AI Tools Assignment Report

Part 1: Theoretical Understanding

1. Short Answer Questions

Q1: Explain the primary differences between TensorFlow and PyTorch. When would you choose one over the other?

- TensorFlow and PyTorch are both powerful deep learning frameworks:

  - TensorFlow (developed by Google) uses static computation graphs (though it now supports eager execution). It's ideal for production environments and deployment with TensorFlow Serving and TensorFlow Lite.

  - PyTorch (developed by Facebook) uses dynamic computation graphs, making it intuitive for research and debugging. PyTorch is widely preferred in academia.

  You might choose TensorFlow for scalability and deployment, and PyTorch for flexibility and experimentation.

Q2: Describe two use cases for Jupyter Notebooks in AI development.

- - Interactive data exploration and visualization.
  - Prototyping and testing machine learning models with immediate feedback.

Q3: How does spaCy enhance NLP tasks compared to basic Python string operations?

- spaCy is a robust NLP library offering pretrained models, named entity recognition (NER), part-of-speech tagging, and dependency parsing. It handles text contextually, unlike string operations which are basic and context-agnostic.

2. Comparative Analysis

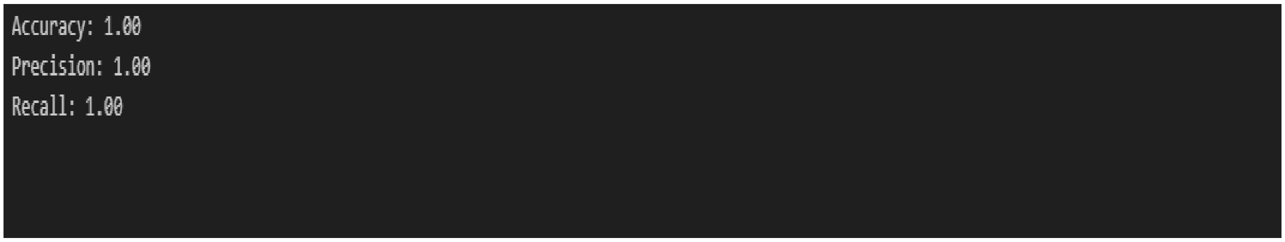
Scikit-learn vs. TensorFlow

- - Target Applications: Scikit-learn is best for classical ML (e.g., decision trees, SVMs), TensorFlow is ideal for deep learning (e.g., CNNs, RNNs).
- - Ease of Use: Scikit-learn is simpler for beginners; TensorFlow has a steeper learning curve.
- - Community Support: Both have large communities, but TensorFlow has broader industrial support due to deployment tools.

Part 2: Practical Implementation

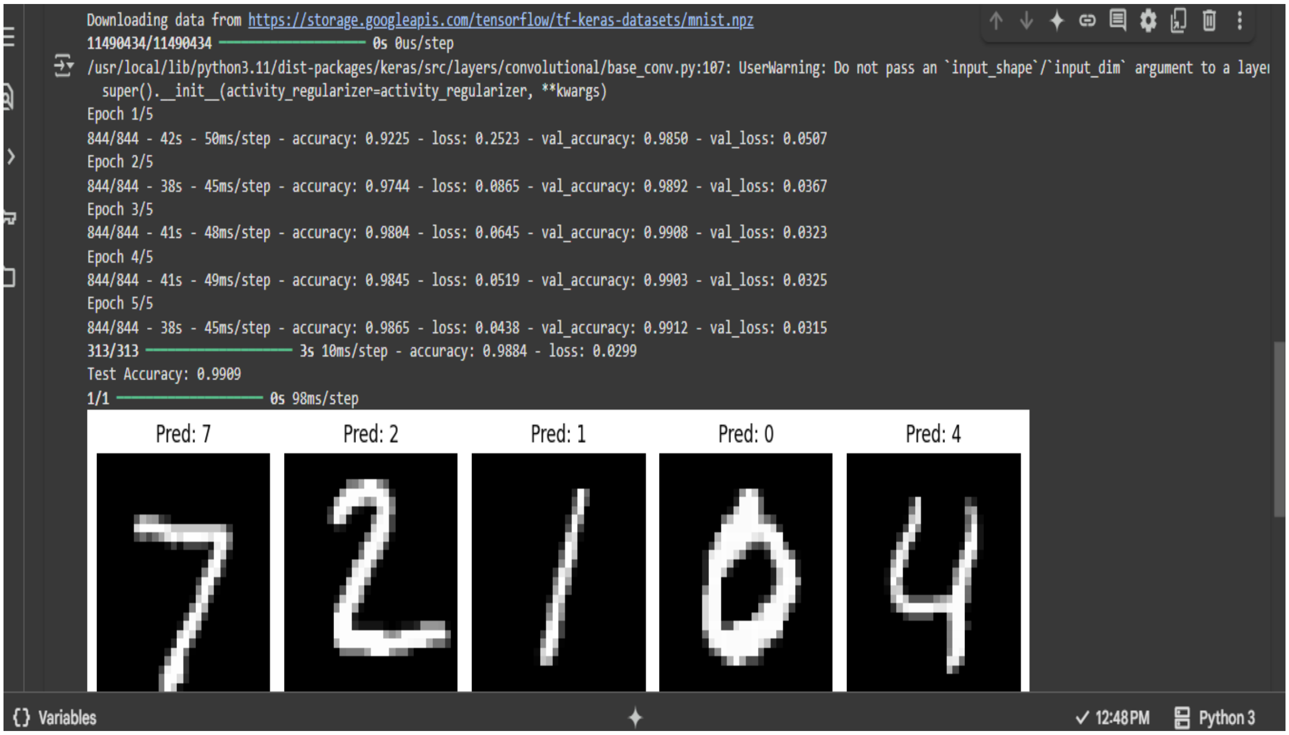
See Jupyter Notebooks for implementation details of the following tasks:

- Task 1: Iris Classification using Scikit-learn



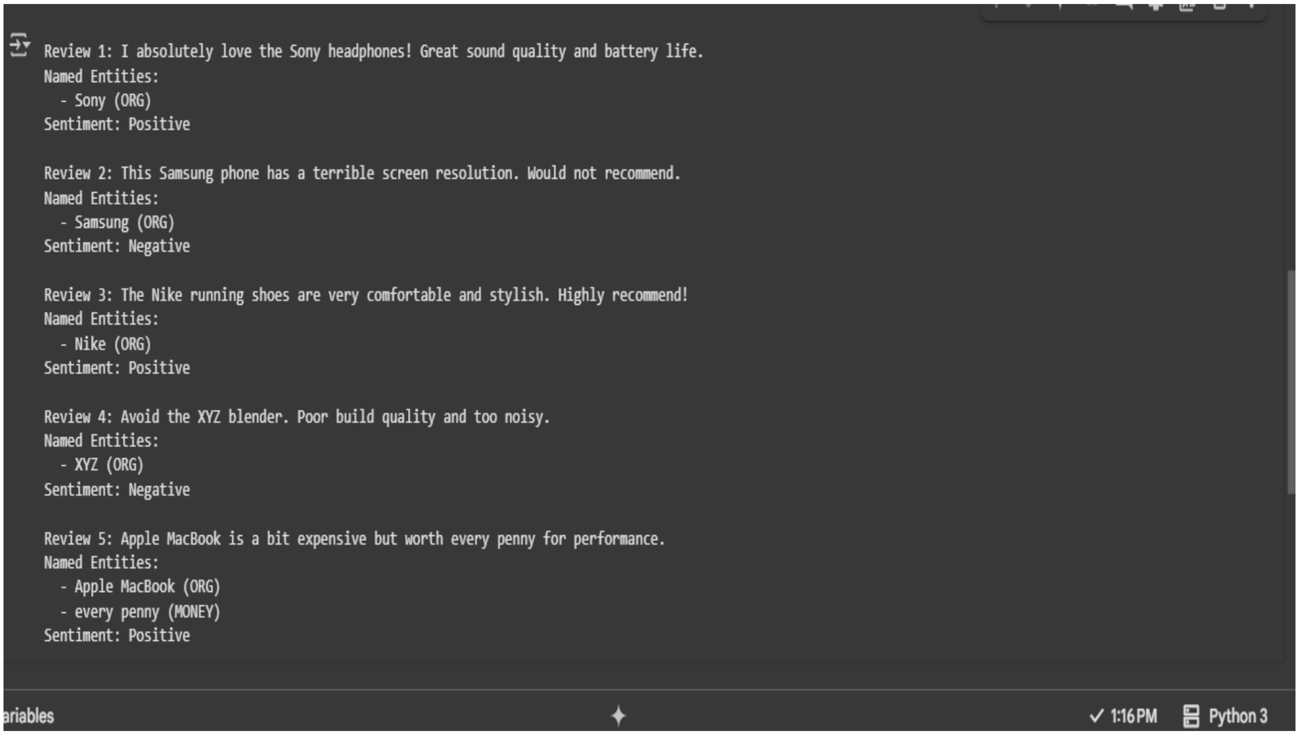
```
Accuracy: 1.00
Precision: 1.00
Recall: 1.00
```

- Task 2: Handwritten Digit Recognition with TensorFlow CNN



```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz
11490434/11490434 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
/usr/local/lib/python3.11/dist-packages/keras/src/layers/convolutional/base_conv.py:107: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Epoch 1/5
844/844 - 42s - 50ms/step - accuracy: 0.9225 - loss: 0.2523 - val_accuracy: 0.9850 - val_loss: 0.0507
Epoch 2/5
844/844 - 38s - 45ms/step - accuracy: 0.9744 - loss: 0.0865 - val_accuracy: 0.9892 - val_loss: 0.0367
Epoch 3/5
844/844 - 41s - 48ms/step - accuracy: 0.9804 - loss: 0.0645 - val_accuracy: 0.9908 - val_loss: 0.0323
Epoch 4/5
844/844 - 41s - 49ms/step - accuracy: 0.9845 - loss: 0.0519 - val_accuracy: 0.9903 - val_loss: 0.0325
Epoch 5/5
844/844 - 38s - 45ms/step - accuracy: 0.9865 - loss: 0.0438 - val_accuracy: 0.9912 - val_loss: 0.0315
313/313 ━━━━━━━━━━━━━━━━━━━━ 3s 10ms/step - accuracy: 0.9884 - loss: 0.0299
Test Accuracy: 0.9909
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 98ms/step
```

Task 3: Amazon Reviews NER and Sentiment Analysis using spaCy



```
Review 1: I absolutely love the Sony headphones! Great sound quality and battery life.
Named Entities:
  - Sony (ORG)
Sentiment: Positive

Review 2: This Samsung phone has a terrible screen resolution. Would not recommend.
Named Entities:
  - Samsung (ORG)
Sentiment: Negative

Review 3: The Nike running shoes are very comfortable and stylish. Highly recommend!
Named Entities:
  - Nike (ORG)
Sentiment: Positive

Review 4: Avoid the XYZ blender. Poor build quality and too noisy.
Named Entities:
  - XYZ (ORG)
Sentiment: Negative

Review 5: Apple MacBook is a bit expensive but worth every penny for performance.
Named Entities:
  - Apple MacBook (ORG)
  - every penny (MONEY)
Sentiment: Positive
```

Part 3: Ethics & Optimization

1. Ethical Considerations

Bias in MNIST Model

Potential biases include class imbalance, style representation bias, and accessibility issues. Mitigation strategies include using TensorFlow Fairness Indicators, data augmentation, and continuous fairness monitoring.

Bias in spaCy + Amazon Reviews

Biases include sentiment skew, cultural/language limitations, and NER errors. Solutions include custom training, rule-based enhancements, and balanced data usage.

2. Troubleshooting Challenge

Original Bugs:

- - Incorrect loss function: used MSE for classification
  - Input shape mismatch: missing channel dimension

Fixes Applied:

- - Used categorical_crossentropy for loss
  - Reshaped input to (28, 28, 1)
  - One-hot encoded labels