Lung Cancer detection with U-Net/Faster R-CNN nodule/region of interest proposal

Jay Destories, Jason Fan, Alex Tong

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1 Introduction and Problem Statement

The problem with segmentation and structure identification within the field of biomedical imaging has become a well developed and very active field in the past years. In 2016 and 2015, the LUng Nodule Annotation (LUNA) challenge and SPIE Lungx challenge, asked researchers to develop models to identify pulmonary nodules in lung CT slices. In the 2016 LUNA Challenge, researchers gained access to annotated CT slices that identified abnormal nodules but did not release data about the malignancy of the nodles. In the 2015 SPIE less than 80 CT annotated images of malignant nodules were released to the public.

However, with the 2017 Kaggle Data Science Bowl, a largeish dataset of 1000+ lung CT images in DICOM format was finally released with cancer/no cancer labels. Preliminary investigations by Kaggle members using 3D-convolutional neural nets have already begun. There is one caveat to this dataset; location of malignant nodules are not labeled.

Inspired by recent work in biomedical image segmentation, region proposal networks and multiple instance learning for whole mammogram classification, We seek to present a novel pipeline for cancer detection by combining region proposal and multiple instance learning (MIL).

2 Method/Algorithm/Pipeline

TODO: fix the diagram - its 6x6x256, and also add FCNN to list of ROI nets
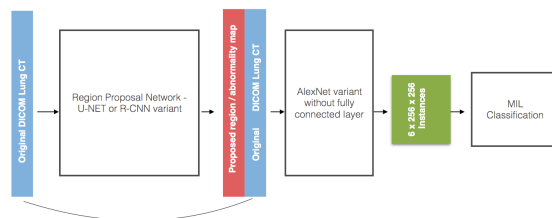
We will enhance multiple instance learning (MIL) by combining MIL with region proposal. We plan to leverage state of the art region proposal networks to propose regions and implicitly weight instances consumed by a downstream MIL classifier.

In our pipeline a region proposal network trained on the LUNA dataset propose abnormal regions in CT slices. These regions are composed with DICOM images are then fed into an MIL classifier that leverages AlexNet and is based on the work on mammogram classification by Zhu et. al.

Region Proposal Networks

We have three region proposal/image segmentation techniques we want to investigate. We will tune one segmentation/region proposal network for our final pipeline.

The first pipeline we will test is U-Net, a CNN for biomedical segmentation developed by Brox et. al add ref. The second pipeline we will test is the fully convolutional neural network developed by Darrell et al add ref. (Jay and Jason will be investigating this network as a paper presentation). And the third pipeline we will test is Faster R-CNN developed by He et. al add ref.

Multiple Instance Learning

We will adapt MIL techniques developed for mammogram classification developed by Lou et. al add ref. Their implementation feeds the 6 by 6 by 256

output of the last convolutional layer of AlexNet as instances that are then

3   Datasets

The number of lung CT scans available to us is very low. The total number of examples available are many orders of magnitudes smaller than the size of datasets for modern, state of the art classification challenges such as ImageNet or MSCOCO.

Listed below are the datsets we will leverage to train our classification/nodule extraction model.

Dataset	# CT scans	Label Type
Kaggle	1000+	Cancer/No-cancer
LIDC-IDRI	888?	Nodule annotation
NLST	?	?
SPIE	80	Nodule annotation

Kaggle Data Science Bowl - (Kaggle)

Lung Image Database Consortium image collection - (LIDC-IDRI)

National Lung Screening Trial - (NLST)

SPIE Lungx Challenge - (SPIE)

4   Goals and Evaluation

The main challenge that we face in lung cancer detection

Goals:?
Tuning Faster/fast RNN or YOLO to detect nodules
Using Alex-net or other 2GPU methods to train cancer classifier
Find ways to reduce false positive/false negatives

Visualizations of 3D convolutions?
Comparison between plain CNN vs. nodule extraction -> CNN?
Comparison between U-NET vs tuned FASTER R-CNN?

1) Nodule extraction with u-net, r-cnn roi proposal, or another pre-trained model. TODO: what will be the extracted features be?!
2) leverage 2 GPU with alex-net like architecture to classify cancer instances, we really dont have more data so we might have to train on the kaggle dataset.

Evaluate and visualize how region proposal/abnormality proposal actually affects MIL classifiers
Evaluate how our technique circumnavigates the problem of having sparse, non-homogeneous data

5   About us

buncha kiddos who have no idea about anything

6   Related Work

7   Questions and challenges

1. What will the output of node-extraction be like?

2. What kind of novelty will we bring to the table?

3. How will we deal with the small dataset(s)?