Cancer Metastases Detection

COMS W4995 Applied Deep Learning
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Outline

01 INTRODUCTION
Background Introduction and Motivation

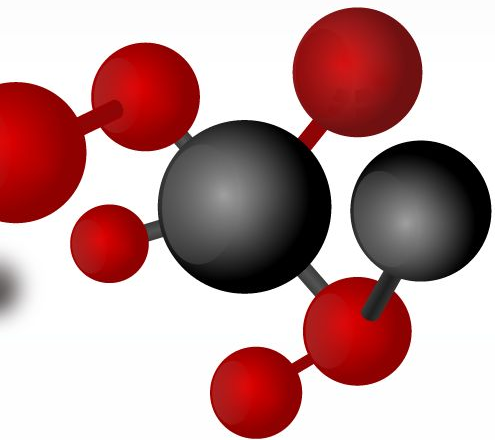## 02 METHODOLOGY
Data Preprocessing and Model Training

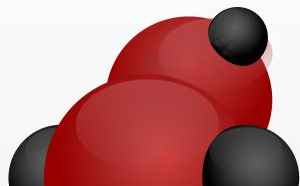## 03 RESULTS ANALYSIS
Model Testing and Metrics Evaluation

04 CONCLUSIONS
Limitation and Future Improvement

01

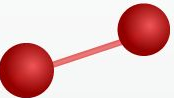## INTRODUCTION

INTRODUCTION

- **Motivation:** The process of manually performing metastasis detection is labor intensive and error-prone [1]. To relieve the workload of pathologists, scholars proposed utilizing deep learning models i.e. Convolution Neural Network (CNN), to assist pathologists by providing second opinions.

- **Objective:** Leverage deep learning model to detect tumor cells on gigapixel pathology image and experiment with multi-scale zoom levels
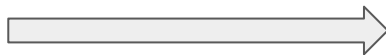
BACKGROUND

- Based on *"Detecting Cancer Metastases on Gigapixel Pathology Images"* (see reference for detail)

- **KEY TAKEAWAYS**:
  - Utilize Inception (V3) architecture
  - Input patch size (299, 299, 3) and label of this patch is determined by the central 128*128 region; classify as **tumor** if at least one pixel in the central region is a tumor pixel
  - Use two levels of magnification
  - Data Augmentation helps

WORKFLOW

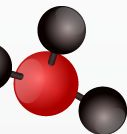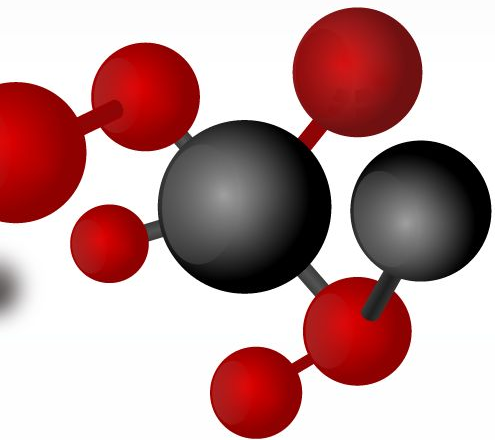Data Preparation and Visualization $\longrightarrow$ Train/Test Split, Patch Generation

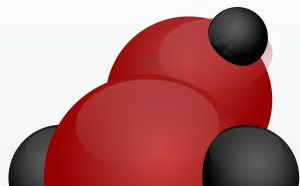Model Testing and Generate Heatmap $\longleftarrow$ Model Building
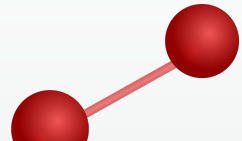
**02**

METHODOLOGY

Data Content

- **Dataset:** Camelyon16
- **Input**: lymph node digitized images, tumor mask
- Different zoom level associates with different dimension and downsample factor (lower level has higher resolution)
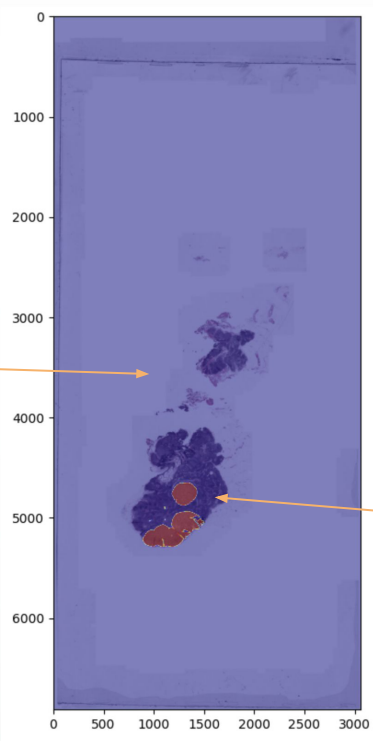
```
Read WSI from /content/gdrive/MyDrive/ADL_Project/slides/tumor_016.tif with width: 97792, height: 221184
Read tumor mask from /content/gdrive/MyDrive/ADL_Project/slides/tumor_016_mask.tif
Slide includes %d levels 10
Level 0, dimensions: (97792, 221184) downsample factor 1
Level 1, dimensions: (48896, 110592) downsample factor 2
Level 2, dimensions: (24448, 55296) downsample factor 4
Level 3, dimensions: (12224, 27648) downsample factor 8
Level 4, dimensions: (6112, 13824) downsample factor 16
Level 5, dimensions: (3056, 6912) downsample factor 32
Level 6, dimensions: (1528, 3456) downsample factor 64
Level 7, dimensions: (764, 1728) downsample factor 128
Level 8, dimensions: (382, 864) downsample factor 256
```
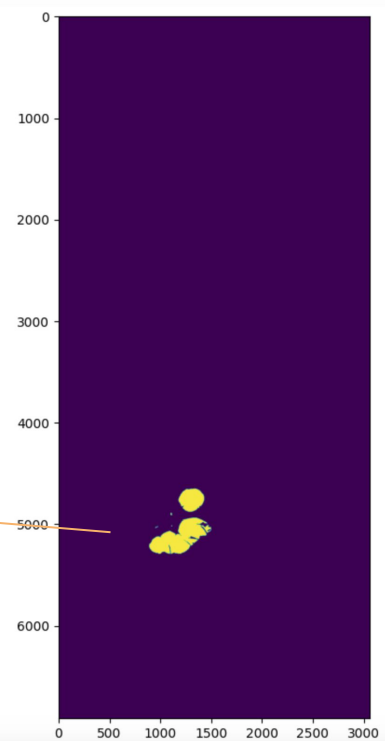
VISUALIZATION
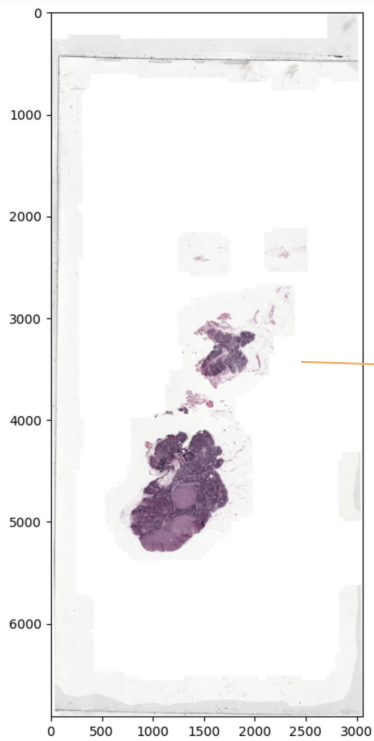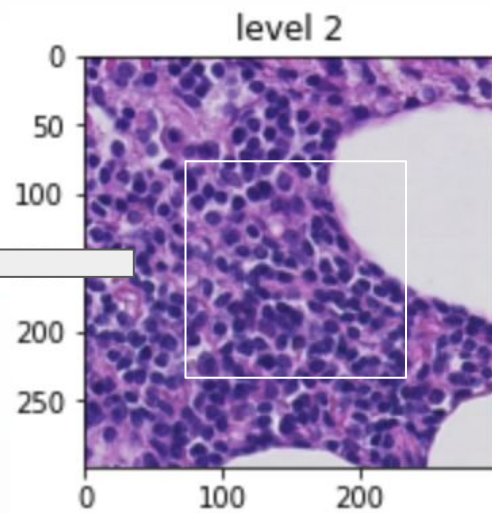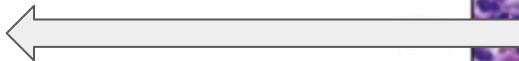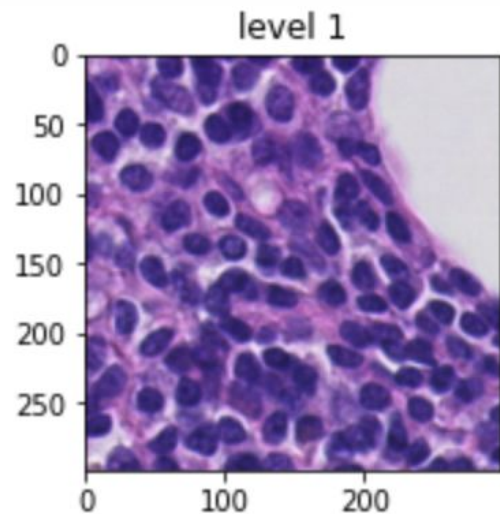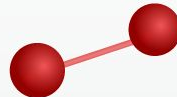

Slide 016 at zoom level 5   Overlay Slide 016   Mask 016 at zoom level 5

VISUALIZATION

PIPELINE

(32*x-85, 32*y-85)

(32*x, 32*y)

128 x 128 patch
of interest
(not to scale)

Surrounding context

40X patch
(299 x 299)

20X patch
(downsampled
to 299 x 299)

10X patch
(downsampled
to 299 x 299)

...

Input images

Label (binary)

Model

Detecting Cancer Metastases on Gigapixel Pathology Images, 2017
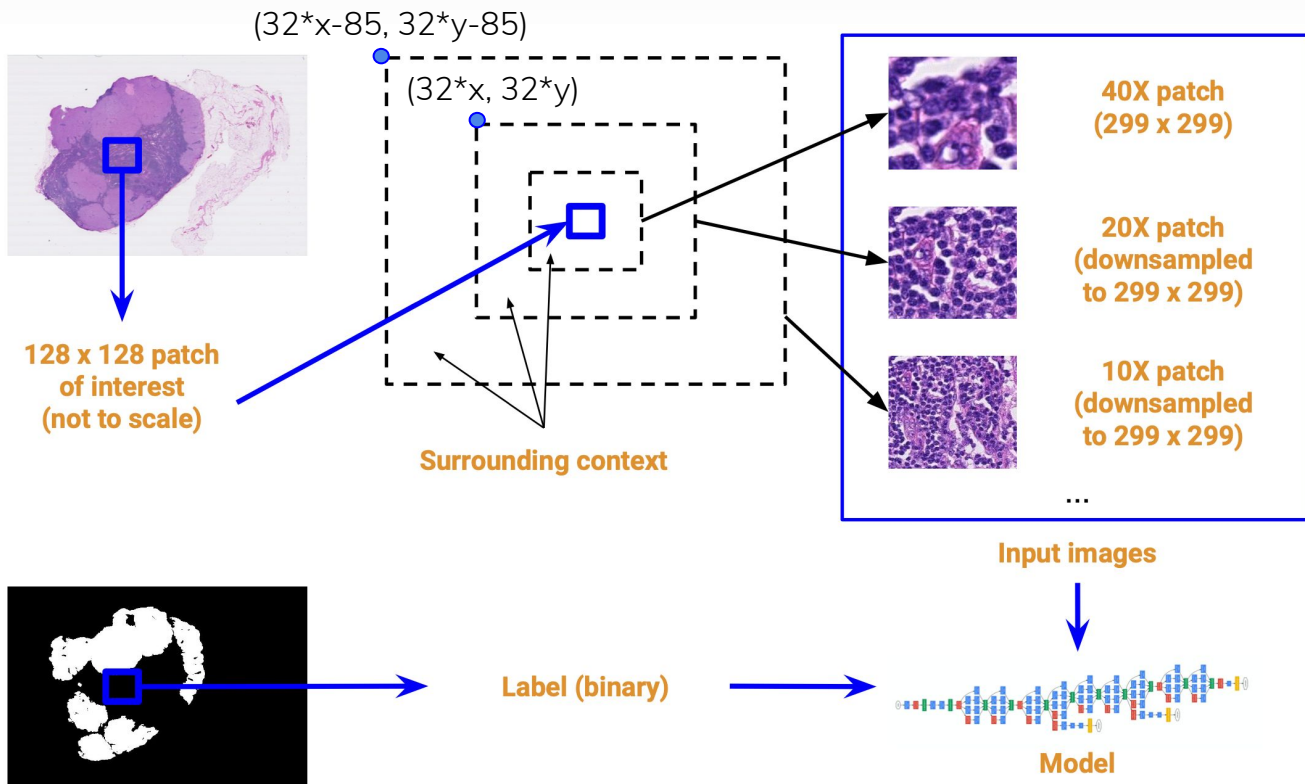
PATCH GENERATION

```
patch_generator(slides, tumor_masks, zoom_level_1, zoom_level_2,
                tissue_percentage=30, base_zoom_level=5, center_size=128, patch_size=299, n_sample=250)
```

1.

For each slide image, get all the normal pixels and tumor pixels i.e.(x, y) pairs, and retrieve the center of this patch

2.

Repeatedly generate normal patches by locating the central region until n_sample is met
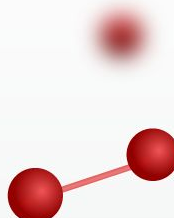
3.

Repeatedly generate tumor patches by locating the central region until n_sample is met
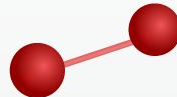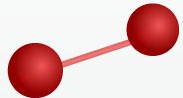
PATCH GENERATION

- Training Slide: 016, 075, 101, 110
- Validation Slide: 064, 094
- Testing Slide: 084, 091

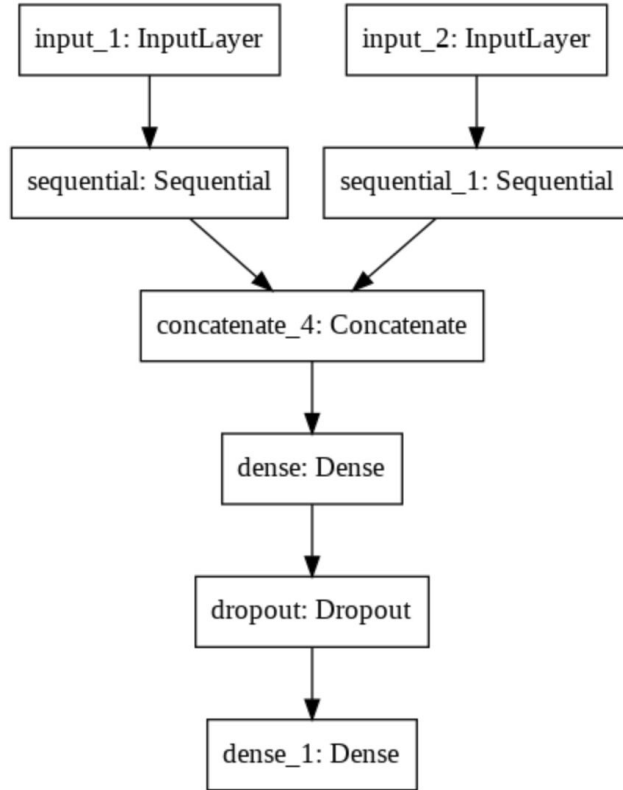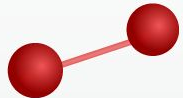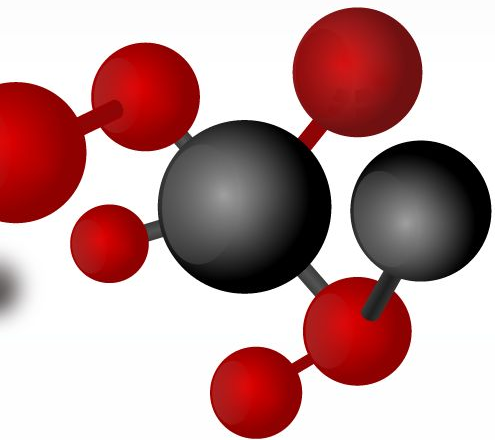|	Tumor	Normal
Training Data	1017	983
Validation Data	506	494

DATA AUGMENTATION

- Horizontal Flip
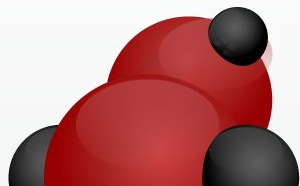- Vertical Flip
- Rotation 90 degree
- Shear range 0.2
- Brightness: [0.7, 1.3]

MODEL BUILDING

- InceptionV3 as base model
- Concatenate model using zoom level 0 and model using zoom level 1
- 0.2 Dropout is used
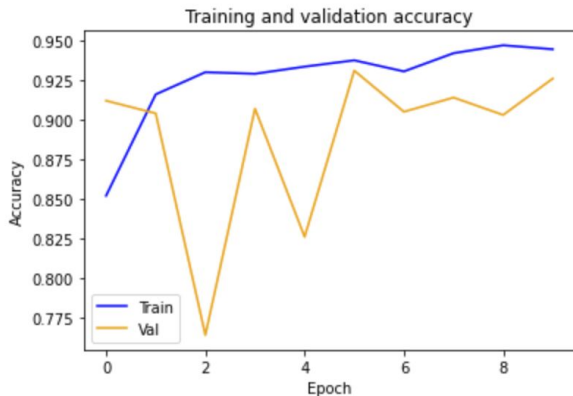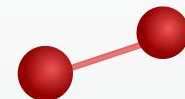- A dense layer with sigmoid activation function is built on top
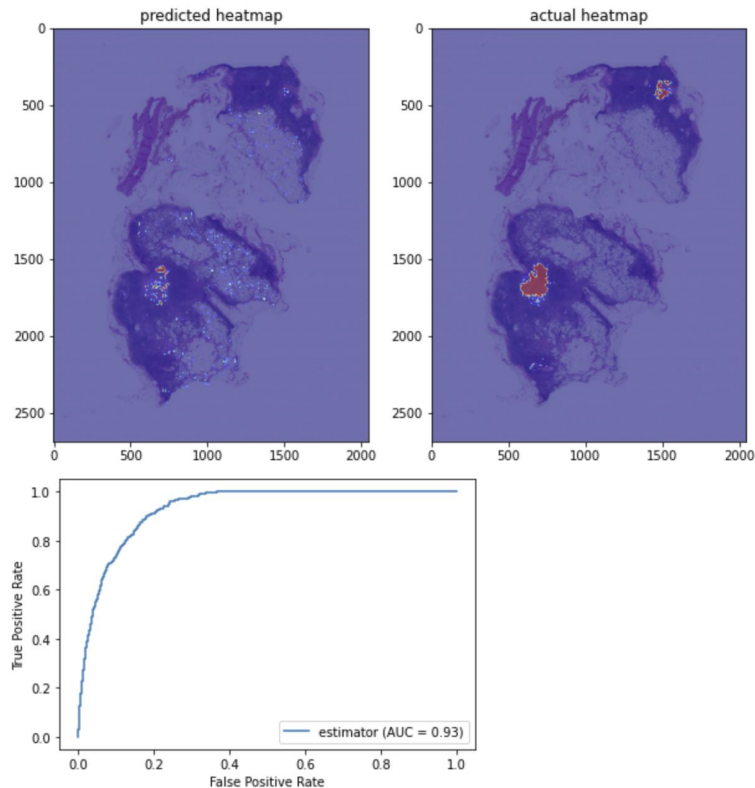
03
RESULT

TRAINING MODEL RESULT
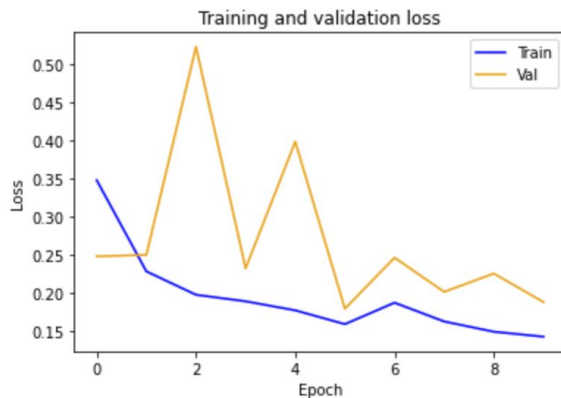
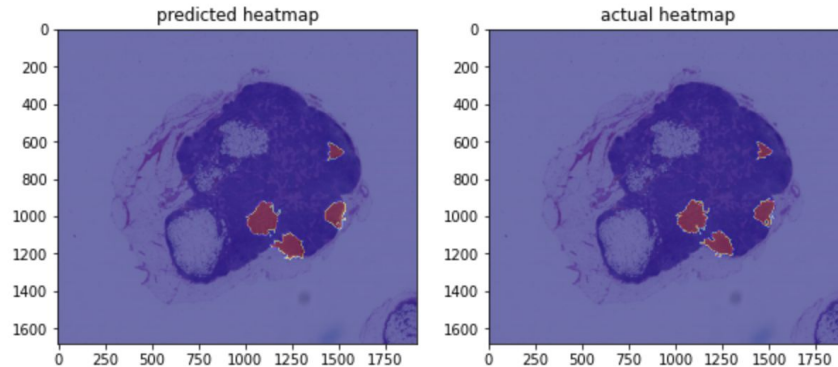|	loss	accuracy
training	0.1309	0.9460
validation	0.1882	0.9260

TESTING SLIDE 084

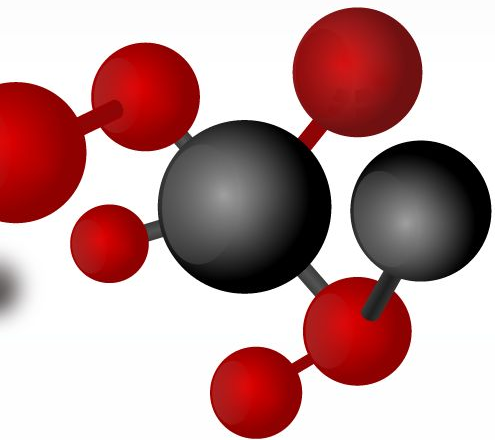AUC: 0.9305, F1 Score: 0.1791, Precision: 0.1338, Recall: 0.2712, ROC AUC Score: 0.9305

- Using 0.7 as threshold while predicting labels
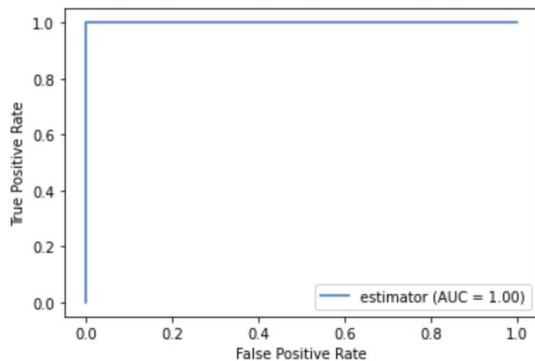
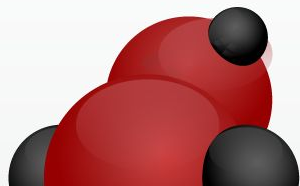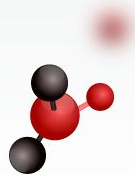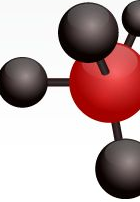- Using 0.7 as threshold while predicting labels
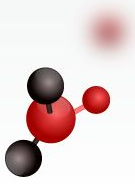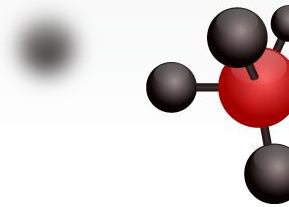
04

CONCLUSION

CONCLUSION

- This model performs surprisingly well on slide 091, but not as well on slide 084

- **Limitation:** limited dataset and the model requires excessive amount of RAM, which makes it unrealistic to train and test on local machine
- **Next step:**
  - Get more data
  - handle margin while finding pixels in a slide
  - Better model and threshold tuning

Reference

[1] Detecting Cancer Metastases on Gigapixel Pathology Images

THANKS