Applying Transfer Learning on a Residual Network for Diagnosing UTI

Parrot.ai

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Background

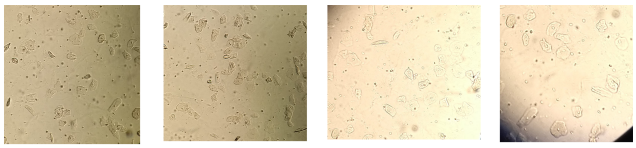
Urinary tract infection (UTI), defined as a condition in which bacteria are established and multiplying within the urinary tract is the among the common infection experienced by humans. In most rural areas in developing countries, they lack medical professionals and laboratory facilities to enable timely UTI diagnosis.

Disease diagnosis has made significant progress in the last few years. Especially with the introduction of Convolutional Neural Networks (CNN).

Problem

Leverage Convolutional Neural Networks for visual recognition to diagnose UTI by processing the microscopic urine sample images. This work discusses progress in development of a method of classifying urine sample obtained from uninfected and UTI infected subjects.

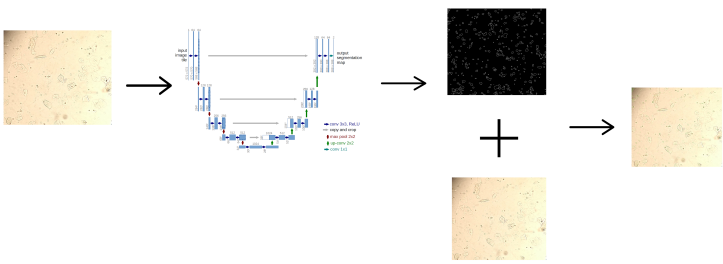
Data & Preprocessing



Sample of microscopic urine

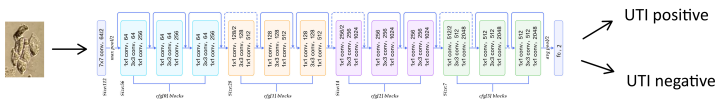
We are using a dataset created from taking pictures of urine samples under a microscope. Images in the dataset were then annotated by a domain expert. The dataset includes 2 category labels which are infected and uninfected urine.

Cell segmentation using U-net



- Used smaller feature map (number of features are 1,3,6,12,24 and 48)
- Used different cost function (Mean square loss function with ReLu activation)
- Used Adam optimizer

Models



We used the ResNet model (Resnet50), to extract the features from the earlier layer and train a classifier on top of that. To achieve this, we removed the last fully connected layer and we added a new FC layer and output layer which outputs 2 categories which tell the probability of the urine sample image being infected or uninfected, then set the weights for earlier layers and freeze them and then train the network.

Results & Analysis

- The U-net did surprisingly well, overall when compared with ground truth mask, the network seem to correctly segment the area around it.

Original image | Original Mask | Generated Mask

- We evaluated the performance of pre-trained CNNs including ResNet-18 and ResNet-50 toward extracting the features from the infected and uninfected urine samples.

- ResNet-50 outperformed the ResNet-18. So far We empirically determined the optimum values to be Cross Entropy loss function and SGD optimizer with a learning rate of 0.001 and a momentum of 0.9.

Performance metrics

Models	Accuracy	AUC	Sensitivity	Specificity	F1-score
ResNet-18	0.723	0.792	0.712	0.721	0.711
ResNet-50	0.785	0.854	0.806	0.792	0.795

Future Works

As it is a work in progress, we aim to collect more dataset, apply image preprocessing techniques and try different tunings to observe how the model improves towards better results. We predict that this additional input will improve classification accuracy.