CAIRO UNIVERSITY

Classification and Detection Fetal Brain Abnormalities Using Deep Learning Techniques

BIOINFORMATICS 19-23

COMPUTER SCIENCE

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1. PROBLEM DEFINITION

Radiologists are not required to diagnose diseases or have in-depth knowledge of radiology-related conditions. Their role is limited to conducting radiology tests and writing reports, and their diagnoses cannot be relied upon. On the other hand, gynecologists/obstetricians are responsible for diagnosing diseases based on the radiology images they observe. However, studying radiology, particularly MRI, is a challenge for them as it is outside their specialization. This is where Deep Learning Techniques roles show its benefit . Our Application aims to assist gynecologists/obstetricians by providing easier access to information and helping them classify fetal brain scans as normal or abnormal and classify the type of abnormality. The application does not replace the doctor but reduces the burden of memorizing theoretical information, allowing them to focus on their field of expertise.

3. Methodology

First Method Architecture (ML):

•Extracted fetal brain MRI dataset from fetal brain atlas= 720 image.
•Applied a lot of preprocessing techniques to the data, few of them worked but the most didn't help our case.
•Used four machine learning classifiers (KNN, DT, SVM, NB).
•Evaluated the results of the classifier.
•Results: KNN = 73%, DT = 60%, SVM= 78%, NB=65%

First method had a lot of draw backs : because of bad accuracy , it's not efficient with our type of data and it need a lot of preprocessing so it's models is able to classify them as they doesn't have feature extraction capabilities .Data set may seem big but most of it was corrupted noised data even augmentation wasn't able to fix that.

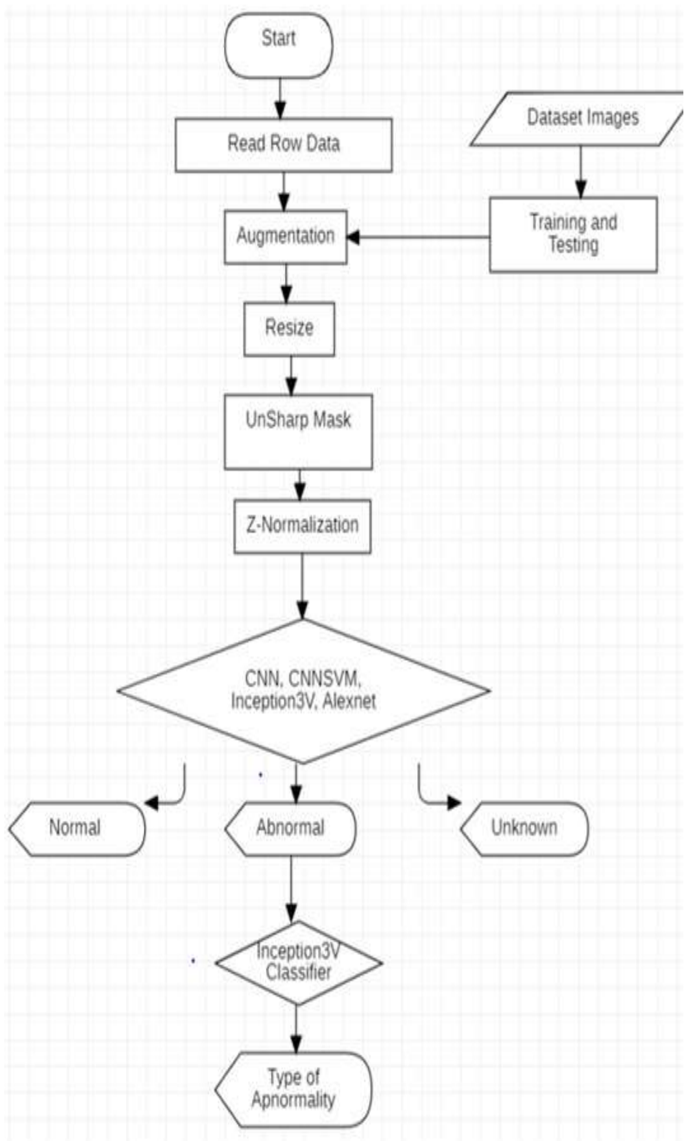
Second Method Architecture (DL):

It was all about fixing the past method : We add deleted corrupted data and add more data from 2 places (Fetal Brain MRI from Stanford Lucile Packard Children's Hospital contains for images for normal class and lastly Radiopedia which where we were able to find abnormal data with categories) with total data size = 1105.

system architecture:

preprocessing:

- Augmentation: we used 2 types of it, augmentation on all data with batch size = 3 and augmentation on training data with batch size = 7
- Resize :not too big to consume run time or too small to decline important details
- Unsharp Mask to sharpen the edges enhancing image details Mask for enhancing edges
- Z-normalization
- Models: Deep learning models with high capabilities for feature recognition and extraction , we used 6 model were used 4 of them are unique, CNN, CNNSVM, Inception3V and Alexnet.



Flow chart of the Proposed system architecture.

2. Objectives

In today's world, we see many cases born with disabilities, one of these is brain disabilities. Between each thousand pregnant women there are 3 of them are having a baby suffer from brain abnormality. Because of delay of discovery appropriate actions are not being taken in the right time so it might lead to permanent disability or even worse consequences like losing the baby. Therefore, early detection and classification are important. If somehow, we were able to detect this abnormality in the baby when it is in the fetal stage, we will be able to know the dimensions of the case and whether there is a chance to treat it and the possibilities of its survival, and to prepare the follow up plans for treatment. We aim to Help doctors to try to detect brain abnormalities during pregnancy and even try to classify it before the babies' born in a try of curing the disability avoiding that delay. This is done by processing the MRI images and applying Deep learning techniques, and crystallizing this into a Website.

4. Deliverables

Our Website Functionality of works as the following: The user enters the Image that is meant to be classified, the output is whether Normal, Abnormal (and their probabilities) or unknown if the image was for a random thing. If the image was abnormal the image enters another classifier and in the End the website returns a result contains the largest probability of the disease type. The website has multiple classifiers users can choose from in their classification.

Results:

Table of accuracy for different models with different augmentation techniques

	Without Augmentation	Augmentation On all data	Augmentation On only Train
CNN Main model (model 2)	Accuracy: 0.9276018099547512 Precision: 0.928 recall: 0.928 F-Measure: 0.928	Accuracy: 0.9411764705882353 Precision: 0.942 recall: 0.941 F-Measure: 0.941	Accuracy: 0.9363636363636364 Precision: 0.937 recall: 0.936 F-Measure: 0.936
Inception3V (model 4)	Accuracy: 0.8914027149321267 Precision: 0.898 recall: 0.891 F-Measure: 0.891	Accuracy: 0.9788838612368024 Precision: 0.979 recall: 0.979 F-Measure: 0.979	Accuracy: 0.9 Precision: 0.905 recall: 0.900 F-Measure: 0.900
Alexnet	Accuracy: 0.9577677224736049 Precision: 0.958 recall: 0.958 F-Measure: 0.958	Accuracy: 0.9562594268476622 Precision: 0.957 recall: 0.956 F-Measure: 0.956	Accuracy: 0.9318181818181818 Precision: 0.932 recall: 0.932 F-Measure: 0.932
CNNSVM	Accuracy: 0.9095022624434389 Precision: 0.910 recall: 0.910 F-Measure: 0.909	Accuracy: 0.8929110105580694 Precision: 0.893 recall: 0.893 F-Measure: 0.893	Accuracy: 0.9181818181818182 Precision: 0.918 recall: 0.918 F-Measure: 0.918

5. Used Technologies

Models and Web

5. Recommendation

In the future, we aim to add all fetal brain diseases to the classification instead of just six types when we obtain more data. We were also able to predict and detect various brain anomalies using images from various gestational ages. In the upcoming work, we want to increase efficiency, we will expand the data sets. And we will categorize various abnormal diseases like tumors and cerebellar hypoplasia using more techniques we haven't tried yet. Additionally, we will try to work on 3D datasets as it's the most common type of data in this field on the internet and it defiantly has more features we want to discover.

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