Automated Malaria Detection Using Convolutional Neural Networks

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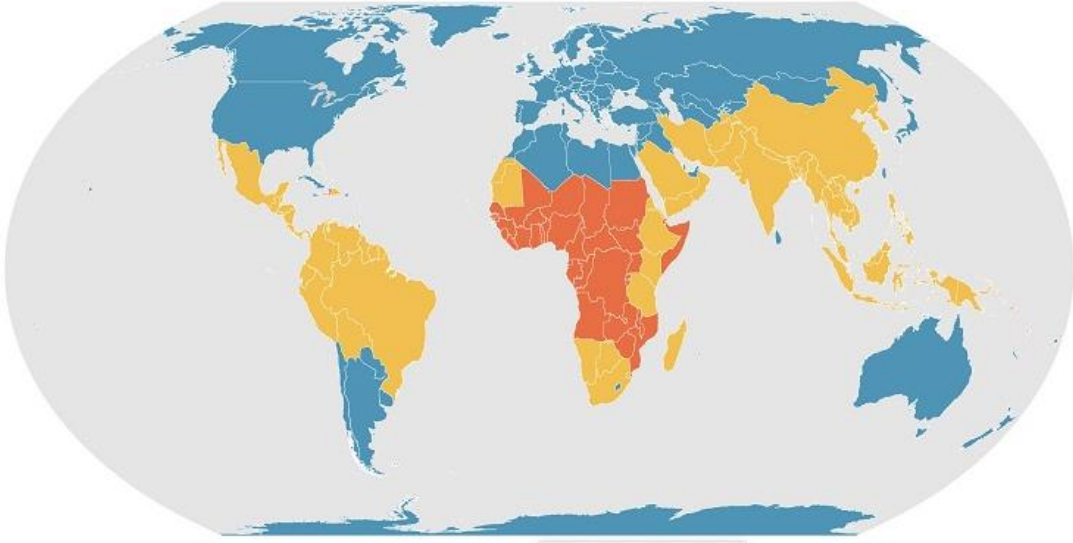
Background

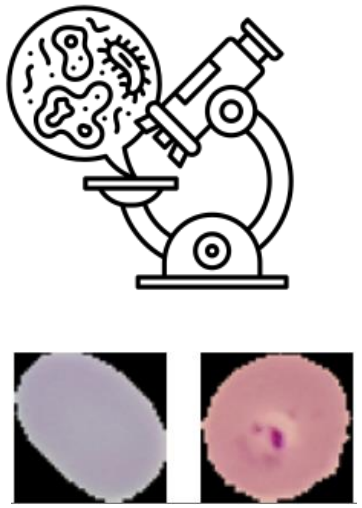
- Malaria is caused by Plasmodium parasites
- In 2020, malaria accounted for 627,000 deaths worldwide
- Early detection reduces morbidity and mortality
- There is an increasing demand for diagnostic tests



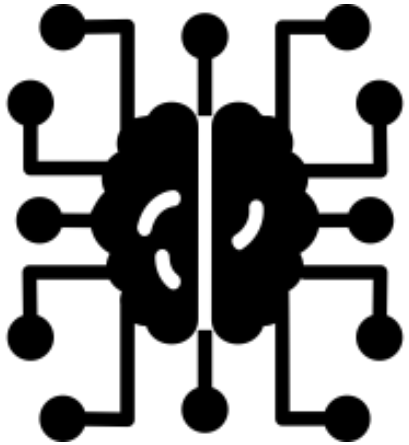
Problem summary

- Malaria diagnosis bottlenecks
  - Shortage of trained personnel
  - Labor intensive
  - Variability in test accuracy
  - Limited availability of testing sites
  - Increase in demand
  - The low-cost rapid test is not very accurate

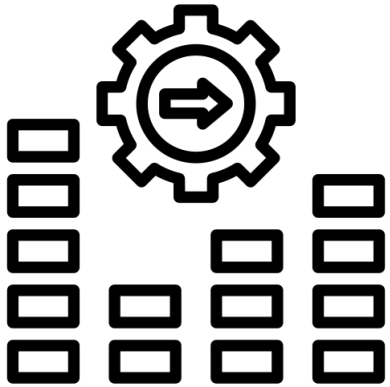
Solution: Automation of malaria detection



Blood smear slides imaging



Malaria detection using Image classification



Quantification of parasitized cells

Diagnosis

Convolutional Neural Network (CNN) models for malaria detection

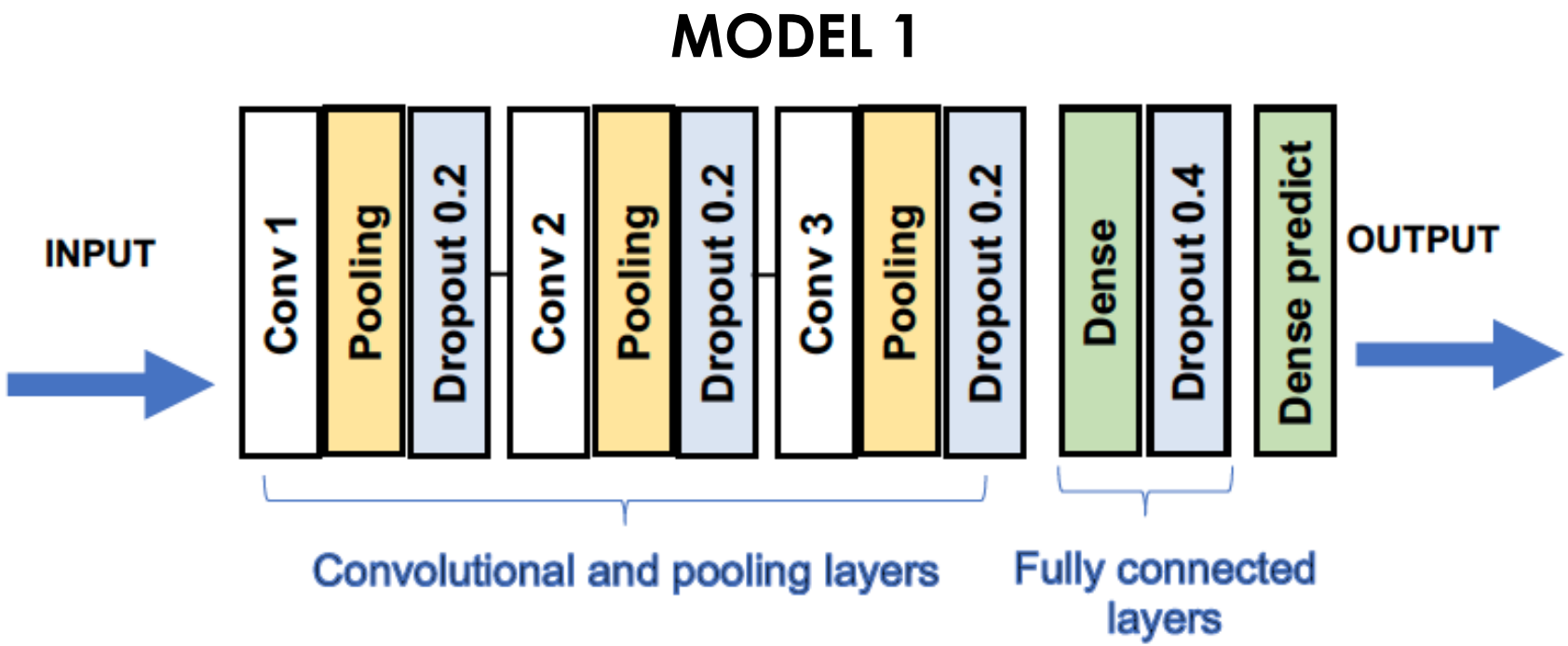
- Tested 5 models
  - Model 1: Base model
  - Model 2: Tunned convolutional layers
  - Model 3: Image augmentation
  - Model 4: HSV color space
  - Model 5: Pre-trained VGG16 model
- 25,000 train and 2,600 test images

Model Comparison

	Model 1	Model 2	Model 3	Model 4	Model 5
Sensitivity (%)	97.4	99.2	97.8	98.8	94.0
Specificity (%)	99.0	98.3	99.3	97.7	95.9
Accuracy (%)	98.2	98.7	98.5	98.3	95.0

- Model 2 outperformed all models, with 99.2% sensitivity, 98.3% specificity, and about 98.7% accuracy

Model insights

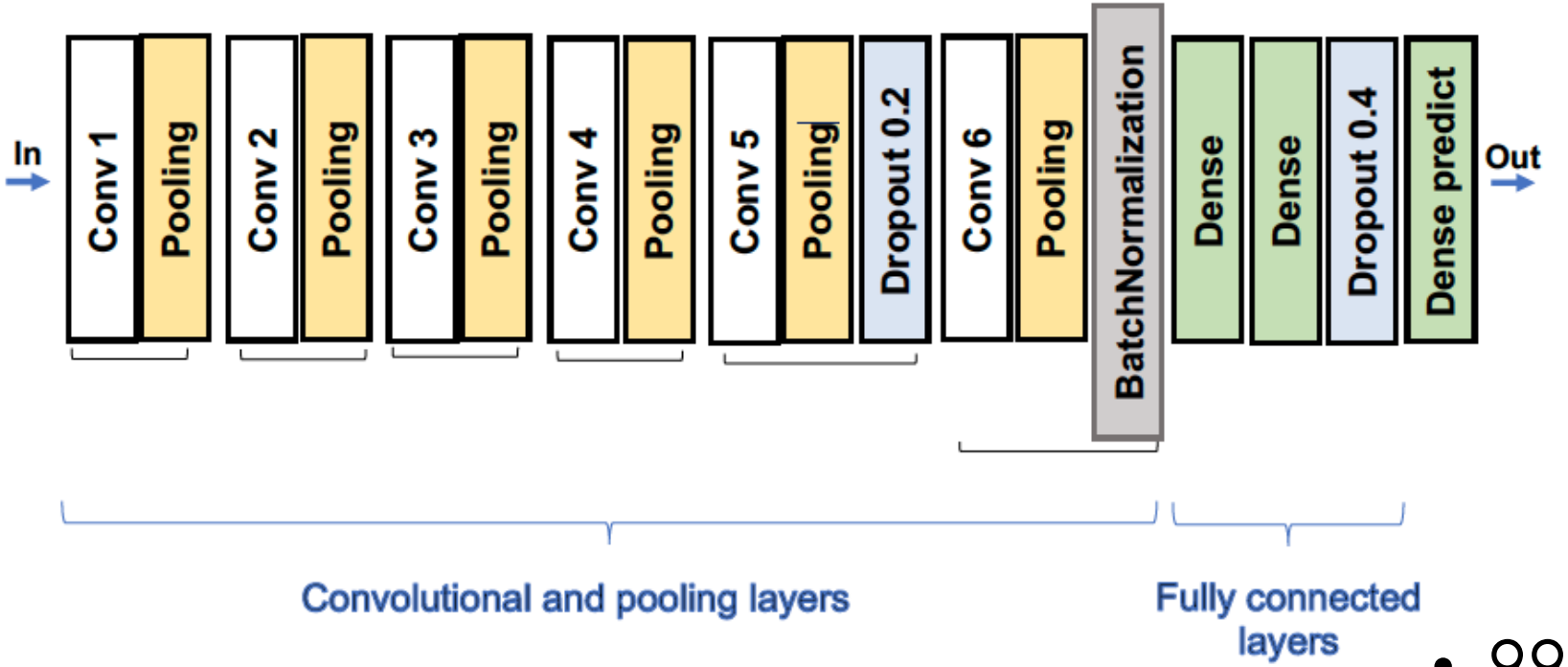


- 1,058,736 trainable parameters

- 97.4% sensitivity
- 99.0% specificity

Model insights

MODEL 2

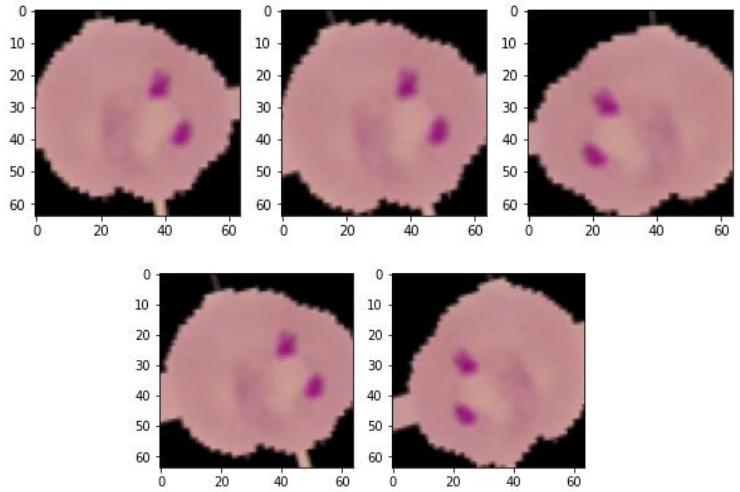


- 272,394 trainable parameters

- 99.2% sensitivity
- 98.3% specificity

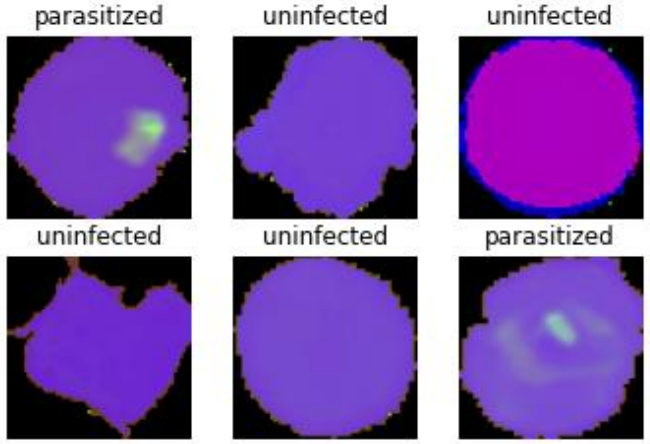
Model Insights

- **Model 3**: Image augmentation



  - 97.8% sensitivity
  - 99.3% specificity

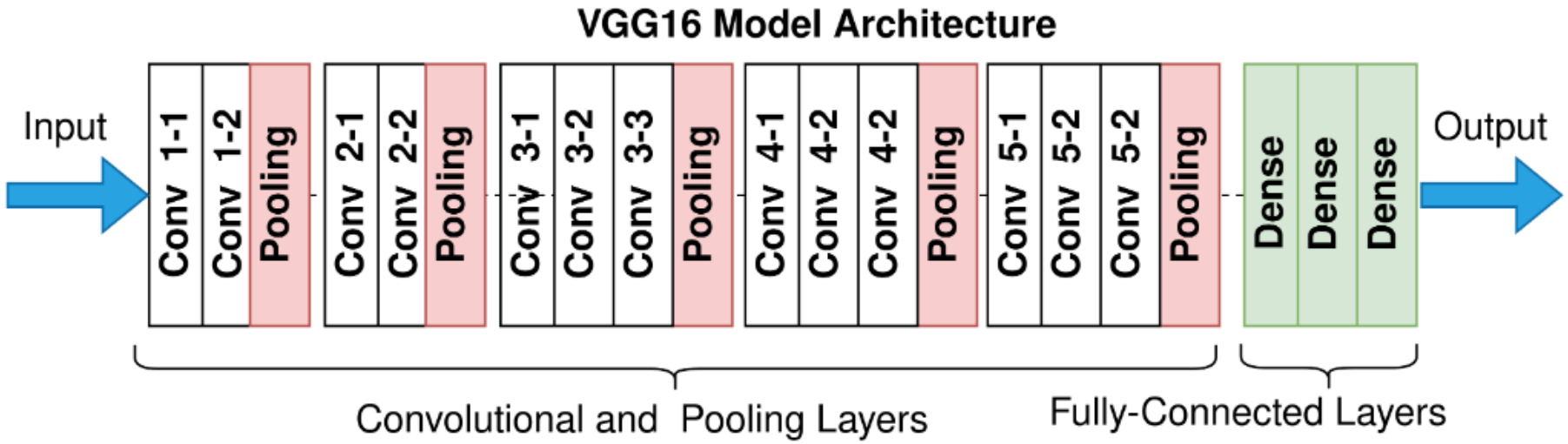
- **Model 4**: HSV color space



  - 98.8% sensitivity
  - 99% specificity

Model Insights

- **Model 5**: Pre-trained VGG16 model



- 94.0% sensitivity
- 95.9% specificity

Recommendations for implementation of malaria detection automation

Benefits

- Quick and accurate diagnosis
- Scalable
- Overcome challenges with expert personnel

Challenges

- Partial automation
- Image quality variability
- Model accuracy on parasites of different stages

Actionable

- Test model with cross-clinic images
- Standardize sample prep and imaging
- Deploy model as a software