LUNG CANCER NODULE DETECTION & CLASSIFICATION USING DEEP CNN

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INTRODUCTION

Lung cancer is the most common forms of cancer among men and third most common type among women. Out of the 1.8 million cases worldwide, 3.9% of those were from India. Most of these cancers are detected at a later stage when it developed and thus it's difficult to operate on, also, the diagnosis costs is high, therefore making it inaccessible to the lower and middle classes of the society.

Through this project we aim to build a computer aided diagnosis system that uses a deep learning architecture called convolutional neural networks (CNN) to detect the nodules in the lung CT scan and further classify them into types - benign and malignant.

LITERATURE REVIEW

Classification of Lung Nodules into its Benign or Malignant:

- Vanilla 3D CNN & Googlenet 3D CNN, used with Adam Optimiser and ReLU activation function and also a dropout layer. Learning rate of 0.0003 and 0.0001 respectively. Accuracy: 0.83.
- 8 layer AlexNet used with ReLu activation function and dropout produced an accuracy of 0.76.
- ResNet CNN architecture produced an accuracy of 0.58.
- A generic ANN architecture with one input, hidden and output layer produced an accuracy of 0.9063. The hidden layer consisted of 22 neurons or hidden units.

Cancer Nodule Detection:

- Noise present in CT scans due to surrounding tissues, bones and air. This is removed by pre-processing the images - normalisation, zero-centering, downsampling.
- U-Net (CNN architecture) used to detect cancer nodule candidates.

OBJECTIVES & TIMELINE

- Learn and implement preprocessing techniques like normalisation, zero-centering and downsampling for noise removal from CT scan images.
- Learn and implement segmentation methods like thresholding and watershed segmentation.
- Learn and implement U-Net CNN for nodule candidate detection.
- Implement a CNN architecture for classification into benign or malignant.

Stage I: Train and test a CNN model to classify lung CT scan images into benign or malignant.

Stage II: Implement architecture to detect lung nodule candidates in CT scan images.

MNIST DIGITS

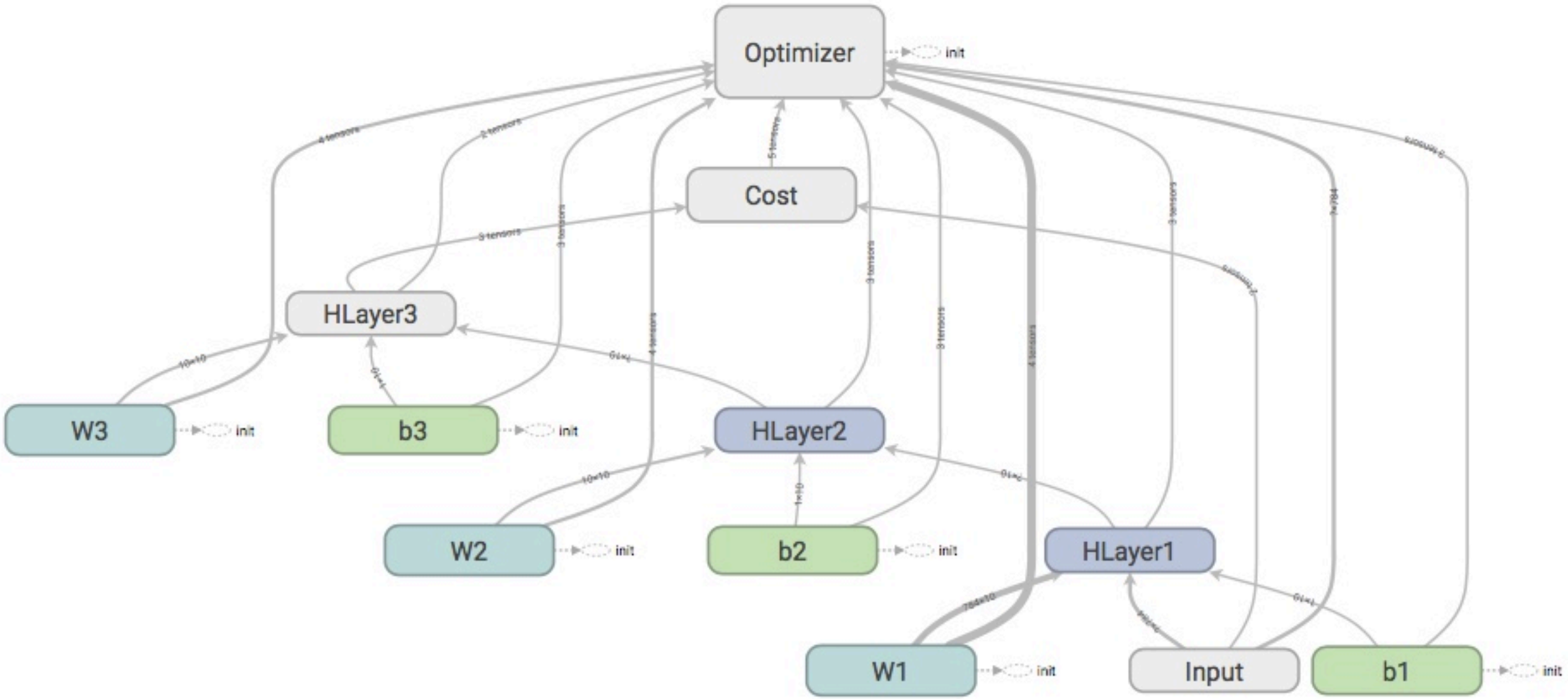
- MNIST dataset (Modified National Institute of Standards & Technology) is the database of handwritten digits (0 to 9) and this is usually referred to as the "Hello World" dataset of computer vision.
- The dataset consists of 60,000 images (50,000 train & 10,000 test) each of which are greyscale images with 28*28 dimensions.
- An ANN (Artificial Neural Network) architecture with one input and output layer and 3 hidden layers with 100 neurons or hidden units each were used.
- Each 28*28 image is flattened out into a one dimensional array of length 784 and fed to the neural net as 784 inputs in the input layer.
- All weights at each hidden layer are initially initialised to random values and biases are initialised to zero.
- ReLu activation function is used.
- 2 architectures are used:
  - Generic ANN
  - Minibatch ANN

MNIST DIGITS

- Both architectures are trained with all of the following optimisers:
  - Gradient Descent
  - RMSProp
  - Adam
- Accuracy for both architectures are given below:

	Generic ANN			Minibatch ANN		
	Gradient Descent	RMSProp	Adam	Gradient Descent	RMSProp	Adam
Train	0.6982	0.9506	0.9465	0.8922	1.0000	1.0000
Development	0.7066	0.9400	0.9240	0.9012	0.9802	0.9778
Test	0.6913	0.9384	0.9258	0.8958	0.9771	0.9781

- The Minibatch ANN uses a batch size of 500 training examples and 100 epochs.



MNIST DIGIT CLASSIFIER

Flow Chart generated using Tensorboard

DATASET

Kaggle Data Science Bowl 2017 dataset:

- Labeled data for 2101 patients.
- Label 0 for no cancer and 1 for cancer.
- 100 to 400 CT scan images for each patient with 512*512 dimensions.

LUng Nodule Analysis 2016 (LUNA16) dataset:

- Labeled data for 888 patients.
- List of nodule coordinates and diameters.
- 100 to 400 CT images for each patient with 512*512 dimensions.

Lung Image Database Consortium (LIDC) database:

- Labeled data for 1018 patients and each patient CT scan consist of 150 to 500 DICOM format images.
- Contains labels for Unknown, Benign, Malignant and Metastatic.
- Image dimensions are 512*512 greyscale pixels.

FRAMEWORKS & DEPENDENCIES

- Python
- Tensorflow
- Tensorboard
- Matplotlib
- Dicom
- Numpy

REFERENCES

Literature Review

- Stewart, B.W.K.P. and Wild, C.P., 2017. World cancer report 2014. *Health*.
- Rao, P., Pereira, N.A. and Srinivasan, R., 2016, December. Convolutional neural networks for lung cancer screening in computed tomography (CT) scans. In *Contemporary Computing and Informatics (IC3I), 2016 2nd International Conference on* (pp. 489-493). IEEE.
- Chon, A., Balachandar, N. and Lu, P., 2017. Deep convolutional neural networks for lung cancer detection. tech. rep., Stanford University. (classification AUC of 0.83)
- Wang, Z., Xu, H. and Sun, M., 2017, December. Deep Learning Based Nodule Detection from Pulmonary CT Images. In *Computational Intelligence and Design (ISCID), 2017 10th International Symposium on* (Vol. 1, pp. 370-373). IEEE.
- Dandıl, E., Çakiroğlu, M., Ekşi, Z., Özkan, M., Kurt, Ö.K. and Canan, A., 2014, August. Artificial neural network-based classification system for lung nodules on computed tomography scans. In *Soft computing and pattern recognition (soCPar), 2014 6th international conference of* (pp. 382-386). IEEE.

REFERENCES

Frameworks, Dependencies & Datasets

- https://www.tensorflow.org/versions/r1.2/get_started/mnist/pros
- https://www.tensorflow.org/versions/r1.2/get_started/summaries_and_tensorboard
- Lung Image Database Consortium (https://wiki.cancerimagingarchive.net/display/Public/LIDC-IDRI#cda78258407d41af86614bf0c054cbbc).
- Lung Nodule Detection (https://luna16.grand-challenge.org/home/).
- Kaggle Data Science Bowl 2017 Dataset (https://www.kaggle.com/c/data-science-bowl-2017).