Challenges

Machine learning on Time Series Analysis

Solutions

Cheng-Yu Han

Investing

Gambling

Personal Life Financial Plan

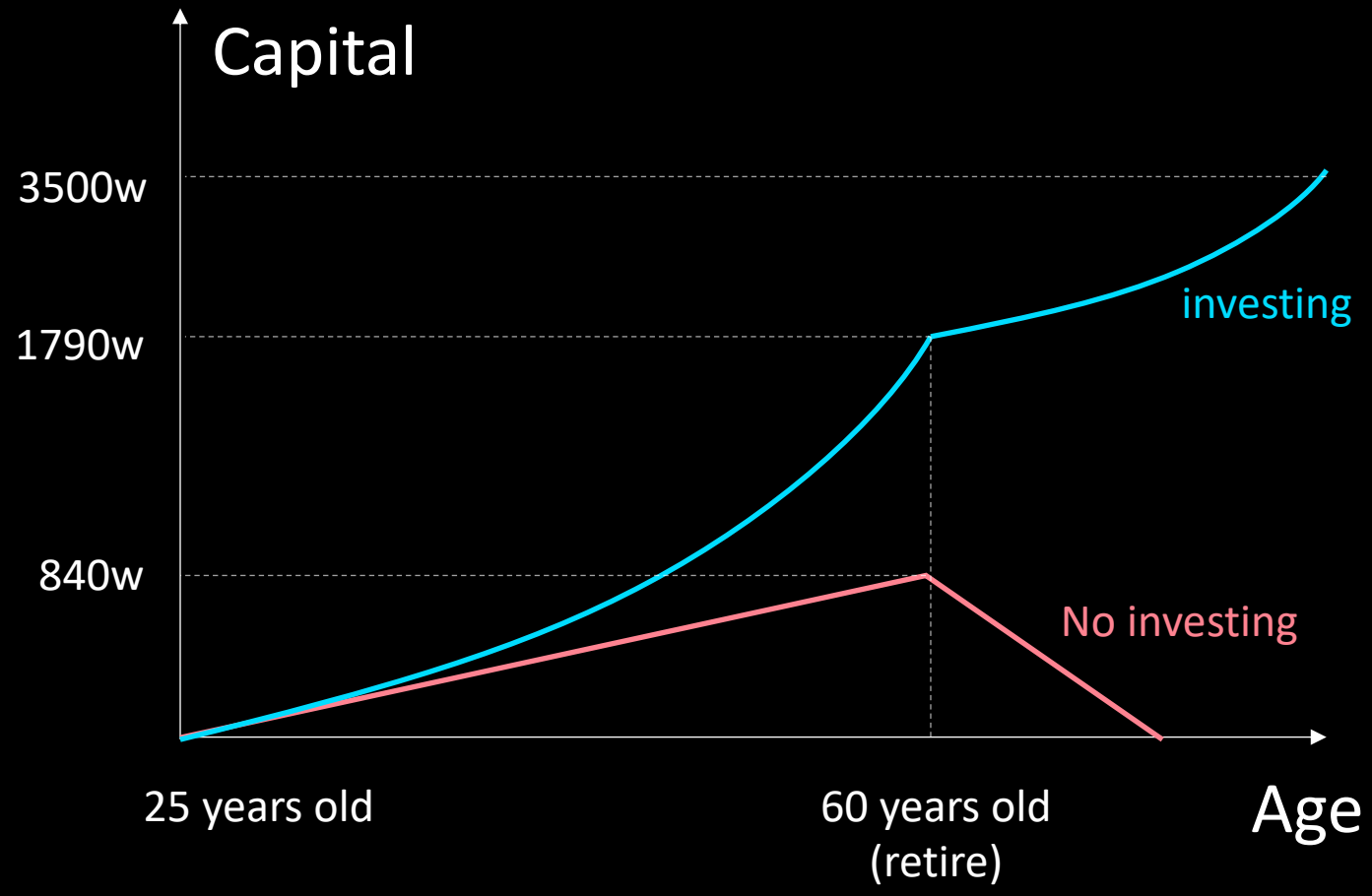
Capital simulation

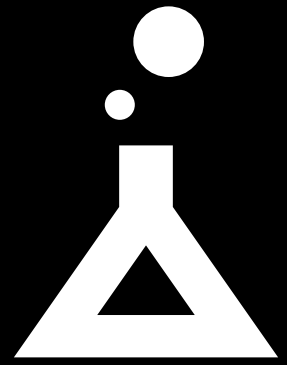
Income per month…..5w (NTD)

Spent per month……..3w (NTD)

Investment……..70% (of total capital)

Compound interest….5% (each year)



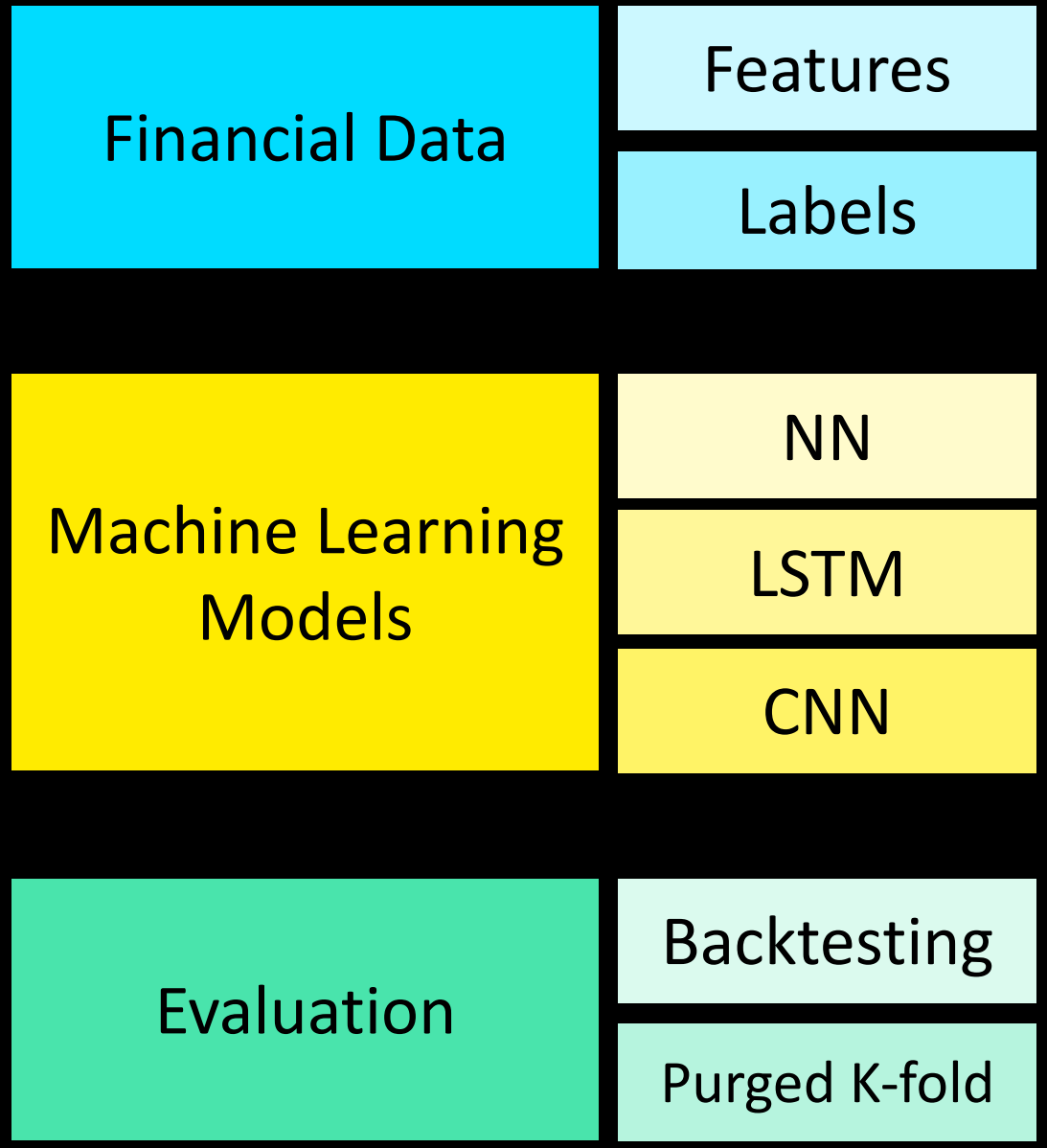


FinLab

FinLab

https://www.finlab.tw/mopcon.html

Outline


Financial Data
Features
Labels
Machine Learning Models
NN
LSTM
CNN
Evaluation
Backtesting
Purged K-fold

Trading programming language

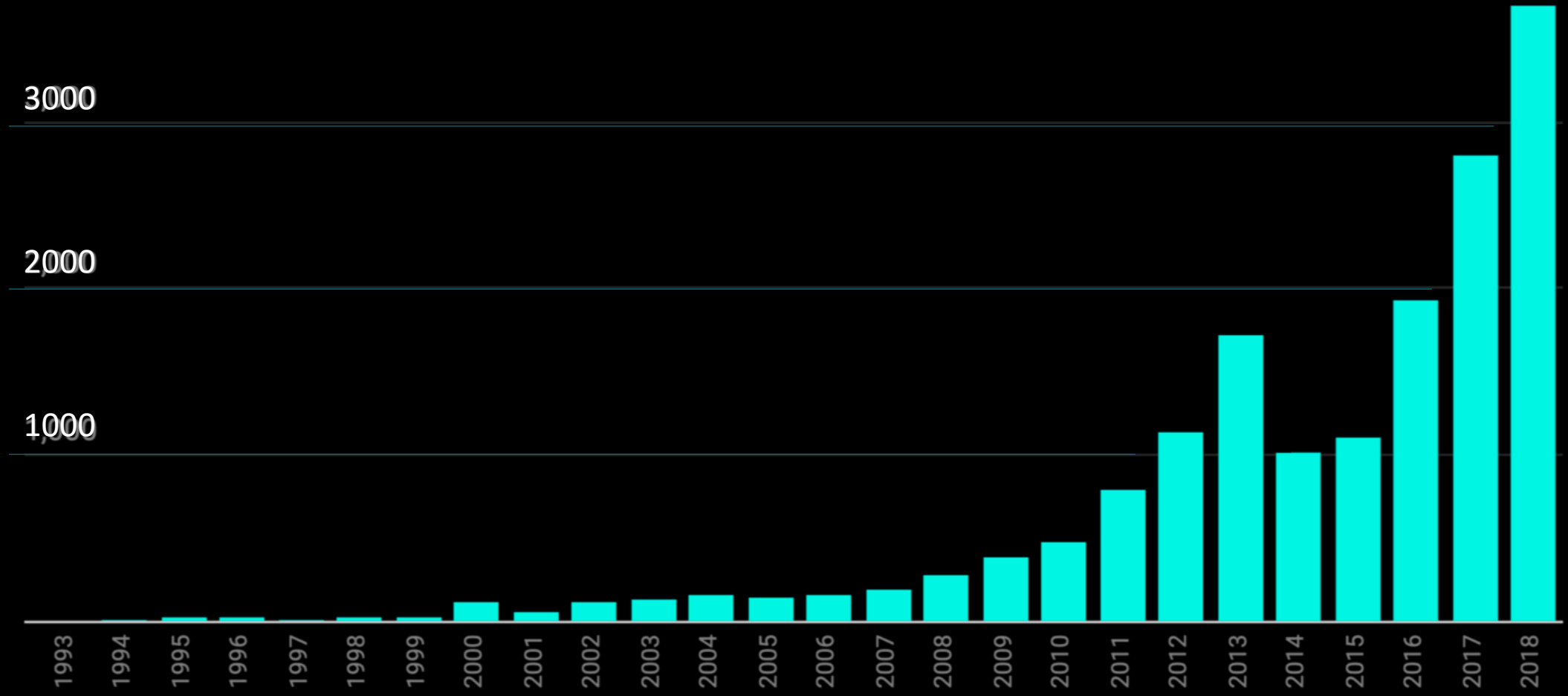
- Easy learning curve for the beginners
- Integrated with language editor in platforms
- Can be extend by external DLL
- Most of the functions are encrypted or the source code is not provided
- Does not support statistic analysis or machine learning toolkit

Trading programming language

- Friendly statistic toolkit

- Friendly statistic toolkit
- Strong community and widely applied
- Easy to deploy (Flask/Django/…)
- More innovative data science applications

Artificial Intelligence papers



All of the papers available in the “artificial intelligence” section (arXiv)

ML algorithms in finance?

Supervised Machine Learning

Training

features | labels

Color	Weight	Age	Category
■	3.2 kg	2	cat
■	4.2 kg	5	cat
■	6.2 kg	4	dog

→ ML Model

Testing

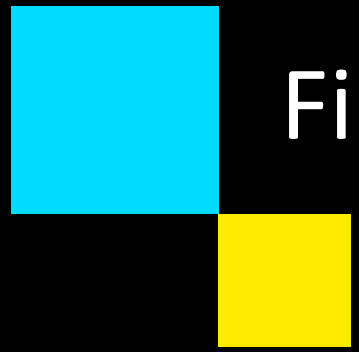
features

Color	Weight	Age
■	3.2 kg	2
■	4.2 kg	5
■	6.2 kg	4

→ ML Model →

labels

True Answer	Prediction
cat	cat
cat	dog
dog	dog



Financial Data (Features)

Financial Data Structures

Fundamental data

Focusing on creating a portrait of a company

- Useful to combine other data types
- Difficult to confirm data release date
- Missing data is often backfilled
- Consider multiple correction

Trading data

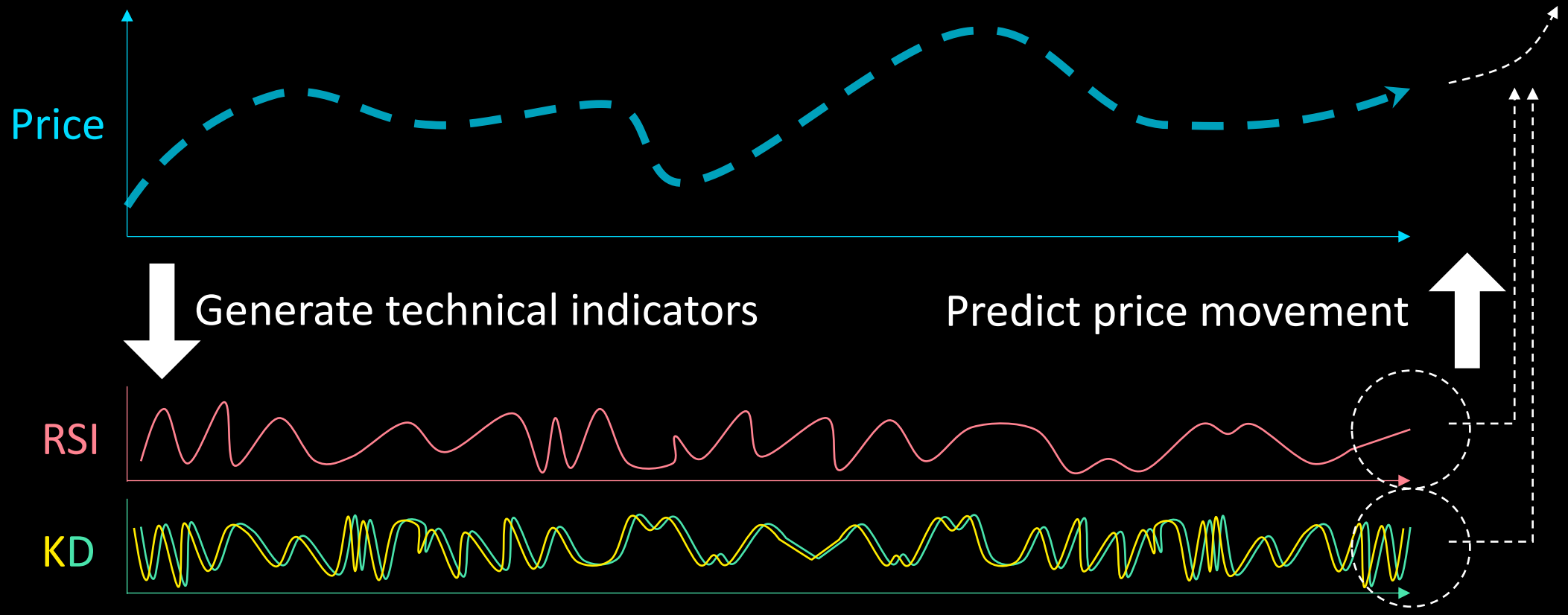
Market participant characteristic footprint

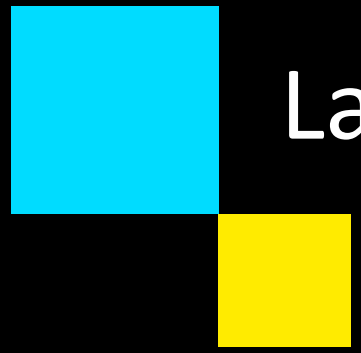
Trading book, price, broker trading summary…etc

- Data often with timestamp
- Generate extra features (ex: technical indicators)
- Massive amount of data generated in one day
- Some of the data is difficult to obtain

Creating Technical indicators

Price historical data





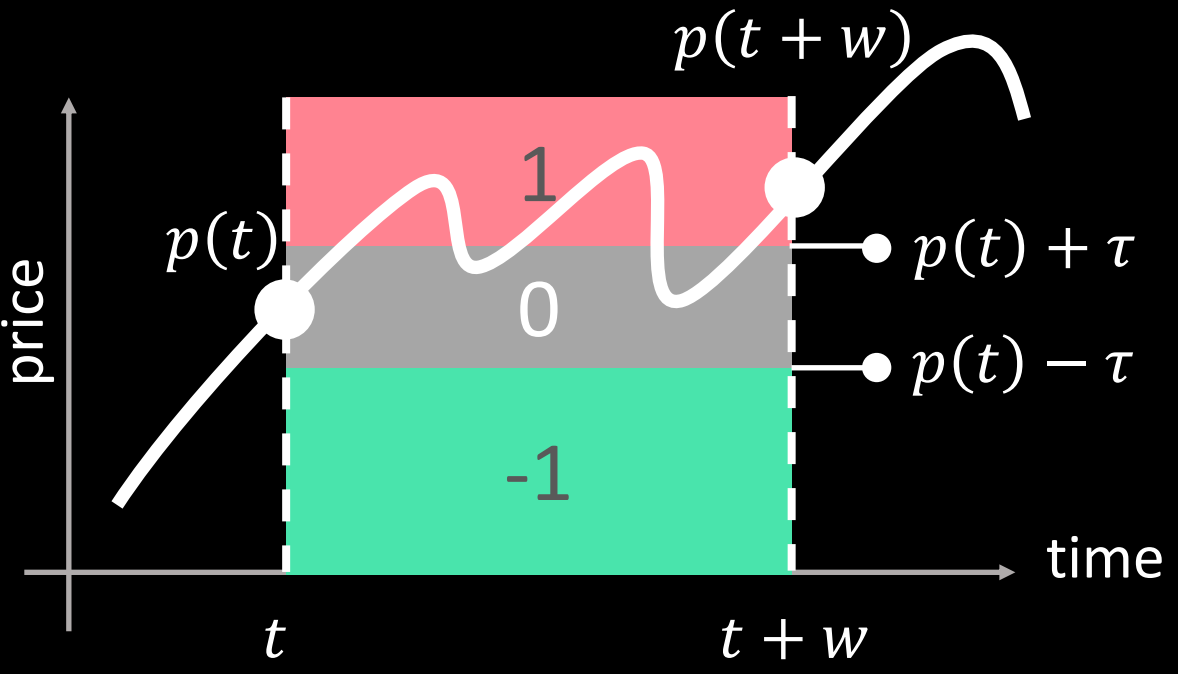
Labeling

Challenging of Labeling the data

Fixed time horizon

A popular method in the literature

- τ is a constant
- Do not have stop-loss limits



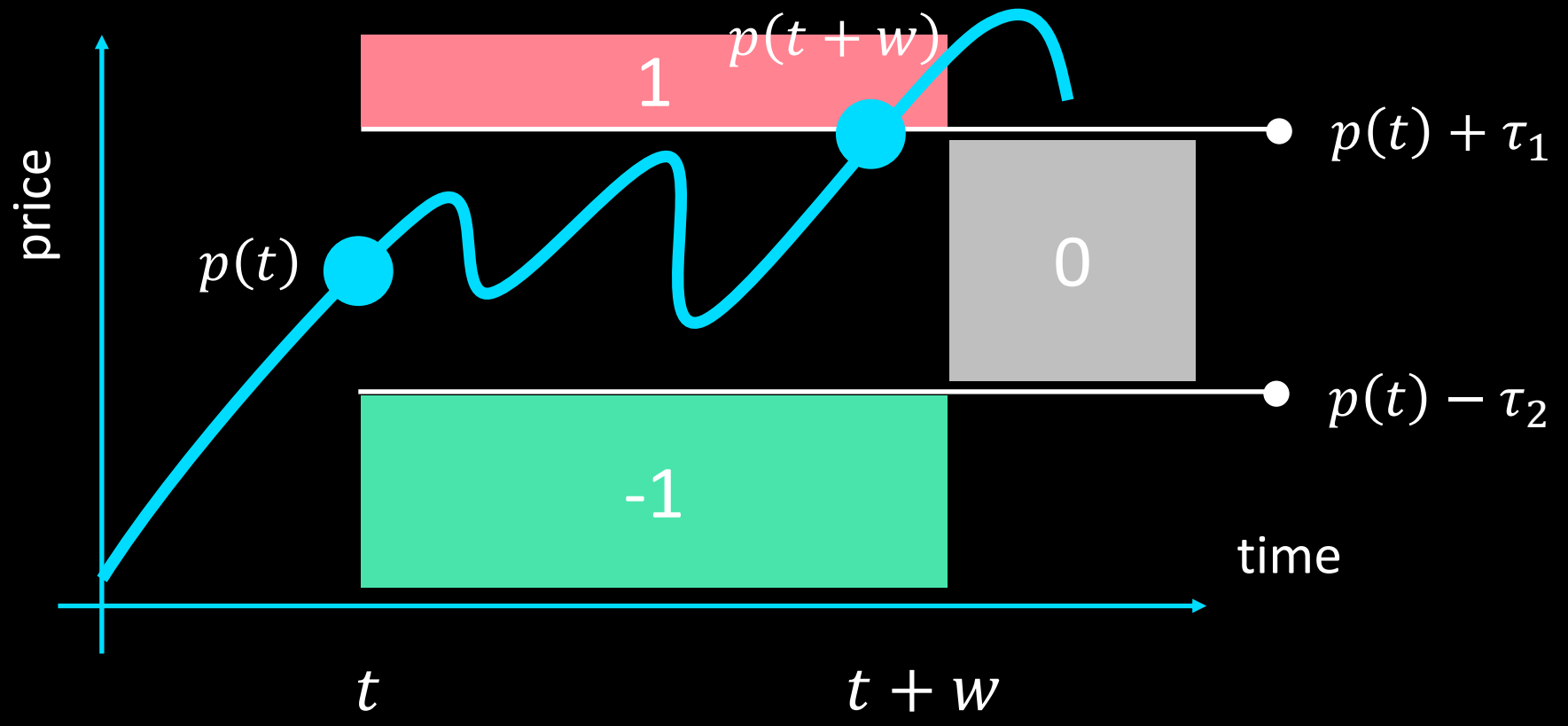
Label Generation Methods

- Triple barrier [Prado 2018]
- Continuous trading signals [Dash 2016]
- Trading Point decision [Chang 2009]

[Prado 2018] Advances in Financial Machine Learning
[Tsantekidis 2017] Using Deep Learning to Detect Price Change Indications in Financial Markets
[Dash 2016] A hybrid stock trading framework integrating technical analysis with machine learning techniques
[Chang 2009] Integrating a Piecewise Linear Representation Method and a Neural Network Model for Stock Trading Points Prediction

Triple barriers [Prado 2018]

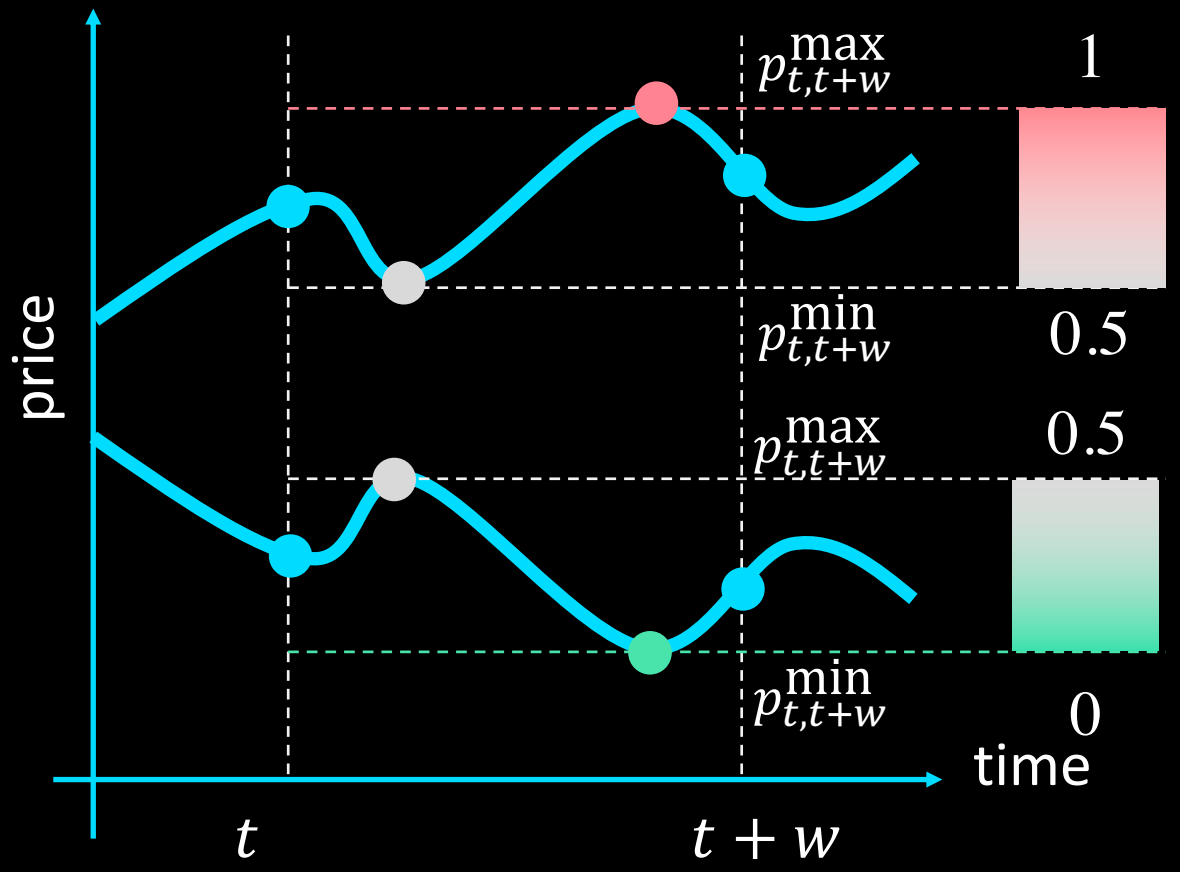
- Horizontal barriers are defined by profit-taking and stop-loss limit
- τ_1 and τ_2 are dynamic according to estimated volatility



Continuous trading signals [Dash 2016]

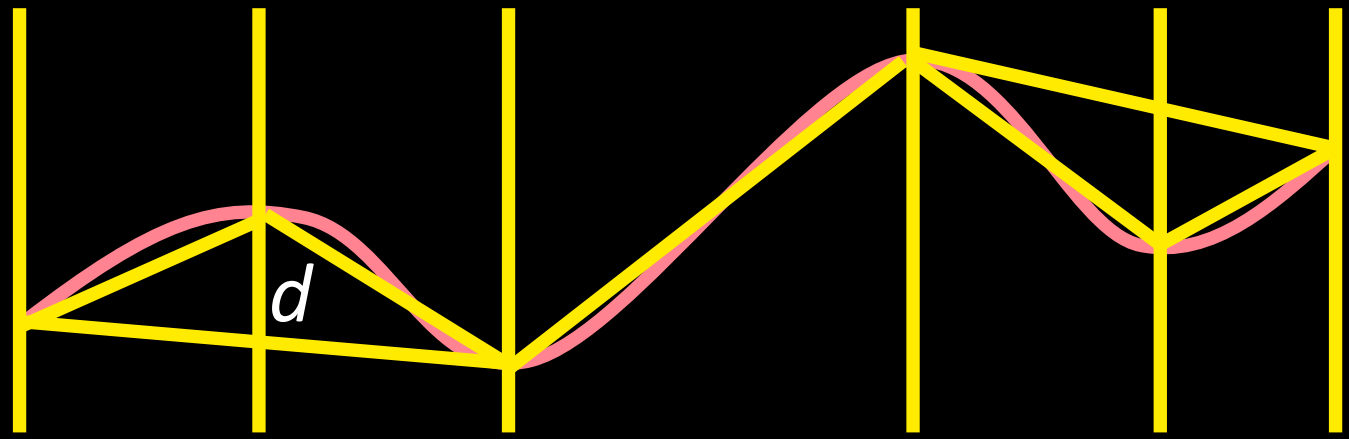
- Using momentum of the stock price
- *y*(*t*)'s are continuous
- Provides more detailed information

$$y(t) = \begin{cases} \frac{p_{t+w} - p^{\min}_{t,t+w}}{p^{\max}_{t,t+w} - p^{\min}_{t,t+w}} & \text{if } p_{t+w} > p_t \\ 0.5\left(1 - \frac{p_{t+w} - p^{\min}_{t,t+w}}{p^{\max}_{t,t+w} - p^{\min}_{t,t+w}}\right) & \text{else} \end{cases}$$



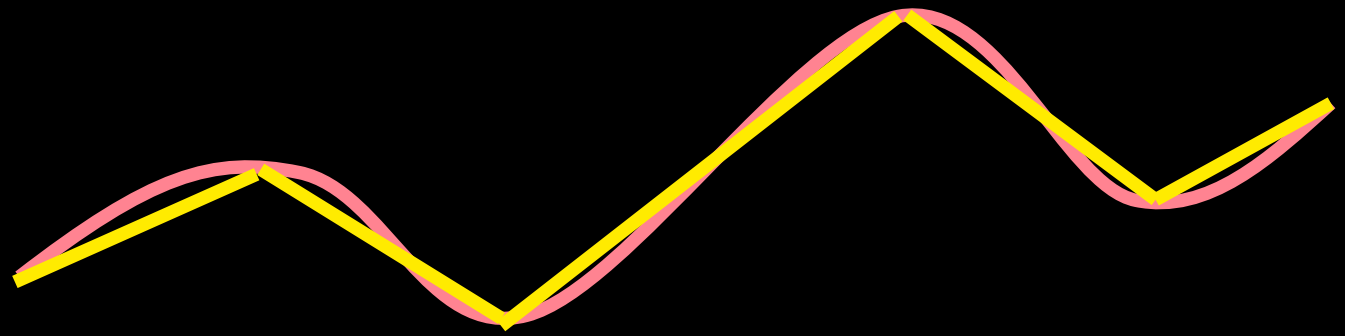
Trading point decision

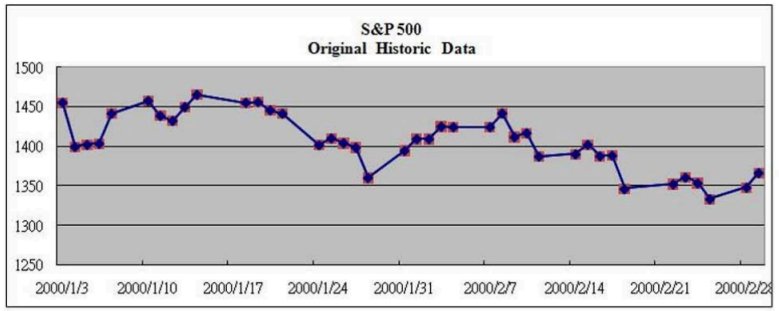
- Find the local minimum and maximum points
- Divide the time series into subsegments
- Threshold value d → length of trend

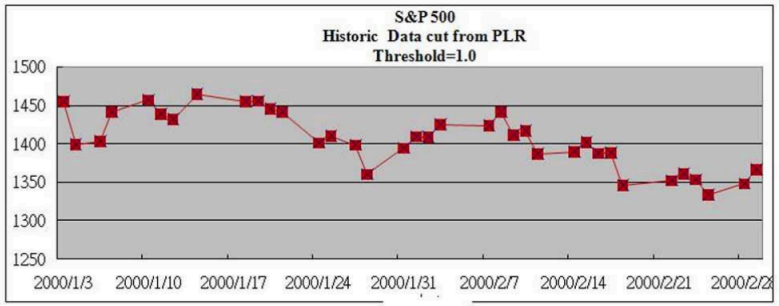


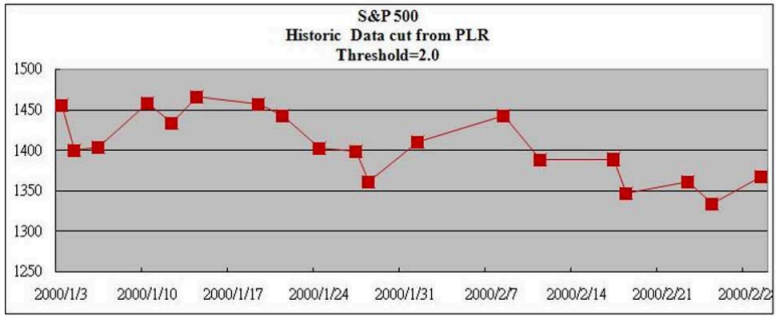
Trading point decision

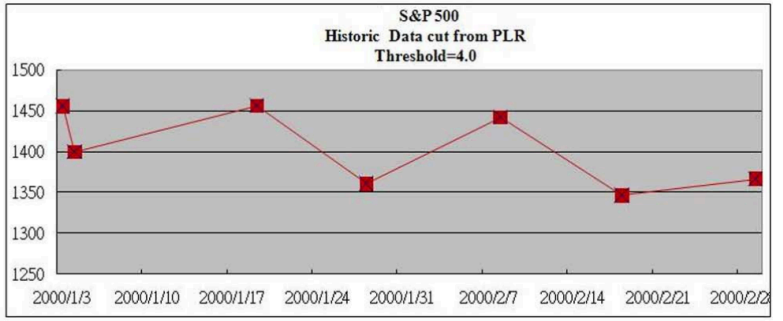
- Find the local minimum and maximum points
- Divide the time series into subsegments
- Threshold value d → length of trend

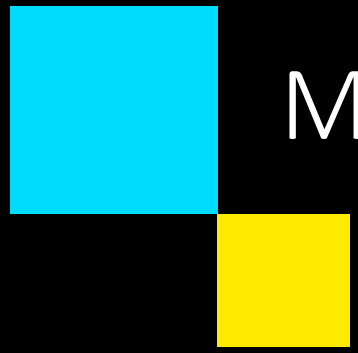










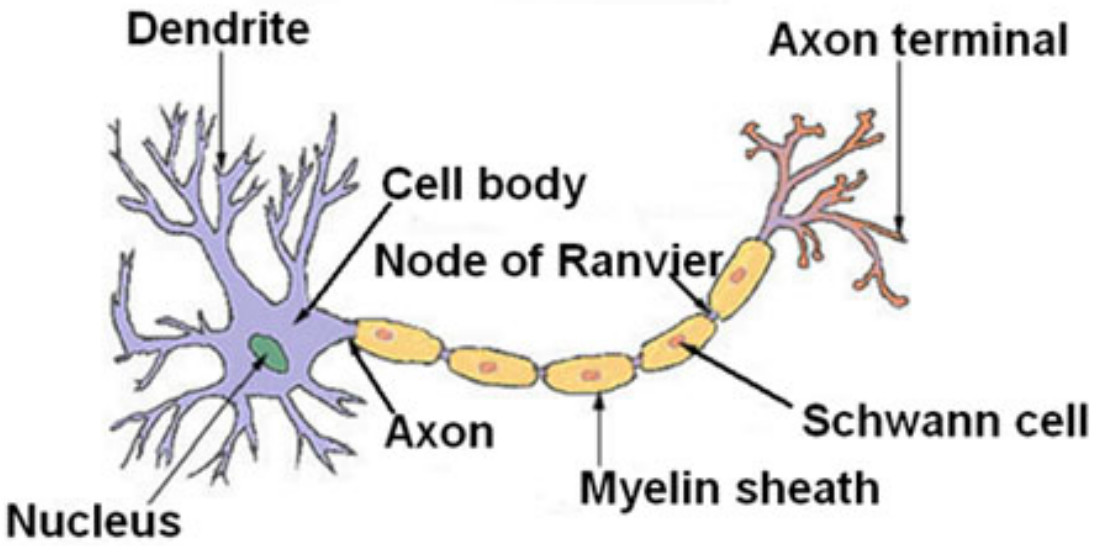


ML Models

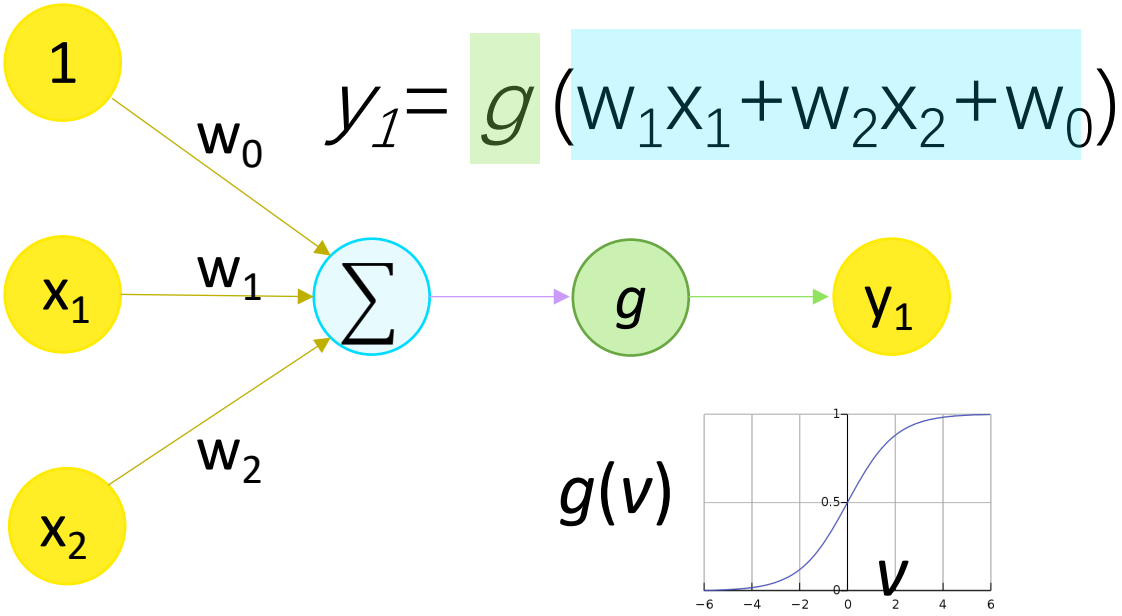
Neural Network

- Built to model the human brain
- interpret numeric data through a kind of machine perception

Human neuron structure

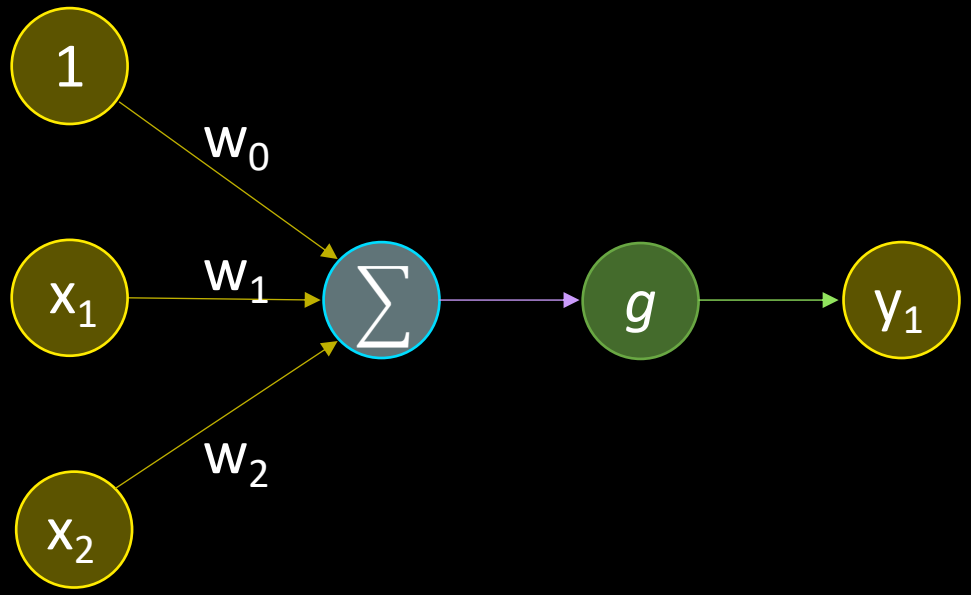


Single neuron model



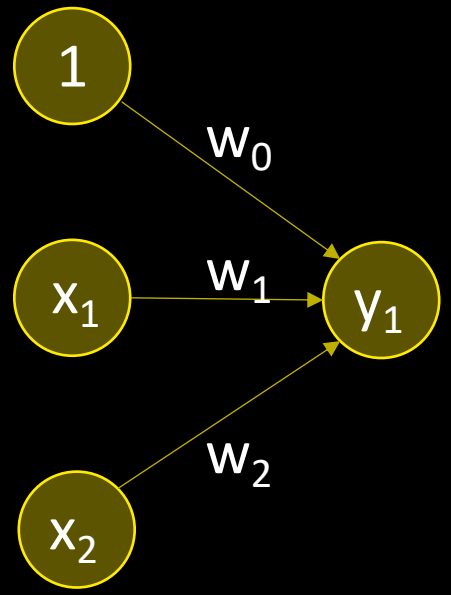
Neural Network

Single node in neural network



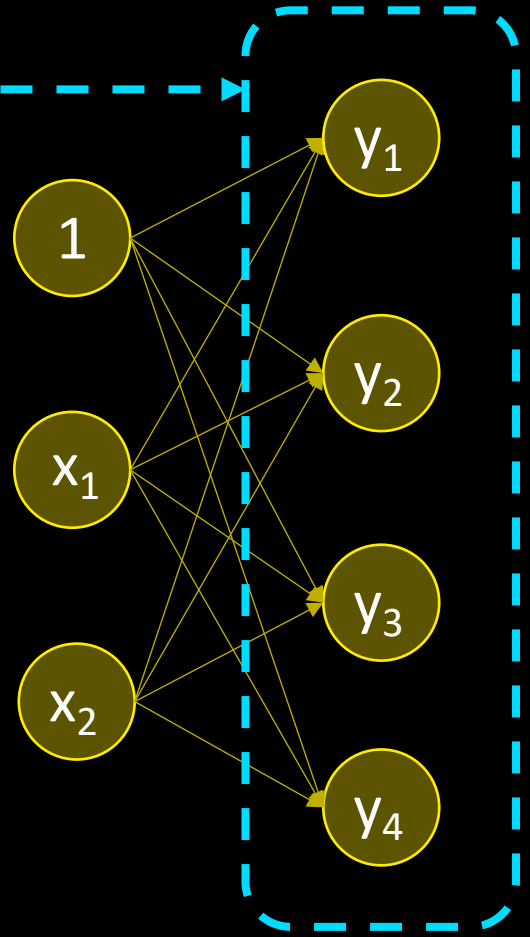
Neural Network

Simplified expression



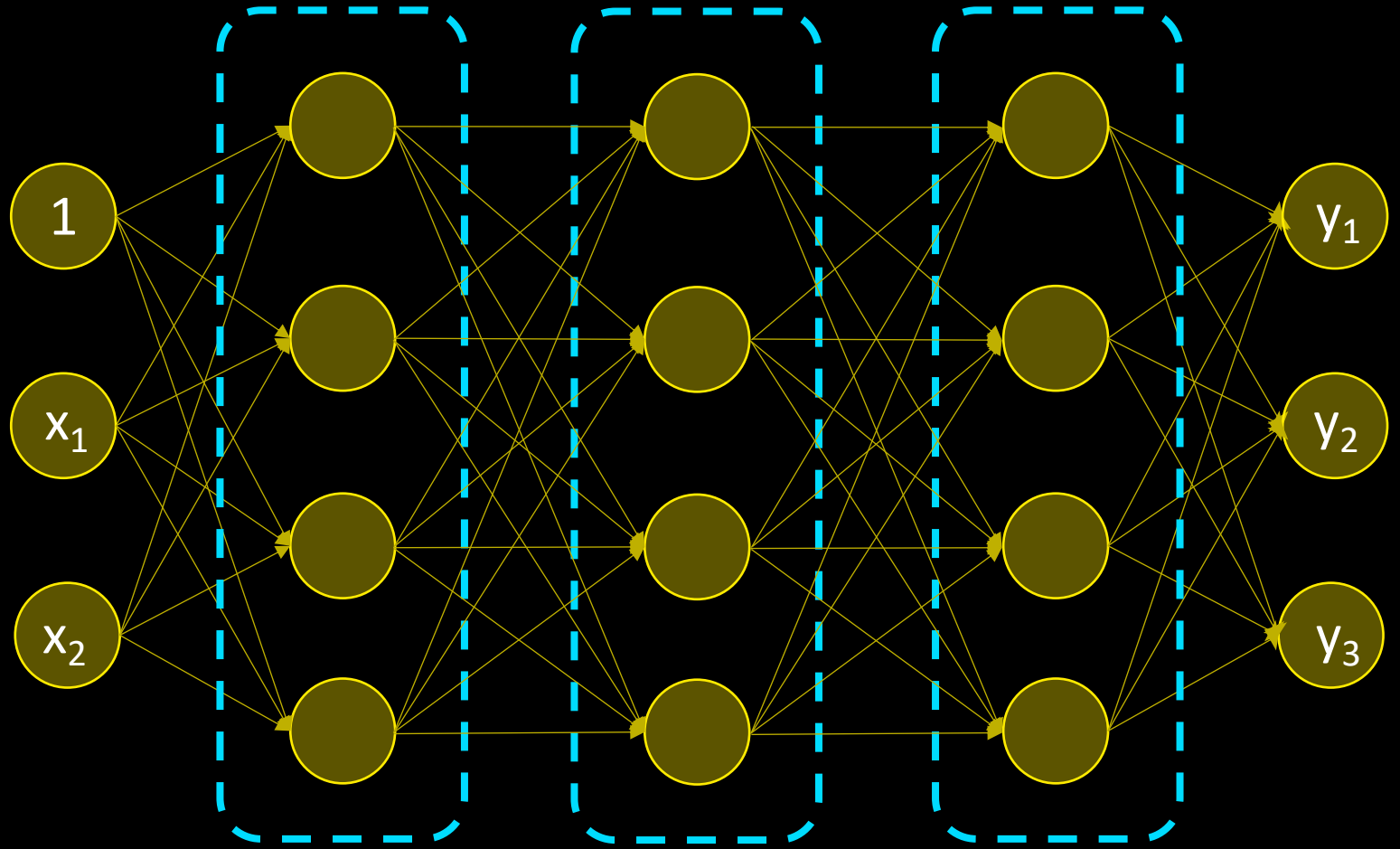
Neural Network

A layer contain multiple neurons

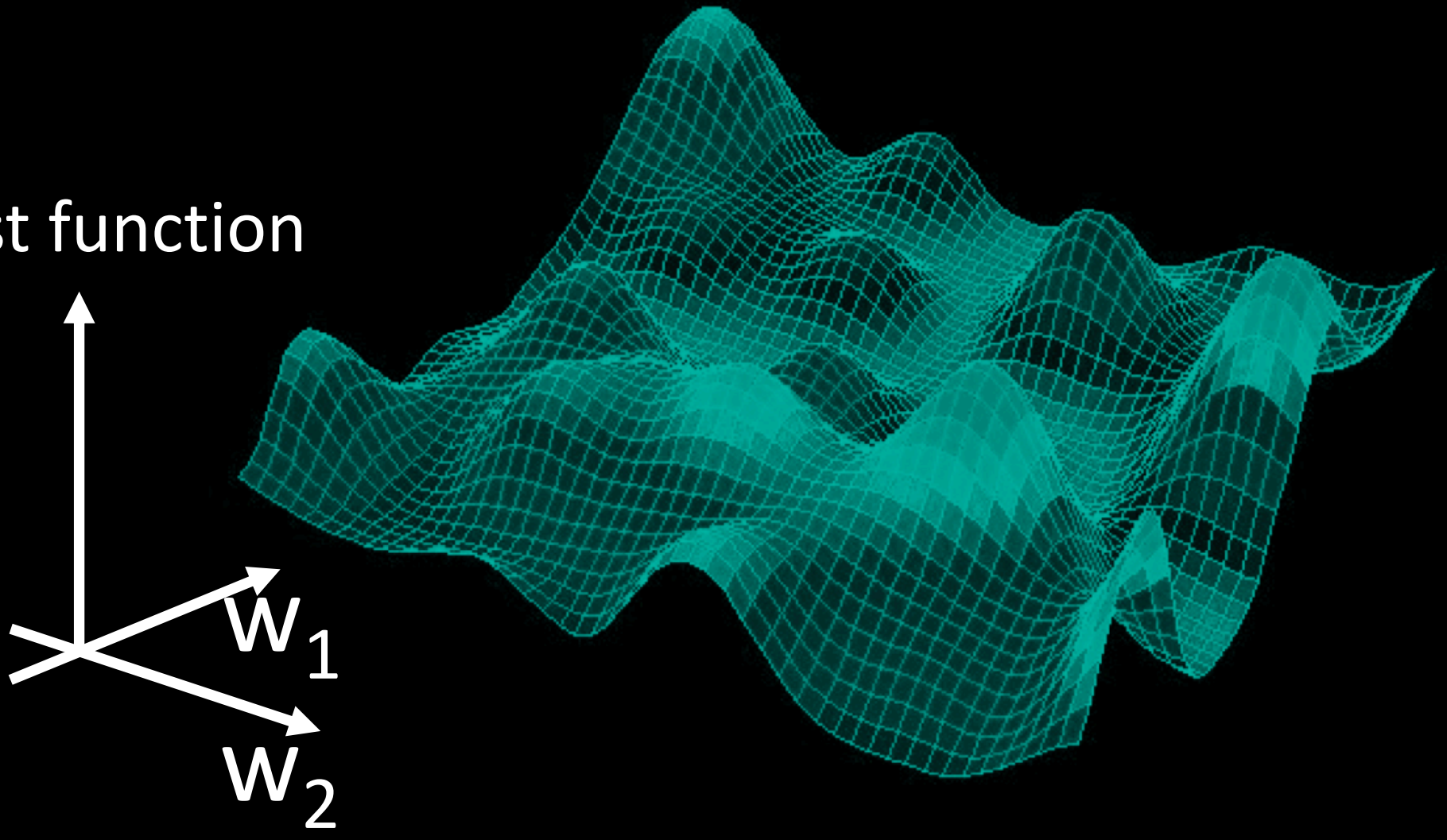


Deep Neural Network

Multi-layer deep neural network



Neural Network Optimization



Deep Neural Network Training Result

Asset

Taiwan Capitalization Weighted Stock Index

Data split

Train	Validate	Backtest
2006 ~ 2014	2015	2016 ~ 2019-3-1

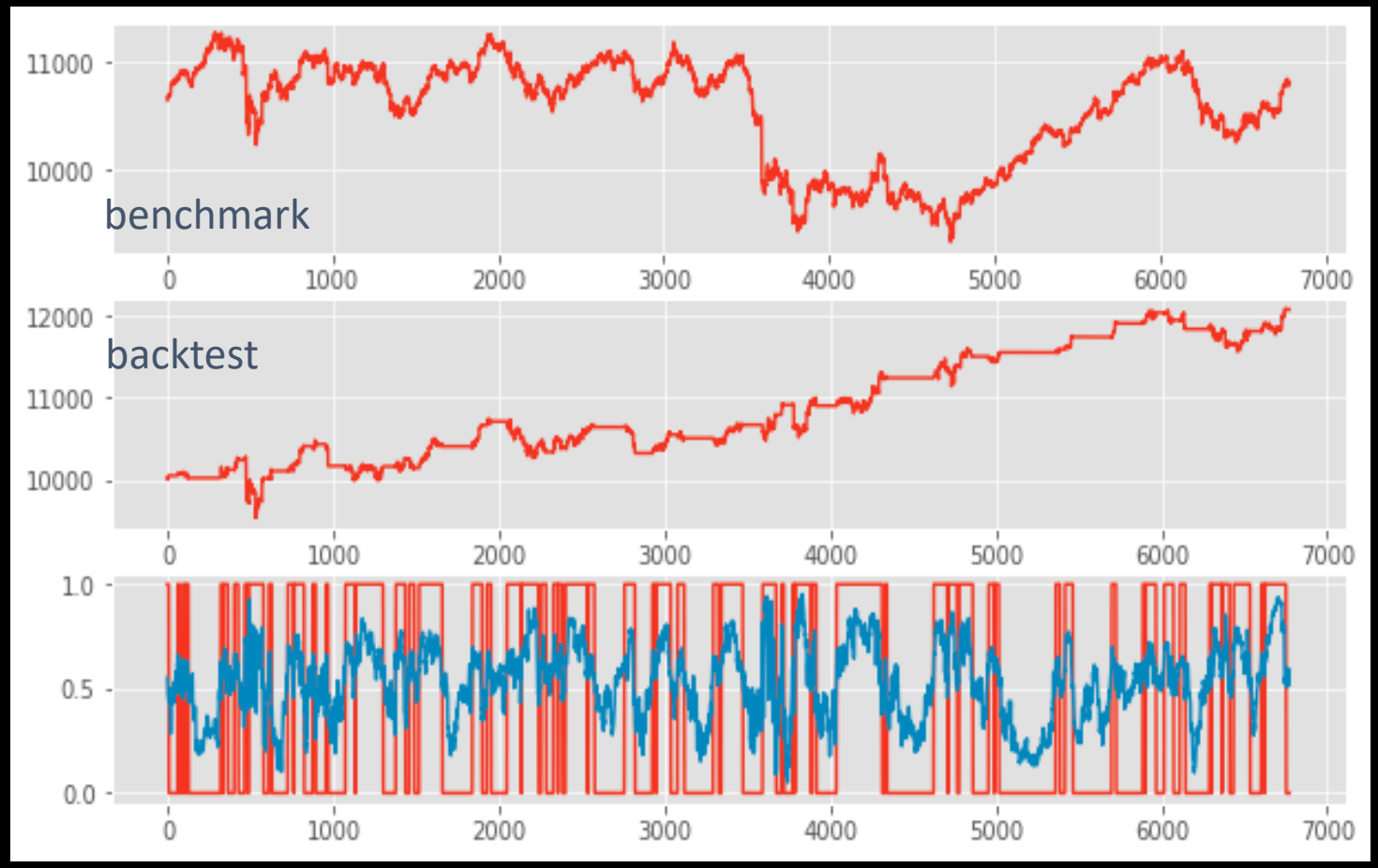
Features

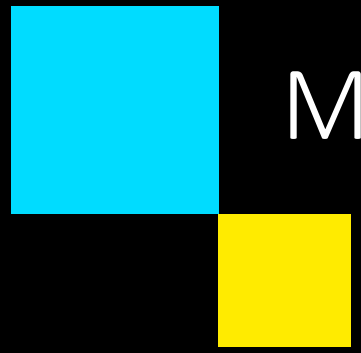
Scaled Technical Indicators

Labels

Fixed time horizon

2018-1-1 2019-7-1

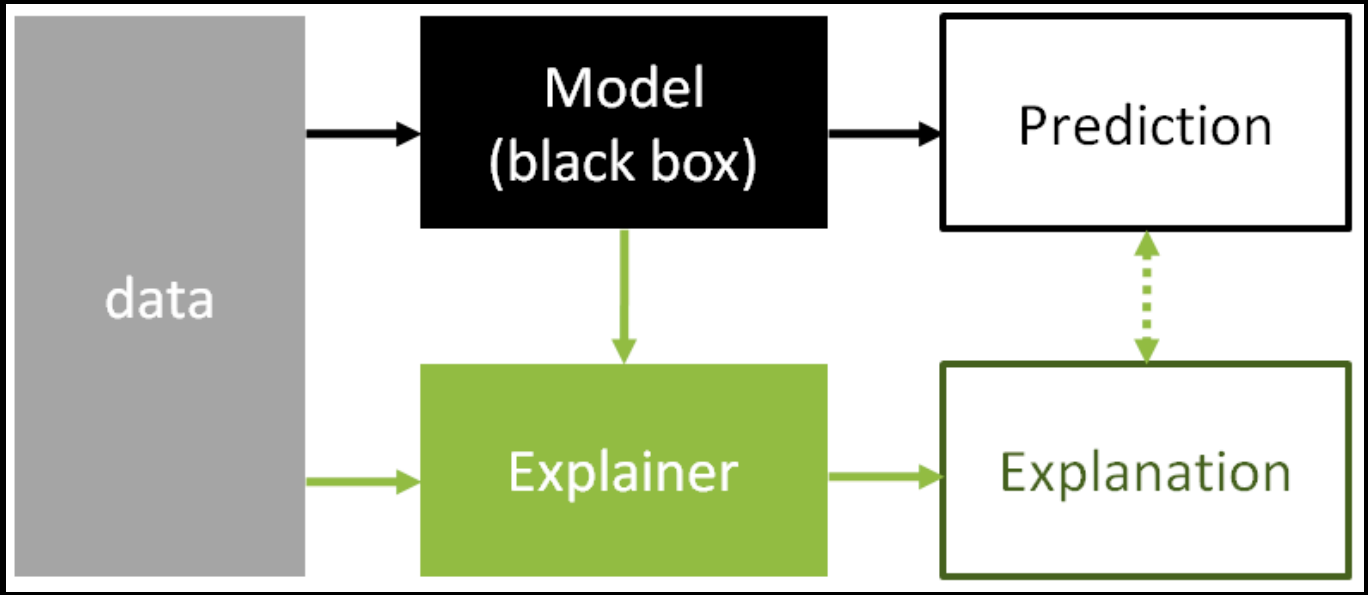


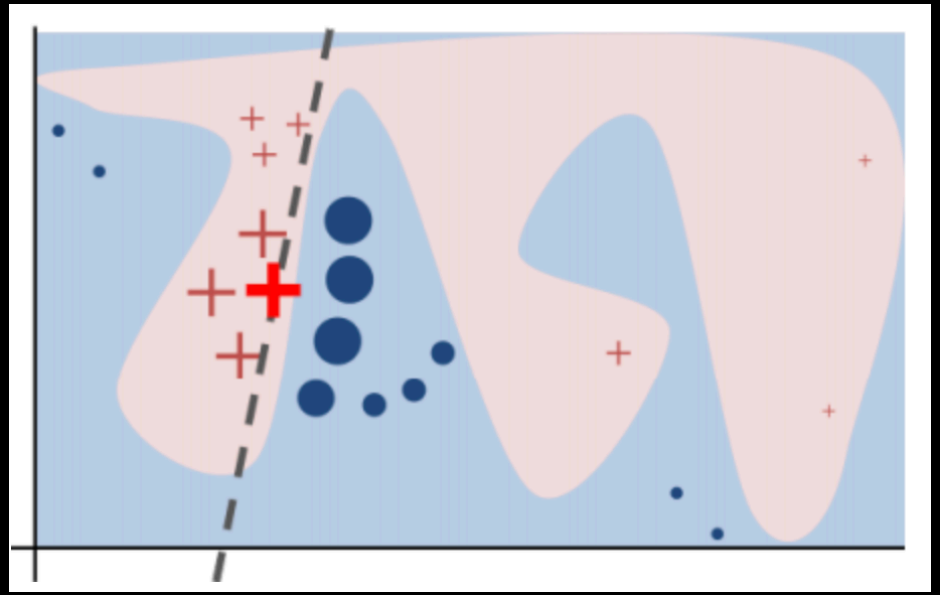


Model Interpretation

Deep Neural Network Training Result

- Explain the predictions of your machine learning models
- Approximate the predictions of the underlying black box model
- Focuses on training local surrogate models to explain individual predictions





https://arxiv.org/pdf/1602.04938.pdf

Backtest

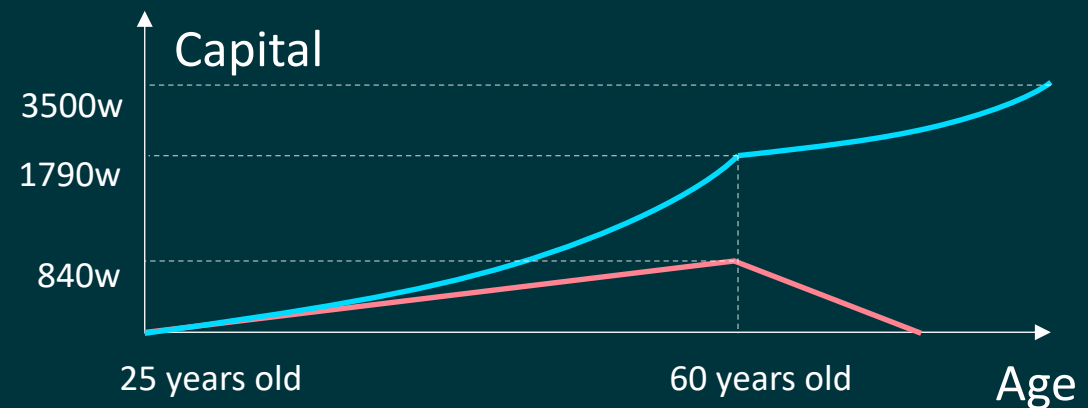
- Survivor bias, lookahead bias, transection cost, outlier, overfitting
- Finding the lottery tickets that won the last game
- Solutions
  - Develop model for entire asset or classes
  - Use Bootstrap aggregating
  - Record every backtest conducted
  - Resist the temptation of reusing a failed strategy

Conclusion

Investing

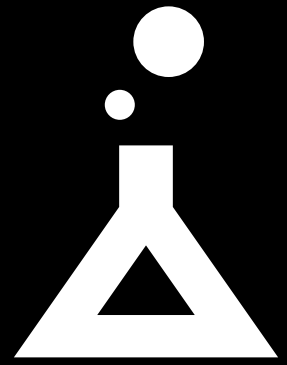
Investing or gambling ?

Life Plan



Machine Learning

Financial Data	Features
	Labels
Machine Learning Models	NN
	LSTM
	CNN
Evaluation	Backtesting
	Purged Validation



FinLab