ECE 313 FINAL PRESENTATION

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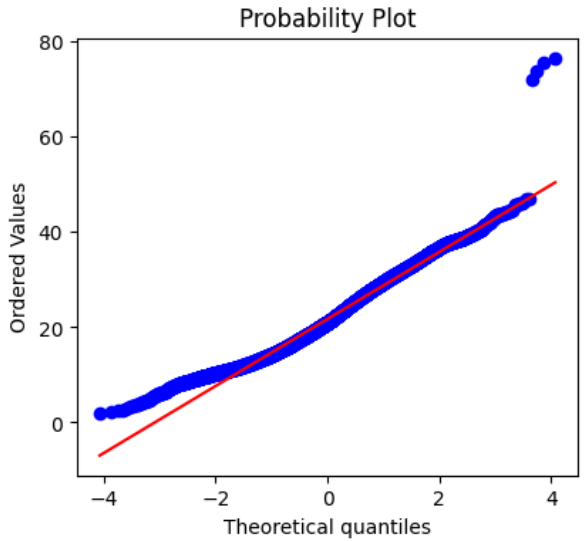
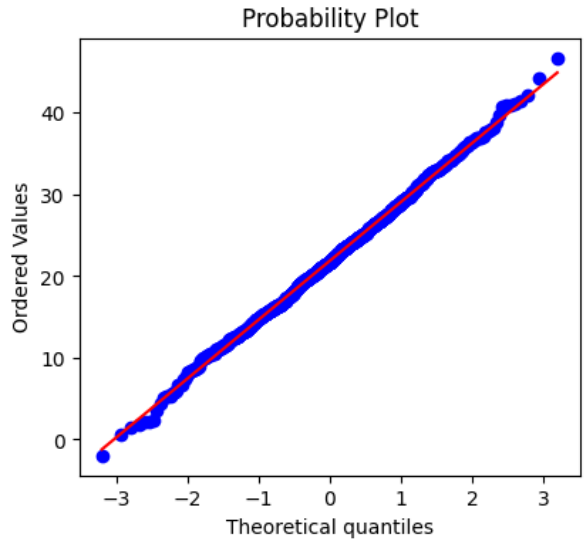
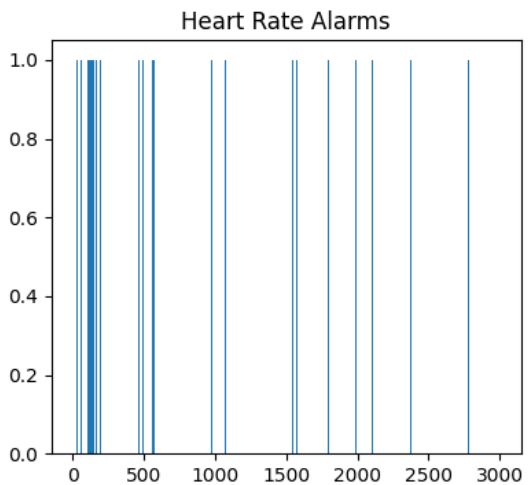
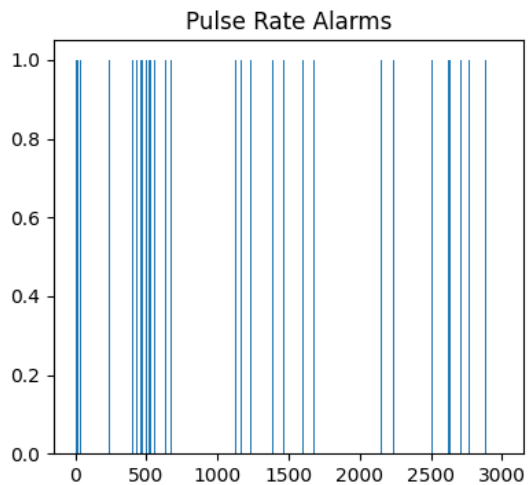
TASKS 1 & 2

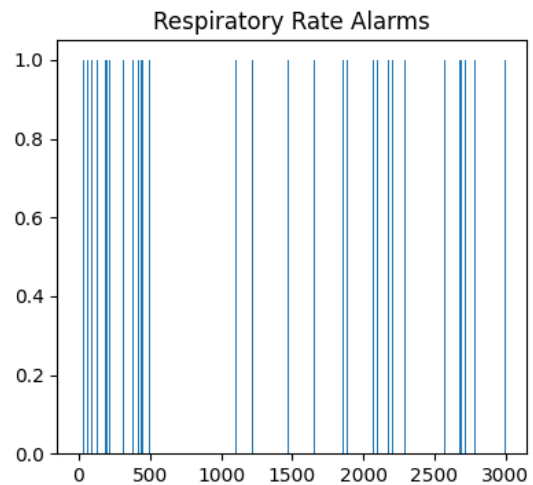
- Generated PMFs, PDFs, and CDFs for respiratory rate samples (sizes 70, 1000, 30,000) and observed reduced fluctuations with larger sizes (hd11).
- Real patient data showed greater deviation from normality (RMSE of **0.9798**) than simulated data (RMSE of **0.2468**) and had a narrower right-skewed range (kappana2).
- Alarms were created using heart, pulse, and respiratory rate thresholds from empirical and normalized distributions (sg97).
- Normalized alarms had a lower error probability (**0.0160**) compared to empirical (**0.0327**), showing better detection performance (hd11).


Probability Plot
Ordered Values
Theoretical quantiles
80
60
40
20
0
−4
−2
0
2
4


Probability Plot
Ordered Values
Theoretical quantiles
40
30
20
10
0
−3
−2
−1
0
1
2
3

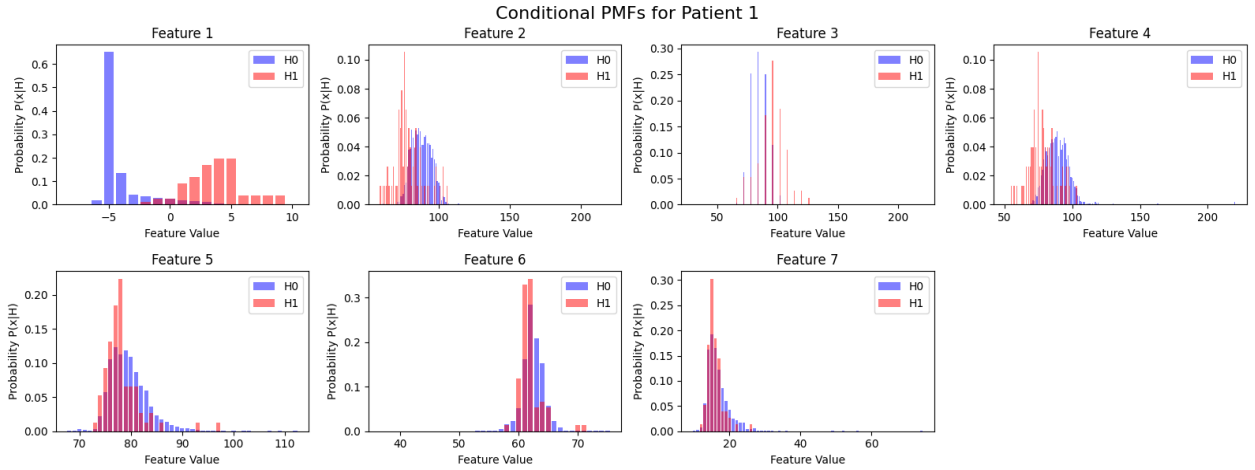

Heart Rate Alarms
1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
2500
3000


Pulse Rate Alarms
1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
2500
3000


Respiratory Rate Alarms
1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
2500
3000

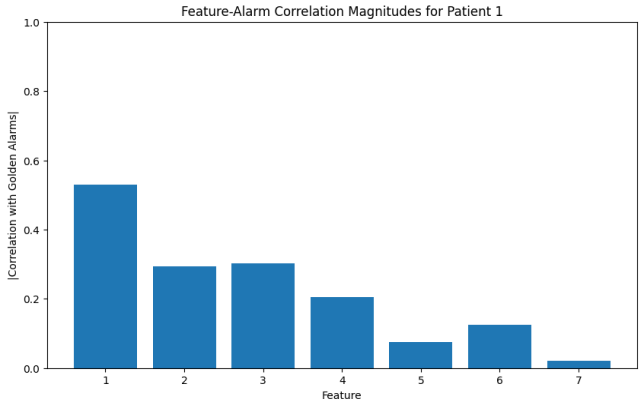
TASK 3

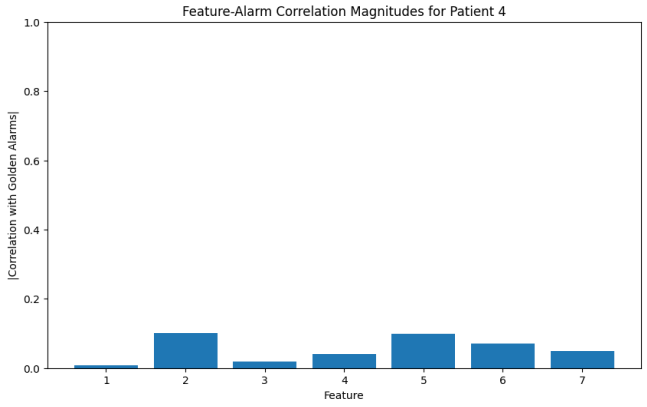
- Constructed conditional PMFs and likelihood matrices for each of 9 patients (sg97).
- Calculated prior probabilities P(H0) and P(H1) for each patient's training data (sg97).
- Built ML and MAP decision vectors from likelihoods and priors (kappana2).
- Used false alarm and miss detection rates to compute overall error probabilities (kappana2).

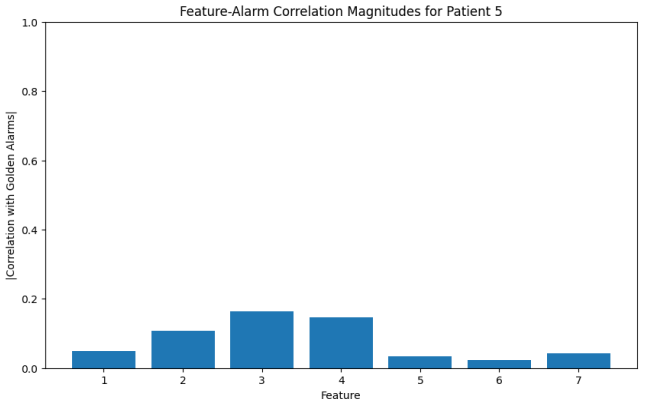


TASK 3 - PATIENT DECISIONS (HD11)

- **Patient 1 (ML):** Features 1 & 3 chosen due to both low error and high impact (**0.0325 error**).
- **Patient 4 (ML):** Features 2 & 5 chosen because feature 5 had lowest error and feature 2 provided strong signal correlation (**0.0332 error**).
- **Patient 5 (MAP):** Features 1 & 3 are the combined best from lowest-error and highest-impact pairs (**0.0256 error**).







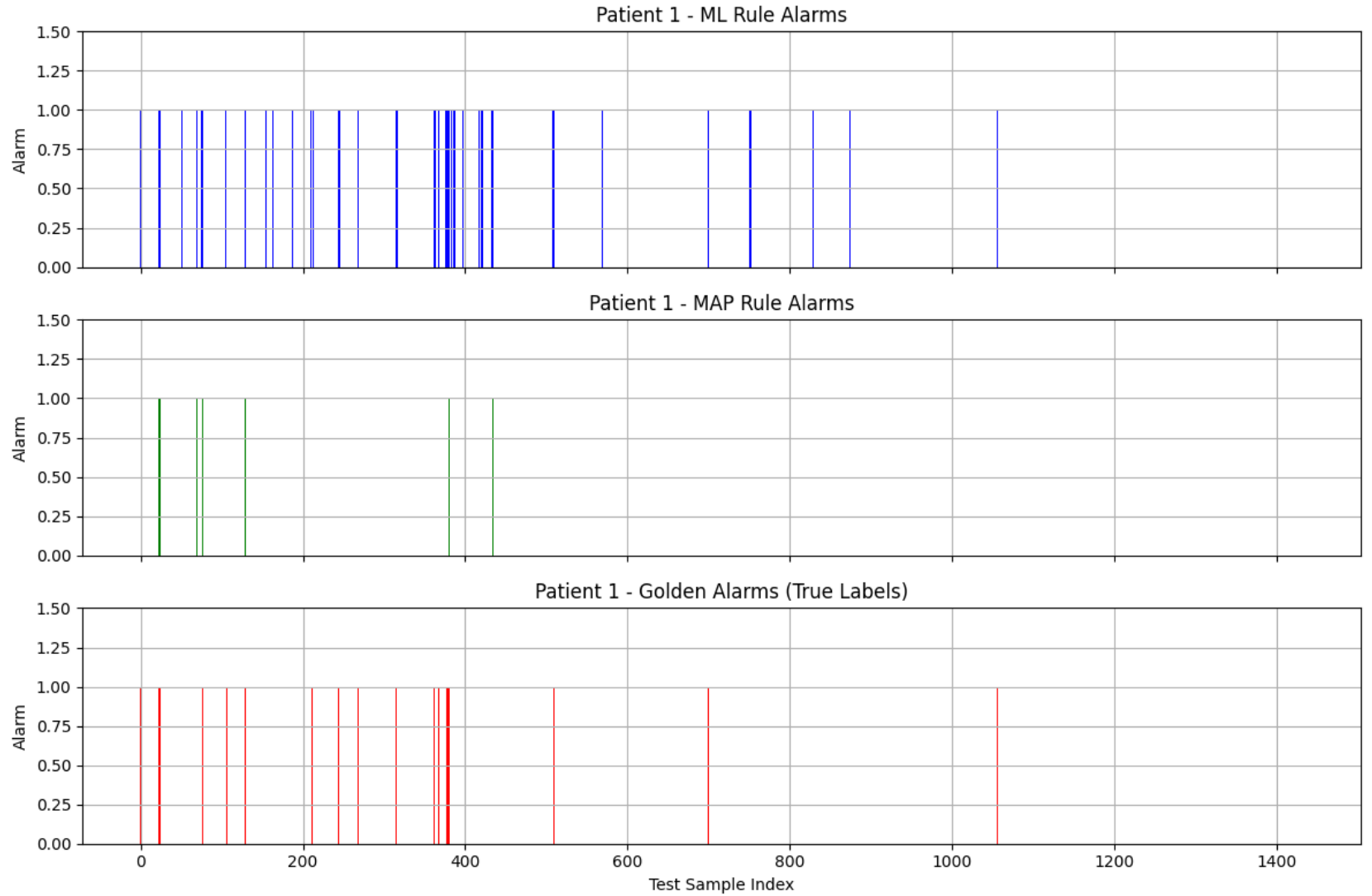
TASK 4

- Constructed joint likelihood matrices **P(X,Y | H0)** and **P(X,Y | H1)** for selected feature pairs (sg97) :
  - **Patient 1:** Features 0 & 2
  - **Patient 4:** Features 1 & 4
  - **Patient 5:** Features 0 & 2
- Created joint ML and MAP decision rules using likelihood ratios and class priors (sg97).
- Generated predicted alarms for each patient and compared to golden labels (hd11).
- Error probabilities were computed for each method and patient (hd11).

Patient	Method	P(FA)	P(MD)	P(E)
Patient 1	ML	3.98%	0.14%	2.06%
	MAP	0.42%	1.33%	0.45%
Patient 4	ML	3.78%	0%	1.89%
	MAP	3.78%	0%	3.78%
Patient 5	ML	3.28%	0.07%	1.67%
	MAP	0.35%	0.07%	0.35%

TASK 4

- MAP rule outperformed ML in Patients 1 and 5 with lower total error (hd11):
  - **Patient 1:** MAP (0.45%) vs. ML (2.06%)
  - **Patient 5:** MAP (0.35%) vs. ML (1.67%)
- Patient 4 showed worse MAP performance, likely due to skewed priors misaligning with feature distribution (kappana2).
- **Average Errors** (kappana2)**:**
  - ML Average Error: 1.87%
  - MAP Average Error: 1.53%
- MAP models are more sensitive to prior distribution assumptions but can dramatically reduce false alarms and misses when aligned well (kappana2).


Patient 1 - ML Rule Alarms
Patient 1 - MAP Rule Alarms
Patient 1 - Golden Alarms (True Labels)
Alarm
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
200
400
600
800
1000
1200
1400
Test Sample Index

BONUS TASK

- Built and evaluated **Logistic Regression** and **Neural Network** classifiers for alarm prediction (kappana2).
- Compared these to the **MAP Rule** from Task 4 using the same test set across all models (kappana2).
- Tested both models with (hd11):
  - T_ML (0.5) - standard threshold
  - T_MAP - threshold with class priors

	Model	Threshold	P(False Alarm)	P(Miss Detection)	P(Error)
0	Logistic Regression	τML (0.5)	0.000086	0.010249	0.005168
1	Logistic Regression	τMAP	0.000000	0.010249	0.005124
2	Neural Network	τML (0.5)	0.000000	0.010249	0.005124
3	Neural Network	τMAP	0.000000	0.010249	0.005124
4	MAP Rule (Task 4)	τMAP	0.015174	0.004652	0.015265

BONUS TASK

- Both Logistic Regression and Neural Network significantly outperformed the MAP rule from Task 3 in total error rate (sg97).
- The MAP Rule had the lowest miss detection rate (**0.46%**) but suffered from a high false alarm rate (**1.52%**) (sg97).
- Neural Network and MAP Rule delivered the lowest total error (**0.51245%**) with zero false alarms (hd11).
- Incorporating priors via MAP Rule improved all models' decision boundaries without hurting recall (hd11).

QUESTIONS?