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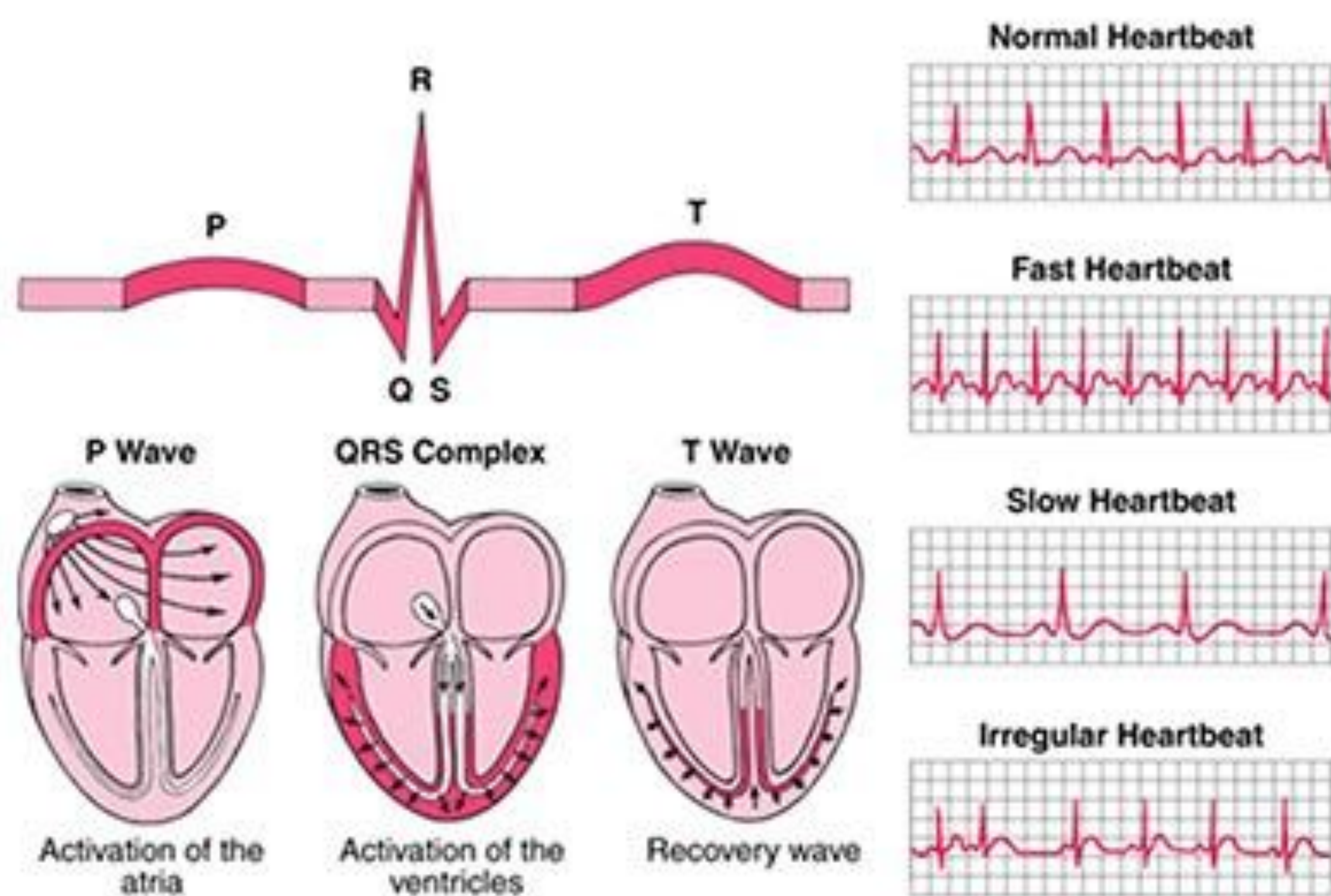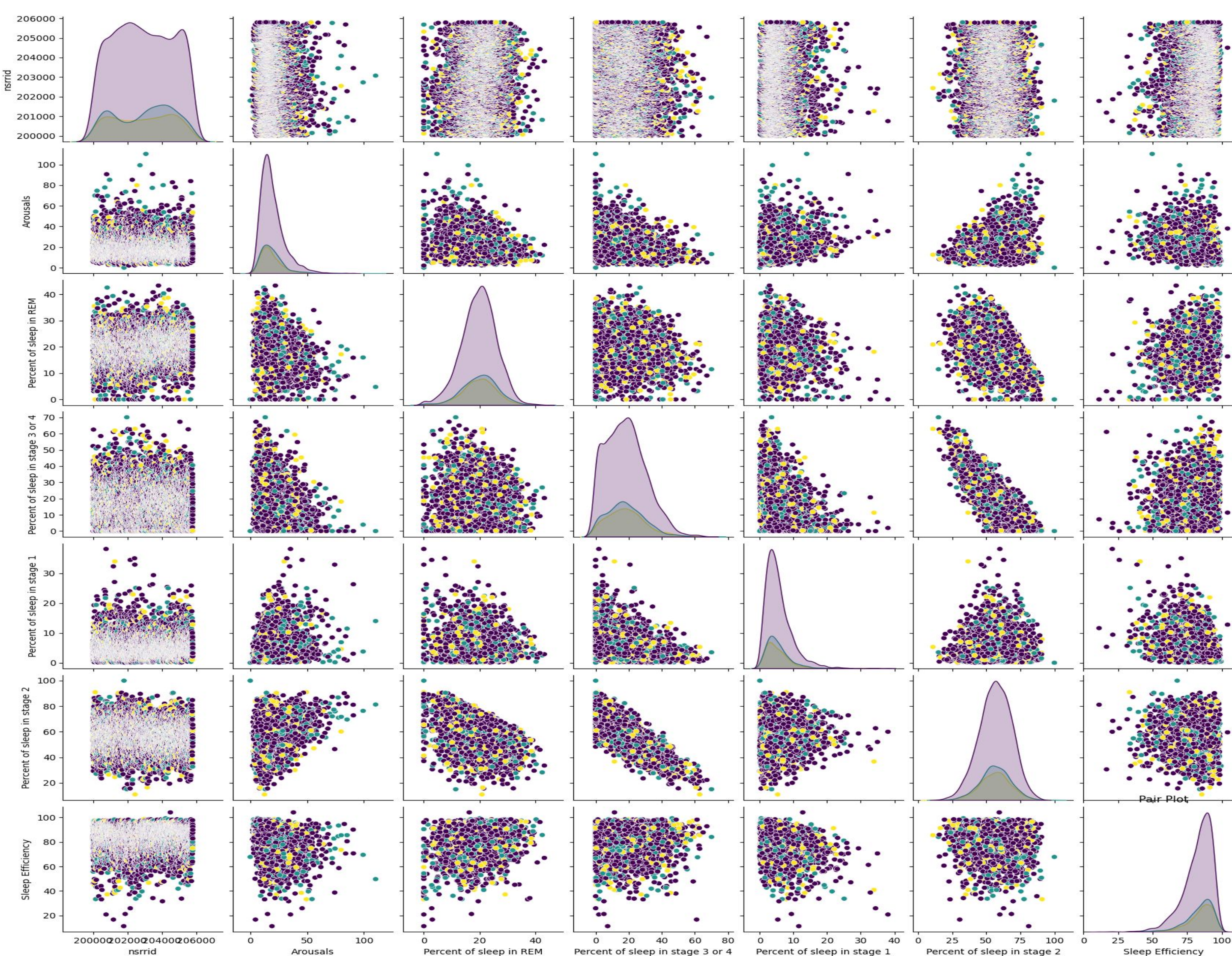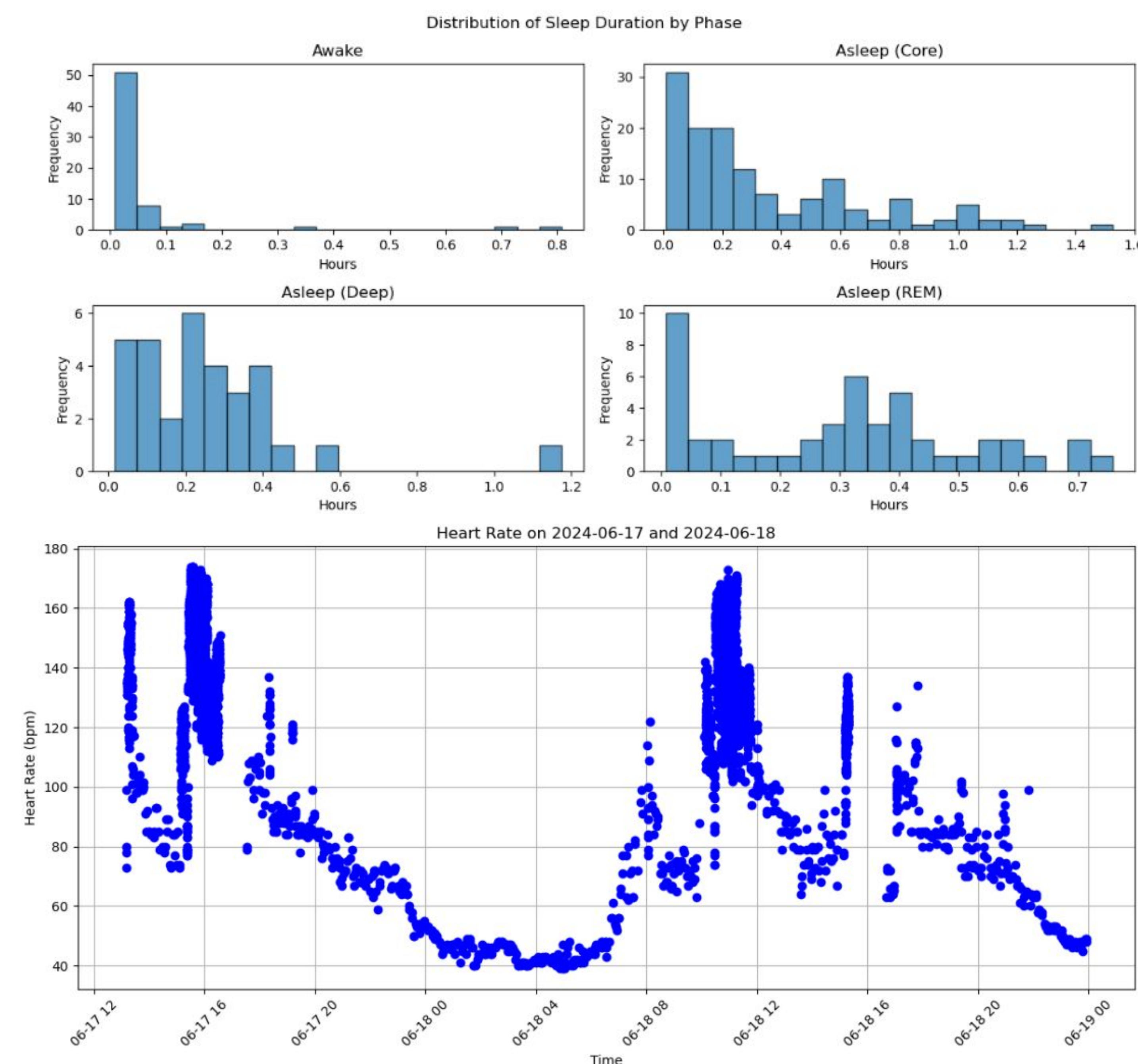
Normal & Irregular Heartbeats [1]

Feature Relationship for Stress Detection

Introduction

- **Objectives**: Develop Intelligent Algorithms to analyze and detect healthcare conditions using various machine learning (ML) models
- **Research Topics**:
  - Detecting Heartbeat Irregularities (Arrhythmia) using ECG Data
  - Sleep Stage Classification and Stress Level Detection
  - Injury and Risk detection in Excessive Health Activities
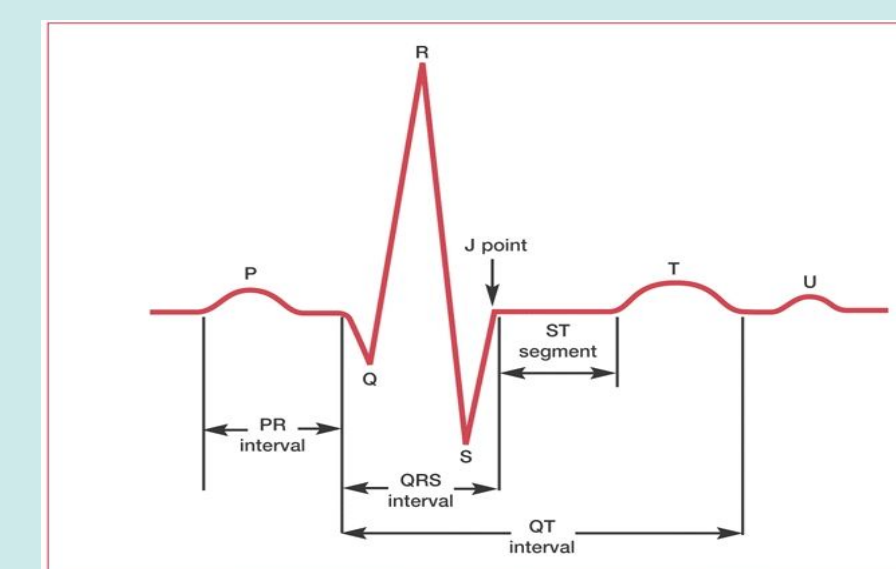
Data Collection

- Apple Watches (Series 9): enable exercise mode while working out, and use two Apple Watches to continuously monitor heart rate and sleep data.
- Three IA team members conducting data collection for 6 months

Public Datasets

- UCI Arrhythmia Dataset [2]
  - 279 attributes, 206 are linear valued and the rest are nominal
  - 452 people across varying ages and body types
- DREAMT (Dataset for Real-time sleep stage Estimation) [3]
  - 100 participants for 1 night - metrics include: BVP, ACC, TEMP, HR, IBI
  - Includes sleep stage labels and clinical metadata for each participant
- The Sleep Heart Health Study (SHHS) [4-5]
  - Multi-cohort study focused on sleep study
  - 5,804 adults: Two exam cycles, 1995-1998 and 2001-2003
  - More than 130 manuscripts have been published investigating predictors and outcomes of sleep disorders.

Arrhythmia Dataset Pre-processing

- The 279 attributes are ECG data, including the averages and the ECG data per each channel
  - Channels/leads represent a different direction of cardiac activation in 3-D space
- Labeled between 1 and 16
  - 1 denotes normal, and 2-16 denote a form of Arrhythmia
- Standardized target to be 0 for normal and 1 for abnormal
- Used **seaborn** and **matplotlib** to graph the correlation matrix heatmap
- Removed all features with low correlation to the target
  - 109 features used in training
  - 170 features excluded
- Filled in missing values with SimpleImputer Mean
- Feature engineering ideas to consider
  - Increasing rows of dataset
  - Balancing the dataset

ECG Waveform [2]

Heart Arrhythmia Detection Models

ML Model	Accuracy	Precision	Recall
Support Vector Machine	73%	84%	57%
Random Forest	73%	84%	57%
Convolutional Neural Network	77%	85%	62%

Data Collection and Analysis

Data Collection Metrics
- Physical activities and exercise: running, walking, cycling, and swimming
- Heart Rate Zones: Current heart rate, time in zone, heart rate average
- Sleep analysis: sleep stages, wrist temperature, respiratory rate
- Energy: Basal energy burned and active energy burned

Stress Detection Preliminary Results
- Supervised & Unsupervised Learning:
  - Decision Tree: 54%
  - K-mean Clustering: up to 63%
- Reliability Analysis:
  - raw_alpha = 0.52, std_alpha = 0.67

Future Exploration

- Continue exploration of new datasets for pertinent information for risk detection/sleep stage analysis.
- Train ML models on acquired data for sleep, injury detection and prevention.

References

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[2] Guvenir, H., Acar, Burak, Muderrisoglu, Haldun, and Quinlan, R.. (1998). Arrhythmia. UCI Machine Learning Repository. https://doi.org/10.24432/C5BS32.
[3] K. Wang, J. Yang, A. Shetty, and J. Dunn, "DREAMT: Dataset for Real-time sleep stage EstimAtion using Multisensor wearable Technology." PhysioNet. doi: 10.13026/NKTQ-0858.
[4] Zhang GQ, Cui L, Mueller R, Tao S, Kim M, Rueschman M, Mariani S, Mobley D, Redline S. The National Sleep Research Resource: towards a sleep data commons. J Am Med Inform Assoc. 2018 Oct 1;25(10):1351-1358. doi: 10.1093/jamia/ocy064. PMID: 29860441; PMCID: PMC6188513.
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