Cancer Metastases Detection

COMS W4995 Applied Deep Learning
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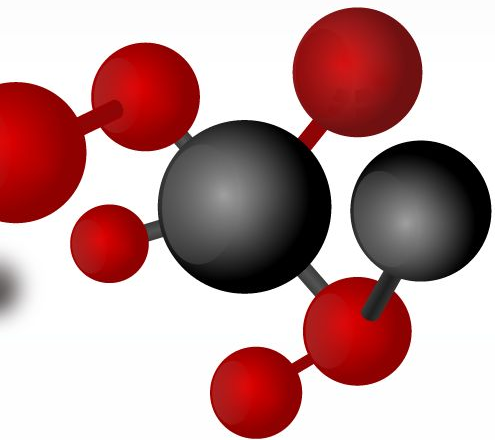Data Preprocessing and Model Training

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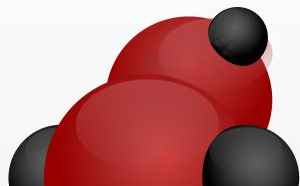Model Testing and Metrics Evaluation

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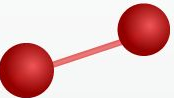
01

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 →
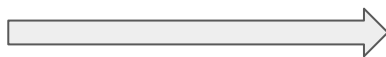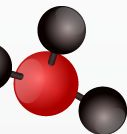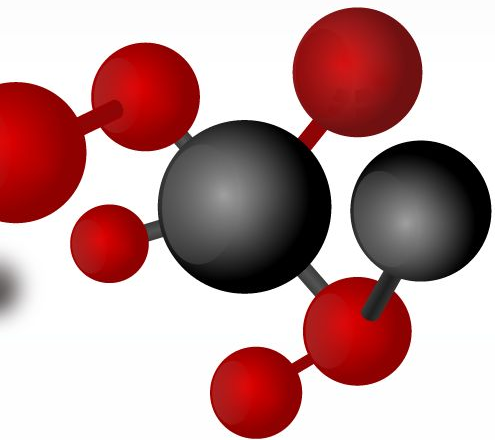
Train/Test Split, Patch Generation
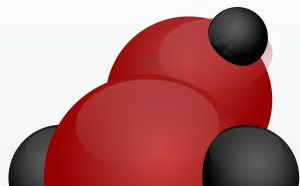
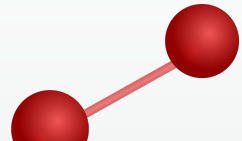Model Testing and Generate Heatmap ←

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)
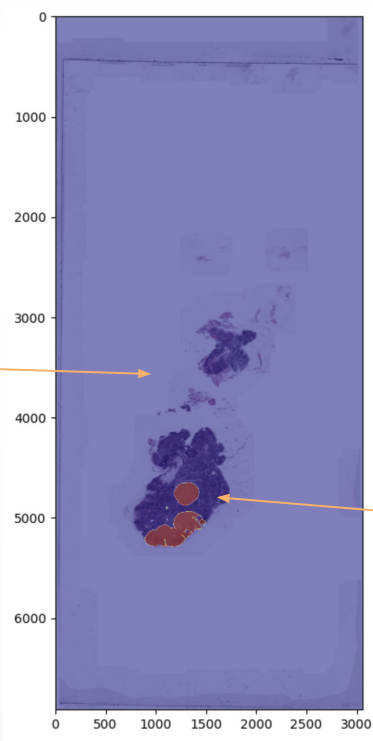
```
Read WSI from /content/gdrive/MyDrive/ADL_Project/slides/tumor_016.tif with width: 97792, height: 221184
Read tumor mask from /content/gdrive/MyDrive/ADL_Project/slides/tumor_016_mask.tif
Slide includes %d levels 10
Level 0, dimensions: (97792, 221184) downsample factor 1
Level 1, dimensions: (48896, 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
```
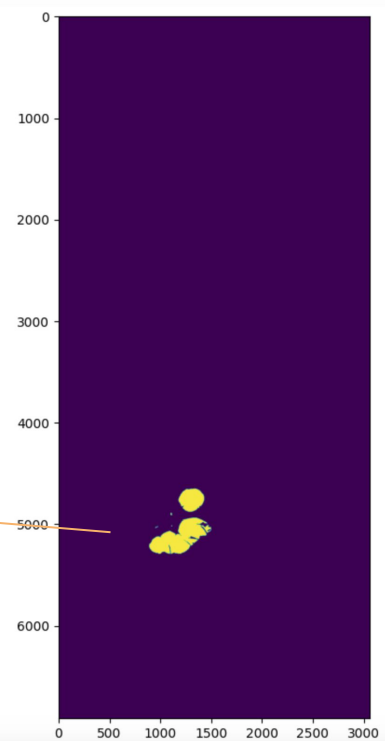
VISUALIZATION
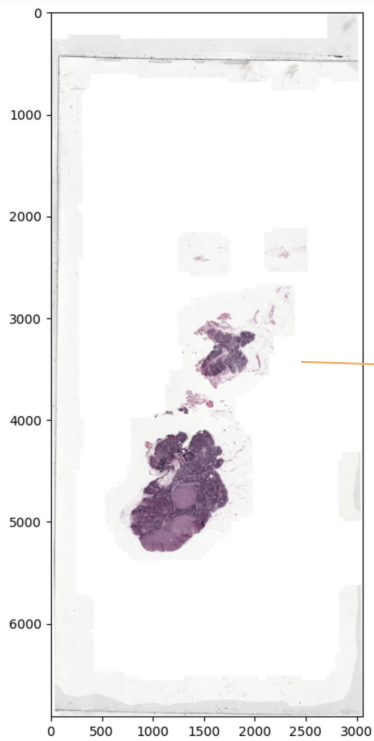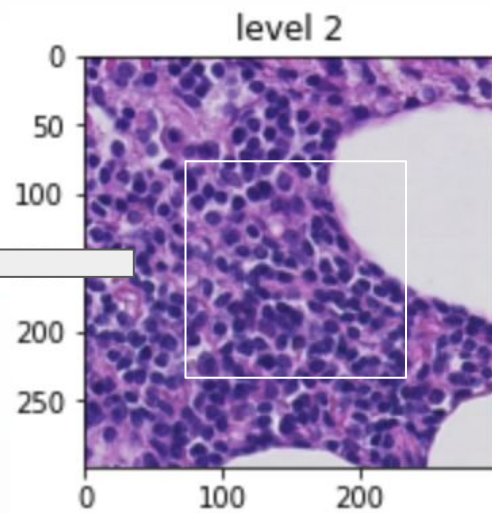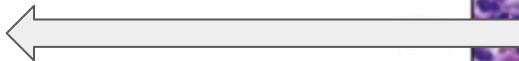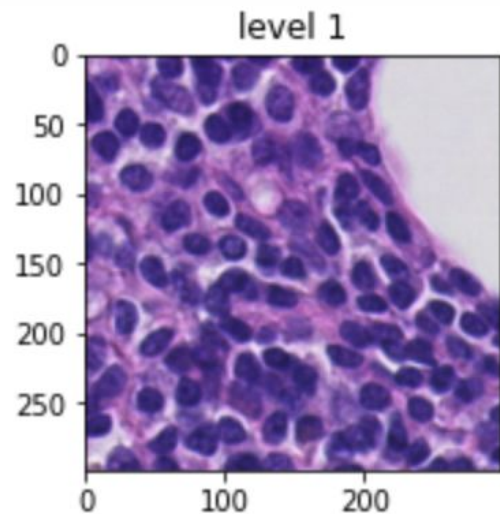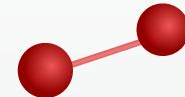

Slide 016 at zoom level 5   Overlay Slide 016   Mask 016 at zoom level 5

VISUALIZATION

PIPELINE

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

(16*x-85, 16*y-85)

85

85

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
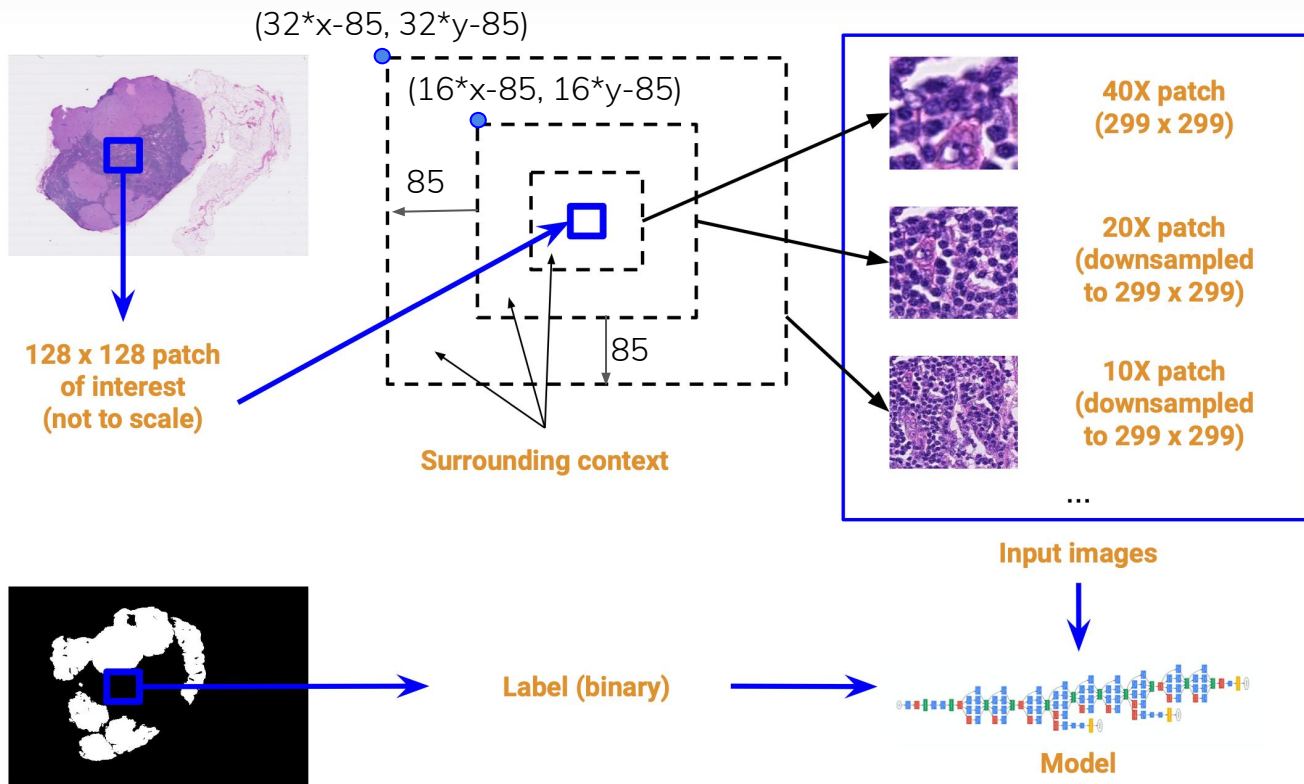
PATCH GENERATION

```
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
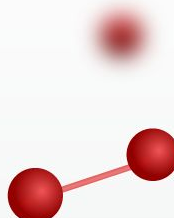locating the central
region until n_sample is
met

3.
_____

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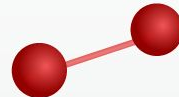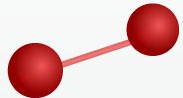
PATCH GENERATION

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

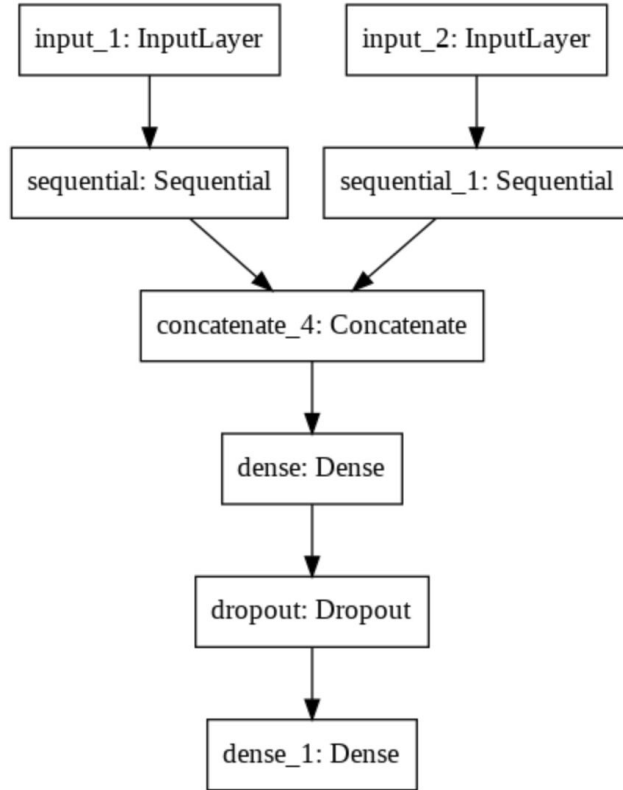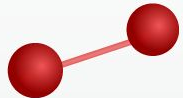|	Tumor	Normal
Training Data	1017	983
Validation Data	506	494

DATA AUGMENTATION

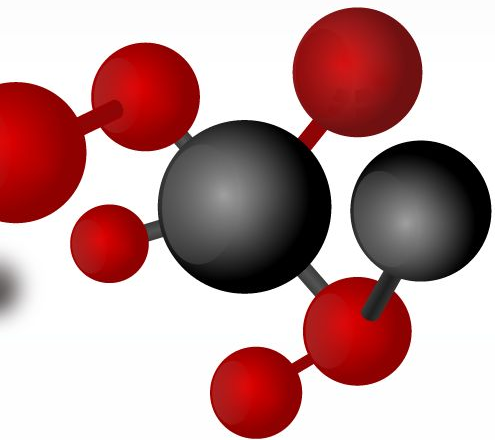- Horizontal Flip
- Vertical Flip
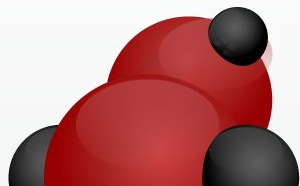- Rotation 90 degree
- Shear range 0.2
- Brightness: [0.7, 1.3]

MODEL BUILDING

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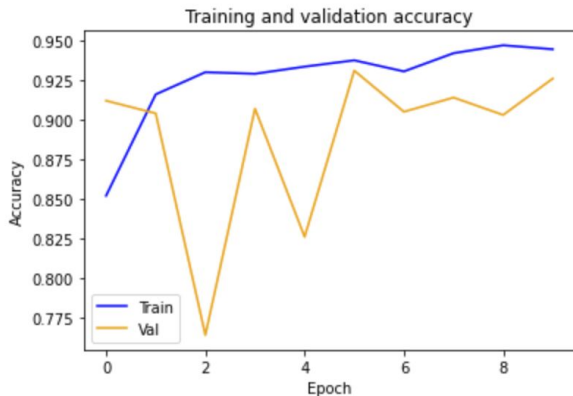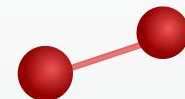- A dense layer with sigmoid activation function is built on top
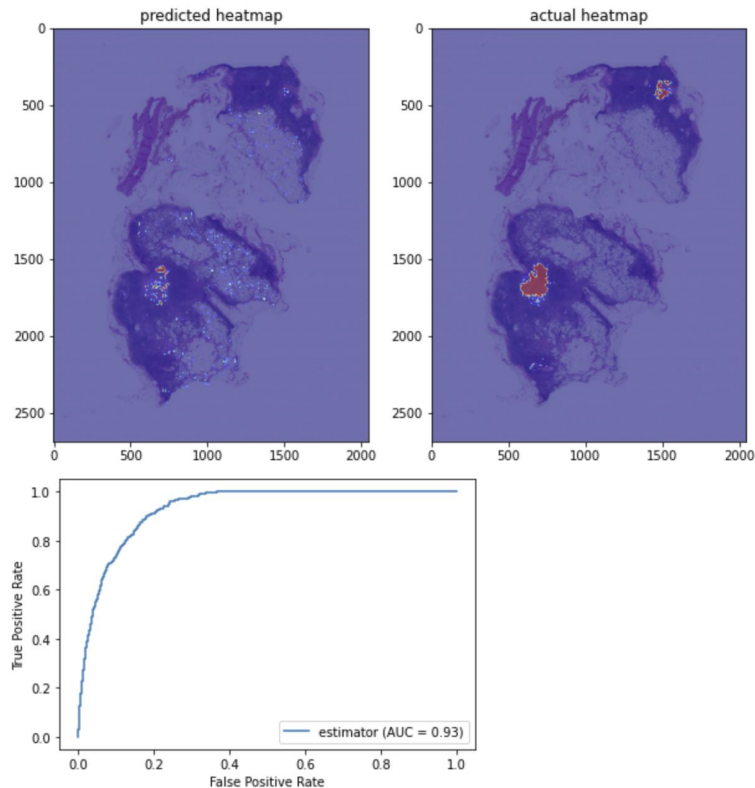
03
RESULT

TRAINING MODEL RESULT
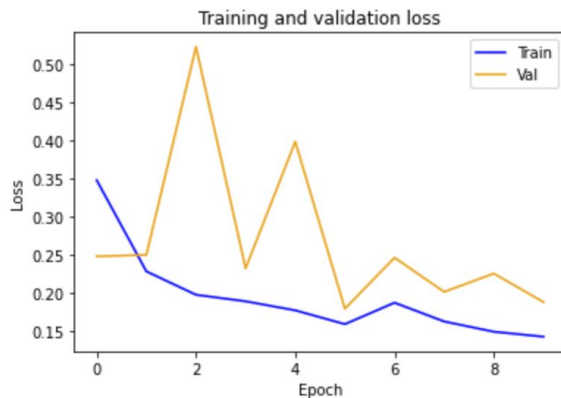
	loss	accuracy
training	0.1309	0.9460
validation	0.1882	0.9260

TESTING SLIDE 084
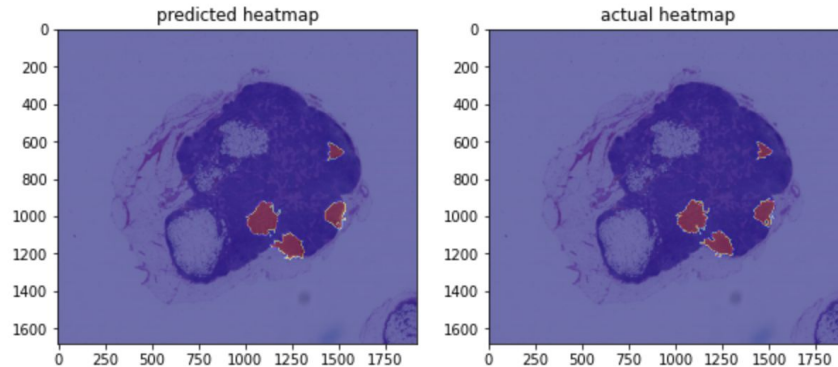

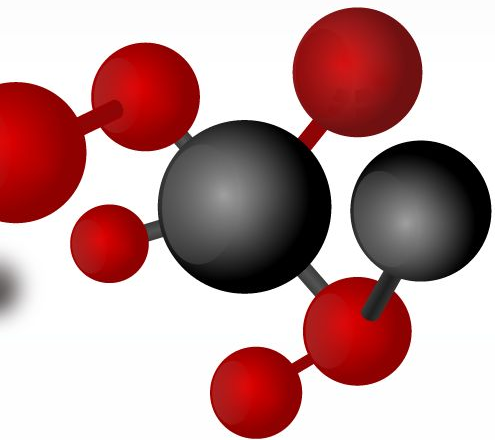AUC: 0.9305, F1 Score: 0.1791, Precision: 0.1338, Recall: 0.2712, ROC AUC Score: 0.9305
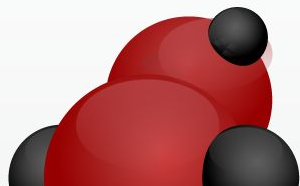
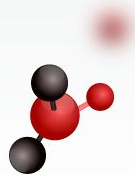- Using 0.7 as threshold while predicting labels
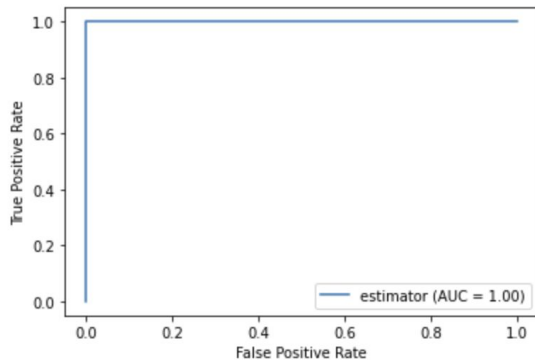
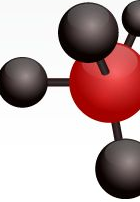- Using 0.7 as threshold while predicting labels
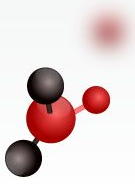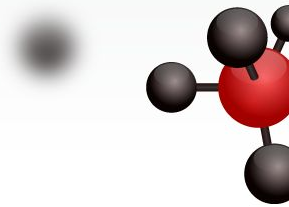
04

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

For more details: https://github.com/BrianHJLi/Tumor-Tissue-Detection