Title: Binary Image Classification Using CNNs
Subtitle: Distinguishing Between Two Object Categories (Cars vs. Bikes)

Introduction

- **What is Binary Classification?**
    - A task in machine learning where the model classifies data into one of two categories.
- **Why this Project?**
    - Applications in security, automation, and quality control.
    - Simplifies tasks like object detection and recognition.

Objectives

1. Develop a CNN model for binary image classification.
2. Achieve high accuracy on test data.
3. Generalize well to unseen images.
4. Create a scalable framework for potential multi-class tasks.

Dataset

- **Dataset Structure**:

```
car_bike_dataset/
    train/
        cars/
        bikes/
    test/
        cars/
        bikes/
```

- **Transformations**:
    - Resized images to 224x224 pixels.
    - Normalization and conversion to tensors.
- **Train/Validation Split**:
    - 80% training, 20% validation.

Model Architecture

- **Model Components**:
    1. **Convolutional Layers**: Feature extraction.
    2. **Max-Pooling Layers**: Dimensionality reduction.
    3. **Fully Connected Layers**: Classification.
    4. **Activation Functions**: ReLU

- **Output**: Binary (Car or Bike).

Training Process

- **Loss Function**: Binary Cross-Entropy with Logits Loss.
- **Optimizer**: Adam.
- **Hyperparameters**:
    - Batch Size: 32
    - Learning Rate: 0.001
    - Epochs: 5
- **Tools Used**:
    - PyTorch, TorchVision.

Results

- **Training and Validation Metrics**:
    - Accuracy and loss across epochs.
    - Graphs showcasing model convergence.
- **Test Accuracy**:
    - [Insert Accuracy, e.g., 91.23%].
- **Confusion Matrix**:
    - Visualization of true vs. predicted labels.

Challenges

- Limited dataset size.
- Overfitting during initial training.
- Model fine-tuning to improve generalization.

Future Work

- Extend to multi-class classification.
- Implement transfer learning with pre-trained models (e.g., ResNet).
- Deploy model for real-world use cases.
- Experiment with additional data augmentation techniques.
