Smartphone-Supported Automated Malaria Parasite Detection

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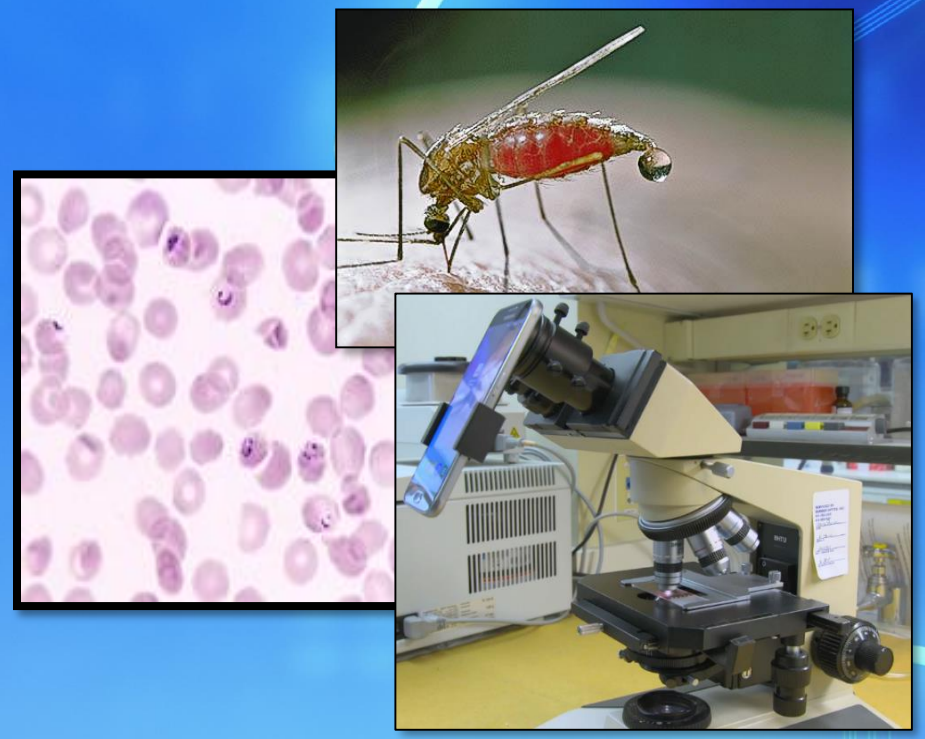

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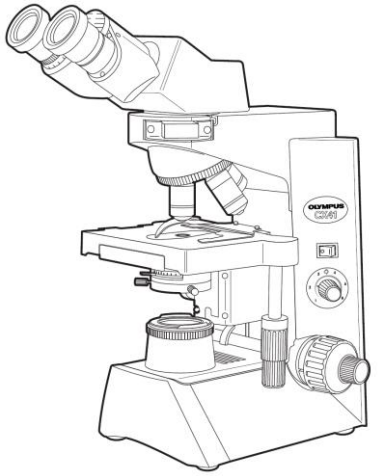
Outline

- Background on malaria diagnosis
- Our deep learning based App for malaria parasite detection
  - On thin blood smears
  - On thick blood smears
- Experimental results
- Conclusion

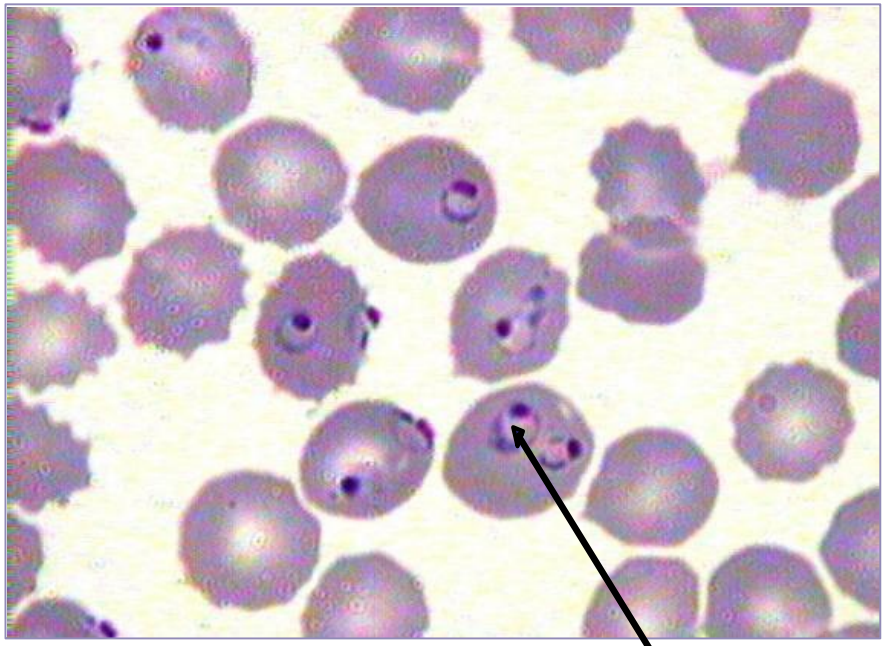
Background(1/2)

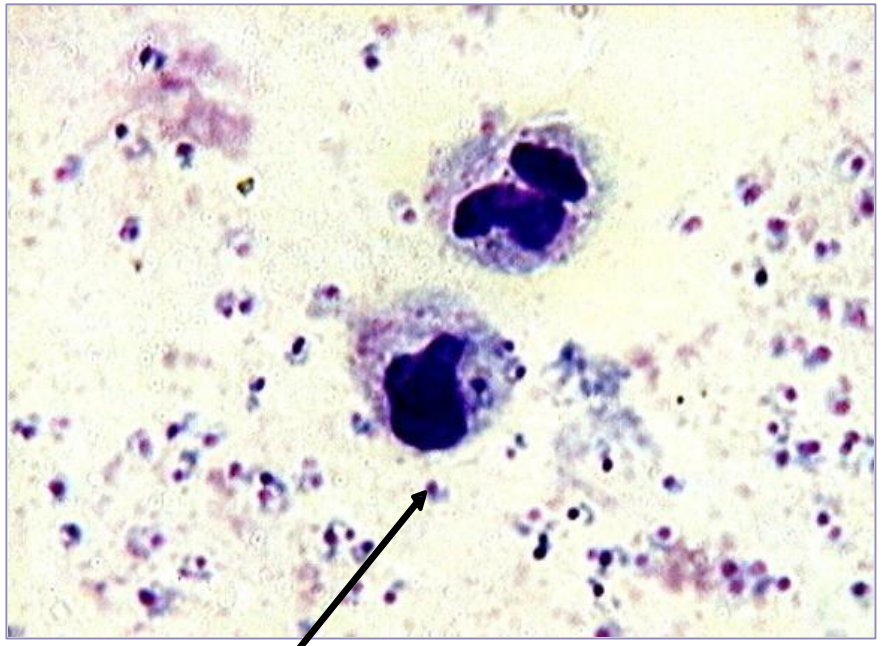
- Malaria is a life-threatening disease.
- According to the 2017 WHO malaria report , an estimated 216 million malaria cases worldwide were detected in 2016, causing approximately 445,000 deaths.
- There are several techniques for malaria diagnosis:
  - Rapid Diagnostic Test (RDT)
    - Species-specific
    - Not quantitative
    - Stay positive after treatment

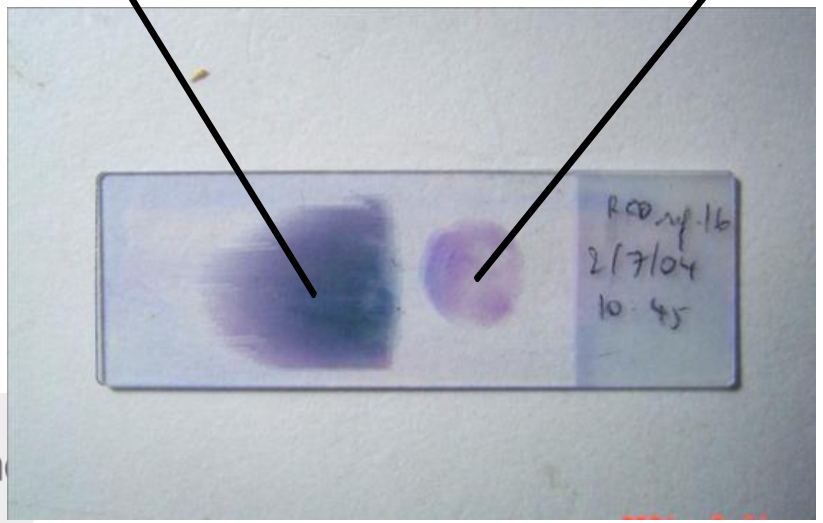
  - Microscopy
    - Gold standard : Quantitative
    - Less expensive
    - Time taken for manual diagnosis: 10-30 minutes



Background(2/2)







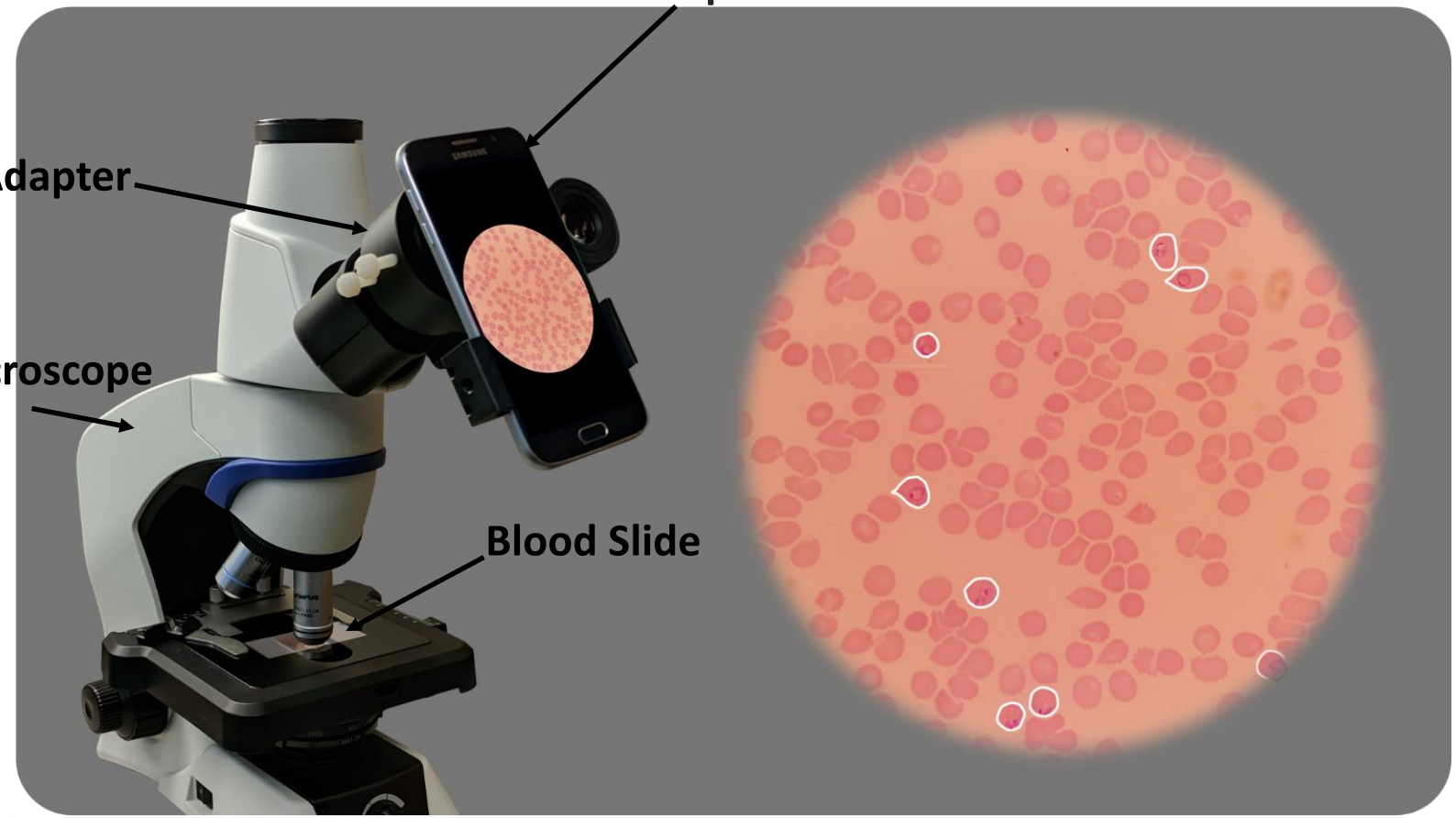
Thin smear

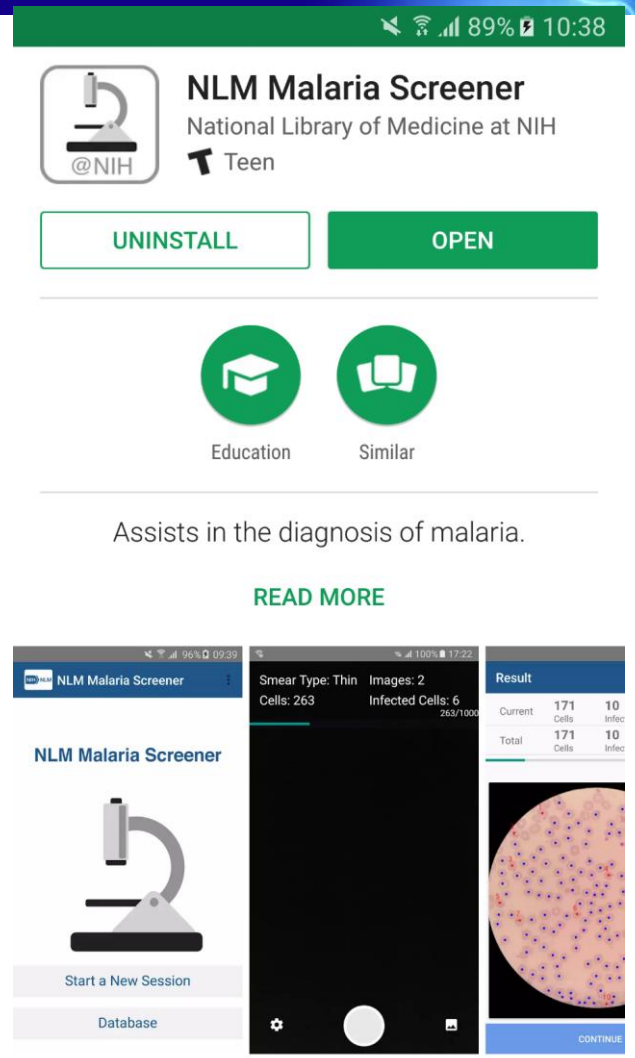
--differentiate parasite species
--detect parasite development stages
-- automatic parasite counting

Thick smear

--detect the presence of parasites

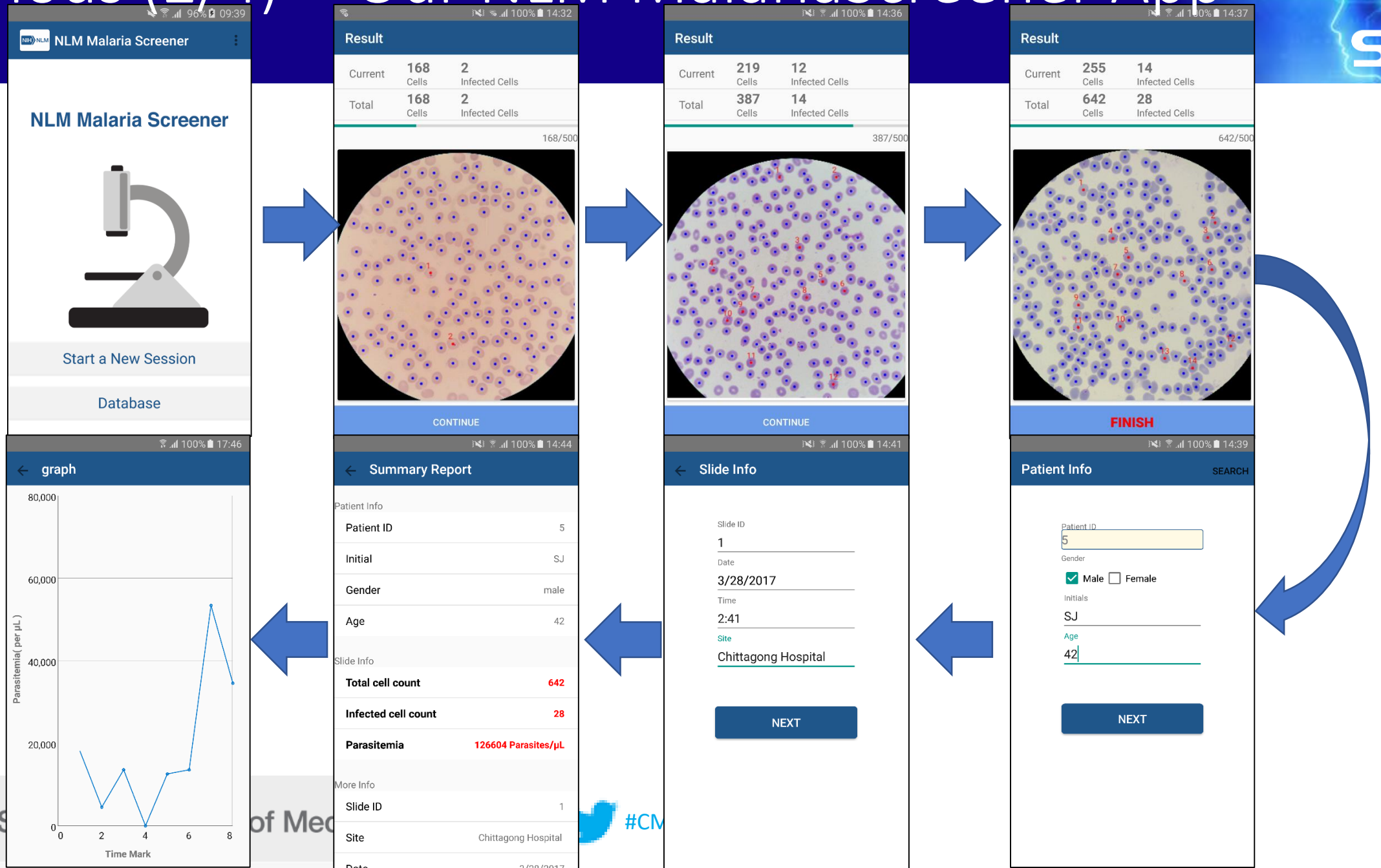
Methods (1/4) -- Our NLM MalariaScreener App





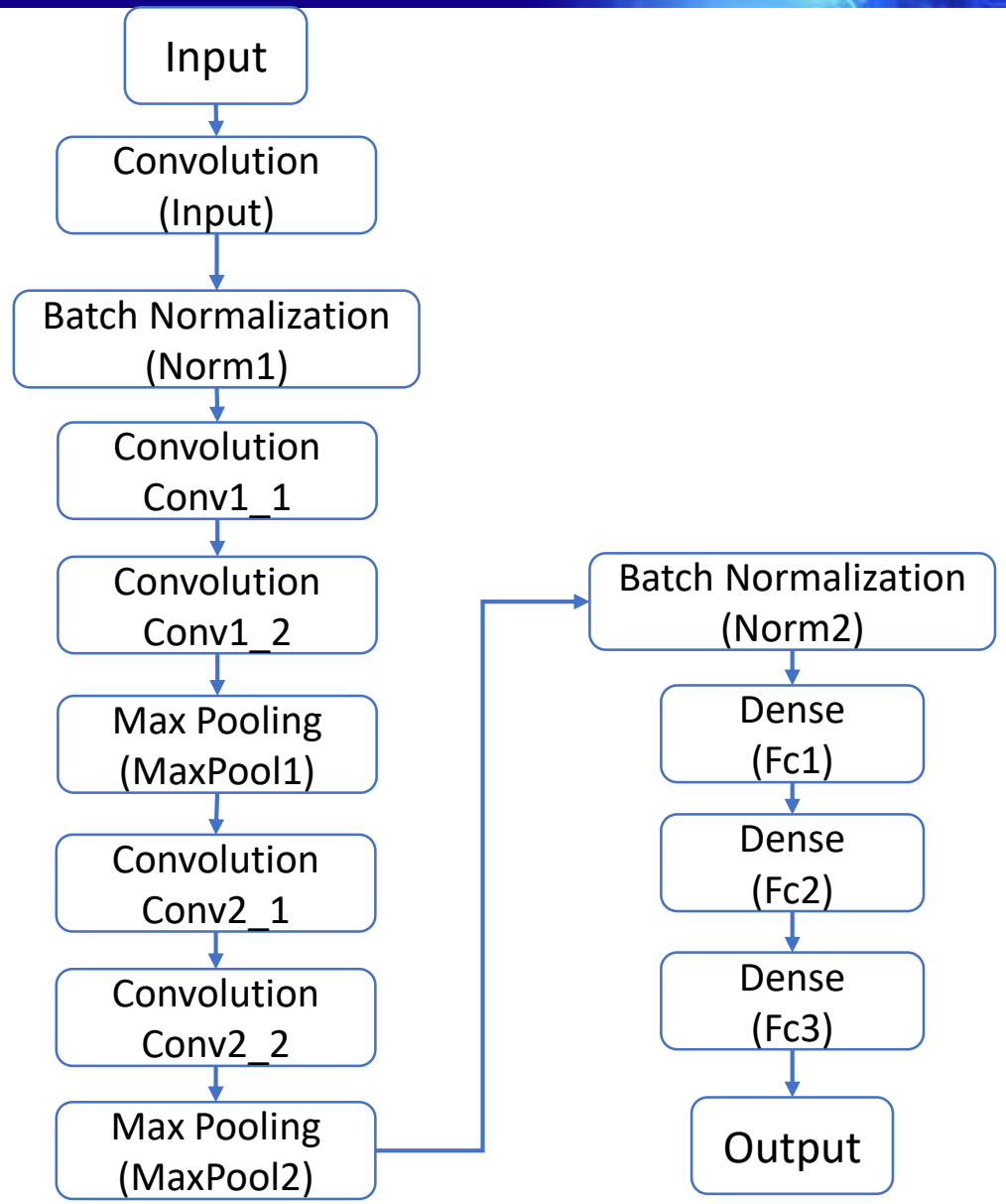
- We are developing an Android smartphone app for malaria parasite detection
- Available in Google Play

Methods (2/4) -- Our NLM MalariaScreener App



Methods (3/4) – Thin blood smears

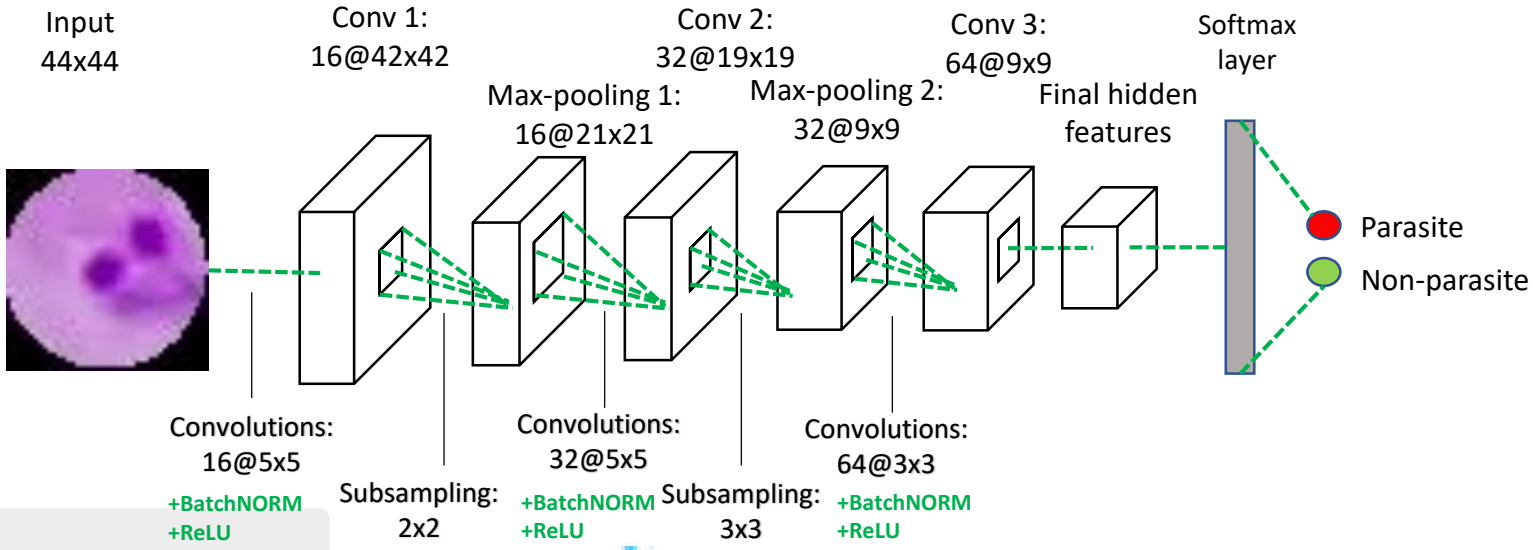
- For thin blood smears:
  - We customize a CNN classifier for parasite detection based on
    - 7 convolutional layers
    - 2 max-pooling layers
    - 3 dense layers.



Methods (4/4) – Thick blood smears

For thick blood smears:

- We propose a customized CNN model for parasite classification. Our customized CNN model consists of three convolutional layers, three max-pooling layers, two fully-connected layers and a softmax classification layer.



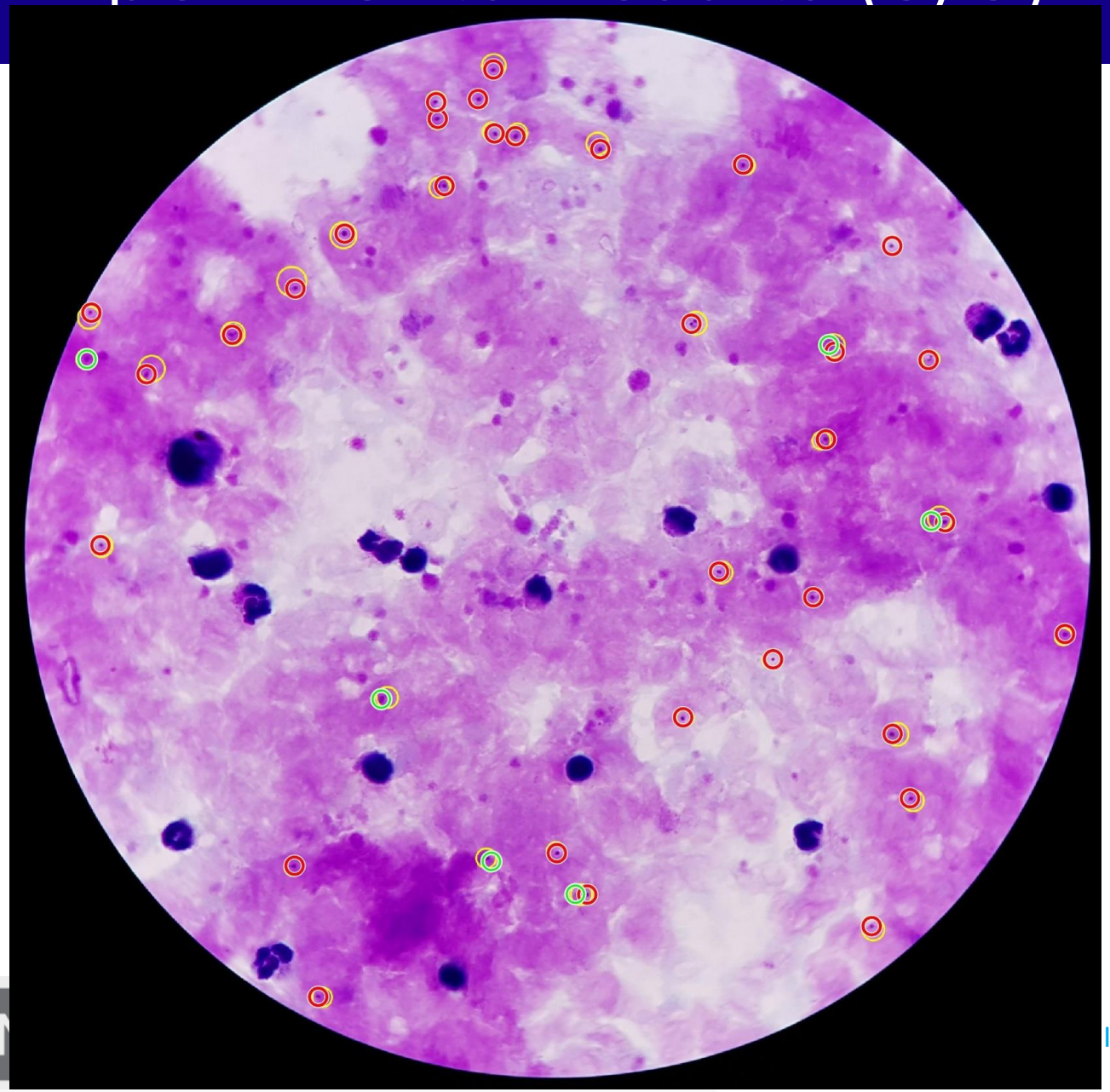
Experimental results (1/3) - Data

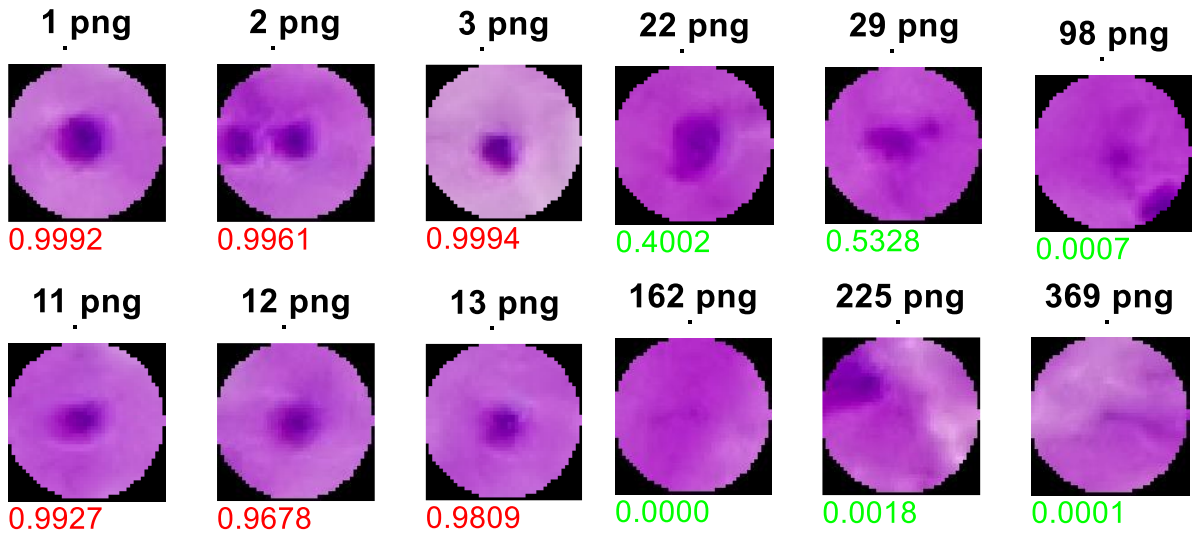
- Images were acquired at Mahidol-Oxford Tropical Medicine Research Unit (MORU), Bangkok, Thailand.
- Manually annotated by an experienced parasitologist
- Thin blood smears: 1200 images from 200 patients
  - Annotated 213,000 cells
- Thick blood smears: 1818 images from 150 patients
  - Annotated 84,961 parasites
  - Annotated 35,036 WBCs

Experimental results (2/3) – Thin blood smears

- Evaluation on thin blood smears is performed based 10-fold cross-validation;
- The accuracy of our customized CNN model in discriminating between parasites and distractors in thick smears is 94.53%;
- Evaluation on thick blood smears is performed based 5-fold cross-validation;
- The accuracy of our customized CNN model in discriminating between parasites and distractors in thick smears is 93.32%.

Experimental results (3/3) – Thick blood smears





Ground-truth Parasites

True Preselected parasites

False Preselected parasites

Conclusion

- Deep learning is an accurate and reliable model for malaria parasite classification on both thin and thick blood smears
- A trained CNN classifier can be run efficiently on a mobile device

https://ceb.nlm.nih.gov/projects/malaria-screener/

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Thanks for your attention!