# Fetal Health Classification Analysis

Introduction

- Child and maternal mortality has been a rising concern over the years. As of 2017, it has accounted for over 295,000 deaths, in which 94% could have been prevented.
- Cardiotocogram (CTG) is a simple and cost accessible option to assess fetal health, allowing healthcare professionals to take action in order to prevent child and maternal mortality.
- It works by sending ultrasound pulses and reading its response, thus providing important information such as fetal heart rate (FHR), fetal movements, uterine contractions and more.

- Using the measurements generated from CTG exams, professional obstetricians haved classified each fetal examination into three groups: Normal, Suspect, and Pathological.
- Normal is classified as having a baseline FHR of 110-160 bpm, frequent accelerations, and decelerations that last for a short amount of time.
- Prolonged and late decelerations are deviations from this and can result in fetal complications.
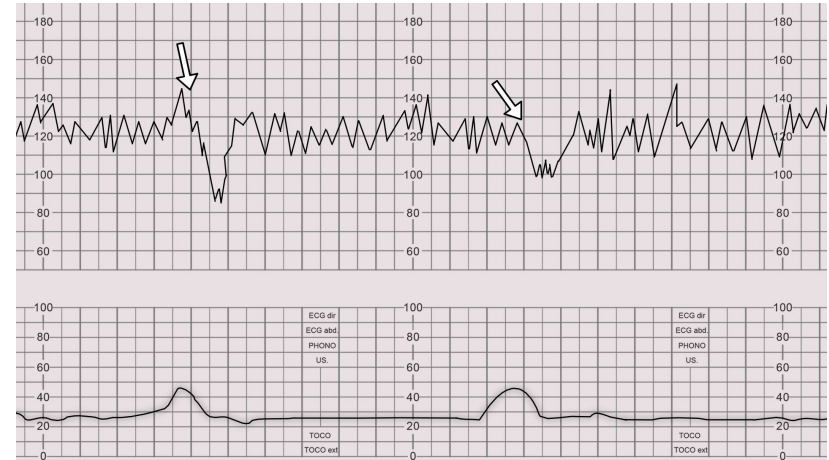
Goal

The goal was to determine which model could be used to accurately determine characteristics that can help implement preventative measures to detect fetal abnormalities.
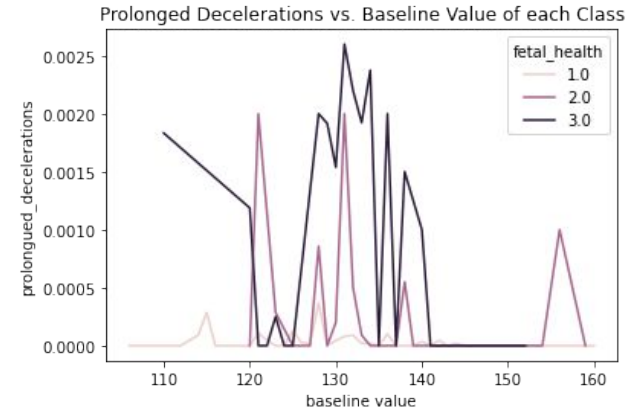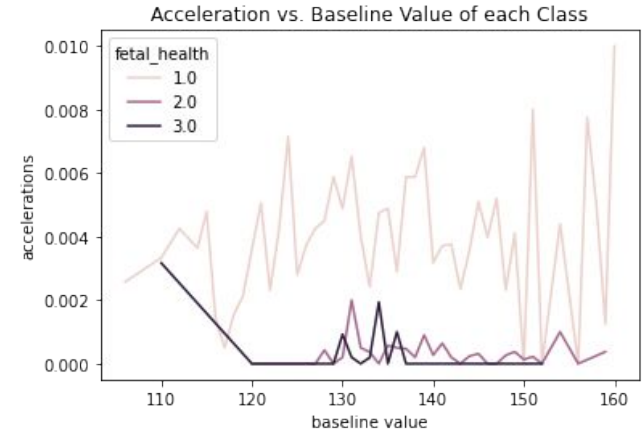
Data

The data set was taken from an assessment in testing a new cardiotocogram and was retrieved from CTG examinations of different fetuses.

Exploratory Data Analysis

- Null values were not present in the data,
- Boxplots were created to compare the other features in respect to the fetal classification
- Outliers were not taken into consideration or removed for analysis.
- Possibility that outliers present for one class might be associated with another class or could be defined differently by other obstetricians.
- Initial findings showed that the fetal classification data was imbalanced.
    - Normal: 1655, Suspect: 195, Pathological: 176

Fetal Class Distribution

NORMAL

77.85%

8.28%

PATHOLOGICAL

13.88%

SUSPECT
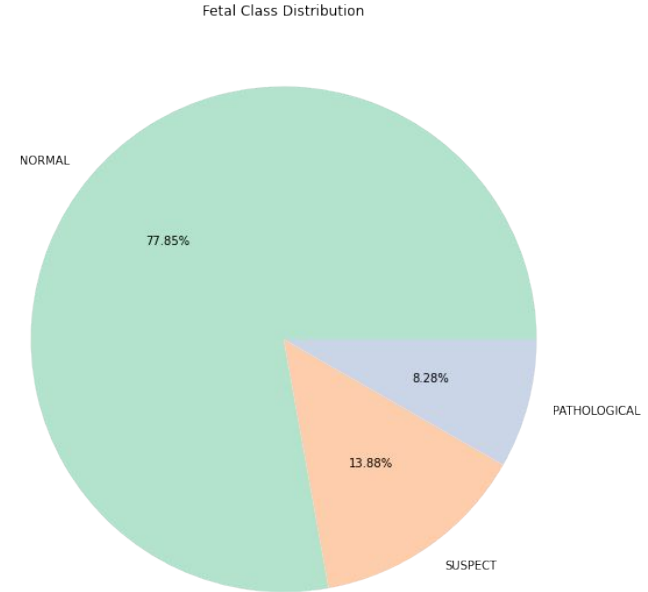
- Those who are classified as pathological showed a relatively low acceleration whereas normal fetuses had frequent acceleration in their heart rate.
- Prolonged decelerations also showed a correlation with fetal health. The longer the decelerations were, the more detrimental it is for the fetal health.
- The minimum and maximum baseline FHR examined was 106 bpm and 160 bpm respectively. Fetuses with minimum FHR were classified as Normal

Acceleration vs. Baseline Value of each Class

Prolonged Decelerations vs. Baseline Value of each Class
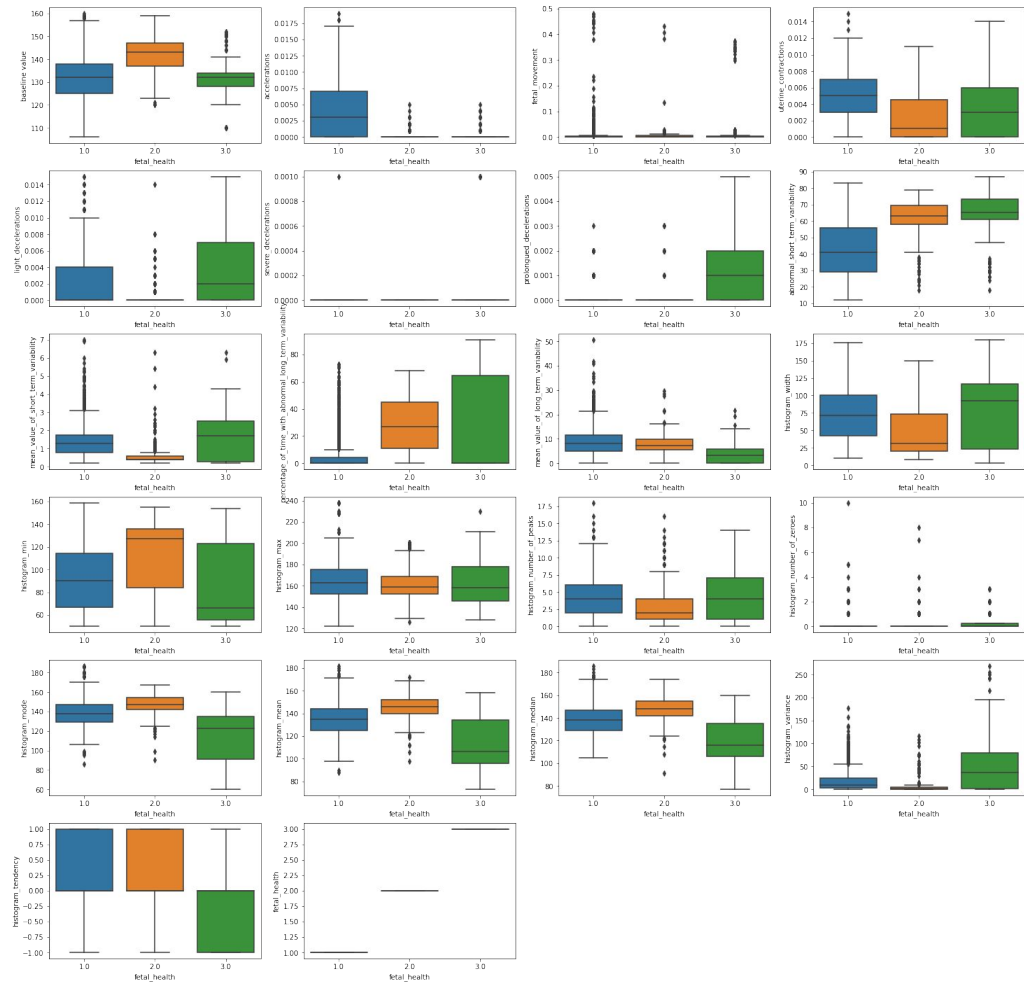
Pre-Processing

- The oversampled data was analyzed with respect to the fetal health
- Undersampled data was analysed with respect to each fetal class. One hot encoding was used to separate the fetal health by their class.
- The correlation map showed that accelerations and prolonged deceleration have a high correlation with fetal health in both of the resampled data.
  - Acceleration: -0.494, Prolonged deceleration: -0.498
- Abnormal short term variability had a VIF factor greater than 5. Because of this, it was considered to not be an important feature.

Modeling

- The over sampled data with respect to the fetal health as a whole showed that the gradient boosting algorithm had the most accuracy.
- The undersampled data showed that the normal class worked better with the random forest classifier and pathological classification worked better with gradient boosting. Both of these algorithms worked in the suspect classification.

Model Accuracy Comparison
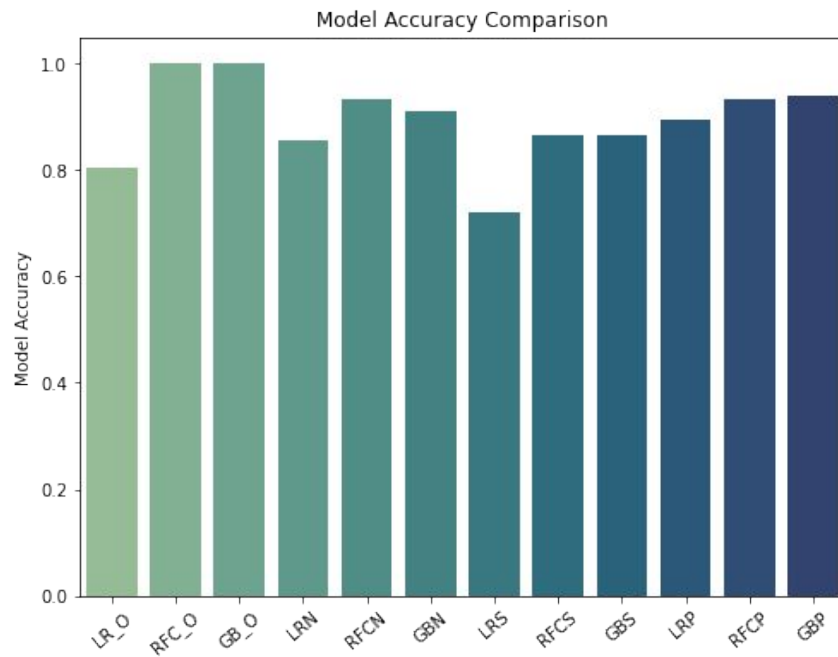
- SHAP analysis showed that accelerations and percentage of long term abnormal variability in oversampled data (L) had a strong importance in its feature
- Undersampled data (R) showed that the histogram mean, which is the average baseline FHR, shows to have a strong feature in respect to each fetal class.
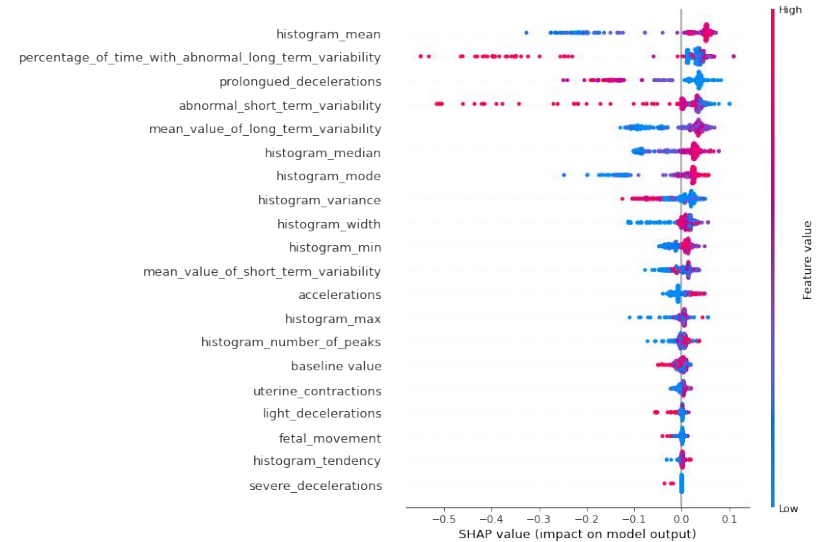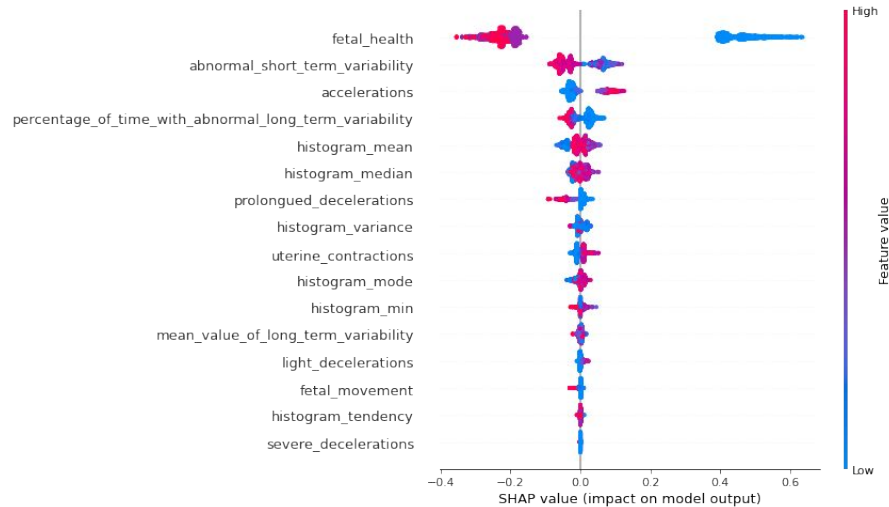
Findings

- Obstetricians should use the accelerations, length of the decelerations, and baseline FHR to determine if a fetus is healthy or at a risk of death.
- If fetal baseline FHR is outside of the average range with accelerations not being present and deceleration being longer than usual, then obstetricians should take measures in bringing their heart rate back to normal.
- Detecting these minute changes in the heart rate can help determine fetal health problems and can help lead to preventative measures for the baby.

Recommendations

- Physicians should take CTG examinations frequently of the fetal to actively assess the heart of the fetus
- If accelerations are low, not frequent or not existent, preventive measures should be taken
- If decelerations are longer than anticipated then preventive measures should be considered.
- Hospitals should provide a systematic procedure in taking care of high risk fetuses to ensure care is properly given.

Future Scope

- In the future, maternal demographics and socioeconomics can be recorded and used to analyze the type of healthcare these expecting mothers have access to.
- One can also look into to see how prominent environmental and genetic factors play a role in fetal heart and see if it has a strong association with mortality.

Resources

- Ayres de Campos et al. (2000) SisPorto 2.0 A Program for Automated Analysis of Cardiotocograms. J Matern Fetal Med 5:311-318
- https://thewomens.r.worldssl.net/images/uploads/downloadable-records/clinical-guide lines/ctg-interpretat ion-and-response_280720.pdf