# Machine Learning Engineer Nanodegree

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# I Definition

## Project Overview

According to the World malaria report [1] , in 2017, an estimated 219 million cases of malaria occurred worldwide (95% confidence interval [CI]: 203262 million), compared with 239 million cases in 2010 (95% CI: 219285 million) and 217 million cases in 2016 (95% CI: 200259 million).

In 2017, there were an estimated 435 000 deaths from malaria globally, compared with 451000 estimated deaths in 2016, and 607000 in 2010. Nearly 80% of global malaria deaths in 2017 were concentrated in 17 countries in the WHO African Region and India; 7 of these countries accounted for 53% of all global malaria deaths.

## Problem Statement

In order to reduce the burden for microscopists in resource-constrained regions and improve diagnostic accuracy, the *National Library of Medicine*[2] provide us with a dataset[3] with which I will create a model to detect malaria parasite in thin blood smear images.

A common approach to create similar models consist in resize the images to a common size in order to train the model, then use this model to predict and classify new images. In this project I will apply a technique called **Progressive resizing** which consist of training different models for different size of images.

The idea behind this technique is to create different models for different image sizes. First I need to decide which sizes could be good to train the model based on the data exploration, then I'll create and train a model with the images resized to the lower size I chose. Once the first model is trained, I will apply transfer learning to create and train the second model with the next size for the images, and so on with all Once the first model is trained, I will apply transfer learning to create and train the second model with the next size for the images, and so on with all chosen sizes.

For each model I will get different metrics in order to know which model performs better and also to know if this technique is useful for this dataset.

## Metrics

This project is based on the research article *"Pre-trained convolutional neural networks as feature extractors toward improved malaria parasite detection in thin blood smear images"*[4] where r Rajaraman S and his team shown a table[5] with the performance metrics results obtained during their experiments, comparing their custom model against other well-known models like AlexNet, VGG-16, ResNet-50, Xception and DenseNet-121.

[1] https://www.who.int/malaria/media/world-malaria-report-2018/en/
[2] https://www.nlm.nih.gov/
[3] https://ceb.nlm.nih.gov/proj/malaria/cell_images.zip
[4] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5907772/
[5] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5907772/table/table-6/

For this project I will use the same metrics and then compare the results against the values of their custom model.

Table 1: Metrics

| **Name** | **Formula** |
| --- | --- |
| Accuracy | $\frac{TP+TN}{TP+TN+FP+FN}$ |
| AUC | formula |
| Sensitivity | $\frac{TP}{TP+FN}$ |
| Specificity | $\frac{TN}{TN+FP}$ |
| F1-score | $\frac{2TP}{2TP+FP+FN}$ |
| MCC | $\frac{TP\times TN-FP\times FN}{\sqrt{(TP+FP)(TP+FN)(TN+FP)(TN+FN)}}$ |

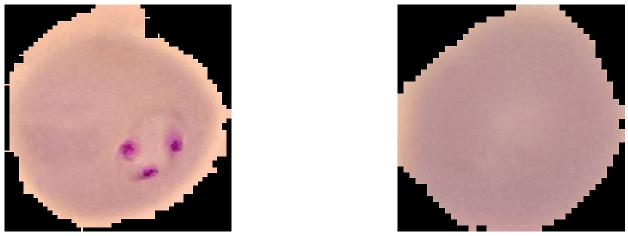
# II Analysis

## Data Exploration

The dataset contains a total of 27558 color images separated in two folders, Parasitized folder and Uninfected folder with 13779 images each.

The images were manually annotated by an expert slide reader at the Mahidol-Oxford Tropical Medicine Research Unit in Bangkok, Thailand.

The image sizes varies between 49x58 and 349x241 pixels.



(a) Parasitized cell (b) Uninfected cell

Figure 1: Dataset sample

## Exploratory Visualization

The plots below show how is the distribution of images regarding of it size in order to select the best values to apply the progressive resizing technique.

The Figures 2 and 3 show us that the X values (width) are between 120 and 145 for most of the images with only a few outliers.

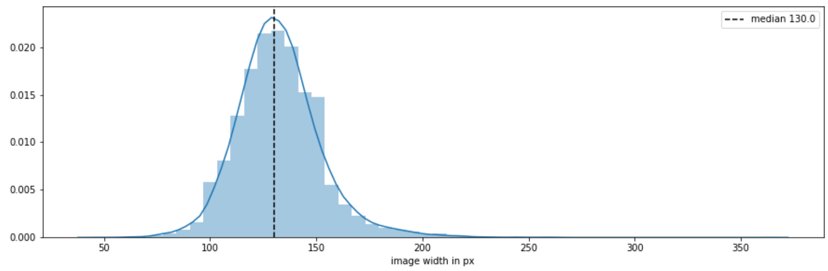



Figure 2: Distribution chart based on the image width

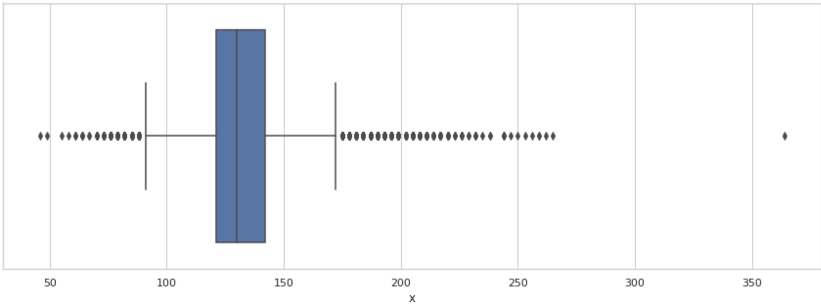



Figure 3: Box chart based on the image width

The Figures 4 and 5 show how is the distribution for the Y values (height) and looks similar to the X values, this means that the images are almost square images therefore there will be not much distortion when I will apply the resizing during the training process.

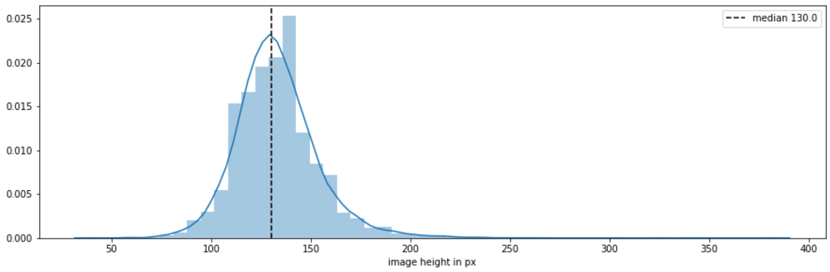



Figure 4: Distribution chart based on the image height

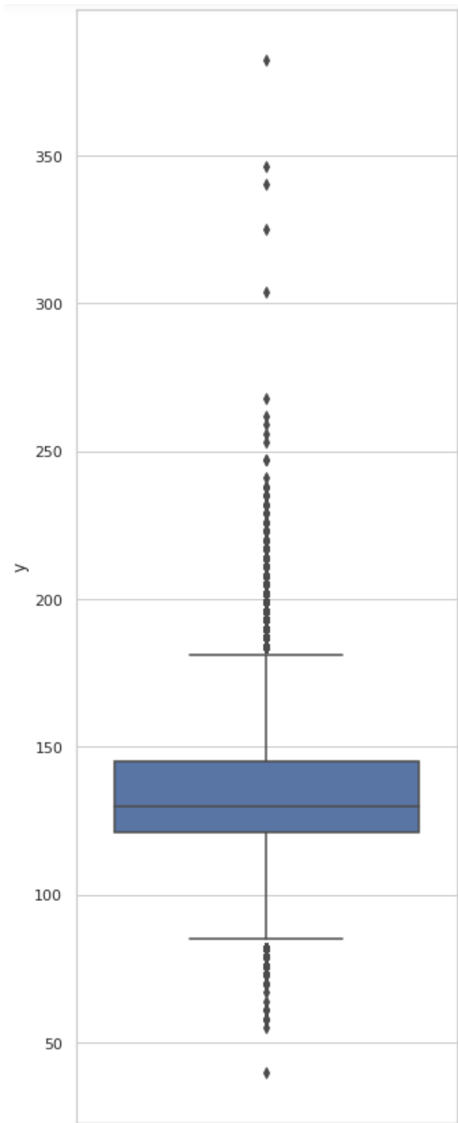



Figure 5: Distribution based on the image height

The Table 2 shows the size for images with min/max values for each property, X and Y.

Table 2: Min/Max mesures

| | X | Y |
|---|---|---|
| Max X | 364 | 340 |
| Max Y | 208 | 382 |
| Min X | 46 | 79 |
| Min Y | 55 | 40 |