

Malaria Cell Detection using Depthwise Separable CNN

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Highlights of Proposed Model

To develop an lightweight computational model that

- Classifies segmented cells as Malaria Infected or Uninfected.
- Takes less time to run when compared to pre-trained models.
- Uses depthwise separable convolutional layers.
- Is more accurate than pre-trained models.

Challenges in classifying Malaria Cells

- Malaria Infested regions don't have access to powerful hardware, hence the model needs to be computationally efficient.
- Pre-processing required due to orientation of cells, precise location of infestation

Proposed Model for Malaria Cell Detection

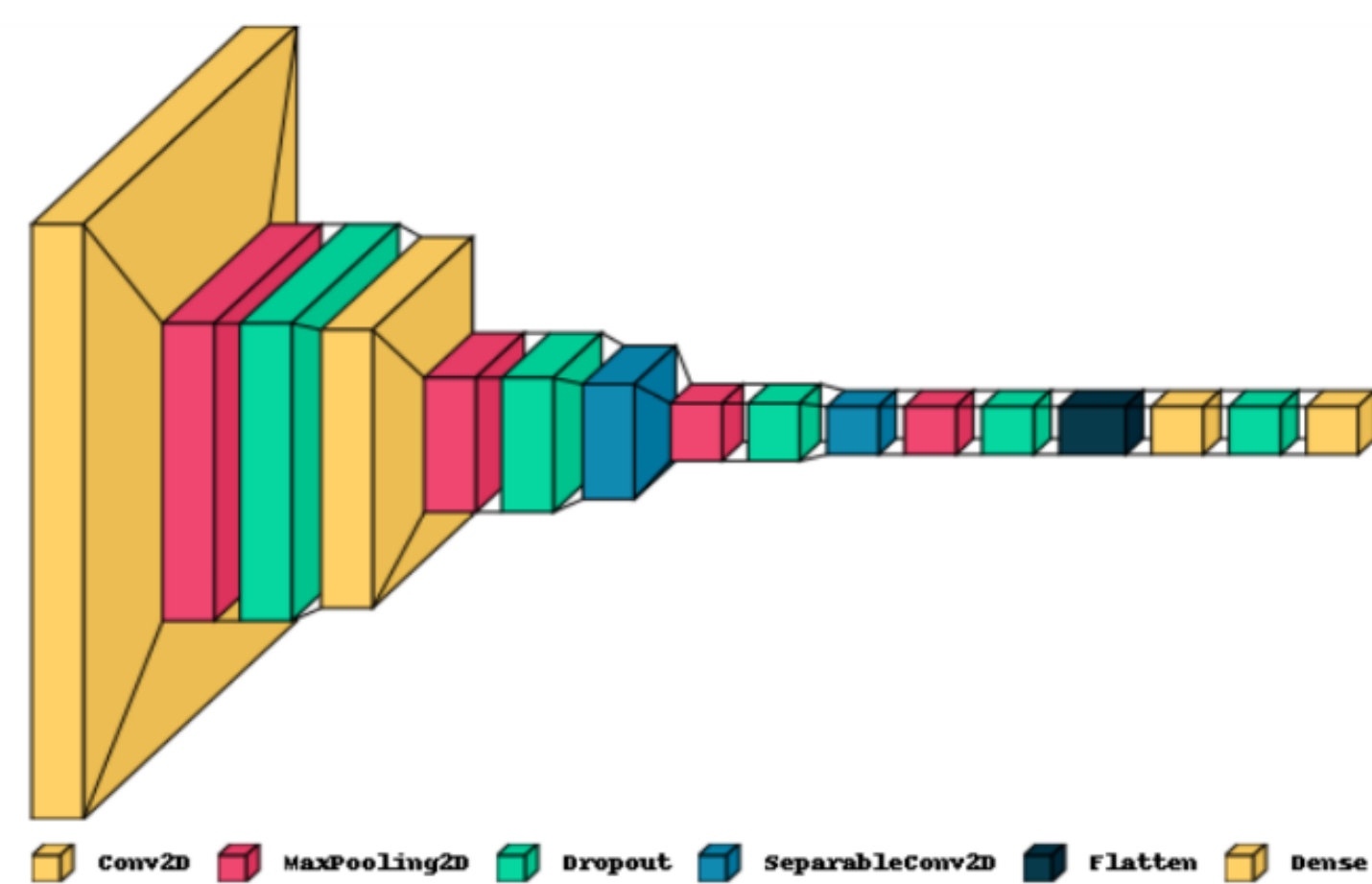


Figure 1. Depthwise Separable model (DS-CNN)

Performance metrics of the models

Model	Accuracy	Precision	Recall	F1 score	Time Taken
DS-CNN	0.93	0.92	0.92	0.92	38.97
Stacked CNN [1]	0.90	0.90	0.90	0.90	76.84
InceptionV3	0.91	0.91	0.91	0.91	179.77
ResNet50	0.90	0.90	0.89	0.89	133.09

Table 1. Performance Metrics of the models

Functional Modules and Dataset Description

- Data Pre-processing
 - Data cleansing
 - Data preparation for infection detection
 - Models Used
 - Pre-trained models such as InceptionV3 and ResNet50
 - Developed our own CNN using depthwise separable convolutional layers (DS-CNN)
 - Developed stacked CNN [1]
 - Malaria Cell Detection
 - Comparison of all 4 models
- 'Malaria Cell Images Dataset' from Kaggle which was sourced from the official NIH website is used.
 - The dataset consists of segmented cell images, both Infected and Uninfected.
 - Total of 27,588 images. The dataset is balanced.
 - From the dataset, 90% of total is taken for training, and the other 10% is taken for testing.

Proposed system

Steps Involved

- Several pre-processing techniques including grayscale conversion, normalization of pixel values to a predefined range, flipping (both horizontal and vertical), rotation, cropping, shearing, and image standardization techniques were employed to increase the randomness of the dataset.
- Transfer learning was utilized as pre-trained models such as ResNet50 and InceptionV3 were implemented
- Depthwise separable model was created using depthwise separable layers with the aim to outperform the pre-trained models while keeping the run-time to a minimum. A normal CNN with similar architecture was also created for comparison.
- The metrics of all 4 models are compared quantitatively.

Depthwise Separable Layers

- Depthwise separable convolutional layers [2] are used in the model instead of normal convolutional layers as they use fewer computations than traditional convolutional layers.
- Depthwise separable convolution splits a kernel into 2 separate kernels that do two convolutions.
- One is depthwise convolution. Another is pointwise convolution
- This leads to fewer trainable parameters and lower execution time.

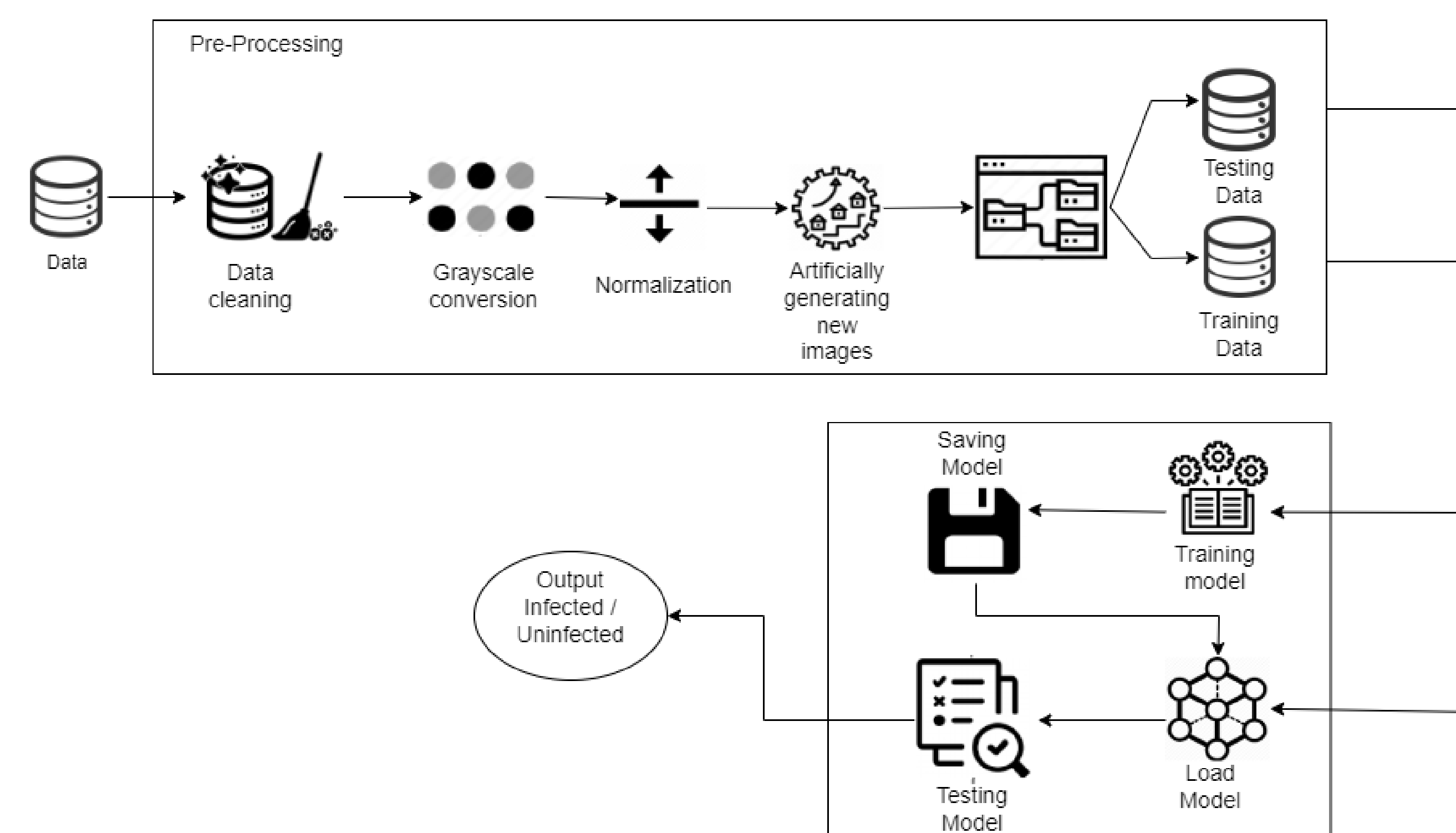


Figure 2. Architecture Diagram

Number of Trainable Parameters

Model	Trainable Parameters
DS-CNN	28,737
Stacked CNN[1]	77,025
InceptionV3	21,073,985
ResNet50	27,783,041

Table 2. Number of trainable parameters in each model

Depthwise Convolution

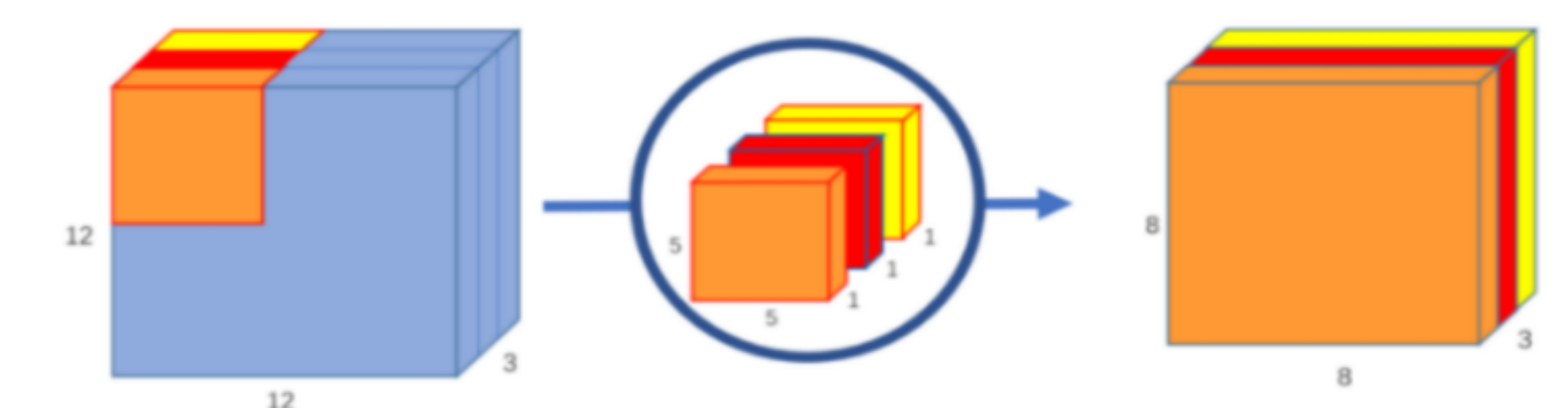


Figure 3. Depthwise Convolution

Pointwise Convolution

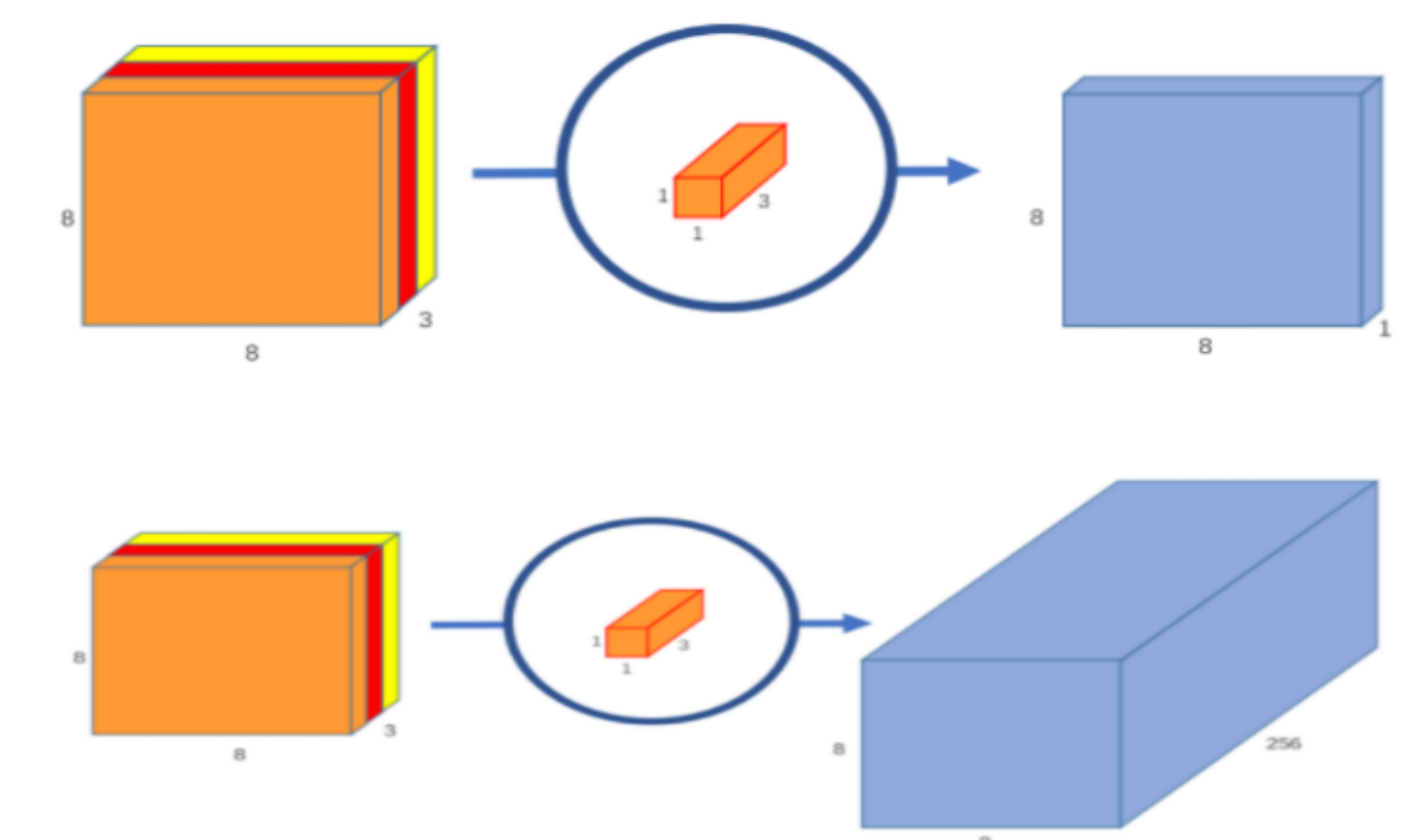


Figure 4. Pointwise Convolution

References

- Muhammad Umer et al. "A novel stacked CNN for malarial parasite detection in thin blood smear images". In: *IEEE Access* 8 (2020), pp. 93782–93792
- François Chollet. "Xception: Deep learning with depthwise separable convolutions". In: *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2017, pp. 1251–1258