Department of Electrical Engineering
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A Talk on

Research & Development Project

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Part 1: **Discriminative Localization in Medical Images**

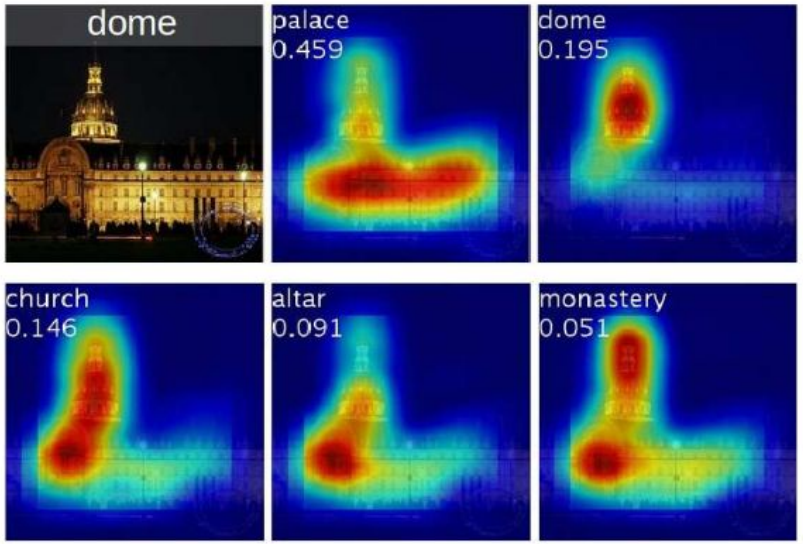
(Jan 2018 to Mar 2018)

Introduction

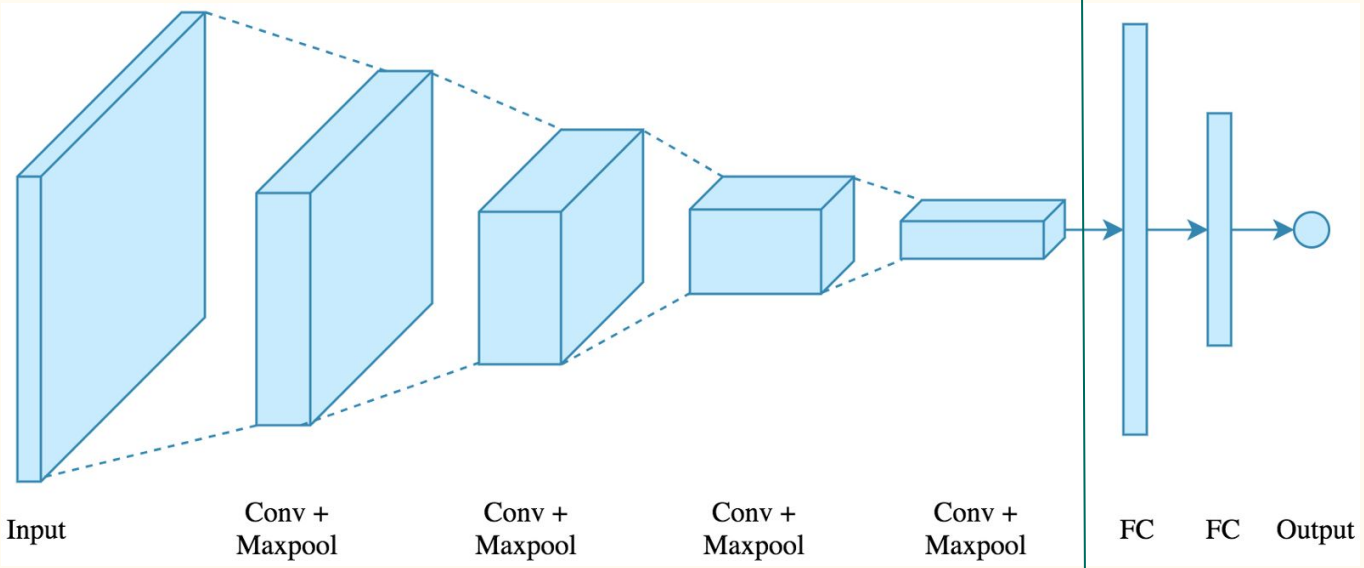
- Identifying Deep Features in Medical Images is a challenge being work upon intensively.
- Not only it is important to classify a tissue to be unhealthy, but to identify which part of the tissue makes it unhealthy.
- The task of the project is to form a Class Activation Map (CAM) which suggests which region of the image influences a particular decision.
- Helpful in identifying deep features in data.

Related Work

- *Zhou et al [1], 2016*, used the idea of **Class Activation Map (CAM)** for Class Localization in an image.



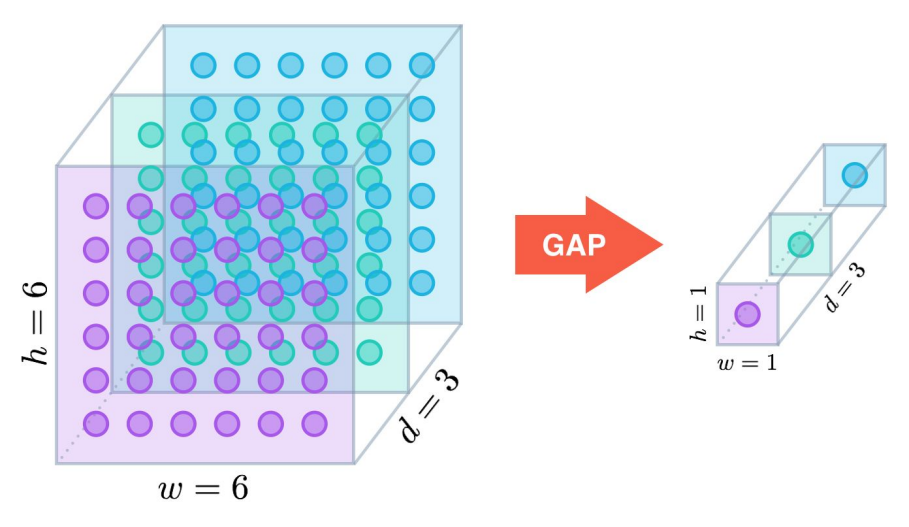
CNN-Architecture



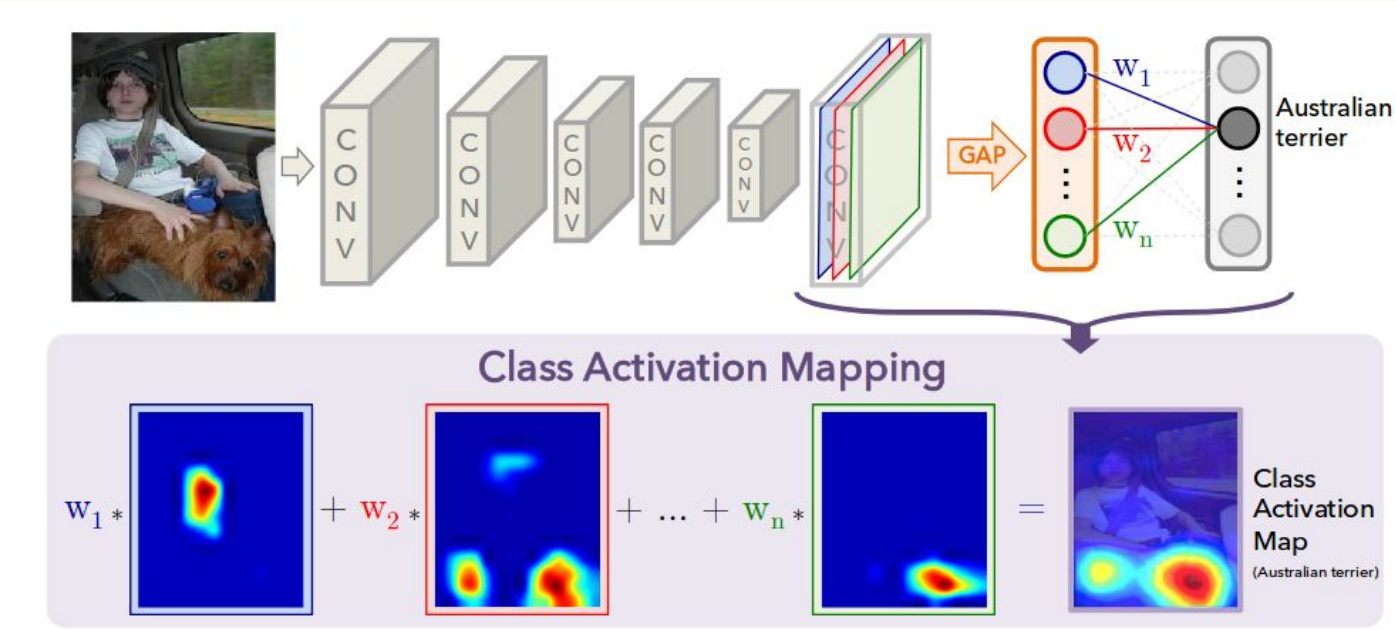
A typical CNN with Fully Connected Layers

we remove FC Layers

Global Average Pooling



Average of each layer is calculated and used as a feature



Proposed Model

Dataset

- The dataset used was ICIAR 2018 Grand Challenge on **BreAst Cancer Histology.**
- Contains 400 images each of 2048 x 1536 pixels.
- Dataset is divided into 4 classes - *Benign*, *In-Situ*, *Invasive* and *Normal*.
- The images were further divided into smaller sized images for processing and training.

Initial Training on BACH dataset

- **Inception V3** was used for training on the dataset. This work was done separately by **Deepak Anand** and **Aditya Golatkar**.
- The training resulted in a validation accuracy of ~84%.
- The results are were satisfactory since the competition dataset is challenging enough.
- The trained model in this step was used for modification and generation of the **Class Activation Map (CAM)** discussed before.

Modification in the architecture

- Dense Layer is removed as discussed before.
- Global Average Pooling Layer is added.
- And finally Softmax Activation Function is used to get the final probabilities.

Results from fine-tuning

- Fine tuning on the modified architecture resulted in a validation accuracy of **~81%**.
- The marginal drop in the accuracy is expected due to change in the architecture and significant reduction in the number of features.
- Weights for Softmax Classification is obtained for further use in generating heatmaps.

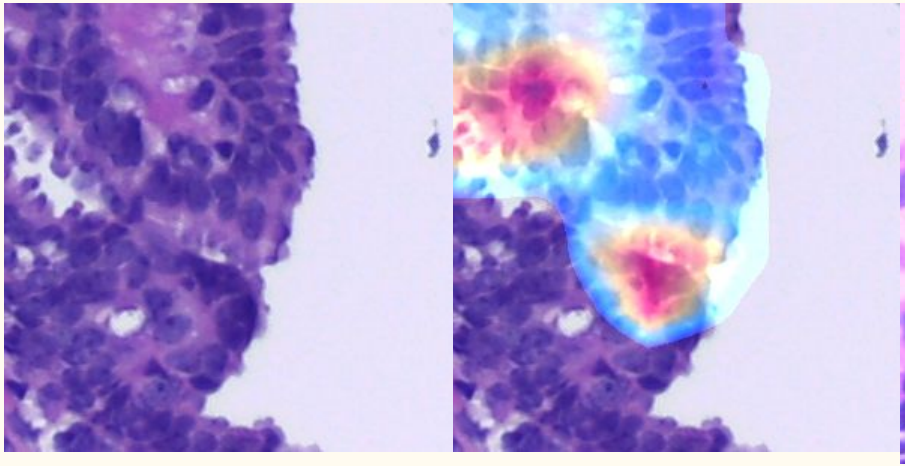
An important point to note

- Since we have removed the **Fully Connected Layer**, the architecture is now size independent, that is, we can give an input of any dimensions and get a results corresponding to the input.

Heatmap Generation

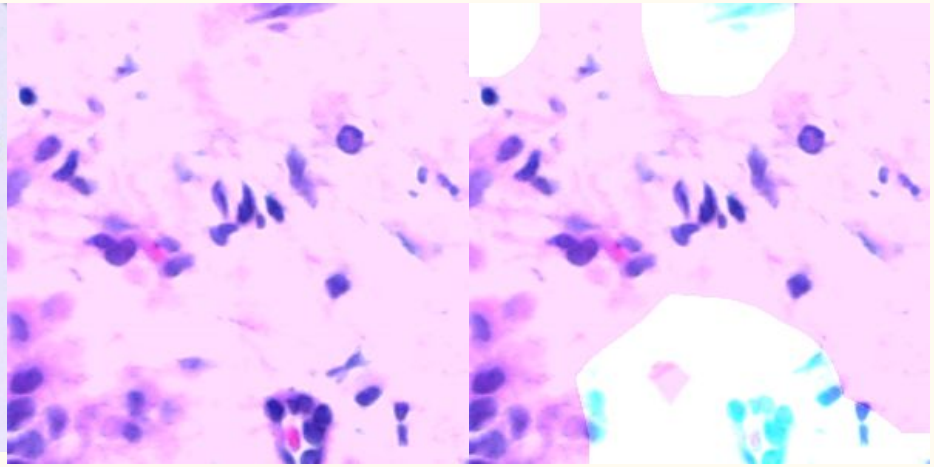
- Now that we have our weights and our architecture, we start the much awaited task of visualization.
- We experimented with patches and full images and obtained heatmaps and compared to results.

Results (on patches)



Original Label: **Benign**

Activation Map: **Benign**

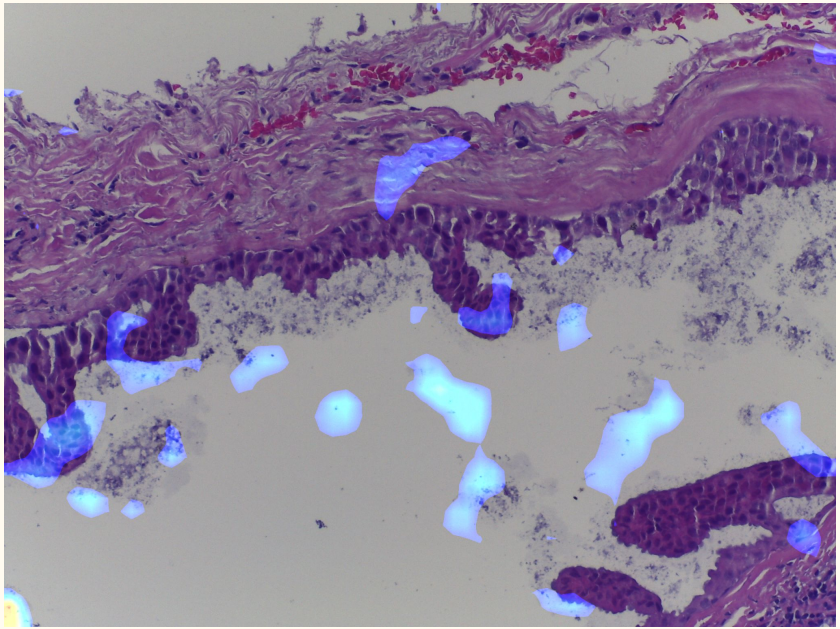


Original Label: **In-Situ**

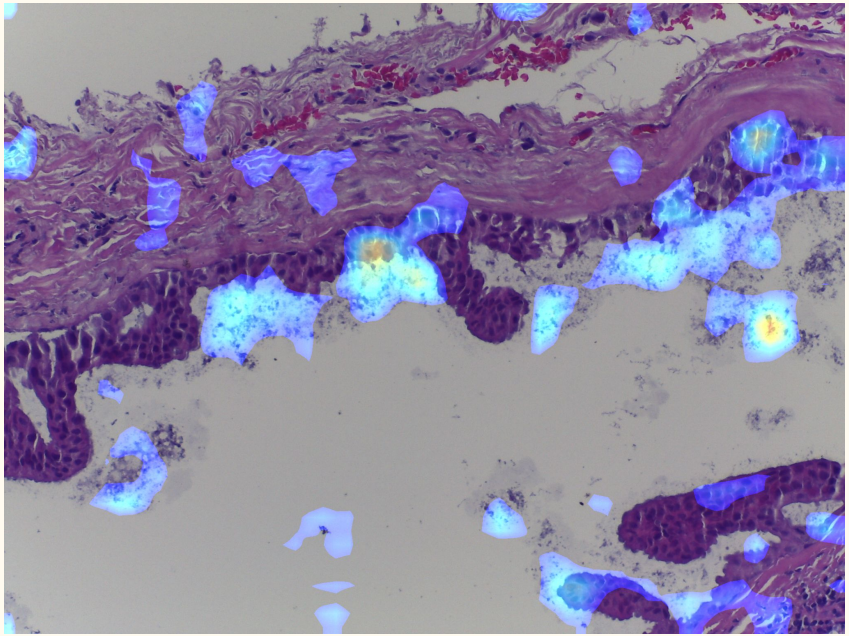
Activation Map: **Benign**

Results (on complete images)

Original Class - **In-Situ**



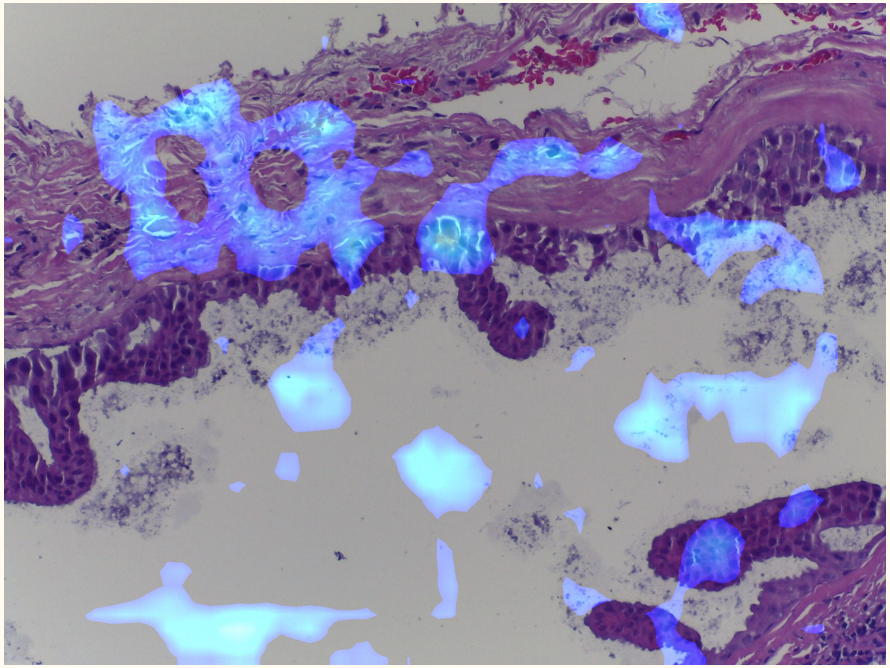
Activation Map : **Benign**



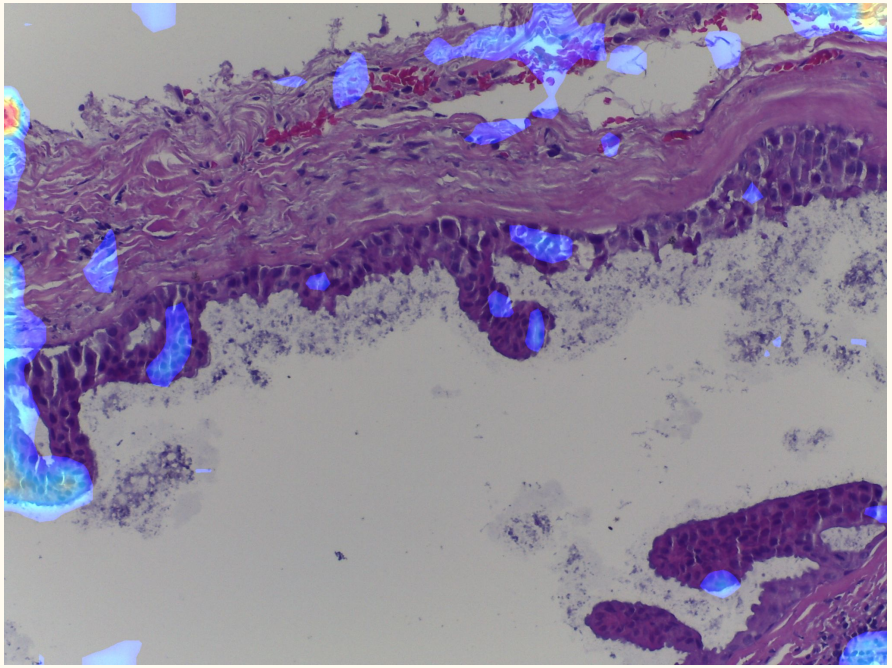
Activation Map : **InSitu**

Results (on complete images)

Original Class - **In-Situ**

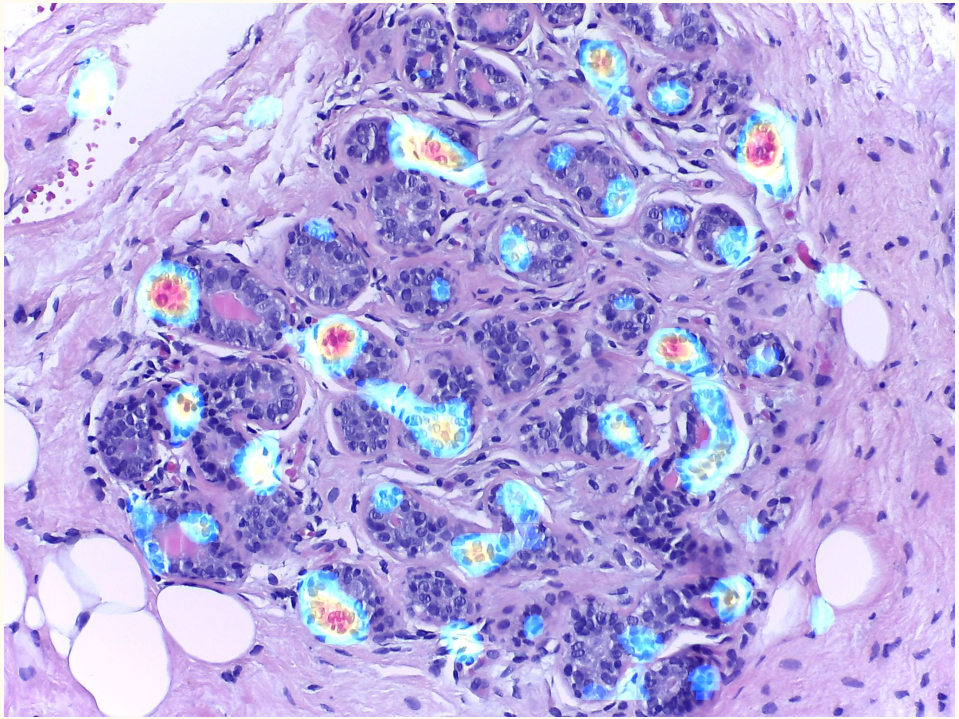


Activation Map : **Invasive**



Activation Map : **Normal**

An Interesting Observation



- This is a **Normal** cell with an **Benign** activation class.
- Although the probability of it being In Situ is less, but the red spots on the image can be inferred as the most vulnerable part of the cell.
- Provides an early-detection features if the training is accurate.

Conclusion

- The proposed method can be applied to any trained CNN architecture with an ease.
- Although the new architecture compromises on its validation accuracy, it is sufficient for visualization purpose.
- The proposed model opens up the possibility of getting deep features which may not be obvious otherwise.
- The proposed method can be easily extended to other datasets and architectures due to it being size invariant.

Future Work

- Testing this on other Medical Image datasets, both with highly accurate models and with less accurate models.
- To make a stand-alone generic algorithm to take a model and change it so as to obtain CAM.

References and Acknowledgments

- Bolei Zhou, Aditya Khosla, Agata Lapedriza, Aude Oliva, Antonio Torralba: "**Learning Deep Features for Discriminative Localization" ,** 2016.
- Pranav Rajpurkar, Jeremy Irvin, Andrew NG: "**CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning",** 2017.

Special Thanks to:
Prof. Amit Sethi, Deepak Anand and Aditya Golatkar for providing constant help in this work and pointing out necessary improvements.

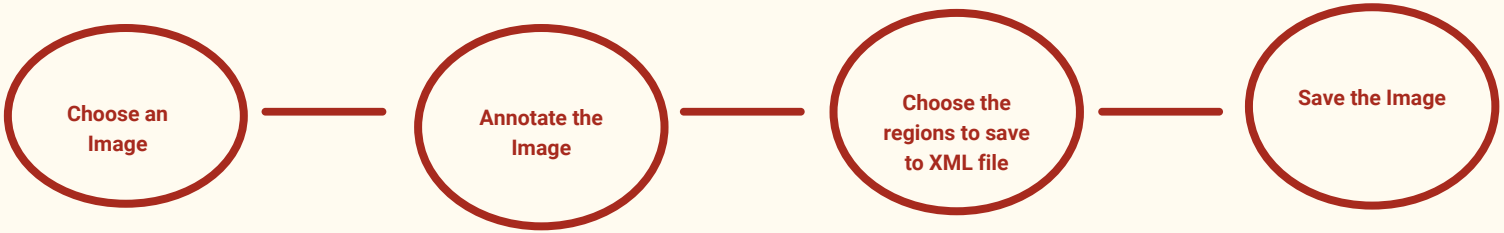
Part 2: **Annotator App**

(April 2018)

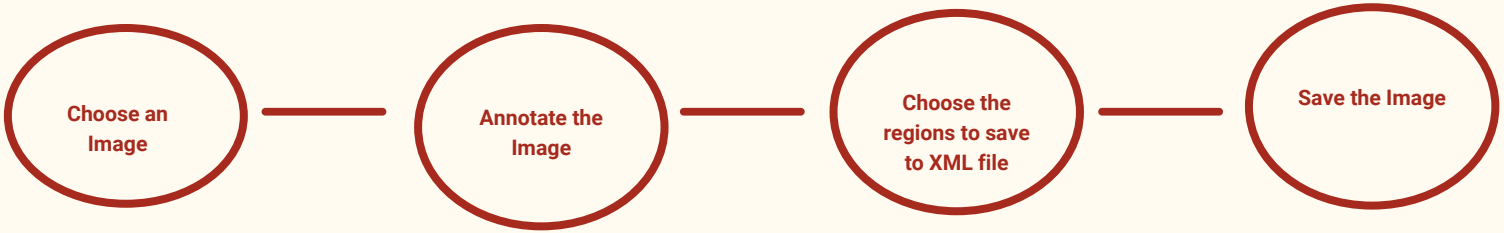
Introduction

- Annotation of Data is a very important task in Medical Imaging.
- Annotation can be a long and tedious task if not done with proper softwares and device.
- **Aperio ImageScope** is the currently used software in the research group.
- Although the software offers great user experiences, it is available only on Windows OS.
- Being a good alternative, Android App would ease the task of annotation to a large extent.

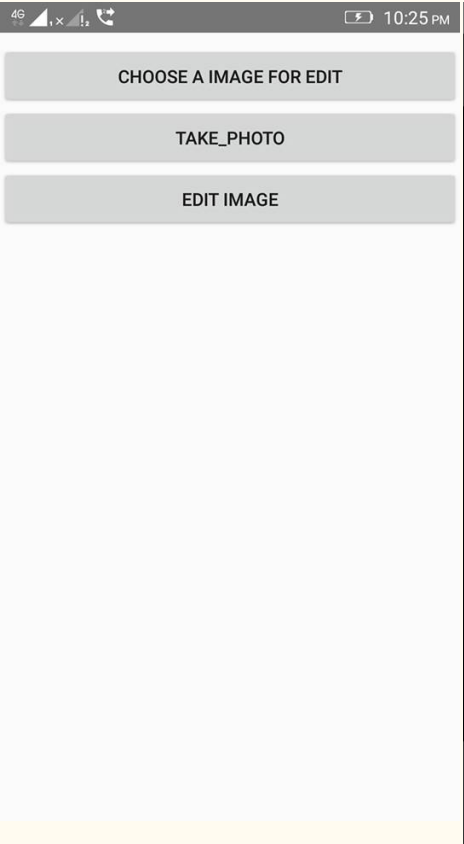
Block Diagram of Developed Application

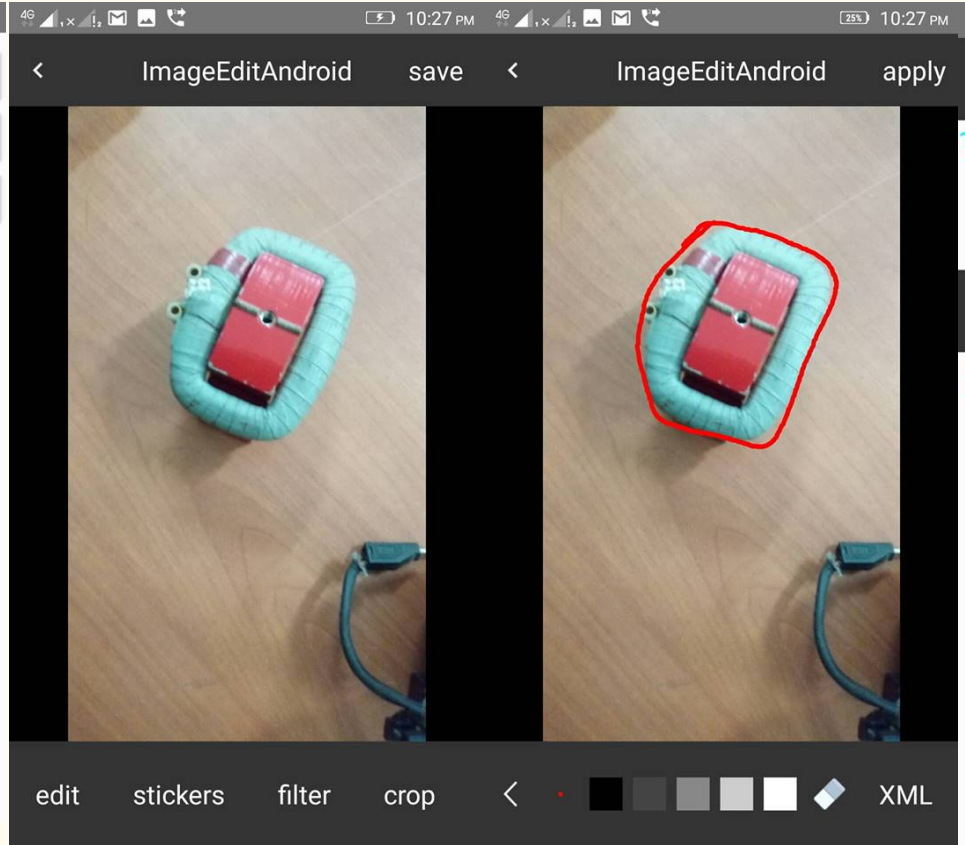


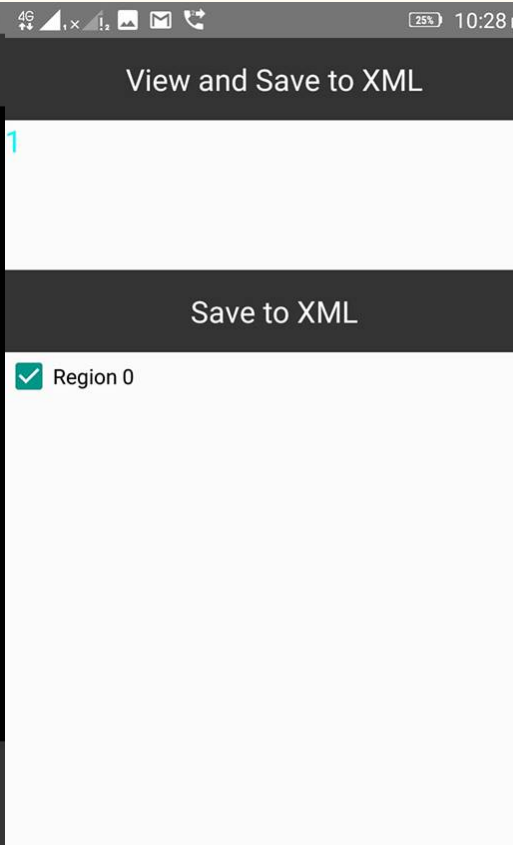
Block Diagram of Developed Application



Layout of the App







Future Work

- An option to load multiple images simultaneously so as to make the annotation task faster.
- Feature to zoom the image while Annotating.

References

- Image Editor Android App. https://github.com/siwangqishiq/ImageEditor-Android

Special Thanks to:

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Thank you !!!