ECE 313 Project Checkpoint

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Task 1

- **Summary of Results:**
  - Generated PMFs, PDFs, and CDFs for respiratory rate samples of sizes 30,000, 1000, and 70. We observed less data fluctuations as sample size increased.
  - Real patient data had a higher RMSE (**0.9798**) compared to artificially generated normal distribution (**0.2468**) based on probability plots.
  - Real patient data had a narrower bounded range compared to the normal distribution due to skewed data.
- **Insights:**
  - Larger sample sizes significantly reduce noise and make distributions more normal-like.
  - The respiratory rate data slightly deviates from perfect normality as it is right skewed and has higher variance.
- **Comments:**
  - This task demonstrated how sensitive probability distributions can be to sample size changes and normality assumptions, which helped prepare us for better alarm detection modeling.

Task 2

- **Summary of Results:**
  - Created alarms based on heart rate, pulse rate, and respiratory rate thresholds using empirical and normalized distributions.
  - Majority voting of alarms had an **error probability of 0.0327** (empirical) and **0.0160** (normalized).
- **Insights:**
  - Standardizing the features by normalizing them reduced both false alarms and miss detections, making alarm detection more reliable.
  - Data that is similar to normal distribution benefits most from standardization, but assuming normality incorrectly can make detection quality worse.
- **Comments:**
  - This task showed us how normalization improves detection in alarm systems and prepared us for applying decision rules like MAP/ML in the next task.

Task 3

- **Summary of Results:**
  - Computed prior probabilities, likelihood matrices, and hypothesis tables for 9 patients.
  - Implemented ML and MAP decision rules to determine best feature pairs for each patient.
  - Selected feature pairs for patients 1, 4, and 5 based on their low error probability (**less than 5%**) and high correlation with golden alarms.
- **Insights:**
  - MAP rule generally outperforms ML rule when prior class probabilities are skewed.
  - Choosing feature pairs based on both error minimization and correlation with alarms leads to better detection models.
- **Comments:**
  - This task brought everything together by applying probability theory directly to patient alarms.
  - It also taught us how feature selection based on both statistical error and correlation can lead to better classification performance.