print and Signature of Principal Investigator/Supervisor **Date**

Completed TCPS2 tutorial:
___YES ___NO ___ In progress

Each student investigator is to indicate if they have completed the Tri-Council Policy Statement, 2nd Edition Tutorial (http://pre.ethics.gc.ca/eng/education/tutorial-didacticiel/). If there are more than two student investigators, please attach a page with the names of each additional student investigator along with their TCPS2 tutorial completion information.

Signature of Student Investigator **Date**

Completed TCPS2 tutorial:
___YES ___NO ___ In progress

Signature of Student Investigator **Date**

Completed TCPS2 tutorial:
___YES ___NO ___ In progress

FOR OFFICE OF RESEARCH ETHICS USE ONLY:

Maureen Nummelin, PhD
Chief Ethics Officer
OR
Julie Joza, MPH
Senior Manager, Research Ethics
OR
Sacha Geer, PhD
Manager, Research Ethics

Date

ORE 101
Revised August 2003