Detecting Horse Cardiac Arrhythmia with ECG Data

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Cardiac arrhythmias in horses are serious conditions that are potentially life-threatening. Our research focuses on analyzing horse ECG data to understand arrhythmia patterns comprehensively. By employing advanced statistical methods on ECG data, we aim to enhance the detection of horse cardiac arrhythmia.

Research Question: How can advanced data analysis of ECG data enhance our comprehension of cardiac arrhythmias in horses?

Data

- **ECG data of 13 horses with 11 windows of time across a 24-hour period**
- **Our focus is on RR intervals, the time between consecutive R waves in ECG**
- **Horses received an endotoxin injection that simulates cardiac arrhythmia symptoms**
- **Treatments were given in the 5-7h window**

Data Preprocessing

- **Poincaré plots:** RR(n) on the x-axis vs. RR(n+1) (the succeeding RR interval) on the y-axis
- **Data Preprocessing:** Atrioventricular blocks (AV blocks) are removed

Methodology

- **Important summary statistics of RR data:**
  - Mean, Variance, Min, Max
  - SD1 and SD2: short-term and long-term variability to quantify cluster shape
  - **Number of components** by Gaussian Mixture Model: capture complexity in cluster dispersion (disperse → more components)

We want to find patterns between the shape of Poincaré plot cluster and the cardiac arrhythmia phase using trends in RR summary statistics.

- **Principal Component Analysis (PCA)**: used to find what variables “contribute” the most to the change in phases
- **Each point is assigned to a cluster based on hierarchical clustering** with complete linkage and Euclidean distance
- **Cluster assignments are used for Chi-squared test** and Mosaic plot against phases and horses

Results

**PCA:**
- 66.6% of total variance are explained
- Contributors to PC1: SD1, Max
- Contributor to PC2: Number of components
- Endotoxin Admin associated with small PC1

**Mosaic Plots:**
- Cluster assignments and phases are not independent
- Cluster assignments are mostly independent with horse

Conclusion

Using our results from PCA and the Mosaic plots, we can distinguish periods before and after endotoxin injection:

- The larger the SD1 and Max, the more likely the horse has not shown severe cardiac arrhythmia symptoms
- If a horse’s RR summary data is assigned to cluster 1 or 3, there is high probability that this horse is in the Endotoxin Admin phase

Future Research:
- Detect differences between Severe Symptoms and Recovery Stage
- Increase sample size for better generalizability
- Incorporate horse info (age, weight, etc.) and further explore the variability among horses

References