Brain Health Alliance Virtual Institute: Teaching Students Medical Informatics via Collaborative Research Projects

Diverse Approaches to Informatics Educational Experiences

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Brain Health Alliance
Disclosure

• We have no financial relationships to disclose!
Overview

• History of Brain Health Alliance
• Brain Health Alliance Virtual Institute:
  • General Guiding Principles
  • Program Structure
  • Project Areas
• Looking back on 5 Years of BHAVI
• Lessons Learned and Changes to the Program
Brain Health Alliance

- Brain Health Alliance (BHA) is a not-for-profit 501(c)(3) tax exempt organization focused on helping build bridges to better brain health.

- BHA operates the BHA Virtual Institute (BHAVI) to mentor high school, college and graduate level students interested in Science, Technology, Engineering, Math and Medicine (STEMM)

- Projects focus on problems related to brain health and diseases especially dementias and neurodegenerative disorders
BHAVI – Aims and Principles

• To build an educational research program which:
  • Is a virtual institute and operated online
  • Only requires: computer with webcam, internet access, time and effort
  • Mentors students on STEMM projects regardless of project complexity or student age
  • Works towards the BHA mission by training students regardless of field of interest (engineering, medicine, computer science, psychology, etc.)

• Our Philosophy
  • If a student sets a scholarly research goal, they can attain it with appropriate effort
  • Issues in brain health can only be solved from interdisciplinary perspectives
BHAVI – Program Structure

- Two kinds of students: new “rookies” and returning “veterans”

- BHAVI runs year round and is divided into quarters for new students:
  1. Application (Fall) – main quarter for submitting applications to join the program
  2. Evaluation (Winter) – 20-40 min writing and literature search exercises
  3. Computation (Spring) – engineering and software exercises with research project proposal
  4. Publication (Summer) – main quarter for completing research and writing a report

- Students considered for rolling admission as funded or volunteer students.

- Current stipends for full-time work in summer quarter: $1000 for high school, $3000 for undergraduate, and $5000 for graduate students

- Continuing students are evaluated quarterly for advancement to next quarter
BHAVI – Program Structure

- Students sign a formal student agreement and code of conduct including:
  - Expectation to work together appropriately regardless of age, schooling level, experience, gender, ethnicity, religion, or sexual orientation
  - Students designate a contact at their degree-granting institution to serve as a local mentor and contact

- Students who complete a year of BHAVI and remain in good standing are eligible for end of year prizes valued at $2500 each for best:
  - contribution to the mission of Brain Health Alliance – Mann Prize
  - report that extends an abstract submitted for professional publication – Siegler Sisters Prize
  - report on working software accompanied by readable source code – Golub Prize
  - report on creative solutions to problems with imagination and ingenuity – Keller Prize
BHAVI – Student Activities

• Students participate in BHAVI all year round
  • Full time during summer break (40 hours per week)
  • Part time during regular school year (hours expected is age-dependent)

• Students divide their time between three activities:
  1. Primary Research Activity ~ 50-60% of time spent
  2. Secondary Research Activity ~20-30% of time spent
  3. Software Education Activity ~10-20% of time spent

• Students are expected to attend all videoconference meetings:
  BHAVI program, team project meetings, and advisor presentations
BHAVI – Student Goals

• Know and learn “4 R’s”
  • Reading, writing, arithmetic, and algorithm

• Become a “Jack of all trades” as a good pursuit
  • Learn to understand a problem broadly from numerous perspectives of: informatician, statistician, mathematician, engineer, scientist, medical provider, etc.
  • Learn to work on a solution from numerous perspectives of software engineering: numeric computing, symbolic computing, and a hybrid of numeric and symbolic

• Develop “real software that really works”

• Learn to conduct research and write reports for presentation and publication at professional conferences and journals

• Be a “brainiac”
BHAVI – Thematic Project Areas

- **BrainWatch Project**: Numeric computing addresses the use of mathematical image processing and virtual reality displays.

- **PORTAL-DOORS Project**: Symbolic computing applies vocabularies, ontologies and semantic web technologies to build a knowledge engineering workbench with the NPDS cyberinfrastructure system.

- **CTGaming Project**: Hybrid computing combines both numeric and non-numeric technologies to develop clinical telegaming applications with telecare monitoring of and therapy for neurodegenerative disorder patients in their homes.
BrainWatch Project (Numeric Computing)

- Humans understand a 3D world with stereoscopic vision yet scan data is often viewed slice by slice on a 2D screen
- Scan modalities are often viewed by themselves
  - PET scans is great for physiological function, not anatomical structure
  - MR is great for anatomical structure, not physiological function
  - Some MR special techniques may assess function
- To improve understanding and readability of medical imaging:
  - Image processing of PET and MR brain scans to generate fused co-registered volume
  - Volume rendering of a brain scan volume in a 3D virtual/augmented reality headset
BrainWatch Project

PORTAL-DOORS Project (Symbolic Computing)

• When asking a scientific question, search problems arise
  • “Cybersilos” problem: Information maintained in silos – caBIG only for cancer and oncology
  • “Informatics Towel of Babel” problem: Failures of interoperability and interpretability that cannot handle differences in community-dependent jargon and language
  • “Information Tsunami” problem: Search example “Are any genes in Alzheimer’s disease associated with treatments?” returns 78,600,000 hits on Google
  • Ethics problem: falsified data and plagiarism in scientific literature – see Retraction Watch

• To improve search
  • Use a semantic system which understands information’s meaning through interlinked information across disciplines
  • Hypothesis focused search for automated meta-analysis of scientific literature
  • Supported further by a concept-validating search engine agent to gather information and citation metrics to check for appropriate citation of work within a research community
PORTAL-DOORS Project

View SOLOMON Resource Metadata Records on Nexus Server

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<th>Handle</th>
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<td>Amyloid beta (Aβ or Abeta) denotes peptides of 36–43 amino acids that are crucially involved in Alzheimer's disease as the main component of the amyloid plaques found in the brains of Alzheimer patients.</td>
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<td>A video about the behavioral component of Dementia with Levy Bodies</td>
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CTGaming Project (Hybrid Computing)

- Parkinson’s Disease patients face a number of challenges in daily life
  - Neuromuscular difficulty – tremors, difficulty walking, and more
  - Sensory processing deficits – difficulty with understanding sensory stimuli [1]
  - Physical Therapy helps maintain mobility with exercise
  - Studies have looked at use of game systems for therapy, such as “Wii-hab” [2]

- To help patients with this issue:
  - Web accessible dynamic difficulty video game for health
  - Disease status tracking and therapy for multi-sensory stimuli processing
  - Initial testing looks at the differences of multi-sensory stimuli processing in healthy beta testers comparing multi-sensory reinforcement and conflict

CTGaming Project

BHAVI Student Papers

Bridging the Semantic and Lexical Webs:
Concept-Validating and Hypothesis-Exploring Ontologies
for the Nexus-PORTAL-DOORS System

Adam Craig, Seung-Ho Bae and Carl Taswell
Brain Health Alliance, Ladera Ranch, CA 92694, USA

2017 JSCI 15:8

Web Service APIs for Scribe Registrars, Nexus Diristries, PORTAL Registries and DOORS Directories in the NPD System

Adam G. Craig, Seung-Ho Bae, Teja Veeramacheni, S. Koby Taswell, and Carl Taswell
2017 SWAT4LS Proc 2042:6

SOLOMON: An Ontology for Sensory-Onset, Language-Onset and Motor-Onset Dementias

Martin Skarzynski, Adam Craig and Carl Taswell
Brain Health Alliance, Ladera Ranch, CA 92694 USA

2015 IEEE BIBM Proc, 10.1109/bibm.2015.7359814

BrainWatch Software for Interactive Exploration of Brain Scans in 3D Virtual Reality Systems

S. Koby Taswell1, IEEE Student Member, Teja Veeramacheni1 and Carl Taswell2, IEEE Senior Member

2017 IEEE EMBC Proc, 10.1109/embc.2017.8037662

Web-Enabled Software for Clinical Telegaming Evaluation of Multisensory Integration and Response to Auditory and Visual Stimuli

Linda Xu, Stephan Loh, and Carl Taswell, Senior Member, IEEE

2015 IEEE EMBS NER Proc, 10.1109/ner.2015.7146729
Looking Back on 5 Years

• As of December 2018
  • Mentored 45 students
  • Produced 14 student written papers, presented by students at professional engineering and medical conferences
  • 1 Regeneron Science Talent Search top 40 winner!

• Since Jan 2019:
  • 11 new students have joined in the year of 2019, 1 not continuing into the summer
  • 13 students participating in the summer quarter of BHAVI (3 continuing “veterans”, 10 new “rookies”)
  • 4 papers/abstracts accepted for presentations, 1 more submitted awaiting response
Lessons Learned and Program Changes

• Initially in BHAVI 2014 the program only operated in the summer
  • Some students had difficulty completing research and reports during the summer
  • Despite this challenge, some students successfully completed projects that were later presented and published
  • Extended the program to summer and fall quarters, but then concluded that a continuous year-round program was necessary to support progress of the students on their projects

• BHAVI 2017 introduced the quarter system, providing students with a clear plan and timeline throughout the entire year
Lessons Learned and Program Changes

• Operating as a Virtual Institute remains a challenge
  • Students are not required to attend and work in a lab in person
  • Hours are flexible and productivity monitoring is needed
  • Communication and productivity can be a challenge, often noticed similarly in other online coursework

• To help keep students on track:
  • Shorten meeting length but increase frequency of meetings, ideally daily
  • Students update each other and discuss progress at each meeting
BHA Web Site

- All of our papers and posters are available for download at: https://www.brainhealthalliance.org/BhaStemm/Papers
- Program description at: https://www.brainhealthalliance.org/BhaviProgram/Programs2019
- Feel free to contact me with questions at: ktaswell@brainhealthalliance.org
Thank you!

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