Milestone 2: Project Proposal

Holly Figueroa and Karlie Schwartzwald

College of Science and Technology, Bellevue University

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Professor Andrew Hua

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A Machine Learning Approach to Cardiotocography Interpretation

Despite modern advances, childbirth remains a risky medical endeavor both for birthing people and the unborn. There exists no replacement for the expertise and direct involvement of a medical professional to manage care. Analytics, however, can offer significant aid in ways it could not before through advanced modeling. Cardiotocography (CTG) is widely used over the course of pregnancy and during labor (*Fetal Heart Monitoring*, 2019). CTG allows monitoring of fetal heart rate and uterine contractions to prevent fetal hypoxia, or oxygen loss in body tissues (Boudet et al., 2020). Creating effective modeling for CTG exam data can provide additional support to those dedicated preventing harm and loss of life. The goal of this project will be to build an effective model to classify CTG data by testing supervised and unsupervised machine learning methods. By examining two, we will also get to compare the performance of both model types for this particular task.

Data Selection

The dataset chosen for model training contains 2126 instances of heart-health-related features taken from Cardiotocogram exams of fetuses. These were then classified by three expert obstetricians into 3 classes: 1 – Normal, 2 – Suspect, or 3- Pathological, making the target a multi-class categorical feature. There are a total of 22 features, both numerical and categorical. We found this dataset on Kaggle, but it was originally published in the Journal of Maternal-Fetal & Neonatal Medicine in the year 2000. This dataset should be useful for creating a model that can predict suspect and pathological health outcomes, with the assumption that some of the features provided will be correlated with fetal heart health.

Model Selection & Evaluation

We plan to implement two different models for this project, both of which will perform classification on the fetal heart health target feature. The first model will be a neural network. We think that this dataset provides a good opportunity to train a neural network because of the substantial number of instances in the data. Neural networks are also considered some of the most accurate models, and they are ideal in a medical setting like this where accuracy is important. We plan to use accuracy to score and evaluate this model. Given that type II errors would be more detrimental than type I errors in this case, it is relevant to look at the confusion matrices as well.

The second model we plan to use is Naïve Bayes classification model. The Naïve Bayes model is considerably faster and more efficient than a neural network model. And even though we have over 2,000 instances, it is possible that this amount of data is not sufficient to train a competent neural network. The Naïve Bayes model is recommended as an alternative in that circumstance. Since we are still doing classification, we will still be using accuracy and confusion matrices to evaluate the results of our model. We can compare the accuracy score of this model to the neural network model in this proposal.

To ensure quality and accuracy, we plan to implement a variety of techniques to improve both models. We will need to clean the data, do some feature scaling, and feature selection. If there are any categorical features that are relevant to the model, we can create dummy variables with them before training the model. We plan to use a grid search to perform hyperparameter tuning on our models as well. Since the target feature has imbalanced classes, we will need to perform oversampling on the underrepresented classes.

Risks and Ethical Implications

Machine learning and artificial intelligence has already earned space in healthcare with the increased use of AI diagnostic systems. Some common examples involve the interpretation of x-rays, MRI scans, CT scans, and other image-related tools of measurement. While machine learning healthcare applications(ML-HCAs) and AI recommendation systems can offer powerful insights for the medical field, limits must be acknowledged. The most fundamental limit being correlation is not causation, therefore their role must be additive to care, not a replacement for expertise. A common hope is that the addition of ML-HCAs and AI diagnostics will circumvent bias within the healthcare system, however, these tools are just as suspectable (Naik, 2022). The data used to train a diagnostic model is critical to how accurately these systems perform for diverse populations. One limitation of this project is the sample population behind our training data is not clear based on our dataset source.

Contingency Proposal

If our proposal plan is not successful, our contingency plan is to use the more familiar random forest classifier model. This model is easy to understand and relatively easy to visualize compared to other models. Furthermore, the random forest classifier typically provides remarkably high accuracy for classification problems. However, this random forest classifier will only be successful if the features available in our data have some predictive power. It would be interesting to see whether a more complicated model like naïve bayes, or neural network, can produce a higher accuracy than a simple random forest classification model.

In addition to changing the type of model we use; we also have the option to change which feature in the dataset is our target. The dataset that we chose contains two possible target features that are categorical. Furthermore, if all the above fails, we could choose one of the numerical features in the dataset as a target to run a regression analysis with the other features.

References

Boudet, S., Houzé l'Aulnoit, A., Demailly, R., Delgranche, A., Peyrodie, L., Beuscart, R., & Houzé de l'Aulnoit, D. (2020). A fetal heart rate morphological analysis toolbox for MATLAB. *SoftwareX, 11*, 100428. https://doi.org/10.1016/j.softx.2020.100428

Fetal Heart Monitoring. (2019, August 14). Johns Hopkins Medicine. https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/fetal-heart-monitoring

Naik, N. (2022, March 14). *Legal and Ethical Consideration in Artificial Intelligence in Healthcare: Who Takes Responsibility?* Frontiers. https://www.frontiersin.org/articles/10.3389/fsurg.2022.862322/full