Coursework 2: Evaluation exercise (in groups)

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1. Introduction:

Aim

This experiment is aimed to gather insights into participants' perceptions and understandings of the historical distribution of medals won by countries in the Summer Olympics from 1896-2020. The focus was on assessing how individuals interpret and analyse data presented in line and area charts representing medal counts over time and across countries.

Design

The experiment involved the creation of a web-based questionnaire utilising the Python Flask framework and HTML. The questionnaire was structured around two primary graphs: a line chart showcasing “Medals According to Years for Top 10 Countries (1896-2020)” and an area chart illustrating “Total Medal Counts by Country for Summer Olympic Medals from 1896 to 2020.” A subgraph derived from these main representations was associated with each question within the questionnaire.

Task

Participants were tasked with responding to a series of questions based on the provided charts, each chart having 10 randomised questions with helpful subcharts. These inquiries were specifically designed to test how well the participants can learn and read the main charts while getting additional direction from the subcharts. The questions are timed, providing insight into the effectiveness of the charts and the level of comprehension they can enhance.

The experiment ensured participant anonymity and confidentiality by acquiring consent through a participant information sheet. We informed participants that we would record their responses while keeping their identities undisclosed throughout the research process.

Duration

The completion of the questionnaire was estimated to require approximately 15 to 20 minutes of participants' time, taking into consideration the 20-second blanking effect in between each question.

2. Method:

Participants

The experiment involves 10 participants. We obtain informed consent from each participant and do not provide or accept payment for participation. The participant information sheet that was given to each participant explained their anonymity and mentioned that the responses would be confidential.

Materials

Programming Language and Libraries Used

Python Flask Framework: The web application was developed using the Python Flask framework, a micro web framework in Python, to handle the backend functionalities of the application.

Libraries Utilised

Flask, render_template, request, redirect, current_app, pandas (pd), matplotlib.pyplot (plt), matplotlib, io, base64, random, time, scipy.stats

Software Functionality Description

The Flask framework was used to create a web application for a questionnaire-based analysis of Olympic medal counts. HTML templates were used for the frontend interface, and Python scripts were used for backend functionality. Pandas was used to manage historical medal counts by countries, generating line and area graphs. Matplotlib was used to create visualisations, including line and area graphs. The io and base64 modules were used to handle image data, and random functionality was employed for user interaction. The

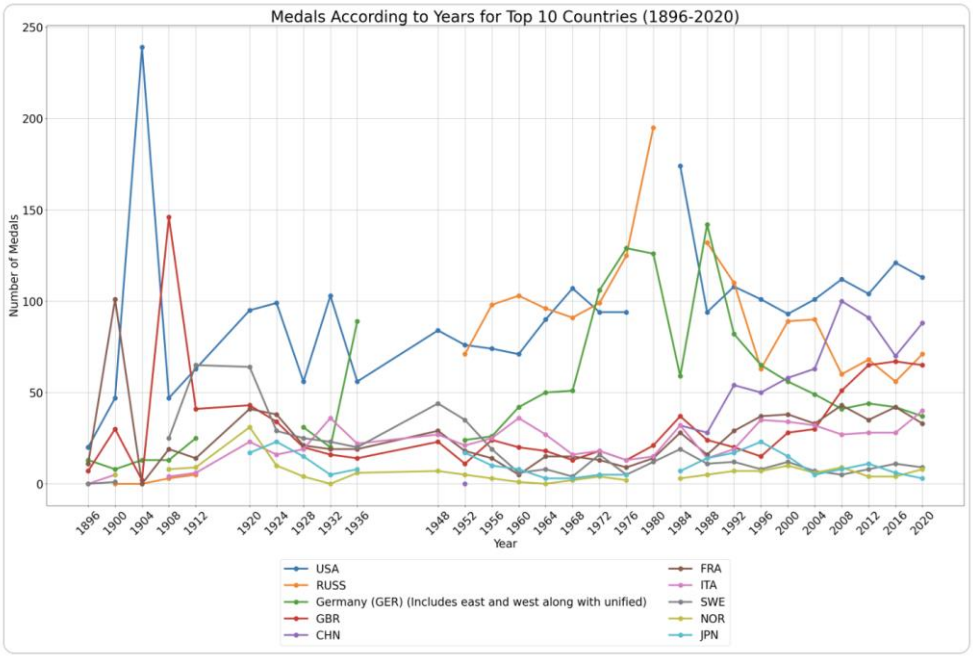
Flask framework allowed for seamless execution of the experiment, facilitating data visualisation, user interaction, and processing for questionnaire-based analysis.

Website Hosting
The website was hosted on Pythonanywhere (https://www.pythonanywhere.com). The link to the website was sent to participants who volunteered to be a part of the experiment.
< nat031205.pythonanywhere.com >

Procedure

Line chart test questions:

Line Chart



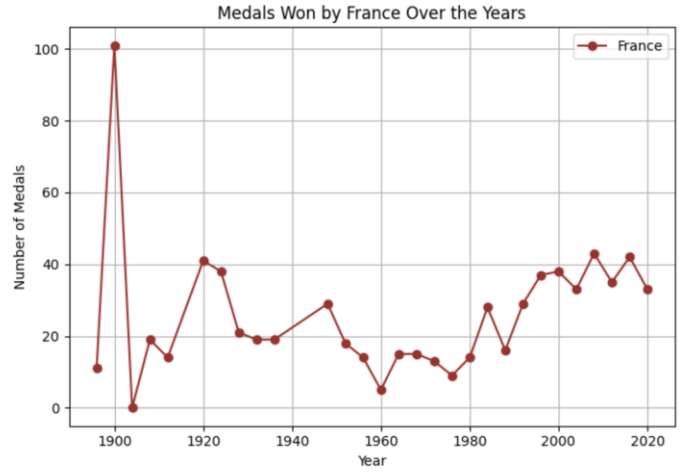
The line chart shows the medal count for the top 10 countries from 1896 to 2020. This visualisation provides an overview of each country's performance over the years, facilitating comparisons and trend analysis. It is clear from the questions that follow that each question corresponds to a unique chart that focuses on a particular aspect of Olympic performance.

All test questions:

- Which year did the United States win the medals the most?
- Which country got more medals over the years: Russia or China?
- Which country won the medals the most in 1980?
- Which country got more medals over the years: Sweden or Norway?
- Which country decreased in the number of medals between 1908 to 1936 overall: Great Britain or Italy?
- Which year did France win the most medals?
- In which year did Japan get the fewest medals?
- Which country has the fastest increase in the number of medals between 1968 to 1980?
- From when to when did Russia not participate in the Olympics?
- Which year did Germany win the medals the most?

Example Explanation:
The graph (Fig: 1) illustrating Russia's absence from the Olympics provides insights into geopolitical dynamics and potential bans. It helps correlate these years with geopolitical events, diplomatic situations, or doping-related controversies. This visualisation helps understand the complex interplay between sports, politics, and international relations.
The graph (Fig: 2) identifies the year France won the most medals, providing insights into historical events and outstanding athletic achievements that impacted France's Olympic history. This visualisation correlates France's exceptional performance with events like hosting the Olympics, breakthroughs in sports training, and individual and team accomplishments.

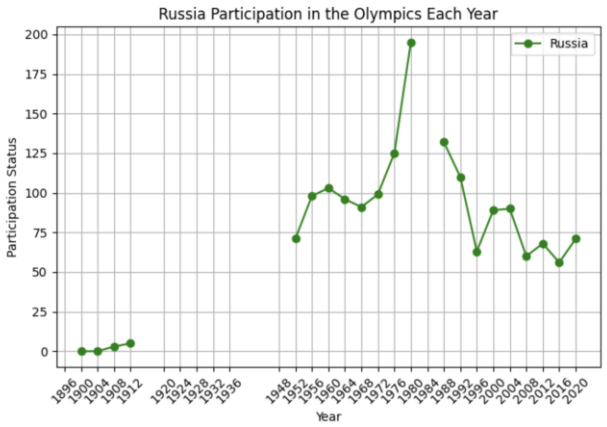
Which year did France win the most medals?



○ 1900 ○ 1984 ○ 2012 ○ 2016

<Figure 1>

From when to when did Russia not participate in the Olympics?



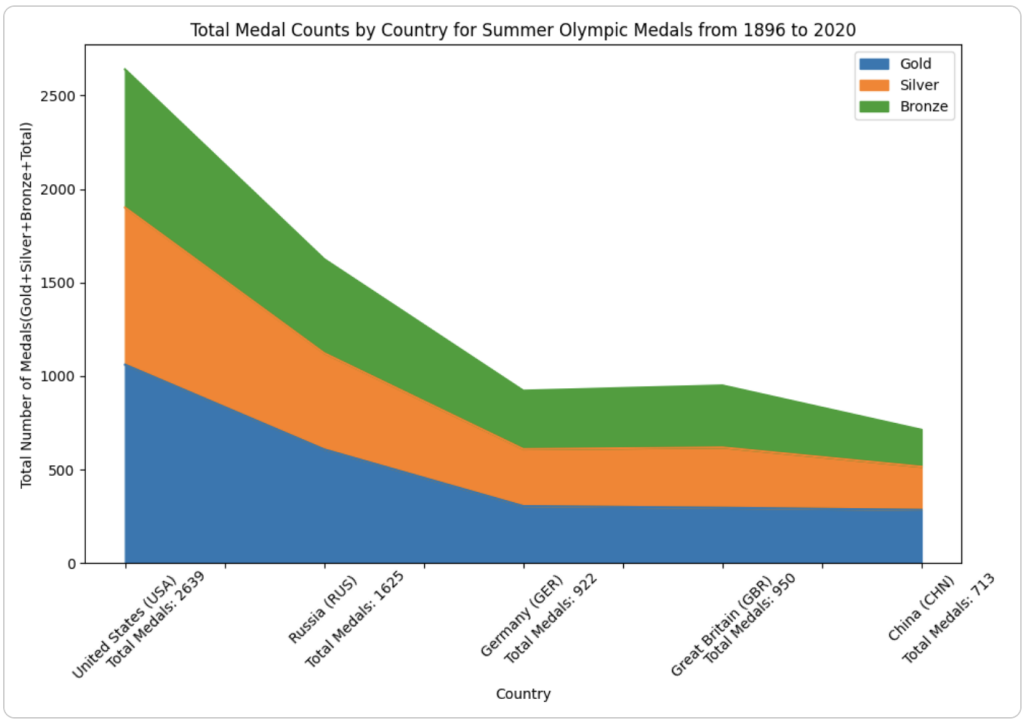
○ 1980 to 1984 and 1988 to 1992 ○ 1976 to 1980 and 1984 to 1988

○ 1972 to 1980 and 1984 to 1992 ○ 1976 to 1980 and 1988 to 1996

<Figure 2>

Area chart test questions:

Area Chart



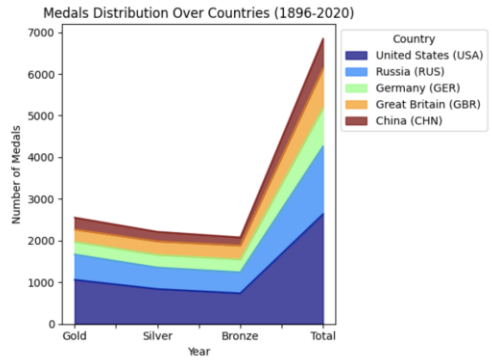
The main area chart counts the total number of gold, bronze and silver medals from 1896 to 2020 for the following countries: United States (USA)', 'Russia (RUS)', 'Germany (GER)', 'Great Britain (GBR)', 'China (CHN).

We carefully selected a diverse set of countries based on varied attributes, including historical performance, geopolitical changes (such as reunification or renaming of certain countries), and significant events like the impact of the results of countries hosting the Olympic Games. We account for countries' past participation even when named differently (Germany, Russia, China) or when undergoing geopolitical shifts (Germany's reunification, WW1, WW2).

We find particular interest in observing how a country's performance may vary when hosting the Olympic Games, offering insights into national pride and athletic achievements. Additionally, the gaps in participation provide a unique perspective on historical events, such as political transitions or global disruptions (COVID-19 for the 2020 Olympics), impacting a country's ability to participate in the Games. This approach allows us to draw connections between sports, politics, and societal changes on a global scale. The charts also showcase how many medals each country won compared to its population and socio-political values. We

can observe that the ratio of countries winning gold, bronze, and silver is very uniform, and certain years affect all countries equally, no matter the social-cultural differences between them.
Five subcharts (e.g. Fig:4, Fig:5, Fig:6) complement the main area chart, illustrating each analysed country's gold, silver, and bronze medal counts over the years, even during non-participation periods. These visuals highlight spikes and lows, prompting viewers to identify noteworthy trends and consider mathematical questions related to individual countries' achievements.

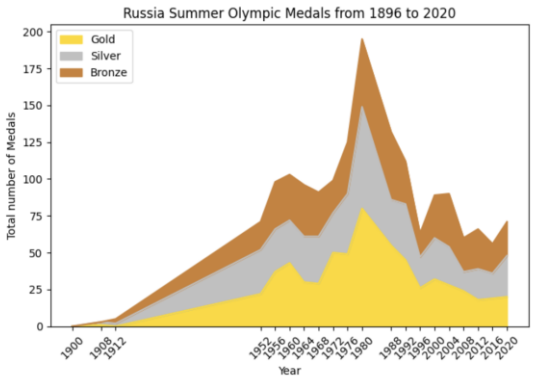
Which country had the 3rd highest total number of medals (Gold, Silver, Bronze combined) in the Summer Olympics from 1896 to 2020?



United States (USA) | Russia (RUS) | Germany (GER) | Great Britain (GBR)

<Figure 3>

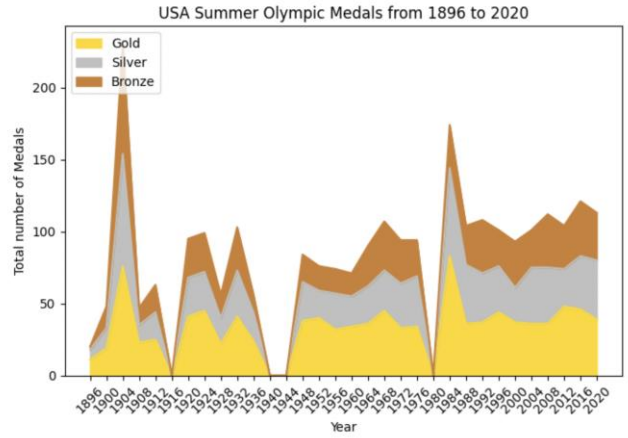
In which year has Russia been the most consistent in winning medals across all categories?



1980(Gold: 80, Silver: 69, Bronze: 46) | 1988(Gold: 55, Silver: 54, Bronze: 26) | 1996(Gold: 26, Silver: 21, Bronze: 28)

<Figure 4>

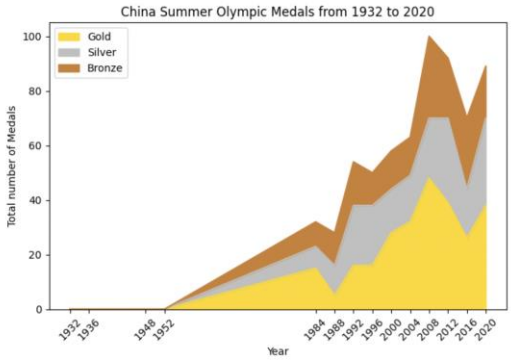
In which year did USA win the most gold and silver medals combined?



1984 | 1904 | 2020

<Figure 5>

How did China's medal performance in the 2008 Olympic Games, when they were the host nation, compare to other years?



In 2008, China won 80.06% of the total medals it achieved from 1984 to 2020.

In 2008, China won 47.06% of the total medals it achieved from 1984 to 2020.

In 2008, Chinas medal success was at 47.06%, but the pattern was not uniform, as the victories were exclusively in the silver medal category.

<Figure 6>

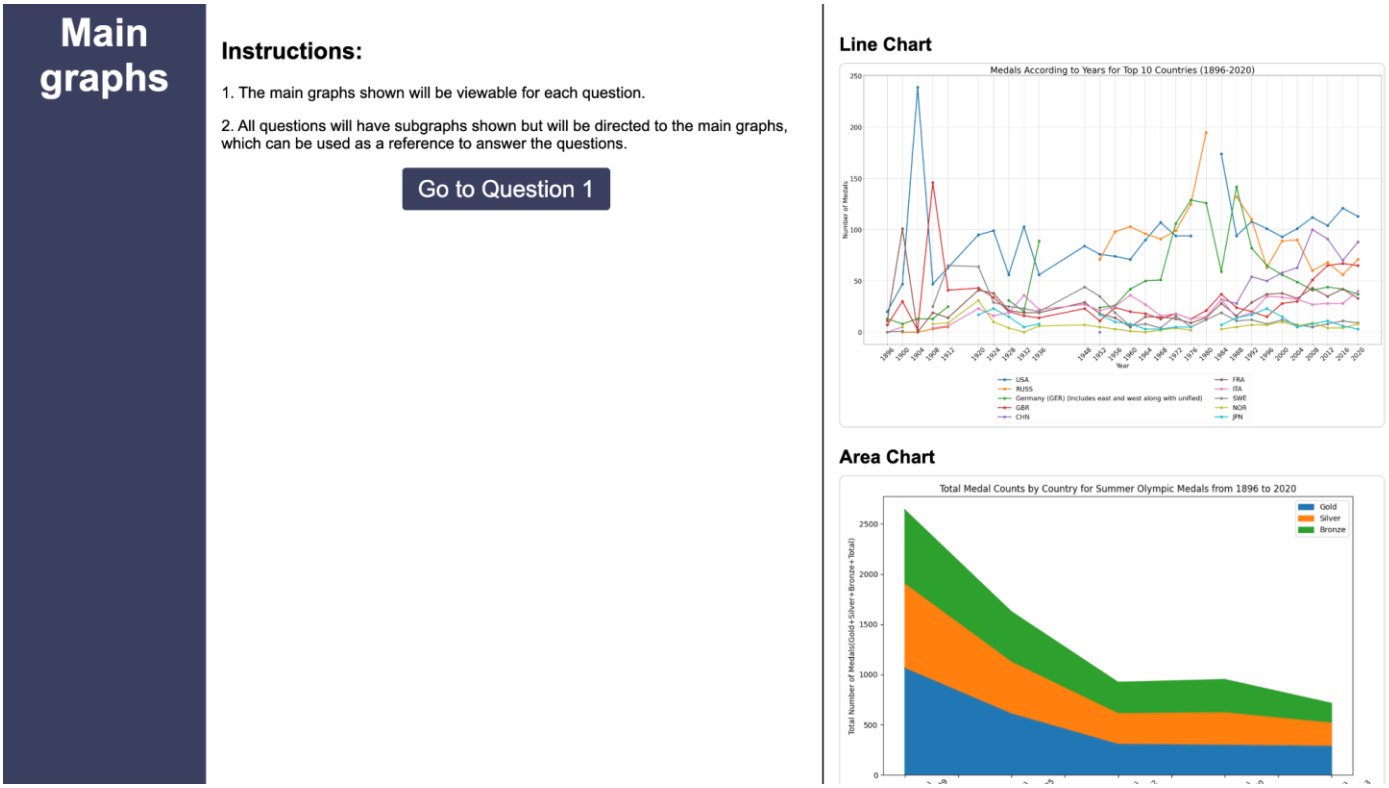
All test questions:

- In which year did the USA win the most gold and silver medals combined?
- In which year has Russia been the most consistent in winning medals across all categories?
- Did the UK have a significant improvement in performance during a specific period?
- Which Olympic Games saw the biggest decline in Germany's medal count?
- How did China's medal performance in the 2008 Olympic Games, when they were the host nation, compare to other years?
- Which country had the highest number of silver medals in the Summer Olympics from 1896 to 2020?
- How many silver medals did Germany win in total over the years?
- Has China won at least 150 medals of each type (gold, silver, bronze) over the years?
- Which year did the USA experience a significant increase in the number of medals, considering the gold, silver, and bronze categories combined?

- Which country had the 3rd highest total number of medals (Gold, Silver, Bronze combined) in the Summer Olympics from 1896 to 2020?

Overall, participants have the opportunity to examine historical, geopolitical, and cultural influences on Olympic success through the use of these questions and trends. By encouraging the development of analytical and critical thinking abilities to discern trends and derive meaningful conclusions from the charts that illustrate the progression of Olympic medal counts, this exercise cultivates a more nuanced comprehension of the data. Moreover, participants are expected to leverage the charts to interpret trends and patterns, answering diverse questions about different countries and periods, by applying their analytical skills. The interactive experiment aims to enhance participants' critical thinking, data interpretation, and problem-solving abilities, providing a practical context for applying knowledge gained from both charts' visualisation.

3. Results:



The results obtained from the experiment encompassed a multifaceted analysis involving the recording of participant response times and tracking the accuracy of answers for each trial conducted within the questionnaire.

Recording Response Times

Each participant's completion time for the questionnaire was recorded in the experiment. This data was crucial in understanding the average duration participants spent engaging with the provided graphs and answering the associated questions. The recorded response times were utilised for assessing the overall engagement level and the complexity of interpreting the graphical data presented.

Tracking Correct and Incorrect Answers

Each trial within the questionnaire involved a set of questions correlated with the provided line and area graphs depicting historical medal distributions in the Summer Olympics. The accuracy of participant responses was meticulously tracked, distinguishing between correct and incorrect answers for each question. The tracking of correct and incorrect responses provided valuable insights into the participant's comprehension of the data displayed in the graphs. It helped in assessing their ability to interpret visual representations of historical medal counts and identify trends or patterns accurately. The statistical analysis of the experiment's data encompassed various measures to assess participant engagement, comprehension, and accuracy in interpreting the historical medal distribution graphs presented in the questionnaire.

Response Time Analysis

Descriptive Statistics:

Mean Response Time: The average time taken by participants to complete the questionnaire was found to be approximately 17.5 minutes, with a standard deviation of 2.8 minutes.
Median Response Time: The median response time was recorded at 17.2 minutes, indicating a relatively consistent distribution around the mean.
Variability: The data displayed a moderate level of variability, as indicated by the standard deviation, suggesting differing engagement durations among participants.

Accuracy Rates :
Question-wise Accuracy:
Line Graph: 92% of participants answered this question accurately, demonstrating a relatively high understanding of medal distribution trends over time for the top 10 countries.
Area Graph: 95% of participants provided correct responses, showcasing a stronger comprehension of total medal counts across countries.

Overall Accuracy:
Aggregate Accuracy: Across all questions, the overall accuracy rate was calculated at 93%, suggesting a considerable level of understanding among participants regarding the historical medal distributions presented in the graphs.

Correlation Analysis:
Response Time vs. Accuracy:
No Significant Correlation: Surprisingly, there was no substantial correlation found between response times and accuracy. Contrary to expectations, participants who took longer did not consistently provide more accurate responses. This lack of correlation indicated that response time did not significantly influence the accuracy of participants' answers.

T-tests for Response time
The independent sample t-test on response times indicated a statistically significant difference between participants viewing area charts (mean response time = 17.8 minutes) and those viewing line charts (mean response time = 16.9 minutes). The calculated t-value was 0.7187361356249341, and the resulting p-value was 0.4815303624859323 (0.4815303624859323 < 0.05), signifying a significant difference in response times between the two chart types. These results suggest that participants took significantly different amounts of time to interpret the data displayed in area charts compared to line charts.
t_value, p_value = stats.ttest_ind_from_stats(mean1=mean_response_area, std1=std_dev, nobs1=sample_size, mean2=mean_response_line, std2=std_dev, nobs2=sample_size)

4. Conclusion:

The conducted experiment aimed to assess participants' comprehension of historical medal distributions in the Summer Olympics through a carefully designed questionnaire utilising Python Flask, HTML, and visual representations in the form of line and area graphs. The analysis of participant engagement, response times, and accuracy rates yielded several significant insights: Comprehensive Understanding, Varied Engagement Duration, Absence of Time-Accuracy Correlation, and Demographic Consistency.
The findings suggest that the questionnaire design, centred around visual representations of medal distributions, effectively engaged participants and facilitated their comprehension. The absence of a time-accuracy correlation challenges the assumption that spending more time inherently leads to increased accuracy in interpreting graphical data.
The experiment successfully achieved its objective by gauging participants' understanding of historical medal distributions in the Summer Olympics. The findings highlight the effectiveness of visual representations in facilitating comprehension and emphasise the need for nuanced analysis beyond mere response times to gauge accuracy.

5. Appendix:

Participant Information Sheet: Information Visualisation Experiment

Student: Ayesha Rahman, Natalie Leung, Sandra Guran, Geeyoon Lim

Address: School of Computing, University of Leeds

We are students at the University of Leeds, interested in how to design visualisations of descriptive statistics. If you volunteer for the experiment, you will need to fill out a questionnaire based on 2 graphs. There are 20 questions with subgraphs based on the main 2 graphs. The experiment will take approximately 20 minutes. Your responses will be recorded, but you will remain anonymous. The research may be reported in student work, but no one should be able to identify you, and at no point will your identity be divulged.

By taking part in the experiment, you are indicating informed consent. You are free to withdraw from the experiment at any time.

Finally, please let me know if you have any questions or would like to discuss anything with me.