IDENTIFY SIGNS OF DIABETIC RETINOPATHY IN EYE IMAGES

using Convolution Neural Network

Developed by:Pravalika Beeravelli,Srija Challagonda,Deepthi Thalla, Vikram Aditya

Smart Bridge-Remote Summer Internship Program

1.INTRODUCTION

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.The process of learning begins with observations or data,such as examples,direct experience, or instruction , in order to look for patterns in data and make better decisions in the future based on the examples that we provde.The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

Diabetic retinopathy is the leading cause of blindness in the working age population of the developed world and is estimated to affect over 93 million people.The grading process consists of recognising very fine details,such as microaneurysms,to some bigger features,such as exudates and sometimes their position relative to each other on images of the eye.

Diabetic retinopathy is a systemic disease which is an ocular manifestation of diabetes affecting a large percentage of people who have had diabetes for a prolonged duration. It is usually caused by damage of the blood vessels of the light-sensitive tissue at the back of the eye (retina). The chances of this disease become more high if you have uncontrolled blood sugar. At first, diabetic retinopathy may cause no symptoms or only mild vision problems.Eventually,it can cause blindness.But the disease can be controlled at earlier stages if its detected and diagnosed on time.The detection of DR is very resource intensive and requires very specialized clinician knowledge.We have tried to implement a Computer vision model for this problem and reduce the amount of human resources required to identify the disease.

Using machine learning algorithms we need to predict whether we can identify the signs of diabetic retinopathy in eye images of a particular person.Based on the symptoms we need to predict whether he is suffering with diabetic retinopathy.

1.1 Overview

People are often worried about the symptoms of diabetic retinopathy in eyes.we need to create a model to help those people in short listing the symptoms of the diabetic retinopathy in

eyes with their details.the predicted output gives them a fair idea about their symptoms of diabetc retinopathy.This analysis should also help the future people who are worried about their health condition of occuring diabetic retinopathy. Data mining is one of the most motivating and vital area of research with the aim of extracting information from tremendous amount of accumilated data sets.the model has been build using data from patients to predict the diabetic retinopathy in eyes.By using the algorithm a flask model has been implemented and tested.The results has been discussed and neural network was selected as best algorithm based on accuracy.

1.2 Purpose

In this project we make use of pandas,numpy,matplotlib,and seaborn libraries using the open-source,object oriented programming language python 3 and packages such as scikit-learn to predict the images of eye of a diabetic retinopathy person.
And in the end ,to predict whether the image of an eye of the diabetic retinopathy person or not using the predictions from the multiple machine learning algorithms and withdrawing the conclusions.

2.LITERATURE SURVEY

Convolutional Neural Network is a deep learning algorithm which can take an input image,assign importance(learnable weights and biases)to various aspects/objects in the image and be able to differentiate one from the other.It is the core of knowledge discovery processs.The various steps involved in extracting knowledge from raw data as depicted .Different data mining techniques include classification,clustering,association rule mining , prediction and sequential patterns,neutral networks,regression etc.classification is the most commonly applied data mining technique, which employs a set of preclassified examples to develop a model that can classify the population of records at large.This approach frequently employs decision tree based classification algorithm.in classification,a training set is used to build the model as the classifier which can classify the data items into its appropriate classes.A test set is used to validate the model.

2.1 Existing problem

The diabetic retinopathy is caused by damage to the blood vessels in the tissue at the back of the eye(retina).Poorly controlled blood sugar is a risk factor.The Digital retinal imaging is a relatively new technology that can be used to assess patients for diabetic retinopathy. We evaluated the impact of adding a primary care–based retinal imaging technology to an existing eye care professional referral process on the rate of surveillance and treatment of diabetic retinopathy in a large, well-defined patient population over a 5-year period.

2.2 Proposed Solution

The main objective is to scale the efforts of lab technicians through technology to gain the ability to automatically screen images for disease and provide information on how severe the condition may be.This project is capable of classifying images based on disease pathology from four severity levels.A convolutional neural network convolves an input image with a defined weight matrix to extract specific image features without losing spatial arrangement information. There will be a web application through which user can give their input image then they can check the predicted output and this application is integrated with trained convolution neural network model.

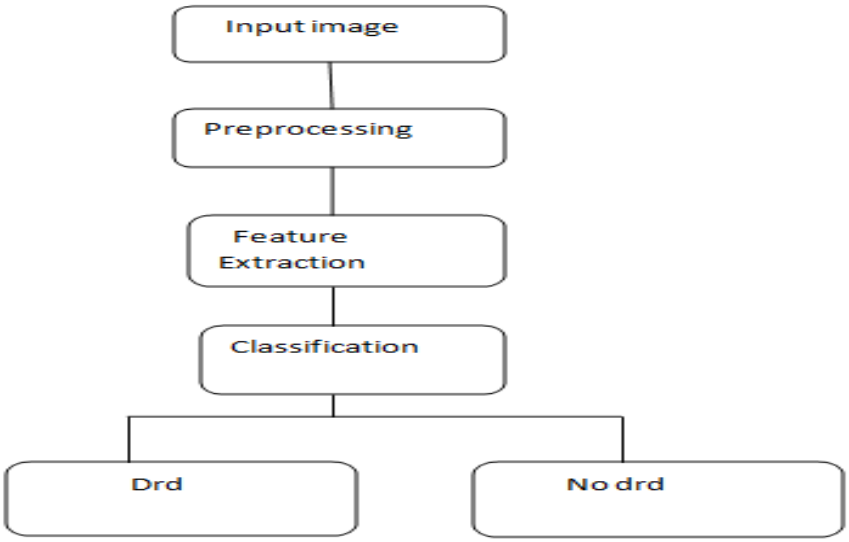
3.THEORETICAL ANALYSIS

While selecting the algorithm that gives an accurate prediction we gone through lot of algorithms which gives the results abruptly accurate and from them we selected only one algorithm for the prediction problem that is neural networks , it gives the output based on the independent variables accurately.

The peculiarity of this problem is collecting the details of the person with symptoms of diabetic retinopathy in real time and working with the prediction at the same time, so we developed an user interface for the persons with the symptoms who'll be accesssing for the daibetic retinopathy prediction. There are several ways to check the convolutional neural network accuracy. Usually we use Root Mean Squared Error.We train convolutional neural network by adding or removing the features to dataset, and see which one has the lowest RME- is the best one.

At first we got like lot of worst accuracies because we tried lot of algorithms for the best accurate algorithm , finally after all of that we tried the best suitable algorithm which gives the prediction accurately is convolutional neural network. And developed it to use as a real time prediction probelm for the diabetic retinopathy prediction.

3.1 Block Diagram



3.2 Software Designing

- Jupyter Notebook Environment and Google Colab
- Spyder Ide
- Machine Learning Algorithms
- Python(pandas,numpy,matplotlib,seaborn,sklearn)
- HTML
- Flask

We developed this identify signs of diabetic retinopathy in eye images prediction by using the Python language which is a interpreted and high level programming language and using the machhine laerning algorithms.For coding we used Jupyter Notebook environment of the Anaconda distributions and the Spyder,it is an integrated scientific programming in the python language.

For creating an user interface for the prediction we used the Flask.It is a micro web framework written in Python.it is classified as a microframework because it does not require particular tools or libraries.It has no database abstraction layer,form validation or any other components where pre-existing third-party libraries provide common functions,and a scripting language to create a webpage is HTML by creating the templates to use in the functions of the Flask and HTML.

4.EXPERIMENTAL INVESTIGATION

The datset we used is derived from GitHub Each image in the dataset was given a name along with severity of the dr. Name consisted of two parts – Serial number with Left/Right to indicate which eye of the patient is under the consideration. All the images in the dataset were not from the single source. Instead, the data was the collection of small datasets which was the main reason for a heterogeneous dataset thus formed. The images were taken through different instruments. And thus images had different sizes, from about 2500X2000 pixels to 5000X3000 pixels. Since the eye photograph is circular in shape, we decided not crop the images in a rectangular way but to keep their radius constant. In such a vast dataset, for a single class of severity the Lesions and Microaneurysms may also appear differently in different color spectrums and may be of different sizes. Hence, the model must be robust to detect that the severity of dr in both the cases is same.

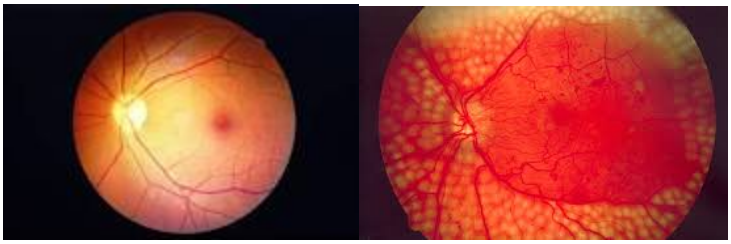


fig1.Images with no drd

fig2.images with drd

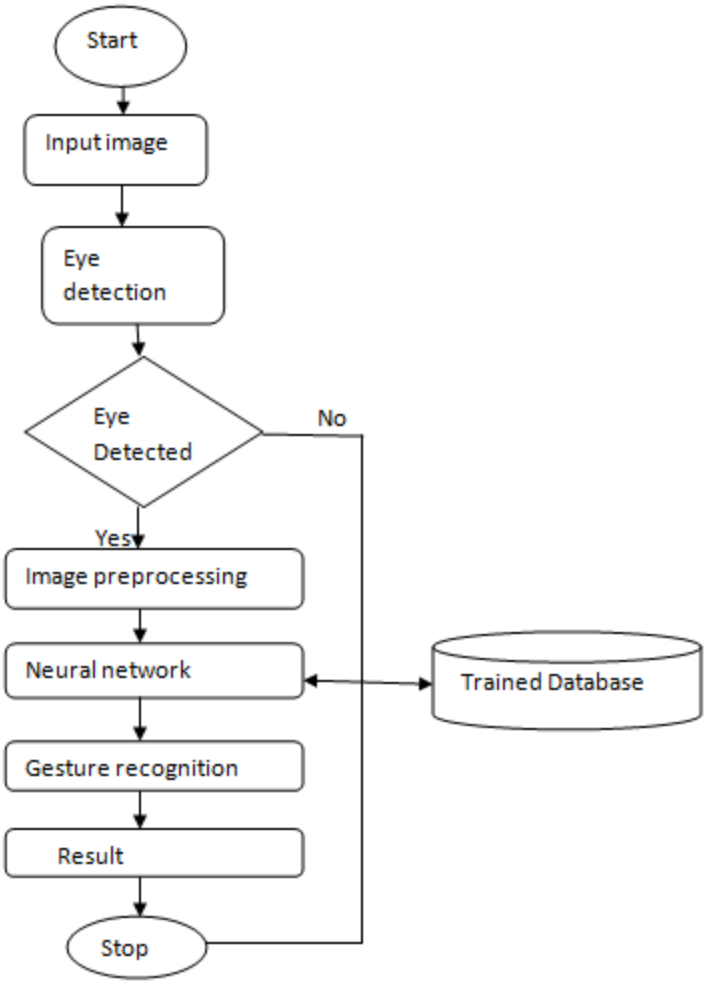
In summary, the main features of the dataset were its vast amount of images and the heterogeneity of images in size, color spectrum and the instrument used to produce them. Also, there was class imbalance among the images of various classes present in the dataset.
To deal with the class imbalance we selected 100 random images from each class except the last one and did our training and testing over that reduced dataset.
Dataset consits of high resolution of images and graded by trained professionals in 5 classes(0-4) which is according to below table and figure below that.

Class name	Meaning

Class 0	Normal eye
Class 1	mild Dr eye
Class 2	moderate Dr eye
Class 3	Severe Dr eye
Class 4	Poliferative Dr eye

Table: Class name description

5.FLOW CHART



6.RESULT

This project is capable of classifying images based on disease pathology from four severity levels. A convolutional neural network convolves an input image with a defined weight matrix to

extract specific image features without losing spatial arrangement information. There will be a web application through which user can give their input image then they can check the predicted output and this application is integrated with trained CNN model.

7.ADVANTAGES & DISADVANTAGES

Advantages:

1. Disease Analysis possible right from home,sparing the need to visit Hospitals nursing homes or health centres.
2. Diseases when identified quicker can be averted or cured much easier.Eases the jobs for government healthcare bodies,corporation health officials etc.
3. The system also makes use of geo-location access,through which it becomes easy to identify whether a patricular disease has become epidemic with respect to that particular location awareness,sugesstions and first aid tips for every disease for quick user reference.
4. Severity of disease,past records and present records of others affected by similar disease presented in user interactive formals.
5. It is composed using the HTML and Python for the web usage in real time.

Disadvantages:

1. CNN do not encode the position and orientation of object.
2. Lack of ability to the spatially inavariant to the input data.
3. Gives only accuracy 76% for detecting the eye damage due to diabeties.

8.APPLICATIONS

As the recall was increased,the precision decreased,and vice versa.In medical applications,all the patients who had the disease needed to be identified,and hence,the recall could be maximized.A low recall could be accepted if the cost of a follow up medical examination was not high.It can be seen that the proposed retina classifier out performed all the individual models.The retina image features,learned by the deep learning models from Imagenet,served as a good initialization error for normal (healthy) images as diabetic retnopathy was greater compared to diabetic retinopathy images as healthy images.This might be because the number of retina images of the normal people was significantly lower compared to the diabetic retinopathy people.

9.CONCLUSION

We presented a computer vision model that detects the diabetic retinopathy problem in eye fluorescein angiography photographs better than the human evaluation metrics. Input size was the key driver for performance using the same model of transfer learning Increasing the radius of the images from 200 pixels to 500 pixels as well increasing the images from 500 to about 800 in each class eradicated the problem of overfitting as well as improved the final test accuracy from 37.6% to 48.2%. This accuracy is achieved due to better image pre-processing techniques like subtracting the local average color of the image from the complete image to highlight the features and removing the class imbalance because the last two classes (in order of increasing severity) represented less than 5% of the total dataset. Further work can be done to improve the accuracy by combining the results of both the eyes.

10.FUTURE SCOPE

In future the convolution neural network can be applied on other data sets available for diabetic retinopathy in eye to further investigate its accuracy.A rigorous analysis of other machine learning algorithms other than these six can also be done in future to investigate the power of machine learning algorithms for diabetic retinopathy eye images prediction.In further study,we will try to conduct experiments on larger data sets or try to tun ethe model so as to achieve the state of art performance of the model and a great UI support syste making it complete web application model.

11.BIBILIOGRAPHY

1. M. Alban, T. Gilligan.http://cs231n.stanford.edu/reports2016/309_ Report.pdf

2. Graham B. Fractional max-pooling. arXiv preprint arXiv:1412.6071. 2014 Dec 18.

3. Gulshan V, Peng L, Coram M, Stumpe MC, Wu D, Narayanaswamy A, Venugopalan S, Widner K, Madams T, Cuadros J, Kim R. Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. JAMA. 2016 Dec 13;316(22):2402-10.

4. Faust O, Acharya R, Ng EY, Ng KH, Suri JS. Algorithms for the automated detection of diabetic retinopathy using digital fundus images: a review. Journal of medical systems. 2012 Feb 1;36(1):145- 57.

5. Dieleman S, De Fauw J, Kavukcuoglu K. Exploiting cyclic symmetry in convolutional neural networks. arXiv preprint arXiv:1602.02660. 2016 Feb 8.

6. Szegedy C, Liu W, Jia Y, Sermanet P, Reed S, Anguelov D, Erhan D, Vanhoucke V, Rabinovich A.

Going deeper with convolutions. InProceedings of the IEEE Conference on Computer Vision and Pattern Recognition 2015 (pp. 1-9).

7. Facts about diabetic disease. NIH National Eye Institute, 2014.

8. https://codelabs.developers.google.com/codelabs/tensorflow-for-poets

9. P. Massin A. Erginay T. Walter, J. Klein. A contribution of image processing to the diagnosis of diabetic retinopathy detection of exudates in color fundus images of the human retina. IEEE Transactions on Medical Imaging.

10. Benetti E. Massignan F. Pilotto E. Varano M. Cavarzeran F. Avogaro A. Vujosevic, S. and E. Midena. Screening for diabetic retinopathy: 1 and 3 nonmydriatic 45-degree digital.

11. Pan SJ, Yang Q. A survey on transfer learning. IEEE Transactions on knowledge and data engineering. 2010 Oct;22(10):1345-59.

12. Szegedy C, Vanhoucke V, Ioffe S, Shlens J, Wojna Z. Rethinking the inception architecture for computer vision. InProceedings of the IEEE Conference on Computer Vision and Pattern Recognition 2016 (pp. 2818-2826).

13. Nielsen M., http://www.neuralnetworksanddeeplearning.com

APPENDIX

HTML:

```
<html lang="en">

<head>
   <meta charset="UTF-8">
   <meta name="viewport" content="width=device-width, initial-scale=1.0">
   <meta http-equiv="X-UA-Compatible" content="ie=edge">
  <title>Identify-signs-of-Diabetic-Retinopathy-in-eye-images</title>
  <link href="https://cdn.bootcss.com/bootstrap/4.0.0/css/bootstrap.min.css" rel="stylesheet">
   <script src="https://cdn.bootcss.com/popper.js/1.12.9/umd/popper.min.js"></script>
   <script src="https://cdn.bootcss.com/jquery/3.3.1/jquery.min.js"></script>
   <script src="https://cdn.bootcss.com/bootstrap/4.0.0/js/bootstrap.min.js"></script>
   <link href="{{ url_for('static', filename='css/main.css') }}" rel="stylesheet">
```

```
   <style>
.bg-dark {
background-color: #42678c!important;
}
#result {
color: #0a1c4ed1;
}
   </style>
</head>

<body>
   <nav class="navbar navbar-dark bg-dark">
      <div class="container">
         <a class="navbar-brand" href="#">diabetic retinopathy in eye images using CNN</a>
      </div>
   </nav>
   <div class="container">
    <div id="content" style="margin-top:2em">
       <div class="container">
          <div class="row">
             <div class="col-sm-6 bd" >
                <h3>eye images detection </h3>
                 <br>
                 <p>Diabetic retinopathy is an eye disease caused by diabetes that can lead to loss of vision or even complete blindness.Diabetic retinopathy accounts for 12% of all new cases of blindness in the United States, and is the leading cause of blindness for people aged 20 to 64 years. Diabetic retinopathy is a diabetes complication that affects eyes. It's caused
by damage to the blood vessels of the light-sensitive tissue at the back of the eye (retina) Millions of people suffer from diabetic retinopathy, the leading cause of blindness among working aged adults.</p>
                                 </div>
<div class="col-sm-6">
     <div>
           <h4>Please upload image</h4>
<form action = "http://localhost:5000/predict" id="upload-file" method="post" enctype="multipart/form-data">
      <label for="imageUpload" class="upload-label">
            Choose...
       </label>
       <input type="file" name="image" id="imageUpload" accept=".png, .jpg, .jpeg">
</form>
```

```
<div class="image-section" style="display:none;">
      <div class="img-preview">
          <div id="imagePreview">
          </div>
 </div>
 <div>
        <button type="button" class="btn btn-info btn-lg " id="btn-predict">Click on this to see what
it is!</button>
 </div>
</div>
<div class="loader" style="display:none;"></div>

<h3>
      <span id="result"> </span>
</h3>

</div>
       </div>
   </div>
</div>
 </div>
</div>
</body>

<footer>
   <script src="{{ url_for('static', filename='js/main.js') }}" type="text/javascript"></script>
</footer>

</html>
```

APP.PY :

```
from flask import Flask,render_template,request
import os
from keras.preprocessing import image
from werkzeug.utils import secure_filename
from keras.models import load_model
import tensorflow as tf
global graph
graph = tf.get_default_graph()
```

```
import numpy as np
model = load_model("mymodel.h5")
app = Flask(__name__)
@app.route('/')
def index():
    return render_template("index1.html", methods = ['GET'])
@app.route('/predict',methods = ['GET','POST'])
def pred():
    if request.method == "POST":
        f = request.files["image"]
        print("hie")
        """take the path of  the current
        running prog,and concatenate to the
        folder where you wouldlike to save the file"""
        basepath = os.path.dirname(__file__)
        print(basepath)
        file_path = os.path.join(basepath,"uploads",secure_filename(f.filename))
        print(file_path)
        f.save(file_path)
        img = image.load_img(file_path,target_size = (64,64))
        x = image.img_to_array(img)
        x = np.expand_dims(x,axis = 0)
        with graph.as_default():
            p = model.predict_classes(x)
            print(p)
        index = ["drd","no drd"]
        text = "the prediction is :" +index[p[0]]
        return text
if __name__ == "__main__":
    app.run(debug = True)
```