

# Diagnosing and Subtyping Lung Cancer Using Deep Learning in Whole Slide Images

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## Introduction

- Lung cancer is the most common cancer and leading one in terms of worldwide mortality.
- Pathologists are required to categorize non Small Lung Carcinoma (NSLC) into Adenocarcinoma (LUAD) and Squamous Carcinoma Cells (LUSC) for appropriate treatment decisions.
- Traditional machine learning would require cell level annotations in order to learn to subtype the lung cancer.
- We demonstrate the effectiveness of training artificial intelligence (AI) on the whole slide image (WSI) using only clinical outcome to deliver a diagnostic decision.

## Material and Methods

- Use public data set from The Cancer Genome Atlas (TCGA), 1583 slides well balanced over the three classes.
- Multiple Instance Learning model and attention mechanism to classify the whole slide from a batch of patches (224x224 pixels).
- Only slide level annotation is required for each case in order to train the model.
- Attention mechanism weights each tile's contribution, which then enables us to show the hotspots that contribute the most to the classification.
- Pathologist reviews and confirms the relevance of the hotspots for the final diagnosis.

## Results

- Model evaluated on 316 slides taking all tile descriptors for final classification.
- Reach 0.966 mean Area Under the ROC curve (Normal: 0.996, LUAD: 0.958, LUSC: 0.944).
- Overall accuracy of 0.883 (p-value of 1.52e-74).

## Discussion

- Training Deep Learning using whole slide image (WSI) delivers accurate results without the use of clinical or genomic data.
- AI can be trained to diagnose and subtype lung cancer with the accuracy of a trained pathologist.
- AI can accurately highlight the regions of interest (hotspots) where the pathologist can investigate further for insights.

AI reveals regions of interest for accurate lung cancer subtyping of adenocarcinoma and squamous carcinoma.

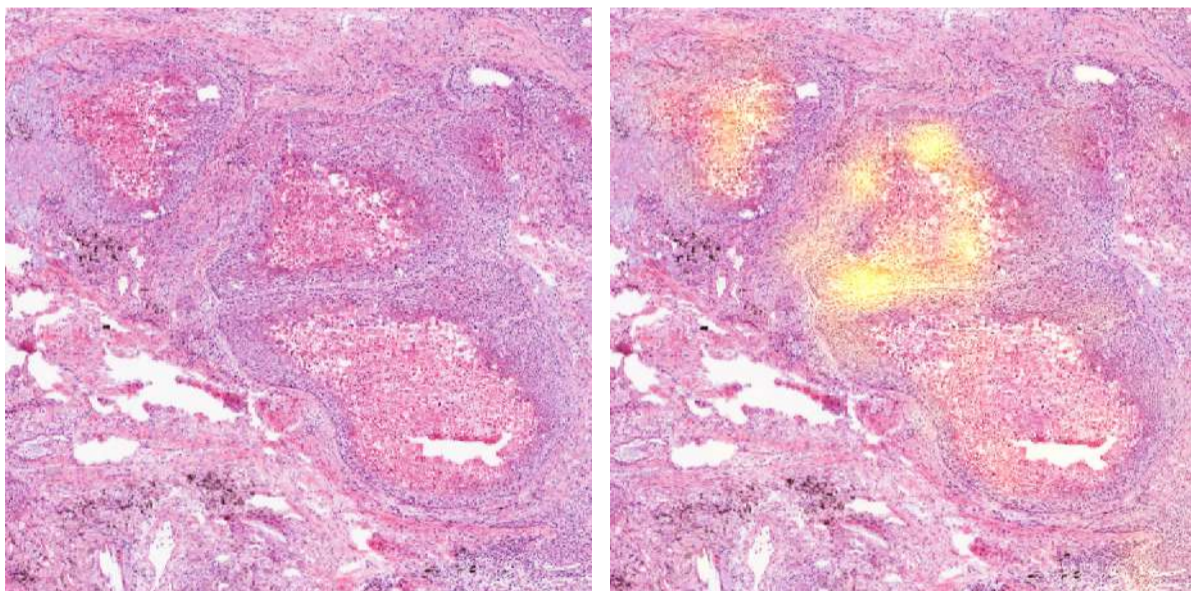


Fig 1. On the left, a sample of Squamous Cell Carcinoma tissue. On the right, the heatmap generated by the model showing hotspots used for classification.

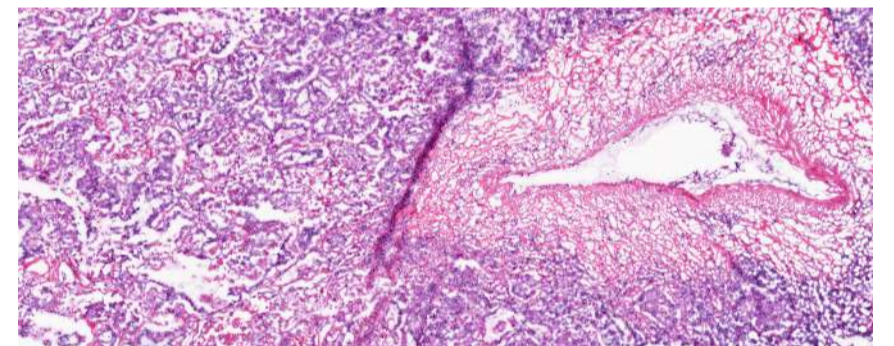


Fig 2. Sample of Adenocarcinoma tissue

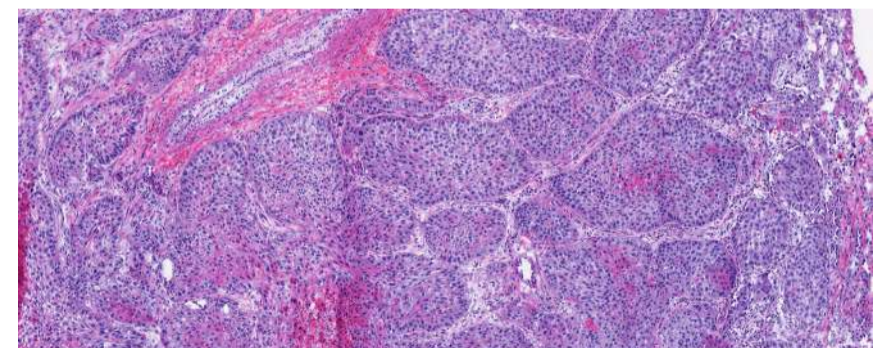


Fig 3. Sample of Squamous Cell Carcinoma tissue

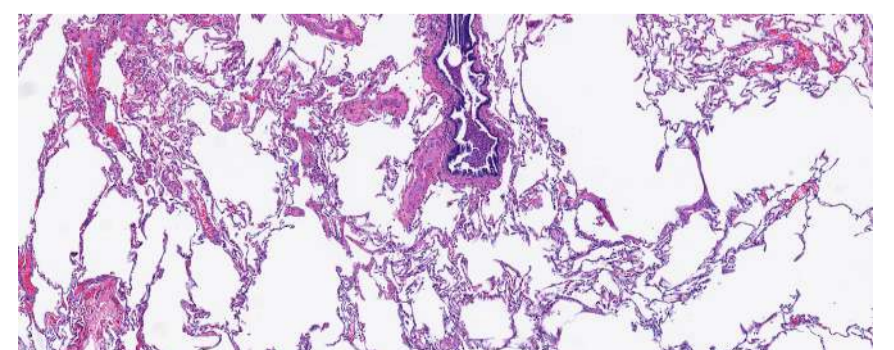


Fig 4. Example for highly degraded tissue.

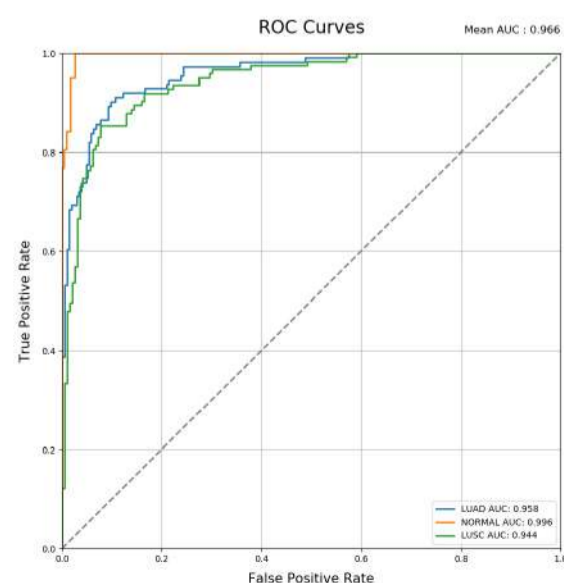


Fig 5. Receiver Operating Characteristic curves for each class. Mean AUC over the three classes of 0.966.

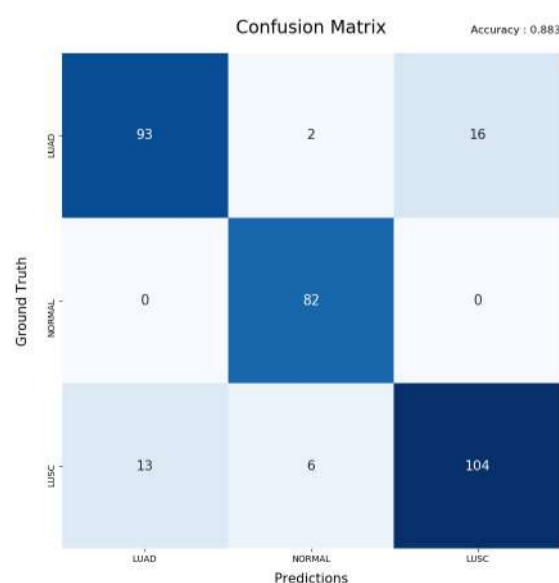


Fig 6. Confusion matrix showing correlation between Ground Truth and Prediction. Overall Accuracy of 0.883.