Project Documentation: Image Classification Model

In this project, we developed an image classification model using deep learning techniques, specifically leveraging the PyTorch framework. Our objective was to build a robust model capable of classifying images into one of 25 distinct categories.

2. Environment Setup

2.1. Required Libraries

To get started, we ensured that these are installed : PyTorch for neural network construction and training, Torchvision for data handling and transformation, Matplotlib for visualizations, and TQDM to track the progress of our training processes.

3. Data Preparation

3.1. Data Loading

We organized our dataset into folders by class, which allowed us to utilize the ImageFolder class from Torchvision. This setup streamlined the data loading process. We also applied a series of preprocessing steps, including normalization, to prepare the images for training.

3.2. Data Management

To efficiently manage our data, we employed DataLoader objects. These handled batching and shuffling of the datasets, facilitating smoother training and validation processes.

Model Building

Model Architecture Summary:

- **Conv2d Layer (1-1):**
  - Number of parameters: 9,408
- **BatchNorm2d Layer (1-2):**
  - Number of parameters: 128
- **Sequential Block (1-3):**
  - **BasicBlock (2-1):**
    - **Conv2d Layer (3-1):**
      - Number of parameters: 36,864
    - **BatchNorm2d Layer (3-2):**
      - Number of parameters: 128
    - **Conv2d Layer (3-3):**
      - Number of parameters: 36,864
    - **BatchNorm2d Layer (3-4):**
      - Number of parameters: 128
    - **Sequential Layer (3-5):**
      - Number of parameters: N/A
  - **BasicBlock (2-2):**
    - **Conv2d Layer (3-6):**
      - Number of parameters: 36,864
    - **BatchNorm2d Layer (3-7):**
      - Number of parameters: 128
    - **Conv2d Layer (3-8):**
      - Number of parameters: 36,864
    - **BatchNorm2d Layer (3-9):**
      - Number of parameters: 128
    - **Sequential Layer (3-10):**
      - Number of parameters: N/A
- **Sequential Block (1-4):**
  - **BasicBlock (2-3):**
    - **Conv2d Layer (3-11):**
      - Number of parameters: 73,728
    - **BatchNorm2d Layer (3-12):**
      - Number of parameters: 256
    - **Conv2d Layer (3-13):**
      - Number of parameters: 147,456
    - **BatchNorm2d Layer (3-14):**
      - Number of parameters: 256
    - **Sequential Layer (3-15):**
      - Number of parameters: 8,448
  - **BasicBlock (2-4):**
    - **Conv2d Layer (3-16):**
      - Number of parameters: 147,456

            - **BatchNorm2d Layer (3-17):**
                - Number of parameters: 256
            - **Conv2d Layer (3-18):**
                - Number of parameters: 147,456
            - **BatchNorm2d Layer (3-19):**
                - Number of parameters: 256
            - **Sequential Layer (3-20):**
                - Number of parameters: N/A
- **Sequential Block (1-5):**
    - **BasicBlock (2-5):**
        - **Conv2d Layer (3-21):**
            - Number of parameters: 294,912
        - **BatchNorm2d Layer (3-22):**
            - Number of parameters: 512
        - **Conv2d Layer (3-23):**
            - Number of parameters: 589,824
        - **BatchNorm2d Layer (3-24):**
            - Number of parameters: 512
        - **Sequential Layer (3-25):**
            - Number of parameters: 33,280
    - **BasicBlock (2-6):**
        - **Conv2d Layer (3-26):**
            - Number of parameters: 589,824
        - **BatchNorm2d Layer (3-27):**
            - Number of parameters: 512
        - **Conv2d Layer (3-28):**
            - Number of parameters: 589,824
        - **BatchNorm2d Layer (3-29):**
            - Number of parameters: 512
        - **Sequential Layer (3-30):**
            - Number of parameters: N/A
- **Sequential Block (1-6):**
    - **BasicBlock (2-7):**
        - **Conv2d Layer (3-31):**
            - Number of parameters: 1,179,648
        - **BatchNorm2d Layer (3-32):**
            - Number of parameters: 1,024
        - **Conv2d Layer (3-33):**
            - Number of parameters: 2,359,296
        - **BatchNorm2d Layer (3-34):**
            - Number of parameters: 1,024
        - **Sequential Layer (3-35):**
            - Number of parameters: 132,096
    - **BasicBlock (2-8):**
        - **Conv2d Layer (3-36):**
            - Number of parameters: 2,359,296

        - **BatchNorm2d Layer (3-37):**
            - Number of parameters: 1,024
        - **Conv2d Layer (3-38):**
            - Number of parameters: 2,359,296
        - **BatchNorm2d Layer (3-39):**
            - Number of parameters: 1,024
        - **Sequential Layer (3-40):**
            - Number of parameters: N/A
- **Linear Layer (1-7):**
    - Number of parameters: 12,825

Total Parameters: 11,189,337
Trainable Parameters: 11,189,337
Non-trainable Parameters: 0

Model Architecture

```
==========================================================================
Layer (type:depth-idx)                             Param #
==========================================================================
├─Conv2d: 1-1                                      9,408
├─BatchNorm2d: 1-2                                 128
├─Sequential: 1-3                                  --
|    └─BasicBlock: 2-1                             --
|    |    └─Conv2d: 3-1                            36,864
|    |    └─BatchNorm2d: 3-2                       128
|    |    └─Conv2d: 3-3                            36,864
|    |    └─BatchNorm2d: 3-4                       128
|    |    └─Sequential: 3-5                        --
|    └─BasicBlock: 2-2                             --
|    |    └─Conv2d: 3-6                            36,864
|    |    └─BatchNorm2d: 3-7                       128
|    |    └─Conv2d: 3-8                            36,864
|    |    └─BatchNorm2d: 3-9                       128
|    |    └─Sequential: 3-10                       --
├─Sequential: 1-4                                  --
|    └─BasicBlock: 2-3                             --
|    |    └─Conv2d: 3-11                           73,728
|    |    └─BatchNorm2d: 3-12                      256
|    |    └─Conv2d: 3-13                           147,456
|    |    └─BatchNorm2d: 3-14                      256
|    |    └─Sequential: 3-15                       8,448
|    └─BasicBlock: 2-4                             --
|    |    └─Conv2d: 3-16                           147,456
|    |    └─BatchNorm2d: 3-17                      256
|    |    └─Conv2d: 3-18                           147,456
|    |    └─BatchNorm2d: 3-19                      256
|    |    └─Sequential: 3-20                       --
├─Sequential: 1-5                                  --
|    └─BasicBlock: 2-5                             --
|    |    └─Conv2d: 3-21                           294,912
|    |    └─BatchNorm2d: 3-22                      512
|    |    └─Conv2d: 3-23                           589,824
|    |    └─BatchNorm2d: 3-24                      512
|    |    └─Sequential: 3-25                       33,280
|    └─BasicBlock: 2-6                             --
|    |    └─Conv2d: 3-26                           589,824
|    |    └─BatchNorm2d: 3-27                      512
|    |    └─Conv2d: 3-28                           589,824
|    |    └─BatchNorm2d: 3-29                      512
|    |    └─Sequential: 3-30                       --
```

```
├─Sequential: 1-6                        --
|    └─BasicBlock: 2-7                   --
|    |    └─Conv2d: 3-31                 1,179,648
|    |    └─BatchNorm2d: 3-32            1,024
|    |    └─Conv2d: 3-33                 2,359,296
|    |    └─BatchNorm2d: 3-34            1,024
|    |    └─Sequential: 3-35             132,096
|    └─BasicBlock: 2-8                   --
|    |    └─Conv2d: 3-36                 2,359,296
|    |    └─BatchNorm2d: 3-37            1,024
|    |    └─Conv2d: 3-38                 2,359,296
|    |    └─BatchNorm2d: 3-39            1,024
|    |    └─Sequential: 3-40             --
├─Linear: 1-7                            12,825
==========================================================================
Total params: 11,189,337
Trainable params: 11,189,337
Non-trainable params: 0
==========================================================================
```

5. Training the Model

5.1. Training Process

Our training loop was designed to iteratively update the model's parameters over several epochs. We carefully tuned hyperparameters such as the learning rate, optimizer type, weight decay, and gradient clipping to optimize the model's performance. Throughout this process, we closely monitored the model’s progress on the validation dataset.

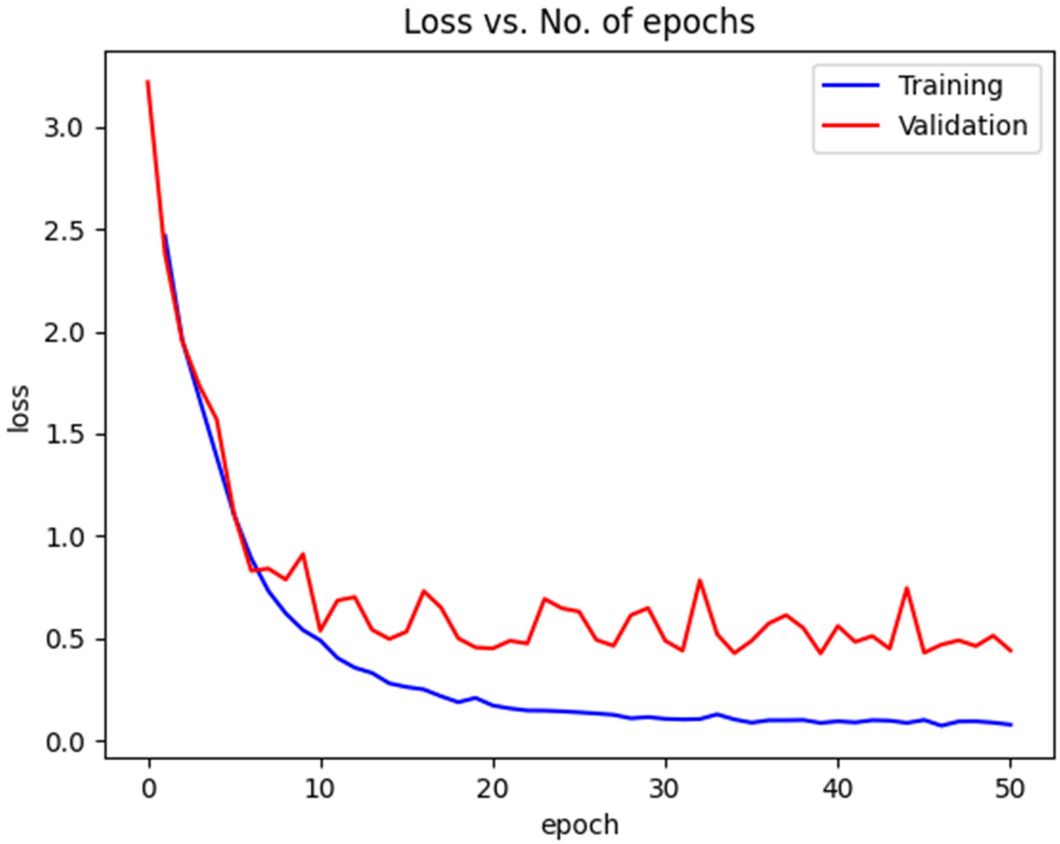
5.2. Hyperparameters

The chosen hyperparameters were critical to the model's success. We experimented with different configurations to find the best combination that would lead to optimal performance without overfitting.

6. Plotting metrics

1. Plot accuracy

2. Plot Loss


Loss vs. No. of epochs
Training
Validation
loss
epoch
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50