Volatility Trading using Machine Learning

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Problem Statement

- Predict the volatility of the S&P 500 index
- Compare predicted volatility levels over a specified time horizon with market implied volatility and select a portfolio of options + index to capture movements in the premium
- Metric: 1. MSE 2. Trading Profitability

Benchmark: GARCH (1,1)

- Use GARCH(1,1) estimates of realized volatility
- Backtest trading strategy as benchmark return

ML Application for Volatility Prediction

- Multiple neural networks (e.g., Jordan Neural Network) demonstrate superiority to GARCH(1,1) models

Trading Strategy

- Trade S&P options based on forecast volatility
- Ex: Expected premium contraction, short option and delta-hedge with daily rebalancing

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Data Sets: Stock Domain and Features

- S&P 500 Index realized volatility
- Set of traded options' implied volatilities
- Date: 1st Jan 2008 - 31st Dec 2017

Data Cleaning:

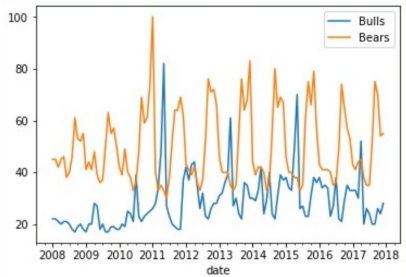
- News Headlines scraped in JSON format
- Time Series Data: Is clean

Technical/Price data

- Source: Bloomberg
- Usage: Technical Indicators based on OHLC Data.

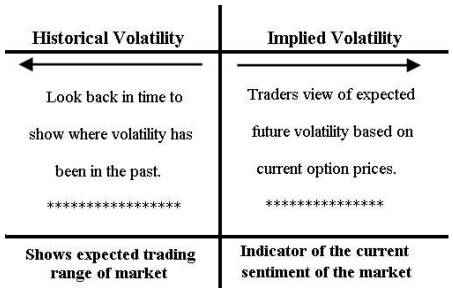
Google Trends

- Source: Google Trends API
- Usage: Word count occurance in searches



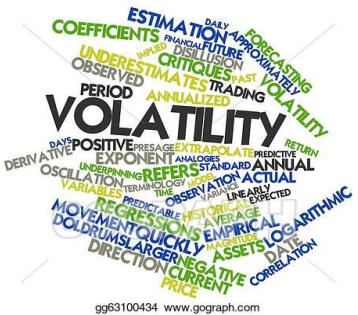
Implied Volatility

- Source: Option Metrics
- Usage: Trading Backtester



News Headlines

- Source: Scraping (WSJ Archives)
- Usage: NLP



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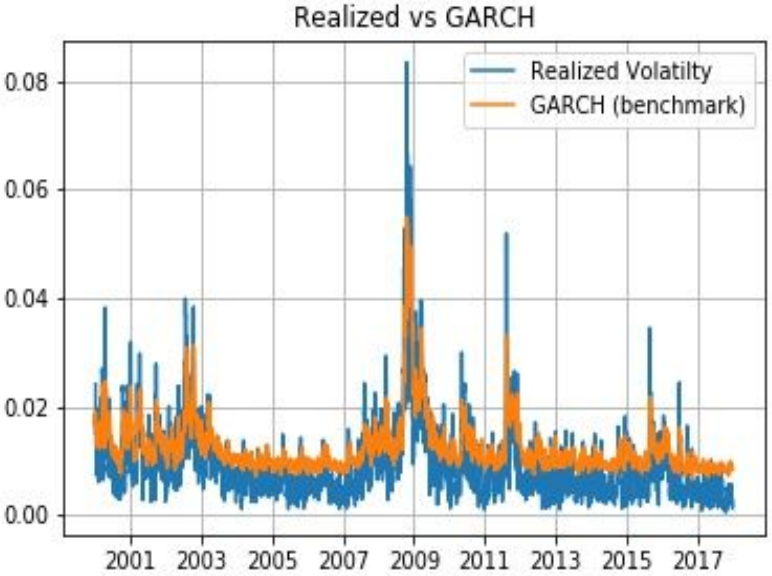
Benchmark



- Volatility has various characteristics:
  - Clustering
  - Asymmetry
  - Regimes Behaviour
  - Long-Term Memory
- GARCH(1,1) model is parsimonious and captures the clustering pretty well. However the asymmetric and regimes behaviour isn't described desirably. The decay of the coefficient on older lags also leads to a loss of long-term memory.
- Neural Networks and other ML algorithms have the ability to capture the missing aspects. They are particularly flexible as information apart from price returns can also be incorporated.

Key References:

[1] Tae Roh, Forecasting the volatility of stock price index
[2] Arnerić, et al, GARCH based artificial neural networks in forecasting conditional variance of stock returns