Lung Cancer Images Classification by Deep Learning

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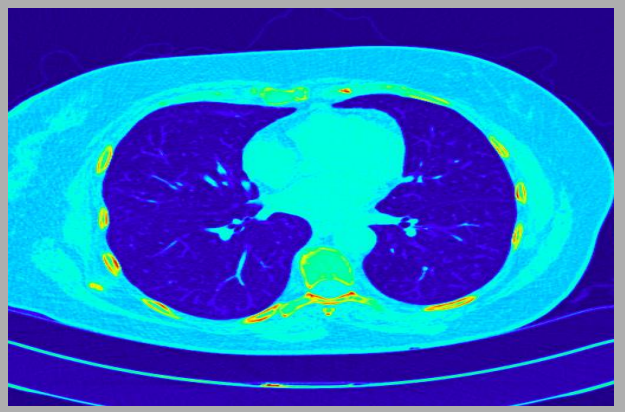
Introduction

- In the United States, lung cancer strikes **225,000** people every year, and accounts for **$12 billion** in health care costs. Early detection is critical to give patients the best chance at recovery and survival.
- One year ago, the office of the **U.S. Vice President** spearheaded a bold new initiative, **the Cancer Moonshot**, to make a decade's worth of progress in cancer prevention, diagnosis, and treatment in just 5 years.
- In 2017, the **Data Science Bowl** will be a critical milestone in support of the Cancer Moonshot by convening the data science and medical communities to develop lung cancer detection algorithms.



Kaggle's Biomedical Computer Vision Competitions

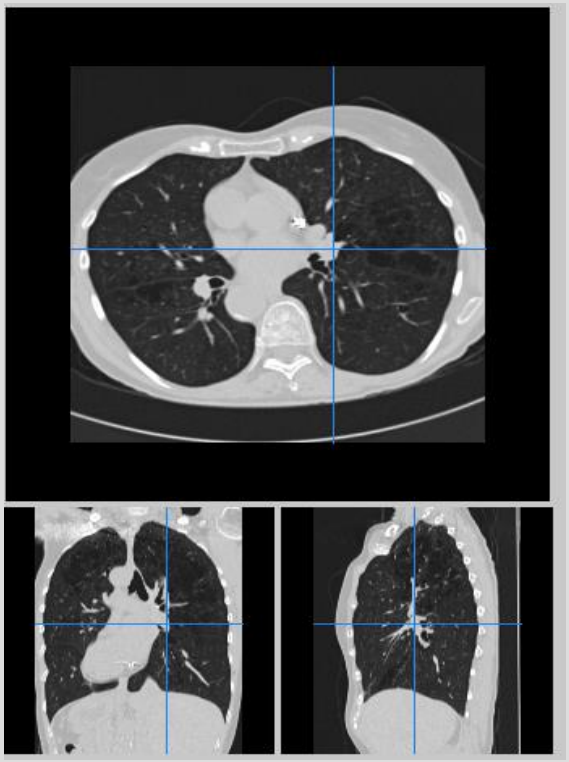
Kaggle: In 2010, Kaggle was founded as a platform for predictive **modeling** and **analytics competitions** on which companies and researchers post their data.

- Statisticians and data scientists from all over the world compete to produce the best models.
- **Data Science Bowl 2017** was the biggest competition focused on "Lung Cancer Detection". The competition was founded by **Arnold Foundation** and awarded **$1 million** in prizes (**1st** ranked **$500,000**).

Train Set: around 150 CT labelled scans images per patient from 1200 patients encoded in **DICOM** format.
Stage 1 test set: 190 patients un-labelled CT scans.
Stage 2 test : 500 patients un-labelled CT scans.

Diagnosis System Training Flow

Training Set (DICOM)



Preprocessing

DICOM to PNG Conversion

.png Images

Denoising Filters

.png Images

SEGMENTATION (U-NET)

(x,y) coordinates

Nodules Distance Merging & Z Merging

(Connected Graphs by Nodules Centre of Mass)

Nodules Images

Classification Model

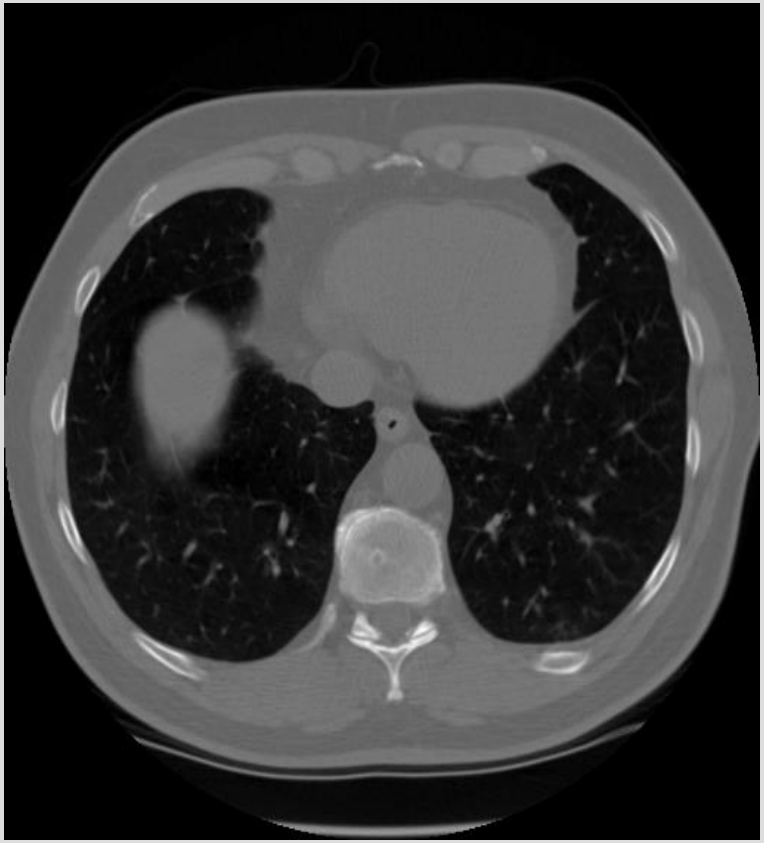
FALSE POSITIVE REDUCTION

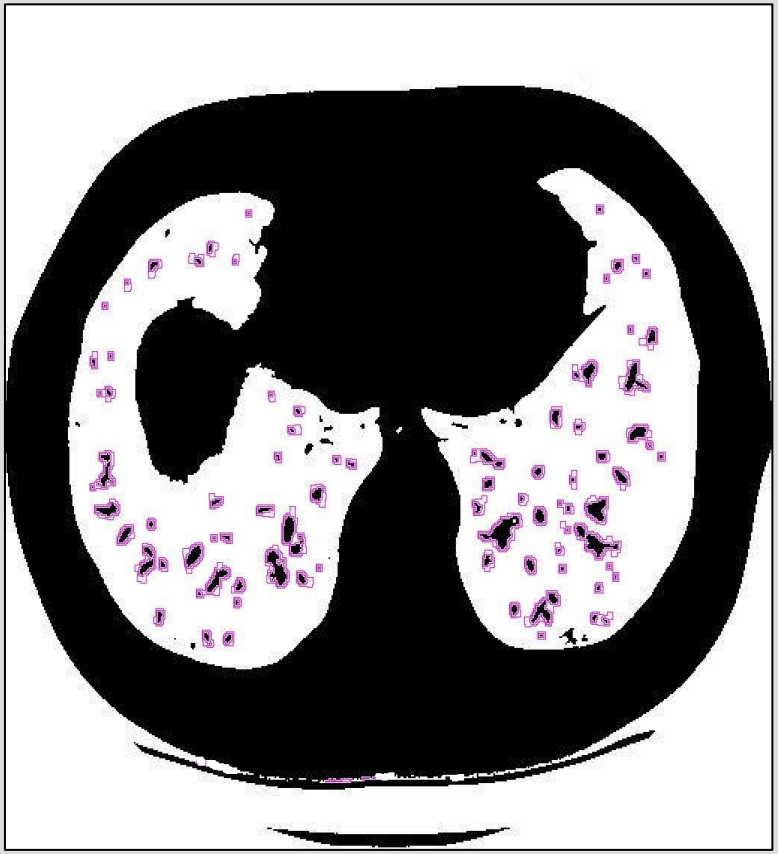
3 Wide Res Net XY, XZ, YZ planes Models

Cancer **Non-Cancer**

Segmentation

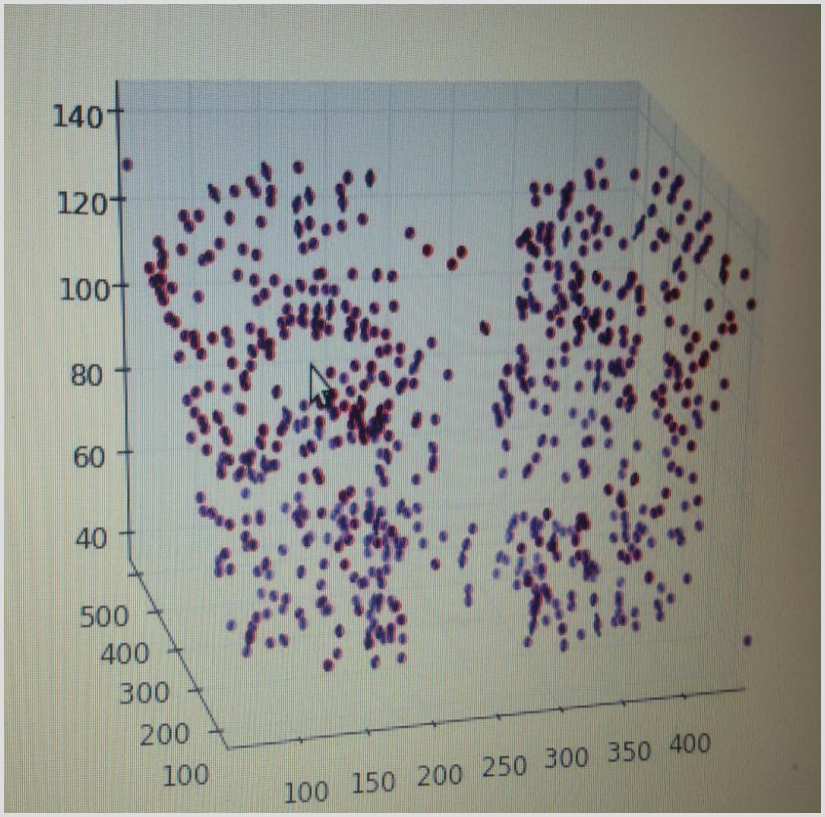
- Segmentation algorithm yields the coordinates (X,Y) of the nodules centers which enable the distance merging algorithm to extract nodules from directly from input CT-Scans.



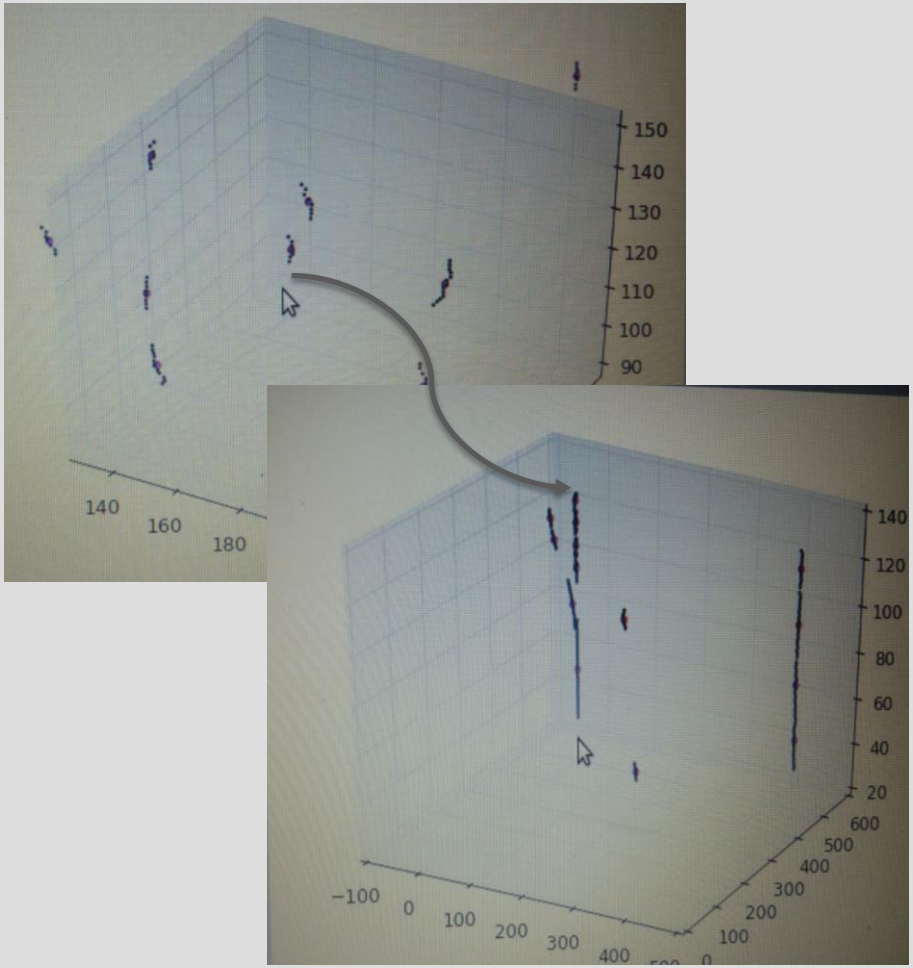


Distance Merging and Z-Merging

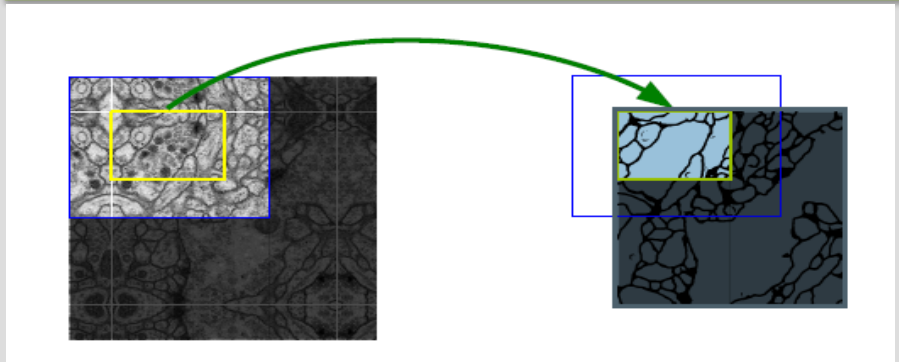
Distance Merging

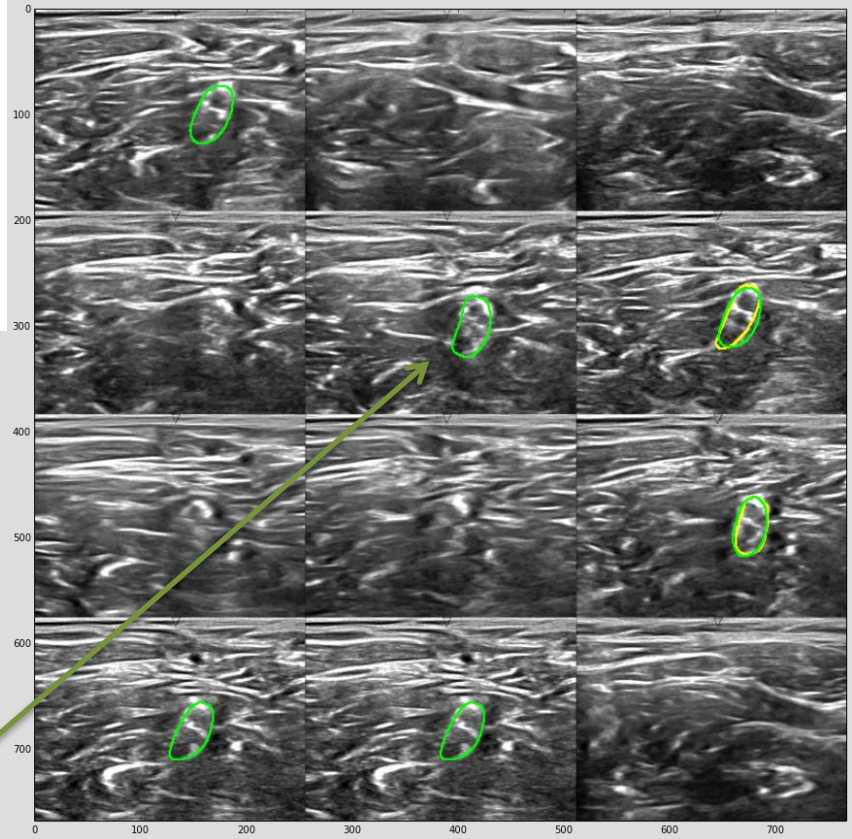


Z-Merging



Segmentation problem: alias with biomedical images CNNs fail





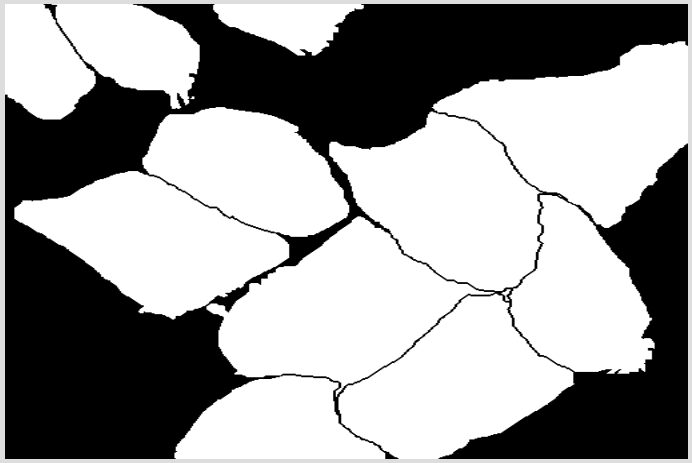
Problems:

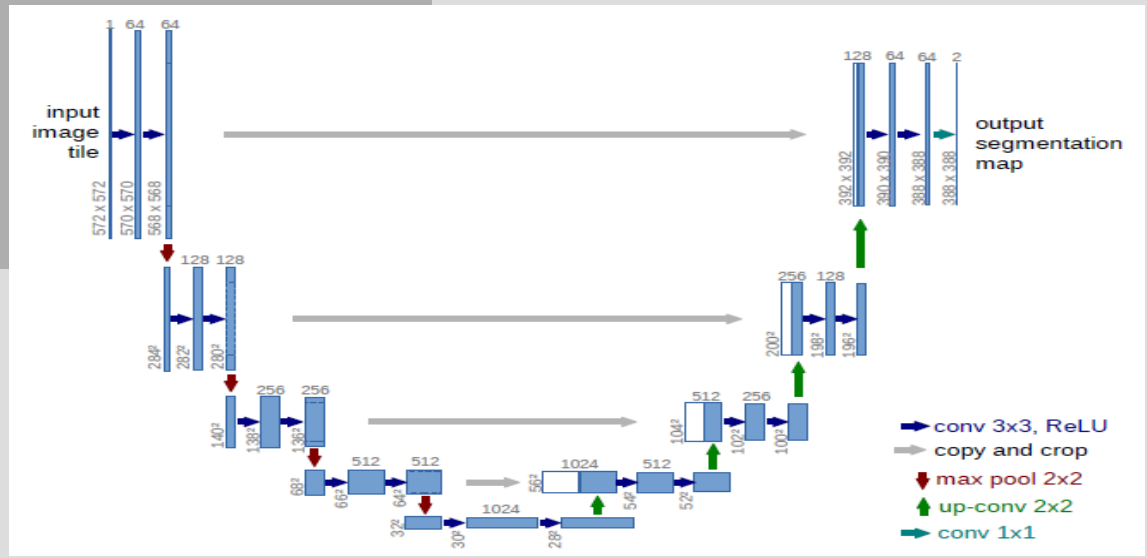
- **Feature extraction:** In biomedicine feature extraction is not as easy as in an Imagenet competition with general images. A previous **Image Preprocessing** is needed. This is called **Segmentation**.
- On Kaggle website there are whole competitions just regarding Segmentation. One of these was called **«Ultrasound Nerve Segmentation».**

U-NET (Fully connected CNN)

Critical Feautures (Ronneberger, O., et al., 2015):

- **U-NET** is a **Convolutional Auto-encoder** that can be trained end-to-end from very **few images** and outperforms the prior best methods.
- It consists of a **contracting path (left side)** to capture context and an symmetric **expansive path (right side**) enabling precise localization.
- **Upsampling part (repeating rows and cols)** has a large number of feature channels which allow the network to propagate context information to higher resolution layers.
- **Spatial Dropout: F**eature maps dropout.
- **Upside: Small training set.**
- **Downside: Risk of overfitting.**





Conclusions

- This wholly **time-consuming** software was trained on an advanced GPUs cluster specifically designed and implemented by us, and nevertheless it needed days to be trained.
- However, results are **encouraging** and prove that accuracies achieved by these Deep Learning systems are **comparable to those of oncologists** and in some cases **over-perform** them.
- One day these classification systems might be part of CT scans systems, doctors' desktop software applications, smartphones apps, etc.

Future Research

- Transfer Learning: we will try to exploit bottleneck features from other pre-trained models in biomedical applications
- Wrap all the system into a mobile device like Android and IOS smartphones

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Aknowledgements

Thank you for attention.

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