Introduction to the Problem

- **GOAL**: Minimize hospital cost for thyroid disorder diagnosis

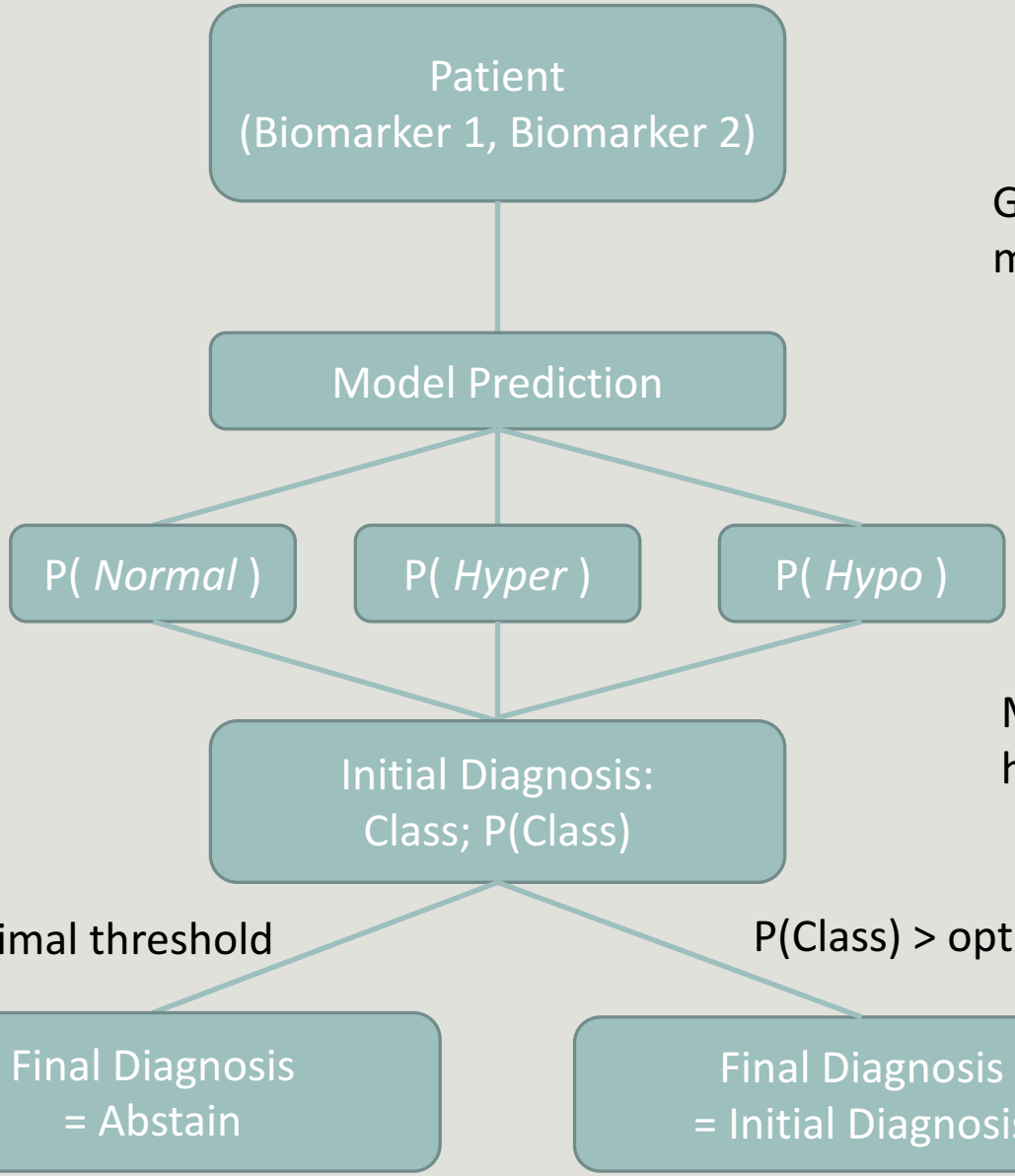
- **BACKGROUND**:
  - Types of diagnosis based on current medical tests:
    - *normal* (class 1)
    - having *hyperthyroidism* (class 2)
    - or having *hypothyroidism* (class 3)

  - Two types of potential cost associated with thyroid disorder diagnosis
    - Misdiagnosis cost -- e.g. if patient were to file law suit seeking compensation
    - Abstention cost (abstaining a diagnosis to mitigate misdiagnosis) -- e.g. forwarding the patient to a thyroid specialist

Total Cost = Misclassification Cost + Abstention Cost

Solution: We have built a new algorithm to automate thyroid disorder diagnosis while minimizing hospital total cost

Our Approach



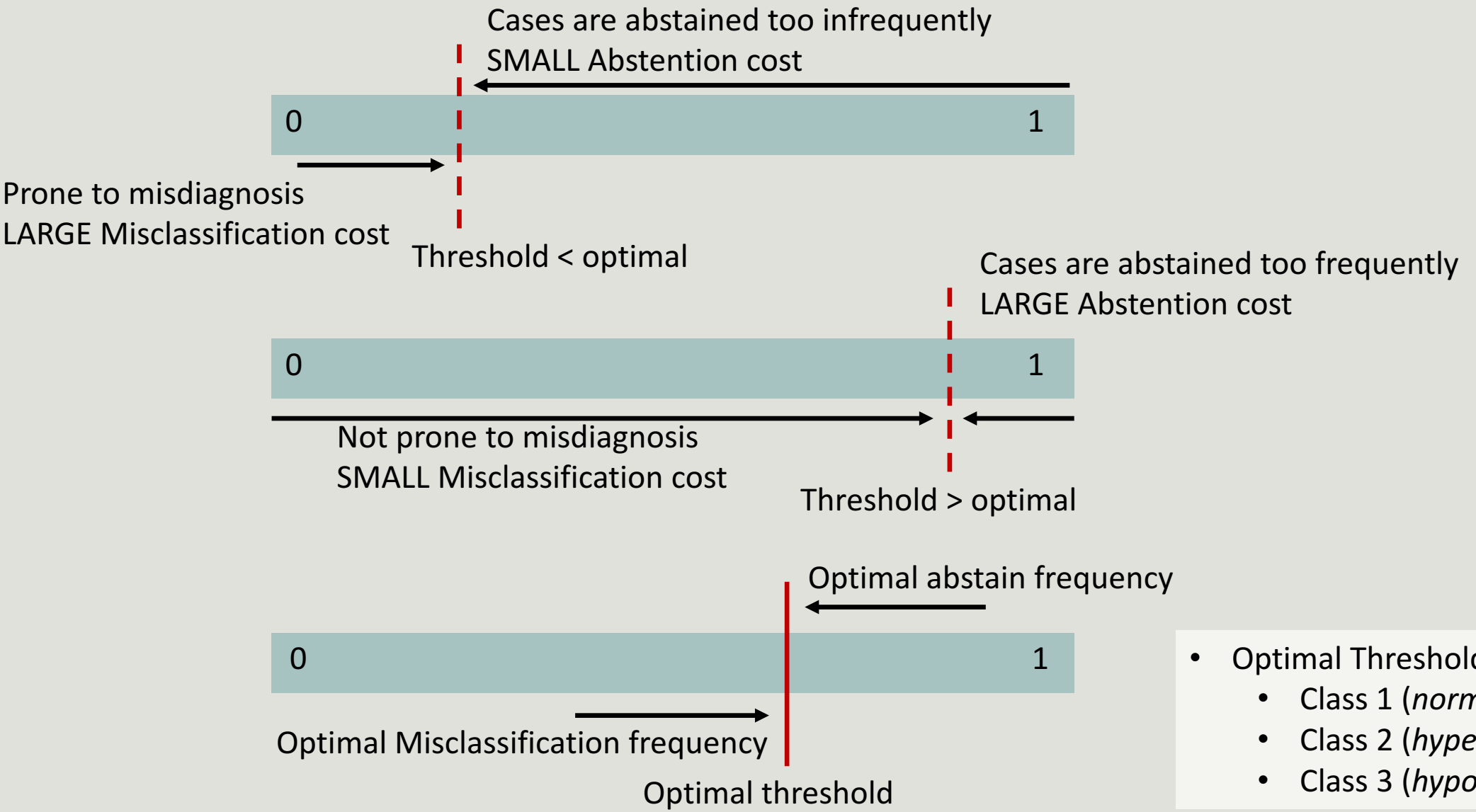
Given a patient's biomarker 1 and biomarker 2 values, model outputs the PROBABILITIES of the patient as

- *normal* (class 1),
- having *hyperthyroidism* (class 2),
- or having *hypothyroidism* (class 3)

Model initially classifies the patient as the class with the highest predicted probabilities

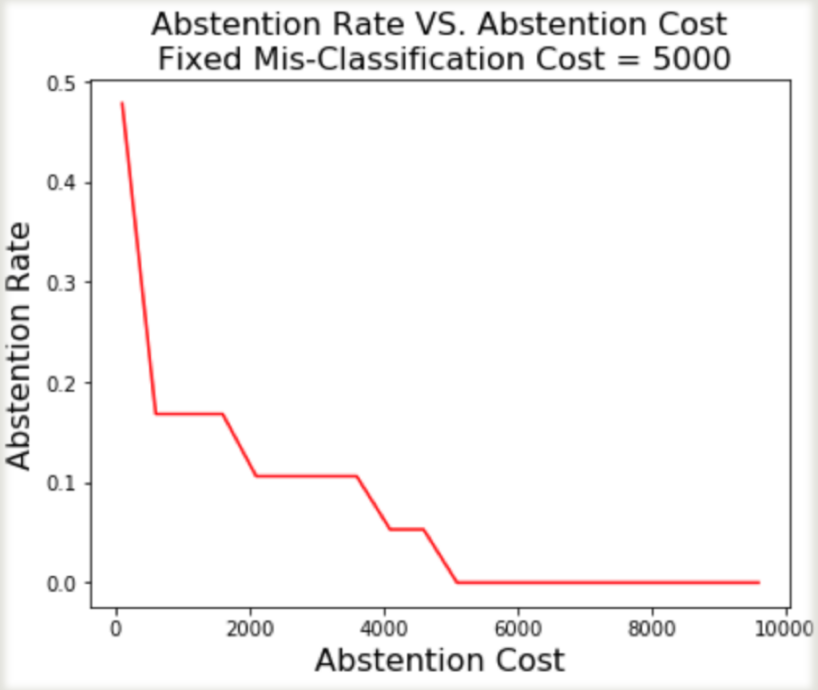
- P(Class) = max[P(Normal), P(Hyper), P(Hypo)]

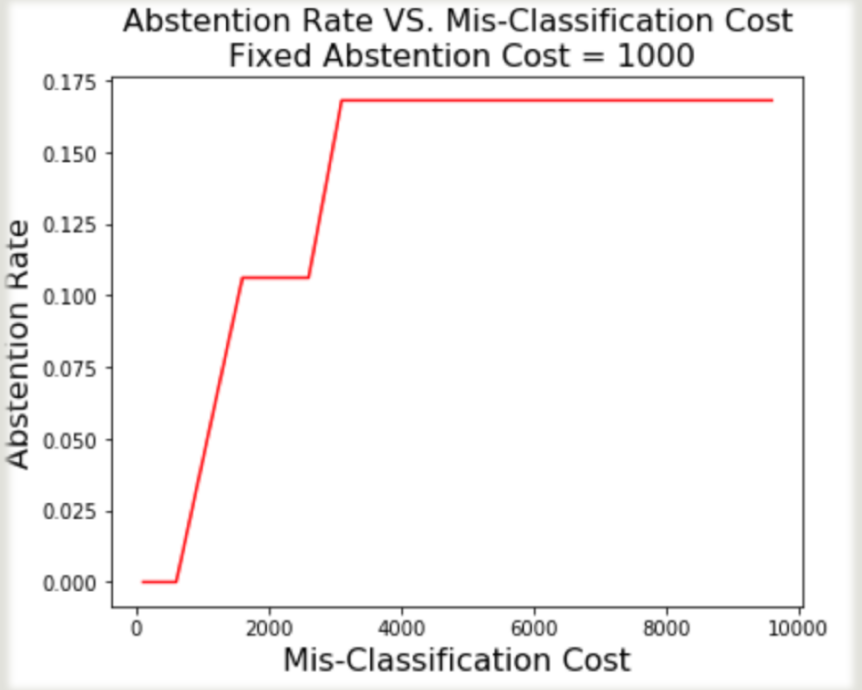
Finding Optimal Probability Threshold for Each Class



- Optimal Thresholds
  - Class 1 (*normal*): t = 0.688
  - Class 2 (*hyper)*: t = 0.812
  - Class 3 (*hypo*): t = 0.274

Algorithm Robustness





- *left* plot: Given a misclassification cost, abstention rate decreases as abstention cost increases
- *right* plot: Given a abstention cost, abstention rate increases as misclassification cost increases

This intuitively demonstrate our model's robustness that the total cost would be minimized if either of the following is true:

- Abstain less when abstention cost is relatively higher than misclassification cost.
- Abstain more when misclassification cost is relatively higher than abstention cost.

Conclusion

- We built a new algorithm to automate thyroid disorder diagnosis with an Abstain option while minimizing hospital total cost
- We applied our algorithm to One-Vs-Rest Logistic Regression model
- We assumed:
  - Total cost = misclassification cost + abstention cost
  - Misclassification cost/patient = $5000
  - Abstention cost/patient = $1000
- **Model Performance** (Have we decreased average cost per patient using the new model?)
  - Without Abstention option: Average cost/patient = $796.46
  - With Abstention option: Average cost/patient = $477.88
  - Average cost saved/patient from using our model = $318.58
- Our model is robust to changes in different types of costs