



Plasmodium parasites remain a major threat in global health, **affecting 200 million people and causing 400,000 deaths a year.**

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## Goals:

1. Make 2 classification models that **detect if the blood is infected by a parasite**, one from thick smears and one from thin smears. (start with the datasets with bounding boxes)
2. Make 2 classification models that **detect the species of the parasite**, one from thick smears and one from thin smears. (start with the datasets with bounding boxes)
3. **Make your own bounding box** from raw microscopy images with yolo.
4. Make a **web interface** that can take a thick smear and a thin smear to give back **diagnostic** and **CDC recommendations**.

## Tools:

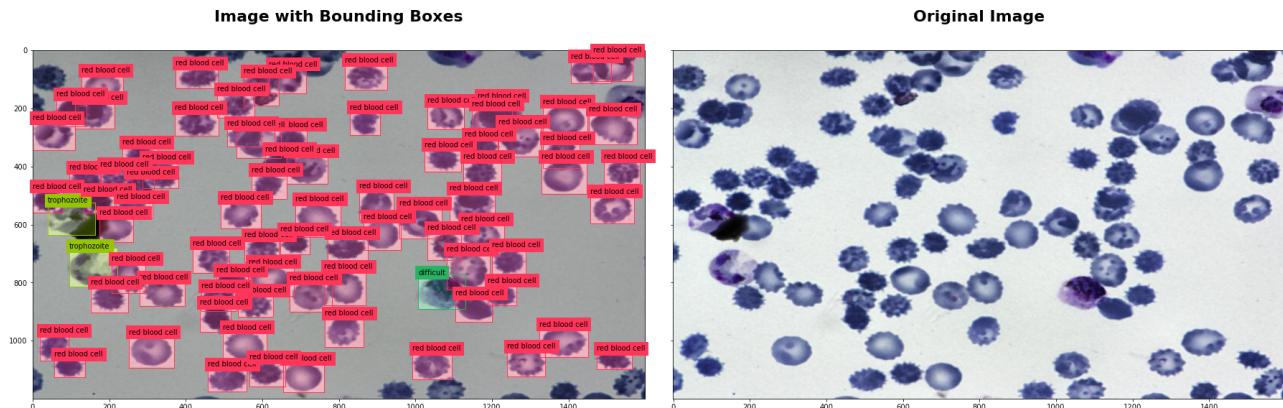
- **Models:** Tensorflow Conv2D CNN
- **Making bounding boxes:** [Yolo](#) / Segment Anything? / Grounding Dino?
- **Image manipulation:** OpenCV
- **Web interface:** Streamlit



# Datasets:

[Github - Multiple datasets repository](#)

[NIH - Malaria Data, Thin smear and thick smear](#)



## Multiple Plasmodium species

[Kaggle dataset](#)

This Dataset contains Four Species of malaria images:

- Plasmodium falciparum
- Plasmodium vivax
- Plasmodium malariae
- Plasmodium ovale

### Plasmodium falciparum

- [Download link](#) | [website](#)

Data: 1182 images of thick smears, parasite bounding boxes given in xml format

J.A. Quinn, R. Nakasi, P.K. Mugagga, P. Byanyima, W. Lubega, A. Andama. [Deep Convolutional Neural Networks for Microscopy-Based Point of Care Diagnostics](#). Proceedings of the International Conference on Machine Learning for Health Care, Journal of Machine Learning Research W&C track, Volume 56, 2016.

- [Download link](#) | [website](#)

Data: 27,558 images of individual cells (infected/ uninfected RBCs) segmented from thin blood smears  
Sivaramakrishnan Rajaraman, Sameer K. Antani, Mahdieh Poostchi, Kamolrat Silamut, Md. A. Hossain, Richard J. Maude, Stefan Jaeger, and George R. Thoma. [Pre-trained convolutional neural networks as feature extractors toward improved malaria parasite detection in thin blood smear images](#), PeerJ., 2018.

- [Download link](#)

655 images of thin smears with bounding boxes around parasites

Tek FB, Dempster AG, Kale I, [Parasite detection and identification for automated thin blood film malaria diagnosis](#). Computer Vision and Image Understanding 2010, 114:21-32.

### Plasmodium vivax

- [Download link](#) | [website \(WITH BOUNDING BOX\)](#)

Data: 1364 images (~80,000 cells)

Hung J, Goodman A, Lopes S, Rangel G, Ravel D, Costa F, Duraisingh M, Marti M, Carpenter A. [Applying Faster R-CNN for Object Detection on Malaria Images](#), arxiv, 2018.

The authors want you to cite this other [paper](#)

## Resources:

[Youtube - How to detect red blood cell and create bounding box with Yolo](#)

[Repository - Data preview](#)

[Repository - Model with tensorflow and yolo](#)

[Repository - Model with Pytorch, FasterRCNN and yolo](#)

## Context:

[Species and stages of development](#)

Human Malaria					
Stages Species \	Ring	Trophozoite	Schizont	Gametocyte	
<i>P. falciparum</i>	A micrograph showing a single ring-shaped malarial parasite within a host red blood cell.	A micrograph showing a malarial parasite that has enlarged and spread within a host red blood cell.	A micrograph showing a malarial parasite that has multiplied within a host red blood cell, forming multiple daughter cells.	A micrograph showing a malarial parasite that has developed into a specialized reproductive stage within a host red blood cell.	<ul style="list-style-type: none"><li>Parasitised red cells (pRBCs) not enlarged.</li><li>RBCs containing mature trophozoites sequestered in deep vessels.</li><li>Total parasite biomass = circulating parasites + sequestered parasites.</li></ul>
<i>P. vivax</i>	A micrograph showing a ring-shaped malarial parasite within a host red blood cell.	A micrograph showing a malarial parasite that has enlarged and spread within a host red blood cell.	A micrograph showing a malarial parasite that has multiplied within a host red blood cell, forming multiple daughter cells.	A micrograph showing a malarial parasite that has developed into a specialized reproductive stage within a host red blood cell.	<ul style="list-style-type: none"><li>Parasites prefer young red cells</li><li>pRBCs enlarged.</li><li>Trophozoites are amoeboid in shape.</li><li>All stages present in peripheral blood.</li></ul>
<i>P. malariae</i>	A micrograph showing a ring-shaped malarial parasite within a host red blood cell.	A micrograph showing a malarial parasite that has enlarged and spread within a host red blood cell.	A micrograph showing a malarial parasite that has multiplied within a host red blood cell, forming multiple daughter cells.	A micrograph showing a malarial parasite that has developed into a specialized reproductive stage within a host red blood cell.	<ul style="list-style-type: none"><li>Parasites prefer old red cells.</li><li>pRBCs not enlarged.</li><li>Trophozoites tend to have a band shape.</li><li>All stages present in peripheral blood</li></ul>
<i>P. ovale</i>	A micrograph showing a ring-shaped malarial parasite within a host red blood cell.	A micrograph showing a malarial parasite that has enlarged and spread within a host red blood cell.	A micrograph showing a malarial parasite that has multiplied within a host red blood cell, forming multiple daughter cells.	A micrograph showing a malarial parasite that has developed into a specialized reproductive stage within a host red blood cell.	<ul style="list-style-type: none"><li>pRBCs slightly enlarged and have an oval shape, with tufted ends.</li><li>All stages present in peripheral blood.</li></ul>
<i>P. knowlesi</i>	A micrograph showing a ring-shaped malarial parasite within a host red blood cell.	A micrograph showing a malarial parasite that has enlarged and spread within a host red blood cell.	A micrograph showing a malarial parasite that has multiplied within a host red blood cell, forming multiple daughter cells.	A micrograph showing a malarial parasite that has developed into a specialized reproductive stage within a host red blood cell.	<ul style="list-style-type: none"><li>pRBCs not enlarged.</li><li>Trophozoites, pigment spreads inside cytoplasm, like <i>P. malariae</i>, band form may be seen</li><li>Multiple invasion &amp; high parasitaemia can be seen like <i>P. falciparum</i></li><li>All stages present in peripheral blood.</li></ul>

[CDC - Malaria treatment](#)

## Determination of the infecting *Plasmodium* species for treatment purposes is important for four main reasons.

Firstly, *Plasmodium falciparum* and *P. knowlesi* infections can cause **rapidly progressive severe illness or death**, while the other species, *P. vivax*, *P. ovale*, and *P. malariae*, are less likely to cause severe disease.

Secondly, *P. vivax* and *P. ovale* infections also require treatment for the hypnozoites, which remain dormant in the liver and can cause relapsing episodes.

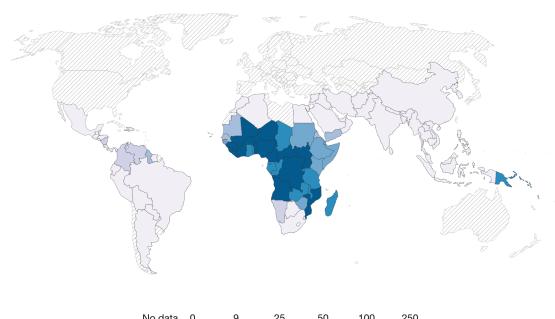
Thirdly, *P. falciparum* and *P. vivax* species have different drug resistance patterns in different geographic regions of the world.

Finally, for *P. falciparum* and *P. knowlesi* infections, the urgent initiation of appropriate therapy is especially critical.

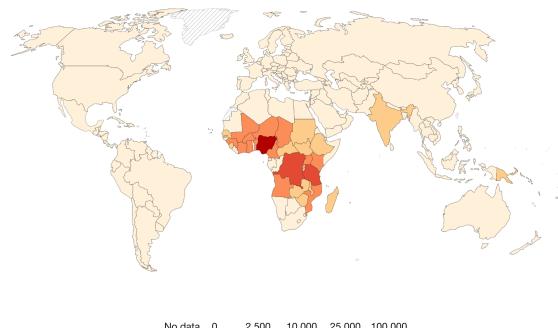
### [Our World in Data - Malaria](#)

Article with interactive maps, charts and statistical data

Malaria incidence, 2020  
Incidence of malaria is the number of new cases of malaria in a year per 1,000 population at risk. SDG Target 3.3 is to end the epidemic of malaria.



Estimated number of deaths from malaria, 2020



Source: World Health Organization (via World Bank)

OurWorldInData.org/malaria • CC BY

OurWorldInData.org/malaria • CC BY

### [Thick smear VS Thin smear](#)

Thick smears consist of a thick layer of dehemoglobinized (lysed) red blood cells (RBCs). The blood elements (including parasites, if any) are more concentrated (app. 30x) than in an equal area of a thin smear.

**Thick smears allow a more efficient detection of parasites (increased sensitivity).**

However, they do not permit an optimal review of parasite morphology. For example, they are often not adequate for species identification of malaria parasites: if the thick smear is positive for malaria parasites, **the thin smear should be used for species identification.**