2020 SUMMER

UNDERGRADUATE RESEARCH SYMPOSIUM

WEDNESDAY, JULY 29

Morning: 10-12 & Afternoon: 1-3

via Zoom

SUMMER UNDERGRADUATE RESEARCH SYMPOSIUM

July 29, 2020

TIME	PRESENTER	PROJECT TITLE	ADVISOR	DEPARTMENT
10:00 – 10:05 a.m. Welcome and Introductions				
10:05	Evan Brinckman	LockLuck	Agnieszka Marczak Czajka	Center for Research Computing (CRC)
10:15	Meghan Coggins	Increase in Computer Science Attitudes is Not Moderated by Either Gender or Underrepresented Race/Ethnicity in STEM+C	Dr. Ying Cheng	Psychology
10:25	Sophia Henn	Visualizing Text Data for Event Classification in the Social Sciences: Applications of NLP to Understand Triggers of Mass Atrocities	Dr. Paul Brenner	Center for Research Computing
10:35	Maya Mosley	How language impacts math and computer science self-perceptions in 4th - 12th grade students	Dr. Ying Cheng	Psychology
10:45	Trent Robinett	Integration of growth factor signaling through cytosolic calcium during organ development	Dr. Jeremiah Zartman	Chemical and Biomolecular Engineering
10:55	Akanksha Sachan	Tissue Cartography: Automated morphometric analysis of epithelial tissues	Dr. Jeremiah Zartman	Chemical and Biomolecular Engineering
11:05	Charles Sleeper	Big Data for a multi-part computational framework to help identify triggering events.	Dr. Paul Brenner	Center for Research Computing
11:15	Abby Sticha	SVMs for Social Science Event Classification: A Case Study on the Triggers of Mass Atrocities	Dr. Paul Brenner	Center for Research Computing
11:25	Yuxin Wu	Identifying irregular respondents through response time	Dr. Zhiyong Zhang	Psychology
11:35	Lixian Yan	On Intelligence, Spike-Timing-Dependent Plasticity, and Rule-Guided Learning Devices	Dr. Alan Seabaugh	Electrical Engineering
11:45 – 12:00 p.m. Conclusion and Final Questions				
Break				
1:00 – 1:05 p.m. Welcome and Introductions				
1:05	Carver Coleman	The 1918-19 Flu Pandemic and Nonpharmaceutical Interventions in Ohio Cities	Dr. Kasey Buckles	Economics
1:15	Audrey Filonczuk	Careless Responding Identified More in Older Children and Minorities; Multiverse Analysis Reveals Stronger Correlations When Removing All Careless Responders	Dr. Ying Cheng	Psychology
1:25	Susana Guerrero	The humanizing effect of white protesters on newspaper articles related to BLM protests	Dr. Bettina Spencer	Psychology, St. Mary's College
1:35	Allison Wan	Determining psychological predictors for attrition rates in surveys measuring the longitudinal effectiveness of an intelligent learning platform on STEM persistence in underrepresented populations	Dr. Ying Cheng	Psychology
1:45	Jordyn Rand	Positive Attitude Heightens Emotional Intelligence	Agnieszka Marczak Czajka	Center for Research Computing
1:55	Eliana Sanchez	Attitudes Towards Computer Programming: An Analysis of Background Experiences	Dr. Ying Cheng	Psychology
2:05	Noah Wamble	Continuous Diafiltration Membrane Cascades for Lithium-Ion Battery Recycling	Dr. Alexander Dowling, Dr. William Phillip	Chemical and Biomolecular Engineering
2:15	Erick J. Mendez	Molecular and process design framework for the separation, recycling, and reuse of hydrofluorocarbon mixtures	Dr. Edward Maginn, Dr. Alexander Dowling	Chemical and Biomolecular Engineering
2:25	Rebecca Ward	Dehumanization of Black Victims of Police Violence in News Media by Gender & Political Bias	Dr. Bettina Spencer	Psychology, St. Mary's College
2:35 – 2:50 p.m. Conclusion and Final Questions				

LockLuck

By:
Evan Brinckman
Center for Research Computing

Faculty Advisor:
Agnieszka Marczak Czajka
Center for Research Computing
Notre Dame Research

Other Contributors:
Adam Czajka, Christopher Sweet,
Priscila Moreira, Mike Villano, and Jordyn Rand

Abstract:

My task was to analyze the deep dream images from LockLuck, a coaching tool to work on improving self-value, self-esteem, and self-confidence of an individual, in relation to the inception5h convolutional neural network and see if these images can be organized into groups based on their layer activations within the inception5h convolutional neural network. Deep dream images are images that are fed to a convolutional neural network to visualize what that model sees in that image. In order to compare the activations of these images with each other and find the layers within the network with the highest activations, the activations first had to be normalized which allowed the data to be more easily interpretable. Once this was done, the results showed that using only the peak activations from each image was not enough. Grouping the images by layers with the highest activation was not able to provide an organization method. This then led to a second method, calculating the activations of both the deep dreamed images as well as the original images and to then take the difference between the two results to see what changed, as change in the activations from before and after deep dream may show which layer(s) within the convolutional neural network were active. In the future, the results of this method may be used to organize the images into groups.

Increase in Computer Science Attitudes is Not Moderated by Either Gender or Underrepresented Race/Ethnicity in STEM+C

By:
Meghan Coggins
Center for Research Computing

Faculty Advisor:
Dr. Ying Cheng
Department of Psychology
College of Arts and Letters

Other Contributors:
Teresa Ober

Abstract:

The National Science Foundation reports only 19% of bachelor degrees in computer science were awarded to women in 2016.1 Further, underrepresented minorities earned only 22% of all science and engineering bachelor's degrees that same year. Underrepresented minority groups in STEM+C are Hispanic/Latinx, Blacks/African American, or American Indian or Alaskan Native. Therefore, this study investigated whether students' gender or race/ethnicity significantly moderated the relationship between their computer science attitudes. Curated Pathways to Innovation (CPI2) is a web-based app that curates science, technology, engineering, mathematics, and computer science (STEM+C) learning programs from different sources and uses machine learning and artificial intelligence to encourage students to pursue these fields. For the 2018-2019 academic year, 228 students completed both the baseline in September 2018 and the last pulse survey in June 2019 (Mean age = 12.36 y/o, %Male = 50.7, %URM in STEM+C = 84.4). The latent factor structure of computer science attitudes, which was composed of six Likert-type items found on the baseline and the pulse surveys, was confirmed to fit a unidimensional factor model. A paired t-test showed that the mean score for computer science attitudes significantly increased between the baseline and pulse surveys, indicating that students' expressed more positive attitudes in the pulse compared to the baseline. Moderation analyses were conducted in a linear regression model in order to determine if gender or URM status significantly moderated the increase in computer science attitudes. The results indicate that the increase in computer science attitudes was not affected by gender or race/ethnicity.

References

National Science Foundation, National Center for Science and Engineering Statistics. 2019. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019. Special Report NSF 19-304. Alexandria, VA. Available at https://www.nsf.gov/statistics/wmpd.
https://ywca-sv.org/curated-pathways-to-innovation/

Visualizing Text Data for Event Classification in the Social Sciences: Applications of NLP to Understand Triggers of Mass Atrocities

By:
Sophia Henn
Center for Research Computing

Faculty Advisor:
Dr. Paul Brenner
Center for Research Computing
Notre Dame Research

Other Contributors:
Abigail Sticha, Timothy Burley, Charles Sleeper

Abstract:

Natural language processing (NLP) tools show promising application within the social sciences to offer a systematic means of analyzing unstructured text data. Our project applies NLP and support vector machines (SVMs) for event classification in order to study the link between nine potential triggering events and instances of state-led mass killings. Using the protest trigger as a case study, I explore ways text data describing these events can be visualized to communicate important insights from our computational tools to broader audiences. Visualizations including histograms, bubble charts, and scatterplots are constructed to illustrate the linguistic differences between positively and negatively-classified articles by both human readers and SVMs. Visualizations are also created to depict how SVMs work to classify the articles and to help explain why some articles are misclassified by the tool. Further exploration within this project will involve visualizing data from larger corpora and across different triggers, alongside the broader objective to better understand capabilities of SVMs and NLP tools to advance research in the social sciences.

How language impacts math and computer science self-perceptions in 4th - 12th grade students

By:
Maya Mosley
Center for Research Computing

Faculty Advisor:
Dr. Ying Cheng, Department of Psychology
College of Engineering

Other Contributors: Teresa Ober, Paul Brenner

Abstract:

Academic curricula have been adapting for generations because of the historic lack of inclusivity fostered in the public education system. These administrative curricula practices neglect cultural and ethnic components of a child's life that may impact their personal learning curve, and an example of this is primary or native language spoken at home. Current literature has explained learning patterns relating to bi/multilingualism and how it can impact children's self-perceptions (Lundetræ, 2011). Common behaviors have also been identified that promote bilingualism and its impact on learning (Moschkovich 2007). Current findings continue to examine how math achievement is related to English language proficiency but neglects how different languages may impact perceived math ability (Roberts, Bryant 2011). The current body of literature has a comprehensive review about how language ability and comprehension impacts math learning (Schleppegrell, 2007) but does not examine how native language spoken at home can impact how a child perceives their ability specifically in the math or computer science field.

Plenty of research has been done on children who are learning English but do not attribute to those who speak different languages. Our research examines how children's self-perceptions about their math and computer science differ based on their parent's educational attainment and what primary language is spoken at home. Parental education level differentiated by no college education and having a college education has many findings suggesting the variable's impact on children's academic performance (The data was collected using the Curated Pathways to Innovation (CPI) platform, an eLearning tool developed to track and suggest relevant educational computer science content to students based on their individual learning and topic preferences. The sample collected was from 575 4th – 12th grade students in the California public school system. Within the sample, there are 300 native English speakers, 266 native Spanish speakers, and 61 students speaking other languages. As another predictor of the student's math and computer science self-perceptions, parental educational attainment, categorized as "no college education" or "at least some college education, was used to further examine the impacts on student's self-perceptions. The outcome variable for self-perceptions was derived as a mean scale score from a linker-type scale having 5 response answers from "strongly disagree" to "strongly agree" with a neutral value. An independent samples t-test determined significant differences in self-perceptions based on parental educational attainment, $t = 18.863$, $df = 401$, p-value $< 2.2e-16$. A two-way (2x3)ANOVA was conducted in order to find significance and differences on the basis of primary language background (English, Spanish, other) and parental educational attainment (no college, some college). Tukey posthoc comparisons will further determine the significance between groups based on the levels of the independent variables. With the information from the research study, we aim to help better diversify educational resources by offering conclusions that support new incentives for adapting teacher curriculum to student's individual learning styles. We also expect to see the impact of the eLearning system on students' self-perceptions to help better individualize the learning process and give underrepresented children and minorities the support they need to charter a career in STEM while closing the widening ethnic disparities in the STEM field.

Integration of growth factor signaling through cytosolic calcium during organ development

By:
Trent Robinett
Chemical and Biomolecular Engineering

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Other Contributors:
Dharsan Soundarrajan

Abstract:

Organ development in animals depends on cellular processes such as proliferation, apoptosis, and division occurring to specific degrees at specifically determined times. These developmental processes are reliant on a variety of primary and secondary messengers for the transmission of signals that regulate development. Cytosolic calcium (Ca2+) is a universal second messenger in animals that regulates proliferation, apoptosis, and division. However, the relationship between many signaling hormones, such as insulin, and Ca2+ is poorly understood. Here we hypothesize that insulin signaling initially stimulates organ growth in part through regulation of PIP2 substrate availability and IP3 production pathway—concurrently, this pathway upregulates Ca2+ signaling, which serves as a growth inhibitor, to maintain proper organ size and patterning throughout development. We confirmed that expressing a constituently active version of the insulin receptor in Drosophila melanogaster resulted in an increase in adult wing size, while expressing a dominant negative version of the insulin receptor resulted in a decrease in adult wing size. Additionally, we found that Ca2+ acts to decrease final organ size in a wild type fly as well as in a fly with a constituently active insulin receptor. Finally, we discovered that the increase in growth and proliferation caused by the constituently active version of the insulin receptor was not uniform across the various regions of the adult wing. Our results demonstrate that Ca2+ plays a multifaceted role in the insulin signaling pathway by regulating epithelial organ growth and patterning, making Ca2+ necessary for proper functioning of the pathway and independently sufficient for reduction of final organ size. Additionally, our results suggest that proper insulin signaling is necessary for correct organization of the developing organ, and that upregulation of this pathway decouples coordination between cell size and cell number.

Tissue Cartography: Automated morphometric analysis of epithelial tissues

By:
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Other Contributors:
Nilay Kumar

Abstract:

Understanding how individual epithelial cells and tissues modulate their shape, and exploring animal development with quantitative tools is essential to constructing new techniques in treating cancer. A key challenge in quantitative biology is how to efficiently assess experimental data for comparison with computational simulations. Quantification of experimental data requires proper identification of the shape and various geometrical features of a tissue. A semi-automatic shape feature extraction pipeline was built using OpenCV, a Python library and ilastik, a machine learning based tool for bio-image segmentation. This pipeline was tested on the wing imaginal disc of Drosophila, which serves as a commonly used model system to study morphogenesis. This pipeline extracts columnar cell height and curvature from the dataset of the wing imaginal disc under perturbation due to collagenase treatment which was also used for benchmarking. The pipeline creates new opportunities for surrogate and image based modeling, additionally, the features extracted also enable calibration and validation of computational models. A framework for obtaining the difference in the shapes of wing imaginal disc cross sections, was established. Wing disc shapes were expressed using Elliptical Fourier Descriptor (EFD), which is a translation, rotation and dilation invariant mathematical shape descriptor. It does not require that points on the outline of the specimen be equally spaced, thus allowing greater sampling from sections of complex shape or high variability of curvature. EFD shape analysis was used to compare shape changes in wing imaginal disc due to perturbations in the Ca2+ signaling pathway. The Gal4-UAS system was used to knock down the expression of these proteins in the Drosophila wing imaginal disc. Further, immunohistochemistry assays were used to visualize tissue shape using fluorescence microscopy. Principal component analysis (PCA) on the Fourier coefficients extracted using the methodology was used to quantify the “intra-class” and “inter-class” variance in shapes arising from these genetic perturbations.

Big Data for a multi-part computational framework to help identify triggering events

By:
Charles Sleeper
Center for Research Computing

Faculty Advisor:
Dr. Paul Brenner
Center for Research Computing
Notre Dame Research

Other Contributors:
Dr. Ernesto Verdeja

Abstract:

The Center for Research Computing has been working with Notre Dame faculty, researchers, and staff to develop a computational framework to help identify triggering events throughout the world. This interdisciplinary project has been developed by social and computer scientists with the hope of identifying potential mass killing trigger events. The required number of news articles needed is in the tens of thousands for just one trigger. Each trigger has specific keywords associated with it to help identify that trigger. Downloading and processing tens of thousands of news articles is too great a task for a human with computational augmentation. This part of the Triggers of Mass Killings (ToMK) project shows how news articles are searched for, downloaded, and further parsed out and prepped for classification inside of machine learning and natural language processing algorithms. This is one critical part of a multipart computational pipeline to help identify the triggering events for state lead mass killings.

SVMs for Social Science Event Classification: A Case Study on the Triggers of Mass Atrocities

By:
Abigail Sticha
Center for Research Computing

Faculty Advisor:
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Center for Research Computing
Notre Dame Research

Other Contributors:
Sophia Henn, Charles Sleeper, Timothy Burley

Abstract:

In the age of growing data sets and the evolution of the data scientist, there still remains a significant number of challenges for social scientists trying to wrangle discovery from the large and complex data accessible to them. Our project aims to create a framework that future social scientists can utilize in order to implement support vector machines (SVMs) to classify large quantities of text documents with a relatively small amount of labeled data. Our project attempts to create this framework by focusing on a case study in which we use SVMs for event classification in order to gain insight to the triggers of state-led mass killings. We focused on the classification of three of nine triggers that our team of political scientists found to proceed state-led mass killings: protests, coups, and changes in political control. We then used pre-labeled data to create, train, and test an SVM model catered to natural language processing and event classifications. The initial findings were very promising and led us to further investigate the SVM's capabilities by tuning hyperparameters such as the slack value (C), the test size, feature selection parameters, and kernel type. Additionally, we looked at several different ways to evaluate the success of the SVM such as accuracy scores, confusion matrices, and precision/recall trade-off scores. These measurements gave us better insight into the success of our framework and allowed us to understand the effects of each hyperparameter. We hope to eventually create and tune an SVM model for each of the nine triggers of interest. Additionally, we will continue to tune and add to the SVM script in order to better understand and build the framework that will be applicable to the broader goal of text classification within the social sciences.

Identifying irregular respondents through response time

By:
Yuxin Wu
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Other Contributors:
Changrong Xiao, Yunlu Chen

Abstract:

Identifying and controlling for poor respondents in online surveys is a difficult and non-trivial task in study design and data collection. The goal of this project is to analyze response time data in a network study and explore ways to identify problematic responses to inform future data collection.

From an online survey, we obtained response time to 1105 questions grouped into six blocks. Through initial exploratory analysis, we classified good and bad respondents by analyzing the number of missing timestamps. Then we visualized the response time of each question by each respondent through time series plots.

To compare response time between different respondents, we used several different methods, including change point analysis, cross correlation analysis, and dynamic time warp. First, we used change point analysis to determine the number of change points and estimate the time of each change. We hypothesized that bad respondents may have fewer change points detected due to their invalidity. Second, we employed cross correlation analysis to measure similarities of different respondents. Third, dynamic time warp was utilized to perform nonlinear “warping” on the series where differences in time are not penalized.

For the next step, we plan to apply clustering techniques so that we can find groups of similar respondent patterns based on their response data to identify valid/invalid.

On Intelligence, Spike-Timing-Dependent Plasticity, and Rule-Guided Learning Devices

By:
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Mir Muntasir Hossain, Wansik Hwang, Karla Adriana González

Abstract:

Artificial Intelligence (A.I.) has not yet reached a satisfactory level as many mass media had covered. So far, the machine learning process still largely depends on backstage experts, who are actually intelligent and coding algorithms. However, algorithm assistance may not enable an autonomous learning that can be considered as intelligent as mankind. Inspired by pioneers like Jeff Hawkins, we went along a path connecting machine learning with the biological neural network. Artificial neural network with breakthrough in spike-like devices as well as application of nanomaterials may become a more pleasing method to approach A.I. One key for mimicking our neural network is the synaptic time dependent plasticity (STDP) learning rule, continuous weight modifications according to time delays between pre-synaptic and post-synaptic signals. Such rule demands a device or devices possessing switchable resistance and nonvolatile memory at the same time. Here, we present several such innovative devices. After analyzing their mechanisms and materials used, we give a possible direction for their further development.

The 1918-19 Flu Pandemic and Nonpharmaceutical Interventions in Ohio Cities

By:
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Other Contributors:
Joseph Price

Abstract:

Background: Several studies suggest that nonpharmaceutical interventions (NPIs) such as school closures, public gathering bans, quarantines, and business limitations are associated with lower excess death rates during pandemics. Many issues with earlier studies call into question the validity of their results, such as the use of coarse-grained data (city-level and monthly data instead of individual-level and weekly data), failure to account for reverse causality, and outdated methods in calculating excess deaths.

Objectives: Evaluate the potential association between nonpharmaceutical interventions and total excess deaths from 1918-1919.

Methods: Individual-level death data were collected using BYU Record Linking Lab's auto-indexing algorithm on all death certificates in Ohio from 1908-1927. Multiple graphics were constructed to ensure the data resembled the existing CDC data. Farrington Algorithms were used to calculate total excess deaths from 1918-1919 using 1909-1917 as a baseline. NPI data was collected for all Ohio cities with populations above 25,000 from online newspaper repositories such as GenealogyBank.com and Chronicling America. Finite Distributed Lag Models with 0, 1, 2, and 3-week lags were used to obtain estimates and 95% confidence intervals (95% CIs) of the non-lagged and lagged effect of NPIs on total excess deaths while controlling for city and week.

Results: School closures were associated with lower excess deaths 2 weeks after their implementation (-74.50, 95% CI: -96.81, -52.19). Public gathering bans were associated with lower excess deaths 2 weeks after their implementation (-53.55, 95% CI: -80.25, -26.84). Only 1 city implemented a quarantine, so the analysis of the effect of quarantines on excess deaths 2 weeks later was inconclusive (17.08, 95% CI: -48.16, 82.32). Business limitations were association with lower excess deaths 1 week (-41.03, 95% CI: -68.89, -13.16) and 2 weeks after their implementation (-39.82, 95% CI: -67.93, -11.71).

Conclusions: School closures, public gathering bans, and business limitations are all associated with lower excess deaths. School closures and public gathering bans have no significant association with lower excess deaths until they have been implemented for 2 weeks, while business limitations are significantly associated with lower excess deaths 1 week after they are implemented.

Careless Responding Identified More in Older Children and Minorities; Multiverse Analysis Reveals Stronger Correlations When Removing All Careless Responders

By:
Audrey Filonczuk
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Other Contributors:
Teresa Ober

Abstract:

Students completing a survey may respond carelessly, answering randomly or inattentively, often without properly reading the question. Removing careless responders from survey data may improve the validity of the measure, since we are excluding meaningless responses. Our data was collected from a survey administered by the Curated Pathways to Innovation (CPI)™ application. The mission of CPI is to educate girls and other underrepresented minorities in STEM fields while encouraging them to pursue jobs in computer science. In order to evaluate the efficacy of the use of CPI in achieving this aim, establishing some evidence of validity from meaningful survey responses is imperative. The sample comprised middle and high school students (N = 551; Mean age = 12.4 years, %female = 43.0) who were administered a baseline survey in fall 2018. After detecting carelessness using five methods - a validity item, intra-individual response variability (IRV), straightlining, Mahalanobis Distance, and synonymous item correlations - a multiverse analysis was conducted, comparing various combinations of careless response indicators as metrics for removal from the data set. Only one combination (removing all responders who were indicated as careless by at least one method) proved to significantly strengthen the stereotype-scale correlations. A chi-squared test was used to test for independence between removal for careless responding and various demographics such as age, gender, race/ethnicity and English-as-a-first-language. We aimed to highlight whether certain groups of students are not particularly engaged with the survey and, thus, not providing accurate responses, while also ensuring that we are obtaining honest perceptions from the minorities whom the CPI aims to serve and not removing them at a disproportionate rate. Careless responding was found to be significantly dependent on each of two variables, age and race/ethnicity, but on neither gender nor spoken language. Based on this result, older children tend to be more careless on the survey, as well as Hispanic/Lantinx students. These results may indicate that these groups are less interested in the survey material or feel that subjects such as stereotypes or attitudes toward math are not imperative to report.

The humanizing effect of white protesters on newspaper articles related to BLM protests

By:
Susana Guerrero
Center for Research Computing

Faculty Advisor:
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Department of Psychology
St. Mary's College

Abstract:

The murder of George Floyd, a 46-year-old black man in an act of police brutality sparked protests throughout the world. The coverage that the media offers in situations of uncertainty such as this one, can have a great effect on how Americans perceive further issues. This study seeks to explore the portrayal of protesters of the Black Lives Matter movement in newspaper articles through the use of humanizing and dehumanizing words. We predict that as the BLM movement gained traction and more white protesters joined, newspapers across the political spectrum started portraying protesters as more "human" than at the beginning of the protests.

A random sample of 24 newspapers across the political spectrum, from representative regions of the United States, was used to analyze the words used to describe protesters affiliated to the Black Lives Matter movement. After conducting a two-way ANOVA test for the effect and interaction of the time point of the articles and political bias of the newspaper, this study found that articles across the political spectrum written during stage 2 had a significantly different amount of humanizing words compared to articles written in stage 1, showing that the increased presence of white protesters is related to newspapers using more humanizing language. However, it was also found that there was no statistical difference between humanizing and dehumanizing words across Conservative, Moderate and Liberal newspapers, showing that the political affiliation of a newspaper is not as influential in their use of humanizing language, as the time point is.

Determining psychological predictors for attrition rates in surveys measuring the longitudinal effectiveness of an intelligent learning platform on STEM persistence in underrepresented populations

By:
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Other Contributors:
Teresa Ober, Meghan Coggins, Audrey Filonczuk, Maya Mosely, Eliana Sanchez

Abstract:

Curated Pathways to Innovation (CPI) is a web based, intelligent learning platform for middle and high school students designed to foster interest in and provide educational resources towards participation in STEM fields, and more specifically computer science, among women and racial and ethnic minorities who are historically underrepresented in these areas. This is particularly pertinent considering the growing demand for an internationally competitive STEM workforce enabled only by fully leveraging the potentials of the nation's diverse talent pool. Since its deployment in 2016, crucial to the assessment of CPI's effectiveness on STEM interest and persistence in unrepresented populations lies in longitudinal analyses made possible by a series of surveys administered before and during student usage on the CPI platform. With an attrition rate of over 50 percent from the original baseline survey administered to middle schoolers (N = 467, Mean age = 12.43) in September 2018 prior to interacting with the platform to the four follow-up "pulse" surveys taken during CPI usage in December and then February, April, and June the following year, it must be ensured that the subset of students taking pulse surveys, upon which longitudinal analyses will be conducted is representative of the greater sample of students interacting with CPI. Specifically, this study asks whether initial interest towards a STEM career, attitudes towards mathematics, comfort and experience working with computers, and engagement in math class reliably predicts student survey taking behavior and overall attrition rates. Having confirmed the operationalization of these predictors through factor analysis, out of four total pulse surveys, a logistic regression revealed STEM career interest, math attitudes, and math class engagement to each be significant predictors for no more than one survey ($p < .05$). Each predictor was significant for a different survey, suggesting the respective significance of these factors may not be so robust. On the other hand, computer usage predicted survey taking for surveys taken in December, February, and April, with students reporting greater initial comfort and enjoyment working with computers being more likely to take the follow up surveys. The total number of surveys a student took was also reliably predicted by computer usage in the same direction, as well as marginally by math class engagement. This suggests survey taking to be a self-selective process, and that caution must be taken in using these surveys for longitudinal analyses testing for platform effectiveness. As survey behavior may be related to overall platform engagement, further research must be done to see if these predictors modulate engagement as well. Finally, inconsistencies in the results between surveys may indicate differences in how they were administered and calls into question the issue of creating standardized administration protocol, both to decrease variation in self-selection as well as the overall attrition rate.

Positive Attitude Heightens Emotional Intelligence

By:
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Other Contributors:
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Priscila Moreira, Evan Brinckman, Adam Czajka

Abstract:

Having a positive attitude has been linked to various beneficial health outcomes including stress relief, improved immunity, and overall wellness. Additionally, emotional intelligence--otherwise known as emotional quotient or EQ--has been increasingly recognized as an important indicator of health. However, less is known about the impact of attitude on EQ. Therefore, the purpose of the present study was to investigate the effects of self-reported attitudes (positive, negative, and neutral) on EQ, which, in this context, is defined as emotional self-awareness, or the ability to identify emotions in ourselves and others. Previous research by Bashivan et al. (2019) suggested that novel images generated through artificial neural networks (ANNs) can be used to influence brain activity in macaque brains. ANNs are multilayer machine learning tools used to extract, recognize, and apply patterns. Extending this research, the present study used images transformed through ANNs to evoke emotional perceptions. Participants were recruited and assessed using sub-scale scores on the Discrete Emotions Questionnaire (DEQ; Bastian et al., 2016). These perceptions were then compared to participants' self-reported attitudes through an ordinal regression analysis in R. When presented with novel images, it was found that across all emotions, participants with positive attitudes had a greater range of emotional perceptions compared to those with negative or neutral attitudes. These results suggest that cultivating a positive attitude may be key in developing emotional intelligence and, therefore, leading a healthy life. However, further research is needed to discern whether positive attitude heightens emotions themselves, or, rather, one's awareness of the emotions. Additionally, further research is needed to clarify the direction of the relationship between attitude and emotions.

Attitudes Towards Computer Programming: An Analysis of Background Experiences

By:
Eliana Sanchez
Center for Research Computing

Faculty Advisor:
Dr. Ying Cheng
Department of Psychology
College of Arts and Letters

Other Contributors:
Teresa Ober

Abstract:

According to the National Science Foundation, women and underrepresented minority groups (URM) - Blacks/African Americans, Hispanics/Latinos, and American Indians/Alaska Natives- are currently underrepresented in the science and engineering field. While their participation is growing, these groups are still underrepresented in educational attainment and the workforce. The Curated Pathways to Innovation (CPI) app is helping bridge the gap between underrepresented groups and STEM+C education beginning their middle school years. The CPI app is meant to expose and increase students' interest and motivation in STEM+C, and has been successful in doing so. Before coming into any program, students enter with a preconceived notion of what STEM+C is and what it entails; this perception already shaped by their surroundings and lived experiences.

While every student's experience is different, there exist barriers that prevent them from experiencing STEM+C, such as access to technology or previous experiences in STEM+C activities like clubs or outside classes. This study looks into how these background experiences -gender, access to technology, and extracurricular activities- affect students' perception of STEM+C after the CPI program during the 2019-2020 academic year. Based on students' completion of a baseline and pulse survey (N=171; mean age = 12.01 years; 44.7% female = 72, URM = 73%), this study was able to assess whether being a part of an underrepresented group, in this case being female, access to technology or previous extracurricular experiences affected the impact the CPI program had on students. A paired samples t-test revealed no significant differences from the beginning of the year to the end of the year, $t(134) = -1.24$, $p > .05$. Moderation analyses were conducted to examine whether the association between students' self-perceptions of themselves as capable of learning computer programming in fall (September) and spring (March) of the academic year was influenced by these factors. There was a main effect of students' self-perceptions measured at the baseline for all factors ($p < .05$). This indicated that students with more positive self-perceptions at the baseline tended to have more positive self-perceptions as measured on the pulse survey. However, no evidence was found that these factors had an effect, or moderate an effect, on students' self-perceptions ($p > .05$). As such, these findings suggest the impact the students had from the program did not vary based on any background experiences. This study provides a basis for exploring the interaction between students' perception of STEM+C and other aspects of their life.

Continuous Diafiltration Membrane Cascades for Lithium-Ion Battery Recycling

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Abstract:

Diafiltration is a continuous operating strategy for staged-membrane cascades, wherein dialysate is strategically added to offset concentration effects and achieve recovery of high purity and high value products. Although common for niche separations in industry, few studies have systematically analyzed multi-stage diafiltration processes. In this presentation, we introduce a novel modeling and superstructure optimization framework to elucidate optimal multi-stage process configurations with complex recycle strategies. As an illustrative example, we consider the separation of lithium and cobalt ions for battery recycling. This model reveals that diafiltration methods can compete with industrial separation processes with fewer than ten stages. The solutions found from the full optimization of this superstructure model are then compared to a subset of more constrained solutions, which limits the flow profile to follow the typical countercurrent flow across equilibrium stages as modelled by the Kremser equation for distillation columns. These Kremser solutions for the diafiltration system reveal the importance of having multiple stages to achieve high purity through staged-membrane cascades. Finally, we discuss the planned extensions of the proposed work into a full molecules-to-systems framework for integrated molecular engineering of new materials.

Molecular and process design framework for the separation, recycling, and reuse of hydrofluorocarbon mixtures

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Abstract:

Chlorofluorocarbon (CFC) refrigerants have been gradually replaced by hydrofluorocarbons (HFCs) to prevent ozone depletion, as mandated by the 1987 Montreal Protocol. A downside of these second-generation HFC mixtures is that they have a high global warming potential (GWP) and the 2016 Kigali agreement ordered their gradual phase-out. Due to the often azeotropic compositions of these HFC refrigerants, existing separation methods for removing high GWP components are currently infeasible or impractical. The goal of this project is to develop tools and processes that enable the separation of high and low global warming potential HFCs. An integrated molecular and chemical process design framework is being developed to engineer novel ionic liquid based HFC separation technologies. To achieve this, we first conducted molecular simulations to compute the density of four different ionic liquids using the Cassandra Monte Carlo modeling package and compared them to experimental data. Next, we simulated the ionic liquids mixed with R-125, R-32, and R-22 to determine the solubility of HFCs in ionic liquids. We optimized these solubility simulations by evaluating multiple cut-off and insertion parameters for each system to minimize CPU time consumption. Finally, to predict the azeotropic behavior of HFC refrigerant mixtures we are using the Gibbs Ensemble Monte Carlo method to predict the Vapor-Liquid-Equilibrium curve of an R-125/R-32.

Dehumanization of Black Victims of Police Violence in News Media by Gender & Political Bias

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Abstract:

The purpose of this study is to broaden the research done on the subject of the dehumanization of Black people in news media, specifically Black victims of police violence. As society becomes more technologically connected, it is becoming more likely that the everyday Americans will get their news from online sources, therefore it is crucial for us to examine the language being used in online news reporting. We analyzed articles reporting on the deaths of two Black victims of police violence, Atatiana Jefferson and Botham Jean, from sites that were chosen based on their political bias (conservative or liberal). We then randomly selected two articles from each source on each victim to analyze using a word mining software that we used to assess humanizing and dehumanizing language. We hypothesize that the right leaning news media will dehumanize Black victims more, and that left leaning news media will humanize the Black victims more. We also hypothesize that the male victim will be more dehumanized, and the female victim will be more humanized. We hope that this study will contribute more to the knowledge of this topic that is so relevant and important in today's society.

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