FINANCIAL TRADING WITH DEEP CONVOLUTIONAL NEURAL NETWORKS: APPLE STOCK

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- **In this era of globalization**, understanding of stocks is being increasingly explored by both academics and practitioners.
- **Technical indicators** related to stocks are used to analyze historical stock price data.
- **With the high availability of data,** algorithmic trading has been developed to automate stock buying and selling processes.
- **Deep Learning** has emerged as one of the predictive models for stock price movements.
- **Technical indicators** are applied to **Convolutional Neural Networks (CNN)** in hopes of improving prediction accuracy.

METHODOLOGY – DATA

Daily stock price data is labeled as **Buy**, **Sell**, or **Hold** based on peak and trough points within a sliding window:

- Buy = Lowest price in the window.
- Sell = Highest price in the window.
- Hold = All other points.

Label Encoding:

- Sell = 0
- Buy = 1
- Hold = 2

METHODOLOGY – TECH INDICATOR

- Technical Indicators
  - Relative Strength Index (RSI)
  - William %R
  - Money Flow Index (MFI)
  - Rate of Change (ROC)
  - Chaikin Money Flow (CMF)
  - Chande Momentum Oscillator (CMO)
  - Simple Moving Average (SMA)

- Technical Indicators
  - Exponential Moving Average (EMA)
  - Weighted Moving Average (WMA)
  - Hull Moving Average (HMA)
  - Triple Exponential Average (TRIX)
  - Commodity Channel Index (CMI)
  - Detrended Price Oscillator (DPO)
  - Directional Moving Indicator (DMI)

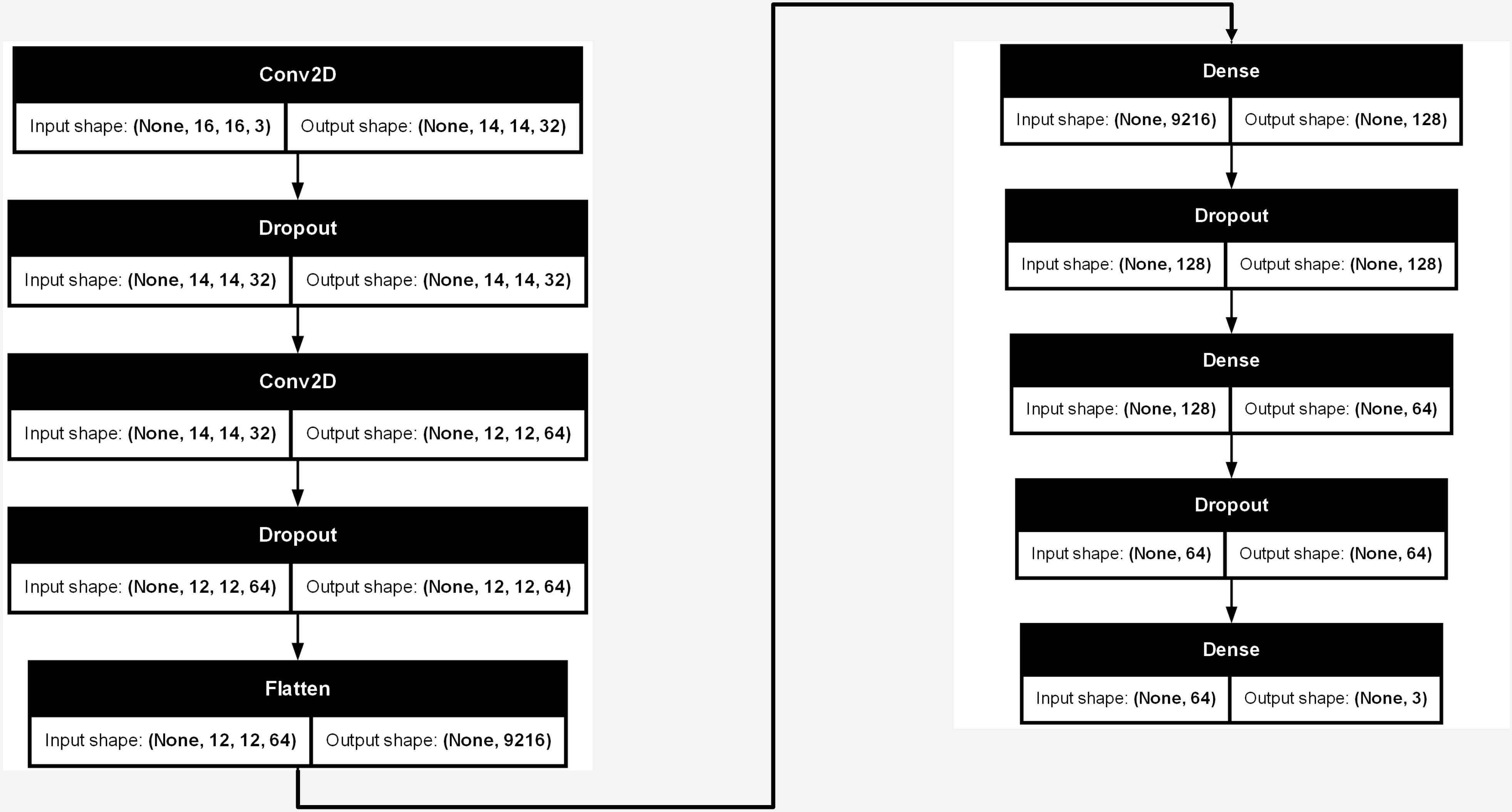
METHODOLOGY - CNN

Convolutional Neural Networks (CNNs) are a specialized form of neural networks designed to process data with grid-like topology (e.g., images, time-series).

Key Concepts:

1. **Convolution**:
   - A specialized linear operation where a **filter** (e.g., a matrix for image data) is applied across the entire input.
   - Extracts local features (e.g., edges, textures) through sliding-window computations.
2. **Fully Connected Layer**:
   - After convolution, features are passed to fully connected layers for **high-level reasoning** (e.g., classification).

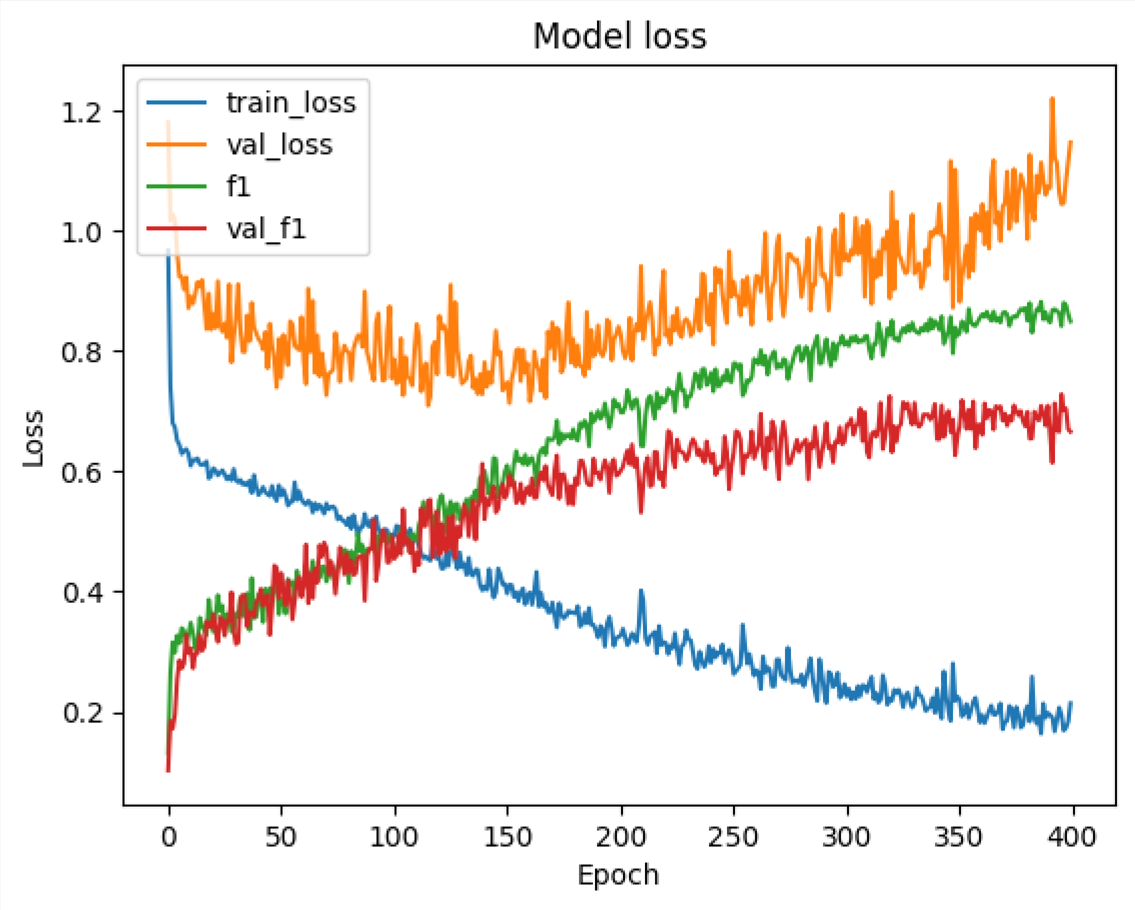
METHODOLOGY - CNN



RESULT

Batch Size: 80
Epoch: 400
LR: 1e-4
Optimasi Adam ($\beta_1 = 0.9, \beta_2 = 0.999$)
Loss: Categorical Loss Enthropy

Acc	**0.8514**
Val Acc	**0.6664**
Loss	**0.2136**
Val Loss	**1.1462**
F1 Score	**0.8514**
F1 Val	**0.6652**



RESULT

	Prediction			
Actual		Sell	Buy	Hold
	Sell	15	2	49
	Buy	0	37	31
	Hold	146	170	752

Total Accuracy: 0.67			
	Sell	Buy	Hold
Recall	0.23	0.54	0.70
Precision	0.09	0.18	0.90
F1-Score	0.13	0.27	0.79

DISCUSSION

Training Fluctuation Plot

Accuracy and Loss Trends: Both metrics show fluctuations, but overall improve as epochs increase.

Accuracy Improvement

Training accuracy and validation accuracy rise with epochs, but the gap between them widens, indicating potential overfitting.

Loss Reduction

Training loss consistently decreases, while validation loss increases—a clear sign of overfitting.

Data Imbalance Issues

- Overfitting Persists: Despite using class weights, the model overfits due to significant data imbalance.
- Impact of Imbalance: Minority class data becomes harder to learn and contains more noise.

SUGGESTION

Data Imbalance:

The dataset exhibits significant class imbalance across the "sell", "buy", and "hold" labels.

Practical Implications:

While this model has practical real-world applications, it carries a substantial risk of overfitting.

Overfitting Issue:

The model demonstrates a strong tendency to overfit, primarily due to the data imbalance.

Overfitting Mitigation Strategies:

One promising approach to address overfitting is data augmentation.

- Data augmentation can effectively balance the dataset by increasing samples in minority classes.
- This technique helps reduce model bias toward majority classes while improving generalization.

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THANK YOU