Malaria-Deep Learning Model for Cell Image Classification

1. Introduction:

This report details the development and evaluation of a deep learning model for the classification of cell images into infected (parasitized) and uninfected categories. The model is designed to assist in medical diagnostics by automating the process of identifying infected cells from microscopic images.

2. Dataset Description

The dataset used consists of cell images collected from various sources, containing two classes: parasitized and uninfected. Preprocessing steps include resizing images to 150x150 pixels and normalizing pixel values to a range of 0 to 1.

Certainly! Let's expand on the model section of the technical report to provide more details about the deep learning architecture used for cell image classification

3. Methodology

Model Architecture:

The deep learning model is designed using a convolutional neural network (CNN), which is well-suited for image classification tasks due to its ability to capture spatial hierarchies of features. The architecture is as follows:

Input Layer:

- Accepts input images resized to 150x150 pixels with three color channels (RGB).

Convolutional Layers:

Conv2D Layer 1:

- Filters: 32
- Kernel Size: (3, 3)
- Activation: Rectified Linear Unit (ReLU)
- Purpose: Initiates feature extraction with basic edge and texture detection.

MaxPooling2D Layer 1:

- Pool Size: (2, 2)
- Purpose: Reduces spatial dimensions, focusing on the most significant features.

Conv2D Layer 2:

- Filters: 64
- Kernel Size: (3, 3)
- Activation: ReLU
- Purpose: Increases complexity, capturing more detailed patterns in the images.

MaxPooling2D Layer 2:

- Pool Size: (2, 2)
- Purpose: Further downsamples the feature maps, retaining critical information.

Conv2D Layer 3:

- Filters: 128
- Kernel Size: (3, 3)
- Activation: ReLU
- Purpose: Deepens feature extraction, enhancing the model's ability to discern finer details.

MaxPooling2D Layer 3:

- Pool Size: (2, 2)
- Purpose: Continues to reduce spatial dimensions while preserving relevant features.

Flatten Layer:

- Purpose: Converts the 2D feature maps into a 1D vector, preparing for input into the fully connected layers.]

Dense Layers:

Dense Layer 1:

- Units: 128
- Activation: ReLU
- Purpose: Learns complex representations of the features extracted by the convolutional layers.

Output Layer:

- Units: 1 (Binary classification)
- Activation: Sigmoid

- Purpose: Produces a probability score indicating the likelihood of the image belonging to the 'infected' class (parasitized).

Training:

The model is trained using the Adam optimizer, which adapts learning rates for each parameter during training to optimize convergence. The loss function employed is binary cross-entropy, suitable for binary classification tasks where each image is classified as either infected or uninfected.

4. Streamlit Application:

An interactive Streamlit application is developed for real-time image classification and hotspot visualization:

- Users can upload cell images for classification.
- Preprocessing includes resizing and normalization.
- Grad-CAM (Gradient-weighted Class Activation Mapping) is used to generate heatmaps highlighting influential regions in the image.
- Heatmaps are overlaid on the original image and displayed in the Streamlit app interface.

5. Experimentation and Results

Evaluation metrics demonstrate robust performance in distinguishing between infected and uninfected cells.

Grad-CAM visualization enhances interpretability by highlighting areas of interest in the images that influence the model's decision.

6. Conclusion

The developed deep learning model and Streamlit application provide an effective solution for automated cell image classification and hotspot visualization. The project underscores the potential of CNNs in medical diagnostics and highlights the importance of interpretability through visualization techniques like Grad-CAM.

7.References:

- https://ieeexplore.ieee.org/abstract/document/7822567
- https://www.analyticsvidhya.com/blog/2021/12/malaria-cell-image-classification-an-end-to-end-prediction/

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