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SOA Predictive Analytics Seminar – Taiwan

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Session 6

Advanced Risk Management Techniques in the Era of FinTech

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31 August 2018

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Predictive analytics

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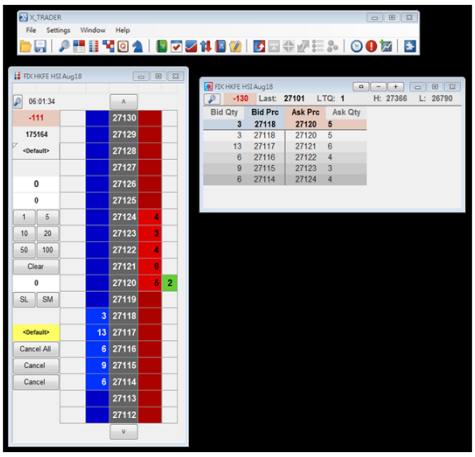
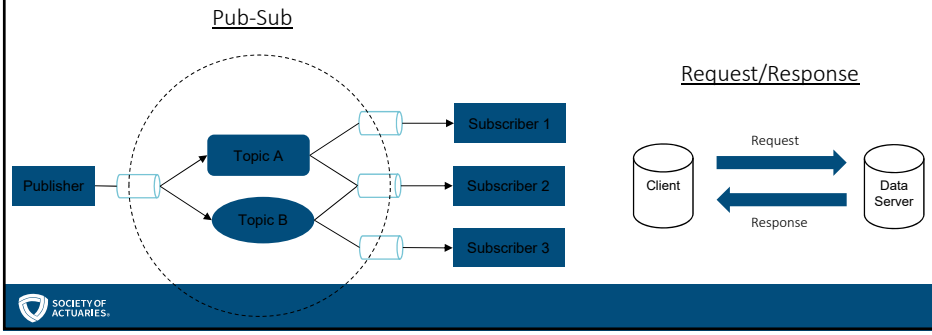
Financial Data

- Type of financial data
  - Trade
  - Bid/Ask
- Others: corporate actions, settlement date, etc.



Handling Financial Data

- Market Data Sources
  - Bloomberg, Reuter, IB, etc.
- Paradigm: PUB-SUB, REQ/REP
- Protocols: TCP, UDP, FIX, API provided by vendor, etc.
- Common use case for pub-sub is distributing large data streams like market data coming from stock exchanges.
- Subscribe to Heartbeat to check if the connection remains

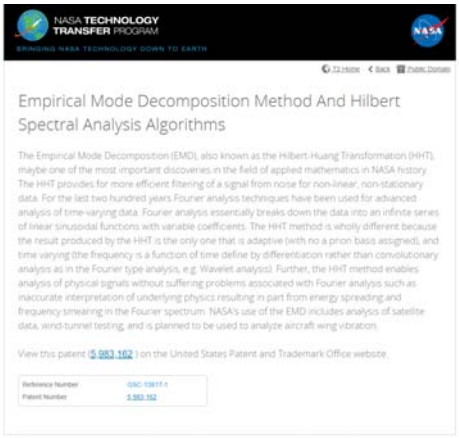


Noise

- Financial data are noisy
  - Microstructure noise
- Example:

Denoising Financial Data

- Denoise data to get better idea
- Financial data are commonly considered non-stationary
- Common denoising techniques like FFT, Wavelet Transform may not work
- Solution: Empirical Mode Decomposition + HHT

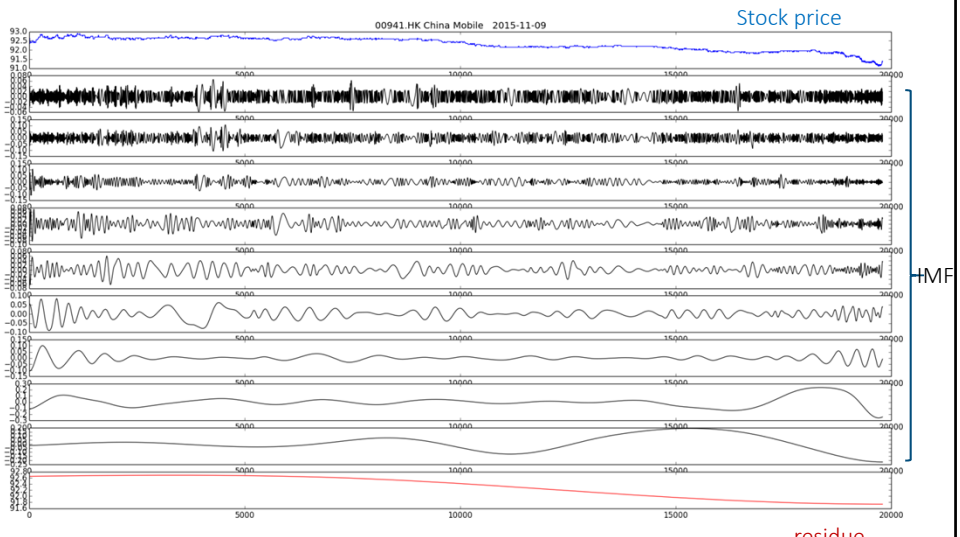


What is EMD?

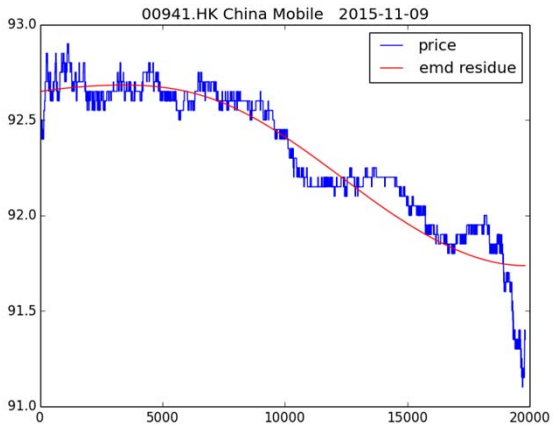
- Mathematically,
- $x = \sum_{k=1}^{m} C_k + r$,

- x: signal,
- C_i : Intrinsic Mode Function (IMF) that has different frequency range
- r : residue that represent the trend
- Is EMD really better?

Stock price and its EMD component



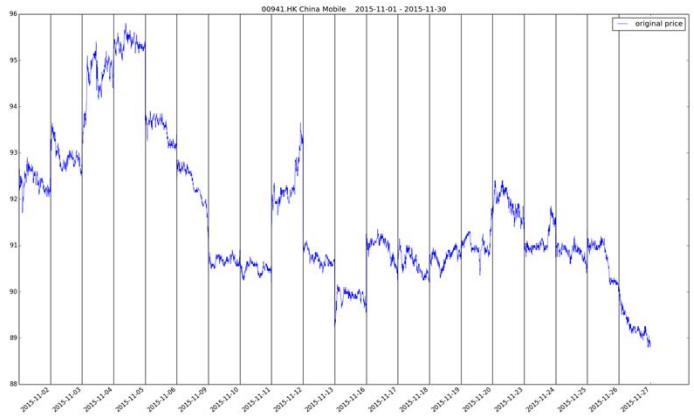
EMD residue: trend of the original data



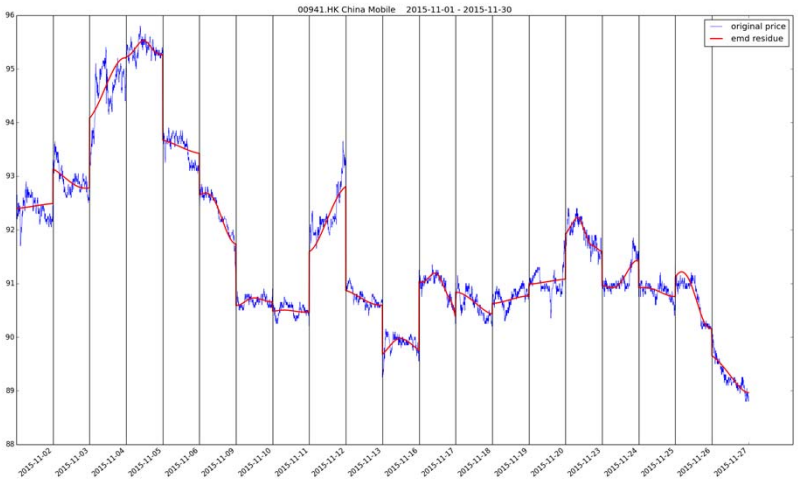
How to use EMD?

- Now we understand how it works (hopefully)
- There are MANY ways to apply EMD on financial data
- We illustrate one application

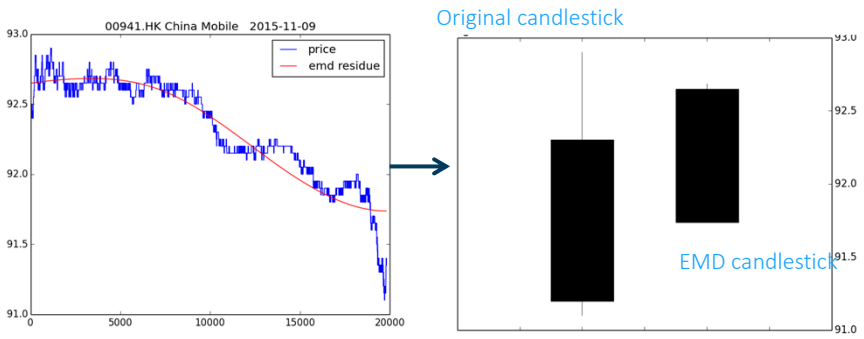
EMD residue: trend of the original data



EMD residue: trend of the original data



EMD-candlestick



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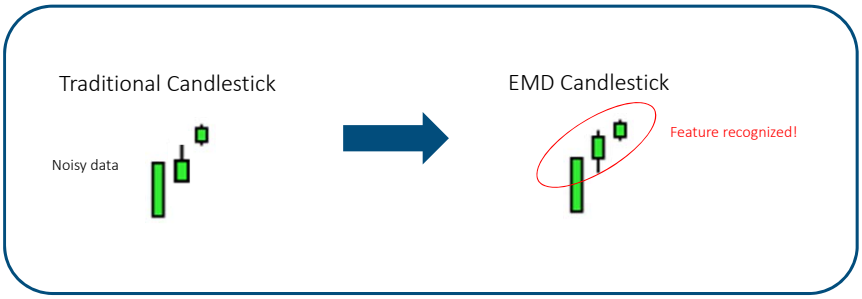
EMD-Candlestick

- EMD-Candlestick is constructed to capture financial information by using EMD to remove noise



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Research

EMD-CANDLESTICK: METHODOLOGY AND APPLICATIONS

ABSTRACT
The paper proposes an application of Empirical Mode Decomposition in technical analysis. The EMD-candlestick is designed to replace the traditional candlestick as the signal generators in technical trading strategies to improve the profitability. We investigate a representative set of technical trading strategies, including moving average, trading range break-out, relative strength index, and intraday and interday trading rules, using the securities included in Dow Jones Industrial Average from 1993 to 2012. Empirical results show that variable length moving average rules, relative strength index rules, and intraday and interday trading rules are more profitable if EMD-candlestick is used than if the traditional candlestick is used.

by Raymond H. Chan, Alfred Ka Chun Ma & Hao Pan

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Alpha i – A.I. trading APP

1) A.I. Alert

- Improve stock price prediction after utilizing noise reduction technique of EMD
- Notify user with a higher expected movement in share price
- Utilised machine learning to predict stock price movement

2) Stock Trading

- Transaction simply requires 3 steps
- Process trade orders up to 0.8 milliseconds

3) Market Information

- Provide Real-time Quote for Hong Kong Stocks, Real-time Index Quote, 24-hour Financial News, Top 20, A vs H Shares and Industry Information

4) Customizable Watchlist

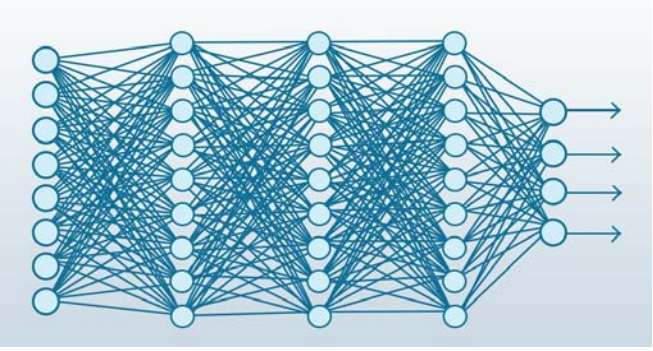
- Support emoji

Technical Analysis

- Standard technical analysis indicators are then used to create features for the deep learning

Deep Learning

- Deep learning is cutting edge AI technology
- LSTM (Long Short Term Memory) is used



Visualization of Financial Data

- Tool box:
  - Highcharts
  - Matplotlib
  - ggplot2 (used in Data Visualization course by HarvardX
  - GraphLab Create (used in Machine Learning @coursera by U of Washington)
- Never reinvent the wheel!

Ex-post Statistical Analysis Tools

for risk management

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The Statistical Analysis Tools…

- Aim To ensure that the strategy
  - behave as designed
  - perform consistently over time
- Should answer the question that
  - whether the performance observed in backtest is the same as the performance in real trading

Context

- Given 2 sets of return:
  - Back test return: $r_1, \ldots, r_N$
  - Real trade return: $\tilde{r}_{N+1}, \ldots, \tilde{r}_{N+K}$
- Assumption
  - No more operational difference
  - Only statistical difference between *period 1 to N* and *period N+1 to N+K*
  - return observed are samples from a **static** distribution

Tests for the purpose

- Welch's t-test
- Mann-Whitney U test
- Welch's T test on ranked data
- Kolmogorov-Smirnov test

Welch's T Test

- Null hypothesis: $H_0: \mu_x - \mu_y = 0$
- Advantage:
  - ✓ relatively robust under
    - unequal variances
    - unequal sample sizes
    - non-normality
- Limitation:
  - × return of certain strategies severely violate normal assumption since they are
    - skewed
    - heavy-tailed
  - × By CLT, aggregating high-frequency data to low-frequency data (e.g. daily return to monthly return) can ease that, but in turn sacrificing sample size
  - × concerns only the mean instead of the whole distribution

Mann-Whitney U test

- Null hypothesis: $H_0: F_x = F_y$
- Advantage:
  - ✓ Non-parametric
    - Robust under non-normality
- Limitation:
  - × Difference in variances would inflate type I error rate

Welch's T test on ranked data

- Mann-Whitney U Test handles severe violation of normality
- Welch's T Test is effective in unequal variances and sample sizes
- Welch's T test on ranked data is the middle ground between them
- Advantage:
  - ✓ Comparatively effective when there is both non-normality and unequal variances
- Limitation:
  - × Still prone to unequal variances like Mann-Whitney U Test

Kolmogorov–Smirnov Test

- Null hypothesis: $H_0: F_x = F_y$

- Advantage:
  - ✓ Non-parametric
    - Robust under non-normality
  - ✓ Sensitive to difference in overall distribution