Backtesting a Trading Strategy in Python

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Outline

- Why Backtest ?
- Methods of Backtesting
- Types of Backtesting algorithm
- Backtest analysis
- Backtest of Time-series Momentum
- Backtest of Pairs-trading

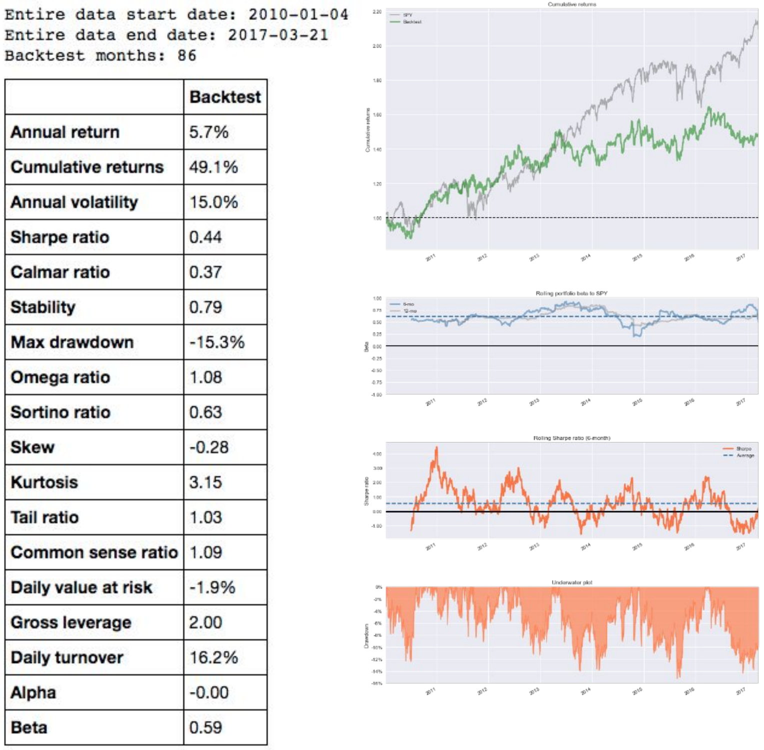
Motivation behind Backtesting

- Does the trading strategy you have hypothesised even perform ?

- Backtest is a process of testing the historical performance of a trading strategy. It is used as to check the if a strategy works on past and what performance we can expect in future.

- A backtest is a simulation which can be used for sanity check on the hypothesis behind the strategy and various factors under a given scenario of the market.

- Backtest is not an experiment and shouldn’t aimed to prove profitability of a strategy as it is only historical performance.



```
Entire data start date: 2010-01-04
Entire data end date: 2017-03-21
Backtest months: 86
```

	Backtest
Annual return	5.7%
Cumulative returns	49.1%
Annual volatility	15.0%
Sharpe ratio	0.44
Calmar ratio	0.37
Stability	0.79
Max drawdown	-15.3%
Omega ratio	1.08
Sortino ratio	0.63
Skew	-0.28
Kurtosis	3.15
Tail ratio	1.03
Common sense ratio	1.09
Daily value at risk	-1.9%
Gross leverage	2.00
Daily turnover	16.2%
Alpha	-0.00
Beta	0.59

Seven Sins of Quantitative Investing

1. *Survivorship bias*: Ignoring the stocks that have gone bust or delisted in past and only considering the existing stocks in the sample. This can lead to overestimation of historical performance. E.g.- Only considering the current composition of SP500.

2. *Look-ahead bias*: Using information that is not available at the current moment.

3. *Storytelling*: Making up a story ex-post to justify some random pattern.

4. *Data snooping*: Using the test sample for tuning the strategy and improving the backtest.

5. *Transaction cost*: Ignoring the transaction cost results inaccurate backtest results. While including transaction cost some strategies that were profitable earlier may fail.

6. *Outliers*: A backtest is severely skewed if it performance (profit or loss) is heavily dependent on few extreme outcomes that is observed in future. E.g.: Flash crash.

7. *Shorting*: Shorting involves finding lender who can lend securities, which is dependent on inventory, relative demand and markets.

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Types of Backtest algorithms

Vectorized

- Vectorized the backtesting loop using Numpy/Pandas
- Fastest
- Not a reliable backtest. Is used as a sanity check.
- Easy to implement.

For Loop

- The backtest is executed using a for loop.
- Slower than vectorized.
- Not a reliable backtest. Is used as a sanity check.
- Easy to implement.

Event Driven

- Uses market simulation and runs the backtest as events takes place.
- Slowest
- The most reliable backtest.
- Difficult to implement.

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Risk and Performance Metrics (1)

- **Cumulative Returns**

$$R_c = \prod_{t=0}^{n}(1 + r_t)$$

where

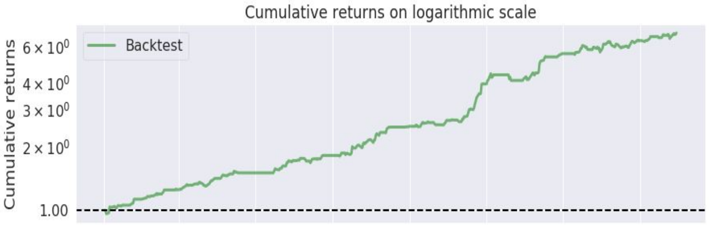
$$r_t = \text{return at } t$$
$$n = \text{number of observations}$$

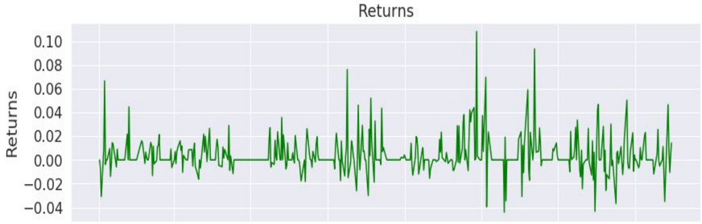
- **Annualized Return**

$$R_A = R_c^{\frac{m}{n}} - 1$$

where

$$R_c = \text{Cumulative returns}$$
$$m = \text{periods per year}$$
$$n = \text{number of observations}$$





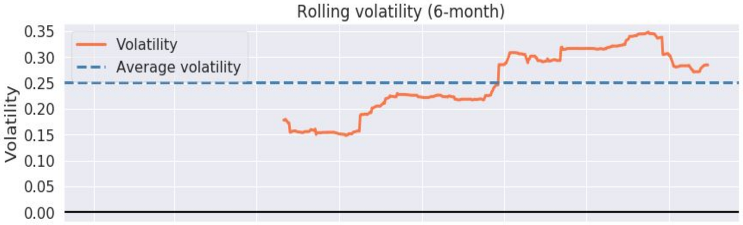
Risk and Performance Metrics (2)

- **Annualized Volatility**

$$\sigma_A = \sigma_r \sqrt{m}$$

where

$$\sigma_r = \text{std. dev. of returns}$$
$$m = \text{periods per year}$$

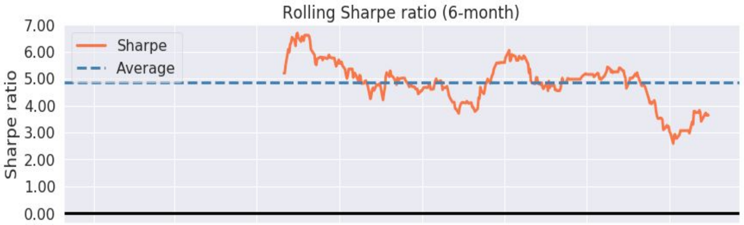


- **Annualized Sharpe Ratio**

$$SR = \frac{R_A - R_f}{\sigma_A}$$

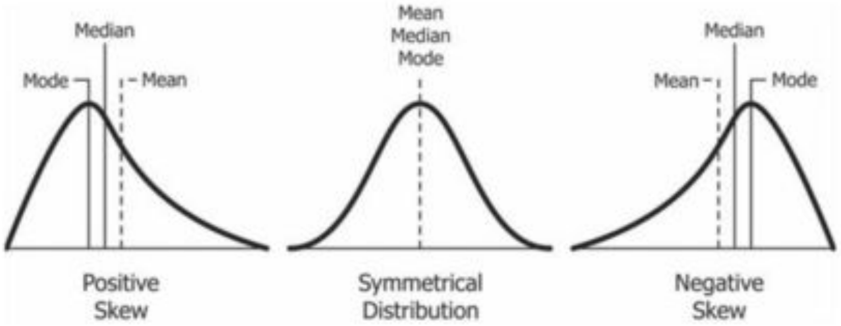
where

$$R_A = \text{Annualized return}$$
$$R_f = \text{risk-free rate}$$
$$\sigma_A = \text{Annualized volatility}$$



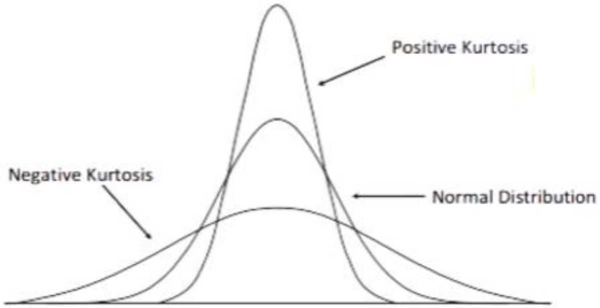
Risk and Performance Metrics (3)

- **Skewness**



Source: wikipedia

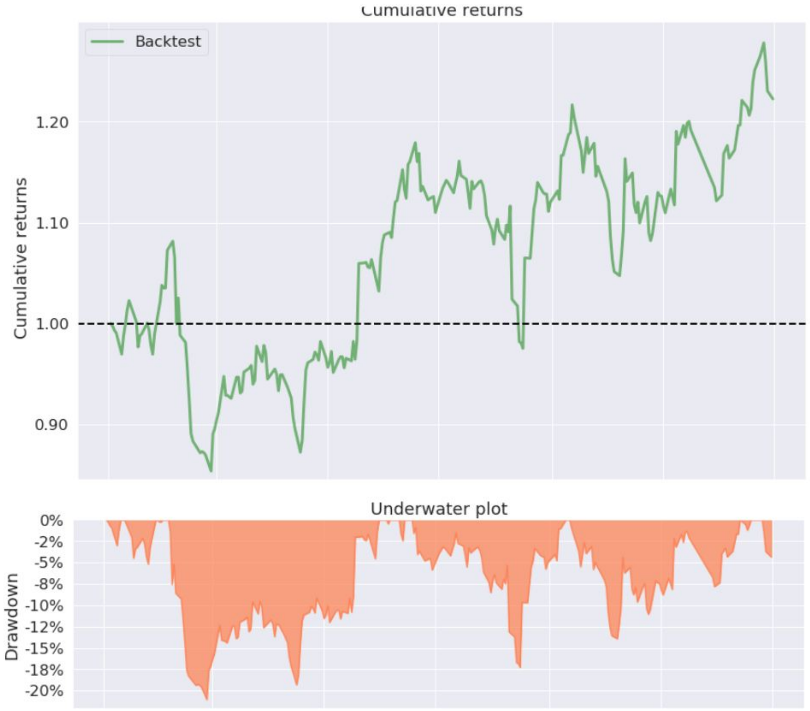
- **Kurtosis**



Risk and Performance Metrics (4)

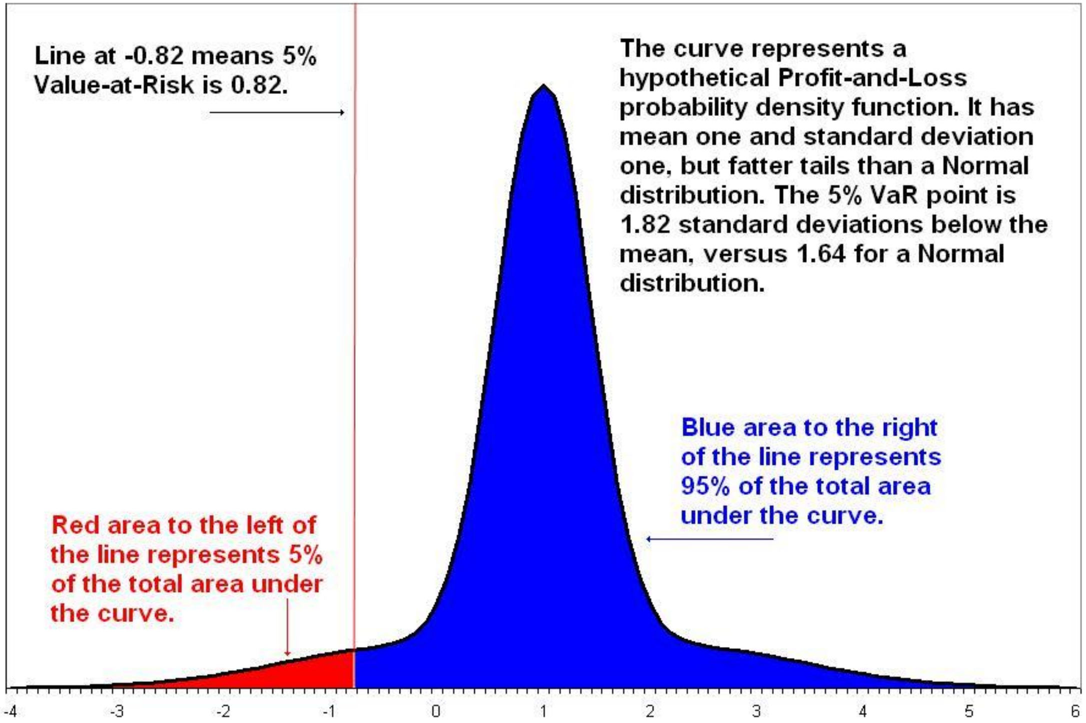
- **Maximum Drawdown**

$$MDD = \frac{\text{Trough Value} - \text{Peak Value}}{\text{Peak Value}}$$



Risk and Performance Metrics (5)

- **VaR (Value at Risk)**



Source: wikipedia

Backtest : Time-series Momentum

Notebook Link: https://bit.ly/3xOvxN8

Backtest : Pairs-Trading

Notebook Link: https://bit.ly/3v7KWWK

References

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QNA

Task for Day 2

Backtest: Time-series Momentum

- Backtest the strategy discussed in the video : https://www.youtube.com/watch?v=D_WhInJePC8

- Perform the backtest on a stock of your choice and collect the historical data using Alpaca Trading API.

- Vectorized backtest is preferable but for-loop can also be used.

- Calculate the risk and performance metrics.

- Plot cumulative returns against a benchmark, drawdown and rolling Sharpe ratio.

- Extra points: Include transaction cost.

- Use Google Colab

- Last date for submission : 05-05-2022

- Submission form link : https://forms.gle/JgrH7U7sdoSMVLUU8