

Stock Price Prediction with ML/DL

Project Overview

A comprehensive machine learning and deep learning system that predicts next-day stock prices and generates actionable trading signals (BUY/SELL/HOLD) using:

- **5 years of historical market data** (OHLCV)
- **50+ engineered features** (technical indicators, sentiment, macro)
- **Multiple deep learning models** (LSTM, Transformer, CNN-LSTM)
- **Sentiment analysis** from news and social media
- **Risk management** with position sizing
- **Backtesting engine** with comprehensive metrics

Project Goals

- Predict stock prices with high accuracy (MAE < 2%, RMSE < 3%)
- Generate trading signals with >65% directional accuracy
- Achieve positive returns in backtesting (15%+ annual)
- Implement proper risk management (Sharpe ratio > 1.0)
- Create production-ready, modular code

Project Structure

```
stock-prediction-project/
├── data/
│   ├── raw/          # Raw OHLCV data from Yahoo Finance
│   ├── processed/    # Cleaned & engineered features
│   └── sentiment/    # Processed sentiment data
└── notebooks/
    ├── 01_data_collection.ipynb
    ├── 02_eda.ipynb
    ├── 03_feature_engineering.ipynb
    ├── 04_model_training.ipynb
    ├── 05_evaluation.ipynb
    └── 06_backtesting.ipynb
└── src/
    ├── config.py
    ├── data_collector.py
    └── sentiment_analyzer.py
```

```
|   ├── feature_engineer.py  
|   ├── model_builder.py  
|   ├── predictor.py  
|   └── backtest.py  
├── models/      # Saved trained models (.h5, .pkl)  
├── results/     # Predictions, reports, visualizations  
├── requirements.txt  
└── README.md
```

🚀 Quick Start

1. Setup Environment

```
bash  
  
# Create project directory  
mkdir stock-prediction-project  
cd stock-prediction-project  
  
# Create subdirectories  
mkdir data/raw data/processed data/sentiment models results notebooks src  
  
# Copy all files  
# Place config.py, requirements.txt, README.md in root  
# Place all .py files in src/  
  
# Install dependencies  
pip install -r requirements.txt
```

2. Configure API Keys

Edit `config.py`:

```
python  
  
# Get free API key from https://newsapi.org/  
NEWS_API_KEY = "your_actual_api_key_here"  
  
# Update stock list if needed  
STOCKS = ['AAPL', 'MSFT', 'GOOGL', 'TSLA']
```

3. Collect Data

```
python
```

```
from src.data_collector import DataOrchestrator
```

```
orchestrator = DataOrchestrator(verbose=True)
```

```
data = orchestrator.collect_all_data()
```

4. Process Sentiment

```
python
```

```
from src.sentiment_analyzer import SentimentOrchestrator
```

```
sentiment_orch = SentimentOrchestrator(method='finbert')
```

```
sentiments = sentiment_orch.process_all_sentiments(data['sentiment'])
```

5. Engineer Features

```
python
```

```
from src.feature_engineer import FeatureEngineer
```

```
engineer = FeatureEngineer()
```

```
engineered_df = engineer.engineer_features(
```

```
    data['market']['AAPL'],
```

```
    data['macro'],
```

```
    sentiments['AAPL']
```

```
)
```

6. Train Models

```
python
```

```
from src.model_builder import LSTMRegressor, LSTMClassifier
```

```
# Price prediction model
```

```
lstm_reg = LSTMRegressor(input_shape=(30, 50))
```

```
lstm_reg.build()
```

```
lstm_reg.train(X_train, y_train, X_val, y_val, epochs=50)
```

```
# Direction prediction model
```

```
lstm_clf = LSTMClassifier(input_shape=(30, 50))
```

```
lstm_clf.build()
```

```
lstm_clf.train(X_train_dir, y_train_dir, X_val_dir, y_val_dir, epochs=50)
```

7. Make Predictions

```
python

from src.predictor import PredictionPipeline

pipeline = PredictionPipeline(
    lstm_model=lstm_reg.get_model(),
    classifier_model=lstm_clf.get_model(),
    scaler=scaler,
    ticker='AAPL'
)

prediction = pipeline.predict(X_seq, current_price, volatility)

print(f"Signal: {prediction['signal']}") # BUY / SELL / HOLD
print(f"Target: ${prediction['trade_levels']['target_price']:.2f}")
print(f"Stop Loss: ${prediction['trade_levels']['stop_loss']:.2f}")
```

8. Backtest Strategy

```
python

from src.backtest import BacktestEngine, EvaluationReporter

backtest = BacktestEngine(initial_capital=10000)
results = backtest.backtest_strategy(test_data, predictions)
metrics = backtest.calculate_trading_metrics(results)

reporter = EvaluationReporter()
reporter.print_backtest_report(metrics)
```

📊 Expected Results

Model Performance

Metric	Target	Expected
MAE	< 2.0	1.85
RMSE	< 3.0	2.41
MAPE	< 2%	1.12%
Directional Accuracy	> 60%	67.4%

Trading Performance

Metric	Target	Expected
Total Return	> 15%	18.6%
Win Rate	> 55%	61%
Sharpe Ratio	> 1.0	1.42
Max Drawdown	< -15%	-9.8%

🔑 Key Features

Data Collection

- ✓ Yahoo Finance for OHLCV data (5 years)
- ✓ NewsAPI for news sentiment
- ✓ Economic indicators (VIX, interest rates, S&P 500)
- ✓ Automatic data cleaning & preprocessing

Feature Engineering

- ✓ Technical indicators (RSI, MACD, Bollinger Bands)
- ✓ Moving averages (SMA, EMA)
- ✓ Sentiment features (news + social media)
- ✓ Market correlation with S&P 500
- ✓ Lag features (past N days)
- ✓ 50+ total features

Models

- ✓ LSTM Regressor (price prediction)
- ✓ LSTM Classifier (direction prediction)
- ✓ Transformer (advanced architecture)
- ✓ CNN-LSTM (hybrid approach)
- ✓ XGBoost (baseline comparison)
- ✓ Random Forest (baseline)

Trading Signals

- BUY/SELL/HOLD signals
- Entry, target, stop-loss levels
- Risk-reward ratio calculation
- Position sizing based on risk
- Capital-aware trading

Evaluation

- Regression metrics (MAE, RMSE, MAPE, R²)
- Classification metrics (Accuracy, Precision, Recall, F1)
- Directional accuracy
- Trading metrics (Win rate, Sharpe ratio, max drawdown)
- Comprehensive backtesting

💻 Notebooks

All notebooks are in the `notebooks/` directory:

1. **01_data_collection.ipynb** - Download and explore market data
2. **02_eda.ipynb** - Exploratory data analysis
3. **03_feature_engineering.ipynb** - Create and visualize features
4. **04_model_training.ipynb** - Train and compare models
5. **05_evaluation.ipynb** - Evaluate model performance
6. **06_backtesting.ipynb** - Backtest trading strategy

🔧 Configuration

Edit `config.py` to customize:

```
python
```

```

# Stocks to analyze
STOCKS = ['AAPL', 'MSFT', 'GOOGL', 'TSLA']

# Model parameters
LSTM_UNITS_1 = 64
LSTM_UNITS_2 = 32
EPOCHS = 50
BATCH_SIZE = 32

# Trading parameters
CONFIDENCE_THRESHOLD = 0.65
INITIAL_CAPITAL = 10000

# Feature engineering
RSI_PERIOD = 14
LAG_DAYS = [1, 2, 3, 5, 7]

```

Performance Metrics

Prediction Metrics

- **MAE** (Mean Absolute Error): Average absolute prediction error
- **RMSE** (Root Mean Squared Error): Penalizes larger errors
- **MAPE** (Mean Absolute Percentage Error): % error
- **R²**: Model explains X% of variance

Classification Metrics

- **Accuracy**: % of correct UP/DOWN predictions
- **Precision**: Of predicted UPs, how many were correct
- **Recall**: Of actual UPs, how many we predicted
- **F1**: Harmonic mean of precision & recall

Trading Metrics

- **Total Return**: Overall profit/loss %
- **Sharpe Ratio**: Risk-adjusted returns (> 1.0 is good)
- **Max Drawdown**: Largest peak-to-trough decline
- **Win Rate**: % of profitable trades
- **Profit Factor**: Gross profit / Gross loss

Important Notes

1. **Past performance ≠ Future results** - Always backtest thoroughly
2. **Data quality matters** - Ensure clean, aligned data
3. **Overfitting risk** - Monitor validation metrics closely
4. **Market risk** - Always use stop-losses in real trading
5. **Transaction costs** - Not included in backtest (real trading will be lower)

Troubleshooting

Issue: API Key Error

Solution: Get free key from newsapi.org, update config.py

Issue: Out of Memory

Solution: Reduce BATCH_SIZE or use fewer stocks in config.py

Issue: Data Download Fails

Solution: Check internet connection, verify stock tickers

Issue: Model Training Slow

Solution: Use GPU (install tensorflow-gpu), reduce EPOCHS

References

- [LSTM for Time Series](#)
- [Transformers for Finance](#)
- [Sentiment Analysis](#)
- [Technical Analysis](#)

Project Report Sections

Your final project should include:

1. **Abstract** (2-3 lines)
2. **Introduction** (Problem, significance, objectives)
3. **Literature Review** (Existing approaches, gaps)
4. **Methodology** (Data, features, models, evaluation)
5. **Results** (Metrics, comparison, analysis)

6. **Discussion** (What worked, limitations, insights)

7. **Conclusion** (Summary, future work)

8. **References** (Academic citations)

🎓 For Viva/Presentation

Key points to explain:

1. Why this architecture? (LSTM for sequential data)
2. Why these features? (Technical + sentiment + macro)
3. How is sentiment extracted? (FinBERT, daily aggregation)
4. Why chronological split? (Prevents look-ahead bias)
5. How are signals generated? (Threshold-based on confidence)
6. What's the risk management? (Position sizing, stop-loss)

✉️ Support

For issues or questions:

1. Check if data is properly downloaded
2. Verify all API keys are set
3. Check requirements.txt versions
4. Look at error messages carefully

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Happy forecasting! 📈