Detecting Cancer Metastasis on Gigapixel Pathology Images

Angad Nandwani – an3077

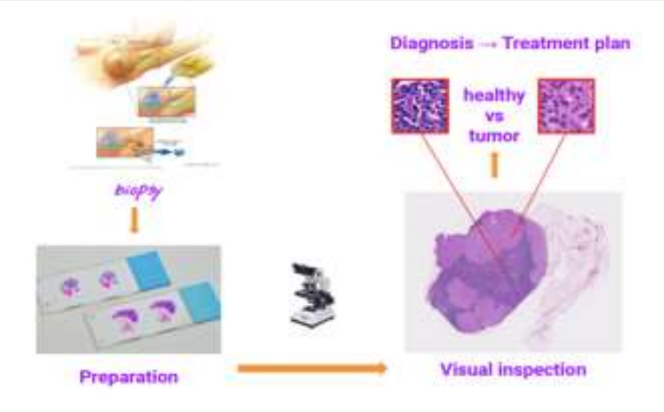
Karthik Shetty – krs2182

Motivation

- Microscopic examination of lymph nodes for breast cancer staging is crucial but can be tedious & error-prone.

- When tissue samples are sliced, they can have many images/samples which can make the process time-consuming.

- Requires highly skilled pathologist.



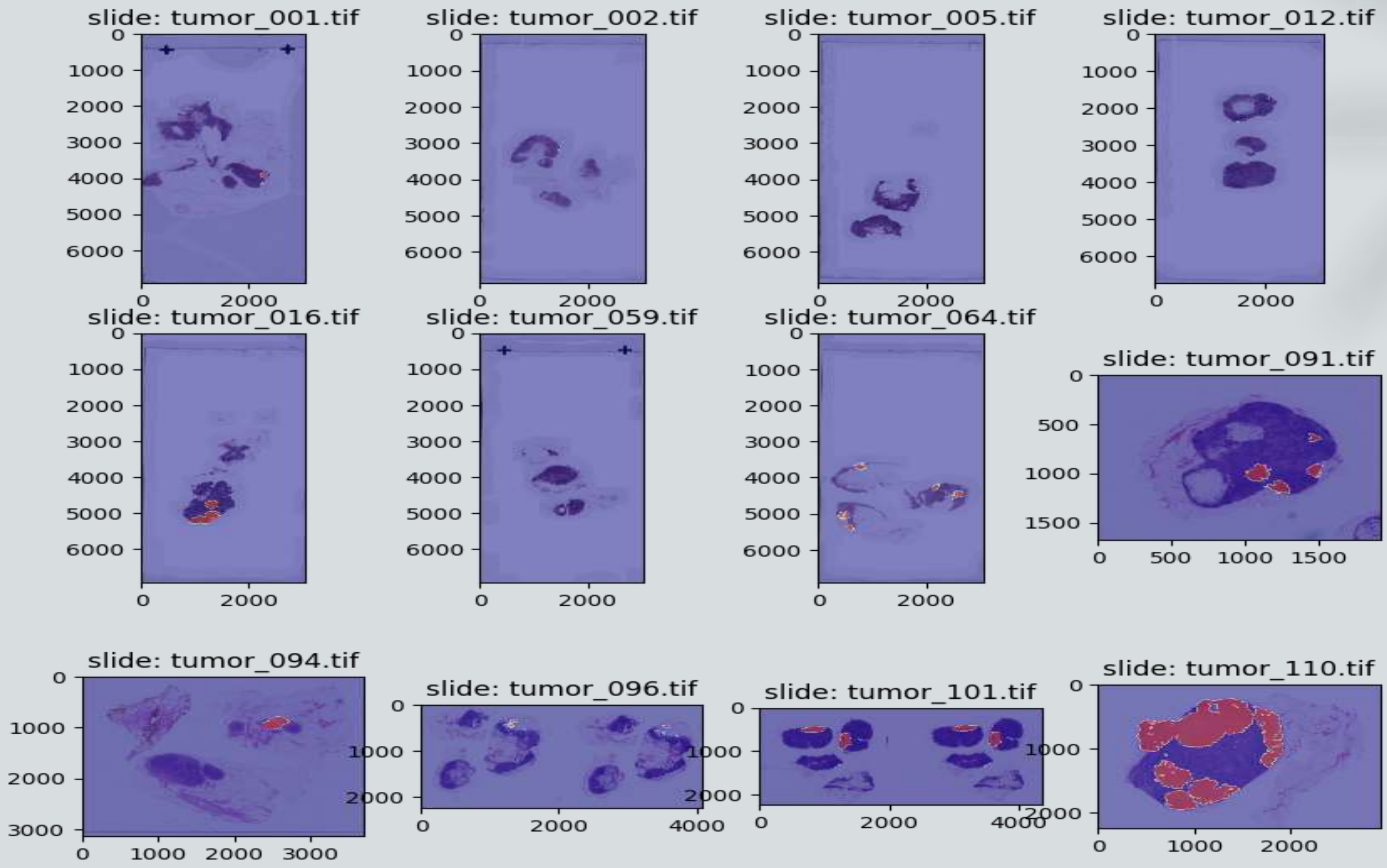
Goal

- To detect and classify breast cancer metastasis and reconstruct the tumor probability heat map using Camelyon16 dataset.

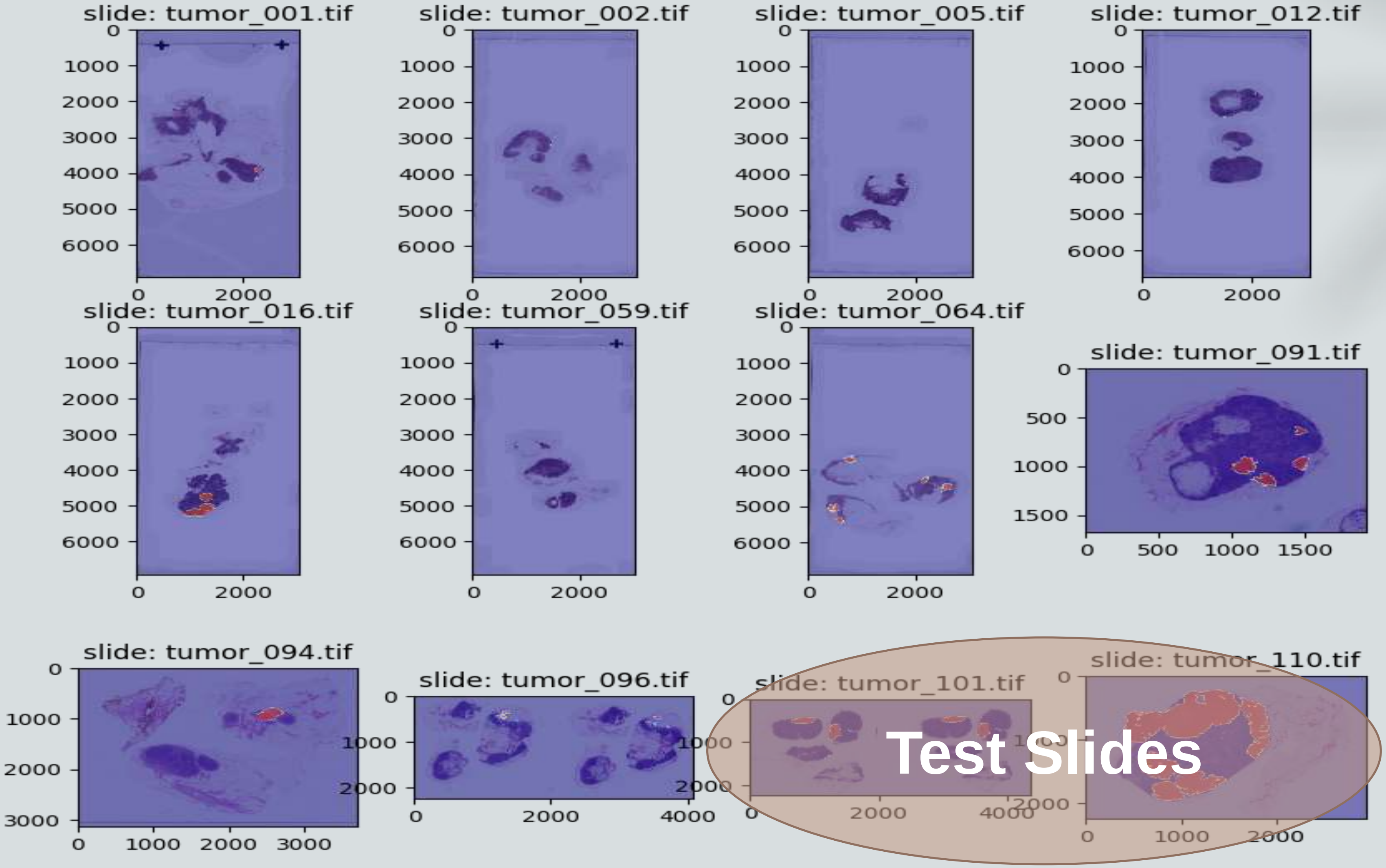
Camelyon16 (Dataset)

- 22 Gigapixel pathology images, each with a slide & tumor masks.
- Each slide has different zoom levels of magnification.
- Used 12 slides & 3 zoom level for this project.

Zoom Level 5 – 12 Slides & Masks



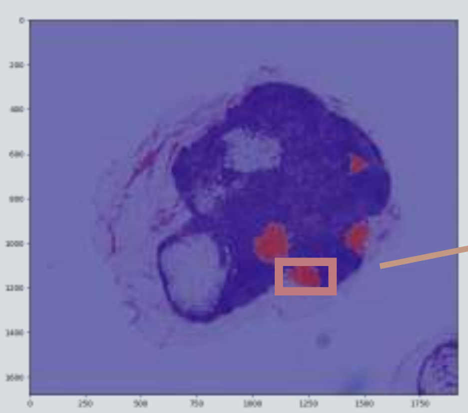
Zoom Level 5 – 12 Slides & Masks



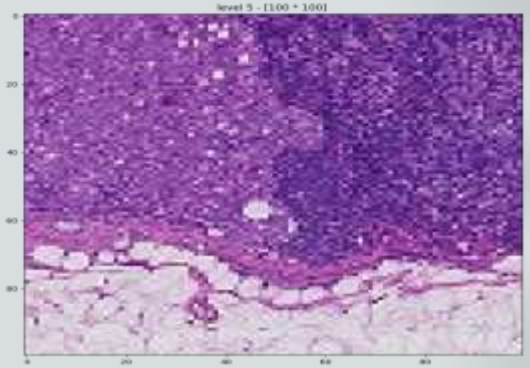
Data Processing - Algorithm

- For each slide at a specific zoom level ("5") in training data
  - Extract a particular patch (100 * 100) of a specific size, from slide
  - Check if that patch has at least 20% tissue pixels (pixel intensity <= 0.8)
    - Extract a patch of 200 * 200 (patch size (100) * zoom factor (2)) from zoom level 3 and crop a 100 * 100 image from center.
    - Extract a patch of 400 * 400 (patch size (100) * zoom factor (4)) from zoom level 2 and crop a 100 * 100 image from the center
    - Assign label cancerous if mask image at the center has at least one pixel to be "1

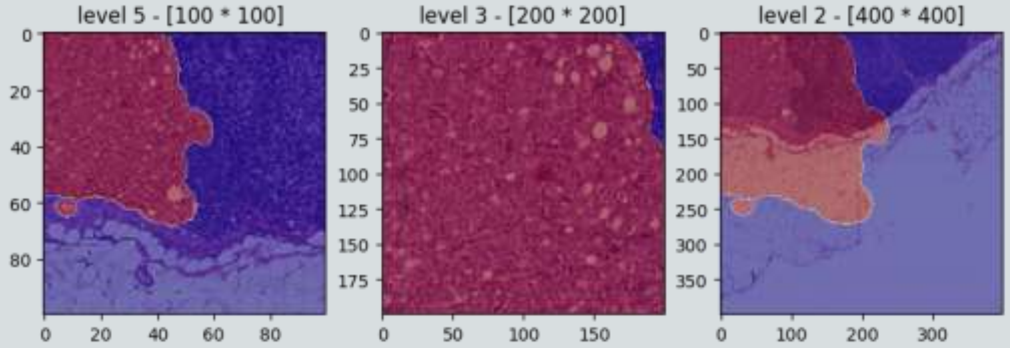
Data Processing on slide 091 at Level 5



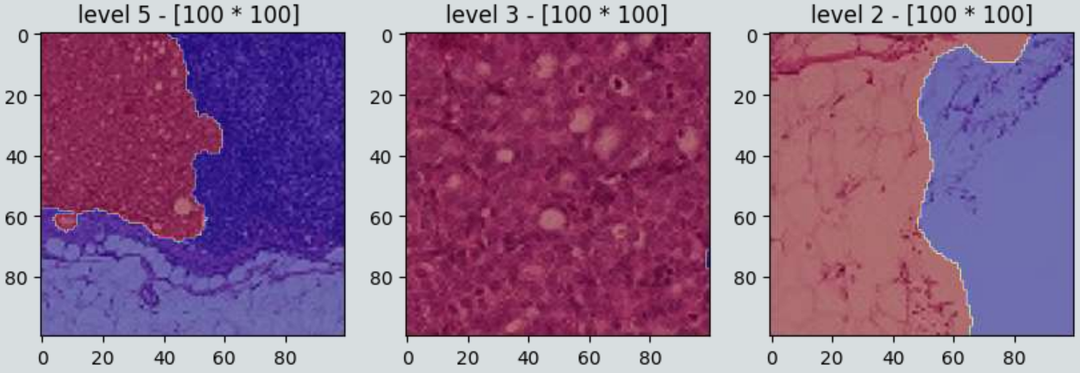
Step 1: Slide & Masks - Level 5



Step 2 - Extract : **(x = 1250 y = 1160)**
patch having at least 20% Tissue pixel



Step 3 – For the same pixel, Extract 200 * 200 & 400 * 400 from zoom level 3 & 2 respectively



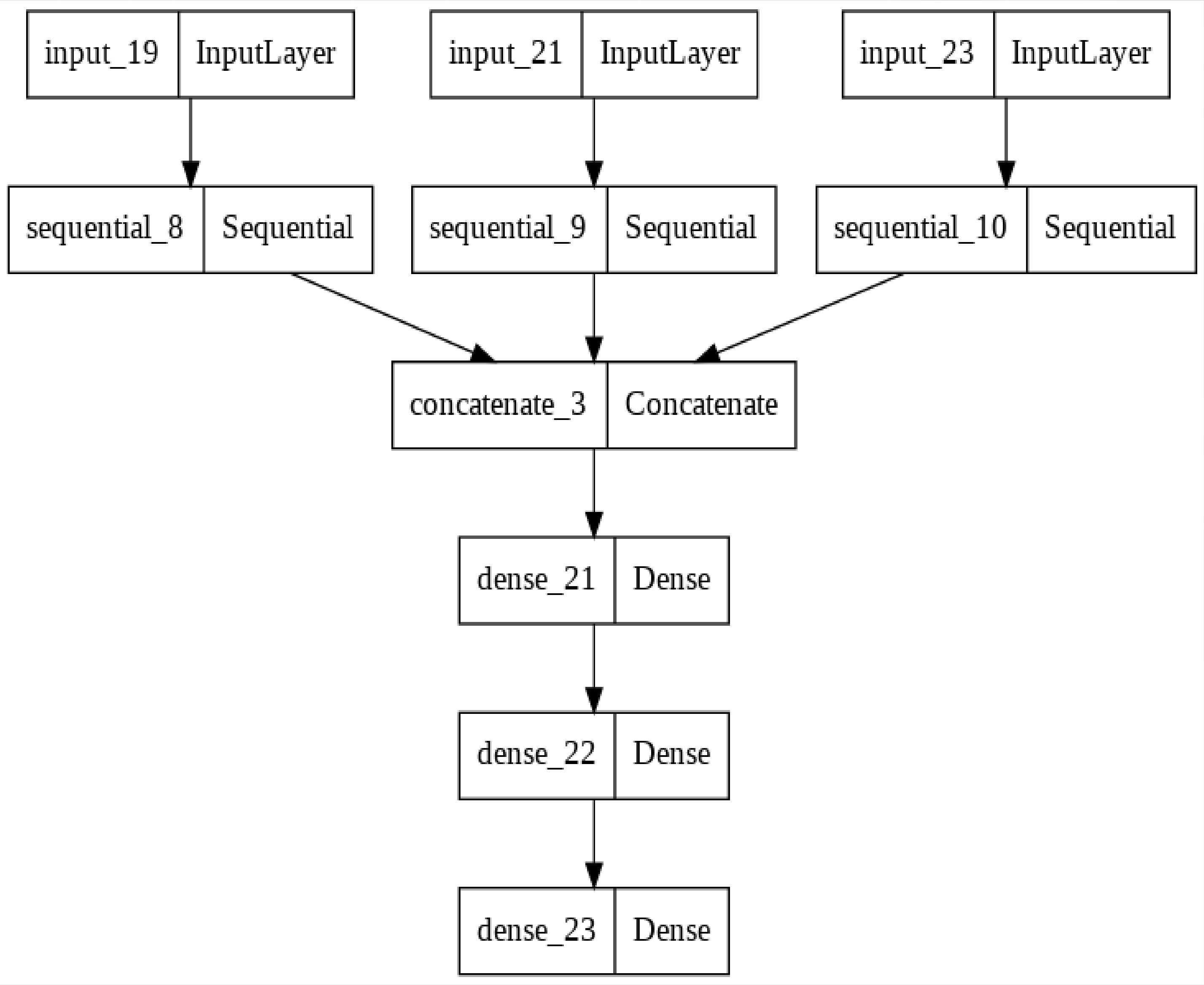
Step 4 – Crop all 3 images into 100 * 100 pixels from center

Experiments

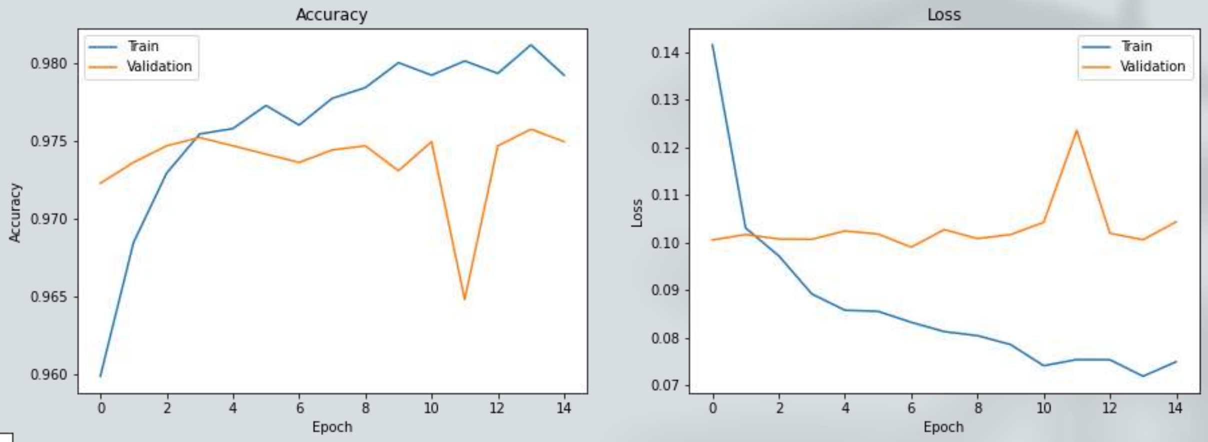
Zoom Level	Patch Size	Threshold for Tissue Pixels	Non Cancerous Patches	Cancerous Points
[5, 3, 2]	100 * 100	10	1781	87
[5 , 3, 2]	100 * 100	20	2347	97
[4, 3, 2]	75 * 75	10	4289	140
[4, 3, 2]	**75 * 75**	**20**	**12503**	**446**

Modelling

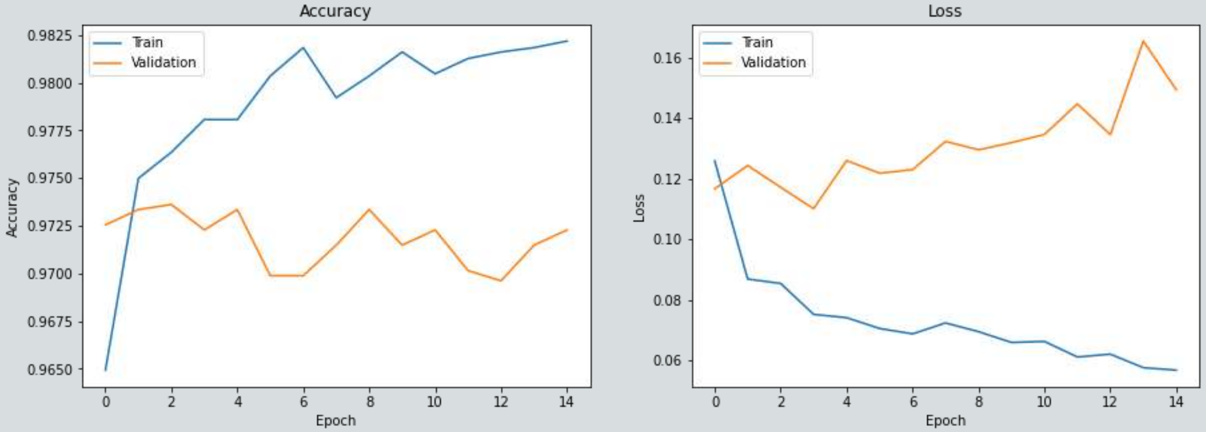
- All models use Adam optimizer and Binary Cross Entropy Loss Function.
- We use Validation split of 0.3 and train for 15 epochs.
- We have trained the following 3 different models and we compare their results using the same hyperparameters.
  - InceptionV3
  - VGG16
  - MobileNet



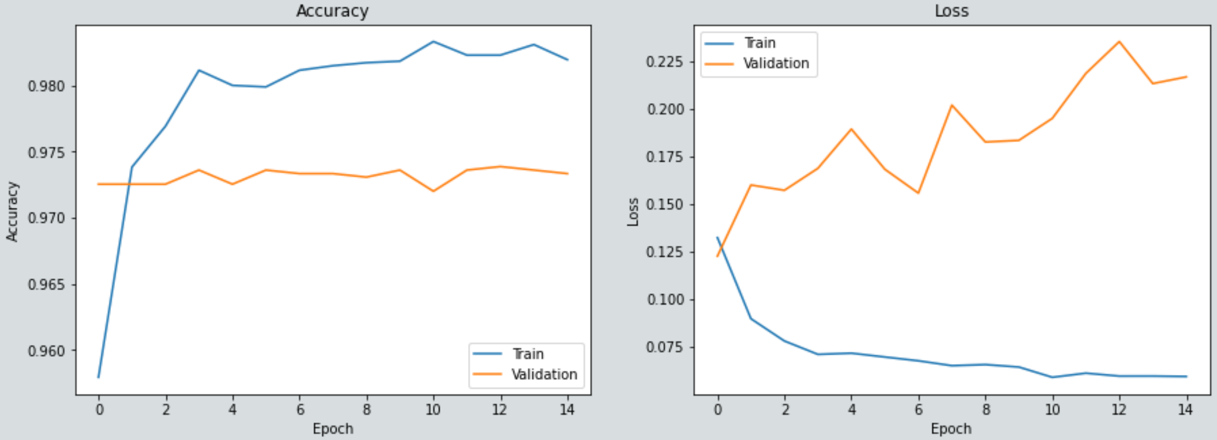
Training Metrics



VGG16



InceptionV3



MobileNet

Results

	Precision		Recall		F1-Score	
	Slide 101.tif	Slide 110.tif	Slide 101.tif	Slide 110.tif	Slide 101.tif	Slide 110.tif
Inception	0.90	1.00	**0.35**	**0.42**	0.51	0.59
VGG-16	0.95	0.99	**0.57**	**0.67**	0.71	0.80
MobileNet	0.91	1.00	**0.42**	**0.43**	0.57	0.59

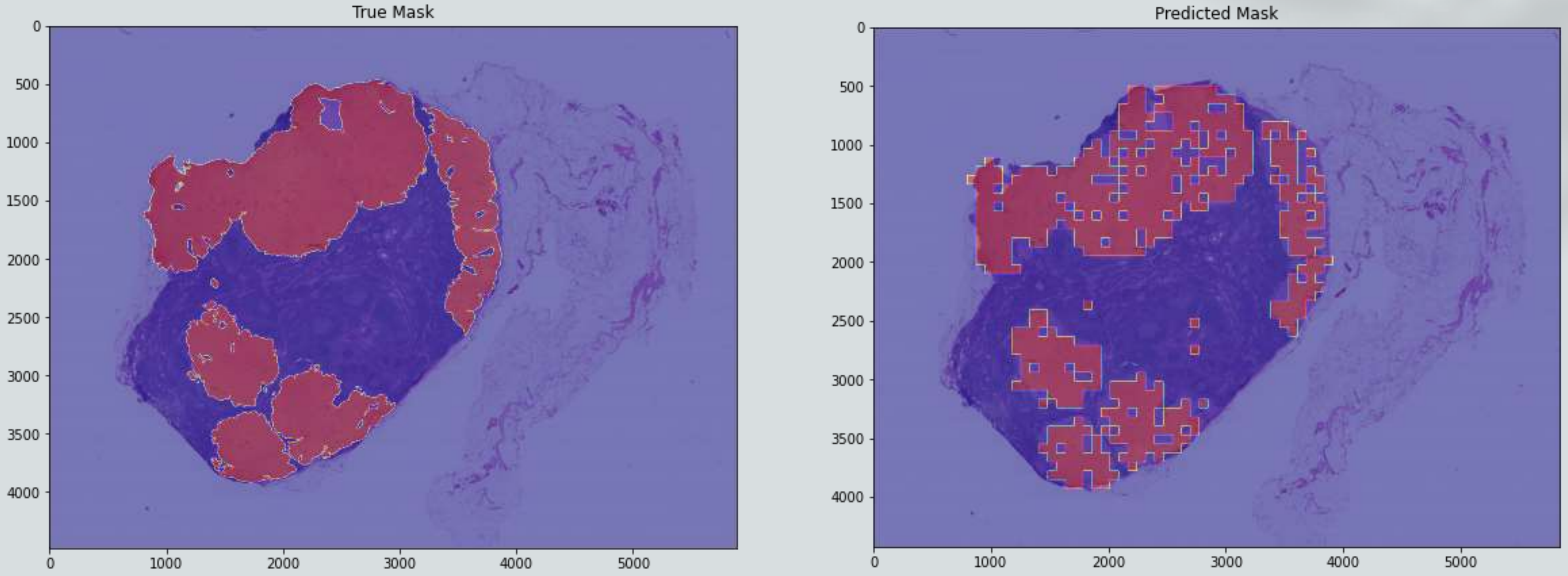
Conclusion

- For diagnosis of cancer using medical images, it is of utmost importance to make sure that all positive cases are detected, even if it at the expense of a few False Positives.

- Recall is a measure of how many actual positive cases were detected. Hence our objective is to maximize recall.

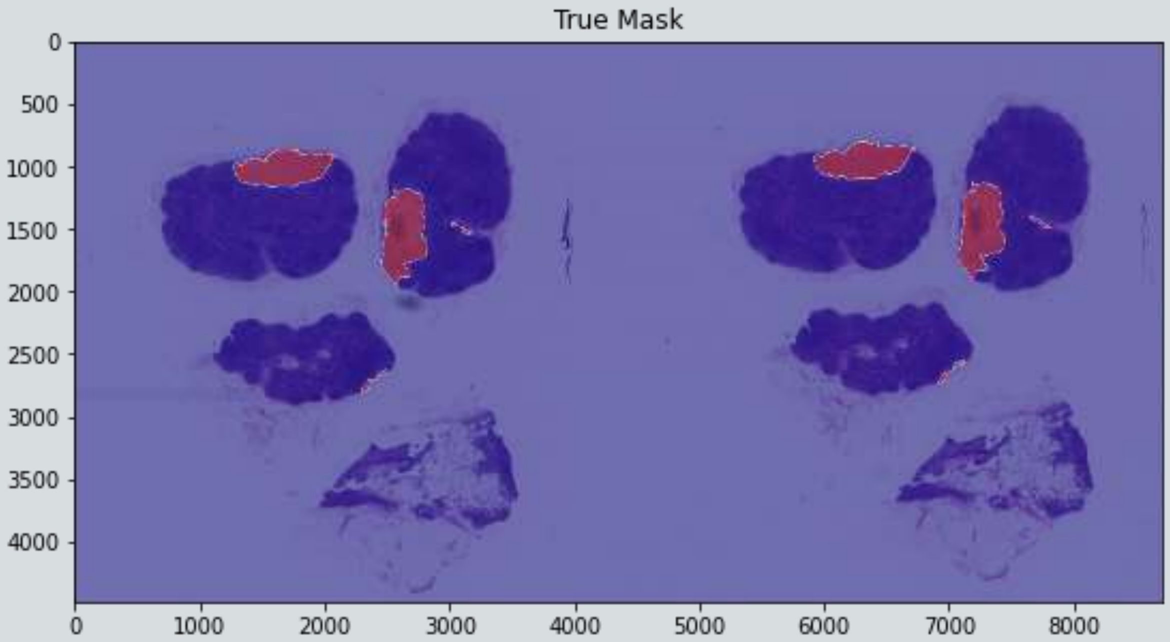
- **VGG-16** shows the highest recall values for both test slides. Hence, we can safely conclude that it is the best performing model for cancer diagnosis in this context.

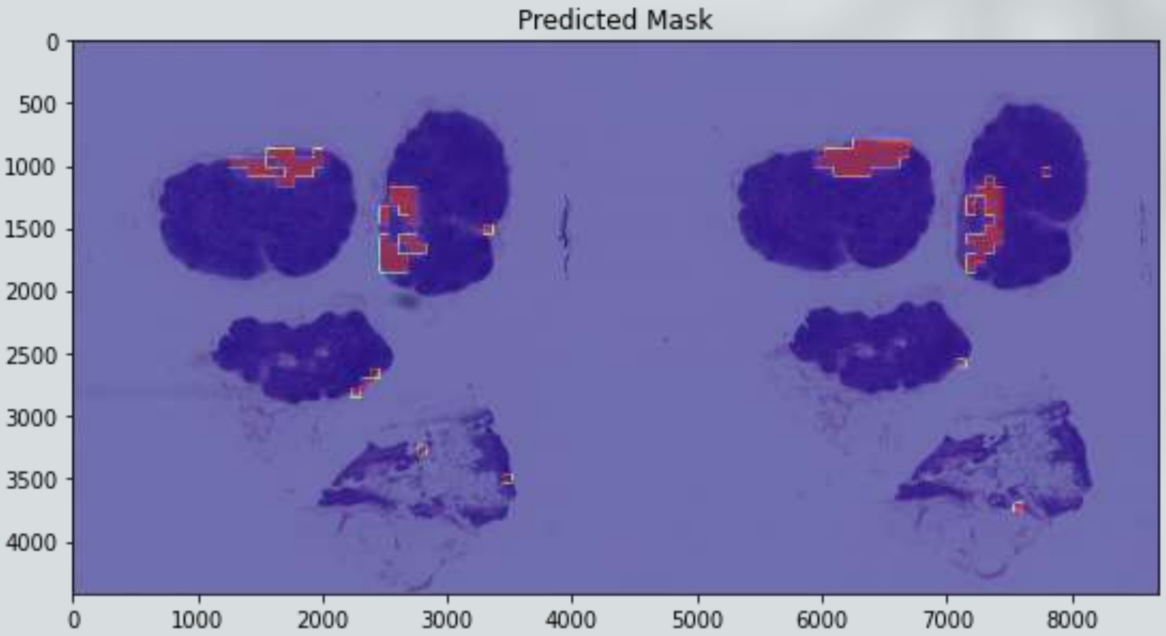
VGG16 - Mask Prediction



Test Slide 110

VGG16 - Mask Prediction





Test Slide 101