CS 6375 Project Report 3

Deep Learning and SVM on Mushroom Classification

Submission Date: May 11th, 2025

Objective

The objective of this project is to build two machine learning models using the Mushrooms dataset:

1. A Convolutional Neural Network (CNN) with a softmax output layer for multiclass classification.
2. A feature extraction where the CNN is used to extract feature embeddings, which are then passed into a Support Vector Machine (SVM) classifier for final prediction.

Data Preparation

- **Dataset:**
  The dataset contains mushroom images categorized into 9 classes:
  Agaricus, Amanita, Boletus, Cortinarius, Entoloma, Hygrocybe, Lactarius, Russula, Suillus.
- **Loading Data:**
  Images are read from disk using TensorFlow and validated by decoding them as JPEG.
- **Data Preprocessing:**
  Each image is:
  - Decoded to RGB (3 channels),
  - Resized to 224 × 224 pixels,

- Normalized by scaling pixel values to [0, 1].

- **Data Splitting:**
  80% of the dataset is used for training and 20% for validation, shuffled with a fixed seed for reproducibility.

- **Data Augmentation**

  To enhance the model's robustness and prevent overfitting, we applied data augmentation during the training phase. These augmentations help simulate real-world variations in rotation and zooming.

Model Architecture

1.Base CNN Model (with Softmax)

- Input: 224 × 224 × 3 RGB image.
- Layers:
  - Conv2D(32 filters, 3×3) + ReLU + MaxPooling.
  - Conv2D(64 filters, 3×3) + ReLU + MaxPooling.
  - Flatten.
  - Dense(128) + ReLU.
  - Dense(9) + Softmax.

This results in 5 layers (2 conv, 2 dense, 1 flatten)

Training Setup:

- Optimizer: Adam (learning rate: 1e-4).
- Loss Function: Sparse Categorical Crossentropy.

- Metrics: Accuracy.
- Epochs: 30.
- Batch size: 32.

Layer (type)	Output Shape	Param #
input_layer_12 (InputLayer)	(None, 224, 224, 3)	0
sequential_6 (Sequential)	(None, 224, 224, 3)	0
conv2d_12 (Conv2D)	(None, 222, 222, 32)	896
max_pooling2d_12 (MaxPooling2D)	(None, 111, 111, 32)	0
conv2d_13 (Conv2D)	(None, 109, 109, 64)	18,496
max_pooling2d_13 (MaxPooling2D)	(None, 54, 54, 64)	0
flatten_6 (Flatten)	(None, 186624)	0
dense_12 (Dense)	(None, 128)	23,888,000
dense_13 (Dense)	(None, 9)	1,161

Total params: 71,725,661 (273.61 MB)
Trainable params: 23,908,553 (91.20 MB)
Non-trainable params: 0 (0.00 B)
Optimizer params: 47,817,108 (182.41 MB)

2. Feature Extraction + SVM

- After training, we create a feature extractor model by cutting off the softmax layer.
- We pass training and validation images through this extractor to get 128-dimensional feature vectors.
- We then train an SVM with linear kernel on these vectors.

Saving Models

- The CNN model is saved in keras format:

  trained_cnn_model.keras
- The trained SVM is saved using joblib:

  trained_svm_classifier.joblib

Test and Evaluation

- CNN softmax accuracy on validation set: 98.14%, loss: 0.0732
- SVM classifier accuracy on validation set: 99.55%.
- CNN softmax model accuracy: Test model, accuracy: 100.00000%, accuracy: 1.0000 - loss: 0.0902
- SVM classifier accuracy: Test model, accuracy: 100.00000%

Environment Setup

The development and testing environment:

- Python: 3.9.15
- TensorFlow: 2.19.0
- Scikit-learn: 1.6.1
- Pandas: 2.2.3

Summary

In this project, we developed two machine learning models: a Convolutional Neural Network (CNN) with a softmax layer for direct multiclass mushroom classification, and a CNN-based feature extractor combined with a Support Vector Machine (SVM) for enhanced prediction. The models achieved excellent performance, with the CNN reaching 98.14% validation accuracy and the SVM achieving 99.55%, both ultimately achieving 100% accuracy on the test set. The data preparation process included resizing images to 224×224, normalizing pixel values, and applying mild data augmentation (rotation and zoom) to improve robustness. Both models were saved for deployment, with the CNN stored in Keras format and the SVM saved using joblib.