Journal of Dawning Research

Selected Abstracts from the New York City Science, Technology, Engineering, and Mathematics Fair

The Terra New York City STEM Fair

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Mission: The New York City (NYC) Science, Technology, Engineering, and Mathematics (STEM) Fair's mission is to celebrate and highlight the innovation of NYC's high school scholars conducting STEM research and foster connections.

About Us: Terra NYC brings together teachers, parents, school leadership, mentors, and most importantly, passionate, motivated, and talented young people creating an undeniable, expansive impact on the STEM landscape of New York City. Sitting in a unique position between education and career exploration, these groups converge at a STEM event that fosters and supports an air of excitement around research and science communication. Our work with teachers aims to support their work in cultivating student research within and outside of traditional laboratory settings by elevating demonstrations or simple classroom activities to high-level research projects. The NYC fair has been operating for more than 60 years, and since 2008, more than 5000 students between the ages of 14-18 have participated. Many of these participants have gone on to impact the world in important ways, such as doing medical research in infectious diseases and educating at both pre-college and college levels. One student founded a robotics company, designing a robot that won a best-in-category award at ISEF and is now being used by surgeons.

The NYC STEM Fair is the only high school science research exhibition event in the five boroughs that is affiliated with the Regeneron International Science and Engineering Fair (ISEF). The winners, the NYC ISEF Finalists, advance to represent the region at the Regeneron ISEF and compete with 1,800 students from around the world. We provide a channel for students during their tenure in high school that populates and generates momentum into STEM academic pathways and career trajectories. Terra NYC is the first step for many students on the path to STEM careers. They explore their passions and establish connections that will help them become tomorrow's leading visionaries.

Probing Ever Deeper and Ever Older in Golema Pešt, North Macedonia: Pleistocene Sedimentary Analyses for ESR Dating Upper-Lower Paleolithic Deposits

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Abstract

A cave 31 m long and 18 m wide, Golema Pešt is a Paleolithic archaeological site near Zdunje, North Macedonia. The cave sits 480 m amsl overlooking the Treska River valley. Reaching > 5.5 m deep, > 21 flatly lying layer silty-sandy matrix-supported gravel layers with éboulis clasts fill the cave. Electron spin resonance (ESR) can date teeth from the whole Paleolithic, but require accurate sedimentary dose rates, especially in caves where internal and cosmic dose rates can approach 0 mGy/y. Compared to typical cave sediment, cryptotephra-rich horizons usually contain high U, Th, and K concentrations, which significantly raise their sedimentary dose rates, while éboulis-rich horizons have very low radioactive concentrations. To find the radioactive concentrations and individual sedimentary dose rates at Golema Pešt, > 125 sedimentary samples from Layers 1b-20c in Trenches 1, 2, and 5 were crushed to 50-100 mesh and analyzed by NAA. Found first in Trench 2b, the Campanian Ignimbrite (CI) cryptotephra has now been identified in Trenches 1, 2a, and 5 at 193-202 cm below datum. New horizons that may be rich in cryptotephra were discovered at approximately 213-219, 222-235, 238-253, 248-254, 257-264, 455-465, and 420-445 cm deep below datum. In Trench 5, new potential cryptotephra-rich horizons lay at 180-182 and 190-193 cm deep below datum. The presence of cryptotephra in these layers still must be confirmed by microscopic analyses. Using these new individual sedimentary dose rates will increase the precision and accuracy in the calculated ESR ages for all the teeth from Golema Pešt.

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Conceptual Design of Small-Scale Martian Reconnaissance Gliders, Accelerating Martian Exploration

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Abstract

Modern aircrafts such as drones have been used in aerial surveying since 1935. Unlike the Earth, Mars has a very thin atmosphere and thus poses many constraints, such as requiring a large wing area to compensate for the low density of the Martian atmosphere. A small-scale, reconnaissance glider comes with high maneuverability and presents the potential for taking high-resolution images and data in dangerous locations such as canyons, ridges, or valleys of less than a couple of kilometers in diameter. Furthermore, these small-scale gliders can also sense the concentration of methane gas in these locations which is crucial in determining their possibilities of becoming a future Martian base. These small-scale gliders have a total wing area of 0.1 m2, an operation time of at least 613.5 seconds, and are designed to be deployed from the NASA ARES Mars Airplane at 2.41 km. All in all, these gliders are cost-effective, and their applications extend to numerous studies.

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Testing the Validity of a Modified Rapid Species Conservation Assessment Method on the Plants of Jamaica

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Abstract

Plants and plant diversity are vital to the survival of all life on Earth and yet human action has resulted in their continued decline. In an effort to combat the decline we need to determine the conservation status of each plant species so we can watch for changes in their populations. The current method of assessment is the International Union for Conservation of Nature (IUCN) Red List method which determines the status through two criteria. This method often results in plant species being categorized as Data Deficient. The new method of determining this status is the NY method which only uses IUCN's Criterion B to determine conservation status. This project takes a modified version of the NY Botanical Garden method (NY method) and assesses 214 plant species of Jamaica and compares it to the conservation status of plants in the IUCN database. This method resulted in a 14.45% overlap out of the 91 species able to be assessed. But it also resulted in 42.52%, 91 out of the 214 species, to be assessed meaning that this modified method could be used to give a preliminary assessment to the 90% of plants that are still unassessed.

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Introducing a Live Tutor After the Sensitive Phase Improves Song Learning in Zebra Finches Trained by an Artificial Tutor – a Pilot Study

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Abstract

Zebra finches may help bridge the gap in understanding developmental vocal learning in humans. Both species share many parallels in their vocal development, one of which is how vocal development is limited to a sensitive phase during early life after which improving upon learning is difficult. Previous studies show that the extent of song modification after the sensitive phase in zebra finches depends on song model availability and levels of social deprivation experienced during vocal development. Birds without song models or in social isolation tend to modify their crystallized songs more than birds in appropriate learning conditions. Live tutors typically result in pupils developing more accurate imitations. In this pilot study, I tested whether song learning in socially isolated birds trained with an artificial tutor can be extended beyond the sensitive phase by introducing a live tutor. Two birds who failed to learn the artificial song were given live tutors singing a similar song to the artificial model. I tracked changes in the pupils' song after the live tutor introduction in comparison with an artificially trained bird who remained socially isolated after the sensitive phase. Birds who received a live tutor made significant changes to the syllable set, structure, and syntax of their song. Most of these changes increased their song's similarity with their tutor's song and were more pronounced than those of the control. These preliminary results suggest that a late introduction of live tutors could extend the sensitive phase for vocal learning in zebra finches.

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Impact of sewage-related floodwater on the relative abundances of bacterial genera deposited on sidewalks

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Abstract

Combined sewer systems found in cities like New York City collect and convey both stormwater runoff and sewage water in a single system. During high-intensity rain events, these systems may become overburdened and backlogged, resulting in street-level flooding. This flood water can contain sewage and its contaminants, potentially including fecal-related bacteria. To explore the effect that such flooding might have on the microbiome of impacted urban surfaces, swab samples were collected from the sidewalks of two locations in Gowanus, Brooklyn: one in an area prone to street-level flooding and the other in an area not expected to experience such flooding. Bacterial DNA in these swab samples was extracted and sequenced in order to characterize the bacterial communities of the two locations. The relative abundance of different bacterial genera in the two locations was determined. Our study also compared the percent differences of the top genera of bacteria from each location, and provides insight on the potential impact of these bacterial genera. One of the study's main findings was that samples collected from the flood-prone location had a higher relative abundance of fecal-related bacteria, such as E. coli and Enterococcus spp. This observation indicates the potential for human fecal bacteria to deposit on urban surfaces after sewage related flood events.

This research is essential as flooding is on the rise due to climate change. With more frequent heavy rainfall events, we can expect to see an increase in the frequency of discharge of sewage water directly to the environment. This research will help elucidate the possible risks of potentially harmful bacteria deposited on inundated surfaces. The ultimate goal of this research is to bring attention to and motivate public health interventions addressing the potential risks of combined sewer flood water on the urban environment.

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Transcriptome Analysis of Muscular Dystrophy in Vertebrate Models

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Abstract

Muscular dystrophies (MD) are a group of diseases that detrimentally affect the lives of individuals around the world. One of the most understudied muscle dystrophies is GMPPB-associated MD, resulting from a mutation in the GMPPB gene. GMPPB along with 15 other genes are involved in the glycosylation of dystroglycan. When examining public mice data on LARGE/DMD MD, we established that glycosylation genes play an important role in these MDs because 5 of these genes were significantly differentially expressed. We examined a gmppb mutant zebrafish dataset containing two time points and two severities of disease, to model patients with varying ages of onset and phenotypes. Since few of the glycosylation genes were significant, we looked into genes shared between time points that had significant ontologies. Genes related to creatine kinase and ATP production, including *eno1b* and *ckmt1*, had similar patterns in regulation, while the MMP and collagen families were inversely regulated. Specifically, *eno1b* and *ckmt1* are both upregulated in 4dpf severe and downregulated in 7dpf severe. Since they are connected through ATP production, this suggests that the two genes may play a significant role in MD. The MMPs were upregulated at both time points, but the collagens were downregulated first then upregulated, suggesting that perhaps the collagens were overexpressed in response to the MMPs, since we know they are connected through the extracellular matrix. Our novel findings not only pave the way for future research, but also provide a deeper understanding of GMPPB-associated MD, which is greatly beneficial for future treatments.

Acknowledgements: The Henry Lab at the University of Maine provided the GMPPB-mutant zebrafish data. Grant money was provided by the University of Maine seed grant, "Muscle and Healthspan Collaborative". The paper, Comparative Transcriptome Analysis of Muscular Dystrophy Models Largemyd, Dmdmdx/Largemyd and Dmdmdx: What Makes Them Different?, written by C.F. Almeida, P. C. Martins, and M. Vainzof, provided us with the LARGE/DMD data set. We thank Dr. J. Davis, and Mrs. J. Cavaliere from the Science and Engineering Research Program for providing guidance and insight.

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Neophilia and responses to novel enrichment in captive endangered thick-billed parrots

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Abstract

Enrichment is used by zoos and other institutions to promote natural behaviors and increase animal welfare by allowing captive species to carry out behaviors they typically would use in the wild. Individual animals have distinct personalities, and that may suggest particular enrichment preferences. The ability to provide targeted enrichment for specific individuals could not only increase animal welfare, but also contribute a layer of ecological preparation in reintroduction programs. Rhynchopsitta pachyrhyncha, the endangered thick-billed parrot, has been the subject of conservation efforts in captivity such as breeding and reintroduction programs. This study aimed to determine how personality and novelty impact the interactions of individual thick-billed parrots with various enrichment items by comparing two novel object trials, two baseline enrichment trials, and a novel enrichment trial. We observed individual differences in tendencies to approach, interact, and feed in novel and baseline conditions as well as variation in other behaviors across trials. In the novel enrichment condition there was a strong negative correlation between individuals' latencies to approach the one-meter perimeter of the enrichment and the durations of their interaction with it (Spearman's Rank = -0.882, df = 8, p = 0.002). In this study, the novel enrichment promoted the most interaction and largest variety of behaviors, as the subjects engaged in foraging behaviors in a novel condition. Better understanding how individuals balance risk behaviors in situations where food is available could help researchers to predict feeding behaviors, such as foraging, that are crucial for success in reintroduction programs. As adding a component of novelty with feeding opportunities garnered larger participation in enrichment sessions, this information is important in planning training for individuals in reintroduction programs. This study and the potential implications of assessing the individual effectiveness of enrichment in general can be important for managing endangered species in captivity and future efforts to promote the conservation of wild populations.

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Correlation between Odor Composition and Neuron Response in the Olfactory Cortex of Mice

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Abstract

The olfactory system, or sense of smell, in mammals is highly important in stimulus recognition, memory formation, and even social cooperation. It is also highly specific, with the human olfactory system able to recognize over 1 trillion odorants. One of the biggest questions scientists have is how the olfactory system is able to recognize and distinguish between so many odorants. What makes this question particularly challenging to answer is the olfactory system's lack of topographical organization. Brain topography is the idea that nearby stimuli make neighboring neurons active. Brain maps have been described for most senses. Surprisingly, olfaction is an exception. Transmissions to the olfactory cortex are randomly mapped, so it is unclear how odors are distinguished. I hypothesized that the chemical nature of odors give rise to topography in the cortex. To test my hypothesis, I used data gathered by Prof. Murthy's team at Harvard University. I recorded over 2,000 neurons from the three main parts of the olfactory cortex. Data was collected from 10 mice, stimulated with a panel of 15 odors. I categorized each odorant based on various chemical traits, and then compared each odorant to determine how many chemical traits they shared. I then compared this to neuron response similarities across all odors and plotted the various parameters together to determine if there is a correlation between chemical similarity and neuron response similarity. I found no such correlation, which then beckons new questions into what other variables might play a role in odorant distinction.

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The Effect of Culture on Adolescent Mental Health

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Abstract

Representation of diverse cultures remains insubstantial in psychotherapy as alternative treatments are often omitted from patient care. In relating culture and mental health, this study intends to identify cultural stigmas against mental illness and demonstrate the need for improved cultural representation of the mentally ill. Relationships between religion, ethnicity, and language with mental health stigmas, self-expression, and treatments were found to be statistically significant. Non-Western cultures embrace broader perspectives on mental health and alternative treatments but not psychotherapy. Muslim and Christian adolescents alongside those of Chinese and South Asian descent are more likely than other groups to retain these broader perspectives on mental health. Jewish participants hold limited perspectives on mental health, yet are receptive to psychotherapy when mental health professionals are of the same race or culture for greater trust in alternative treatments. While Muslim participants recognize stigma against mental health, expression of mental distress remains limited for fear of scrutiny. They are receptive to psychotherapy only if mental health professionals are not of the same race or culture. Trends identified among Chinese and Muslim participants often fluctuated for uncertain reasons. Dialect, for instance, could have affected these relationships. Atheists and Agnostics recognize stigmas against mental health and are more receptive to expression, psychotherapy, and alternative treatments than other groups, on average.

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18-Year Trends in Phytoplankton Blooms and Associated Physical Variables in New York and San Francisco Estuaries

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Abstract

Phytoplankton is a critical producer in aquatic food webs, but copious blooms can harm ecosystems through eutrophication. In northern urban estuaries, seasonal fluctuations in water properties encourage phytoplankton growth, leading to seasonal blooms. The current experiment aimed to analyze phytoplankton growth in the urban estuaries bordering the New York-New Jersey coasts and the San Francisco region. Remotely-sensed [Chl-a], FLH, and SST data was gathered, spanning the years 2002 to 2020, whereas remotely-sensed salinity data was available from 2015 to 2020. The medians of monthly data composites were the primary form of data analysis. Spring blooms, autumn blooms, and seasonal SST and salinity trends were expected. The study found that median [Chl-a] confirmed known blooms and confirmed the impacts of hurricanes on blooms, while FLH data raised questions regarding low FLH measurements during months of known peak phytoplankton activity. Remote sensing limitations may have impacted data. The data indicated an overall decline in phytoplankton, but the relationships between FLH and [Chl-a] were weaker than expected (r2 = .184 for NY; r2 = .254 for SF), conveying the need for additional studies. The greatest significant changes (p ¡ .05) in [Chl-a], FLH, and SST were only found in NY. Monthly SST values increased across the seasons in NY (0.04-2% per year) and SF (0.08-0.6% per year). High phytoplankton biomass was consistently found near coasts, which may experience more severe pollution than oceanic areas, highlighting the need for continued monitoring of NY bays and rivers and the San Francisco Bay area.

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Detecting Meteorites From Outside the Ecliptic Plane with Multi-messenger Astronomy

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Abstract

Meteorites can carry important information about the solar system and its origins. Unfortunately, there is no official network in the United States dedicated to finding meteorites after observing meteors. The availability of low-cost computers and cameras such as the Raspberry Pi has made it possible to create affordable meteor observing station networks that could be set up by Citizen Scientists. We investigate the basic design of such a meteor station and will use it to test the hypothesis that it is possible to identify materials that arrive at Earth from other planetary systems. Specifically, we will look for extrasolar meteorite candidates because they can offer pristine information about our area of the universe before the formation of the Solar System. At the present time, we have calculated the expected luminosities of fireballs in optical, infrared, and radio wavelengths and are in the process of building and testing elements of the system.

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Teenage Awareness on the Current Situation of Immigrants

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Abstract

Immigrants experience social discrimination and mental health repercussions. They face trauma, troubles with emotional development, and severe psychological disorders at rates greater than the general public. As a result of language barriers and bullying, immigrants have fewer paying jobs and job-related benefits such as insurance coverage compared to native born citizens. Despite these apparent issues, information regarding immigrants is fairly limited. This research aims to answer the questions of how gender, age, and living with recent immigrant family members ($t \leq 5$ years) impact the awareness of teenagers to the current situation of immigrants in the United States. A survey was administered to 121 participants via Google Forms consisting of 3 demographic questions and 21 statements regarding the topic of immigration. The mean percentages for the score between the 2 groups in each category were around 70%. T-test results showed that gender, age, and living with recent 5 year immigrants had an insignificant impact on the questionnaire scores. When assessing the 210 correlations between each question to see the possible trends, they were weak but significant. Health care statements had the highest intercorrelation with 7 other statements and such as those regarding medical care at $r = .440$. Results can help people advance their knowledge on different aspects of immigrant life and lead to possible improvements in the conditions of immigrants. This questionnaire is a replicable measuring tool that provides meaningful data while still maintaining coherence. Other researchers can accommodate for other immigration topics while still keeping research dimensions specific.

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Distinguishing Bacterial Motion Quantitatively: A Diagnostic Method for Intestinal Disease

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Abstract

Gastrointestinal illnesses afflict more than 100 million people in the U.S. alone and are often indicated by gut microbiota motility. Typically, swarming bacteria are indicators of infection while swimming bacteria are more innocuous. Current diagnostic methods for intestinal diseases are lengthy, expensive, non-specific, or lead to serious complications. This study proposes a novel way to diagnose Inflammatory Bowel Disease (IBD) through quantitatively distinguishing bacterial motion. Current methods of discerning bacterial motility involve only qualitative description without consideration of potential medical applications; no quantitative models to differentiate bacterial motility exist. In this study, a novel interdisciplinary diagnostic tool was developed that distinguishes swarming and swimming SM3 bacteria quantitatively for the first time. Photolithography was used to create PDMS sheets and microgears for studying both motilities. Software captured images for Particle Image Velocimetry (PIV) analysis for the calculation of Vortex, Nematic, and Polar Order Parameters, which were fed into a developed machine learning algorithm; accuracy was analyzed to ascertain the importance of each variable in motility distinction. VOPs were used to generate a Vicsek model for differentiating swimming and swarming, which demonstrated the importance of cell-cell alignment force in motility distinction — the model yielded high and low VOP values for swarming and swimming respectively. Studies of motility on intestinal tissue supported modeling trends from prior PIV analysis on agar. This novel tool can be tested in a variety of intestinal diseases to provide a preliminary diagnosis, operating more economically, efficiently, specifically, and safely than conventional procedure.

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Searching for Ultra-Short-Period Planets using a Deep Neural Network

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Abstract

Ultra-short-period (USP) planets are rare Earth-sized planets with the shortest possible orbital periods of all planets in existence. The study of this group is extremely important to theories of planet formation, especially given the scarcity of ultra short period samples in circulation at present time. However, traditional methods of USP detection have proven to be inefficient, time-consuming, and imprecise. For the first time, we introduce a novel Deep Convolutional Neural Network (CNN) specifically trained and developed with the intent of searching for USP planets. The CNN yielded several promising candidates for new USP discoveries, among them planets KID 5446285 and KID 7294743, two of the first USP candidates to be discovered through the use of a neural network method. In our paper, we present novel, more efficient, and more accurate methods of exoplanet detection which can also be applied to other interesting planet populations beyond USPs. The streamlined routine we have developed through machine learning and GPU parallel processing has dramatically sped up the processing and analyzing of hundreds of Kepler light curves, reducing the total processing time from three to four days to only a couple of hours, enabling vast advancements in exoplanet research and detection. We also discuss how further adjustments can be made, making this system even more efficient and powerful.

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Water Quality in New York based on Levels of Chlorophyll A

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Abstract

The photosynthetic pigment chlorophyll a is often used as an indicator of phytoplankton biomass in bodies of water. Levels <5 μg/L are considered healthy, and >20 μg/L are unhealthy. This study investigated the water quality status of different regions in the New York Harbor region based on levels of chlorophyll a as reported by a long-term monitoring data set from the New York City Department of Environmental Protection (NYC DEP). It is hypothesized that water quality levels will have improved since 2017. To test this hypothesis, every reported sample was assigned a grade based on a scale where less than 5 was best, 5-10 was good, 11-15 was fair, 16-20 was poor, and greater than 20 was the worst. To find the average grade of the location, each individual grade was assigned a numeric value where best was 1, good was 2, etc. Then locations were grouped into regions to assess regional water quality health. The average of these grades was used to determine the overall grade of the region. Our results indicated that the best water quality was in the Hudson and East Rivers, and the most degraded water quality was in Jamaica Bay. The East River, which is not as well-flushed as the Hudson, has indeed improved since 2017, when it scored a "failing grade" of F. Jamaica Bay, also a dead end canal, has not improved and retained its status as the most degraded site. Overall, chlorophyll a levels in the harbor have improved since 2017, indicating some gains in water quality management.

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Crater Correlations: A Morphological Analysis on Lunar and Mercurian Simple Impact Craters

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Abstract

Impact cratering is the circular depression byproduct of meteorite collisions on a solid celestial body. Impact craters are important geological and geomorphological features that not only may have a commercial impact, such as reservoirs of ores, but also are pivotal for studying terrestrial geology, comparative paleontology, and other scientific pursuits and investigations. It was hypothesized that Mercurian craters (1) are shallower due to quicker landform degradation and topographical evolution on Mercury than on the Moon, and (2) have smaller ejecta radii on average when compared to Lunar craters due to the Moon's smaller gravity. Data was collected from NASA's Mercury Surface, Space Environment, Geochemistry and Ranging spacecraft (MESSENGER) and the Lunar Reconnaissance Orbiter (LRO). From ACT-REACT planetary interfaces, the depth, diameter, and ejecta radius of simple impact craters were measured via the respective body's QuickMap, then subjected to a linear regression analysis. It was found that between the two celestial bodies, the sequence from most to least familiar correlations was the crater depth vs diameter relationship, followed by the ejecta radius vs crater diameter relationship and the ejecta radius vs crater depth relationship. On average, it was found that Mercurian craters are shallower, supporting the first part of the hypothesis, and that Lunar ejecta radii are smaller, refuting the secondary hypothesis.

Acknowledgements: The Applied Coherent Technology (ACT) Corporation provided the Lunar and Mercurian ACT-REACT QuickMap planetary interfaces utilizing data from NASA's Mercury Surface, Space Environment, Geochemistry and Ranging Mission and Lunar Reconnaissance Orbiter Mission. We thank Katherine Cooper and Susan Brustein for their support.

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Utilizing Hydrostatics to Describe the Paleoecology of *Orthoceras*, an Extinct Fossil Nautiloid

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Abstract

Orthoceras is an extinct genus of orthoconic Nautiloids that are characterized by a straight, conical shell. These inhabited deep seas about 450 million years ago, and are related to modern cephalopods, such as the *Nautilus*, octopus, and squid, which are keystone species in decline. These elusive species are often hard to study as a result of the depths they inhabit, and paleoecology can thus be an efficient alternative to protect these species from extinction. This project intends to determine the extent to which mathematical models and principles of fluid dynamics and hydrostatics can be used to determine and describe the paleoecology of the genus *Orthoceras*. It is hypothesized that the *Orthoceras* would have a horizontal living orientation, and would use water in a system of jet propulsion to move, as a result of present similarities between *Orthoceras* and the extant *Nautilus*. To test the hypothesis, Pyplot was used to create contour plots to find average measurements of the animal for which neutral buoyancy was possible in order to generate a hypothetical *Orthoceras*. A vertically-sliced shell of the species, *Nautilus pompilius*, was obtained and measured. Curves were generated for the septal thickness, positioning, and chamber size, relative to the shell diameter and thickness at each point; these were then used to plot septa on the hypothetical shell, and then find the size of other anatomical parts- the body chamber, shell, and phragmocone. A center of mass equation and center of buoyancy equation were created for the *Orthoceras*, and these were then used to calculate the stability index of the shells. Volumes of water were then added to the apex of the shell, which moved up the center of mass, eventually creating a stability index of 0 when the volume of water was about 470 cm^3. The increased stability of the shell with water supports the theory that orthocones pulled water into the apex of their shell through their siphuncle, and ejected it as needed to maintain buoyancy.

Acknowledgements: We thank Dr. John Davis from Staten Island Technical High School for his guidance throughout the project.

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The Effect of Antibiotics on the Eisenia Fetida's Ability to Adapt to Changes in its Environment

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Abstract

The extensive use of antibiotics at Concentrated Animal Feeding Operations (CAFOs) has led to an increase in antibiotics present in soil and water bodies. The purpose of this research was to determine whether the influx of antibiotics in the soil has had an effect on the ability of earthworms to adapt to changes in their environment. It was hypothesized the antibiotics would disrupt the activities within an earthworm's microbiome, leaving them more vulnerable to ecological disturbances and changes in environmental conditions that might arise due to climate change, given the vital role microorganisms play in an earthworm's digestive system. This experiment was conducted using 10 groups of worms, half of which were exposed to a broad-spectrum antibiotic used to treat cattle, with the focus being on Eisenia fetida worms. In addition, 8 groups were subjected to environmental conditions outside of their fundamental niche, including increased temperature and salinity and decreased moisture and pH. The results indicated that exposure to antibiotics does have a negative impact on the survival rate of E. fetida in soil with increased temperature and decreased pH levels but there was no such indication in soil with increased salinity and decreased moisture levels. Overall, these results do support the initial hypothesis but only to a certain extent. Expansions to this research could include an analysis of an earthworm's microbiome after exposure to antibiotics, an investigation of behavioral patterns in worm's treated with antibiotics, and a study of worm survival rates in a wider variety of environmental conditions.

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Modifying Structures of Hydropower Turbines Present in Impoundment Facilities to Reduce Damage Inflicted Upon Anadromous Species

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Abstract

Studies have shown that if everyone lived the way of the average American, humans would require approximately five planets to sustain all of the resources diminished annually. Several of the Earth's resources are finite, meaning that the Earth only produces a limited quantity and is subsequently unable to supply at such a rate where it can keep up with human consumption. Consequently, the resources cannot be recreated by individuals once they have been depleted. Generators are a backup source of electricity, and can be found in homes as well as in vehicles. However, they run on several non renewable resources, such as fossil fuels, including gasoline and petroleum. Dynamos that are powered from renewable resources, particularly water and wind, serve as a necessity as they allow for the production of electricity without exhausting any natural resources. While several hydroelectric dams such as the Hoover and Ice Harbor dams are notorious for their generators, they are known to have negative impacts on freshwater organisms during their migration through the dam. Migrating fish have a mortality rate of three percent due to the strong current of the water, which is produced by the turbines situated in the structure of the dams. It is hypothesized that if the number of blades on the water turbine is decreased, then the pressure of the flowing water will decline, therefore reducing the quantity of anadromous species injured amid fish migration. In contrast, the null hypothesis states that if the number of blades on the water turbine is decreased, there would be no noticeable difference to the quantity of anadromous species injured amid fish migration. This tentative explanation gives rise to an experimental question regarding the method in which water turbines can be modified to reduce the damage inflicted upon freshwater organisms during fish migration.

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CROTON: An Automated and Variant-Aware Deep Learning Framework for Predicting CRISPR/Cas9 Editing Outcomes

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Abstract

CRISPR/Cas9 is a revolutionary gene-editing technology that has been widely utilized in biology, biotechnology, and medicine. CRISPR/Cas9 editing outcomes depend on local DNA sequences at the target site and are thus predictable. However, existing prediction methods are dependent on both feature and model engineering, which restricts their performance to existing knowledge about CRISPR/Cas9 editing. Herein, deep multi-task convolutional neural networks (CNNs) and neural architecture search (NAS) were used to automate both feature and model engineering and create an end-to-end deep-learning framework, CROTON (CRISPR Outcomes Through cONvolutional neural networks). The CROTON model architecture was tuned automatically with NAS on a synthetic large-scale construct-based dataset and then tested on an independent primary T cell genomic editing dataset. CROTON outperformed existing expert-designed models and non-NAS CNNs in predicting 1 base pair insertion and deletion probability as well as deletion and frameshift frequency. Interpretation of CROTON revealed local sequence determinants for diverse editing outcomes. Finally, CROTON was utilized to assess how single nucleotide variants (SNVs) affect the genome editing outcomes of four clinically relevant target genes: the viral receptors ACE2 and CCR5 and the immune checkpoint inhibitors PDCD1 and CTLA4. Large SNV-induced differences in CROTON predictions in these target genes suggest that SNVs should be taken into consideration when designing widely-applicable gRNAs.

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Relations between Social Determinants of Health and Health Outcomes on Physical, Dental, and Mental Basis

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Abstract

This study intends to investigate the relationship between social determinants of health (SDOH) and health outcomes. Nine SDOH are examined, encompassing social, economic and environmental conditions. Nine health outcomes are also examined, which are selected with the intention of emphasizing prevalent diseases in the U.S. population today. Data utilized in this study is retrieved from the National Health and Nutrition Examination Survey, and data analysis is done in Excel using the logistic regression statistical package downloaded from the Real Statistics website. The study population is limited to adults who are 20 years and older. A binary logistic regression model is developed for assessing the relationship between each SDOH and health outcome. From the model, coefficients for the intercept and the independent variable are utilized to evaluate the probability of obtaining a poor health outcome. Other statistical measures like the Wald statistic, odds ratio, chi-square test, and p-value are employed to further assess the significance of the logistic regression model developed. Overall, the results show that as the SDOH improve in terms of greater quality or magnitude (applicable for two independent variables), there is a decreasing probability of obtaining poor health outcomes. Thus, the relationship between SDOH and better health outcomes is proven with sufficient evidence. This conclusion suggests the need to invest in public policies to improve social, economic, and environmental conditions for those are at risk of obtaining diseases.

Acknowledgements: This study cannot be completed without the guidance of Dr. Macrae Maxfield, who is the author's mentor. Therefore, a special thanks is given to Dr. Maxfield for his assistance and consistent feedback throughout this process. The author would also like to acknowledge the Alumni Foundation at Brooklyn Technical High School for supporting research in the school environment and funding the Weston Research Scholars Program. The support of these groups of people allows the research described to happen and this paper to be produced.

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Predicting Secondary Structure and Disorder Patterns in Alpha-Synuclein Using a Novel Framework with Applications to Neurodegenerative Disorders

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Abstract

With visual modeling software USCF Chimera and the s2D method, a much more capable model of amino acid hydrophobicity and secondary structure characteristics of intrinsically disordered proteins (IDPs) has been developed. IDPs are proteins that have disordered or unorganized structures. This makes it difficult for researchers to predict the behavior of IDPs since they can vary depending on slight changes in structure. In particular, predicting secondary structures of IDPs is notoriously difficult, with many researchers denying the existence of patterns in the disorder of IDPs. IDPs are important in the field of neurology because they account for some of the most common neurodegenerative disorders in humans including Alzheimer's disease (AD), Parkinson's disease (PD), and muscular system atrophy. This project focuses on alpha-synuclein, a notorious IDP responsible for the synucleinopathies mentioned above. In AD, it is responsible for neuritic tangles and b-amyloid plaques, and more. To understand the alpha-synuclein protein, it is integral to understand the secondary structure, to make sense of the disorder, and predict disorder behavior patterns. For successful neurodegenerative preventing and stalling drugs, it is necessary to understand the intrinsically disordered structure of alpha-synuclein. The s2D method effectively does this generating a diagram describing disorder based on NMR chemical shifts to determine the statistical distributions of secondary structures with low error rates. Modeling of the amino acid hydrophobicity was done through the visual molecular dynamics program USCF Chimera in which the structure was manipulated for visualization purposes. Together, with a visual structure highlighting the hydrophilic more permeable areas of the molecule and a clearer understanding of disorder behavior in alpha-synuclein, this data can be used for drug research against the many neurodegenerative disorders alpha-synuclein and other IDPs are involved in.

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Compiling a Comprehensive Database of Food Security Indicators

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Abstract

This project involves collecting a database of open-sourced data to examine the full spectrum of the food security pipeline in order to drive research into accomplishing the United Nations' Sustainable Development Goals of eliminating hunger and ensuring global food security. The database contains food security metrics such as food prices, population counts, and the Integrated Phase Classification analyses for food security covering all countries tracked by the United Nations Food and Agriculture Organization (FAO). The database accounts for evolving crises such as the COVID-19 pandemic and increased frequency of extreme weather events, and incorporates text-based data streams from news and research sources to enrich current datasets and promote a holistic approach to analyzing food security trends. Future steps include deploying the database on an open-sourced platform for use by researchers and policymakers.

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Keeping an Eye on the Retinal Vasculature

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Abstract

Studying neurovascular diseases in humans is an invasive and complicated process. Recently, there has been linkage between the retinal vasculature and the cerebrovasculature. These vascular beds consist of similar neuronal, vascular, and glial cell types that give rise to the neurovascular unit (NVU). Thus, the retinal vasculature can potentially be utilized as a noninvasive and less costly approach to studying various vascular disorders that occur in the brain. In this study we analyzed the myogenic response in the pressurized ex vivo retina from transgenic mice. We found that as intraluminal pressure increased, blood vessel diameter decreased thus indicating the presence of a functional myogenic response ex vivo. This led us to conclude that studying the myogenic response and vascular autoregulatory process in the pressurized ex vivo retinal vasculature has the potential to build on and expand our current understanding of cerebrovascular mechanisms.

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The Effect of Flipped Learning on Scores for Different School Subjects

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Abstract

The purpose of this experiment was to see how flipped learning affects scores when looking at different subjects and if different subjects respond better to the flipped learning process. We hypothesized that flipped learning will have an overall positive effect and increase scores in all subjects. Specifically, we hypothesized that science would perform the best under the flipped learning method. Additionally, we hypothesized that the participants would prefer traditional learning as opposed to flipped learning. The four core subjects were tested for this experiment: English, Math, Science, and Social Studies. For each subject, a pre-test survey, practice questions, a Kahoot game, and a post-test survey were created and distributed to participants. The experiment tested a group of participants for four days for four weeks consecutively. The pre-test was distributed on the first day, the practice questions the second day, the Kahoot over Zoom took place on the third day, and the post-test was distributed on the fourth day. Scores from all tests were calculated. The data supported our hypothesis that flipped learning had an overall increase in scores for all subjects, the overall average score in the pre-test improved in the post-test. Our hypothesis on which subject would perform best in was supported because Science experienced the greatest percent increase with flipped learning. After completion of the experiment, our hypothesis on preference was not supported; participants favored flipped learning compared to traditional learning. In the future, the study can test the effect of flipped learning in different sub-fields of science.

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The Effects of Increased CO_2, Soil Acidification, and Drought on Aperture, Density, and Potential Conductance Index of Stomata demonstrated by Buckwheat Plants (*Fagopyrum esculentum*) and Pea-plants (*Pisum sativum*)

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Abstract

The preservation of plants deteriorating over climate change is critical for organisms that depend on them for sustenance. Within the plants, the stomata - pores specialized by parenchymatic cells - regulate 95% of gas and water network between the plant and its environment by modifying its size and density. However, the climatic fluctuations are challenging plants with environmental conditions of increased CO_2, drought, and soil acidification. Strikingly, less research on how stomata respond to said environmental factors warrants a study that explores the effect on stomatal density, size, and conductance in buckwheat and pea-plants. The experimental setup includes seven groups per plant: a control, two positive controls with increasing CO2, and four groups with increased CO_2 combined with soil acidification and drought. It was hypothesized that density, size, and potential conductance would all decrease and that climate change will ultimately lead to a progressive decline in the efficiency of plants to maintain homeostasis. Data was collected for a four-week period and it was revealed that both plants exposed to 700ppm and 950ppm CO_2 levels resulted in a substantial reduction in size and density as well as a patent degradation in plant vigor. A detailed formula was utilized to determine the potential conductance using variables like net assimilation rate. However, our presumption that climate change would lead to a progressive decline in all plants cannot be supported as our research only investigated C3-crop plants, not taking into perspective the other varieties of plants such as C4 and CAM.

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Behavioral changes of C. *elegans*: An *in vivo* experimental model for the study of JUUL's addictive potential

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Abstract

JUUL is a newly developed electronic cigarette that is gaining popularity among teenagers and young adults. Although nicotine has been proven to cause long-term health consequences and is addictive, there is a paucity of research testing the risks for addiction and detrimental effects of the JUUL. I devised a method of testing and analyzing how the decision making of *Caenorhabditis elegans*, a model organism, is affected by addiction to two concentrations of the JUUL solution. Thirty nematodes were tested in total: 6 were fed *E. coli* for 24 hours, 12 were fed *E. coli* and nicotine for 24 hours (6 with 3% nicotine and 6 with 5% nicotine), and 12 were fed E. coli and JUUL pod solution for 24 hours (6 with 3% JUUL pod solution and 6 with 5% JUUL pod solution). Thirteen out of 17 of the nicotine and JUUL addicted nematodes (those accounted for) chose to swim to a 3% JUUL cube of agar over an *E. coli* cube of agar when starving. These data suggest that JUUL solution affects the behavior of *C. elegans*, and JUUL addiction takes precedence over the basic instincts of hunger and survival. This experiment, which sheds light on the impact of the JUUL on the behavior of nematodes, can potentially serve as a model to study the effects of JUUL addiction on human behavior.

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Plastic, the New Invasive Species? Microplastics in Soil and its Effects on Potato (*Solanum tuberosum*)

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Abstract

Microplastics has become a gradually growing concern due to its ability to enter farmland soil from plastic wastes. Here, we investigated the effects of microplastics present in soil and how it affects the growth of potatoes using the most common plastics found in farmland soils. The potatoes were grown in 4 different groups with 1 control group that contained no plastics, and 3 groups that had varying amounts of plastics within the soil. The different plastics were cut up into pieces that were less than 5 mm in length and placed in a mixture of soil, fertilizer, and sulfur. Each group had 2 containers, and 3 seed potatoes were placed in each container. The height of each sprout stem was recorded each day after planting. When all the leaves turned brown, the potatoes were harvested and the masses of the potatoes in each group were recorded. Future works would include recreating this experiment in a more reliable environment, as well as using a different method to obtain smaller and more uniform microplastics.

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A Novel Differential Equations Based Methodology For An Exponential Rate Restoration Of Coral Reefs

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Abstract

Arguably the most detrimental global issue continues to go unheard of year after year; this issue being the drastic loss of coral reefs. Given that over 50% of coral reefs are destroyed with irreversible damage, it is crucial that a wider audience becomes aware of the effects that losing the coral reefs have on our evolving society. As of right now only marine biologists are aware of the matter that there is a consistent depletion of staghorn coral trees, the specific species of coral reefs in which I centered my research on. Although the deprivation of the coral reefs might not seem as though this affects the general population, as coral reefs continue to affect the surrounding ecosystems they further deplete plant and animal life, there is a decrease in tourism succession, job opportunities are lost, and food supply grows more scarce. Through the implementation of a differential parameter methodology and isolating the two enzymes in which would repair the coral reefs, the rapid growth of coral will then be recorded. No known procedure pre-exists to where coral reef regrowth is the main priority of the scientific discovery, heightening the absolute need for an outlined, scientifically proven methodology where staghorn coral will be consistently grown.

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Can dry and fresh *Carica papaya* (Papaya) and *Persea Americana* (Avocado) peels be used to remove oil contaminants in soil?

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Abstract

Oil carries itself into both the aquatic and terrestrial environment as pollutants through extraction processes or elements of discarded items. Exposure to oil negatively affects terrestrial life. With the widespread prevalence of oil spills, there have been persistently increasing inquiries for cheaper and more efficient oil absorption methodologies for inland oil spills. As a result, the development of efficient, environment-friendly soil purification processes has become ever-so-important. Owing to the multifunctional characteristics of bio-peels, biosorption is a promising alternative to conservative oil absorption strategies due to its environmental friendliness, efficiency, cost-effectiveness. Hence, the purpose of this study was done to examine the efficiency of dried and fresh avocado and papaya peels in the removal of oil in the soil. It was hypothesized that the dried peels would absorb more oil than the fresh peels. This was tested in trial 2 of the experiment. Trial 1 tested only fresh peels. In both trials, all groups were given 10 grams of soil while papaya groups got 3 tablespoons of vegetable oil and avocado groups got 3.5. This was done based on pre-trial runs conducted before the experiment began. In trial 1, the avocado groups absorbed slightly more oil than papaya peels did. In trial 2, dried papaya peels absorbed significantly more (*$p < 0.05$) oil than its control group. In future studies, more trials with more samples should be conducted. The study should also be conducted with better equipment and environment.

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Comparison of Three Monte Carlo-based Simulations of Light Propagation in Biological Tissue

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Abstract

The principle of Monte Carlo-based light propagation simulation has been studied, developed and used for biomedical optical imaging for years. Numerous software packages have been developed for different purposes, each having their own advantages and disadvantages. With the large variety of software packages, the process of selecting an appropriate one for a specific study has become crucial and difficult. Therefore, this project aims to compare three different softwares – Monte Carlo model of steady-state light transport in multilayered tissues (MCML), MCxyz, and Monte Carlo eXtreme (MCX) – with an end goal of selecting one to validate a phantom study for laparoscopy surgery where diffuse reflectance spectroscopy is used to detect underlying tubular inclusions. The performance of each model was evaluated based on a group of designed mediums. The merits and demerits, mainly focused on accuracy, efficiency and flexibility, were discussed. The Monte Carlo simulation package needs to be able to simulate light propagation in a heterogeneous tissue that has a subsurface tubular inclusion and yield accurate surface fluence distribution. With everything put into consideration, MCX was the best fit.

Acknowledgements: This research was conducted under the mentorship and support of Dr. Chen Xu from the Computer Engineering Technology Department at New York City College of Technology.

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A Eugenius Way of Anesthesia: The Effects of Natural Anesthesia on Earthworm Functionality and Behavior

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Abstract

Clove oil, *Eugenia caryophyllata*, has been implemented as a home therapeutic medicine for its anesthetic effects. This experiment aimed to find the best concentration of clove oil to effectively anesthetize earthworms without irreversible side effects. This insinuates the cruciality for patients to have a selection of natural anesthesia versus perioperative steroidal analgesics. Prior studies determined that general hydrocortisone anesthesia prompts retention loss, reduction in stimulus, and hindrance in wound healing. Additionally, clove oil can be considered as an antioxidant, anticarcinogen, and an efficient aquatic analgesic. The organisms tested were earthworms, *Lumbricus terrestris*, appertaining to their amiable complex neurological functionalities. The physical mobility and the stimuli response to a probe of earthworms were measured after clove oil immersion ranging from 1%-3%. It was hypothesized that concentrations less than 3% of clove oil would be able to tranquilize earthworms non-deleteriously. The results demonstrated that 1% and 3% concentrations were most effective in sedating whereas the 1% concentration was effective without inducing convulsions. Nevertheless, the 2% concentration and the 3% concentrations induced convulsions and hindered the vitality. The limitations of this experiment consist of not consistently regulating the temperature of the medium, so that it is constant. The future implications consist of more trials to validate the results and incorporating regeneration tests after surgery with clove oil. To conclude, the 1% concentration of clove oil immersion was found to be most effective to sedate without hindering the vitality of earthworms.

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Analyzing the Predictors of Sudden Infant Death Syndrome (SIDS)

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Abstract

Sudden Infant Death Syndrome (SIDS) is when a presumably healthy infant under the age of one year passes away unexpectedly due to an unexplained cause. SIDS is determined to be the cause of death once no other explanation is found after an investigation or autopsy. Since the start of the Safe to Sleep (formerly known as Back to Sleep) campaign in 1994, rates of SIDS have decreased dramatically but since then the rates of SIDS have plateaued. As of 2017, SIDS is the fourth leading cause of infant mortality in the United States. In 2017, there were 3,600 infant deaths due to SIDS. To determine the predictors of SIDS, data from CDC Wonder was analyzed. It was found that male infants have a significantly higher rate of SIDS. Infants of Native American or Alaskan Indian and Black or African American descent had the highest risk of SIDS. Asians had the lowest SIDS death rate. In the United States, infants in the Southern region had the highest risk of SIDS. Low birthweight and prematurity were also found to be strong predictors of SIDS. Further research needs to be conducted on the genetics behind SIDS to find the cause.

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The Impact of Covid-19 on Electricity Demand in the US

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Abstract

The COVID-19 pandemic has had serious economic consequences worldwide. It is important to examine the ways in which it has affected electricity demand in the US. Understanding the impact of lockdown policy on electricity demand can be useful to policy makers, helping them better predict recovery and design tools to boost the economy. To analyze the difference in electricity demand during the pandemic as compared to the demand it would otherwise have been in the absence of a pandemic, an artificial neural network model was created to predict the latter demand on a given day. It was found that the model predicted the demand in New York in a non-pandemic year with an accuracy such that R^2 was 0.91, the relative RMSE was 0.04, and the relative MAE was 0.03. The model qualitatively demonstrates COVID-19's impact on New York, showing significant decrease in demand from the predicted baseline between March and June, and is able to forecast long term demand with accuracy. Therefore, it may assist in decisions to change electricity production or balance the regional supply and demand, as they require long term planning.

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COVID-19 Disease Severity: A Comparison of Comorbidity and Societal Factors in the Underrepresented Communities

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Abstract

The mistreatment of Native Americans from past centuries has led to their standing as one of the most underserved ethnic populations, lacking basic necessities from healthcare to housing. With such a crisis in health equity, Native Americans are adversely impacted by wholly inadequate access to comprehensive health care, with higher rates of preventable diseases, including heart disease and diabetes as compared to their "non" counterparts. With the subsequent emergence of the COVID-19 pandemic, instilling a new illness in the worries of disadvantaged Native Americans, they've become the center front of devastation, with higher risks of infection and the status after it. And although the public health community is generally aware that there is a substantial burden in terms of illness from social factors, they're often excluded from policy discussion, sparking a necessity, especially from the data, to create more equitable advocacy for the minority group.

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The Effects of Autonomous Sensory Meridian Response (ASMR) on Memory Retention and Recall

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Abstract

Autonomous Sensory Meridian Response (ASMR) and its effects on people's emotions and behaviors is a fairly recent topic of study in the field of neuroscience. This experiment examined not only the type of ASMR, but also the delivery method on memory retention and recall. Research has shown that positive emotions enhance the processing of emotional stimuli and memory consolidation, involving other memory-related brain structures such as the hippocampus (Tyng et al, 2017). Therefore, we hypothesized that whispering ASMR, being the most popular ASMR trigger, would have the greatest impact on words recalled by participants. In addition, we hypothesized that over-ear headphones would be most effective in aiding memory retention because of its overall sound quality due to its structure and ability to cancel out external noise. To test this, we placed thirty-five participants into nine categories based on the type of ASMR (whispering, tapping, and crinkling) and the type of audio device (headphones, earbuds, and no audio device). The experiment lasted for three weeks, and participants were required to memorize a set of words before each session. A two-way ANOVA test was used to assess potential differences in the dataset. The probability value (p-value) for the ASMR triggers was 1.14% while the p-value for the audio devices was 4.02%. The probability of any of these results happening randomly is less than 5%, thus making the means statistically different. The data revealed that whispering ASMR and earbuds were the most effective amongst their respective groups since they resulted in the greatest increase of words remembered. From weeks one to three, whispering ASMR had the greatest percent increase in words recalled by participants of 38.80% and earbuds had the greatest percent increase by 40%. Based on the results, the hypothesis was partially supported, with the negation involving the most effective audio device. Possible sources of error included the lack of racial and gender diversity among participants and non-uniformity in audio-device groups. This positive connection between ASMR and memory suggested that it could be used as a studying tool or as a resource for memory-related activities. This experiment can lead to further research regarding the recent studies of ASMR, and can contribute to how ASMR impacts the brain.

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The Effectiveness of Laminaria Digitata on Mitigating Ocean Acidification Through pH Analysis

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Abstract

In recent years CO_2 levels have been rising worldwide, causing increased acidification of ocean water. Currently the average oceanic pH is 8, and while it is known that ocean water is naturally slightly alkaline, CO_2 emissions continue to rise and the ocean continues to absorb these emissions. This leads to a decrease in oceanic pH as it continues to become more acidic. The pH levels of the ocean have already fallen by 0.1 in the last 200 years. A 0.1 decrease may not seem drastic but consider the fact that the human body has a natural pH of around 7.4, and if it drops to 7.2 (just a 0.2 decrease) it may lead to death. A seemingly insignificant difference in pH level can have drastic effects on the human body, thus, the same can be considered when it comes to the ocean. Ocean acidification has already impacted many different forms of marine life and will continue to do so if no method is found to prevent the further acidification of ocean water. In the following experiment, Laminaria (kelp) was tested for capabilities of neutralizing the pH of ocean water. To combat the current ocean acidification conflict, recently, macro-algae have been in the spotlight for its capabilities of absorbing CO_2 from ocean water with remarkable results. Laminaria has proven to be particularly effective at absorbing CO_2 and restoring pH levels of ocean waters, justifying its use in this experiment.

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New Computational Model for Mitosis to Save Lives from Cancer

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Abstract

In this paper, I propose individualized pre-diagnoses to the many Americans affected with an abnormal form of mitosis in the breast (breast cancer) using a custom convolutional neural network (CNN). It was predicted earlier this year that 276,480 cases of invasive breast cancer would be detected in women and 48,530 of them would be expected to die from the disease, making it the 2nd leading cause of cancer death in women. Although the effects of breast cancer can be limited with treatments such as chemotherapy, the cancer must first be diagnosed before being treated. As the five-year survival rate declines among untreated patients from 100% at stage 0 cancer to 22% at stage 4 cancer, it is critical that the cancer be diagnosed as early as possible before treatments become ineffective.

Using a custom parallel distributed CNN with synchronous gradient descent, my research presents 83% validation accuracy and a 89% ROC-AUC score, 10% better than pathologist classification in early stages of cancer and roughly 10% better than pathologists in later stages, in order to classify benign and metastatic lymph nodes in the breast for patients of all stages and determine where cancer cells have spread for effective treatment on those areas. Furthermore, my research proposes the best setup for analyzing cancerous lymph nodes in order to maximize neural network accuracies in more generic CNNs. The impact of my study allows for the use of similarly created synchronous CNNs to be used to detect related cancers on the increasing number of patients diagnosed with these diseases year-round.

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The Potential in LIDAR for Analyzing Risk Factors for Accidents

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Abstract

A road accident often requires physical investigations to find out what led to it initially. Investigators are only able to produce a limited amount of information on the risk factors. However, LIDAR (short for Light Detection and Ranging) is a newly developed technology that can scan landscapes to collect accurate information about its features, such as its elevation or vegetation present that can prove to be physical obstructions to road users. This study aimed to discover to what extent can LIDAR identify physical structures that create risk factors in bicycle/pedestrian road accident locations. To test the hypothesis, I had found several accidents in Burlington County, New Jersey to look at LIDAR scans taken of them. LIDAR scans of one accident involved a driver crashing into a tree, showing that it might have been due to a difference in elevation of the road she was driving on. LIDAR pointed out in another accident involving a scooter rider and a car that the presence of trees posed a physical obstruction to the scooter's sight lines. Initial results dis suggest that LIDAR does have the ability to identify risk factors for bicycle/motorist accidents. However, there was a lack of enough case studies in a timespan of a few months in which we were not able to reach a valid conclusion. Nevertheless, LIDAR scans clearly can prove to be a powerful addition to investigating accidents rather than just physically investigating them to predict what played a role in the crashes.

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