Bone Tumor Detection Using Deep Learning

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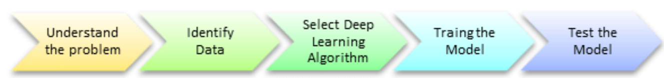
Abstract- *Image recognition technology has a great potential of wide adoption in various industries. In fact, it's not a technology of the future, but it's already our present. Such corporations and startups as Tesla, Google, Uber, and Adobe Systems etc heavily use image recognition. To prove that the technology marches around the world let's look at the recent statistics. Researchers predict that the global market of image recognition will reach $38.92 billion by 2021.. What helps the expansion of image recognition technology today? Its open-source tools that make programming easier, while computing more affordable. Open-source frameworks and libraries today make it possible for companies to benefit from image recognition technology exponentially. For instance, such massive open databases as Pascal VOC and Image Net give access to millions of tagged images. Image processing have a vast area under research, in which Medical Imaging is the most significant area to work in. As in biological cases such as fractures, tumors, ulcers, etc image processing made it easier to find out the exact cause and the best fitted solution. Specifically in tumor detection medical imaging achieved a benchmark by resolving various complexities. Basically Medical Imaging can be explained as the process of creating human body images for medical and research work. For tumor detection various techniques such as MRI (Magnetic Resonance Imaging), CT (Computerized tomography) scan and Microwave are available among mentioned techniques MRI delivers the best images as it has higher resolution. In this the tumor detection has been proposed using deep learning.*

Keywords- Image Recognition, Deep Learning, MRI, CT.

I. INTRODUCTION

Deep learning is a class of machine learning algorithms that uses multiple layers to progressively extract higher level features from the raw input. For example, in image processing, lower layers may identify edges, while higher layers may identify the concepts relevant to a human such as digits or letters or faces. Deep learning is computer software that mimics the network of neurons in a brain. It is a subset of machine learning and is called deep learning because it makes use of deep neural networks.

Deep learning algorithms are constructed with connected layers. The first layer is called the Input Layer. The last layer is called the Output Layer. All layers in between are called Hidden Layers. The word deep means the network join neurons in more than two layers. A deep neural network provides state-of-the-art accuracy in many tasks, from object detection to speech recognition. They can learn automatically, without predefined knowledge explicitly coded by the programmers.



To grasp the idea of deep learning, imagine a family, with an infant and parents. The toddler points objects with his little finger and always says the word 'cat.' As its parents are concerned about his education, they keep telling him 'Yes, that is a cat' or 'No, that is not a cat.' The infant persists in pointing objects but becomes more accurate with 'cats.' The little kid, deep down, does not know why he can say it is a cat or not. He has just learned how to hierarchies complex features coming up with a cat by looking at the pet overall and continue to focus on details such as the tails or the nose before to make up his mind. A deep neural network (DNN) is an artificial neural network (ANN) with multiple layers between the input and output layers. The DNN finds the correct mathematical manipulation to turn the input into the output, whether it is a linear relationship or a non-linear relationship. The network moves through the layers calculating the probability of each output.

1.1 TYPES OF DEEP LEARNING ALGORITHM

The different types of deep learning algorithm are:

- Convolutional Neural Network (CNN)
- Recurrent Neural Networks (RNNs)
- Long Short-Term Memory Networks(LSTMs)
- Stacked Auto-Encoders.
- Deep Boltzmann Machine(DBM)
- Deep Belief Networks(DBN)

1.2 SCOPE OF THE PROJECT

In this we are using one of the deep learning algorithms which is Recurrent Neural Network.

The main contributions of this project therefore are:

- Loading dataset from the file
- Data Analysis
- Feature Selection
- Training the Deep Learning Model
- Prediction.

II. RELATED WORK

This is section we discuss about literature survey, existing system, proposed system and architecture framework.

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The Algorithm used here is RNN (Recurrent Neural Network).

III. LITERATURE SURVEY

A. Analysis of the Social Network Miner (Working Together) of Physicians

The main objective of the study is to analyze and investigate the relationships between staff and resources in a hospital using process mining social network miner technique with respect to working together metric. Using social network miner (working together metric) we could better track and trace the behavior of doctors during the treatment process of patients. Using this technique, we could better visualize and analyze the working behavior of physicians as well as identifying the doctors who actively played a major contribution during the treatment process. Therefore, the results of this study can be facilitate the treatment process of patients in a more timely, effective and efficient manner.

B. Emerging Applications of Data Mining for Healthcare Management - A Critical Review

In this paper, we present a critical review of the various researches currently being undergoing in applications of data mining for healthcare management. The objective of this study is to explore new and emerging areas of data mining techniques used in healthcare management. The applications included in this paper are infection control surveillance, diagnosis and treatment of various diseases, healthcare resource management, customer relationship management, fraud and anomaly detection, healthcare administration, hospital management and public health. The data mining goals achieved, functions performed and algorithms used in these applications have been analyzed in this paper.

C. Inductive Visual Miner Plugin Customization for the Detection of Eventualities in the Processes of a Hospital Information System

Process Mining is a novel alternative to analyze the real processes, from extraction of knowledge of the event logs available in the information systems. The discovery is one type of process mining that allows obtaining process models, which can be observed visually eventualities in the processes modeled. Inductive Visual Miner is a plug-in of ProM tool that supports the discovery and can generate animated process models inspired in a Business Process Modeling Notation. Actually, the knowledge needed to model hospital processes is acquired from empirical methods of researchers in the health institution. Hospital Information Systems possess an event log of processes activities, and it is not being exploited to detect eventualities in hospital processes. This research focused on the development of an Inductive Visual Miner customization, for the detection of eventualities in hospital processes. To develop the solution was used Java 1.6 as programming language, JBoss 4.2 as the application Server and Eclipse 3.4 as Integrated Development Environment. Java Enterprise Edition 5.0 platform was used during the whole process. The investigation allows to generate models of processes where can be observed eventualities of hospital processes.

D. RTLS-based Process Mining: Towards an Automatic Process Diagnosis in Healthcare

Log files constitute the main data source required to be able to use a Process Mining tool. As soon as an information system enables to record events corresponding to activity changes, it is rather simple and rapid to completely and automatically model a process. In numerous fields, information systems do not record events enough detailed. Therefore the model obtained with Process Mining will not be accurate and detailed enough for further analysis. In this article, we are interested in modeling with Process Mining patient pathways in an external consulting service of a hospital center. Apart from recording patients at the front desk and when they are leaving, the information system does not collect enough events in order to manage to model in details the different patient pathways. As a result, the model must be realized with successive observations, interviews and manual collects. This work often represents a significant workload without ensuring data quality and representativeness. To resolve this issue we suggest using a Real Time Location System (RTLS) that enables to automatically record events according to patient locations in the service. The log file obtained can contain the pathway tracks followed by the patients with enough details to precisely rebuild the process with Process Mining. This article is intended for users, for diagnosis experts who will be able to realize an accurate diagnosis and then propose improvements. This article deals with our on-going work through a real case study

E. Temporal Data Mining and Process Mining Techniques to Identify Cardiovascular Risk-Associated Clinical Pathways in Type 2 Diabetes Patients

In this work we present the results of a workflow mining approach to analyze complex temporal datasets of Type 2 Diabetes (T2D) patients. The research has been performed within the EU project MOSAIC, which gathers T2D patients' data coming from three European hospitals and a local health care agency. The main idea underlying our approach is to use a suite of temporal data mining methods in order to derive healthcare pathways. The approach starts by processing raw data, derived from heterogeneous data sources, and create event logs, which contain meaningful healthcare activities. Once event logs have been obtained and tasks and transitions defined, it is possible to explore how state-of-art process mining techniques can be used to gain insights into T2D patients care. In the experimental section of this paper we illustrate the results of this approach applied to an integrated data repository containing clinical and administrative data of 1,020 T2D patients.

IV. EXISTING SYSTEM

The existing system treat an image patch as a high dimensional manifestation of a low dimensional representation, with the intuition that the co variation within image patches has small intrinsic dimensionality relative to the number of voxels in the patch. To capture the anatomical variability across subjects, we employ a Gaussian Mixture Model (GMM) to represent local structure of 3D patches in the vicinity of a particular location across the entire collection. We then explicitly model the observed and missing information. The existing system do not explicitly model slice thickness, as in many clinical datasets this thickness is unknown or varies by site, scanner or acquisition. Instead, we simply treat the original data as high resolution thin planes and analyze the effects of varying slice thickness on the results in the experimental evaluation of the method. We also investigated an alternative modeling choice where each missing voxel of patch yi is modeled as a latent variable. This assumption can optionally be combined with the latent low-dimensional patch representation. Intuitively, learning our model with sparse data is possible because each image patch provides a slightly different subset of voxel observations that contribute to the parameter estimation. All subject scans have the same acquisition direction. Despite different affine transformations to the atlas space for each subject, some voxel pairs are still never observed in the same patch, resulting in missing entries of the covariance matrix. Using a low rank approximation for the covariance matrix regularized the estimates.

Limitations of the existing system:

- Still missing-features problem exists
- Input is vastly different from the mean and therefore potentially erroneous
- Observations with large number of incomplete records
- Computational analysis impractical
- Do not generalize well across problem domains

V. PROPOSED SYSTEM

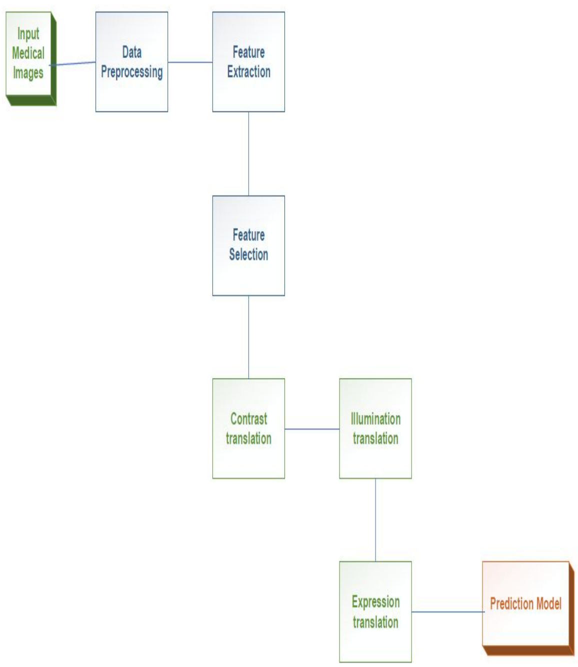
The proposed system use recurrent neural network (RNN) to predict the medical examination data with missing parts. There often exist missing parts in medical examination data due to various human factors, for instance, because human subjects occasionally miss their annual examinations. Such missing parts make it hard to predict the future examination data by machines. Thus, imputation of the missing information is needed for accurate prediction of medical examination data. In the proposed system, among various types of RNNs, we choose simple recurrent network (SRN) and long short-term memory (LSTM) to predict the missing information as well as the future medical examination data, as they show good performance in many relevant applications. In our proposed method, the temporal trajectories of the medical examination measurements are modeled by RNNs with the missed measurements compensated, which is then used to predict the future measurements to be used as diagnosing the diseases of the subjects in advance. In order to handle data with missing parts without extra training data composed of missing examples, we propose missing data imputation using RNNs. In our proposed method, the trained RNNs are used both for missing data imputation and target data prediction.

In the proposed system, when there are no missing data, the RNN is processed normally; when there appears missing data, the output of the RNN in the previous time step is used as the input of the current time step. With such missing data imputation method, the target data with missing parts may be predicted by our proposed RNNs.

Advantages of Proposed System:

- RNN can model sequence of data (i.e. time series) so that each sample can be assumed to be dependent on previous ones
- Recurrent neural network are even used with convolutional layers to extend the effective pixel neighborhood.
- Can handle non-linear data.

VI. SYSTEM ARCHITECTURE



VII. MODULES

1) Image Import & Preprocessing
2) Image Augmentation
3) Model Building
4) Model Prediction and Performance.

1) Data Import and Preprocessing

Pre-processing is a common name for operations with images at the lowest level of abstraction both input and output are intensity images. The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing. Convert color images to grayscale to reduce computation complexity: in certain problems you'll find it useful to lose unnecessary information from your images to reduce space or computational complexity. For example, converting your colored images to grayscale images. This is because in many objects, color isn't necessary to recognize and interpret an image. Grayscale can be good enough for recognizing certain objects. Because color images contain more information than black and white images, they can add unnecessary complexity and take up more space in memory (Remember how color images are represented in three channels, which means that converting it to grayscale reduces the number of pixels that need to be processed).One important constraint that exists in some machine learning algorithms, such as CNN, is the need to resize the images in your dataset to a unified dimension. This implies that our images must be preprocessed and scaled to have identical widths and heights before fed to the learning algorithm.

2) Data Augmentation

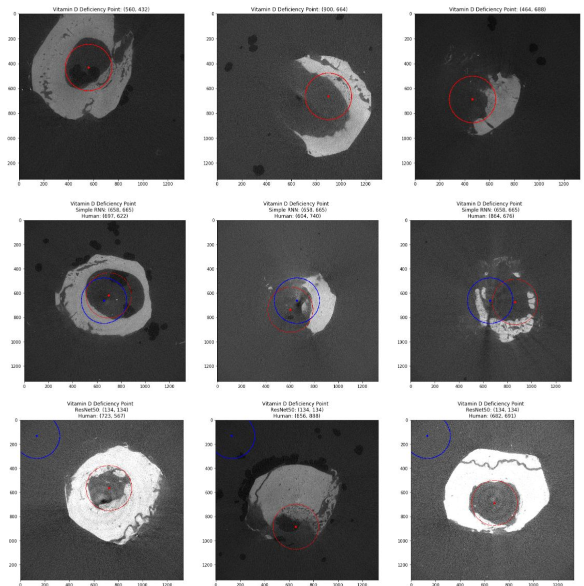
We use effective methods that you can use to build a powerful image classifier, using only very few training examples --just a few hundred or thousand pictures from each class you want to be able to recognize. In order to make the most of our few training examples, we will "augment" them via a number of random transformations, so that our model would never see twice the exact same picture. This helps prevent over fitting and helps the model generalize better. The right tool for an image classification job is a convnet, so let's try to train one on our data, as an initial baseline. Since we only have few examples, our number one concern should be over fitting. Over fitting happens when a model exposed to too few examples learns patterns that do not generalize to new data, i.e. when the model starts using irrelevant features for making predictions. For instance, if you, as a human, only see three images of people who are lumberjacks, and three, images of people who are sailors, and among them only one lumberjack wears a cap, you might start thinking that wearing a cap is a sign of being a lumberjack as opposed to a sailor. You would then make a pretty lousy lumberjack/sailor classifier. Data augmentation is one way to fight over fitting, but it isn't enough since our augmented samples are still highly correlated. Your main focus for fighting over fitting should be the entropic capacity of your model --how much information your model is allowed to store. A model that can store a lot of information has the potential to be more accurate by leveraging more features, but it is also more at risk to start storing irrelevant features. Meanwhile, a model that can only store a few features will have to focus on the most significant features found in the data, and these are more likely to be truly relevant and to generalize better. There are different ways to modulate entropic capacity. The main one is the choice of the number of parameters in your model, i.e. the number of layers and the size of each layer. Another way is the use of weight regularization, such as L1 or L2 regularization, which consists in forcing model weights to taker smaller values.

3) Model Building

VGG16 is a convolutional neural network model proposed by K. Simonyan and A. Zisserman from the University of Oxford in the paper “Very Deep convolutional Networks for Large-Scale Image Recognition”. The model achieves 92.7% top-5 test accuracy in Image Net, which is a dataset of over 14 million images belonging to 1000 classes. It was one of the famous models submitted to ILSVRC-2014. It makes the improvement over Alex Net by replacing large kernel-sized filters (11 and 5 in the first and second convolutional layer, respectively) with multiple 3×3 kernel-sized filters one after another. VGG16 was trained for weeks and was using NVIDIA Titan Black GPU’s.The input to cov1 layer is of fixed size 224 x 224 RGB image. The image is passed through a stack of convolutional (conv.) layers, where the filters were used with a very small receptive field: 3×3 (which is the smallest size to capture the notion of left/right, up/down, center). In one of the configurations, it also utilizes 1×1 convolution filters, which can be seen as a linear transformation of the input channels (followed by non-linearity). The convolution stride is fixed to 1 pixel; the spatial padding of conv. layer input is such that the spatial resolution is preserved after convolution, i.e. the padding is 1-pixel for 3×3 conv. layers. Spatial pooling is carried out by five max-pooling layers, which follow some of the conv. Layers (not all the conv. layers are followed by max-pooling). Max-pooling is performed over a 2×2 pixel window , with stride 2.ModelCheckpoint helps us to save the model by monitoring a specific parameter of the model. In this case I am monitoring validation accuracy by passing value accuracy to Model Checkpoint. The model will only be saved to disk if the validation accuracy of the model in current epoch is greater than what it was in the last epoch.

4) Model Prediction and Performance.

As we train your classification predictive model, we want to assess how good it is. Interestingly, there are many different ways of evaluating the performance. Most data scientists that use Python for predictive modeling use the Python package called scikit-learn. Scikit-learn contain many built-in functions for analyzing the performance of models.



VIII. CONCLUSION

This research work involves bone tumor detection using connected component labeling where the proposed method can also detect the non-presence of the tumor and can classify the tumor is benign or malignant class after its detection. The proposed ANN approach is considered one of the most robust classification algorithms. The proposed classification method gives an acceptable performance of 92.5% accuracy. The purpose of this work is to develop a tool for discriminating malignant bone tumors from benign ones and thus, make an impact in clinical diagnosis.

XI. FUTURE ENHANCEMENT

In future, the system can be developed to classify not only benign or malignant tumor but also the types of sarcomas like chondroma, Ewing sarcoma, and chondrosarcoma etc.

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