
DCH: DEEP
COGNITIVE HEDGERS
INTELLIGENT TRADING
THROUGH HYBRID AI

# CHALLENGES

## 01.

Market Uncertainty

## 02.

Limitations of traditional approach

# SOLUTION

## 01.

A hybrid ML/RL trading system:

- Gated Recurrent Unit (GRU)
- Transformer
- XGBoost
- Random Forest
- Deep Q Learning (RL)

# DATA PROCESSING PIPELINE

### Market Data

Historical stock price data from Yahoo Finance using yfinance API

### Technical Indicators

Added additional labels:

- Moving Average / Rolling Window
- RSI (Relative Strength Index)
- MACD

### Feature Engineering

Data preprocessing by handling outliers & missing data

### Model Training

Multi-model ML/RL approach:

- Deep Learning
- Traditional ML
- DQNAgent

### Trading Signal Generation

- ML signal
- RL signal
- Combined signal weighting algorithm

### Backtesting

Key metrics:

- Total return
- Annual return
- Sharpe Ratio
- Maximum drawdown

## US EQUITIES DATA - YAHOO FINANCE

Daily stock data of the most liquid US Stocks are used: NVDA, AAPL, GOOGL, MSFT, .. (from 2018 onwards)

## Parameters

- Open price
- Highest price in a day
- Lowest price in a day
- Closing price
- Capital gains
- 5-days Moving Avg
- 20-days Moving Avg
- EMA_12
- EMA_26
- MACD
- MACD Signal
- RSI
- Volatility
- Daily return

# DATASET

Features such as Moving Average, MACD, RSI are added to the raw data by doing feature engineering.

# FEATURE ENGINEERING

## MA (Moving Average)

$$MA(n) = \frac{\Sigma P}{n}$$

Where P is the average closing price of a specified day period within the total days. MA_5 considers all possible 5-day in a row averages.

## MACD (Moving Average Convergence DIvergence)

$$EMA(t) = Price(t) \times \frac{2}{span + 1} + EMA(t-1) \times \left(1 - \frac{2}{span + 1}\right)$$

MACD line = EMA(12) - EMA(26)

## RSI (Relative Stability Index)

$$RSI = 100 - \left(\frac{100}{1 + \frac{Gain_{avg}}{Loss_{avg}}}\right)$$

## Volatility

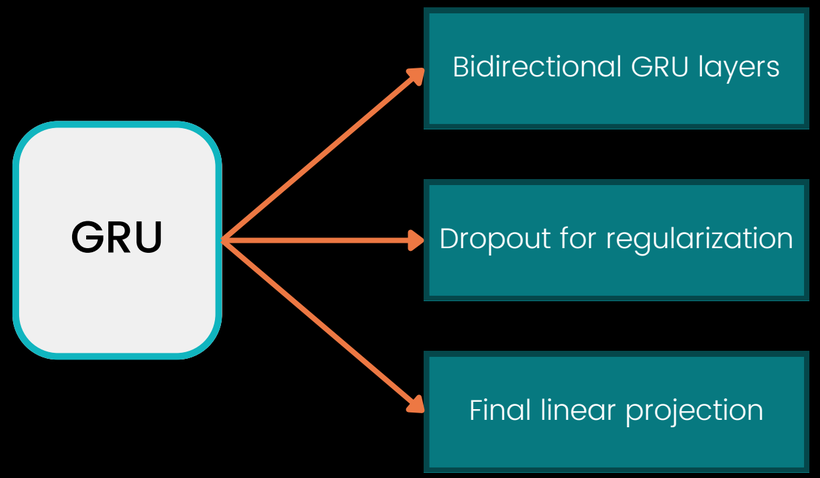
Formula: Standard deviation of closing prices over 20-day period

## Daily Return

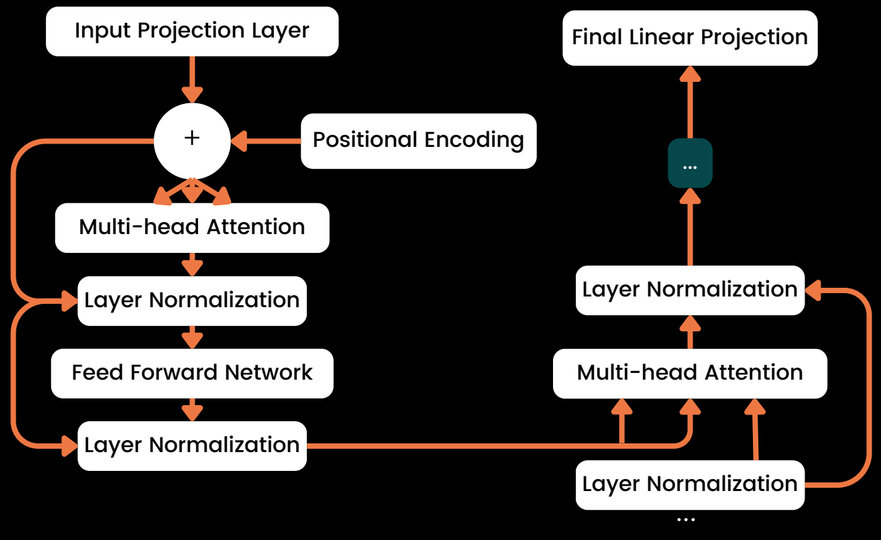
$$DailyReturn = \frac{CurrentClose - PreviousClose}{PreviousClose}$$

# MACHINE LEARNING MODELS

## DEEP LEARNING




**Transformers**



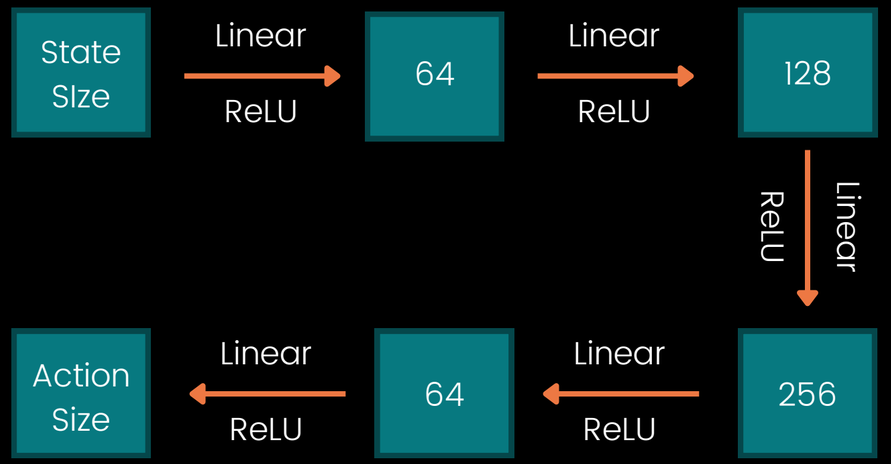

Dueling DQN Architecture (for RL agent):
Feature layer: State → 128 → ReLU → 128 → ReLU
Value stream: 128 → 64 → ReLU → 1
Advantage stream: 128 → 64 → ReLU → action_size
Combined: Q(s,a) = V(s) + (A(s,a) - mean(A(s,:)))

Transformer Architecture:
Input projection layer
Positional encoding
Multiple self-attention blocks:
Multi-head attention
Layer normalization
Feed-forward network
Final projection layer

GRU Architecture:
Bidirectional GRU layers
Dropout for regularization
Final linear projection

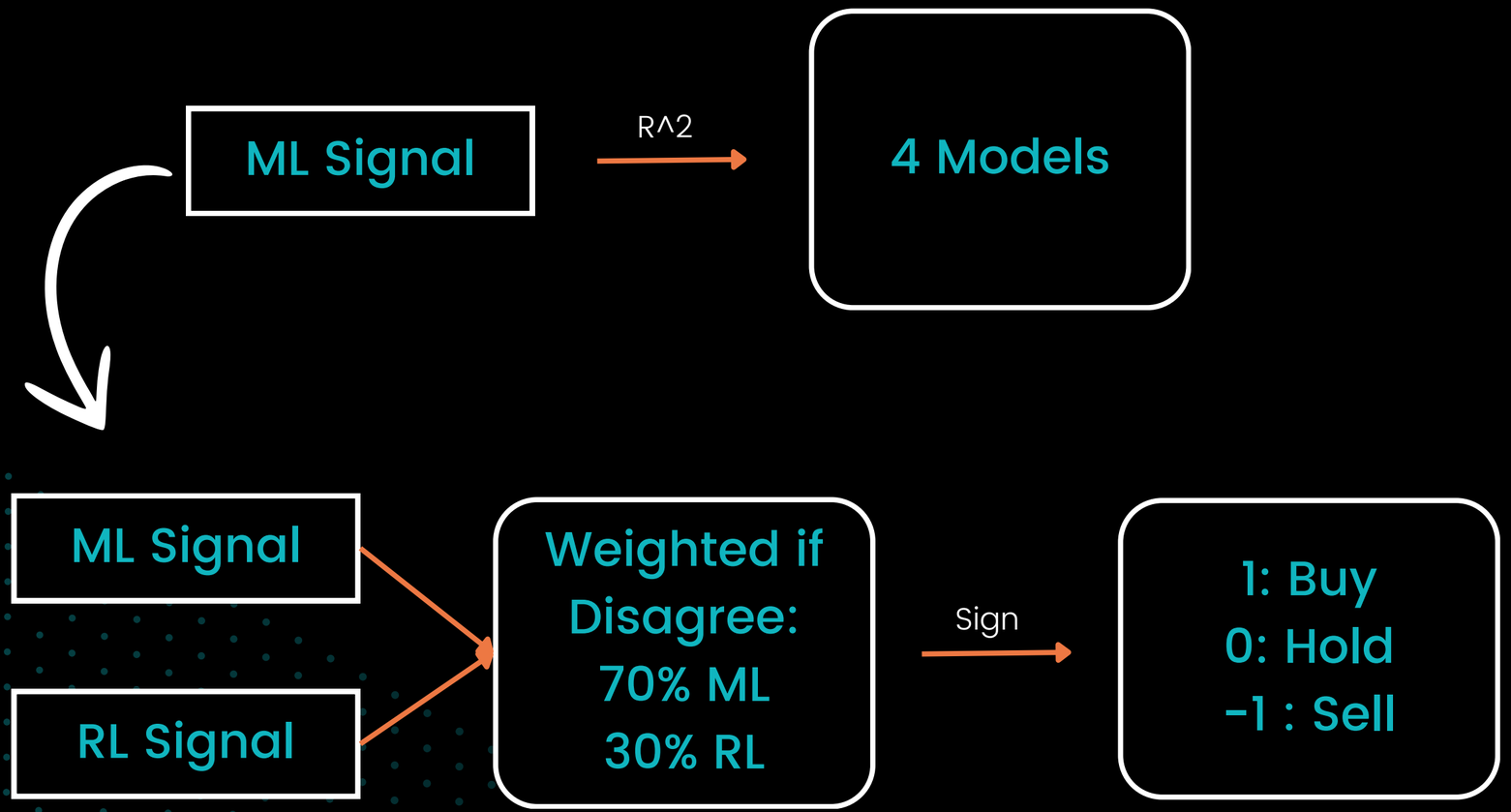
Dueling DQN Architecture"

## REINFORCEMENT LEARNING

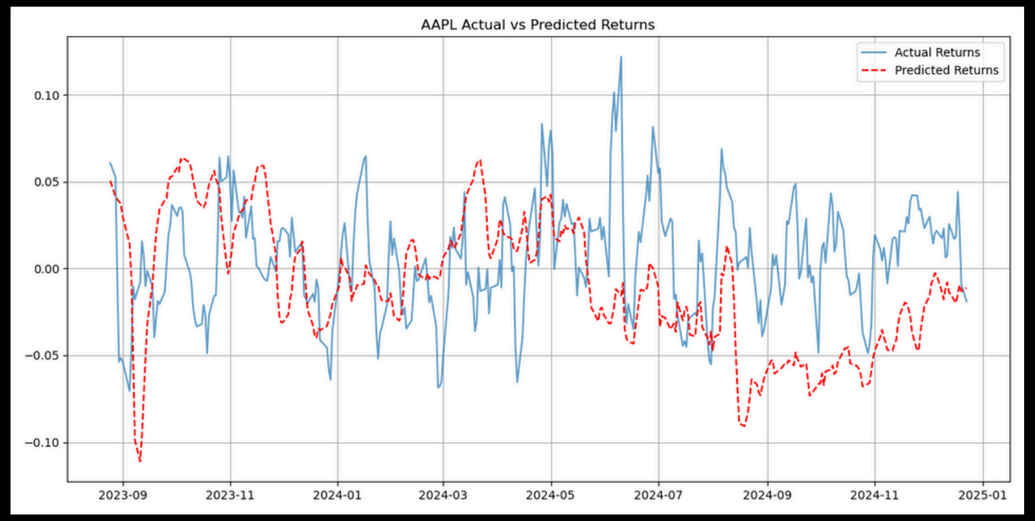


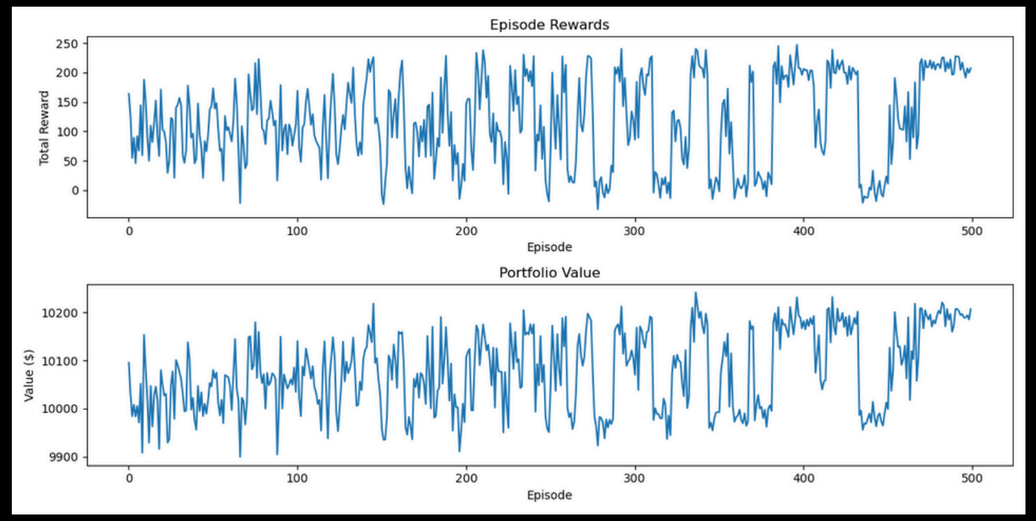

The agent learns through experience replay, storing past trades in memory and using them for training. It balances exploration of new strategies (random actions) and exploitation of learned patterns (predicted actions) using an ε-greedy approach, where ε gradually decreases from 1.0 to 0.01. The system uses two identical networks - a main network for actions and a target network for stable learning, with periodic updates between them to ensure consistent improvement.

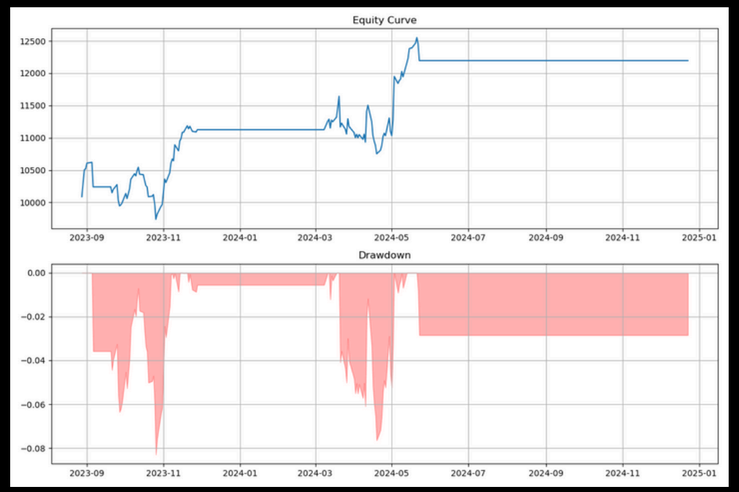
# SIGNAL GENERATION



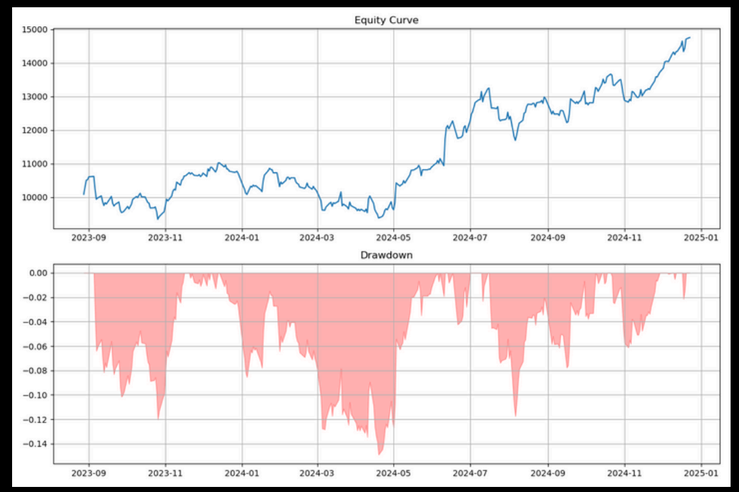
# RESULTS



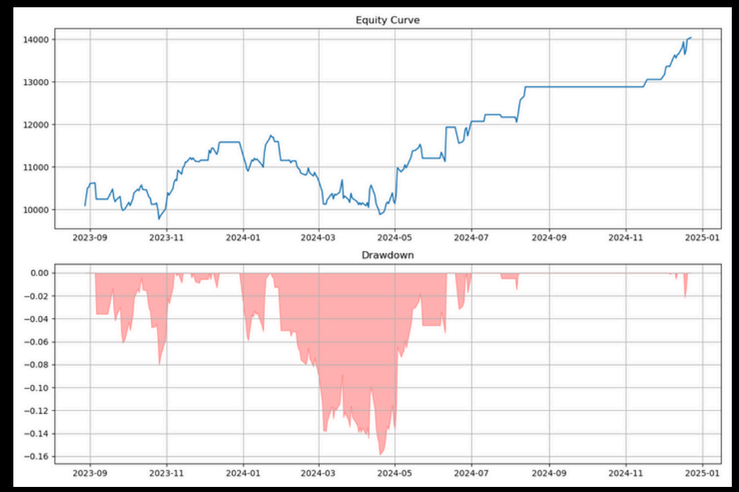




ML Result




RL Result



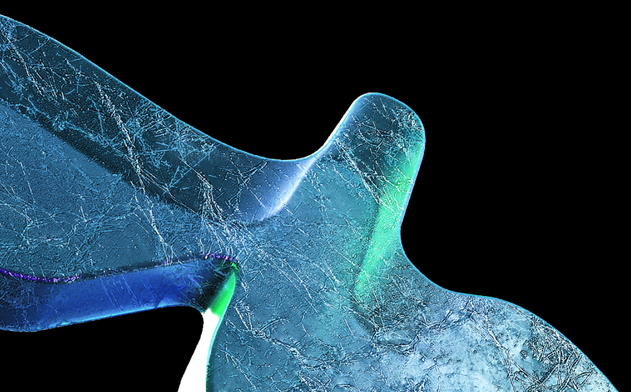

Combined Result

# RESULTS

**29.19%**
Average annual returns

**>40%**
Hedge Funds beaten
(Average Hedge Funds returns = 9.7%)

**40.42%**
ROI in 2025



## Generalized Model

Ensemble method was used to make a more generalized model, which hypothetically could improve accuracy especially in the volatile field of stock trading

# CONCLUSION