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DeepFet

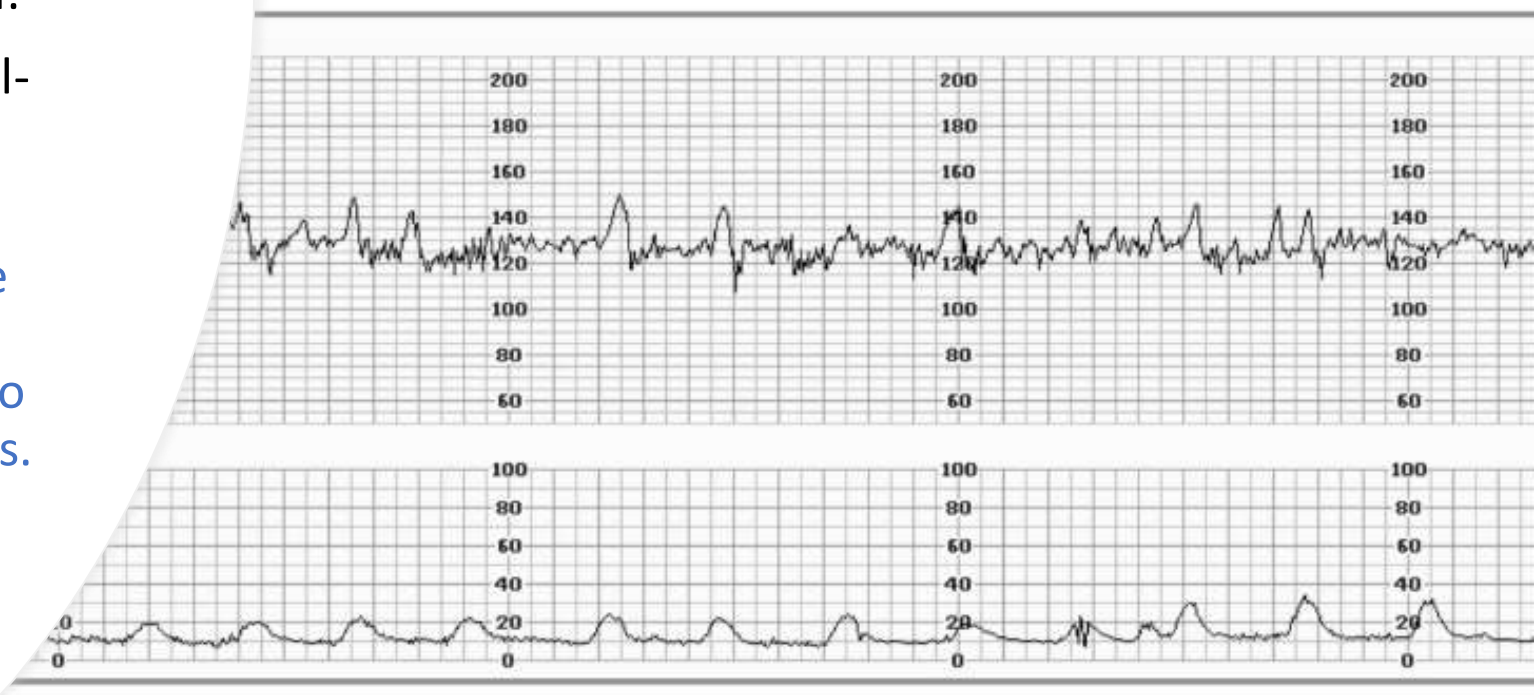
A Fetal Health predictor using machine learning and OT APIs

Laxman B

laxmanb@opentext.com

Cardiotocograph and Fetal Health

- A cardiotocograph (CTG), is a medical device used in obstetrics to monitor the fetal heart rate (FHR) and uterine contractions during pregnancy and labor.
- It is a valuable tool for assessing the well-being of the fetus and the progress of labor.
- Abnormal patterns or fluctuations in the fetal heart rate can provide important insights into the baby's health, helping to identify potential issues or complications.



Why AI for fetal health monitoring?

- AI algorithms can analyze FHR signals in real-time, enabling early detection of fetal distress or abnormalities.
- AI can provide continuous, 24/7 monitoring of FHR, ensuring that no subtle changes or anomalies go unnoticed
- AI models can predict potential complications before they become critical, allowing for preemptive measures and interventions.
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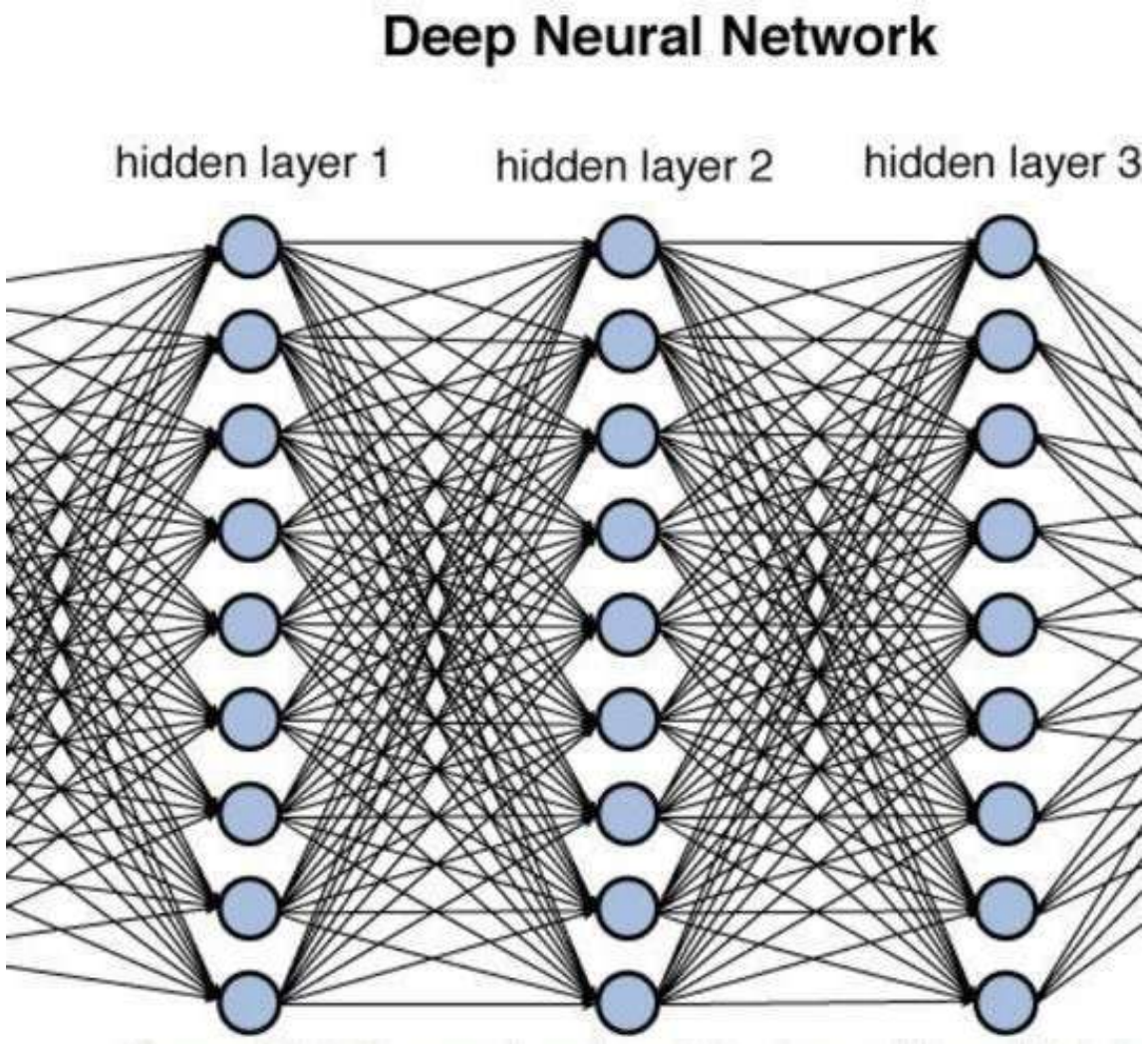
Deep Neural Network for fetal health prediction

- DNNs are capable of automatically learning hierarchical features from raw FHR signal data. They can capture intricate patterns and relationships that may not be apparent with traditional feature extraction methods.
- FHR patterns can be complex, with varying shapes and durations. DNNs can learn to recognize diverse FHR patterns, such as accelerations, decelerations, and baseline variability.
- FHR signals are temporal sequences, and DNNs are can handle sequential data well.



Dataset

- For this project, the dataset is taken from PhysioNet CTU-CHB Intrapartum Cardiotocography Database

- CTU-CHB Intrapartum Cardiotocography Database v1.0.0 (physionet.org)

- This is a collection of 552 CTGs from the Czech Technical University (CTU) in Prague and the University Hospital in Brno (UHB) was carefully selected from 9164 recordings recently collected at UHB. Each recording is up to 90 minutes long, and includes a fetal heart rate time series, a uterine contraction signal, and maternal, delivery, and fetal clinical details.

Proposed Methodology

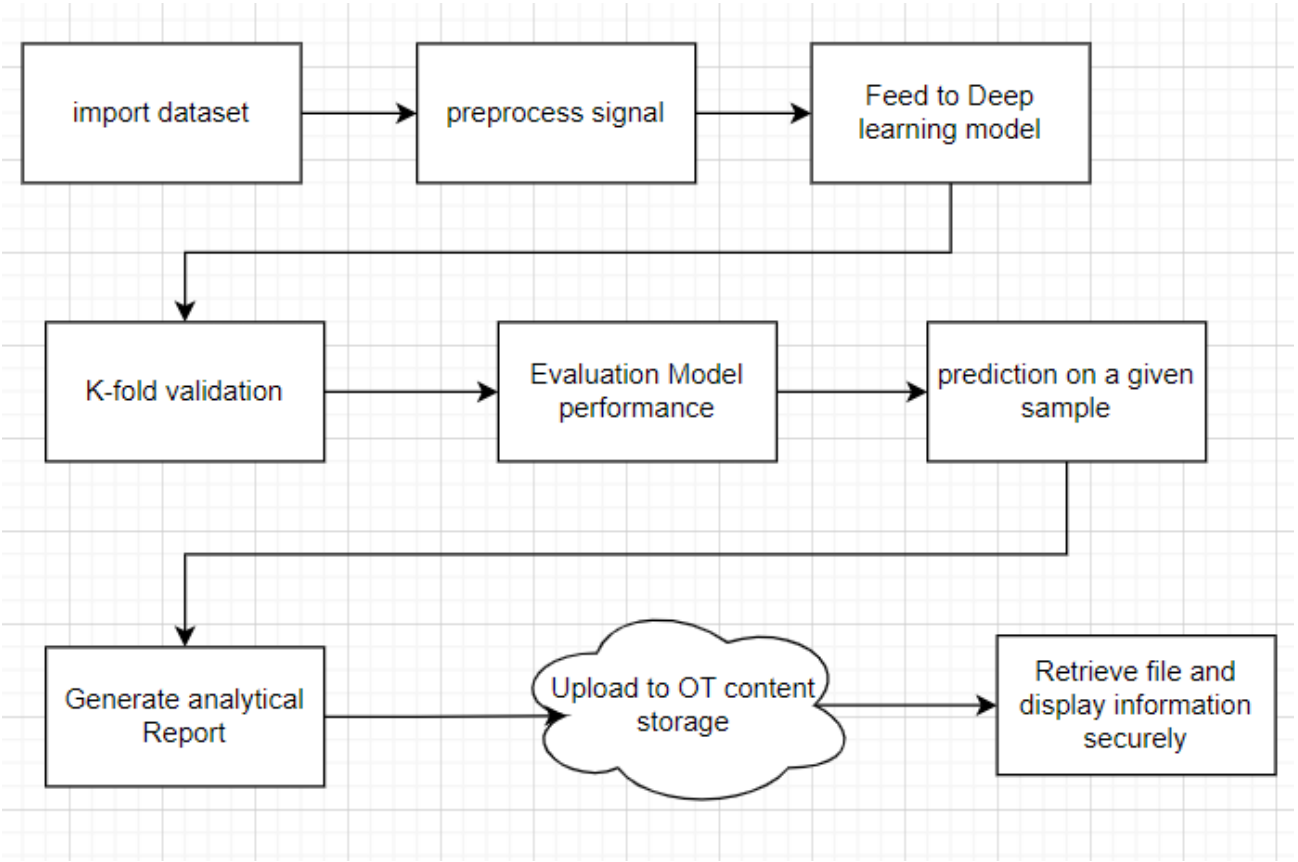
- FHR and UC signals is obtained from the dataset
- FHR and UC signals are processed to eliminate or correct abnormal or erroneous data points in the signal
- The last 15 minutes of signal is extracted as they are particularly critical because they provide a snapshot of the fetus's condition as it approaches birth.
- The FHR and UC signals is provided as an input to a custom build neural network.
- An intensive K-fold validation is performed on the AI model and is tested against test data.
- A Fetal health risk prediction is made on a sample data and a Report is created providing featus health status and several other metrics and statistics regarding fetal well-being.

OpenText API

- OpenText Content Storage Service:

- OT content storage service APIs are used wherein the report generated is uploaded and later retrieved to see the report contents.
- With this service, your content is safe and secure with active virus scanning and data encryption

Architecture Diagram



Performance and Characteristics

- Model achieved an accuracy of 74% for 10-fold validation

Classification Report:

	precision	recall	f1-score	support
0.0	0.29	0.18	0.22	11
1.0	0.81	0.89	0.85	44
accuracy			0.75	55
macro avg	0.55	0.53	0.54	55
weighted avg	0.71	0.75	0.72	55

- Statistical analysis of FHR and UC signals and Personalized Report generation .
- Secure storage and retrieval of report data using OT content storage service.

Sample Report

Fetal Health Report

Min heart beat: 64.75 bpm

max heart beat: 180.75 bpm

skewness: -0.88

kurtosis: -0.31

signal_variability (standard deviation): 27.59

Mean fhr for last 15 mins: 128.13 bpm

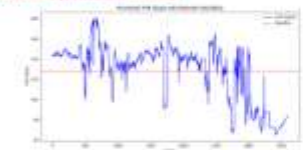
Mean fhr for last 10 mins: 120.56 bpm

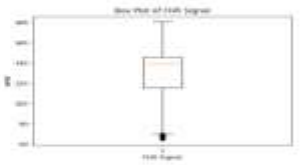
Mean fhr for last 5 mins: 102.54 bpm

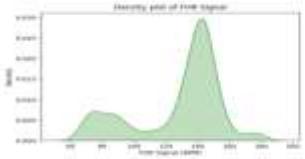
number of accelarations of heart beat: 21

number of decelarations of heart beat: 19

Verdict: Fetal Health in Risk







1. Skewness:
   - Definition: Skewness is a measure of the asymmetry or lack of symmetry in the probability distribution of the FHR values. It quantifies the degree to which the FHR signal is skewed to the left (negatively skewed) or to the right (positively skewed) relative to the mean.
   - Interpretation:
     - Negative Skewness: The FHR values are concentrated on the right side of the distribution, indicating a tendency toward higher heart rates.
     - Positive Skewness: The FHR values are concentrated on the left side of the distribution, indicating a tendency toward lower heart rates.

2. Kurtosis
   - Definition Kurtosis measures the "tailedness" of the probability distribution of the FHR values. It quantifies the degree to which the FHR values are concentrated near the mean (leptokurtic) or spread out more widely (platykurtic).
   - Interpretation
     - Leptokurtic: Higher kurtosis values indicate that the FHR values have heavier tails and are more concentrated around the mean.
     - Platykurtic: Lower kurtosis values indicate that the FHR values have lighter tails and are more spread out.

3. Baseline FHR (Baseline)
   - Definition The baseline FHR represents the average fetal heart.
   - Interpretation A normal baseline FHR typically ranges from 110 to 160 beats per minute (bpm). Deviations from this range may indicate potential issues with fetal well-being.

4. Signal Variability (Signal Variability or FHR Variability):
   - Definition Signal variability measures the variations in the fetal heart rate. It is typically assessed through short-term and long-term variability.
   - Interpretation
     - Adequate Variability: Healthy fetuses typically exhibit moderate and consistent variability, which is reassuring.
     - Reduced Variability: Minimal or absent variability can be concerning and may indicate fetal distress.

5. Number of Accelerations
   - Definition Accelerations are abrupt increases in the FHR, and their presence is often considered a sign of fetal well-being.
   - Interpretation A higher number of accelerations is generally reassuring and indicates that the fetal nervous system is responding to stimuli appropriately.

6. Number of Decelerations
   - Definition Decelerations are abrupt decreases in the FHR, and their presence may require closer evaluation.
   - Interpretation The number and type of decelerations are considered in the context of the overall FHR pattern to assess fetal well-being.

SCOPE

- one can leverage the core concepts and techniques used in FHR prediction and apply them to a wider range of fields where the data is represented in the form time-series.
- Similiar such model can be trained for heart-risk prediction, glucose monitor, epilepsy/seizure prediction, earthquake prediction etc.
- The key is to adapt the model to the unique characteristics and requirements of the new domain while maintaining best practices in machine learning and data science.

Link to project resources

- Google Colab Notebook: https://colab.research.google.com/drive/1Iq6Iz4Im9En_gcBTHt1c5eCiWecVHX_K?usp=sharing

- Github Repo: https://github.com/laxmanbalaraman/DeepFet

- Sample Report: https://drive.google.com/file/d/16-I5c5MLF2nuXDgiAL98BE_zEg0NTIwF/view?usp=sharing

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THANK YOU