Report Practical Work 2: Fetal Head Measurement Prediction

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***Abstract*—Predicting a baby's head circumference (HC) from ultrasound data is very important for checking how a baby is growing during pregnancy. This project uses a machine learning method called Random Forest to see how changing different settings affects the accuracy of these predictions.**

I. Introduction

Using computers to measure medical images helps make sure the results are consistent, avoiding the small differences that happen when different doctors take measurements by hand. This report looks at how well a Random Forest model can predict head size using shapes and features already taken from the HC18 dataset. We compare three different versions of the model, starting from a simple setup to a more detailed one, and look at the errors and graphs to see which works best.

II. Dataset and Features

We used data from the HC18 Fetal Head Circumference Challenge [1]. This dataset includes 999 training examples that turn ultrasound images into numbers that describe the shapes in the image.

A. Data Splitting

To test if the model works on new data, we cleaned the `training_set_pixel_size_and_HC.csv` file by removing filenames and keeping only the useful numbers. We then split the data, using 80% for training the model and 20% for checking its accuracy. We used a fixed "seed" (random_state=36) so that our results stay the same every time we run the code.

B. Image Features

The data uses numbers that describe the shape and brightness of the baby's head in the scan. Since the data was already organized into a table and the numbers were ready to use, we did not need to do any extra resizing or scaling. The Random Forest model could use these features directly to learn the patterns.

III. Methodology

A. Model Setups

Instead of using just one version of the model, we tested three different configurations to see how the number of "trees" and their depth changed the results. The first version, Model 1, used a basic setup with 100 trees and no limit on how deep they could grow. Model 2 increased this to 200 trees to try and make the results more stable. Finally, model 3 was a more controlled version using 500 trees with a maximum depth of 20 and a rule that each "leaf" must have at least 2 samples. This last version was designed to keep the model from just memorizing the training data.

B. Measuring Success

We measured how well the model performed using Mean Absolute Error (MAE). This tells us, on average, how many millimeters the prediction was off by. We also made a scatter plot to show the real measurements versus what the computer predicted to see where the model makes the most mistakes.

IV. Results and Discussion

The tests showed that tuning the settings makes the model more accurate. As shown in Table I, Model 3 had the smallest error. This proves that limiting how deep the trees grow and using more of them helps the computer find real patterns instead of getting distracted by "noise" or random errors in the ultrasound data.

TABLE I
Comparison of Model Results

Model	Number of Trees	Max Depth	Min Samples	MAE (mm)
Model 1	100	None	1	28.2444
Model 2	200	None	1	28.1134
Model 3	500	20	2	**27.7004**

A. Looking at the Graphs

The prediction plot in Figure 1 shows that the model is generally good at following the growth trend. However, there is more variation when the head size is between 150mm and 250mm. While most predictions are close to the red line (the perfect score), some outliers suggest that very small or very large measurements are harder for the computer to get exactly right.

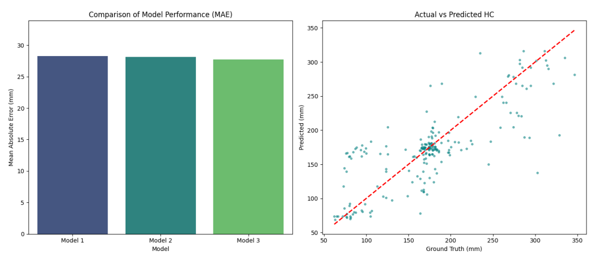

Fig. 1. Performance bar chart (left) and the prediction accuracy plot (right).

V. Conclusion

This project created a way to predict a baby's head size with an average error of about 27.70 mm. The results show that Random Forest is a strong tool for this kind of medical data, especially when you limit the model's complexity so it doesn't overthink the data. In the future, adding more information about the patients might help make the predictions even more accurate in the difficult ranges.

References

[1] van Enk, J., et al. (2018). *Fetal Head Circumference Challenge (HC18)*. Zenodo. https://zenodo.org/records/1327317