Project Proposal

How does the genetic mutation associated with cystic fibrosis impact lung function in rats?

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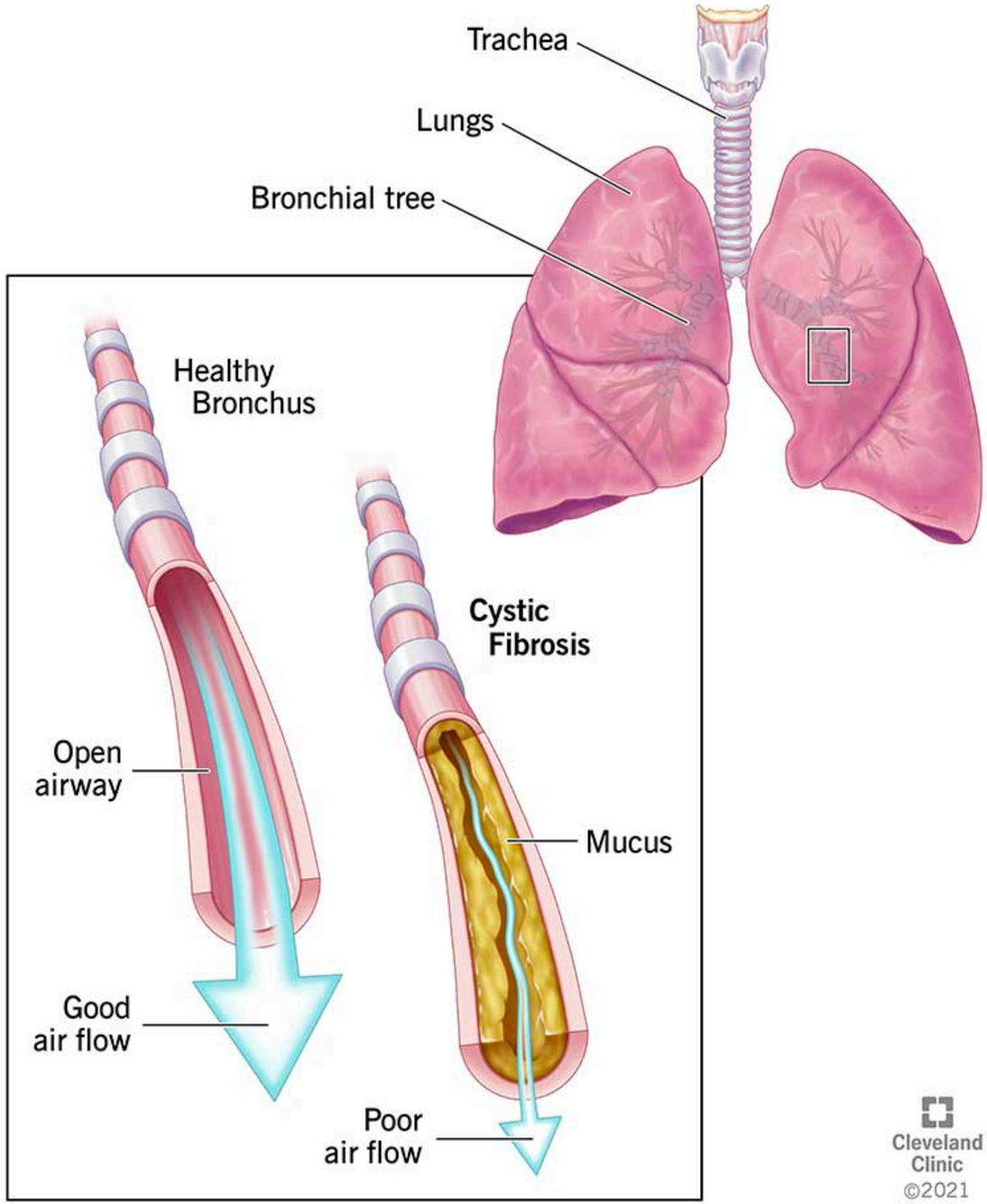
What is Cystic Fibrosis?

- Cystic fibrosis (CF) is a genetic disorder that affects the respiratory, digestive, and reproductive systems.
- It is caused by mutations in the CFTR gene, leading to the production of thick and sticky mucus.
- This mucus can clog airways, impair lung function, and cause respiratory infections.
- CF also affects the pancreas, leading to difficulties in digesting food and absorbing nutrients.

While there is no cure, advancements in treatment and care have improved the quality of life and life expectancy for individuals with CF.



Purpose

- To investigate and understand the effect of genetic mutation responsible for cystic fibrosis on lung function and airway characteristics in rats

- The research can contribute to our knowledge of how the genetic mutation affects the respiratory system and potentially provide insights into strategies for managing or treating cystic fibrosis-related lung issues.

Data Source

- Data collected and compiled in a study by Prof. Martin Donnelley, Prof. Antonios Perperidis, Prof. David Parsons and Prof. Ronan Smith.
- XV technology used to collect data developed by 4D Medical.
- Contains 8246 observations of the rat genotypes before and after they were affected by beads.
- Combination of integer and textual datatypes.
- Variables:

  - XYZ columns representing co-ordinates of each region of lungs.

  - Ventilation in different areas of lungs : left, right, lower and upper.

Methodology

- Using Python, pandas, and Matplotlib to sort and present data effectively.
- Leveraging pandas to manipulate data.
- Using Matplotlib for creating impactful visuals
- Using Jupyter Notebook to analyse dataset.

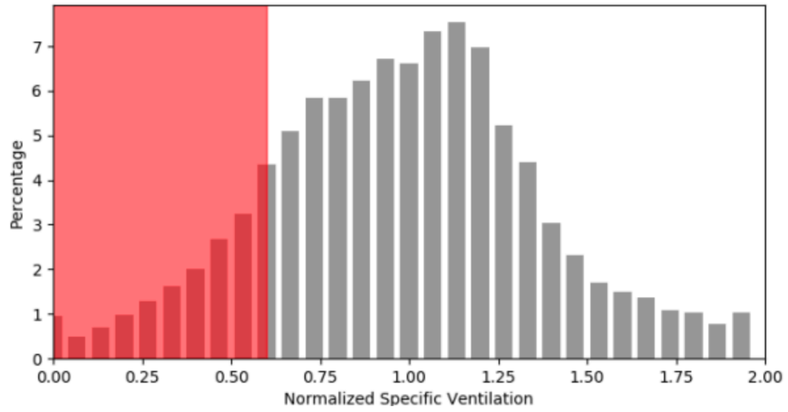
Preliminary Investigation

- In my research, I am using data from a study where a groups of rats were XV scanned which were either wildtype (healthy), or had the phe508del or the KO (knockout) cystic fibrosis mutation. These rats then had a dose of agar beads to either the left or right lung to see how they responded, and were scanned again.
- The specific ventilation in different areas of lungs were recorded and stored.
- Specific Ventilation is defined as the change in volume of that region of lung between peak inspiration and exhalation (breathing all the way out to all the way in), divided by the volume of the region.

Preliminary Investigation

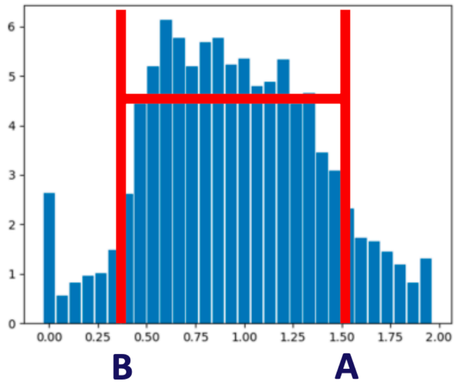
- Specific Ventilation can further give us information on Tidal Volume, Ventilation Heterogeneity (VH), and Ventilation Defect Percentage (VDP) that can in turn prove instrumental to study the affect of Cystic Fibrosis in respiratory system of humans.

Figure 3: Ventilation Defect Percentage



(a) VDP = lung regions with specific ventilation values less than 60% of mean specific ventilation (shown in red)

Figure 4: Ventilation Heterogeneity [VH] methodology

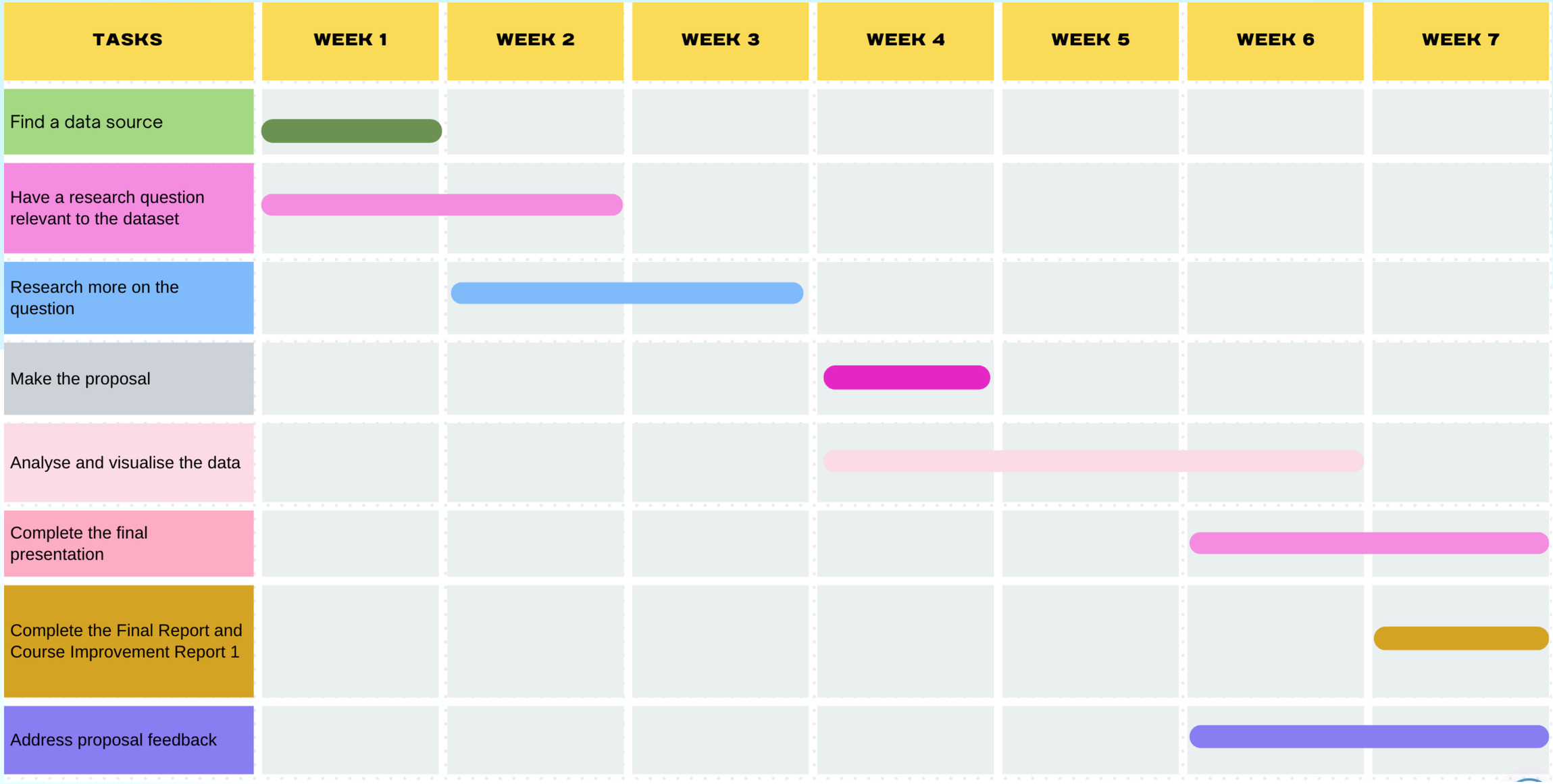


VH= [(A-B) / mean specific ventilation] x 100%

Graphics Used

- Throughout my research, I will primarily be using Histograms and bar charts to visualise how the XV data changed in different regions of lungs that did/did not have beads.
- I am also planning to explore correlations between specific ventilation and coordinates (x, y, z). For this I will be using scatter plots to visualise the relationships.
- Some challenges would be tackling the NaN values where no data was found to ensure I have a complete dataset to work with.

Timeline


TASKS
WEEK 1
WEEK 2
WEEK 3
WEEK 4
WEEK 5
WEEK 6
WEEK 7
Find a data source
Have a research question relevant to the dataset
Research more on the question
Make the proposal
Analyse and visualise the data
Complete the final presentation
Complete the Final Report and Course Improvement Report 1
Address proposal feedback

Benefits of this selection of Data

- By studying the effects of cystic fibrosis in rats mutated to replicate cystic fibrosis in humans we can gain insights into how this condition affects the lung functions and airway path in humans.

- On further research, it can potentially lead to the development of more targeted and effective treatment approaches.

Thank You