Machine Learning to Detect Intrapartum Fetal Hypoxia Using Cardiotocography

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Background

Cardiotocography (CTG) can identify babies at risk of fetal hypoxia by detecting changes in fetal heart rate and womb contractions. However, variability in CTG interpretations affects intervention timings. Machine learning (ML) has been applied to this problem and showed the potential to distinguish CTG accurately. Previous research mainly used babies' blood pH levels as a surrogate marker for fetal hypoxia with varying pH benchmarks.

Aim

We proposed using 5 minutes Apgar score as the surrogate marker of hypoxia in our ML algorithms. Low Apgar scores have shown a high correlation with hypoxic diagnosis and abnormal CTG, and it is a routine, standardised measurement of babies' physiology and condition after birth.

Method

We used the CTU-UHB database, which contains 552 CTGs. For signal processing, we extracted features and signal characteristics from GTG. Next, we built ML algorithms using signals extracted from signal processing. Dataset was split into a training set and a test set. We employed the Synthetic Minority Sampling Technique to overcome imbalanced dataset and grid search cross-validation optimisation. We used different classifiers such as decision tree (DT), random forest (RF), support vector machine (SVM), k – nearest neighbour (kNN) and artificial neural network (ANN) to compare their performances. Sensitivity and F1 scores were measured for each classifier.

Results

We found that the number of intrinsic mode functions is the important feature for classification among 20 generated features. The ANN had the highest sensitivity (92.55%), while the RF classifier had the highest F1 measure (63.27%) (Table 1).

Conclusion

Apgar scores can be used as a surrogate hypoxia marker for classifying CTG. Our model could benefit from more CTGs associated with low 5-minutes Apgar scores to maximise ML model performances. Further research is needed to study the potential use of Apgar scores for classifying fetal hypoxia during labour.

Classifiers	Sensitivity (%)	F1 score (%)
DT	90.00	62.10
RF	90.36	**63.60**
SVM	90.06	62.10
kNN	80.12	61.60
ANN	**92.55**	63.27

Table 1: comparison of performances between classifiers on the test set.