2023-2024 High School Big Data Challenge: Leveraging Generative AI and Data Cybersecurity to Conserve and Foster Local Biodiversity

Under the Patronage of the Canadian Commission for UNESCO

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The STEM Fellowship High School Big Data Challenge provides students with the unique opportunity of Open Data inquiry into one of the UN Sustainable Development Goals and experiential learning of fundamentals of data analysis – an essential skill set for a young researcher in the digital age.

This year, students explore *Generative AI and Data Cybersecurity to Conserve and Foster Local Biodiversity* and to suggest their own evidence-based solutions following the principles of Open Science. They investigated different topics, ranging from Enhancing Forest Fire Predictions with Sequential Models for Ecosystem Preservation and Public Safety to Leveraging Semantic Segmentation to Perform Wildfire Prediction.

We designed an interdisciplinary and agile educational environment, and in-depth learning modules for students as a means of bridging the gap between traditional high school courseware and digital reality and computational science. Students learned how to uncover hidden patterns and trends in structured and unstructured data using a range of data analytics tools and programming languages. Python, R, LaTeX, and machine learning were some of the tools the students learned and used. On behalf of the STEM Fellowship, we extend our sincere congratulations to all students who participated in the challenge, and wish them the best for their future endeavours. We want to express our appreciation to all the mentors and volunteers.

This program would not be possible without patronage of CC UNESCO and generous support of our sponsors: RBC Future Launch, Let's Talk Science, CISCO Networking Academy, Canadian Science Publishing, Schulich Foundation, SciNet at University of Toronto, and the University of Calgary Hunter Hub for Entrepreneurial Thinking. We were privileged to witness first-hand the analytical capabilities of the data-native generation of students, and we are confident they will demonstrate excellence throughout their academic and professional careers.

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From pixels to protection: Artificial intelligence in species identification for biodiversity conservation

Joyi Xue, Sunni Xue, and Irene Chen
Anderson CVI

In the 21st century, the importance of biodiversity conservation has never been more critical. Biodiversity is not only essential for the health of ecosystems, but also directly tied to achieving Sustainable Development Goal 15 (SDG 15) set by the United Nations, which aims to halt biodiversity loss. This study explores an innovative application of artificial intelligence (AI) in biodiversity conservation, with a focus on the identification of endangered bird species in Ontario, Canada. Birds are indispensable contributors to ecosystem health, as they fulfill vital roles such as connecting ecosystems, insect population control, pollination, and seed dispersal. The study's primary objective is to develop and evaluate AI-driven models' capability of processing and classifying photographic data to recognize and monitor critical bird species. While previous research predominantly used camera-trap images mainly capturing terrestrial animals, this study broadens the scope to encompass bird species, specifically focusing on species local to Ontario. We focused on classifying four endangered bird species, the Barn Owl, Piping Plover, Loggerhead Shrike, and Acadian Flycatcher. To accomplish this, we leveraged transfer learning using the pre-trained ResNet-18 model, and a self-constructed, three-layer CNN. Our ResNet-18 model achieved an impressive validation accuracy of 93.1% after only five epochs, outperforming the CNN model, which achieved 85.7% accuracy. The results demonstrate AI's potential to automate the time-consuming task of identifying species. With continued development and refinement, AI holds the promise of significantly enhancing conservation efforts, suggesting a pivotal role in developing strategies to safeguard biodiversity and contribute to achieving SDG 15.

A multivariate analysis on the relationship between biodiversity and the climate

Aromal Mihraj, Anshuman Shah, Jasmeet Saini, Rohith Iruku, and Thanosan Prathifkumar
Central Peel Secondary School

The United Nations' 13th, 14th, and 15th Sustainable Development Goals prioritize environmental preservation, emphasizing the need to understand and protect ecological systems. Achieving these goals necessitates effective modeling of biodiversity and its influencing variables, such as pollution, temperature, and human activity. This study employs statistical analysis, environmental science, and computational algorithms to investigate Canadian biodiversity data from 1970 to 2018, sourced from the Canadian species index and the Open Government Portal. Multivariate analysis, using statistical methods, aids in modeling biodiversity, providing insights crucial for conservation planning. The study utilizes various computational methods, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), long short-term memory networks (LSTMs), and reinforcement learning (Q-learning). These techniques help analyze spatial patterns, predict time series data, and establish strategies for conservationists. Results highlight the significant impact of pollution on fish species, emphasizing the importance of addressing environmental factors beyond pollution for species stability. The discussion explores the use of reinforcement learning, climate modeling, and time series predictions, acknowledging the limitations and errors in data collection. Future research directions include refining predictive models and exploring external factors affecting species. The findings contribute to the broader discourse on AI applications in conservation, offering valuable insights for policymakers and conservationists. This research lays the groundwork for future studies aiming to enhance biodiversity protection through advanced computational methods.

Monitoring ocean species (coral reefs) using AI models

Nini Lu and Daphne Hong
Collingwood School

Coral reefs, vital ecosystems that support a variety of marine life, are facing unprecedented threats due to climate change, pollution, and overfishing. This paper introduces an AI-driven methodology for monitoring ocean species, focusing on coral reefs. Leveraging artificial intelligence models, we propose a novel system for automated species identification and tracking. The paper outlines the methodology, detailing the application of machine learning algorithms to image and

sensor data. The results demonstrate extreme differences in air temperature over the years, which will negatively impact coral reefs, causing them to diminish in great numbers. Our findings hold significant importance for marine conservation efforts, providing a scalable and efficient solution for assessing the health and diversity of coral ecosystems. This research contributes to the intersection of environmental science and technology, while using AI to effectively monitor these reefs, and collecting already analyzed information to scientists or researchers, and see what we can do to help these reefs and prevent extinction.

Determining the role of AI in biodiversity conservation efforts

Shinshin Wang, Sarah Yang, Tina Gu, and Karen Zhao

Collingwood School

Biodiversity stands as a critical cornerstone for ecosystem sustenance, playing a crucial role in the preservation of the planet we call home. However, human activity has introduced various challenges for the diverse selection of creatures that help maintain this very biodiversity. Addressing these challenges, AI may play a pivotal role in helping us preserve biodiversity both on a global scale and within the borders of Canada. This study aims to analyze the advantages and limitations of using AI in our efforts to conserve biodiversity, and evaluate the sources that are currently incorporating AI into their conservation efforts. The data in this research paper was collected from Parks Canada and sources analogous to our research topic. This research paper reviews and analyzes data surrounding AI being incorporated into wildlife conservation efforts, aiming to contribute valuable insights to the topic of AI.

Leveraging semantic segmentation to perform wildfire prediction

David Shan, Jacob Jansen, Mathis Luo, Robbie Muranaka, and Jeff Qiu

Crescent School

The ever-escalating threat of wildfires continues to pose a significant risk to global biodiversity, demanding innovative solutions aligned with the United Nations' Sustainable Development Goals. This paper presents an approach to predicting wildfires prior to their occurrence through the implementation of a trained AI model that analyzes area temperature, precipitation, wind, humidity, and past wildfire trends of the Contiguous United States (CONUS). By training the model on the Wildfire Hazard Potential Map and employing semantic segmentation using UNet and FCN ResNet50 models, the research achieved an 80% accuracy rate in predicting wildfires on UNet and 76% accuracy rate on FCN ResNet50. The generated heat maps highlight and conclude that areas are at a high risk when precipitation and humidity are low, and wind speeds and temperature are high. This paper provides a potential tool to be used by many audiences to stop the loss of biodiversity from the permanent damage caused by wildfires.

Advancing carbon credit accuracy: A machine learning approach for precise carbon sequestration estimation

Eric Mao, Tom Zheng, Chengtai (Richard) Li, Ken Cheng, and Hudson Haas

Crescent School

Carbon credits are an essential tool in the global fight against climate change. Traditional methods for estimating carbon sequestration have faced many inaccuracies, often leading to over-crediting and undermining the effectiveness of carbon offset programs. This study introduces a novel machine learning model utilizing advanced geographic data and advanced AI techniques to predict carbon sequestration in trees more precisely and efficiently. Our model processed global canopy height data from LiDAR sensors and tree species data from the U.S. Forest Service and presented a sophisticated analysis of canopy height and basal area data, generate a more precise baseline and crediting system. The effectiveness of our model was validated through rigorous comparison tests against established carbon crediting methodologies and one reviewed study. Our results indicate a significant improvement in accuracy, with the machine learning model achieving an error bound of ±5%. This high level of precision was evidenced in the successful re-calibration of carbon sequestration rates for specific land plots, demonstrating the model's potential to enhance the

reliability of carbon credit calculations.

Utilizing generative artificial intelligence and robotics to pinpoint high squirrel activity areas for improved biodiversity protection

William Zhao and Miriam Tay
Deer Lake School

In Vancouver, the population of squirrels is spread across many community parks and local forests. From the eastern gray squirrel to the native Douglas squirrel, these rodents play an essential role in our biodiversity, providing us with different species of plants and animals. Squirrels are known for their unique behaviors including seed gathering, dispersal, and burying. They are actively contributing to plant regeneration and the overall biodiversity in different natural habitats. These actions performed by squirrels are like nature's gardeners, helping us grow our green lands. Despite squirrels being common in many Vancouver parks, we have yet to fully understand their unique behaviors and the specific areas in a habitat where squirrels appear the most frequently. This project utilizes the power of generative AI to further explore the high squirrel presence areas in Vancouver's parks and forests, teaching us the patterns of squirrel appearances in specific areas. By tracking these areas, researchers can identify the crucial areas within a habitat for squirrel activities like foraging and burying. This information helps protection acts to be focused in a specific area. Squirrels might seem like another creature running around. But their unnoticeable actions can make a huge and lasting impact. As cities grow and environments shift causing habitats to change, it is crucial to understand which areas are critical to protect so we can withstand these changes and handle all these shifts. We, humans, can learn how to better care for and protect our parks with each piece of information.

A conditional generative adversarial network to simulate species coexistence patterns

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This study introduces a novel application of conditional generative adversarial networks (cGANs) to simulate and analyze species coexistence patterns in ecological systems. By leveraging eBird observation data in conjunction with environmental information provided by the National Centers for Environmental Prediction (NCEP), our approach represents a significant advancement in the realm of species distribution models (SDMs). Our cGAN models successfully generate realistic species patches, reflecting both observed and potential species coexistence under various environmental conditions. These models not only replicate known patterns but also predict plausible new combinations, thus offering a powerful tool for ecological research and conservation initiatives. This research highlights the potential of integrating generative AI with ecological studies, paving the way for more accurate and comprehensive models in environmental science. Our methods provide a deeper understanding of species interactions and the impact of environmental factors on biodiversity, offering significant contributions to the fields of ecological modeling and conservation biology.

Assessing and predicting the impacts of lithium extraction from brines on flamingo populations in chile's atacama desert

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Since the late 20th century, battery-powered innovations became thoroughly integrated into our lives, including electric vehicles designed to greenify our transportation. These battery-powered technologies require immense amounts of lithium, which is most commonly recovered from brines through evaporitic techniques. The practices mentioned above require unprecedented amounts of water to execute, affecting local water systems, and thus, the local species they support. This paper's geographical scope is Chile's Salar de Atacama, the country's largest salt flat, which supports 3 of the 6 species of flamingo worldwide, Phoenicopterus chilensis, Phoenicoparrus andinus, and Phoenicoparrus jamesi. This paper utilizes data from Dryad containing the area's local flamingo populations, surface water area, and water pumping rate from 1997 to 2018. Additional data was collected from Reuters, detailing the lithium production in Chile per year from 1996 to 2022. All data was cleaned and

harnessed to perform a multivariate predictive analysis using generative AI in the form of 3 regressive models and an artificial neural network. The models show that Chile's lithium production will grow exponentially, resulting in higher water usage and lower surface water area for the flamingos to utilize for procreation, alimentation, and sustenance. With all variables taken into account, the neural network predicts that the flamingo population will become much more volatile and susceptible to any challenges it might face in the future. These results call for the use of more benign lithium techniques, such as direct lithium extraction, in place of water-heavy evaporitic technologies that syphon from their surrounding environment.

Thermoregulatory paradigms: A novel approach for mitigating the impact of elevated temperatures on ecological habitats

Amy Feng, Angela Xiong, Billy Wu, Elaine Xu, and Richard Cai

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Habitats throughout the world are being harmed by ozone depletion. Within this study, we aimed to answer the impacts that the ozone hole had on the Adélie penguin population in Petermann Island, Antarctica. This study aims to (1) identify the main contributors to damaged habitats in Antarctica, (2) determine the correlation of the main contributors on the Adélie penguin species in Petermann Island, Antarctica, and (3) analyze the effects of using the carbon capture and storage method (CCS) to mitigate climate change. By achieving all of these aspects, we can spread awareness of the importance of ozone depletion and find solutions to combat this. Toward solving this problem, we aimed to find effective, quick lasting solutions by researching methods that reduce greenhouse gas emissions. Throughout this study, we used exploratory data analysis to find the relationship between the increasing ozone depletion and the Adélie penguin population. In the datasets by PenguinMap, Kaggle, Our World in Data, and Scar, we have identified a correlation between the increasing ozone hole and the decreasing population of Adélie penguins in Petermann Island, Antarctica. This supported our objective as this knowledge will increase the severity of ozone depletion and may cause for there to be more action in reducing greenhouse gas emissions. The study's main conclusion is that the mass production of greenhouse gasses will increase the ozone hole and reduce the population of penguins. This is important to know as this can help specialists to focus specifically on reducing emissions.

Using BirdNET and AI to build a conservation platform for at-risk bird species

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With the continued expansion of unsustainable industries such as mining and logging, the discussion around biodiversity has persisted. The rapid growth of such industries and the development of urban areas have been the main causes of deforestation, leading to a disastrous impact on animals that are highly sensitive to changes in their habitat environment. To understand the severity of this issue, we propose using birds as an effective indicator to evaluate Canada's overall environmental change. The study uses ecological and wildlife conservation data over a 22-year period. Using statistical significance tests, likely causal relationships were determined between deforestation, a decrease in Canada's overall ecosystem health, and an increase in at-risk bird species. With this in mind, we suggest possible actionable pathways to conservation by using Bird-NET, an auditory bird identifier, in conjunction with artificial intelligence tracking systems. Implementing these technologies to track birds' movements can significantly contribute to biodiversity conservation efforts. For example, data collected through these methods can be used to proactively preserve their habitats by avoiding deforestation or urban expansion planning in specific areas identified through the tracking systems. The plans outlined in this study can be plausibly extended to address habitat loss for other vulnerable wildlife species. Nevertheless, these solutions address the symptoms of biodiversity loss, not the causes. Thus, further research should be conducted into full remedies, such as a movement to sustainable industries or more wildlife-conscientious urban expansion policies.

Analyzing urban heat islands and their impact on monarch butterfly population

Ibrahim Khawar, Ibrahim Ansari, Alia Wahban,

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The monarch butterfly (Danaus plexippus) plays a crucial role in ecosystem health as a vital pollinator. However, North America's western and eastern populations of monarchs have recently become endangered, posing a threat to various ecosystems and food sources. While previous studies have examined large-scale factors such as global climate change and habitat loss affecting monarch populations, limited attention has been given to variables at the municipal level. This research focuses on analyzing monarch populations in Toronto, Montréal, and Vancouver, exploring the impact of urban heat islands (UHIs). Using stratified samples obtained from the Global Biodiversity Information Facility (GBIF) and Google Maps application programming interfaces (APIs), we investigated the relationship between monarch occurrences and daily temperature recordings. Our analysis revealed a positive influence of urban warming on monarch populations when temperatures ranged from 28-29°C, but populations declined with further heating. Subsequently, we explored the role of urban green spaces (UGSs) in mitigating UHIs and enhancing monarch populations. While UGSs have shown effectiveness in reducing the UHI effect in previous studies, their planning and equitability have posed challenges for various demographics. This study introduces the use of generative artificial intelligence (AI) to plan equitable and efficient green spaces, addressing the UHI effect and supporting monarch populations. To monitor the effectiveness of UGSs, a computer vision model was developed to classify 100 different species of butterflies and moths. This model allows for tracking the impact of UGSs by observing monarch populations within these green spaces. The findings and recommendations from this research provide valuable insights for enhancing city planning and conserving monarch populations across municipalities.

How news media and scholarly articles impact the public interest in emerald ash borers

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Emerald ash borer (EAB) is a highly-publicized insect species invasive to North America. They can and have caused major damage, in addition to killing a significant number of ash trees within a short period of time. Public interest has shown to be effective in reducing spread or impact of many viral diseases as well as invasive species. The paper aims to determine how much effect media, more specifically news articles, and research articles have on the public interest of EABs. By using various reliable sources such as Google trends, news sites, and various levels of government websites in Canada and the US, we were able to model and find their correlation and determine which of the two has more effect on public interest. We used tools in Google Sheets to graph the data we've collected. It was found that there is a strong correlation between the amount of Google Scholar articles and public interest. This shows that for the public to understand, more scholarly articles need to be written and more studies need to be done for them to also attract media attention. Saving the ash trees from EABs can help preserve local biodiversity within Canadian and American forests.

Utilizing spatial analysis to identify correlations between plant species and biological variety to determine traits that foster biodiversity in ecosystems

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Biodiversity has an extremely important impact on numerous aspects of society. From the reliability of food sources and the production of medicine to ecosystems that provide stable economic growth; biodiversity plays a vital role in maintaining a safe and sustainable environment hospitable to human life. However, the world has seen an average 68 percent drop in mammal, bird, fish, reptile, and amphibian populations since 1970. This study aims to (1) identify key plants within ecosystems that are of importance in fostering biodiversity, (2) locate traits of importance that contribute to increased biodiversity, and (3) find efficient and effective methods of utilizing said traits to generate increased ecosystem growth. To maximize accuracy and relevance to local regions, only data specific to Canada was analyzed. Although our observations are limited to Canada, our methods can be readily geared toward different ecosystems in regions across the globe. Multiple linear regression and map-splitting

techniques were used on the occurrence data from the Global Biodiversity Information Facility portal, global terrestrial species richness and rarity patterns (0.25 degree) datasets from ArcGIS Hub, and the TRY Plant Trait Database data sets from TRY; they reveal that plants' tolerance to fire, fruit/seed conspicuousness, vegetative reproduction rate, increased shoot organic nitrogen and potassium content contribute the most towards increased biodiversity. Our research concludes that introducing and protecting the beneficial plant species could improve biodiversity, and suggests the possibility of using novel technologies such as gene editing to increase the prevalence of beneficial traits.

Investigating the correlation between pollution and coral reef destruction

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In different tropical areas of the world, people enjoy scuba diving to appreciate the colourful corals that grow at shallow depths in the ocean. However, human destruction and pollution in the oceans are the leading causes of coral reef bleaching in the 21st century. The Coral Reef Conservation Program created a list of goals to protect coral ecosystems in 2010 for 2015, but many of the items have yet to be put into action. Since the 1950s, destruction has been a prevalent issue affecting coral ecosystems around the world. Chemical contamination due to human activity, sedimentation, and nutrient imbalance destroy coral reefs at a devastating rate. With an estimated 70-90 percent of coral predicted to go extinct by 2050, the Pacific Ocean, home to 1/4 of coral reefs in the entire world, is becoming increasingly vulnerable to the consequences humans have caused. To protect the future of coral reefs, critical action should be taken starting today to limit the amount of ocean pollutants and contaminants in the future. This study aims to investigate the various ways ocean pollutants affect coral reefs and whether there is a direct relationship between pollution factors and the destruction of reefs. By exploring the extent of pollution in coral ecosystems and the relationship between pollutants and coral damage, future risks can be better understood to help coral reef ecosystems continue to prosper.

Effectiveness of generative ai tools in creating educational articles about conservation of biodiversity

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Lillian Osborne High School

Biodiversity conservation has become an increasingly urgent global concern due to the impacts that climate change has on local and global ecosystems. This study explores the efficacy of generative artificial intelligence (AI) in raising awareness and promoting engagement for biodiversity conservation through targeted education campaigns. The study employs four distinct AI models – Perplexity, Bing, ChatGPT, and Bard – to generate educational articles on biodiversity-related topics. The topics cover various aspects such as the significance of native plants, the role of pollinators, and practical tips for creating wildlife-friendly habitats. This investigation utilized several statistical methods such as data visualization and comparison. Through our analysis, we found that ChatGPT was the AI model which produced the highest quality of content out of the four AI models.

Analyzing arctic ocean temperature and sea ice volume trends to assess the impact on biodiversity

Khushman Buttar and Kavya Sharma

Maples Met School

The Arctic is at the forefront of a worldwide climate shift. One of the numerous documented changes studied and reported annually is the massive loss of sea ice over the last few decades as air and ocean temperatures in the Arctic have increased, as shown by satellite photography. This report examines how rising global temperatures have led to the drastic melting of sea ice in the Arctic and its impact on marine biodiversity, specifically altering habitat dynamics of the flora and the fauna, migration patterns, and changes in the food web. The direct and indirect consequences on the flora and fauna of the Arctic expanse are majorly explored in this study. Open-access data from the sources Pan-Arctic Ice-Ocean Modeling and Assimilation System (PIOMAS) and the National Oceanic and Atmospheric Administration (NOAA)

was used to analyze the correlation between increasing temperatures and declining sea ice. As the temperature rises, the megafauna of the Arctic, such as polar bears and sea lions, are facing habitat loss and declining food availability. Simultaneously, the flora, typically consisting of grass species and small plants, is faced with the expansion of larger plant species, which causes a competitive environment. This study emphasizes the importance of understanding these impacts and taking meaningful action to mitigate these effects.

Artificial intelligence in conservation: predictive modeling of biodiversity responses to land use changes

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This study delves into the intricate relationships between land use changes and biodiversity in the Canadian context. The primary objective is to unravel the nuanced dynamics shaping the impact of human activities on species populations and biodiversity. Leveraging data from governmental and international organizations, this study employs linear regression to analyze percentage changes in land use, gas emissions, and species populations. The initial dataset, spanning 1971 to 2011, offers insights into land use dynamics in selected geographical areas, focusing on categories such as built-up settlements, roads, arable land, and natural/semi-natural land. Aligning with this, the greenhouse gas emissions data by the economic sector from 1990 to 2021 are meticulously linked to land use categories, enabling a targeted examination of sectors associated with specific land uses. Meticulous processing of the Living Planet Index report's species data from 1950 to 2020 involves filtering for exclusively Canadian species, allowing for a comprehensive average of percentage changes across diverse species. As these datasets are systematically processed and analyzed, the study aims to contribute valuable insights into the complex relationships between land use changes, greenhouse gas emissions, and biodiversity. Through our analysis, we learned that arable land unexpectedly exhibits a positive correlation with species populations, challenging conventional assumptions. These insights inform conservation strategies, emphasizing the need to integrate biodiversity considerations into agricultural practices. Future initiatives can benefit, fostering sustainable coexistence between human activities and thriving ecosystems.

Human intervention

Arlo Mollot, Anchit Singla, Yohann Ibe, Nahum Delriobazan, Shyra Lantican

Met Centre for Arts and Technology (MCAT)

In the present day, I am certain that plenty of people are aware of the causes of biodiversity loss and the reasons why it is happening due to human practices. A variety of biomes and species going extinct due to activities such as pollutions caused by factories, bombs and gases used in wars, overfishing, to our own crops that we grow as well as to make sure us consumers get produce causes a disruption in our eco-systems due to the chemicals that we use. At an individual level, we can correctly collect and prepare our data, create datasets with diverse cohorts, evaluate error rates across different cohorts all using technologythough what if there were different ways we can show through human talents that we can make a difference? Human interference has harmed all of our eco-systems in various ways: overfishing has caused our precious fish species to nearly go extinct, leaving coral reefs in a destructive and dull state. Industries produce more and more products that contain extremely toxic chemicals within clothing lines, only for consumers to not even try to donate them back to a thrift store to reuse. The population of pests and use of pesticides cause our own products to be inedible or at loss. We are all a part of the reason why our environment is falling apart; let us turn this human interference with our earth into shouting our voices to each other of what we are doing wrong.

How generative AI can model, plan and monitor ecosystem-based salmon habitat restoration efforts along the Yakima River and its tributaries

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Mount Si High School

The Yakima River, located in south central Washington

state, is a tributary of the Columbia River and once supported annual runs of Pacific salmon ranging in the hundreds of thousands. Over the past century, salmon have been depleted to historic lows, with some species facing extinction. Efforts to restore salmon to the Yakima have been expensive and unsuccessful at scale, and lack ecosystem-based modeling to account for, predict, and plan biodiversity outcomes. Many factors have contributed to salmon depletion, but a primary factor is habitat degradation resulting in water temperatures too hot for salmon to thrive in. The purpose of this study is to analyze water temperatures in key sections of the Yakima and its tributaries as a baseline minimum determinant of the Yakima's capability to naturally support a robust, biodiverse ecosystem for salmon. We obtained water temperature data from the U.S. Geological Survey and Washington Department of Ecology to model "heat maps" of select key waterways. We discuss how a generative AI model might synthesize the same temperature data in addition to data about salmon biomass, river modifiers (dams, fish passages), riparian vegetation, bird density, and economic impacts to aid in planning and prioritizing ecosystem-based salmon habitat restoration projects. Finally, we discuss cybersecurity and how data from government-funded research should be readily and easily accessible to model, with protocols in place to ensure data integrity.

A greener tundra: The impact of climate warming on arctic tundra biodiversity

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Arctic tundra biodiversity has been profoundly impacted by global warming and other associated drivers including soil temperature, snow regimes, permafrost thaw, and nutrient dynamics. A comprehensive analysis of these environmental and ecological factors and their interactions is vital to understand the responses of tundra ecosystems to changes in climate, and to anticipate potential global effects that may result from the alterations to local biodiversity. This study utilized Python and Excel to extract and process wide-ranging data from various research studies encompassing spaceborne satellite sensing, low-altitude remote sensing, and field observations. Normalized difference vegetation index data from satellites revealed widespread greening in the Arctic tundra biome, linked to increased shrub productivity. Air and soil temperature data with broad geographic and temporal coverage from the Arctic Data Center were synthesized to elucidate the relationships between air temperature, soil temperature, and vegetation. Repeat air photos provided clear evidence of vegetation changes, showing extensive expansion of shrubs and significant decline of lichens in the Western Canadian Arctic. Field studies were conducted on plant phenology, growth, and productivity in relation to climate data and depicted the responses of plants to the changing environment. Long-term trends of increasing growth in common tundra plant species were observed through the monitoring of key plant traits, suggesting that warming promotes tundra species productivity. The synthesis of these data offers valuable insights on climate change impacts on tundra biodiversity, highlighting the importance of responding to these changes through data-driven decision-making.

AI's role in identifying sites of landfill through deep learning models

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This research paper explores the utilization of artificial intelligence in detecting landfills by analyzing satellite images. A deep learning model was developed with the capability of accurately identifying landfills using data from satellite imagery. The model was trained using machine learning algorithms on a large dataset of over ten thousand satellite images of landfills in different terrains. The model learned to recognize distinct features associated with landfills, acquiring the ability to detect these sites when processing new satellite images. The final trained deep learning model achieved an accuracy of 100% and confidence of 70-99% in correctly pinpointing landfill locations even in diverse geographic settings. This study examines methods of monitoring harmful impacts of landfill pollution on nearby ecosystems and evaluates risks on animal species. This deep learning model has the potential to be implemented in regulation of waste

management to detect illegal landfills. Through this approach, the research highlights the urgent needs for improved waste management strategies and policies to mitigate the impact of landfills on the environment.

Enhancing forest fire predictions with sequential models for ecosystem preservation and public safety

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In recent years, Canada's diverse forests have suffered increasingly intense wildfires across its diverse natural landscape. These events have consequences beyond the devastation of ecosystems, depleting natural wood reserves, affecting tourism, and straining the country's financial resources. While the current systems against forest fires are successful to a degree, they possess significant limitations that render them ultimately insufficient in preventing the escalating threat. The objective of this study is to apply the sequential model to enhance forest fire predictions for improved community safety and ecosystem preservation. In the data processing procedure, normalization techniques such as logarithmic transformation are applied to ensure uniform distributions in the raw data. Afterwards, it implements a sequential neural network model using Keras which is trained on a dataset that is partitioned into a 70/30 split for training and testing. Finally, the Root Mean Square Propagation (RMSProp) optimizer and iterative testing is applied to refine and validate the model's performance. A key innovation of this project lies in its incorporation of a user-friendly web interface that takes in environmental data and outputs areas susceptible to fires alongside practical recommendations for fire prevention and management. The results validate the effectiveness of the sequential machine learning model in forest fire prediction, pose potential improvements, and facilitate further exploration in the field of AI in regard to forest fire prevention.

Effect of increasing carbon-dioxide gas emissions on biodiversity in polar ecoregions

Ebosetale Esekheilu and Luke Salonka

St Francis High School

An exploration into the interplay between carbon dioxide emissions and polar biodiversity. Caused primarily by greenhouse gases, climate change and global warming have been major escalating global threats for years. So, via this platform, we wanted to see not just how these problems affect the planet itself, but also the organisms residing in it. Leveraging the use of several tools like SQL, Microsoft Excel, and Google Collab Notebook, we were able to thoroughly analyze data we sourced from various databases in the form of CSV files. Carbon dioxide (CO_2) was used as the focus greenhouse gas in our study and the polar regions were selected as our biome of study. Specifically, we analyzed the biodiversity of birds, fish, invertebrate and zooplankton that reside in the polar ecoregions. We compared the data, looking for a relationship between rising carbon dioxide emissions and polar biodiversity. We saw a steady increase in carbon dioxide emissions over the years, and saw increases and decreases in the biodiversity of several arctic organisms. This showed us that although greenhouse gas emissions have had an impact on our planet, there is still a chance to turn things around and save our planet's biodiversity. In essence, our study highlights that there is still a possibility for positive change and a proactive approach is required to achieve that.

Exploring the methods and the need for data anonymization of species locational data

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Our research provides datasets on different national parks and the different species that were seen there before. The name of the national park is provided at the top of each dataset. Both the scientific name and the common name of a species is provided by the dataset. The datasets give better understanding on how we can sustain the biodiversity of specific areas. We use geospatial masking and AI-assisted anonymization to ensure that the sensitive information of species occurrences is not exposed to unauthorized users. Data security, legal and ethical ways, and possible threats to

the biodiversity of regions are the main factors we focused on while coming up with our method of creating the research paper and solutions to sustaining biodiversity.

Analyzing the correlation between biodiversity indexes, carbon emissions, and government investment into public transport to identify feasible pathways to improving biodiversity in the future

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In the world of increasing CO_2 emissions, where transportation alone contributes to 28% of this environmental burden, its impact on climate has been a widely discussed topic. The main impact is global warming, which can change biodiversity drastically by disrupting ecosystems and changing living conditions for organisms. With this in mind, our study aims to investigate and establish the correlation between CO_2 and biodiversity to evaluate periods of increased CO_2 emission to biodiversity change in particular ecosystems in North America. Our second objective of this study is to seek out potential financial solutions governments could implement to mitigate CO_2 emissions' negative impacts on biodiversity. To identify relationships among the data we used, we used a fine-tuned chatbot we made on Open AI's token-based platform and Python to sort multiple datasets, including biodiversity data from the Living Planet Index Organization and annual CO_2 emissions data from Our World Data. To take this further, we continued to use Python to create graphs to visualize relationships and correlations between the data used. We hypothesize that there is an inverse relationship between biodiversity and carbon emissions. However, the effect of carbon emissions on biodiversity can be significantly decreased by putting into practice strong environmental solutions by receiving financial backing from governments. We identified a strong negative correlation between CO_2 emissions and biodiversity and a moderate positive correlation between investment in public transport and CO_2 levels.

Investigating the correlation between human activity and animal biodiversity in Canada

Favour Atewologun and Oluchukwu Favour Iheanyichukcu
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Biodiversity remains essential for the stability and security of our ecosystems. However, with the growth of human activity in our current day and age, we must step back and analyze our impact on the biodiversity in our nation Canada. The goal of our project was to determine the human impact on animal biodiversity in Canada. Determinants of human activity in this study were annual human population estimates in Canada and greenhouse gas emissions while the number of animal species was used to measure animal biodiversity. The programming language Python was used as a tool to not only find notable statistical correlations, but to also make visual representations of data. The results of this study showed weak and moderate correlation between our explanatory variables, human population and greenhouse gas emissions, and our response variables, the total number of animal species in Canada, and the number of species of birds, fish, and mammals. Overall, this paper draws attention to the overall biodiversity of animals in Canada, and focuses on three specific categories - birds, fish, and mammals - to understand the trends in biodiversity since 1990, suggesting ways to limit negative human impacts and preserve the diversity of animals in Canada.

An investigation of industrialization's ecological impact: unveiling the dynamics of anthropogenic aerosols and petrochemical contaminants on global biodiversity across diverse ecosystems

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This extensive research endeavors to conduct a thorough investigation into the intricate dynamics between industrialization-induced pollutants and their profound repercussions on global biodiversity, which for the most part is fairly significant. Anthropogenic aerosols and definitely petrochemical contaminants, arising from industrial activities. Employing advanced external datasets, and a multifaceted analytical approach, we aim to definitely

provide a nuanced understanding of the diverse pathways and consequences of industrialization-related pollutants on ecosystems worldwide. This expansive research embarks on a comprehensive exploration, delving deep into the intricate dynamics shaped by industrialization-induced pollutants and their far-reaching consequences on global biodiversity in a really major way. By integrating particularly external datasets and a multifaceted analytical approach, our objective actually is to not only quantify but also basically unravel the nuanced interplay of industrialization-related pollutants and their varied impacts on ecosystems worldwide.

Optimizing reforestation to reduce the effects of climate change by fostering biodiversity

Boyd Hamilton, Khadija Sheikh, Nicole Sun, and Talia Zhang

Westmount Charter Mid-High

Trees and forests are recognized as a mitigator of climate change, a pressing issue. They not only provide carbon sequestration but also support wildlife species. However, many previous reforestation efforts often cultivate monocultures and suffocate native species. It is evident more effective reforestation methods are necessary. This paper looked at oak powdery mildew infection, birds and animal diversity, and carbon sequestration to evaluate the importance of biodiversity. To study a forest's health, we study the significance of soil erosion, biodiversity, and native/non-native status of species. Our algorithm integrates AI to create a 'smart forest' that mirrors the natural ecosystem; the algorithm predicts the best trees to plant at any point. Evaluating latitude, longitude, and species, the criteria ensures trees will thrive in the area, increase biodiversity and discourage monocultures, and help the forest become an efficient carbon sink. Assigning criteria to the N-score (native score), B-score (biodiversity score), and C-score (carbon sequestration score), the algorithm should increase the B-score and C-score while decreasing the N-score, encouraging biodiversity and carbon capture while discouraging non-native species. In simulating 31 sample forests through the algorithm, we assessed whether our algorithm significantly improved forest health. We found increasing tree diversity hosted more diverse bird species, decreased the prevalence of oak powdery mildew infection, and increased carbon sequestration. Our research and AI focus on biodiversity, native tree planting, and maximizing carbon sequestration in sustainable reforestation efforts to develop effective strategies to combat global warming.

Impacts of agricultural activity on fish biodiversity in freshwater ecosystems

Robert Lin[1], Shotaro Richardson[1], Arya Shahabi[2], Jasleen Randhawa[3], and Abigail Conley[3]

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Detailed knowledge regarding the factors impacting aquatic freshwater ecosystems still remains limited in a time where agricultural runoff is becoming an increasingly severe problem. This investigation attempts to address this problem by analyzing the relationship between agricultural activities and fish biodiversity. After identifying the Great Lakes region as both ecologically critical and at-risk, fish population data from the region was found and converted into two biodiversity metrics: the Shannon Diversity Index and Simpson's Diversity Index. Each index was subsequently graphed in relation to the agricultural concentration of the region it belonged to. Analysis of the graphs found high agricultural concentration values were consistently moderately correlated with a high Shannon Diversity Index value and a low Simpson's Diversity Index value. Taking into account the nature of the two metrics, it was found higher agricultural activities were consistently correlated with higher biodiversity. The method used was able to elucidate a significant trend in the data, albeit one that deviates from existing literature. Confounding variables were addressed by examining correlations between agricultural concentration and other variables, including water depth and farm size. The conclusions gathered from this investigation suggest a need for further research to clarify the nature of the correlations between agriculture use and fish biodiversity, and may be used to guide government conservation efforts and regulations around agricultural pollution.

Developing a generative ai model to protect biodiversity from mining in mainland united states of america

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The International Energy Agency projects that hitting net zero by 2050 would require that worldwide mineral extraction increases sixfold. The report further states that metals such as lithium, nickel, and cobalt are essential in technologies like electric cars, wind turbines, and solar panels. This means that the number of mines will skyrocket, creating new environmental problems. In order to measure and mitigate these problems, a significance test was conducted to determine the impact of mining activities on local biodiversity. A clear difference in a calculated mean. Biodiversity Index was found for mining locations and US locations, identifying the looming threat of increased mining operations on local biodiversity. A generative adversarial network was constructed which develops a mining location distribution that tries to reduce impact on the local biodiversity, but also tries to maintain a similar degree of mineral extraction in order to feed sustainability initiatives. The model was successful in developing a mining location distribution in coastal regions, but exhibited bias in landlocked regions, indicating a need for further refinement. These results indicate a promising start for increased sustainability in mining.

Leveraging generative artificial intelligence to predict the impacts of fishing on local biodiversity

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Being bordered by three major oceans, Canada has maintained a close relationship with its aquatic resources. Fishing in particular is an integral component of Canada's culture and economics. This being said, with the significance of the industry comes the importance of ensuring its responsible and sustainable implementation. A major threat to the health and biodiversity of our ocean's ecosystems is overfishing which plummets fish populations to unsustainable levels. Legislative actions addressing this issue include the creation and enforcement of guidelines that regulate fishing rates based on. While these guidelines have seen success, they are based on generalizations and conservative estimates of fishing impacts. Generative artificial intelligence (AI), with its ability to learn trends from data, holds the potential to optimize conservation strategies by providing accurate predictions of environmental impacts. Our project aims to utilize generative AI to assess the impacts of fishing on local biodiversity in Canada's Atlantic region using a neural network. The neural network was trained on data provided by Canadian agencies regarding annual fishing yields and biodiversity indexes. Our results were promising with all generated output values being insignificant compared to the true values. This being said, numerous errors were present with the most notable ones being the datasets used and the complexity of the model itself. For future projects, more breadth of learning could be achieved through teaching the model to make predictions based on a variety of factors rather than just one. Additionally, using larger datasets will improve learning and reduce the risk of overfitting.

An analysis examining the possibilities of pharmacogenomics curing cancer

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The present study investigates the possibility of pharmacogenomics as a means of tackling the problem of cancer cure. The study focuses on genetically connected cancer and attempts to give researchers and experimenters a theoretical framework. Pharmacogenomics provides a more focused approach by customizing cancer medicines according to a patient's genetic profile. The focus of the theoretical plans and theories is on tumors related to genetics only. Three pharmacogenomics-related topics are also covered in the paper: transcriptomics, proteomics, and metabolomics. The findings show that by identifying mutations, comprehending protein relationships, and focusing on altered cancer metabolism, these strategies help cure cancer in an indirect manner. According to the study, pharmacogenomics may be essential for cancer prognosis, treatment management, and detection in the future.

LLMs and AES for accelerated and secure species classification in conservation applications

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The classification of biological organisms has been essential in studying biological research and developing conservation strategies. Currently, scientists most commonly employ the Linnaean system of classification and group organisms by manually identifying behavioural, structural, and physiological commonalities. This process is often inefficient and time-consuming, while the results are often conflicting. Our research aims to accelerate species classification through large language models (LLMs). By leveraging DNA's capacity to dictate behavioural, structural, and physiological features and the ability of LLMs to evaluate text, we create an efficient tool that classifies species using their DNA fragments 1000x faster than humans. We simultaneously employ the Advanced Encryption Standard (AES) methods to protect the DNA fragments in our dataset. The accuracy of our model was additionally verified by comparing computational predictions with broadly agreed upon classifications in the scientific community.

How Does pH of 1-13 Affect Copper(ll)-EDTA absorbance at wavelength of 700nm?

Tim Zhang

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The experiment investigated the research question: "How Does pH of 1-13 Affect Copper(ll)-EDTA absorbance at wavelength of 700nm?" The experiment undertaken in this study carries substantial implications for both pharmaceutical and industrial applications. One particularly noteworthy application of the experimental findings lies within the realm of pharmacy, specifically in the context of treating lead poisoning. EDTA, a well-known chelating agent, possesses the remarkable ability to form hexadentate chelates with Pb2+ ions. These chelates play a pivotal role in mitigating lead toxicity by facilitating the removal of lead from the body. To optimize its pharmaceutical applications, it is imperative to comprehend the acid-base equilibrium of EDTA and its profound influence on the formation and dissociation of metal-EDTA complexes.