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THE INTERNATIONAL STATISTICAL LITERACY PROJECT

INTERNATIONAL STATISTICAL POSTER COMPETITION WINNERS

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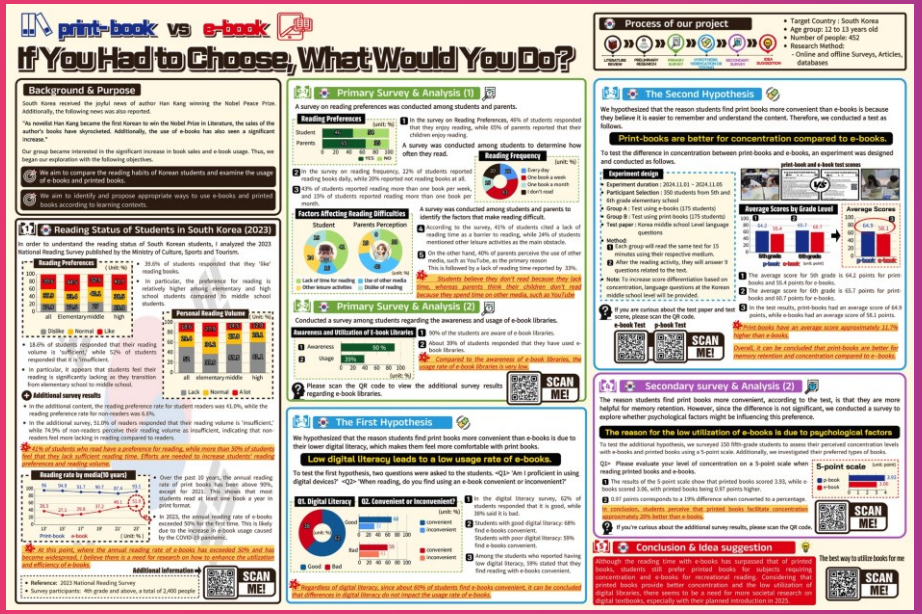

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ELEMENTARY SECOND PRIZE WINNERS: JAPAN

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Analysis of traffic accidents involving elementary school students in Matsuyama (2021-2023)

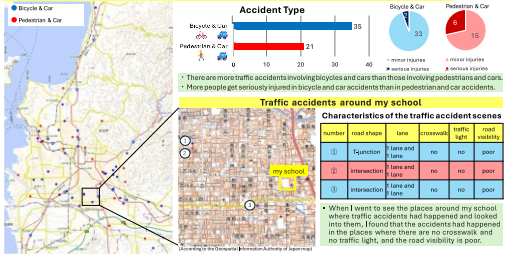
Motivation for research

At my elementary school, there is a traffic safety class for the third graders. In the class, I was curious about the types of the traffic accidents that had happened to the elementary school students in my town, Matsuyama, so I decided to find out more information about them.

Research method

- Collect data about the traffic accidents involving the elementary school students in Matsuyama from the Ehime Prefectural Police Website.
- Go to the places around my school where traffic accidents involving the elementary school students happened and see the characteristics of the traffic accident scenes.

What types of traffic accidents happened to the elementary school students in Matsuyama?



- There are more traffic accidents involving bicycles and cars than those involving pedestrians and cars.
- More people get seriously injured in bicycle and car accidents than in pedestrian and car accidents.

Traffic accidents around my school

According to the Ehimepolice Information Authority of Japan map)

Characteristics of the traffic accident scenes

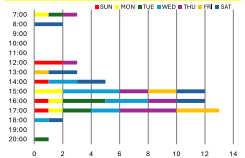
number	road shape	lane	crosswalk	traffic light	road visibility
③	T-junction	1 lane and 1 lane	no	no	poor
②	intersection	1 lane and 1 lane	no	no	poor
①	intersection	1 lane and 1 lane	no	no	poor

- When I went to see the places around my school where traffic accidents had happened and looked into them, I found that the accidents had happened in the places where there are no crosswalk and no traffic light, and the road visibility is poor.

How has the number of traffic accidents changed?

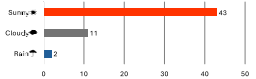
- From 2021 to 2023, the number of the traffic accidents involving the elementary school students went up every year.
- In the past three years from 2021 to 2023, March and June had the most accidents in total, with 8 each.

What time of day did traffic accidents happen?



- When looking at the days of the week, Wednesdays had the most accidents, with 12, and Saturdays had 11 in the past three years.
- When looking at the time of day, traffic accidents often happened between 15:00 and 18:00 on weekdays.
- I think the elementary school students may have been involved in an accident on their way home from school, or on their way from home to their friend's house.

What was the weather like when traffic accidents happened?



- I thought there were more traffic accidents on cloudy or rainy days, but actually, more traffic accidents happened on sunny days.
- I think the number of accidents goes up on sunny days because it's easier to go out on sunny days than on rainy days.

Quotation

Ehime Prefectural Police Website
(https://www.police.pref.ehime.jp/section/koutsuubu.html)
(Confirmed on 2025.1.15)

Impressions after completing the survey

- We could understand the characteristics of the traffic accidents better by showing the details in graphs, tables, and maps.
- Next, I want to research whether the elementary school students wore their helmets or not when they had bicycle accidents.
- I will keep following traffic rules to avoid accidents.

Students: Ayaha Watanabe and Kokomi Watanabe

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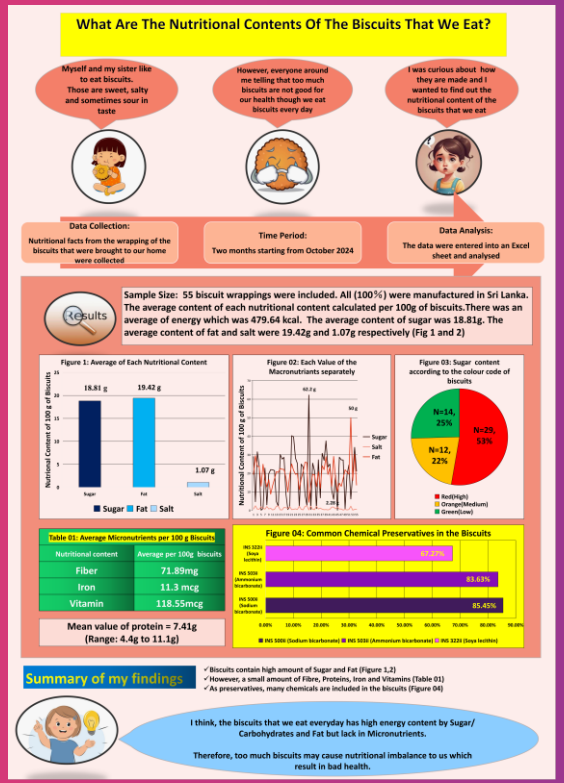
SRI LANKA

Students:
Ashmi Methusari Bandara



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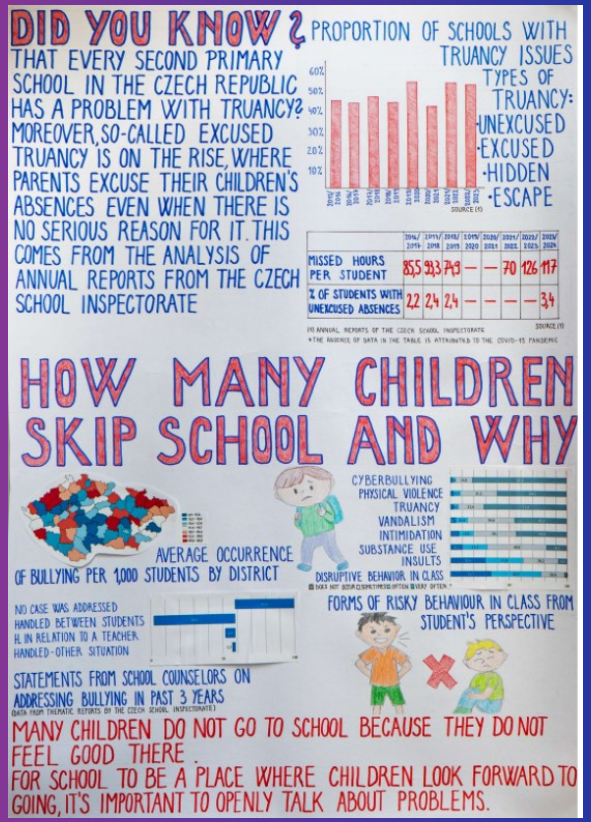

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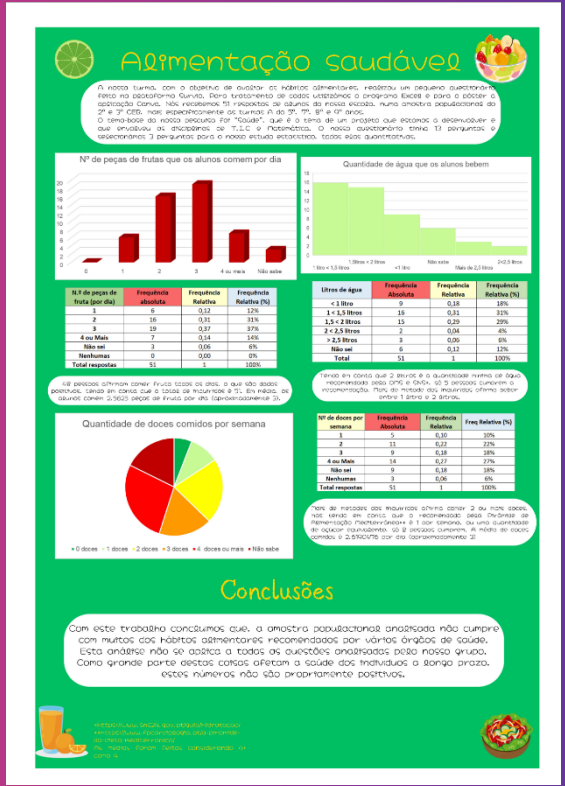
Gonçalves



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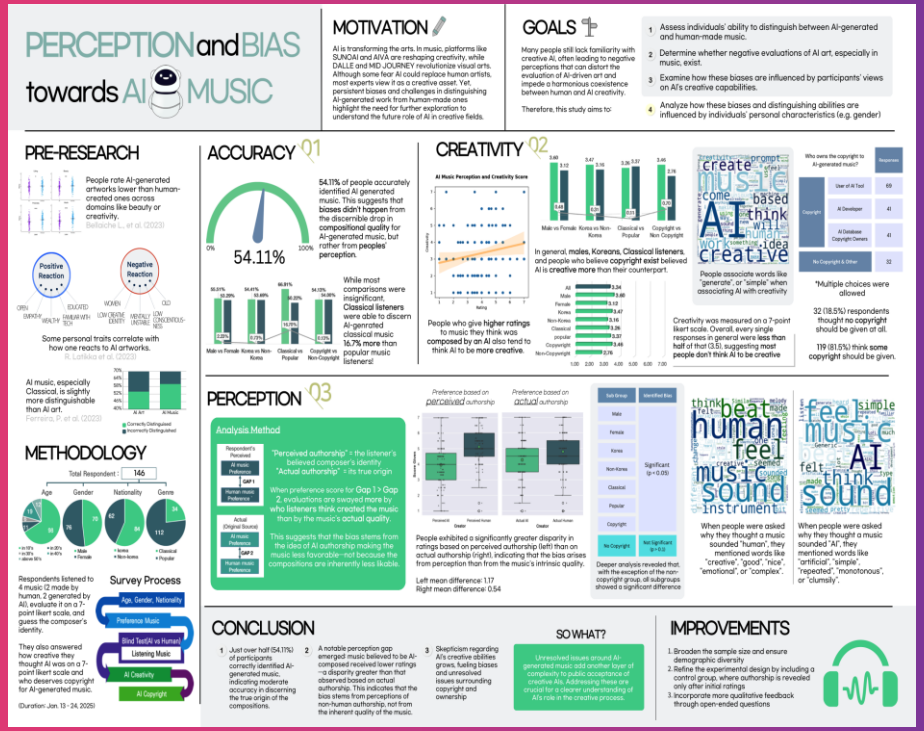

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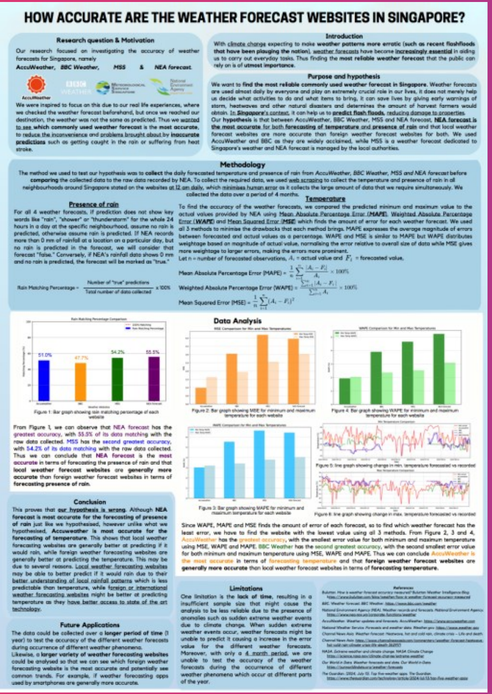

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WINNERS: CANADA

Students:
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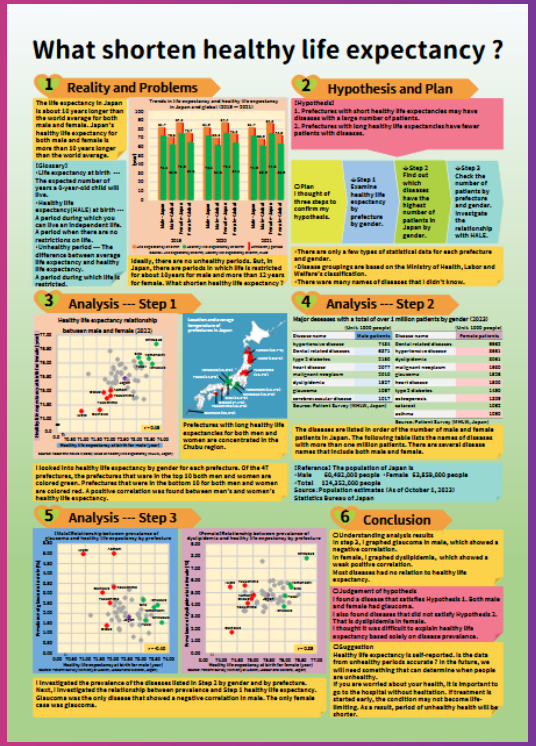

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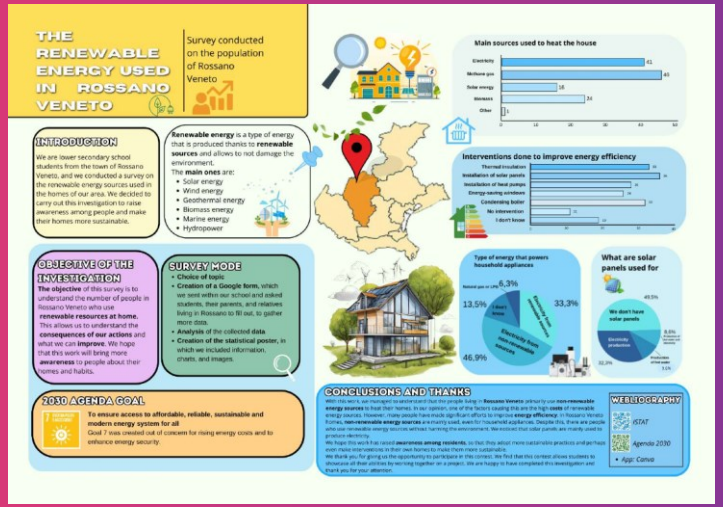

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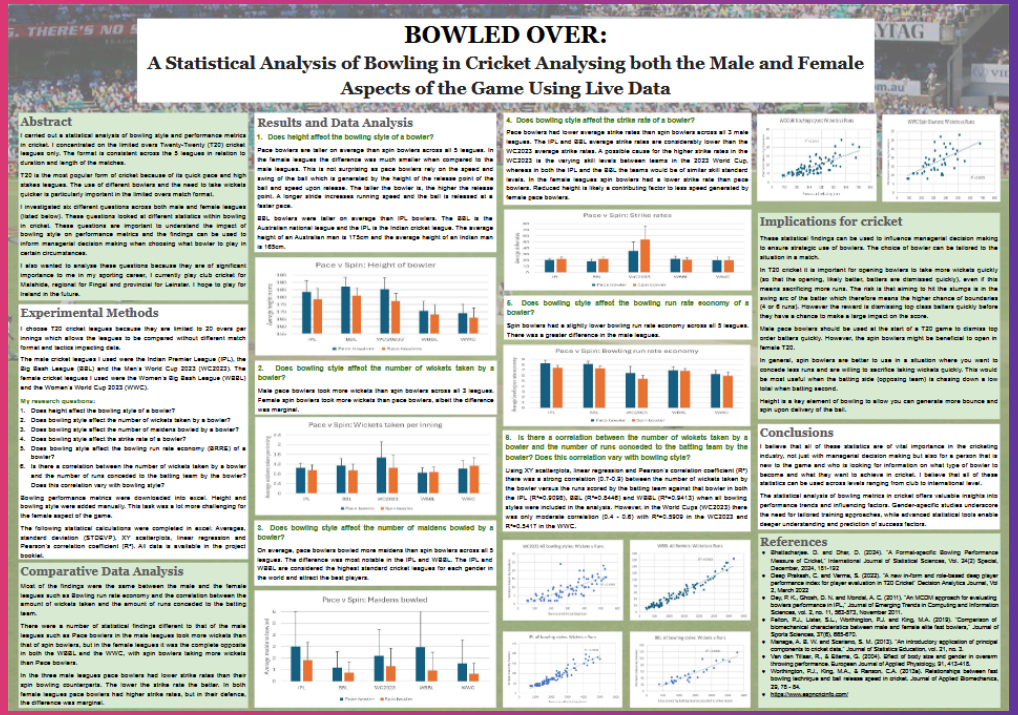
IRELAND

Students:
Eli John Kiernan



BOWLED OVER:
A Statistical Analysis of Bowling in Cricket Analysing both the Male and Female Aspects of the Game Using Live Data

Abstract

I carried out a statistical analysis of bowling style and performance metrics in cricket. I concentrated on the limited overs Twenty-Twenty (T20) cricket leagues only. The format is consistent across the 5 leagues in relation to duration and length of the matches.

T20 is the most popular form of cricket because of its quick pace and high stakes leagues. The use of different bowlers and the need to take wickets quicker is particularly important in the limited overs match format.

I investigated six different questions across both male and female leagues (listed below). These questions looked at different statistics within bowling in cricket. These questions are important to understand the impact of bowling style on performance metrics and the findings can be used to inform managerial decision making when choosing what bowler to play in certain circumstances.

I also wanted to analyse these questions because they are of significant importance to me in my sporting career. I currently play club cricket for Malahide, regional for Fingal and provincial for Leinster. I hope to play for Ireland in the future.

Experimental Methods

I choose T20 cricket leagues because they are limited to 20 overs per innings which allows the leagues to be compared without different match format and tactics impacting data.

The male cricket leagues I used were the Indian Premier League (IPL), the Big Bash League (BBL) and the Men's World Cup 2023 (WC2023). The female cricket leagues I used were the Women's Big Bash League (WBBL) and the Women's World Cup 2022 (WWC).

My research questions:

1. Does height affect the bowling style of a bowler?
2. Does bowling style affect the number of wickets taken by a bowler?
3. Does bowling style affect the number of maidens bowled by a bowler?
4. Does bowling style affect the strike rate of a bowler?
5. Does bowling style affect the bowling run rate economy (ERRG) of a bowler?
6. Is there a correlation between the number of wickets taken by a bowler and the number of runs conceded to the batting team by the bowler? Does this correlation vary with bowling style?

Bowling performance metrics were downloaded into excel. Height and bowling style were added manually. This task was a lot more challenging for the female aspect of the game.

The following statistical calculations were completed in excel: Averages, standard deviation (STDEVP), XY scatterplots, linear regression and Pearson's correlation coefficient (R²). All data is available in the project booklet.

Comparative Data Analysis

Most of the findings were the same between the male and the female leagues such as Bowling run rate economy and the correlation between the amount of wickets taken and the amount of runs conceded to the batting team.

There were a number of statistical findings different to that of the male leagues such as Pace bowlers in the male leagues took more wickets than that of spin bowlers, but in the female leagues it was the complete opposite in both the WBBL and the WWC, with spin bowlers taking more wickets than Pace bowlers.

In the three male leagues pace bowlers had lower strike rates than their spin bowling counterparts. The lower the strike rate the better. In both female leagues pace bowlers had higher strike rates, but in their defence, the difference was marginal.

Results and Data Analysis

1. Does height affect the bowling style of a bowler?

Pace bowlers are taller on average than spin bowlers across all 5 leagues. In the female leagues the difference was much smaller when compared to the male leagues. This is not surprising as pace bowlers rely on the speed and swing of the ball which is generated by the height of the release point of the ball and speed upon release. The taller the bowler is, the higher the release point. A longer stride increases running speed and the ball is released at a faster pace.

BBL bowlers were taller on average than IPL bowlers. The BBL is the Australian national league and the IPL is the Indian cricket league. The average height of an Australian man is 175cm and the average height of an Indian man is 165cm.

Pace v Spin: Height of bowler

2. Does bowling style affect the number of wickets taken by a bowler?

Male pace bowlers took more wickets than spin bowlers across all 3 leagues. Female spin bowlers took more wickets than pace bowlers, albeit the difference was marginal.

Pace v Spin: Wickets taken per inning

3. Does bowling style affect the number of maidens bowled by a bowler?

On average, pace bowlers bowled more maidens than spin bowlers across all 5 leagues. The difference was most notable in the IPL and WBBL. The IPL and WBBL are considered the highest standard cricket leagues for each gender in the world and attract the best players.

Pace v Spin: Maidens bowled

4. Does bowling style affect the strike rate of a bowler?

Pace bowlers had lower average strike rates than spin bowlers across all 3 male leagues. The IPL and BBL average strike rates are considerably lower than the WC2023 average strike rates. A possible cause for the higher strike rates in the WC2023 is the varying skill levels between teams in the 2023 World Cup, whereas in both the IPL and the BBL the teams would be of similar skill standard levels. In the female leagues spin bowlers had a lower strike rate than pace bowlers. Reduced height is likely a contributing factor to less speed generated by female pace bowlers.

Pace v Spin: Strike rates

5. Does bowling style affect the bowling run rate economy of a bowler?

Spin bowlers had a slightly lower bowling run rate economy across all 5 leagues. There was a greater difference in the male leagues.

Pace v Spin: Bowling run rate economy

6. Is there a correlation between the number of wickets taken by a bowler and the number of runs conceded to the batting team by the bowler? Does this correlation vary with bowling style?

Using XY scatterplots, linear regression and Pearson's correlation coefficient (R^2) there was a strong correlation (0.7-0.9) between the number of wickets taken by the bowler versus the runs scored by the batting team against that bowler in both the IPL (R^2=0.9098), BBL (R^2=0.8446) and WBBL (R^2=0.8413) when all bowling styles were included in the analysis. However, in the World Cups (WC2023) there was only moderate correlation (0.4 - 0.6) with R^2=0.5909 in the WC2023 and R^2=0.5417 in the WWC.

Implications for cricket

These statistical findings can be used to influence managerial decision making to ensure strategic use of bowlers. The choice of bowler can be tailored to the situation in a match.

In T20 cricket it is important for opening bowlers to take more wickets quickly (so that the opening, likely better, batters are dismissed quickly), even if this means sacrificing more runs. The risk is that aiming to hit the stumps is in the swing arc of the batter which therefore means the higher chance of boundaries (4 or 6 runs). However the reward is dismissing top class batters quickly before they have a chance to make a large impact on the score.

Male pace bowlers should be used at the start of a T20 game to dismiss top order batters quickly. However, the spin bowlers might be beneficial to open in female T20.

In general, spin bowlers are better to use in a situation where you want to concede less runs and are willing to sacrifice taking wickets quickly. This would be most useful when the batting side (opposing team) is chasing down a low total when batting second.

Height is a key element of bowling to allow you can generate more bounce and spin upon delivery of the ball.

Conclusions

I believe that all of these statistics are of vital importance in the cricketing industry, not just with managerial decision making but also for a person that is new to the game and who is looking for information on what type of bowler to become and what they want to achieve in cricket. I believe that all of these statistics can be used across levels ranging from club to international level.

The statistical analysis of bowling metrics in cricket offers valuable insights into performance trends and influencing factors. Gender-specific studies underscore the need for tailored training approaches, while advanced statistical tools enable deeper understanding and prediction of success factors.

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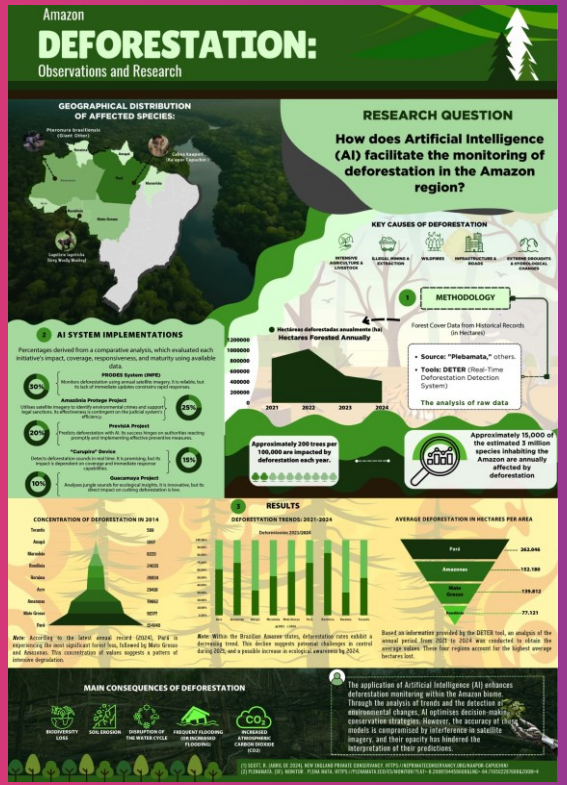

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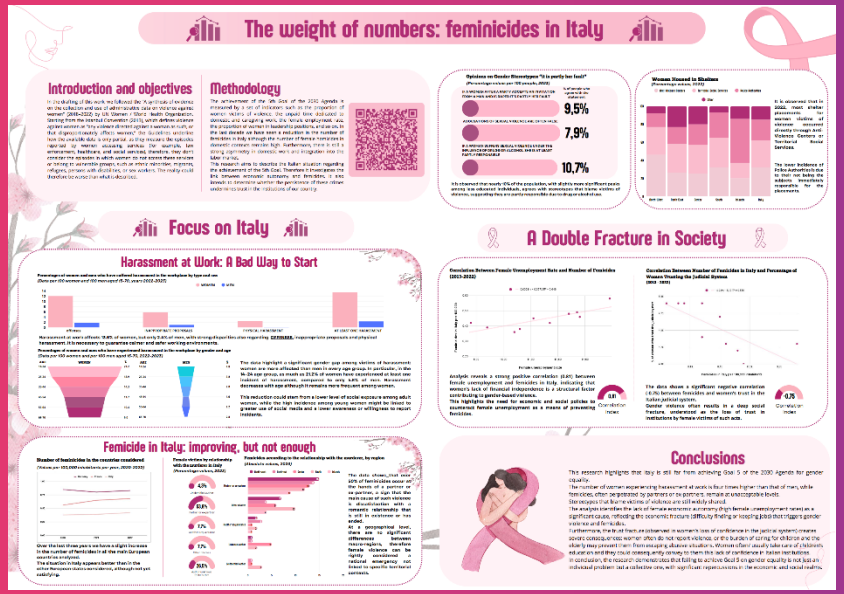

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HONOURABLE MENTION: JAPAN

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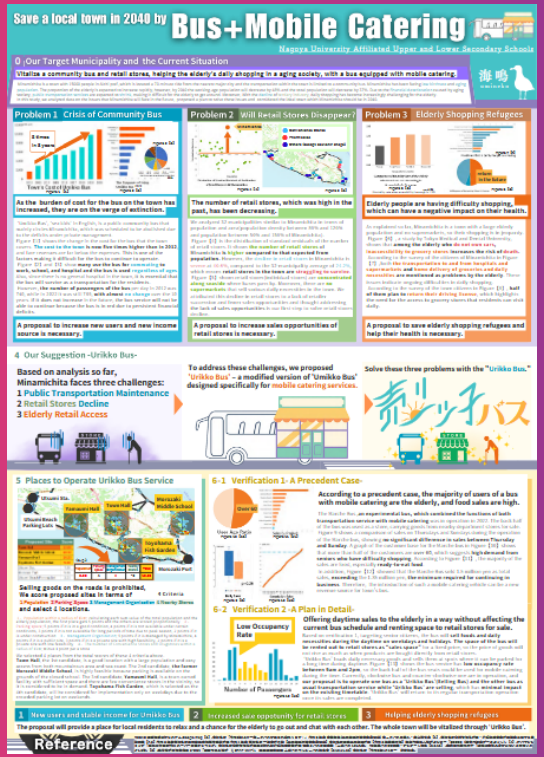

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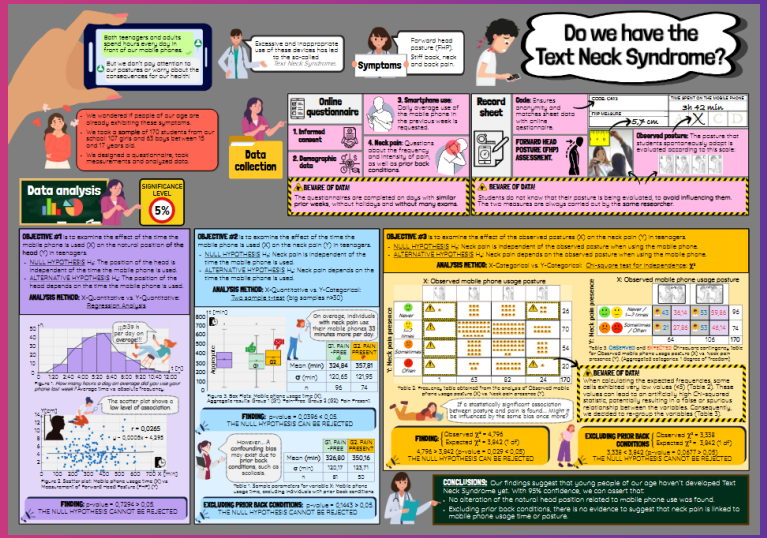

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UPPER SECONDARY
HONOURABLE MENTION:
CZECHIA

Students:
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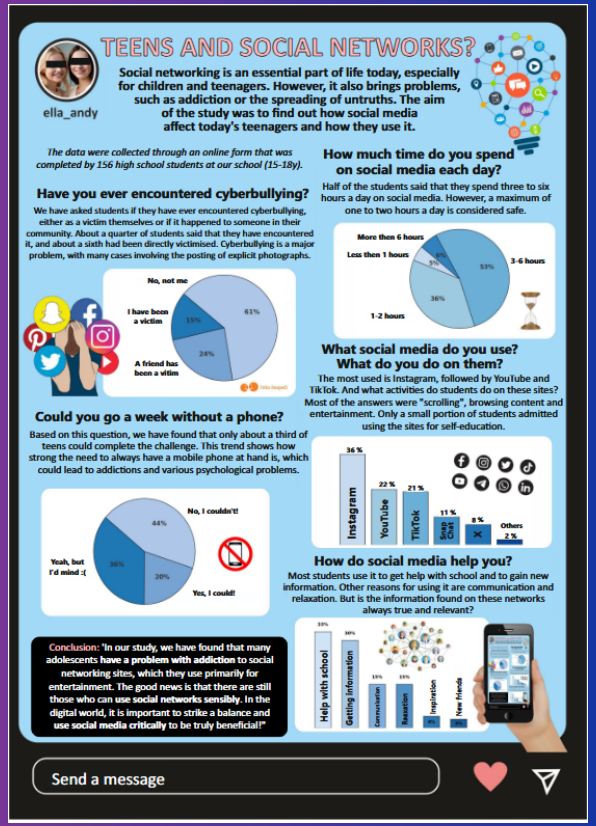

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WINNERS: POLAND

Students:
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Julia Gierszewska,
Piotr Gradowski,
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Agata Nowak

Assessment of the level of addiction, preferred methods of nicotine consumption, and the impact of a change in residence on nicotine use among medical students

Introduction

- **Nicotine** is a psychoactive substance that acts on the autonomic nervous system, which controls the "fight or flight" response. In small doses, it raises **blood pressure** and increases the secretion of **stomach acid**, while in large doses it acts in the opposite manner [1].
- By releasing **dopamine** - the pleasure neurotransmitter - nicotine becomes highly addictive, which explains its popularity [1].
- In Poland, tobacco smoking used to be very widespread [2], but it has **declined** thanks to regulations and public health campaigns since the 1990s; however, according to WHO (2022), 27.6% of men and 19.1% of women still smoke [3].
- Today, nicotine is more frequently consumed **not only in cigarettes**, but also via e-cigarettes, heated tobacco, or nicotine pouches.

Research objectives

- Assessment of the degree of nicotine addiction among medical students.
- Analysis of the preferred methods of consumption of this substance.
- Evaluation of the impact of changes in residence on nicotine consumption-related behaviors.
- Evaluation of the influence of nicotine on overall psychophysical condition.

The analyses conducted may serve as a basis for developing improved addiction prevention standards.

Materials and methods

- The study involved **574 medical students** from 17 universities in Poland.
- A modified research questionnaire consisting of **55 questions** was used. **The survey** was conducted between **January 29 and February 15, 2025.**
- Calculations were performed using statistical analysis methods, including the **Shapiro-Wilk** test to assess the normality of the distribution. For further analyses, the **chi-square** test, **Kruskal-Wallis** test, **prop-test,** and **Wilcoxon** test with **Bonferroni** correction were employed, along with **Spearman's** correlation coefficient.
- A significance level of **$\alpha = 0.05$** was assumed.
- p-value annotations: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Limitations

- An insufficient number of responses from students in years 4–6 prevented the analysis of the dynamics of nicotine habits over the course of their studies.
- The potential for an increased interest from nicotine users may result in limited randomness of the sample.

Frequency of nicotine intake and subjective sleep quality assessment

Kruskal-Wallis p = 3.15e-05

Pairwise comparisons using the Wilcoxon Test with Bonferroni correction

Frequency of nicotine intake and mental health assessment

Kruskal-Wallis p = 0.00489

Pairwise comparisons using the Wilcoxon Test with Bonferroni correction

Impact of smoking onset age on nicotine addiction severity

Degree of nicotine addiction depending on gender

Estimated sleep onset time and nicotine intake before bedtime

Percentage of daily users and their first experience with nicotine

Usage patterns of various nicotine forms among consumers

Conclusions and results

- Research shows that the percentage of people using nicotine is similar across both genders, though **men tend to achieve higher levels of addiction** (0.75 points according to the modified Fagerström Scale*).
- The most commonly used form on a daily basis are e-cigarettes with liquid (36% of users), while disposable ones or traditional cigarettes are mostly used occasionally.
- **Stress reduction** (72%) is nicotine consumption's most frequently reported positive effect, which may be a reason for its use.
- **Positive initial experiences increase the likelihood** of continued daily nicotine use, and past **exposure to secondhand smoke predisposes** individuals to become ongoing users (37.3% vs. 25.2%).
- No correlation was found between changing residence and increased nicotine use.
- Daily nicotine use is associated with **poorer sleep quality**, shorter sleep duration, and worse mental health, while using nicotine directly before bed extends the time to falling asleep by approximately 10 minutes.
- **Earlier initiation** of nicotine use correlates with **a higher degree of addiction** according to the modified Fagerström Scale*.

*A modified version of the Fagerstrom Scale was used for the study, which also included alternative forms of nicotine consumption.

Sources

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UNIVERSITY SECOND PRIZE WINNERS: URUGUAY

Students:
Facundo Morini

Logistic Regression in Forensic Odontology

Sex determination through dental measurements

In the field of forensic odontology teeth are an excellent research material. Furthermore teeth are almost an indestructible material. The information provided by their shapes and sizes allow us to determine some characteristics of an individual such as sex or age. This research seek to evaluate the efficiency of logistic regression for sex classification. For that it was used dental pieces in a sample of 524 individuals.

Data used

The data used correspond to 524 lower plaster models(264 males and 260 females) of patients treated at an orthodontic clinic in Montevideo, Uruguay [1]. From each cast the following were obtained: the mesiodistal diameter, the gingivo-incisal height of both canines and the inter canine distance.

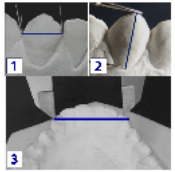

Figura 1: Considered measurements. 1 Mesiodistal Diameter (DMD) 2 . Gingivo-Incisal Height(AGI) 3. Inter canine Distance (DIC).

Within the set of measurements: (in millimetres), multivariate outliers were sought using Mahalanobis distance; observations whose right or left DMD exceeded 8.5 mm and whose right or left AGI exceeded 11.5 mm were removed, leaving a total of 511 observations.

Measuremet	Male (N=255)	Female (N=256)
DMD Right (DMDd)	7.110 (0.440)	6.707 (0.448)
AGI Right (AGId)	9.231 (0.957)	8.932 (0.891)
DMD Left (DMDI)	7.125 (0.465)	6.744 (0.449)
AGI left (AGII)	9.260 (0.970)	8.977 (0.869)
DIC	26.448 (2.319)	25.491 (2.010)

Cuadro 1: Mean (SD) values by sex for each measurement (without outliers).

Methodology

First, a logistic regression model is fitted to discriminate sex by considering all measurements from both the left and the right sides. After that it was used models that only consider the measurements of each side plus the inter canine distance.

- Full Model:
  Y : Sex; X : (DMDd, DMDI, AGId, AGII, DIC)
- Left side model:
  Y : Sex; X : (DMDI, AGII, DIC)
- Right side model :
  Y : Sex; X : (DMDd, AGId, DIC)

The study focuses on the predictive power of these models and therefore evaluates their performance through several metrics: **Accuracy, Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, F1 and balanced accuracy.**. All metrics are calculated by 10 fold cross validation.Analyses are performed in *R*, mainly using the *caret* library for model fitting and metric extraction

Results

The estimated coefficients and performance metrics for each model are presented.

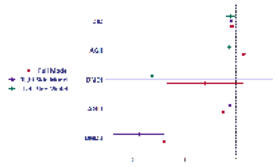

Figura 2: Estimated coefficients and 95 % confidence intervals for each model

Metrics	Full	Left side	Right side
Sensitivity	0.678	0.667	0.667
Specificity	0.684	0.668	0.711
PPV (+)	0.681	0.667	0.697
NPV (-)	0.680	0.668	0.682
Accuracy	0.681	0.667	0.697
F1	0.680	0.667	0.681
Balanced ACC	0.681	0.667	0.689

Cuadro 2: Cross validated performance metrics.

Conclusions

Logistic regression showed good overall performance, with an accuracy of almost 70 % for the right side model. Given the sensitivity and Specificity values obtained- both around 70 % (the capacity to correctly recognize males and females, respectively) the model can distinguish the two group satisfactorily. The same conclusion is supported by the positive and negative predictive values. However, as seen in the estimated coefficients, only a few of the variables proved statistically significant, suggesting that including additional variables or constructing new indicators from the existing ones could improve the model.

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- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (2nd ed.)
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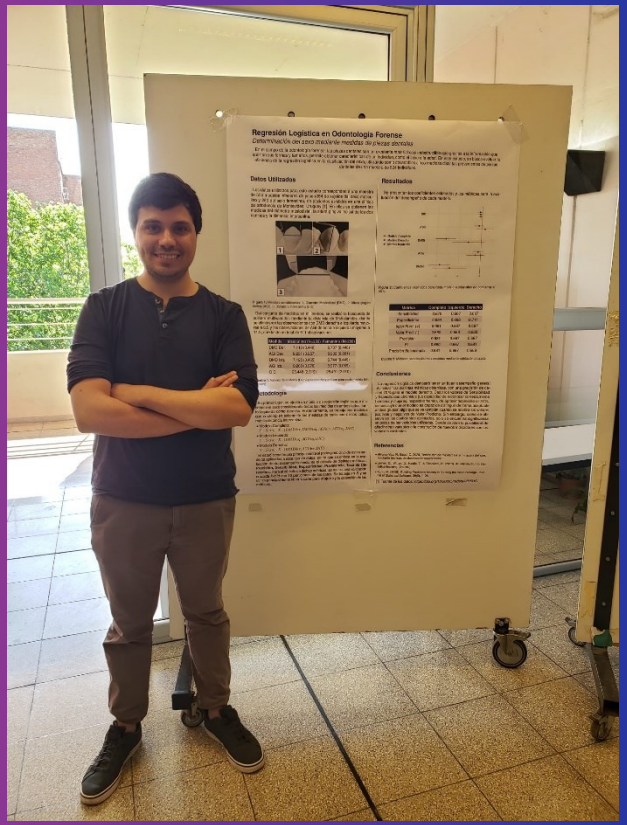
[1] Data Source: *https://doi.org/10.60059/Fredata/JUSUG*



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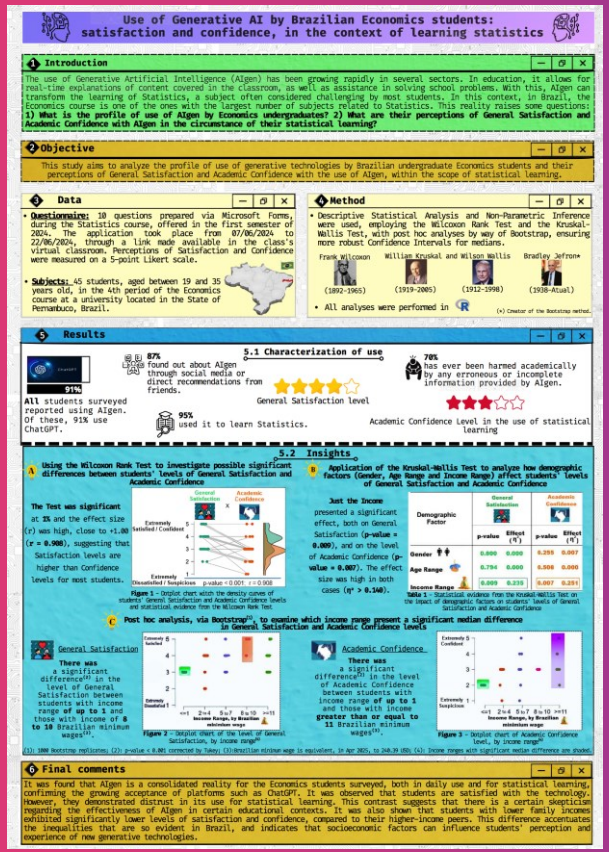

Use of Generative AI by Brazilian Economics students: satisfaction and confidence, in the context of learning statistics

1 Introduction

The use of Generative Artificial Intelligence (AIgen) has been growing rapidly in several sectors. In education, it allows for real-time explanations of content covered in the classroom, as well as assistance in solving school problems. With this, AIgen can transform the learning of Statistics, a subject often considered challenging by most students. In this context, in Brazil, the Economics course is one of the ones with the largest number of subjects related to Statistics. This reality raises some questions: 1) What is the profile of use of AIgen by Economics undergraduates? 2) What are their perceptions of General Satisfaction and Academic Confidence with AIgen in the circumstance of their statistical learning?

2 Objective

This study aims to analyze the profile of use of generative technologies by Brazilian undergraduate Economics students and their perceptions of General Satisfaction and Academic Confidence with the use of AIgen, within the scope of statistical learning.

3 Data

- **Questionnaire:** 10 questions prepared via Microsoft Forms, during the Statistics course, offered in the first semester of 2024. The application took place from 07/06/2024 to 22/06/2024, through a link made available in the class's virtual classroom. Perceptions of Satisfaction and Confidence were measured on a 5-point Likert scale.
- **Subjects:** 45 students, aged between 19 and 35 years old, in the 4th period of the Economics course at a university located in the State of Pernambuco, Brazil.

Method

- Descriptive Statistical Analysis and Non-Parametric Inference were used, employing the Wilcoxon Rank Test and the Kruskal-Wallis Test, with post hoc analyses by way of Bootstrap, ensuring more robust Confidence Intervals for medians.

Frank Wilcoxon (1892-1965) · William Kruskal and Wilson Wallis (1919-2005; 1912-1998) · Bradley Jefron* (1938-Atual)

- All analyses were performed in R

(*) Creator of the Bootstrap method.

4 Results

91% — All students surveyed reported using AIgen. Of these, 91% use ChatGPT.

87% found out about AIgen through social media or direct recommendations from friends.

5.1 Characterization of use

General Satisfaction level

95% used it to learn Statistics.

70% has ever been harmed academically by any erroneous or incomplete information provided by AIgen.

Academic Confidence Level in the use of statistical learning

5.2 Insights

A Using the Wilcoxon Rank Test to investigate possible significant differences between students' levels of General Satisfaction and Academic Confidence

The Test was significant at 1% and the effect size (r) was high, close to +1.00 (r = 0.908), suggesting that Satisfaction levels are higher than Confidence levels for most students.

Figure 1 - Dotplot chart with the density curves of students' General Satisfaction and Academic Confidence levels and statistical evidence from the Wilcoxon Rank Test.

B Application of the Kruskal-Wallis Test to analyze how demographic factors (Gender, Age Range and Income Range) affect students' levels of General Satisfaction and Academic Confidence

Just the Income presented a significant effect, both on General Satisfaction (p-value = 0.009), and on the level of Academic Confidence (p-value = 0.007). The effect size was high in both cases ($\eta^2 > 0.140$).

Demographic Factor	General Satisfaction p-value	General Satisfaction Effect (η^2)	Academic Confidence p-value	Academic Confidence Effect (η^2)
Gender	0.999	0.000	0.355	0.007
Age Range	0.794	0.000	0.508	0.000
Income Range	0.009	0.235	0.007	0.251

Table 1 - Statistical evidence from the Kruskal-Wallis Test on the impact of demographic factors on students' levels of General Satisfaction and Academic Confidence

C Post hoc analysis, via Bootstrap[1], to examine which income range present a significant median difference in General Satisfaction and Academic Confidence levels

General Satisfaction

There was a significant difference[2] in the level of General Satisfaction between students with income range of up to 1 and those with income of 8 to 10 Brazilian minimum wages[3].

Figure 2 - Dotplot chart of the Level of General Satisfaction, by Income range[4]

Academic Confidence

There was a significant difference[2] in the level of Academic Confidence between students with income range of up to 1 and those with income greater than or equal to 11 Brazilian minimum wages[3].

Figure 3 - Dotplot chart of Academic Confidence level, by Income range[4]

(1): 1000 Bootstrap replicates; (2): p-value < 0.001 corrected by Tukey; (3):Brazilian minimum wage is equivalent, in Apr 2025, to 2x0.39 (8h) (4): Income ranges with significant median difference are shaded.

6 Final comments

It was found that AIgen is a consolidated reality for the Economics students surveyed, both in daily use and for statistical learning, confirming the growing acceptance of platforms such as ChatGPT. It was observed that students are satisfied with the technology. However, they demonstrated distrust in its use for statistical learning. This contrast suggests that there is a certain skepticism regarding the effectiveness of AIgen in certain educational contexts. It was also shown that students with lower family incomes exhibited significantly lower levels of satisfaction and confidence, compared to their higher-income peers. This difference accentuates the inequalities that are so evident in Brazil, and indicates that socioeconomic factors can influence students' perception and experience of new generative technologies.

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Students:
Jaedon Naidu,
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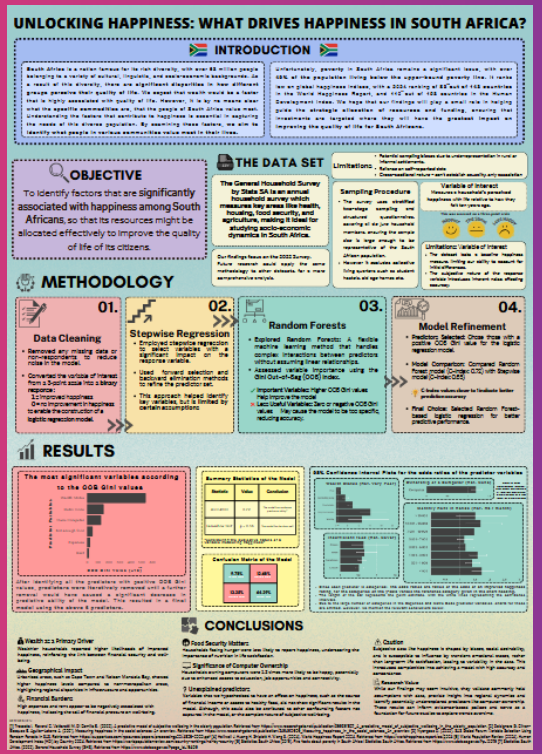

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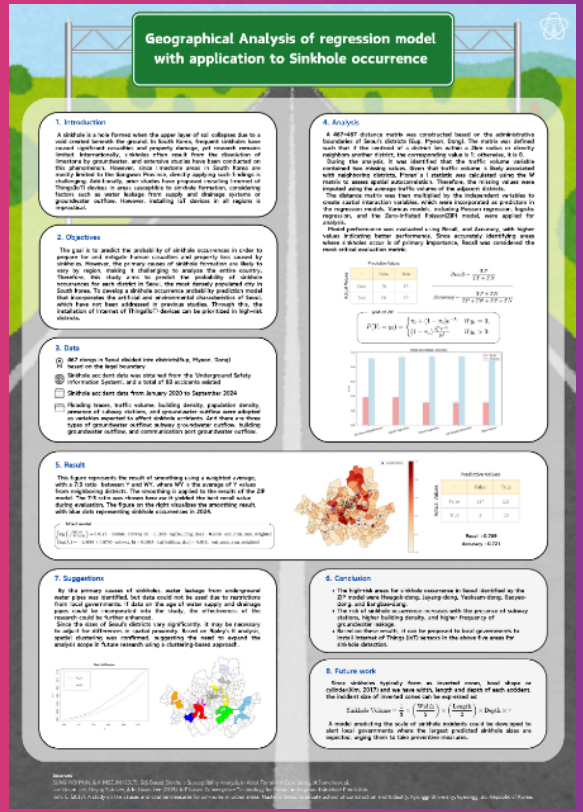

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Pamela Ortega Quiñones,
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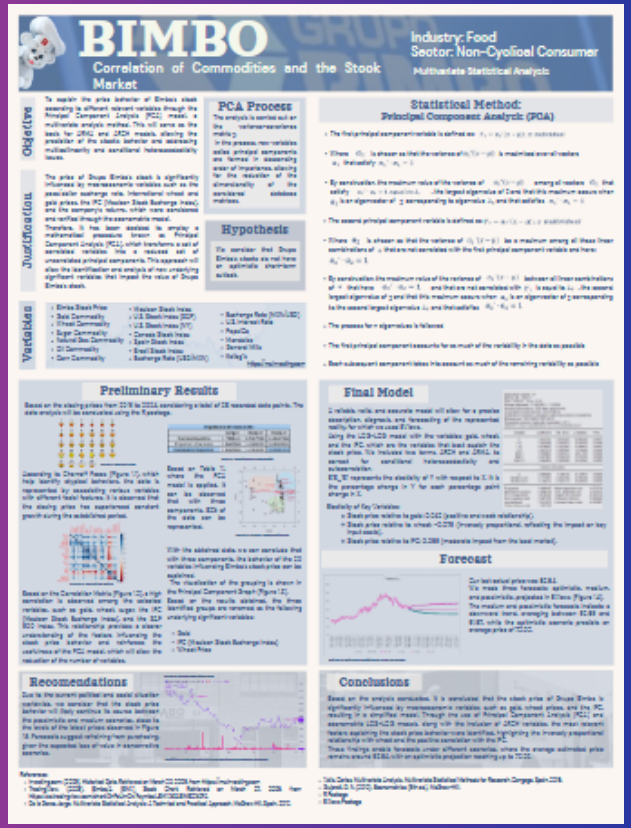

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