Joseph Bohman
Class 2025

Research Portfolio

Short Bio/About Me:

I am a passionate researcher and advocate for environmental innovation, focusing on real-world challenges such as environmental justice, climate change, and sustainability. My research spans projects like Climate Sentiment Analysis using AI and drone applications for environmental monitoring. Through these efforts, I aim to combine data science, advocacy, and technology to create meaningful solutions for a sustainable future.

This portfolio highlights five key projects spanning my high school years, along with a summary of my civic engagements. To learn more about me, you can visit my LinkedIn profile, explore my blog at Energy for Future Presidents, or follow my sports journey on Facebook.

Project 1

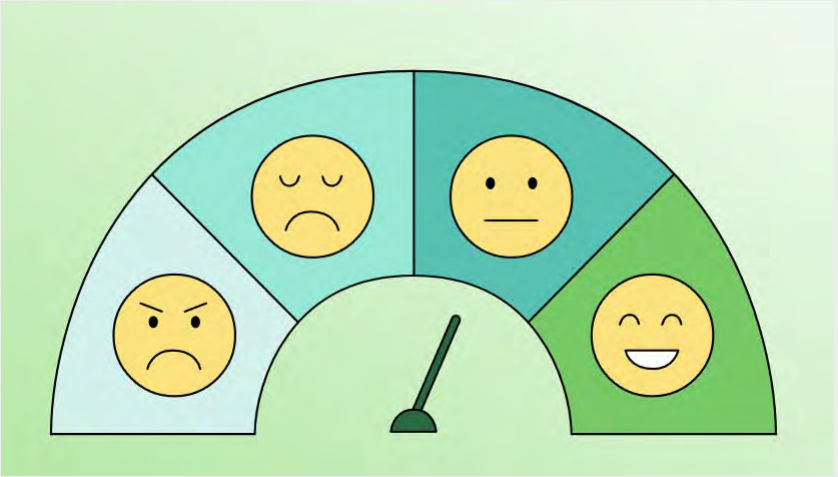
Title/Problem:

Does Public Sentiment about Climate Change Influence Green Spending?

This research was published in the *Journal of Quantitative and Qualitative Research*, Fall 2024, ISBN 9798343014815

Question:

How are sentiments on social media related to investments in green technologies? Do negative or skeptical views act as barriers, or are sentiments not a factor at all?



Abstract

In today’s digitally connected world, social media has become a key platform for expressing opinions and mobilizing movements, particularly those advocating for environmental sustainability. This study utilizes machine learning algorithms to conduct a sentiment analysis on NASA’s climate-related Facebook posts, exploring the potential correlation between public sentiment and consumer investments in green technologies, such as solar panels and electric vehicles. The initial hypothesis suggested that positive sentiment toward NASA’s climate posts would correlate with increased spending on green energy technologies, as reflected in sales data. However, the analysis revealed no significant correlation between the two, indicating a disconnect between favorable public sentiment and actual investments in sustainable technologies. This finding challenges the assumption that positive social media discourse directly influences market behavior, suggesting other factors play a larger role in green technology adoption. The study underscores the importance of a long-term strategic focus by investors in the green technology sector, independent of short-term public enthusiasm. Such an approach can help stabilize the market and support the ongoing transition to sustainable solutions.

Background Research: Climate Change --- A Sense of Urgency

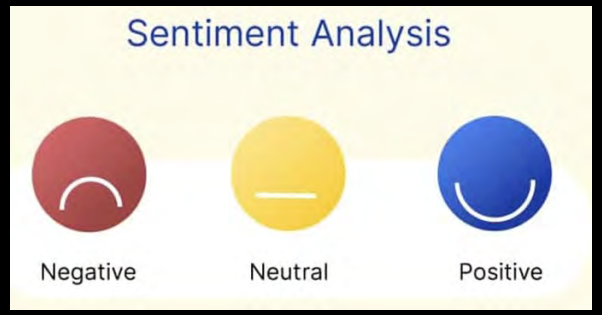
Climate change remains one of the most pressing challenges facing modern society. Since the onset of the Industrial Revolution, average global temperatures have risen by at least 1.1 degrees Celsius, with projections estimating an increase of 0.15 to 0.20 degrees Celsius per decade, according to NASA. This warming has driven a global sea level rise of 212.18 mm since 1900 and has intensified critical issues, including food scarcity, coastal flooding, and the spread of infectious diseases.

Addressing climate change necessitates a combination of individual actions, community initiatives, and systemic policy changes. In my research, I will focus on the policy dimension, investigating whether public opinion on climate change influences the adoption of green policies and examining how this impact takes shape.

Drought In Lake Powell, Arizona And Utah
Reference: https://www.boredpanda.com/nasa-before-after-pics-images-of-change-climate/

Hypothesis

•Based on my background research, I hypothesize that positive sentiments toward NASA's climate posts are likely to correlate with increased spending on green energy technologies, negative sentiments may decrease spending, and neutral sentiments could result in spending remaining flat.

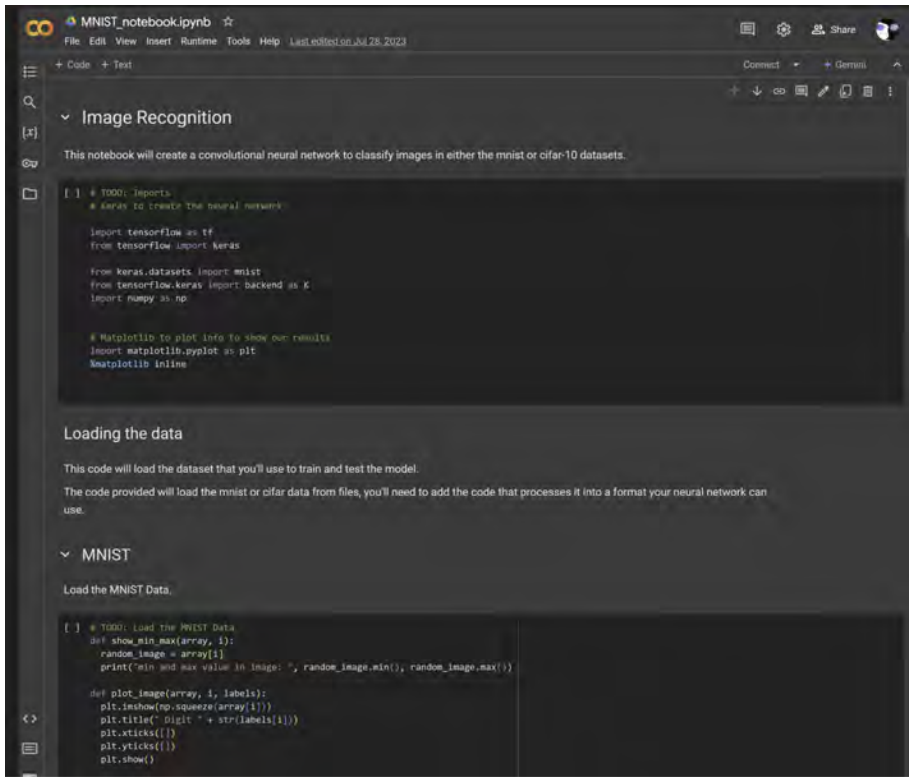


Reference: The images on this page are sourced from publicly available online resources.

Materials

Materials used in this research:

- A laptop computer
- Google Colab software
- Analytical thinking and problem-solving skills



Google Colab platform on my desktop.

Procedure

Using Machine Learning to Analyze Sentiments on Climate Posts

My research focuses on analyzing comments from NASA's Global Climate Change Facebook page: NASA Climate Change. This page, with approximately 1.5 million followers, serves as a platform for NASA to share the latest climate science and its impacts on Earth. Analyzing the comments on these posts provides insights into public sentiment and engagement with climate-related topics.

Steps in the Research

1. Downloading NASA's Climate Posts Dataset

The dataset includes over 500 comments from NASA's Climate Change posts, which serve as the foundation for sentiment analysis.

2. Sentiment Analysis Using Google Colab

I chose Google Colab for sentiment analysis due to its user-friendly interface and ability to handle computational tasks seamlessly. Colab is a free cloud service based on Jupyter Notebooks and widely used in data science and machine learning.

Workflow:

1. Load the dataset.
2. Use **Convolutional Neural Networks (CNNs)** to classify comment sentiment (positive, negative, or neutral).
3. Extract key terms like "Solar" and "Electric Vehicle" for deeper insights.
4. Plot the data to visualize trends and results.

Code Snippet for Sentiment Analysis:

```
dfn = pd.read_csv(io.BytesIO(uploaded['climate_nasa.csv']))
dfn['polarity'] = dfn['text'].apply(lambda x: TextBlob(str(x)).sentiment.polarity)
```

3. Analyzing Additional Datasets

To explore potential relationships, I analyzed:

- **Photovoltaic panel shipment data**: To track trends in solar technology adoption.
- **Electric vehicle (EV) sales data**: To assess consumer spending on green technologies.

These datasets were examined over the past 10 years to identify correlations between public sentiment and green technology adoption during the same period.

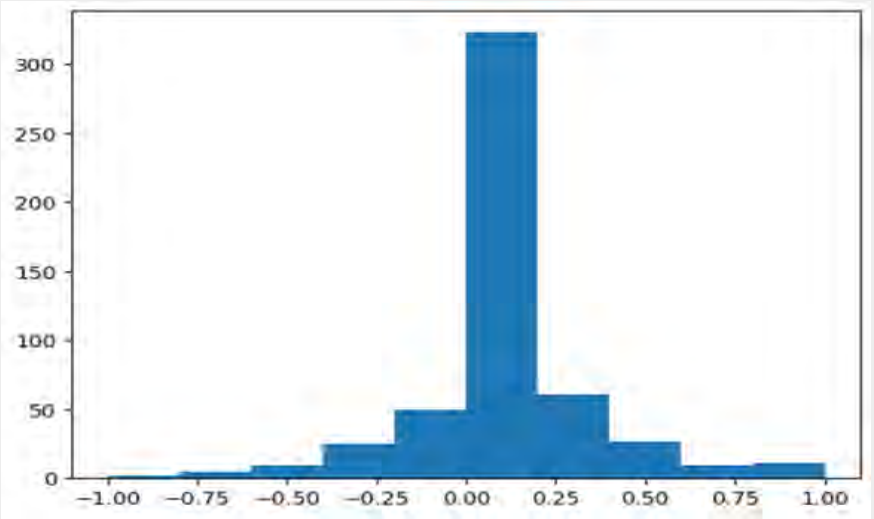
4. Data Visualization and Conclusions

The results were plotted to compare trends in sentiment scores, solar panel shipments, and EV sales. This helped evaluate the relationship between public sentiment and consumer behavior in the green technology sector.

This approach demonstrates how machine learning and sentiment analysis can uncover valuable insights from social media data and its correlation with real-world trends in green energy adoption.

Results - Data/Observations

Sentiment Score Distributions Chart:



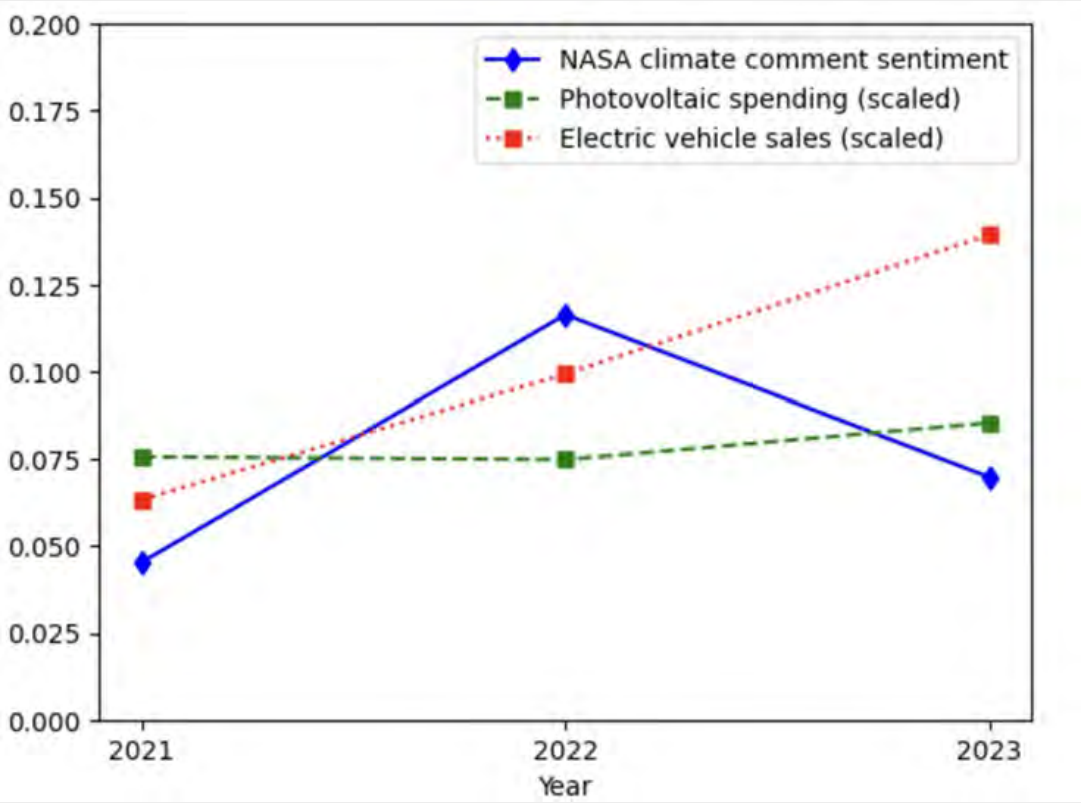
The x-axis value indicates the sentiment score:

- A negative value means negative sentiment, which in this case is against climate change subject;
- A positive value means a positive sentiment in climate change subject;
- The y-axis value indicates the number of comments in that sentiment bin, which 300 is top value for the set.
- A boundary value from a negative to a positive is set to 0.25, as recommended by the NLP algorithm. If a popularity score is smaller than -0.25, it is counted as “negative;” where it is greater than 0.25, it is considered “positive;” anything in between is “neutral.”

The result shows most of the sentiments are in the “neutral” zone.

Results (continued)

Sentiment score distribution vs solar panel activity and electrical vehicle sales chart



The results are clear: they don't align! The sentiment score trend, represented by the blue line, does not match the trends of green energy adoption (green line) or EV sales (red line). While these topics do appear in the comments on Climate Posts, as confirmed by earlier keyword searches, the trends show no direct correlation.

Discussion

A sentiment analysis was conducted on NASA's climate-related Facebook posts to explore the potential correlation between public sentiment and investment in green energy technologies. The initial hypothesis suggested that a positive sentiment toward NASA’s climate posts would correlate with increased investment and spending in green energy, as indicated by sales data for solar panels and electric vehicles. However, the analysis found no significant correlation between the two. Although 78% of the sentiment scores from the climate posts were neutral, the market activities for solar panels and electric vehicles have shown an upward trend, particularly in recent years.

Possible reasons for the discrepancy between Climate Post Sentiment and Green Energy Adoption could include:

1> Government Policies and Support for Green Energy;

2> Technological Advancements in Solar Panels and Electric Vehicles;

The unexpected growth in the green energy sector, despite neutral sentiment, suggests that other factors are at play. This insight can serve as a positive reinforcement for investors in green technologies.

Conclusion

The analysis of the data presented in this study leads to a surprising conclusion: there is a clear mismatch between public sentiment on climate change posts and actual spending on solar panels and electrical vehicles. This finding contradicts the common expectation that positive sentiment on social media about climate solutions correlates directly with increased consumer investment in such technologies.

Traditionally, sentiment analysis is employed to forecast market trends and consumer behavior, under the assumption that positive public opinion will translate into corresponding economic actions. However, in this scenario, the lack of a clear alignment between public sentiment and actual investments in green technologies presents an unexpected view for investors. This insight is valuable for those involved in green technology sectors, emphasizing the importance of maintaining a long-term commitment even in the face of subdued public enthusiasm. This perspective should encourage investors to remain focused on the strategic, long-term benefits of their investments, which play a crucial role in the gradual transition towards sustainable technologies. Such a steady approach can help stabilize the market and ensure continued progress in the development and adoption of green solutions, independent of short-term fluctuations in public opinion.

Reflection/Application

The initial hypothesis suggested that positive sentiment toward NASA's climate posts would correlate with increased spending on green energy technologies, but the data did not support this assumption. This finding indicates that factors beyond social media sentiment play a more significant role in green technology adoption.

Despite the unexpected findings in my research, there were notable limitations in the study that warrant consideration:

Key limitations of the study include:

1. **Datasets and Tools**: The dataset of NASA's climate posts may have been too small, and the focus on solar panel and electric vehicle activities might not fully capture the complexities of market behavior.
2. **Predicting Behavior with Sentiment Analysis**: Sentiment analysis offers insights into public perception but falls short in accurately predicting consumer behavior due to the complex interplay of social, psychological, and economic factors.

Further research is needed to refine sentiment analysis methodologies and better understand its connection to real-world actions, particularly in the green energy sector.

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[3] Irene Lorenzoni, et al. "Barriers perceived to engaging with climate change among the UK public and their policy implications", 2007. https://www.sciencedirect.com/science/article/abs/pii/S0959378007000209

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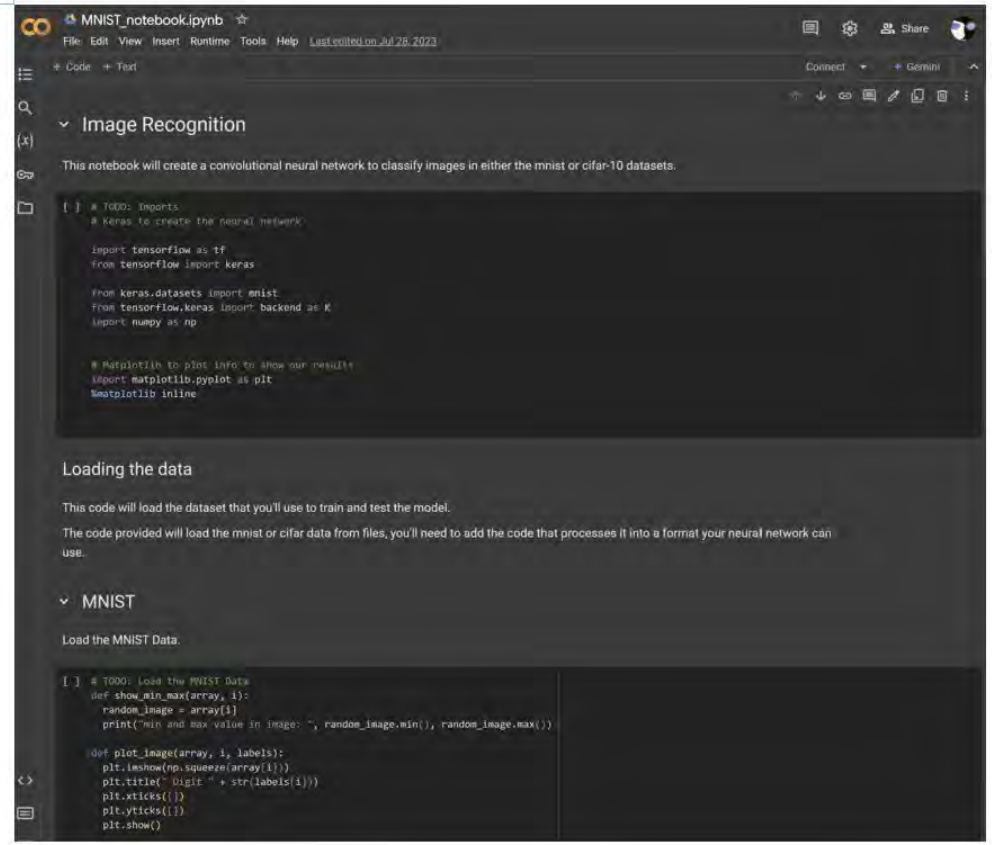
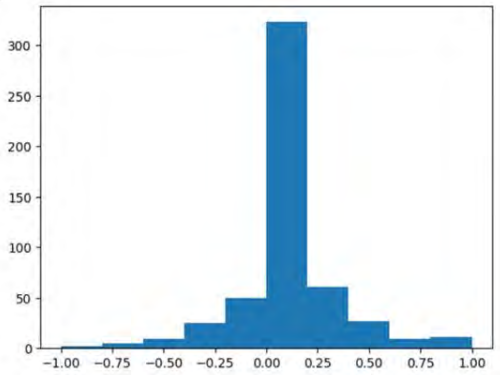


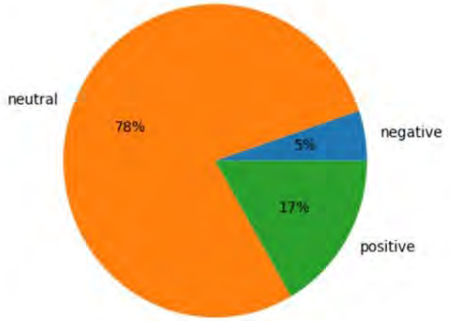
August 16, 2024

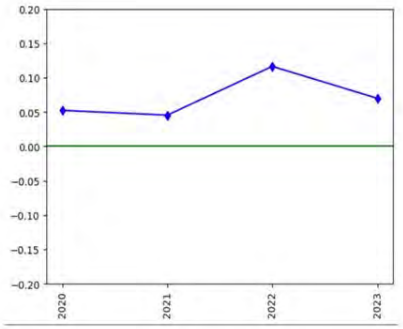
The project is pretty much finished, here are some data results during the process:

```
(522, 5)
['date' 'likesCount' 'profileName' 'commentsCount' 'text']
```

	date	likesCount	profileName	commentsCount	text
0	2022-09-07T17:12:32.000Z	2	4dca617d86b3fdce80ba7e81fb16e048c9cd9798cdfd6d...	NaN	Neat comparison I have not heard it before.\n ...
1	2022-09-08T14:51:13.000Z	0	518ab97f2d115ba5b6f03b2fba2ef2b120540c9681288b...	NaN	An excellent way to visualise the invisible! T...
2	2022-09-07T17:19:41.000Z	1	d82e8e24eb633fd625b0aef9b3cb625cfb044ceb8483e1...	3.0	Does the CO2/ghg in the troposphere affect the...
3	2022-09-08T00:51:30.000Z	4	37a509fa0b5177a2233c7e2d0e2b2d6916695fa9fba3f2...	NaN	excellent post! I defo feel the difference - o...
4	2022-09-07T19:06:20.000Z	16	e54fbbd42a729af9d04d9a5cc1f9bbfe8081a31c219ecb...	26.0	Yes, and carbon dioxide does not harm the Eart...


300
250
200
150
100
50
0
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00


neutral
78%
negative
5%
17%
positive


0.20
0.15
0.10
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−0.15
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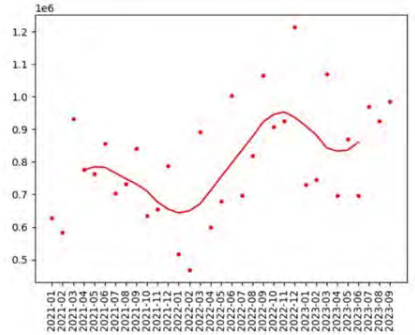
2020
2021
2022
2023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1.1
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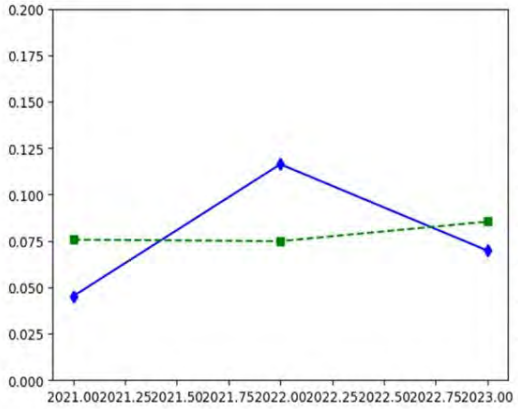
0.200
0.175
0.150
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0.050
0.025
0.000
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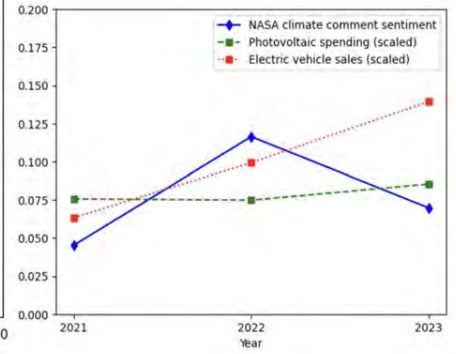
2022.75
2023.00


NASA climate comment sentiment
Photovoltaic spending (scaled)
Electric vehicle sales (scaled)
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
2021
2022
2023
Year

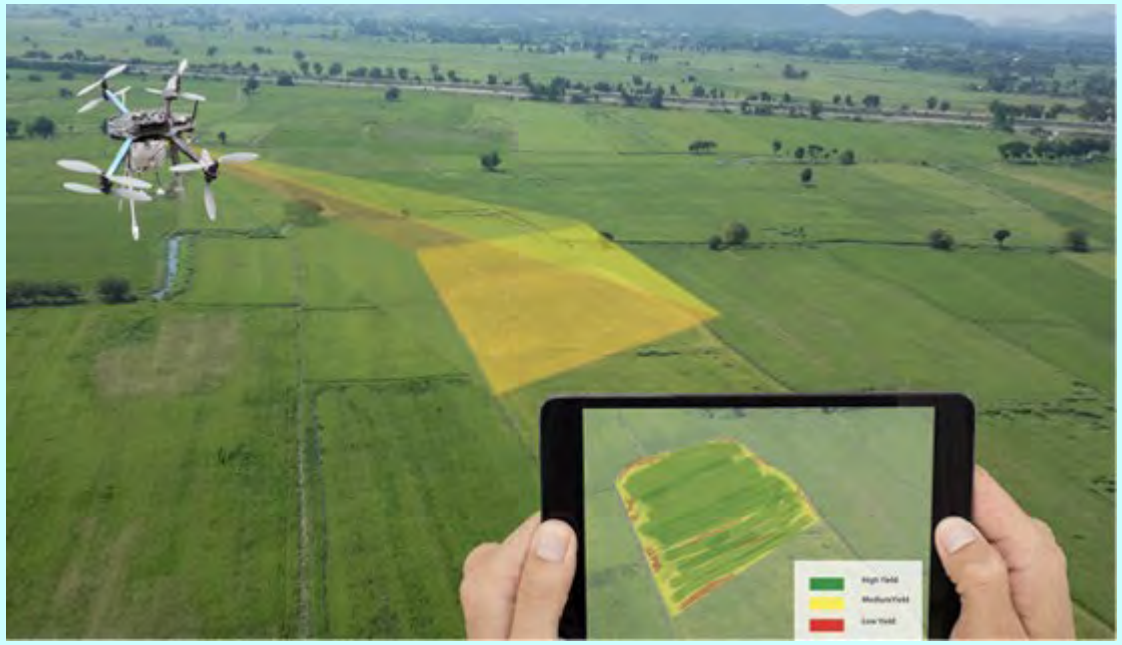
Project 2

An Aerial Eye for the Environment: Integrating Drones and Aruco Tags in Environmental Monitoring

---Revolutionizing Conservation Efforts Through AI Technology

Problem:

We aim to develop methods for detecting specific objects through a drone's camera, which will aid in environmental monitoring tasks. These tasks include assessing water quality, monitoring wildlife and habitats, analyzing plant health, and responding to disasters.



Abstract

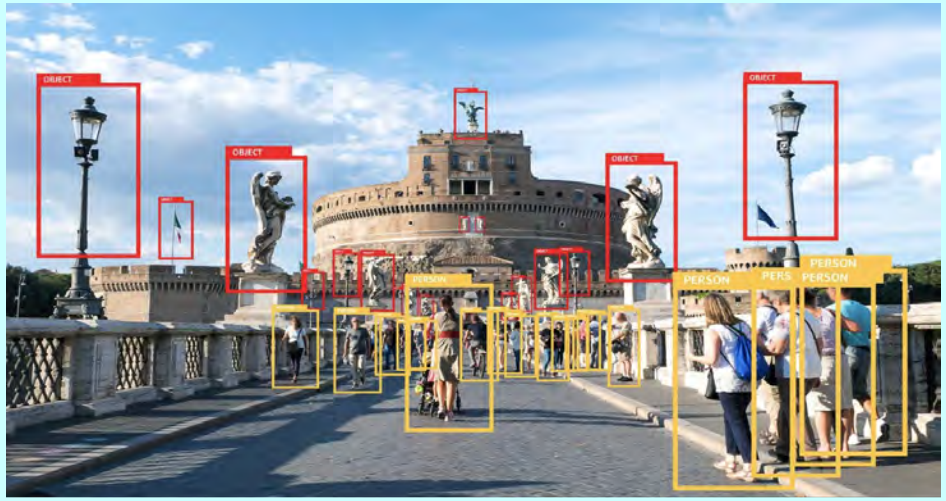
Computer vision has evolved dramatically over recent decades, evolving from a specialized academic field into a fundamental technology with extensive applications. Notably, the accuracy of computer vision for detection and recognition tasks has greatly improved with the rise of deep learning. However, accuracy varies based on factors like input data quality, the algorithms or models employed, training data, task complexity, and environmental conditions. Simple object detection tasks (such as identifying cats in photos) often achieve accuracies above 90%. In contrast, more intricate tasks, such as scene interpretation or emotion detection, may have lower accuracy rates. In real-world object detection scenarios, factors like lighting, occlusions, complex backgrounds, overlapping objects, and biases in AI training datasets can impact accuracy. Additionally, real-time image processing continues to pose challenges, requiring substantial computational power.

This project explores the use of drones equipped with cameras and OpenCV's Aruco tags for object detection. Preliminary experiments in controlled environments have demonstrated a 100% accuracy rate in identifying objects marked with Aruco tags. This promising approach could significantly enhance environmental monitoring and assessment efforts. Applications such as water quality monitoring, wildlife and habitat monitoring, plant health analysis, and disaster response could benefit from this cost-effective solution, leveraging advanced computer vision technology to achieve efficient and accurate environmental assessments.

Introduction (Background Research)

Computer vision has evolved dramatically over recent decades, evolving from a specialized academic field into a fundamental technology with extensive applications. Notably, the accuracy of computer vision for detection and recognition tasks has greatly improved with the rise of deep learning. However, accuracy varies based on factors like input data quality, the algorithms or models employed, training data, task complexity, and environmental conditions. Simple object detection tasks (such as identifying cats in photos) often achieve accuracies above 90%. In contrast, more intricate tasks, such as scene interpretation or emotion detection, may have lower accuracy rates. In real-world object detection scenarios, factors like lighting, occlusions, complex backgrounds, overlapping objects, and biases in AI training datasets can impact accuracy. Additionally, real-time image processing continues to pose challenges, requiring substantial computational power.

In summary, real-world object detection presents complex challenges with no straightforward solutions. This project introduces an innovative approach for precise image detection that holds significant potential for widespread application, particularly in the field of environmental assessment.



The Engineering Solution, Prototype/Model to be tested.

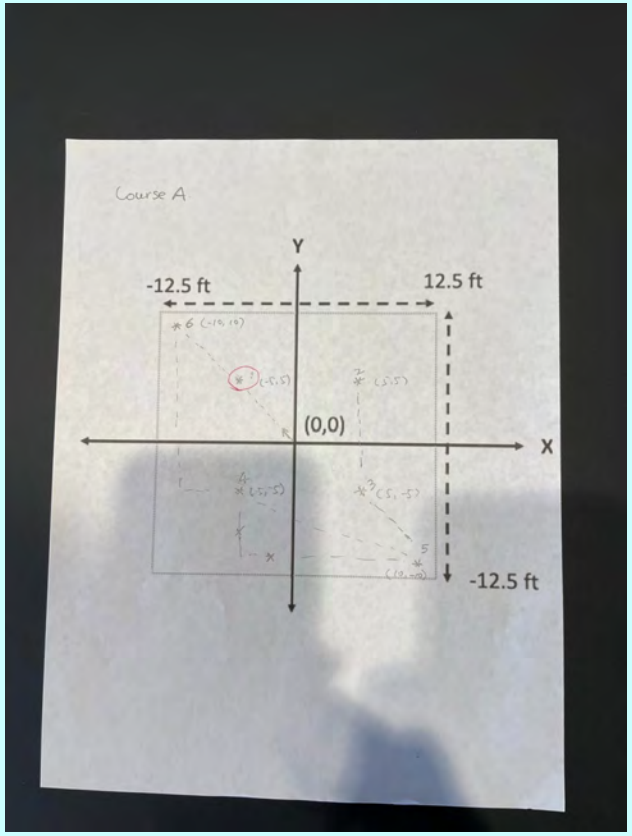
The engineer solution is to use Python flying drones, and use Aruco Marker in OpenCV library to process the real time image. OpenCV stands for Open Source Computer Vision Library, is a library of programming functions primarily aimed at real-time computer vision.

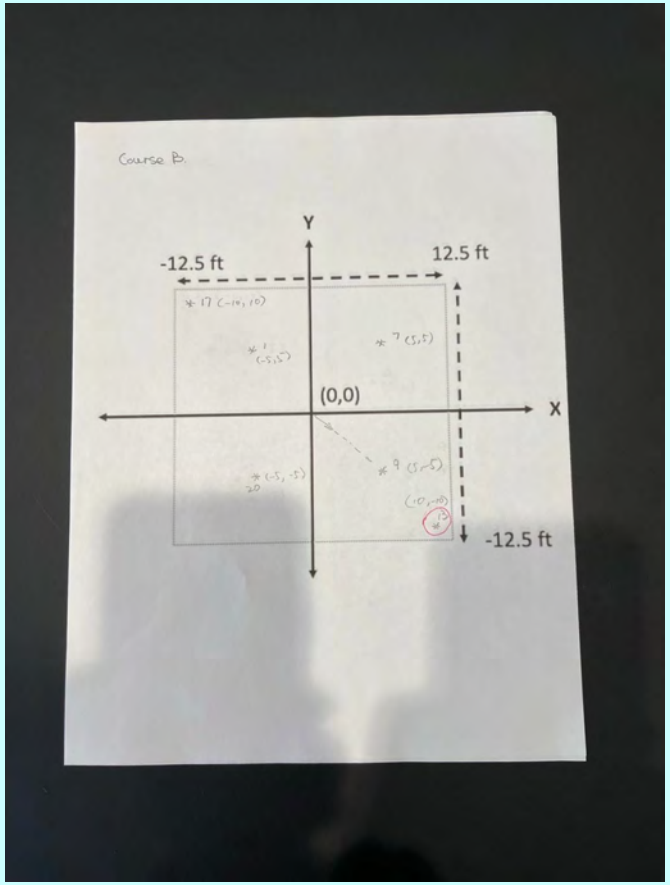
Materials

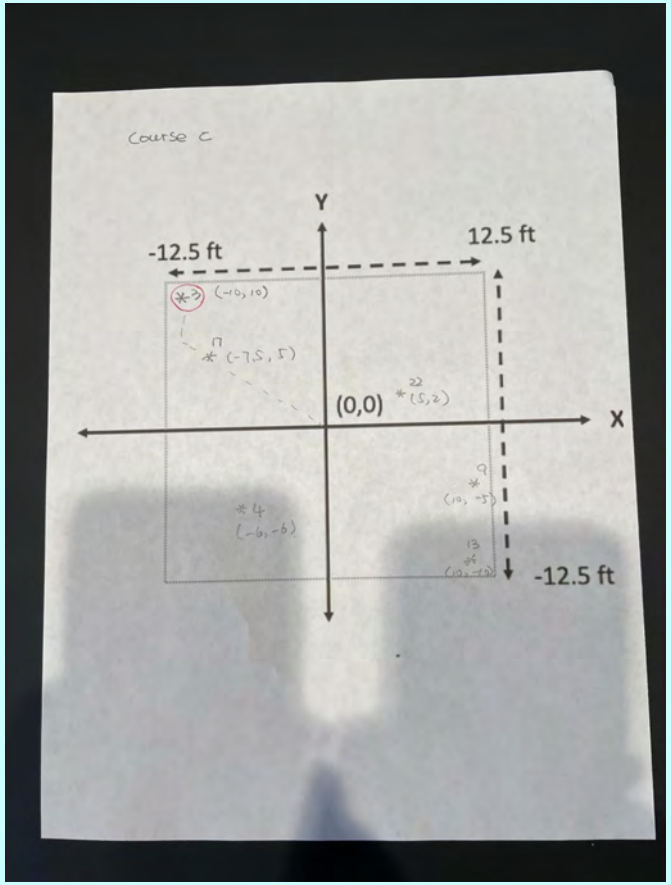
- Drone
- Ballons
- Aruco Markers
- Computer
- Testing field

Procedure

Design 3 different courses A, B, C. Each course has 6 balloons in different colors and each has a different Aruco tag attached. Identify all Aruco tags on the field and pop 1 balloon with specific color. Course A, Pop Red Balloon Aruco Tag 1







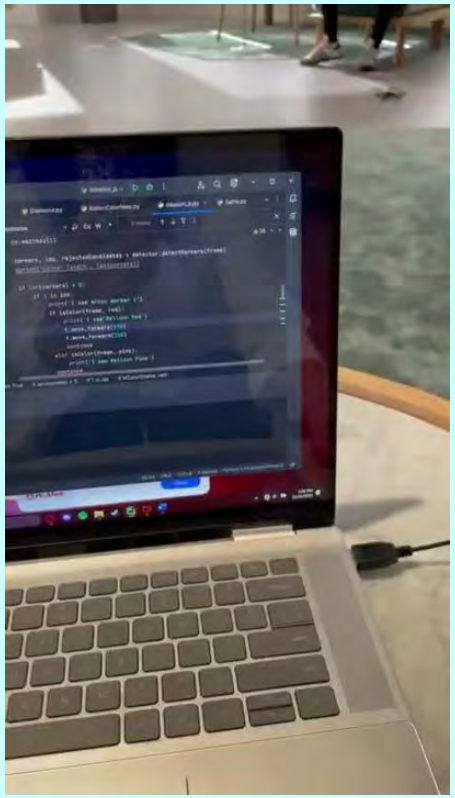
Course A, Pop Red Balloon Aruco Tag 1

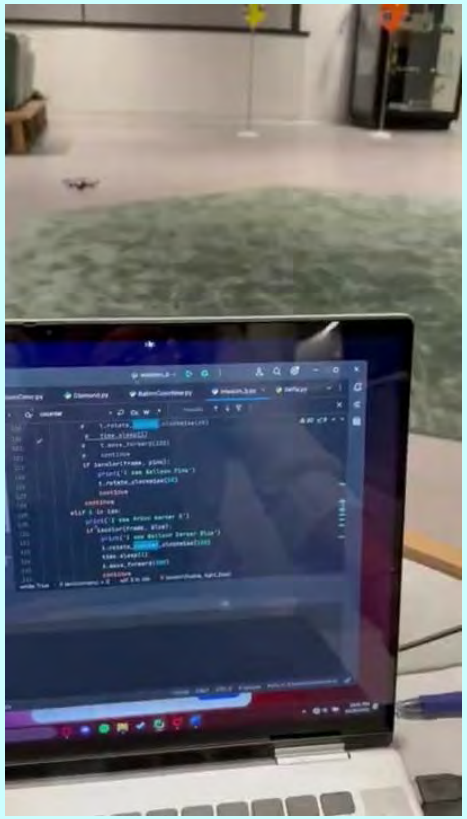
Course B, Pop Purple Balloon Aruco Tag 13

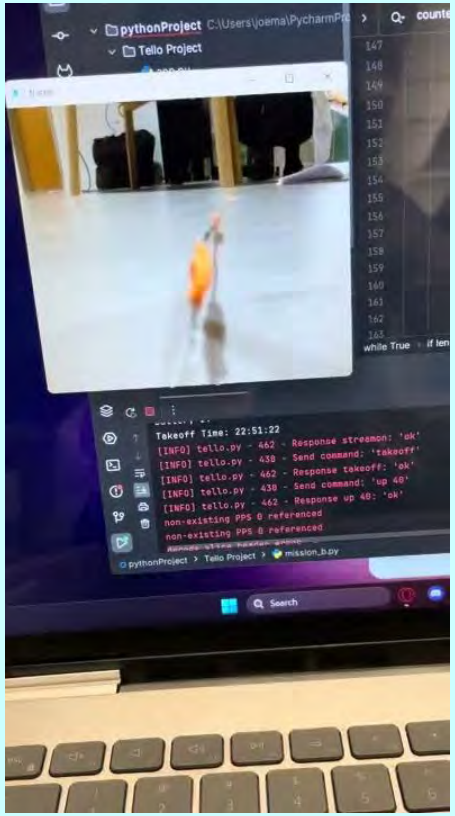
Course C, Pop Light Blue Balloon Aruco Tag 3

Results – Data/Observations

See attached recording for flying through each course:



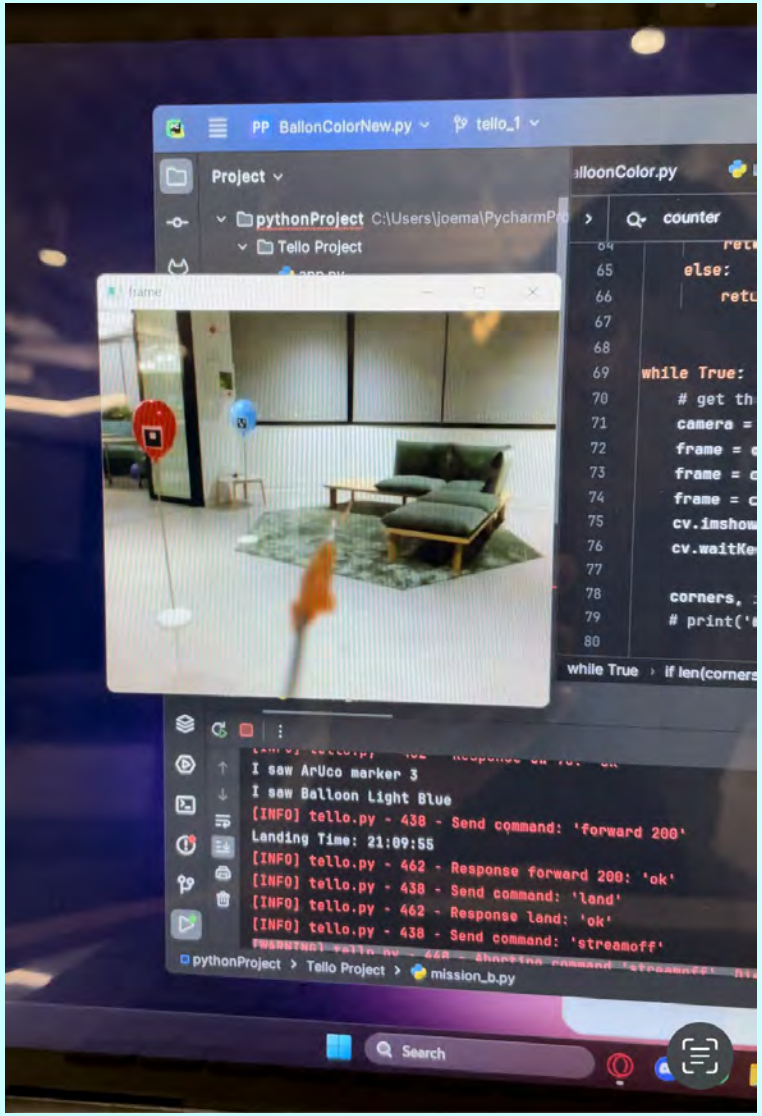




1> It is observed balloons Aruco tag detection is 100% and they can be seen very quickly without getting too close;
2> Due to flying error, the purple balloon in course B was missed, but drone flied by it. If the purpose of the task is to take pictures, the result is acceptable. Also flying error can be easily corrected in code; So this miss is insignificant.
3> If no Aruco tag presents, the video stream can't be delivered, drone sees nothing.

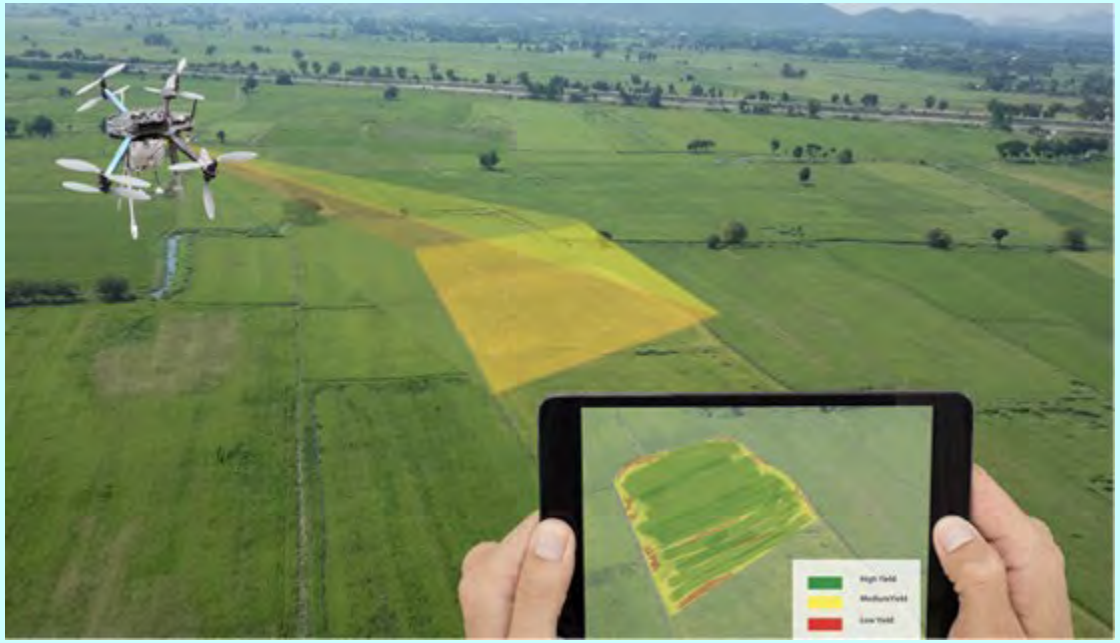
Discussion

While the use of Aruco tags for visual assistance in object detection may seem like a step back compared to the advancements in deep learning within AI and computer vision, it's important to consider the value of specialization in AI models. After the development of large-scale AI models, there's a growing need to tailor these "giant brains" into more focused, specialized models. By customizing an environment with elements like Aruco tags, we can optimize the performance of existing AI applications, such as drone cameras. This strategy accelerates the practical implementation of AI technologies, facilitating their integration into societal applications more swiftly. Consequently, this approach not only leverages the strengths of current AI developments but also hastens the enhancement of human lives through more efficient and targeted AI solutions.



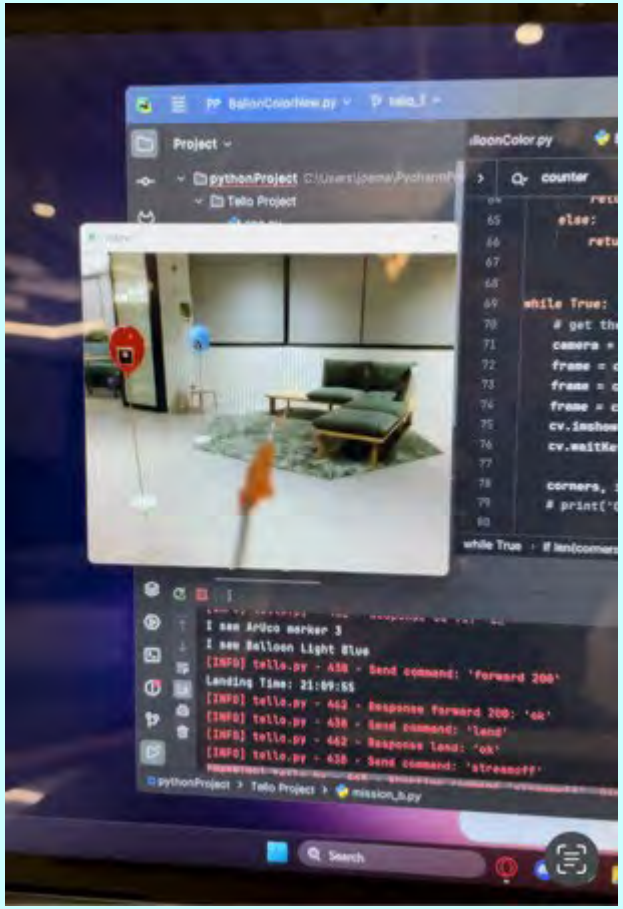
Conclusion

This project proofs the use of drones equipped with cameras and OpenCV's Aruco tags for object detection is successful. Preliminary experiments in controlled environments have demonstrated a 100% accuracy rate in identifying objects marked with Aruco tags. This promising approach could significantly enhance environmental monitoring and assessment efforts. Applications such as water quality monitoring, wildlife and habitat monitoring, plant health analysis, and disaster response could benefit from this cost-effective solution, leveraging advanced computer vision technology to achieve efficient and accurate environmental assessments.



Reflection/Application

This project has been incredibly enjoyable. I've gained an understanding of the basics and history of computer vision development, and learned to use Python for color identification and Aruco code recognition. One significant insight is that drone control is more challenging than it appears. Once airborne, numerous factors can alter its flight path, leading to missed targets. Even with Aruco tag detection, achieving precise actions remains difficult. The fascinating aspects of computer vision have sparked my curiosity for further exploration. Assisting computers in 'seeing' the world feels like providing humans with an additional set of eyes, together we see better.



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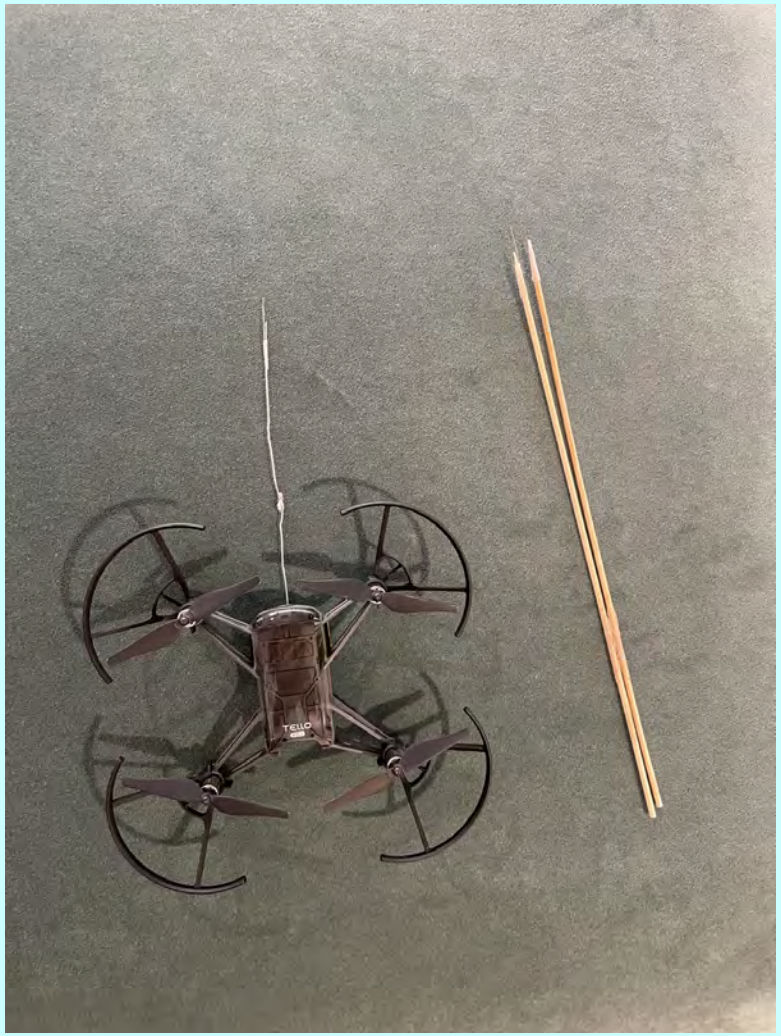
https://ceur-ws.org/Vol-2744/short14.pdf

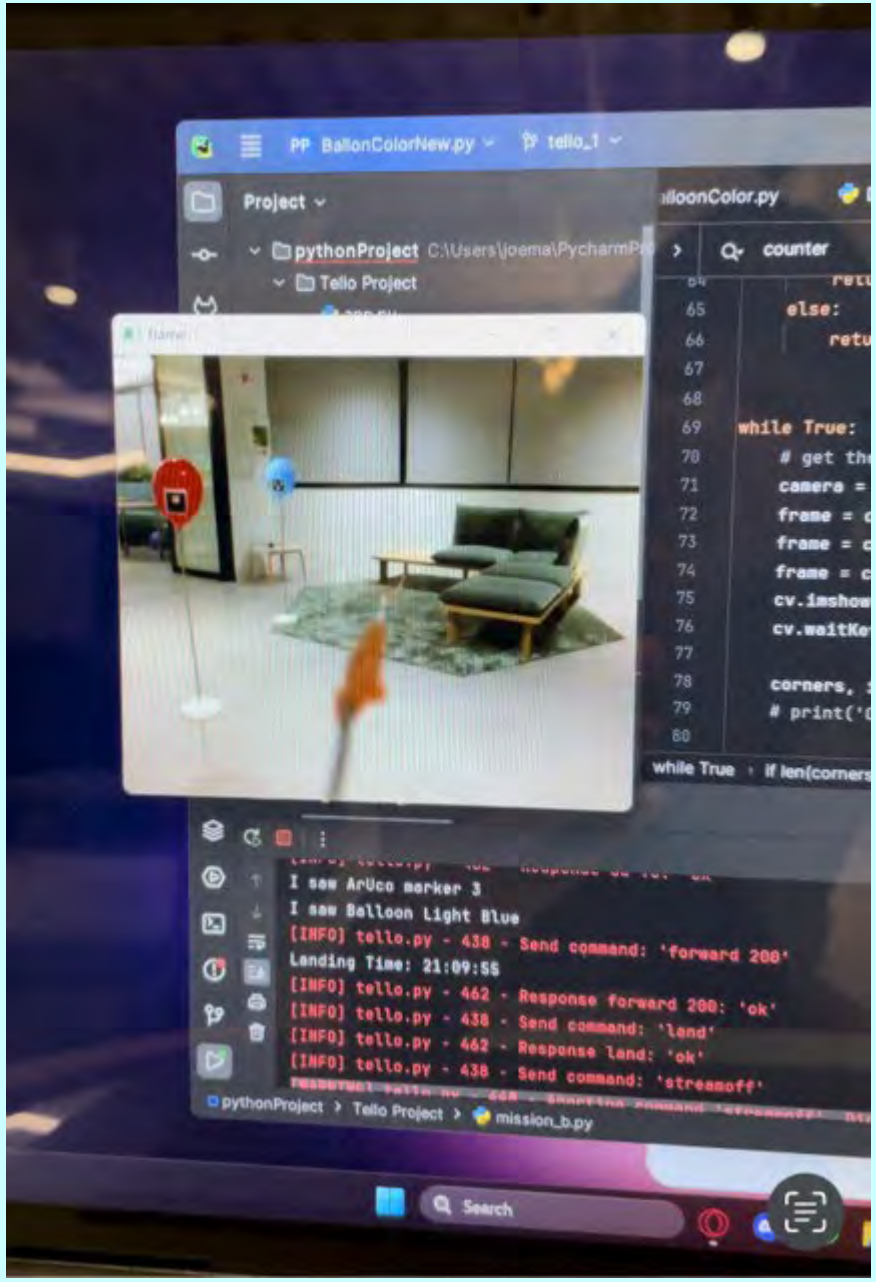
3> Accurate Autonomous UAV Landing Using Vision-Based Detection of ArUco-Marker: https://link.springer.com/chapter/10.1007/978-3-030-60337-3_18

4> The effects of ArUco marker velocity and size on motion capture detection and accuracy in the context of human body kinematics analysis. https://intapi.sciendo.com/pdf/10.37705/TechTrans/e2020036

5> OpenCV: https://opencv.org/about/

Work in progress photos:




BalloonColorNew.py
tello_1
Project
pythonProject
Tello Project
counter
while True:
I saw ArUco marker 3
I saw Balloon Light Blue
[INFO] tello.py - 438 - Send command: 'forward 200'
Landing Time: 21:09:55
[INFO] tello.py - 462 - Response forward 200: 'ok'
[INFO] tello.py - 438 - Send command: 'land'
[INFO] tello.py - 462 - Response land: 'ok'
[INFO] tello.py - 438 - Send command: 'streamoff'
pythonProject > Tello Project > mission_b.py
Search

```
mission_b_final.py 3
C: > Users > tingt > OneDrive > Documents > Joseph > Robotics > 23-Fall > code > mission_b_final.py > ...
from djitellopy import Tello
import cv2 as cv
import numpy as np
from datetime import datetime
import time

# this work is done by Joseph Bohman mainly for projects in Fall 2023
# bgr order
red = [0, 0, 255]
blue = [255, 0, 0]
green = [0, 255, 0]
pink = [220, 200, 248]
purple = [128, 0, 128]
light_green = [50, 205, 50]
yellow = [0, 234, 255]
orange = [28, 172, 255]
light_blue = [230, 216, 173]

t = Tello()
t.connect()
print('battery', t.get_battery())
t.streamon()

current_time = datetime.now()
formatted_time = current_time.strftime('%H:%M:%S')
print('Takeoff Time:', formatted_time)

t.takeoff()
t.move('up', 40)

dictionary = cv.aruco.getPredefinedDictionary(cv.aruco.DICT_4X4_250)
parameters = cv.aruco.DetectorParameters()
detector = cv.aruco.ArucoDetector(dictionary, parameters)


def get_limits(color):
    # here insert the bgr values which you want to convert to hsv
    c = np.uint8([[color]])
    hsvc = cv.cvtColor(c, cv.COLOR_BGR2HSV)

    lowerlimit = hsvc[0][0][0] - 10, 100, 100
    upperlimit = hsvc[0][0][0] + 10, 255, 255

    lowerlimit = np.array(lowerlimit, dtype=np.uint8)
    upperlimit = np.array(upperlimit, dtype=np.uint8)

    return lowerlimit, upperlimit
```

```
def iscolor(image, color):
    lowerlimit, upperlimit = get_limits(color)
    # print('lower', lowerlimit)
    # print('upper', upperlimit)

    # input image is in BGR format from OpenCV
    # Converting BGR image to HSV format
    image_hsv = cv.cvtColor(image, cv.COLOR_BGR2HSV)

    # get input color mask
    mask = cv.inRange(image_hsv, lowerlimit, upperlimit)

    if mask is not None:
        # print('color mask', mask)
        return True
    else:
        return False


while True:
    # get the image from tello
    camera = t.get_frame_read()
    frame = camera.frame
    frame2 = cv.cvtColor(frame, cv.COLOR_BGR2RGB)
    frame2 = cv.resize(frame2, (420, 360))
    cv.imshow('frame', frame2)
    cv.waitKey(1)

    corners, ids, rejectedCandidates = detector.detectMarkers(frame)
    # print('Corner length', len(corners))

    if len(corners) > 0:
        if 1 in ids:
            print('I saw ArUco marker 1')
            if iscolor(frame, red):
                print('I saw Balloon Red')
                t.move_forward(270)
                t.move_forward(150)
                continue
            if iscolor(frame, pink):
                print('I saw Balloon Pink')
                time.sleep(2)
                t.rotate_counter_clockwise(90)
            continue
        elif 2 in ids:
            print('I saw ArUco marker 2')
            if iscolor(frame, blue):
                print('I saw Balloon Darker Blue')
                # t.rotate_clockwise(30)
                t.move_forward(20)
```

```
            break
        elif iscolor(frame, pink):
            print('I saw Balloon Pink')
    elif 3 in ids:
        print('I saw ArUco marker 3')
        if iscolor(frame, green):
            print('I saw Balloon Darker Green')
            t.rotate_clockwise(20)
            t.move_forward(150)
            continue
        elif iscolor(frame, light_blue):
            print('I saw Balloon Light Blue')
            t.move_forward(280)
            t.rotate_clockwise(160)
            t.move_forward(300)
            continue
    elif 4 in ids:
        print('I saw ArUco marker 4')
        if iscolor(frame, red):
            print('I saw Balloon Red')
            t.rotate_counter_clockwise(60)
            time.sleep(1)
            t.move_forward(220)
            continue
        elif iscolor(frame, pink):
            print('I saw Balloon Pink')
            t.rotate_clockwise(50)
            continue
        else:
            continue
    elif 5 in ids:
        print('I saw ArUco marker 5')
        if iscolor(frame, blue):
            print('I saw Balloon Darker Blue')
            t.rotate_counter_clockwise(130)
            time.sleep(1)
            t.move_forward(300)
            continue
    elif 6 in ids:
        print('I saw ArUco marker 6')
        if iscolor(frame, green):
            print('I saw Darker Green')
            t.rotate_counter_clockwise(150)
            time.sleep(1)
            t.move_forward(360)
            continue
```

```
            t.move_forward(150)
            continue
    elif 9 in ids:
        print('I saw ArUco marker 9')
        if iscolor(frame, light_green):
            print('I saw Balloon Light Green')
            t.move_right(200)
            t.move_forward(300)
            t.rotate_counter_clockwise(20)
            t.move_forward(20)
            continue
        elif iscolor(frame, yellow):
            print('I saw Balloon Yellow')
            t.rotate_clockwise(25)
            continue
        else:
            continue
    elif 20 in ids:
        print('I saw ArUco marker 20')
        if iscolor(frame, pink):
            print('I saw Balloon Pink')
            break
    elif 13 in ids:
        print('I saw ArUco marker 13')
        if iscolor(frame, purple):
            print('I saw Balloon Purple')
            t.move_forward(170)
            t.move_back(30)
            t.rotate_counter_clockwise(100)
            t.move_forward(300)
            continue
        if iscolor(frame, orange):
            print('I saw Balloon Orange')
            t.rotate_clockwise(90)
            continue
        else:
            continue
```

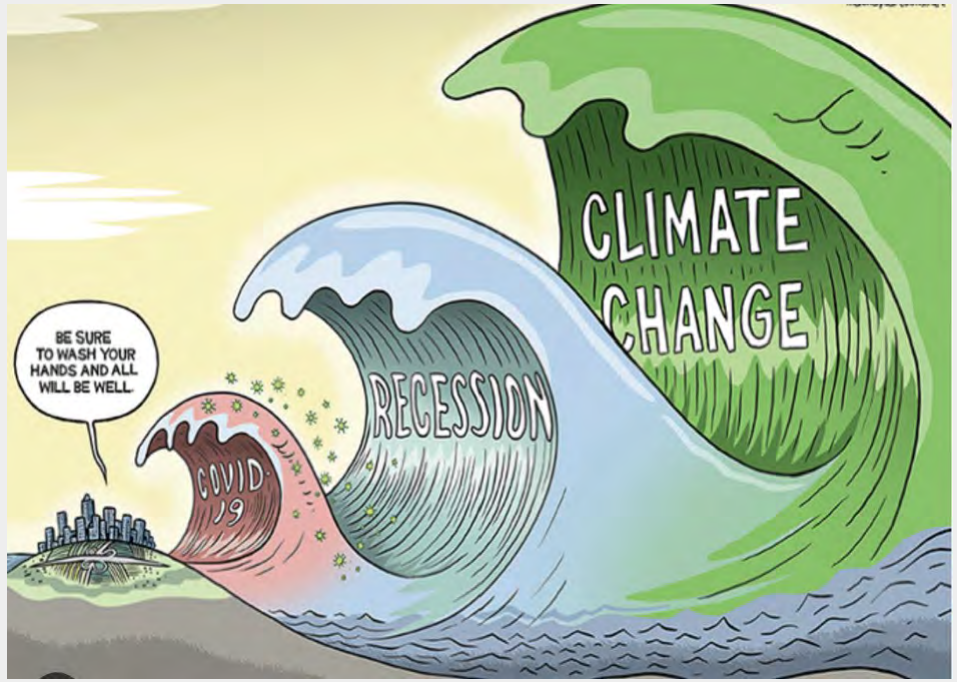
```
        elif 17 in ids:
            print('I saw ArUco marker 17')
            if iscolor(frame, light_green):
                print('I saw Balloon Light Green')
                continue
            if iscolor(frame, red):
                print('I saw Balloon Red')
                t.move_forward(260)
                continue
            else:
                continue
        elif 22 in ids:
            print('I saw ArUco marker 22')
            if iscolor(frame, purple):
                print('I saw Balloon Purple')
                t.rotate_clockwise(40)
                continue
        else:
            continue
    else:
        # print(' No ArUco marker found')
        t.rotate_clockwise(10)
        continue

    # wait for hitting q key to stop
    if cv.waitKey(1) & 0xFF == ord('q'):
        break

current_time = datetime.now()
formatted_time = current_time.strftime('%H:%M:%S')
print('Landing Time:', formatted_time)
t.land()
```

Project 3

Irvine Climate Analysis Model

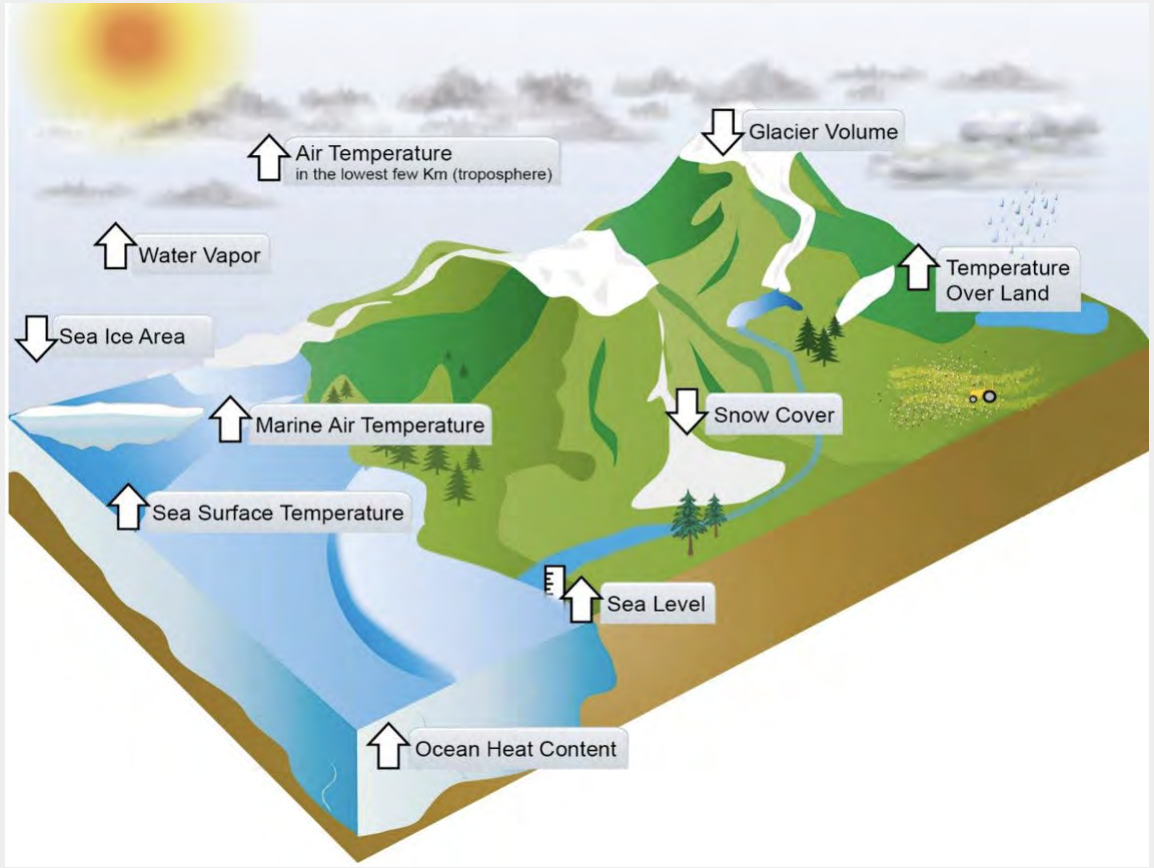
Abstract

Global climate is changing and this change is apparent across a wide range of observations. The global warming of the past 50 years is primarily due to human activities. Global climate is projected to continue to change over this century and beyond. The magnitude of climate change beyond the next few decades depends primarily on the amount of heat-trapping gases emitted globally, and how sensitive the Earth's climate is to those emissions. In this project, I will use the current greenhouse data (focusing on Carbon Dioxide) as a baseline to build a climate model to predict the climate change trend in next century using a simulation software. Based on the results, some environmental policies on climate matter are suggested to city Irvine government to help slow down the climate change in a long run.



Problem

What factors are involved in a local level are impacting climate change change? What policies can a local government such as city Irvine implement to slow down the climate change?



Introduction (Background Research)

Global warming is the long-term heating of Earth’s surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth’s atmosphere. This term is not interchangeable with the term "climate change." Since the pre-industrial period, human activities are estimated to have increased Earth’s global average temperature by about 1 degree Celsius (1.8 degrees Fahrenheit), a number that is currently increasing by more than 0.2 degrees Celsius (0.36 degrees Fahrenheit) per decade. The current warming trend is unequivocally the result of human activity since the 1950s and is proceeding at an unprecedented rate over millennia.

Climate change is a long-term change in the average weather patterns that have come to define Earth’s local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term. Changes observed in Earth’s climate since the mid-20th century are driven by human activities, particularly fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth’s atmosphere, raising Earth’s average surface temperature. Natural processes, which have been overwhelmed by human activities, can also contribute to climate change, including internal variability (e.g., cyclical ocean patterns like El Niño, La Niña and the Pacific Decadal Oscillation) and external forcings (e.g., volcanic activity)

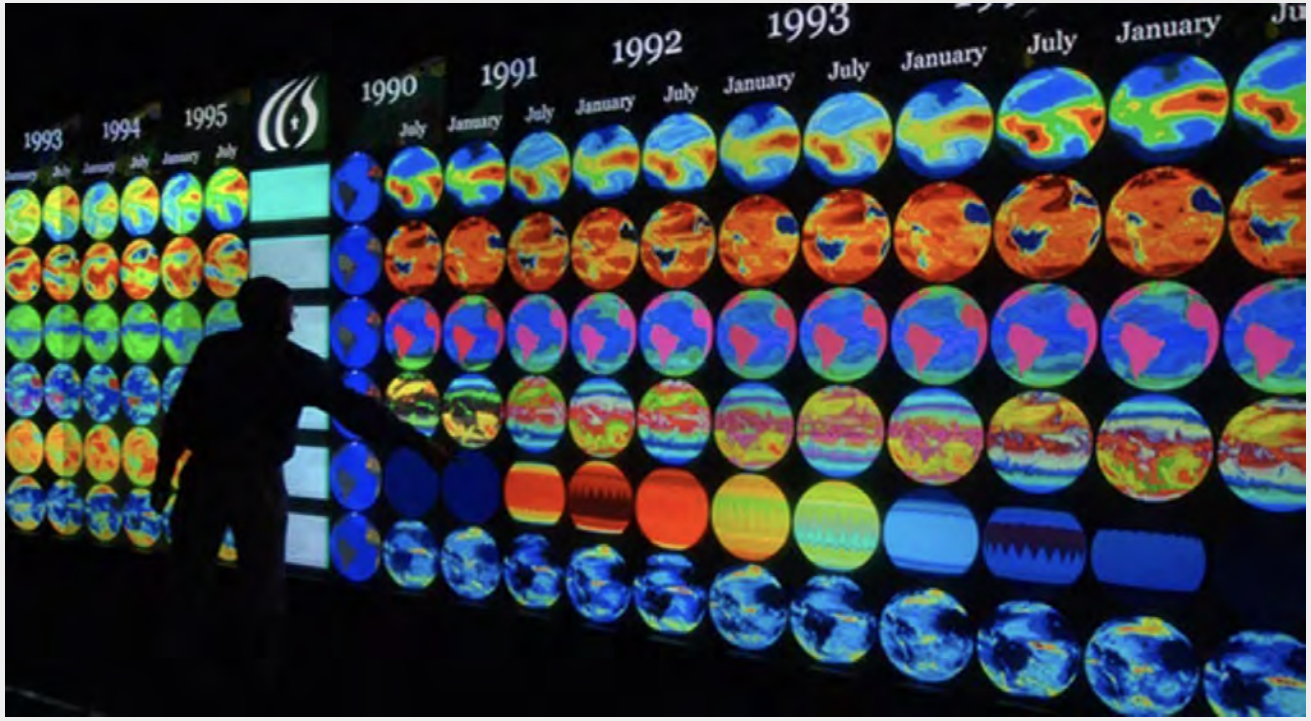
Scientists use observations from the ground, air, and space, along with computer models, to monitor and study past, present, and future climate change. Climate data records provide evidence of climate change key indicators, such as global land and ocean temperature increases; rising sea levels; ice loss at Earth’s poles and in mountain glaciers; frequency and severity changes in extreme weather such as hurricanes, heatwaves, wildfires, droughts, floods, and precipitation; and cloud and vegetation cover changes.

Hypothesis

Based on the current climate change rate, if we do nothing, Irvine temperature will raise 6F degree in next 100 years, but if we start to make some changes in the area of energy, transportation, land and industry, we will be able to reduce this rise to a lower number.

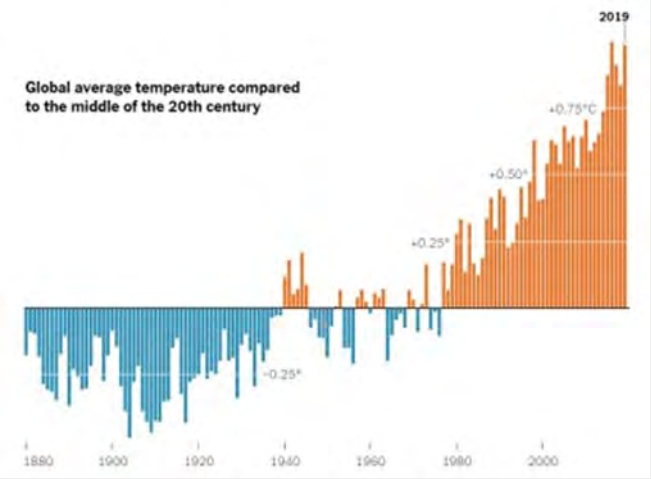
Materials

A computer with Climate Simulation Software En-ROADS and a research-driven mindset.



Procedure

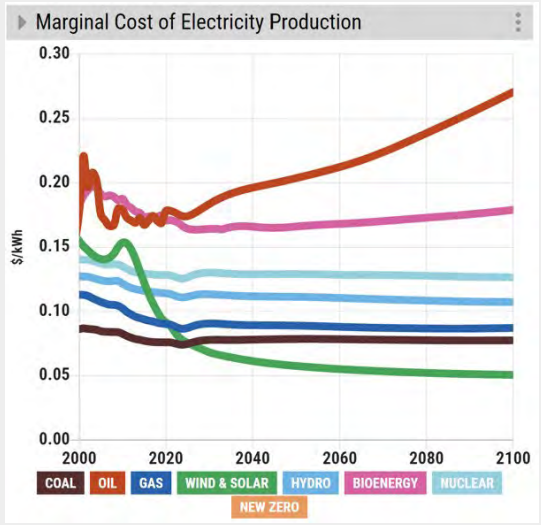
- Find out greenhouse gas emissions inventory in city Irvine, details see reference 4.
- Focusing on Carbon Dioxide (CO2) from Greenhouse Gas (GHG), find out the main CO2 sources in communitywide operations.
- Input this data to simulate the impact in next century using En-ROADS software.
- Taking top 3 CO2 emission in Irvine which is Energy, Transportation and Buildings and Industry, changing the parameter, observing the result.
- Based on the result, climate change policies are suggested.



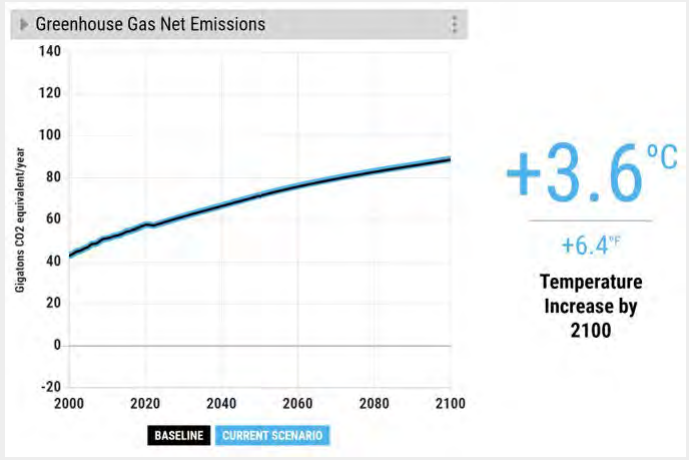
Results

Here are the simulation result:

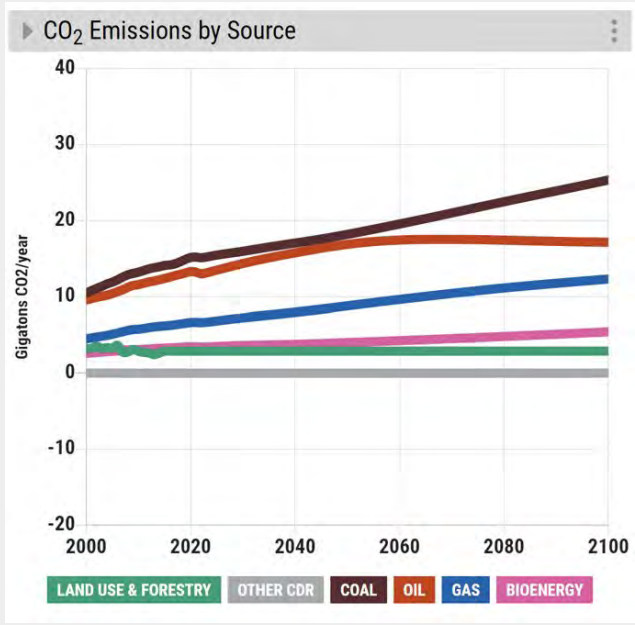
1> Energy used to generate electricity:



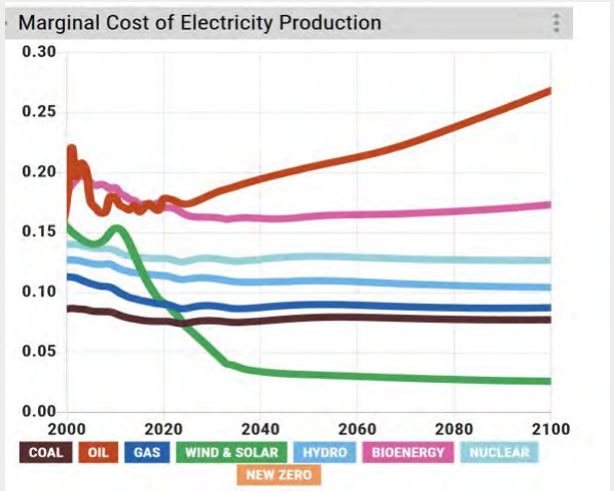
Current energy cost



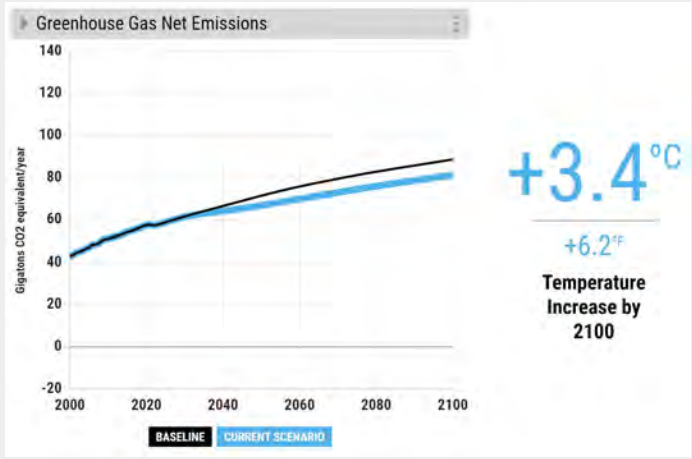
Current temperature increase by 2100



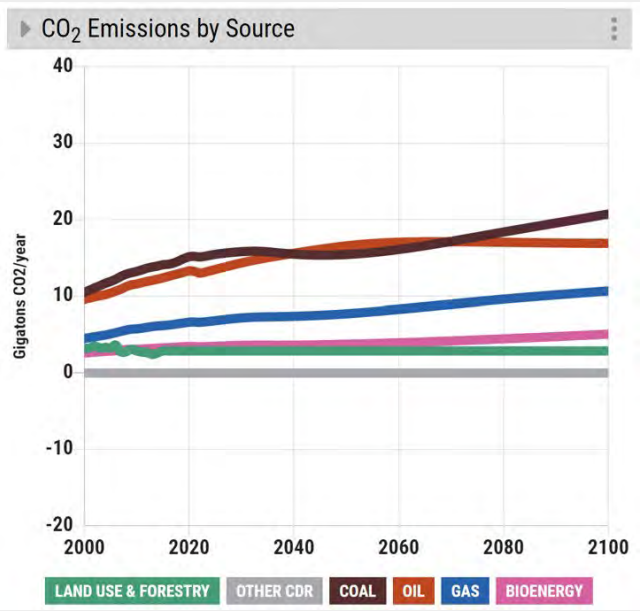
CO2 emission by 2100



After reduce renewables tax/subsidy by -0.03 $/kWh



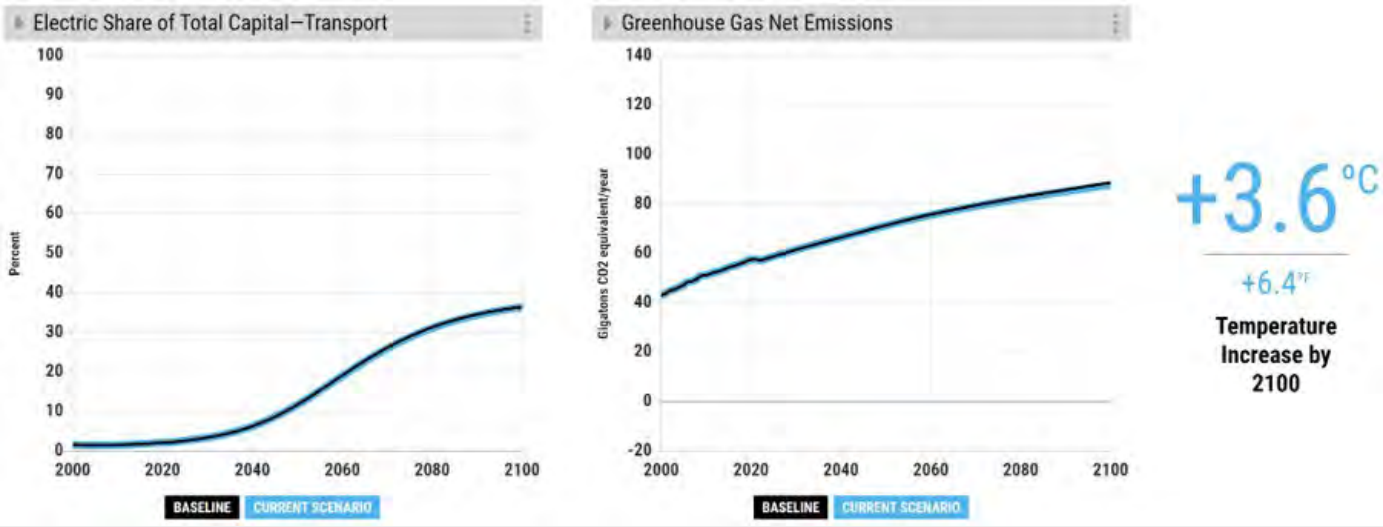
Temperature increase by 2100 after renewables tax/subsidy



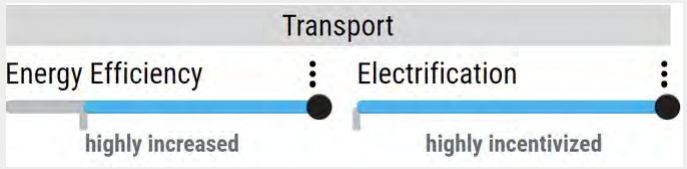
CO2 emission by 2100 after tax/subsidy

Results(Continued)

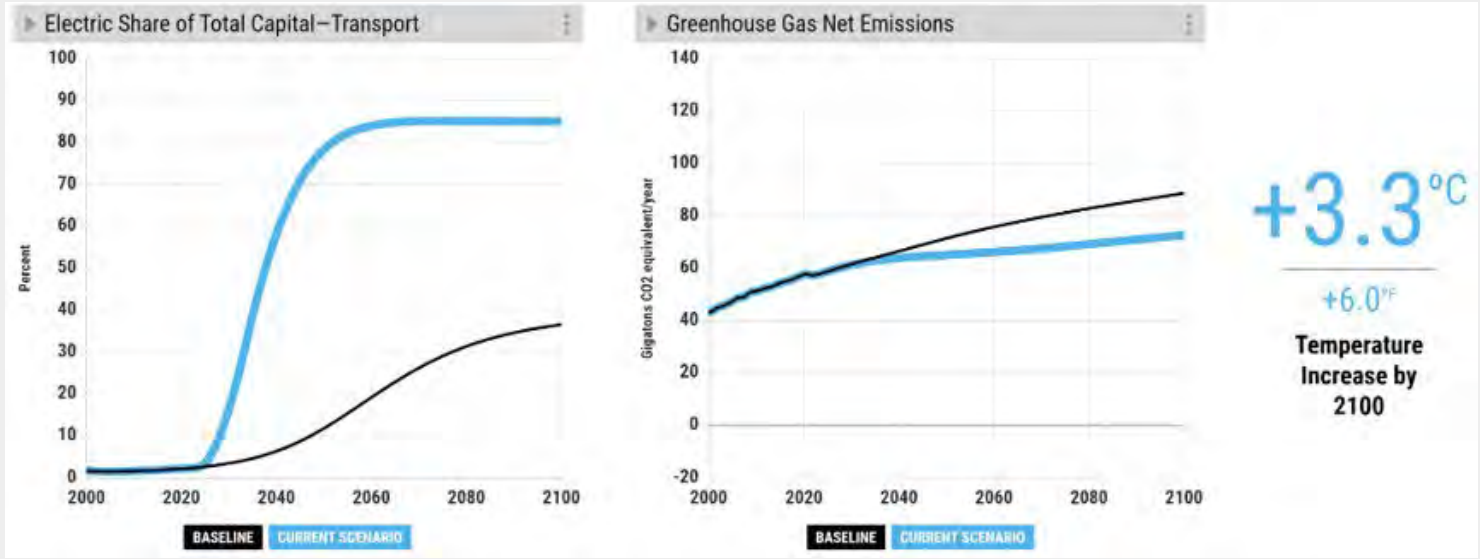
2. Transportation



After adjust these two parameters:

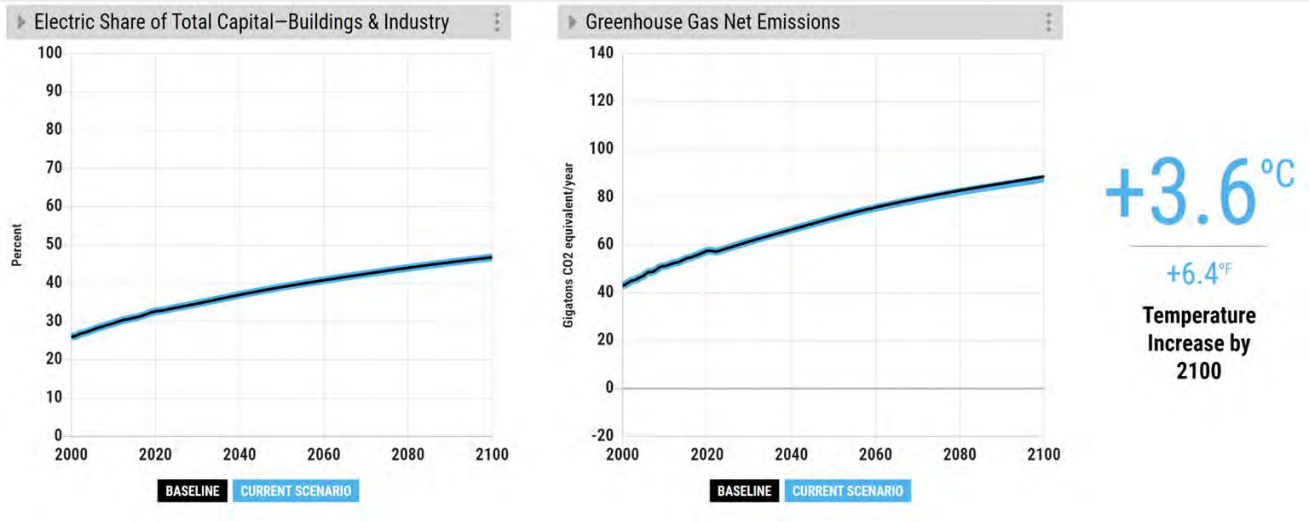


We have new chart below:

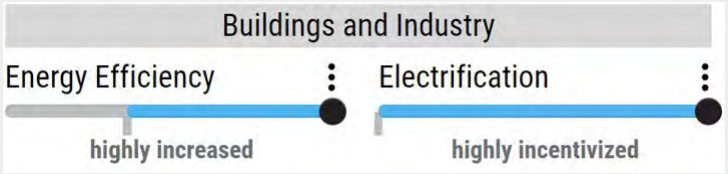


Results(Continued)

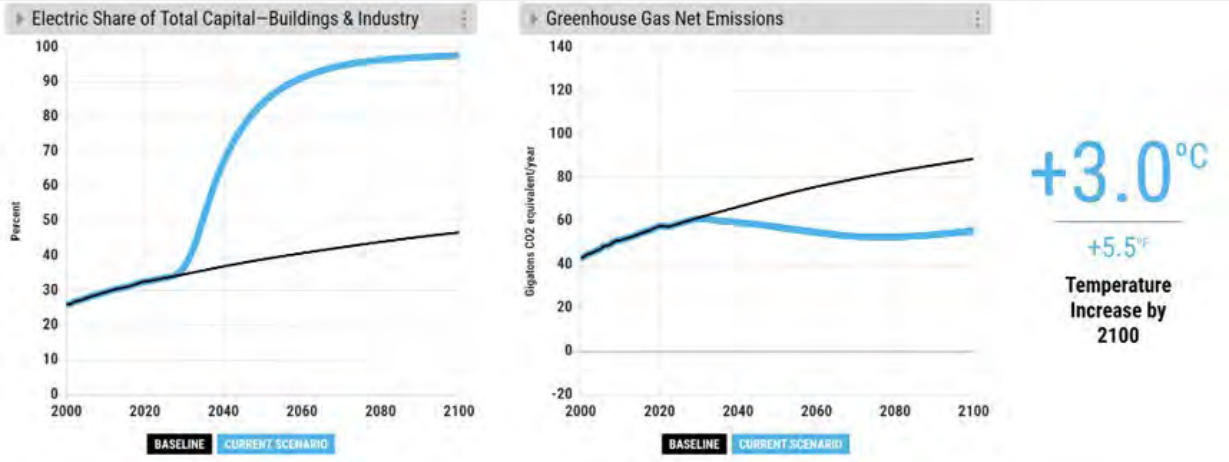
3. Buildings & Industry



After adjusting these two parameters:



We have the new chart below:



Discussion

Here are few things I would like to discuss after playing around with the simulation:

1> The right policy from the government does help climate change;

2> The buildings consumes a lot of energy than I thought;

3> THere are many more areas that we can try other than just focusing on big business, such as personal lifestyle, what we use daily and what we eat etc. Will explore them more in the future projects.

Conclusion

Here is the conclusion:

Based on the simulation result, I would suggest to city irvine government to start the following policies:

1> Provide tax or subsidy relief to renewables energy business to encourage producing more renewable energy, it will help to reduce the emission of CO2 and reduce the temperature rising;

2> Invest on the technology in energy efficiency and electrification to car manufacturers, it will help to lower the CO2 emission and easy on the climate change;

3> Finding different ways to make building more energy efficient and use new technologies in industries to help increase energy and electrification. As chart shows, it will have a bigger impact on climate change than transportation.

If each city starts to implement policies on environmental front like suggested above, together we are hopeful to control the climate change in next century.

Reflection

- Although climate change is a major topic today, it took time for me to identify the right software for the simulation work I envisioned. Initially, I attempted to build a project using Apache Climate App, only to discover that the base project had been retired, leaving key libraries inaccessible. After some trial and error, I explored other tools, including SimClimat and En-ROADS. Ultimately, I chose En-ROADS for its comprehensive suite of tools and ability to model various variables effectively.
- Through this process, I not only learned to navigate technical challenges but also deepened my understanding of the science behind climate change and how different factors interact to impact the environment. Initially, I planned to focus solely on Irvine, but I soon realized that the effects of climate change extend far beyond local boundaries, prompting me to think on a broader scale. This journey reshaped my perspective and approach to tackling environmental issues.
- In the end, I was proud to recommend data-driven policies to the city of Irvine, backed by scientific insights generated through the simulation. It was a rewarding experience that blended technical problem-solving with a meaningful contribution to my community.

References Cited

1> https://climate.apache.org/
2> https://nca2014.globalchange.gov/
3> https://climate.nasa.gov/interactives/climate-time-machine/
4> https://legacy.cityofirvine.org/civica/filebank/blobdload.asp?BlobID=34472
5> https://web.lmd.jussieu.fr/~crlmd/simclimat/index_english.html
6> https://www.epa.gov/ghgemissions
7>https://climate.nasa.gov/ask-nasa-climate/2910/what-is-the-suns-role-in-climate-change/

Oct 3, 2022:

1. Install Climate Workbench 1.3.0 here: https://climate.apache.org/, then create a project folder call "Science Fair", unzip the installed zip file there;
2. Install Node JS and Microsoft VS Code;
3. Use VS code to open the project in the fold under "Science Fair";
4. Read file "README.md";
5. Then checkout this: https://cwiki.apache.org/confluence/display/CLIMATE/Getting+Started#GettingStarted-Introduction, and start to explore by reading through for now;

Oct 15, 2022:
Downloaded Apache Climate Workbench and played around with it.
Mainly study the example and get it running.

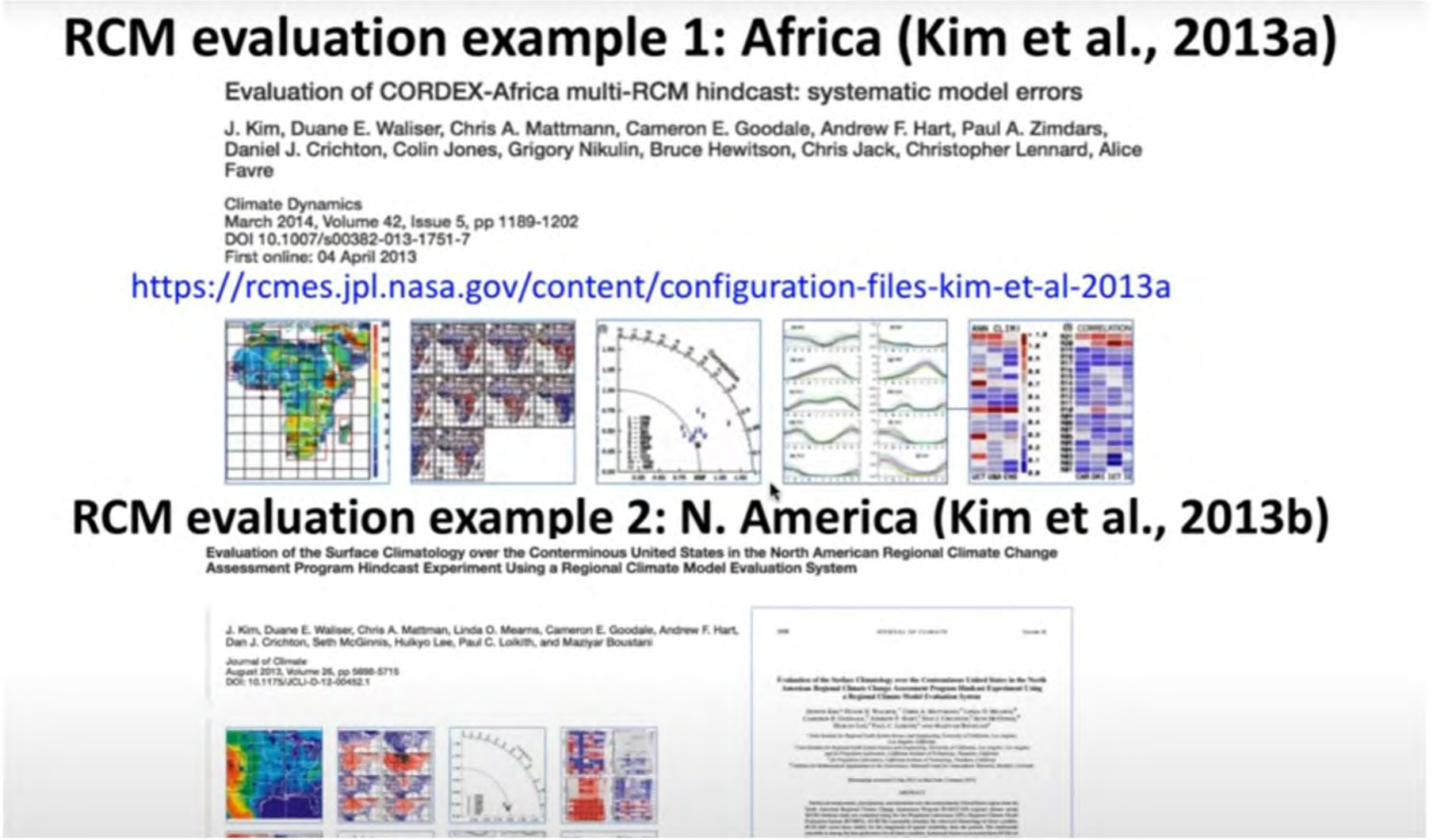
Nov 23, 2022:
After trying few times, found that the tool has been retired, so adding new functions won't run anymore. The example I saw early is no longer available, so I have to find a different tool.

Dec 23, 2022:
After research, finalized two simulation software: SimClimat and En-ROADS, decide to use En-ROADS since it has more factors that I can choose.
Getting local data at here: Irvine current Greenhouse data: https://legacy.cityofirvine.org/civica/filebank/blobdload.asp?BlobID=34472

Apache Open Climate Workbench

https://climate.apache.org/ --- there is a video that has many useful information.

Minutes at 36 minutes,

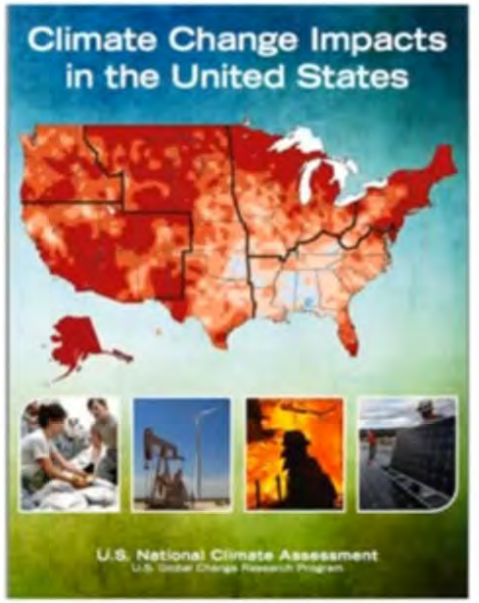


Where to find more information:

- http://rcmes.jpl.nasa.gov
- http://climate.apache.org/
- General Questions: rcmes-general@jpl.nasa.gov
- Technical Questions: rcmes-dev@jpl.nasa.gov

Future Direction

- Development is ongoing…
  - Adding more metrics to assure traceability and reproducibility of model evaluation results.
  - Growing user and developer base.
- Develop a comprehensive model evaluation system for regional climate assessments, including CORDEX and the US National Climate Assessment.



http://nca2014.globalchange.gov/

Project 4

Bird Diversity
Around the San Pedro River


CAUTION!
EXTREME
HEAT
DANGER

300+

Bird species nest by the San Pedro River

Research Question

Question How will bird species diversity be affected by an increased distance from the San Pedro River?

Hypothesis Bird species diversity will not change significantly. Each environment will have species that fulfill ecological niches.

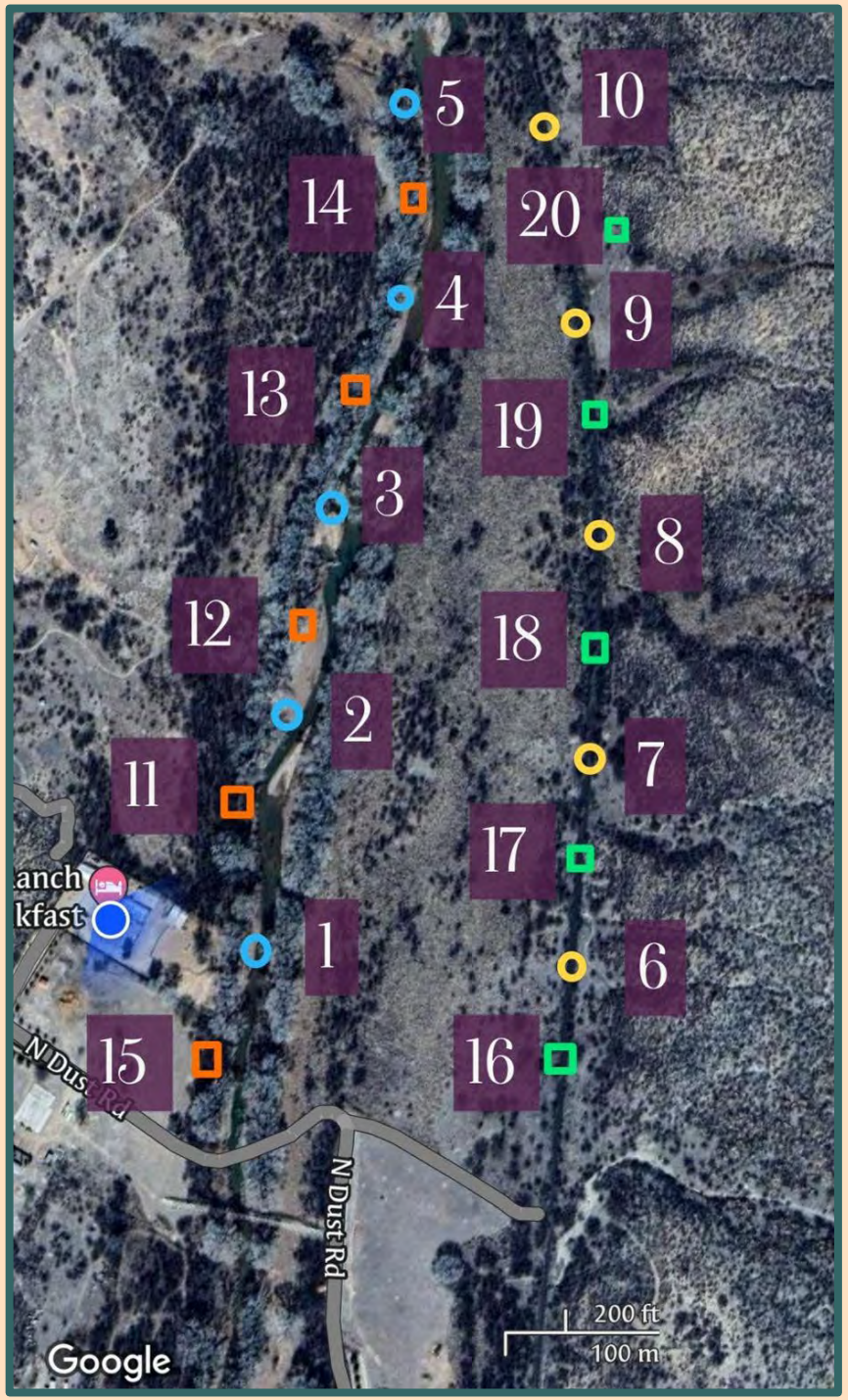
Merlin Bird ID

From the Cornell Lab of Ornithology

http://bit.ly/MerlinApp

Site Map

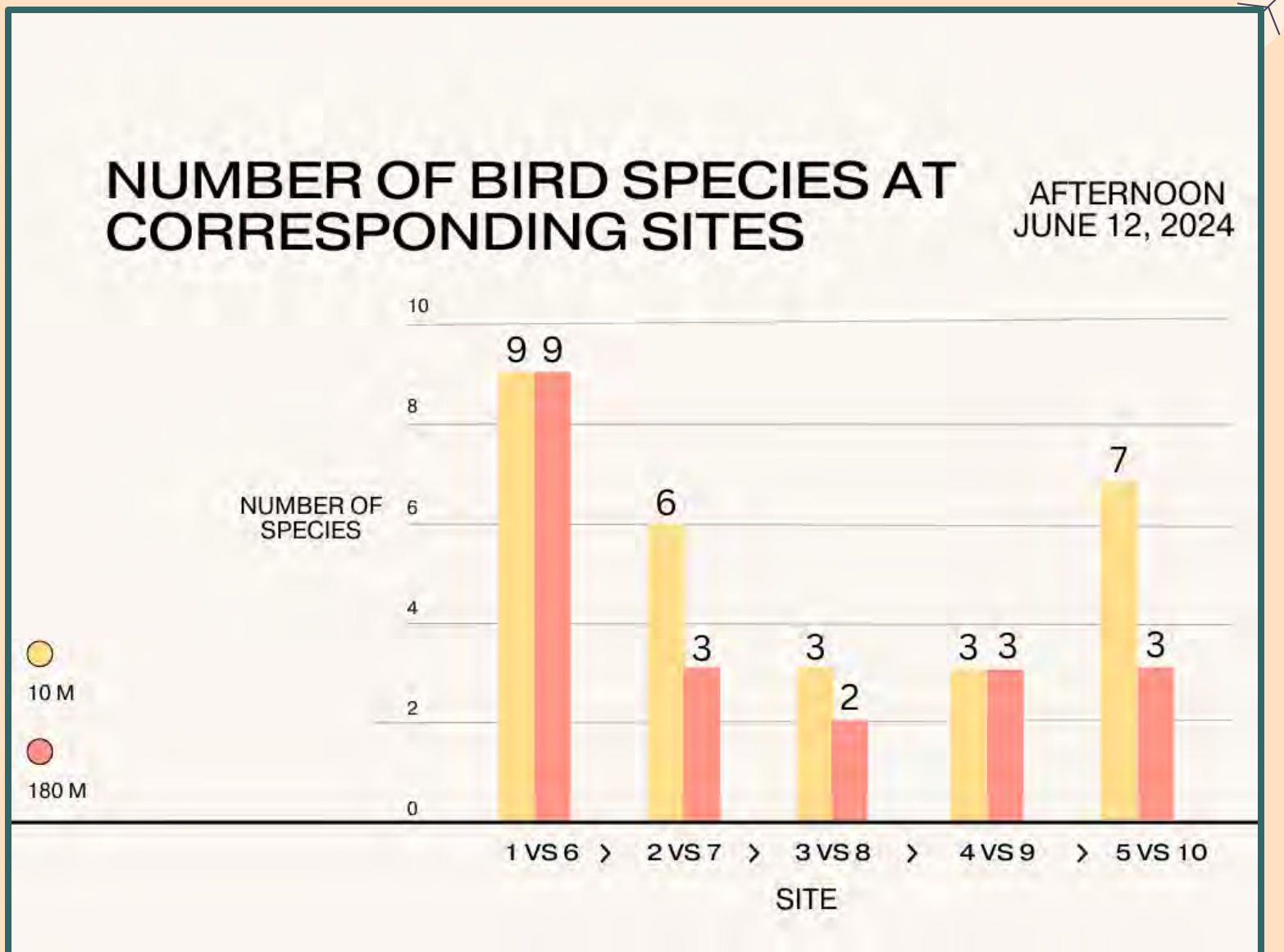
- 20 sites total
- West bank: 10 m from river
- East bank: 180 m from river
- Each site 75 m away from others



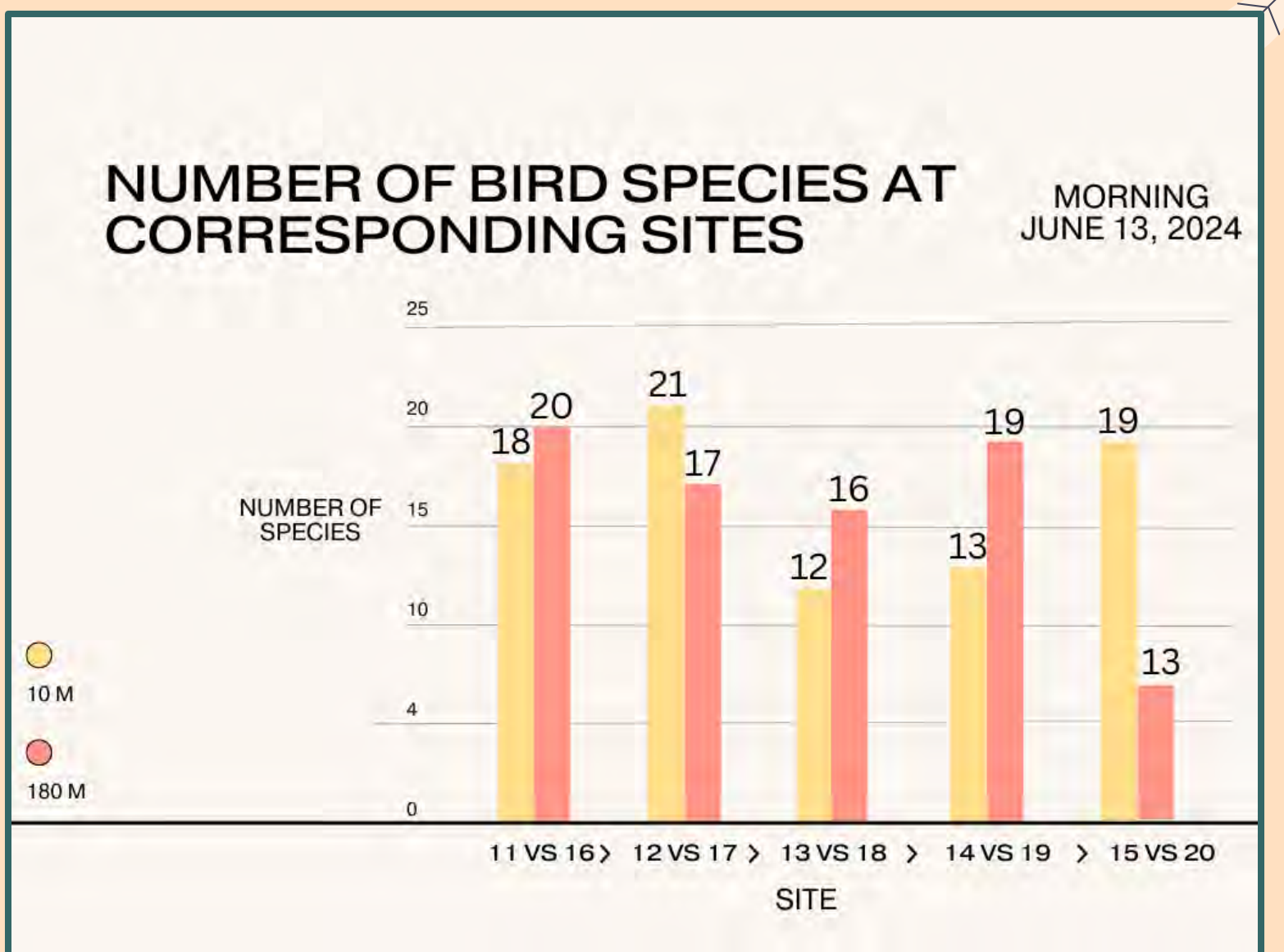
Research Methods

- **June 12** 6:08 PM to 7:21 PM, sites 1-10
- **June 13** 6:35 AM to 7:55 AM, sites 11-20
- 10 min recording at each site

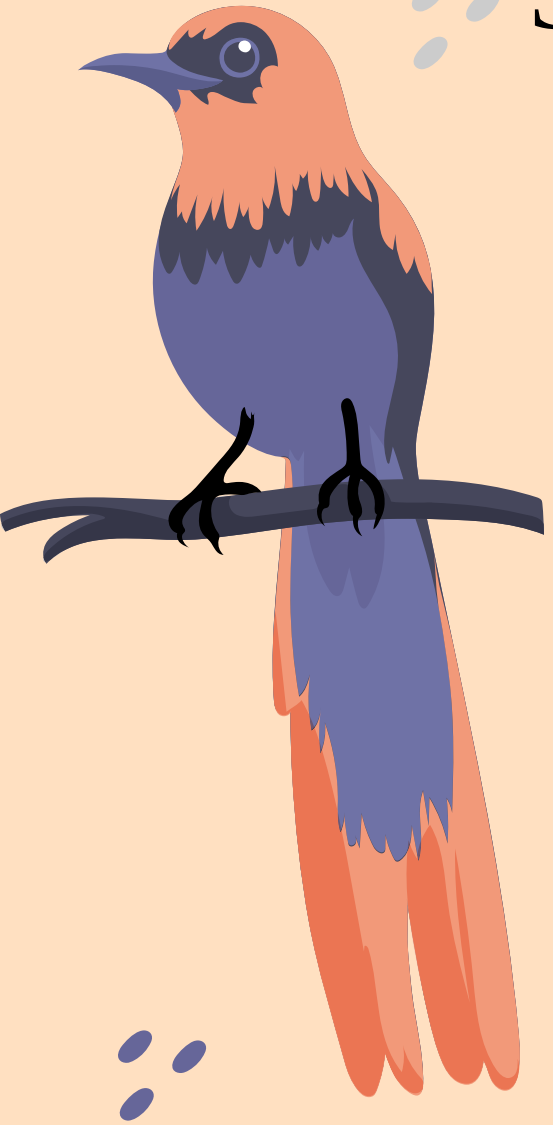
Graph 1 - Afternoon



Graph 2 - Morning



Stats Analysis: Morning



Step 1:
H_o: u_1 = u_2,
H_a: u_1 ≠ u_2,
u_1 = the mean number of sightings for each species per 5 sites 10 meters from the river
u_2 = the mean number of sightings for each species per 5 sites 180 meters from the river, **2 Sample T Test**

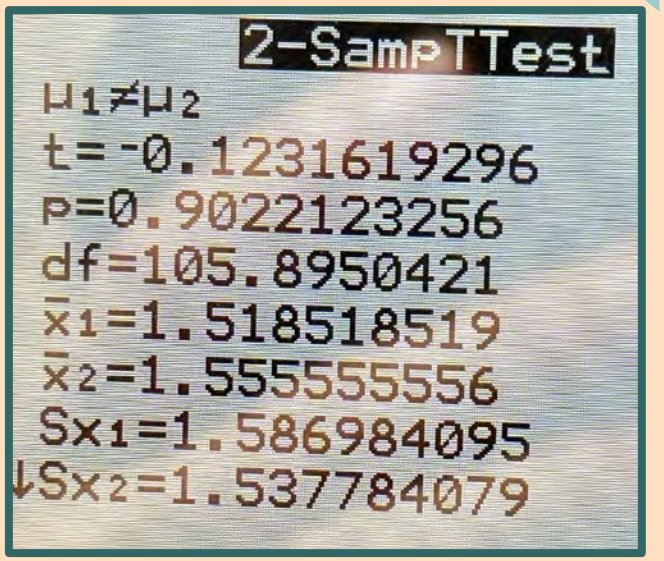
Step 2:
Random sample taken
54 < 10% of all birds species in the San Pedro River

- Assume independent observations

54 > 30, by CLT (central limit theorem)

- Assume approximately normal

Steps 3 and 4:
T value of -0.1232, p value of 0.9022 obtained



Because our p value of 0.9022 is greater than significance level of 0.05, we fail to reject H_o, meaning that there is significant evidence that there is no difference in the mean number of species per 5 sites 10 meters from the river and 180 meters from the river.

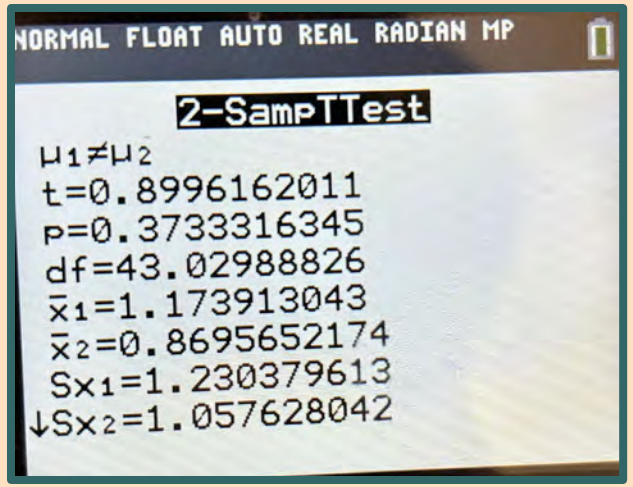
Stats Analysis: Afternoon

Step 1:
H_o: u_1 = u_2,
H_a: u_1 ≠ u_2,
u_1 = the mean number of sightings for each species per 5 sites 10 meters from the river
u_2 = the mean number of sightings for each species per 5 sites 180 meters from the river, **2 Sample T Test**

Step 2:
Random sample taken
23 < 10% of all birds species in the San Pedro River
- Assume independent observations

23 > 30 is not true, by CLT (central limit theorem)
- Cannot assume approximately normal

Steps 3 and 4:
T value of 0.8996, p value of 0.3733 obtained



Because our p value of 0.3733 is greater than significance level of 0.05, we fail to reject H_o. However, we must proceed with caution because our data is not approximately normally distributed. We can cautiously conclude that there is significant evidence that there is no difference in the mean number of species per 5 sites 10 meters from the river and 180 meters from the river.

Conclusion from Data Analysis

- The data support our hypothesis
- No significant difference in bird biodiversity as distance from the river increases

Discussion

Interpretations What do our results mean?

Implications What do these results imply?

Limitations What can our data not tell us?

Confounding Variables

- Bird calls travel far
- Noise from humans scares off birds
- Cicada buzzing interfered at sites 1-5
- Phone microphone accuracy was low

Future Actions

- Future research is recommended
- Carry out future experiments at different distances and times

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Project 5

How Does Encryption Process Affect Internet Performance?

Abstract

In today’s online world, encryption is commonly used. There are many different ways to add data encryption to a website. The encryption standards such as DES (Data Encryption Standard), AES (Advanced Encryption Standard) and EES (Escrowed Encryption Standard) are widely used to solve the problem of communication over an insecure channel. With advanced technologies in computer hardware and software, these standards seem not to be as secure and fast as one would like. There are research works on new algorithms to improve the encryption process, but not much research done on different encryption methods used today about how they affect performance in the encryption and decryption process. In my research, I am going to do a set of experiments by using different encryption methods and draw a conclusion about my findings. It will provide useful data analysis to guide encryption/decryption algorithm design in the area of internet data security.

Problem

The problem I am trying to solve is if adding encryption to a website is causing internet performance issue? If so, how different encryption methods affect internet performance?

Introduction (Background Research)

I am sure you have heard of the word “encryption” if you do anything online these days, so what is “encryption” then? Encryption is the process of encoding information. This process converts the original representation of the information, known as plaintext, into an alternative form known as ciphertext. Only authorized parties can decipher a ciphertext back to plaintext and access the original information. Encryption does not itself prevent interference but denies the intelligible content to a would-be interceptor. Say I want to send you a private message, so I encrypt it using one of the encryption programs. The message looks like this:
“U2FsdGVkX19K4nRDfnqs4PhXWmXfgXN4hOOsZPN1d7ORFxLHR2xD2g+uJJtmFUAR”
But after the message is decrypted with a keyI sent you, it is actually like this:
“Let’s play soccer at 6:30 pm.”

But does this encrypt/decrypt process slow things down? And How?

Hypothesis

- Encrypted site will be more secure than unencrypted, but slower in performance;
- For encrypted site, the internet performance depends on encryption algorithm;
- Independent Variable: Different encryption methods used on the websites;
- Dependent Variable: Website that uses those encryption methods. Due to limited resource, here I use an encryption simulation tool that simulates a website with a fixed block of data loading;

Materials

- Computer used: Dell Laptop
- Encryption Simulation Tool
- Encryption methods: AES, TripleDES, Blowfish, Twofish, Serpent
- Performance analytic tools used: Chrome Development Tool, Google Performance monitor

Procedure

- Case 1: Performance on a secure site (https) vs non-secure site (http)
- Case 2: Performance on loading block of data to AES encryption method, key length-128 bit, block size - 128 bit
- Case 3: Performance on loading block of data to TripleDES encryption method, key length-64 bit, block size -- 64 bit but repeated 3 times
- Case 4: Performance on loading block of data to Blowfish encryption method, variable key length -32 to 448 bit, block size - 64 bit
- Case 5: Performance on loading block of data to Twofish encryption method, key length - up to 256 bit, block size -- 128 bit
- Case 7: Performance on loading block of data to Serpent encryption method, key size -- 32 bit, block size --32, but run in parallel

Results

1> Secured site vs Non Secured site:

	Performance: Loading data of 20k
Non-Secured Site (http)	34 ms
Secured Site (https)	728 ms

Results (Contin.)

2> Simulating to use different encryption methods to same block of data.

• Compare to asymmetric, symmetric encryption methods will perform faster since it has only one key;

• Performance is decided by algorithm used in each encryption software. The higher key length and run repeatedly will be slower in the process compare to those which uses smaller blocks but runs in parallel;

	Performance: Loading data of 23k
AES	926 ms
Triple DES	628 ms
Bluefish	689 ms
Twofish	689 ms
Serpent	475 ms

Discussion

I play around with different input on this tool: http://serpent.online-domain-tools.com/ with data, found:

1> If I increase size of input, trend on performance(time spent) is similar;

2> If input data is an image file, none of the methods works;

3> I also did a small program that does encryption dynamically by using online encryption lib:

```
// (B2) ENCRYPT
encrypt : function (clear) {
  var cipher = CryptoJS.AES.encrypt(clear, crypt.secret);
  cipher = cipher.toString();
  return cipher;
},
```

Found that I can use it in my webpage. This will offer a more accurate timing on performance in my future work.

Conclusion

- 1> Non-secured site loading is more than 21 times faster!
- 2> Using 5 common encryption methods, Serpent is the winner. Because Serpent is using smaller key size and block size but runs in parallel in the encrypting process.
- 3> In order to improve the internet performance while keep data secure, a complicated encryption method should be implemented to keep data secure but not by increasing key length or data size, but focusing on the process path, like in parallel or multi-threading.

Reflection / Application

I went on to compare the algorithm design for each of these software, observing the following fact:

1> Compare to asymmetric encryption methods, symmetric encryption methods will perform faster, the reason is obvious since it has only one key. All above methods are symmetric type;

2> Although trying to be secure, an encryption algorithm can go on and on to break the data block further more, but performance of such software will be a lot slower;

3> There are rooms to improve encryption algorithm to enhance the data encryption process, my next research will dig into this direction;

4> Encrypting image data is another challenge area I would like to explore more.

We do know the reason why encrypting data online is important, otherwise we can’t do online banking, but we also don’t want to wait for a long time when we transfer money, right? So having a secured encryption method to use and yet run fast is my goal for my further work., that will involve in actual writing/enhancing existing encryption program.

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Civic Engagement

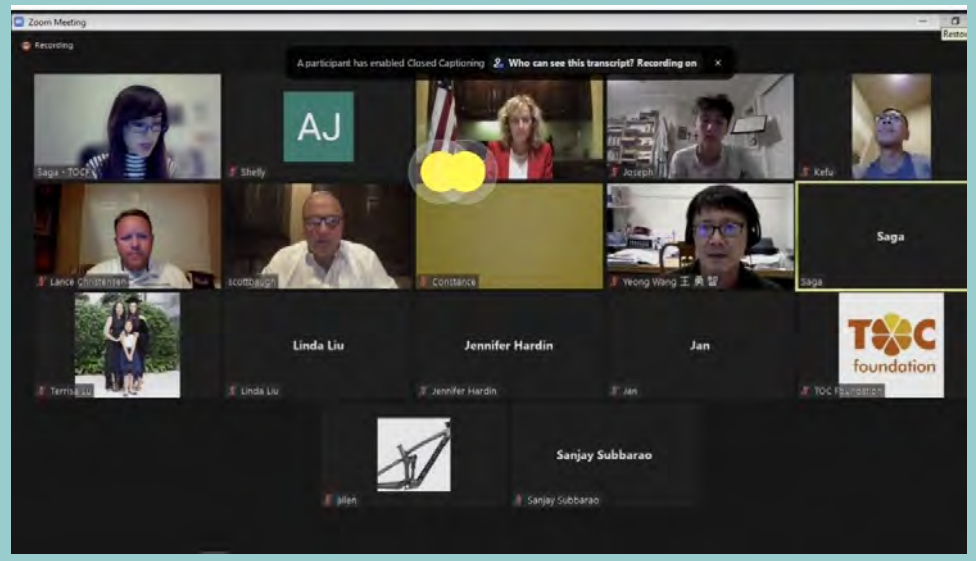
Building a Better Community:

My Four-Year Civic Engagement Experience

Irvine Public Hearing on All American Asphalt

Talking to Mick Carroll and Irvine Police Officer

Support Mari Barke



Civic Engagement

Campaign for Scott Baugh

Political Fundraising