

Intro to Quant Investing

Brainteaser

Problem:

A drawer contains 2 red and 8 black pens. Alice and Bob randomly take pens from the drawer until a red pen is selected. Alice selects the first pen, then Bob selects second, and so on, in each case **without replacement**.

Find the probability that Alice selects the red pen (just give methodology of solving, don't need to compute final value).

Hint: think about what the probability of Alice picking a red pen on her first selection is, then what if she doesn't get it on her first selection but on the second, etc.

Brainteaser

Solution:

Let A_i , $i \in \{1, 3, 5, 7, 9\}$ denote the event that Alice withdraws the first red pen when the i -th pen is to be chosen.

$$\begin{aligned} P(\{\text{red pen is chosen by A}\}) &= \\ &= \bigcup_{i \in \{1, 3, 5, 7, 9\}} P(A_i) = \\ &= \frac{2}{10} + \frac{8}{10} \frac{7}{9} + \frac{8}{10} \frac{7}{9} \frac{6}{8} + \frac{8}{10} \frac{7}{9} \frac{6}{8} \frac{5}{7} \\ &\quad + \frac{8}{10} \frac{7}{9} \frac{6}{8} \frac{5}{7} \frac{4}{6} \\ &\quad + \frac{8}{10} \frac{7}{9} \frac{6}{8} \frac{5}{7} \frac{4}{6} \frac{3}{5} \end{aligned}$$

Quant Update

Quant Week in Review

- Former Tradeworx founder receives support from JP Morgan
 - Part of larger movement of Market Makers transitioning to quant hedge fund
- New research shows that funds are investing significantly in quant talent
- Smart Beta, Machine Learning, and Big Data are the focus at annual Morgan Stanley Quant Conference
 - Quant funds are holding off on launching smart beta vehicles themselves as they conduct more research
- DRW begins trial with CFTC over market manipulation

Quant Investing

What is Quant Investing?

- Employ a lot of techniques from mathematics, statistics, and computer science to search for, 'backtest', and optimize financial investments; these are still grounded on fundamental ideas however.
- A few strategies that we use: mean reversion, momentum, factor modeling

Quant Investing

Mean Reversion

- Idea that asset prices will 'even out' over time
- If something is overpriced for an extended amount of time, it is a good opportunity to sell. Or if it is underpriced for an extended amount of time, it is a good opportunity to buy
- Can be captured with pairs trades
 - Take two related securities, which have had a historical spread level or ratio
 - When spread / ratios deviate too far from historical levels, short the overpriced security and buy the underpriced security

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Momentum

- Idea that ‘winners’, stocks that have done well, will continue to do well. And vice-versa, ‘losers’, those that have done poorly, will continue to do poorly
- Seems very simple but many quant funds and asset managers (most notably AQR) support the existence of momentum and even use strategies that boils down to longing ‘winners’ and shorting ‘losers’.

Quant Investing

Factor Models: What is a 'Factor'

- 'Factors' are characteristics that relate a group of securities, which are important in explaining their returns and risks
- Some of the most popular factors:
 - Value – cheap stocks are better than overpriced ones
 - Low Size – smaller companies better than larger ones
 - Low Volatility – companies with less volatile share prices better
 - Momentum
- These are just examples of factors for equities, but there are factors for currencies, commodities, credit, etc.

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Factor Modeling

- Actual factor models use specific factor values to pick investments
 - e.g. a higher 'momentum factor score' for stock x implies it is a better investment
- There are a few ways to come up with the factor scores themselves
 - One metric for each factor, e.g. EV/EBITDA -> Profitability
 - Multiple metrics + dimensionality reduction
- As well as a few ways to select assets based on the factor scores
 - Weighing factors & ranking among them
 - Long top basket, short bottom basket
 - Forecasting returns based on factors

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Factor Modeling – ranking method example

- Rank the stocks s based on the sum of their scores in each factor

$$\begin{array}{cccc} \textit{Size} & \textit{Value} & \textit{Profitability} & \textit{Reinvestment} \\ \left[\begin{array}{c} s_{1,s} \\ s_{2,s} \\ \vdots \\ s_{n,s} \end{array} \right] & \left[\begin{array}{c} s_{1,v} \\ s_{2,v} \\ \vdots \\ s_{n,v} \end{array} \right] & \left[\begin{array}{c} s_{1,p} \\ s_{2,p} \\ \vdots \\ s_{n,p} \end{array} \right] & \left[\begin{array}{c} s_{1,r} \\ s_{2,r} \\ \vdots \\ s_{n,r} \end{array} \right] \end{array}$$

- Then long the 20 highest-ranked stocks, short the 20 lowest-ranked

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Steps of the Process

1. Brainstorm ideas by looking at past research and analyzing data
2. Build models / strategies for these ideas
3. Backtest the strategies and assess performance
4. Apply novel techniques to optimize / improve strategies, then repeat 3
5. If strategy performs well, start trading it 'forward'

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What is Backtesting?

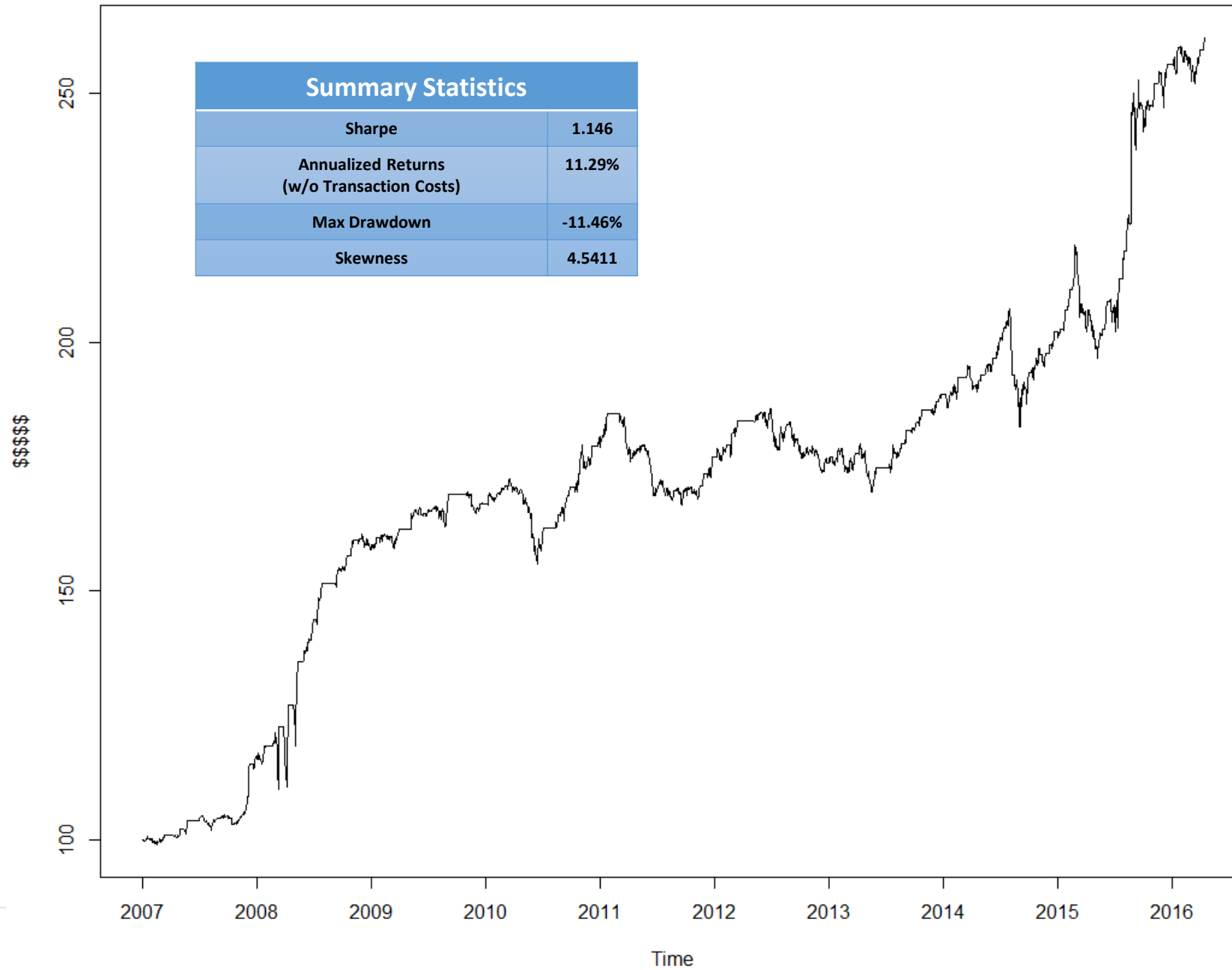
- Assume you have a strategy to trade some security that is grounded on some fundamental ideas. Before you can use the strategy on your own PA, you want to know how well the strategy performed in the past = **backtesting**
- Basically take historical data, test strategy over it, then assess performance
- Things to keep in mind: In-Sample and Out-of-Sample, **OVERFITTING**

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How to assess performance?

- Average returns
- Volatility of returns (measured in standard deviation)
- Sharpe Ratio:
 - - mean portfolio return
 - - risk-free return
 - - std. dev. of portfolio returns
- Histogram of returns to look at its shape
 - Skewness
 - Kurtosis
- Max Drawdowns
- Equity Curve

How much you make if you traded Crack Spread from 2007 to 2016



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What are industry players / real-world Quant hedge funds doing?

- High frequency trading
 - Latency arbitrage
 - Front running
 - Market making
- Data Science
 - Funds have access to and analyze **TONS** of data (numerical, text-based, imagery, plus more) to help guide investment decisions
 - Unsurprisingly, a bulk of the data analysis is done by employing machine learning techniques
 - Examples: emails; social network data; images of farms, mines, oil silos, parking lots

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Famous Quants

