Rocket Science?

Forecasting Palestinian attacks on Israel

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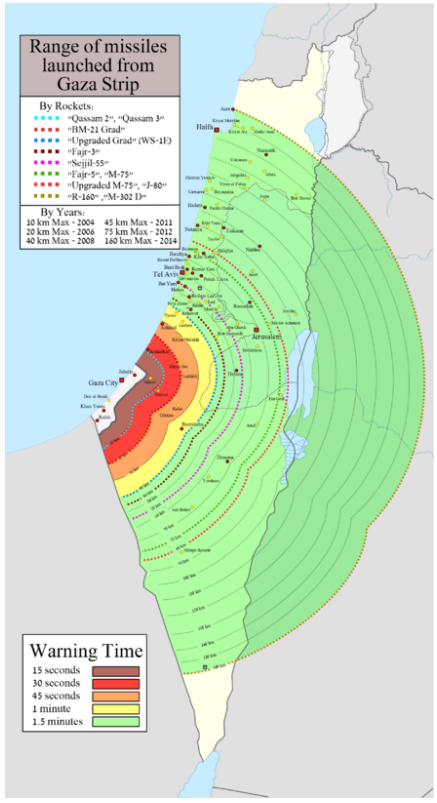
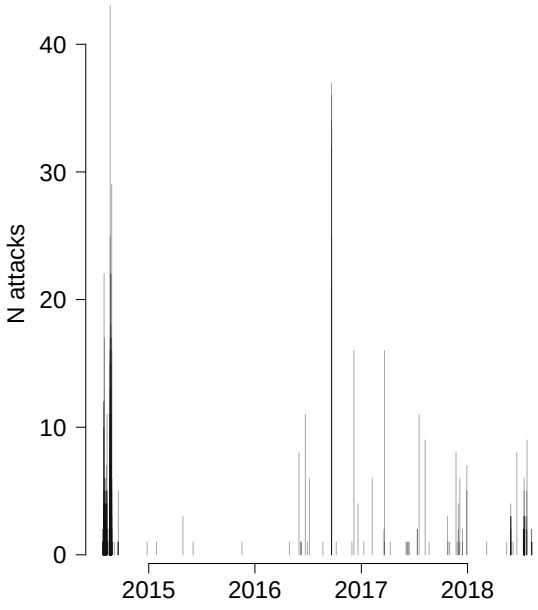
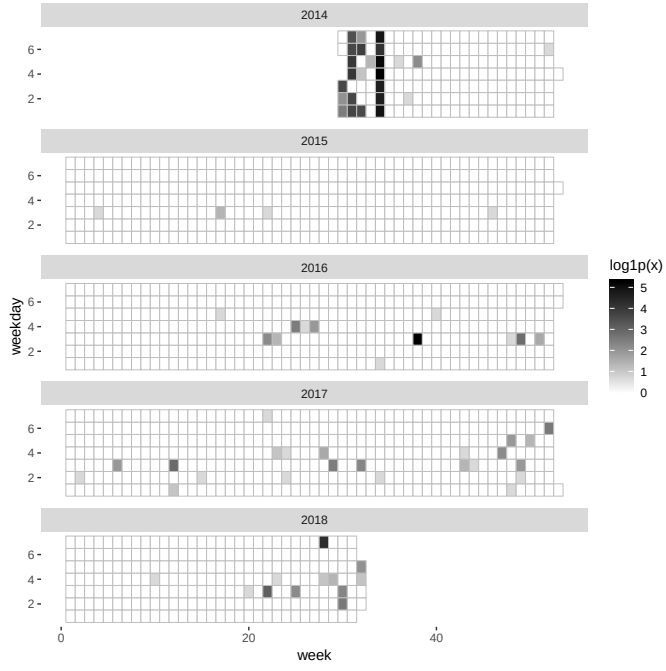
15 October 2018

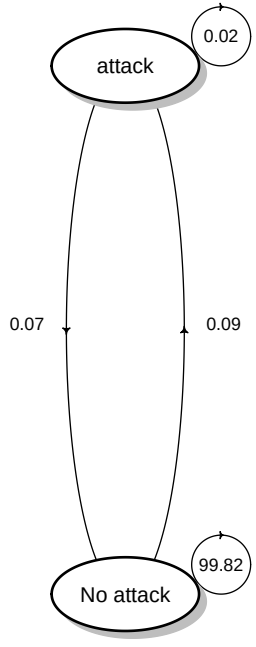
Palestinian rocket launches on Israel



Pattern of attacks



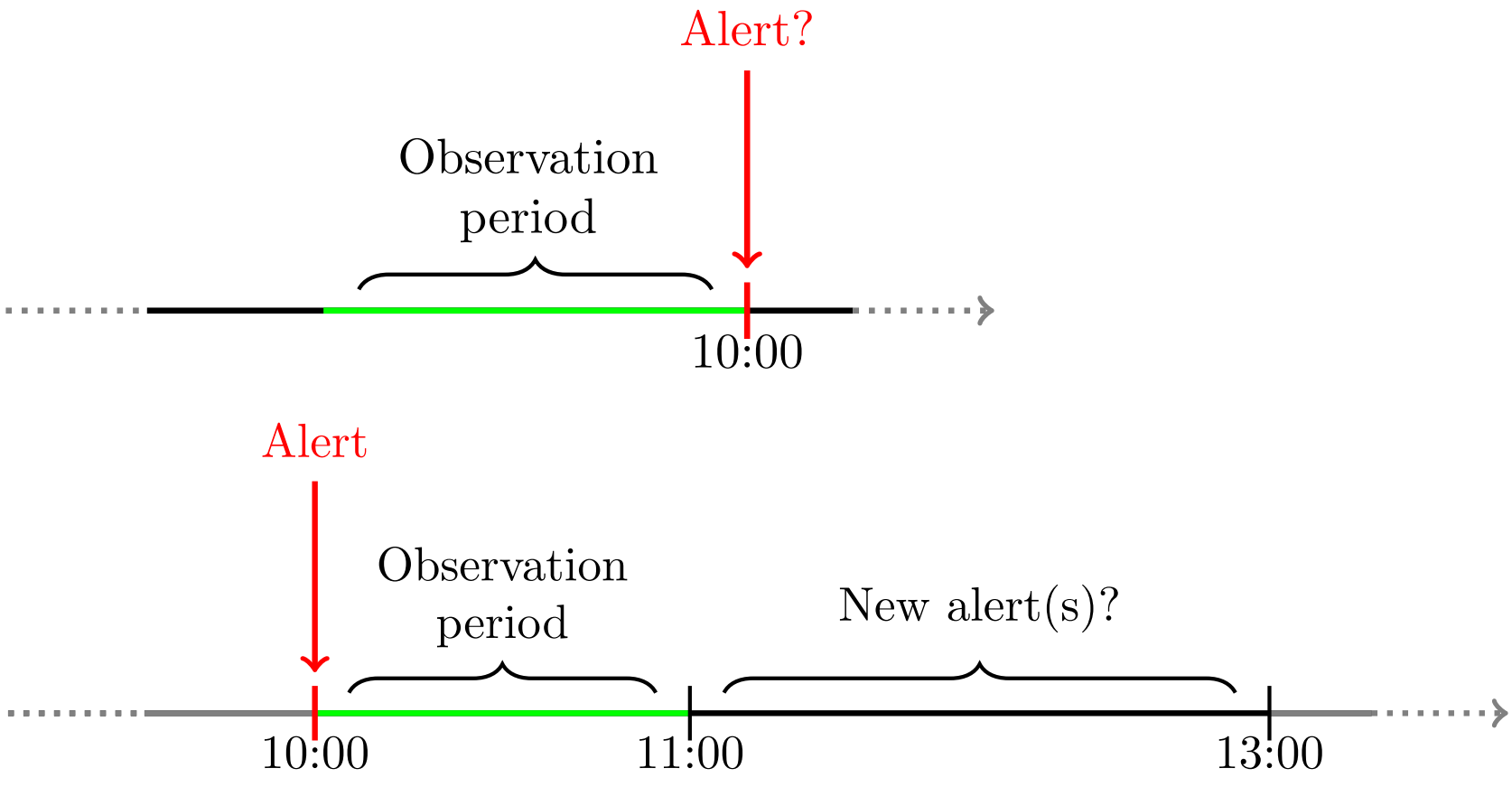




Rocket launches

- Minute-level from Home Front Command
- 2014 - present
- 5,266 alerts since July 24 2014

What we want to predict: Occurrence and recurrence



A first go...

$$Y = f(\text{time since L(attack)}^k, \text{time since L}^t\text{(attack)})$$

... poor results

Data

Finance

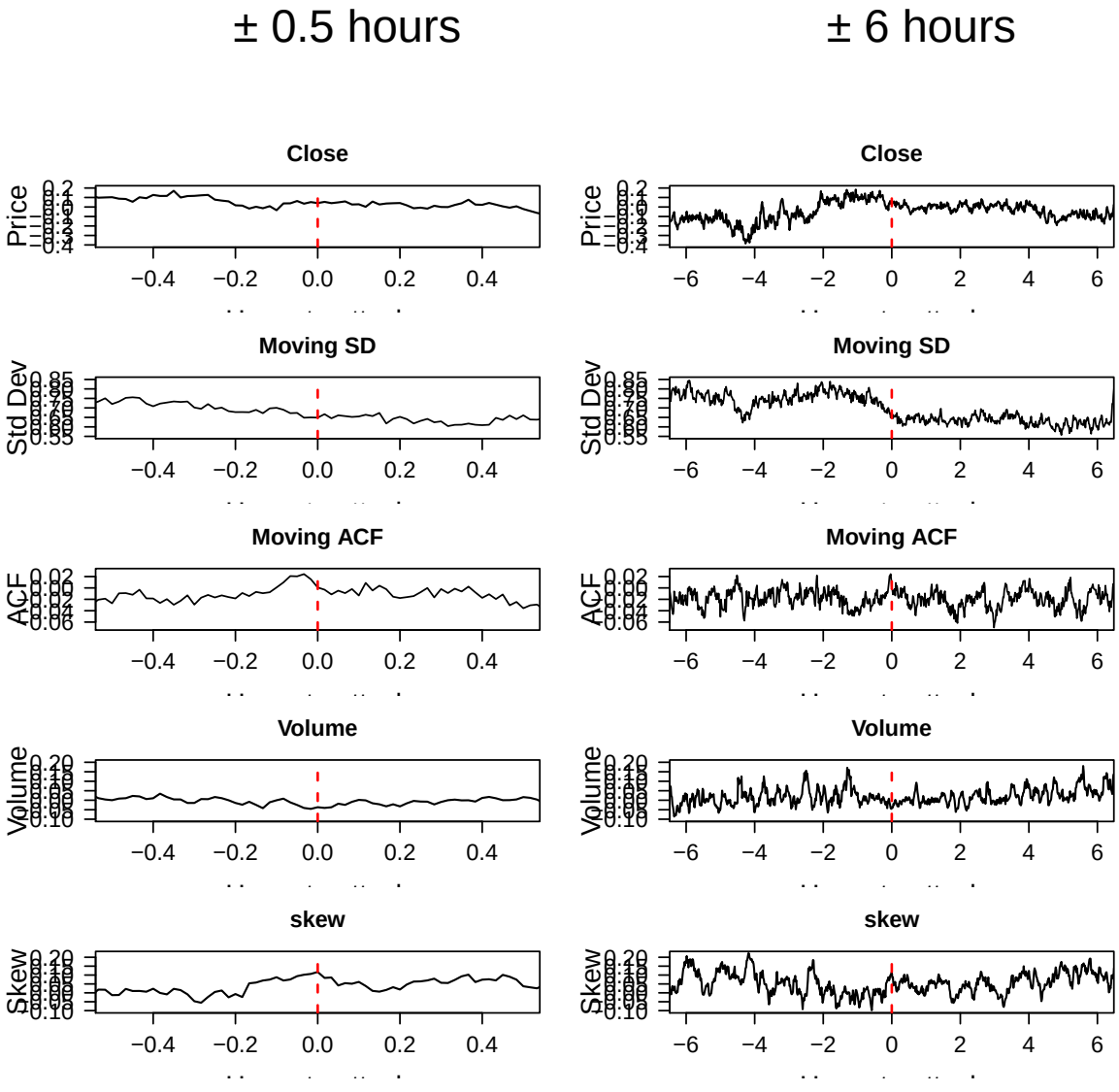
Minute-level stock prices for 500 Israeli companies listed on the T.A.S.E.

Limitations:

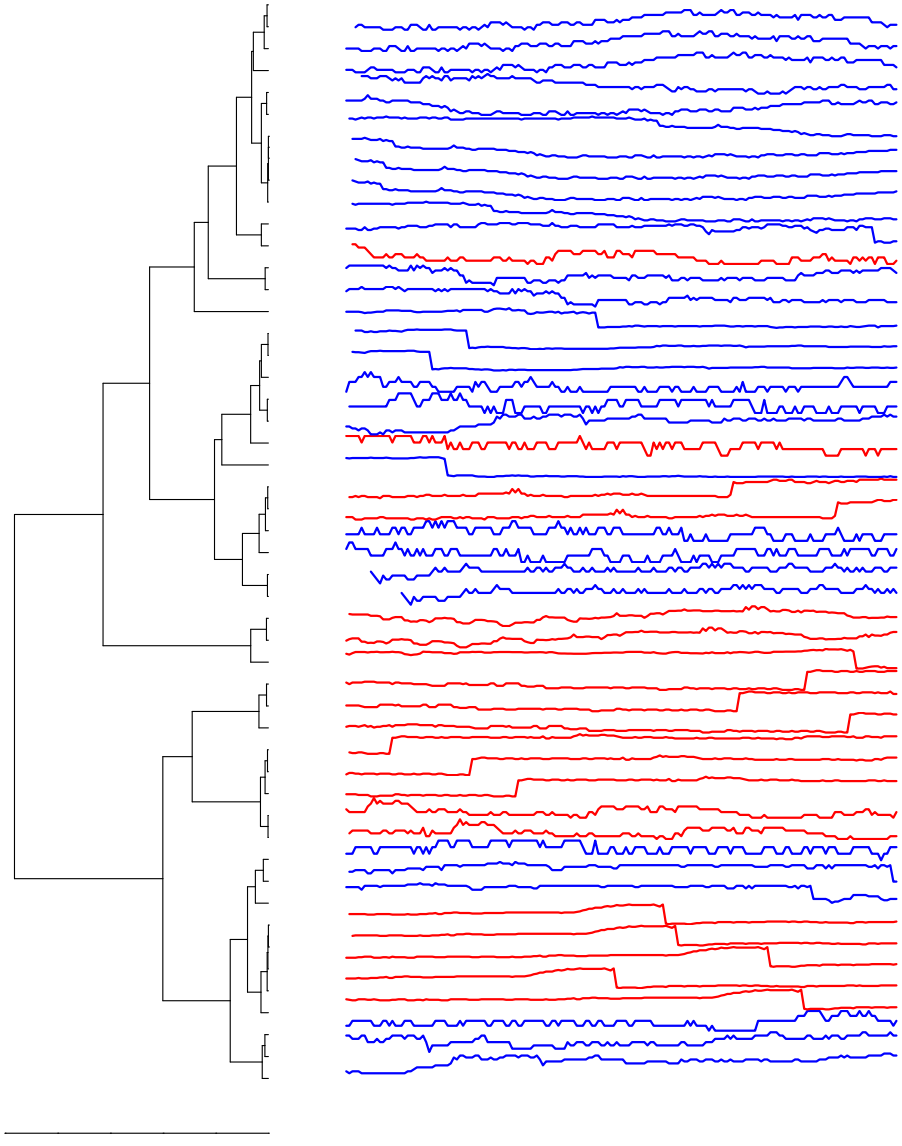
- Liquidity: Only 15-20 with liquid enough market
- Opening hours:
  - Trades 9:45am - 5:25pm (4:25pm on Sunday)
  - Friday + Saturday closed

$\Rightarrow$ Of the 5,266 alerts since July 24 2014, only 1,789 during business hours

Raw data


± 0.5 hours
± 6 hours
Close
Price
Moving SD
Std Dev
Moving ACF
ACF
Volume
skew
Skew
−0.4
−0.2
0.0
0.2
0.4
−6
−4
−2
0
2
4
6

Clustering



The challenges of matching (financial) time series

- Highly non-linear
-

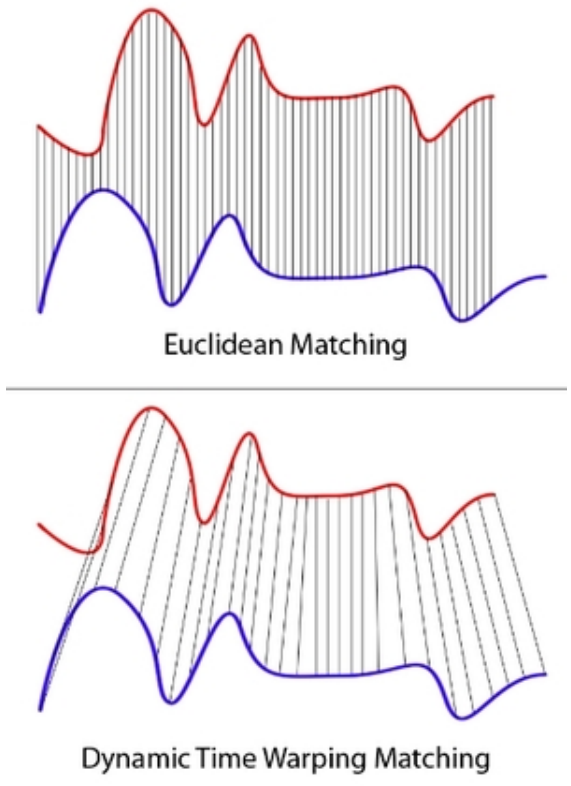
Model-free approaches

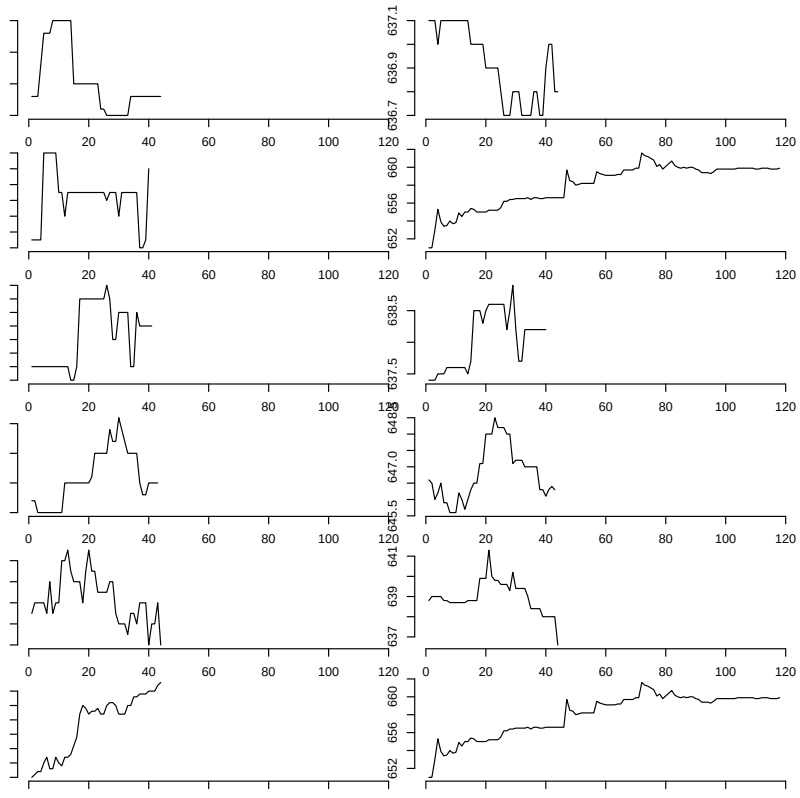
- Dynamic Time Warping
- Correlation
- Autocorrelation functions
- Periodogram-based distances
- etc.

Complexity-based approaches

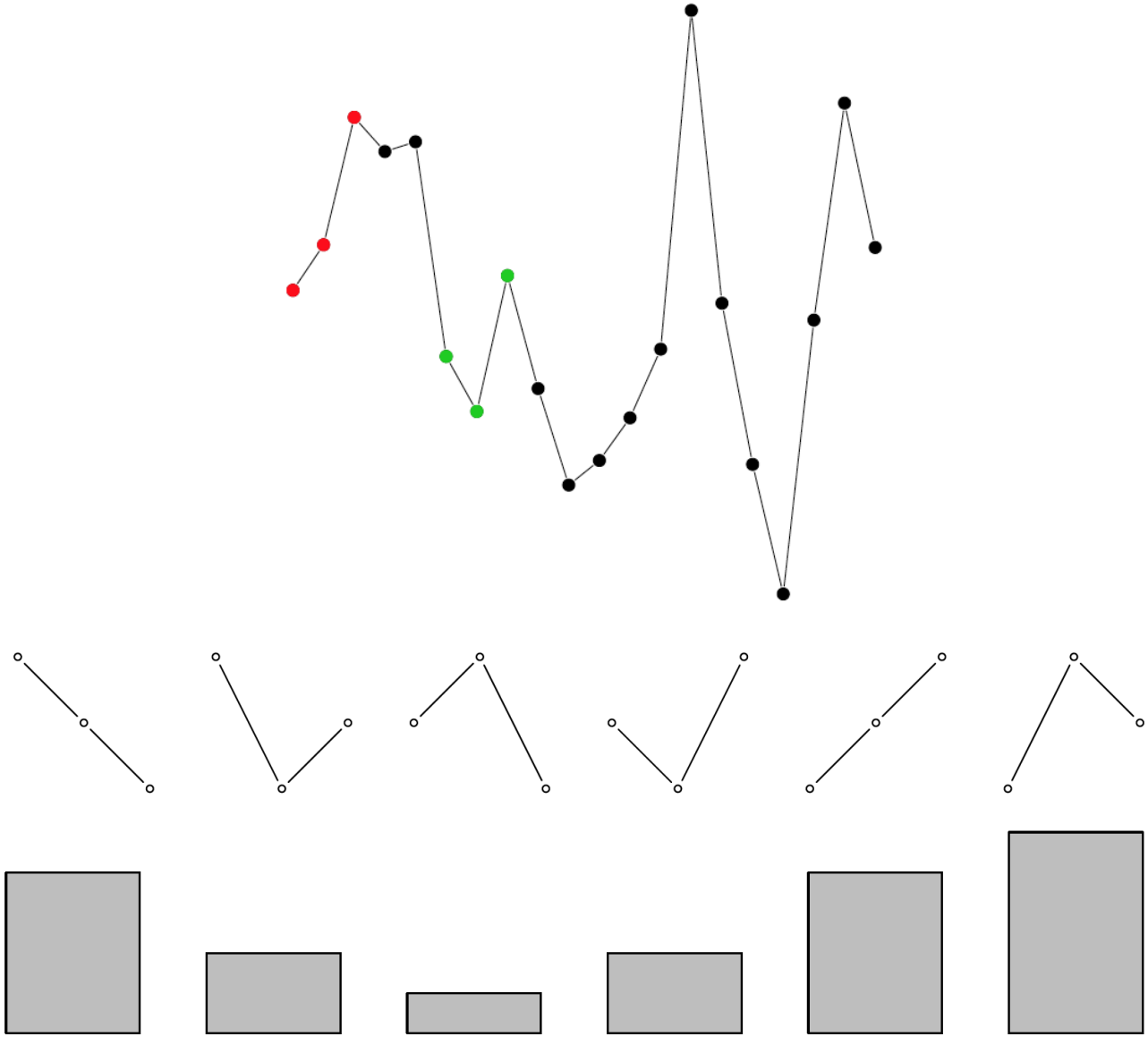
- Permutation distribution clustering
- Complexity-invariant dissimilarity
- etc.

Model-free approaches | e.g.: Dynamic Time Warping

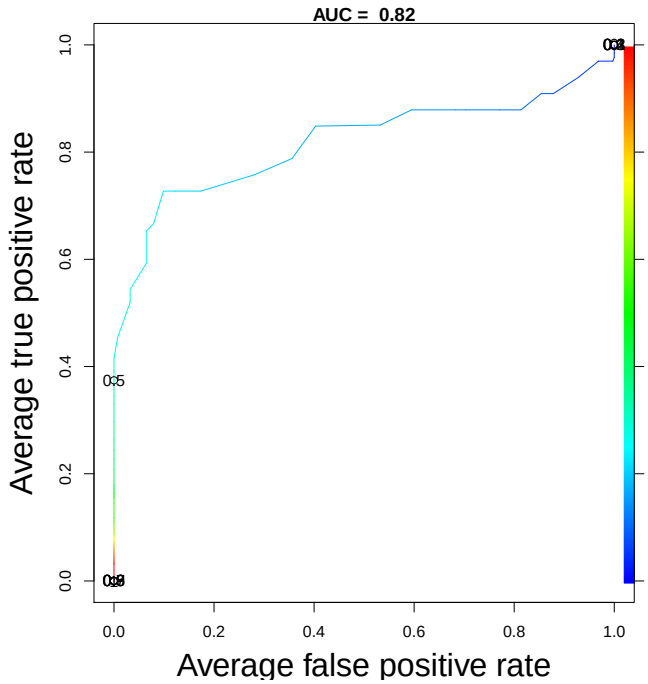


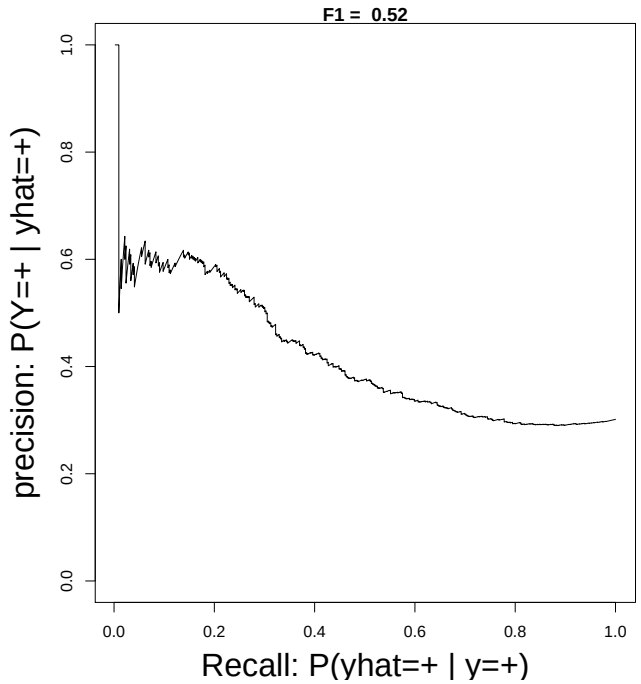


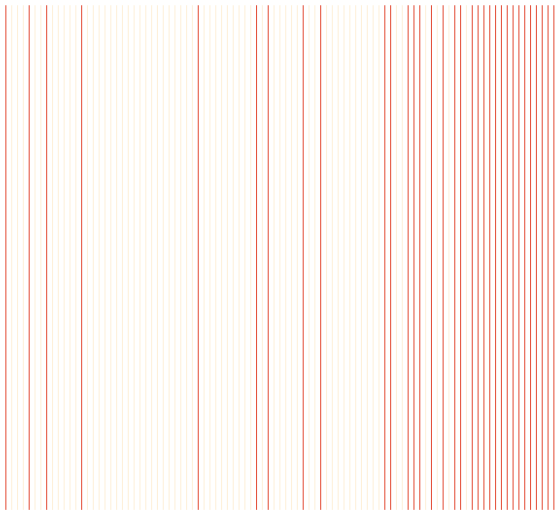
Complexity based clustering: Permutation distribution clustering

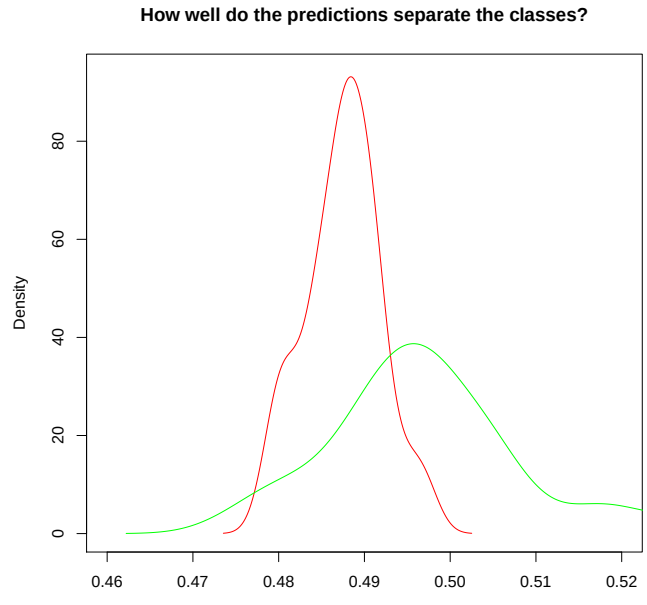


Performance | Stock = TEVA (Pharma), method = PACF

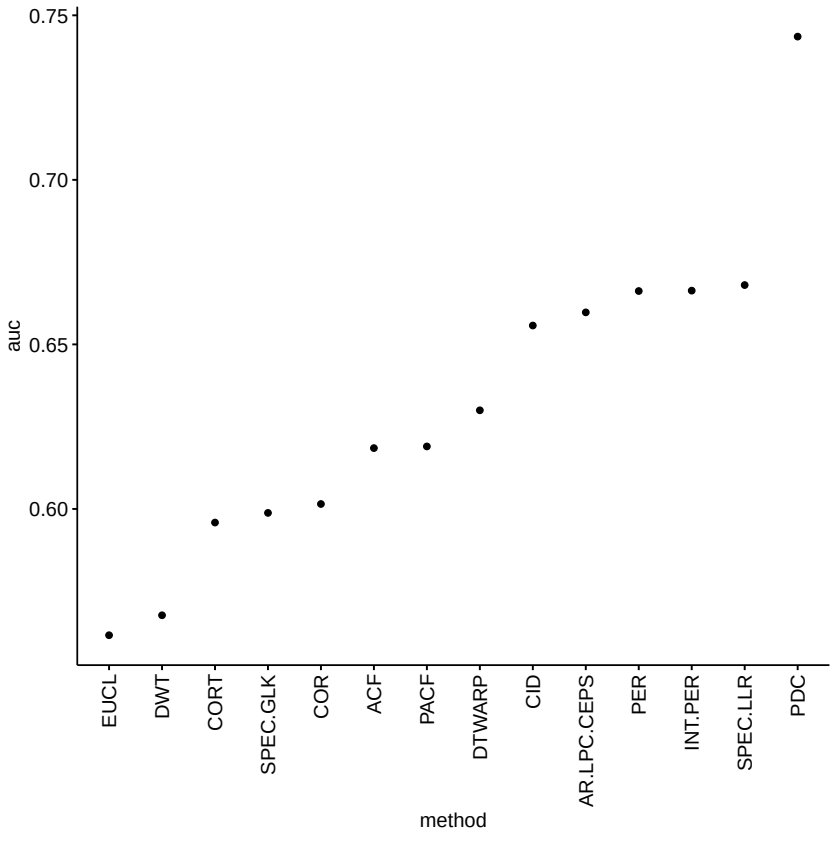


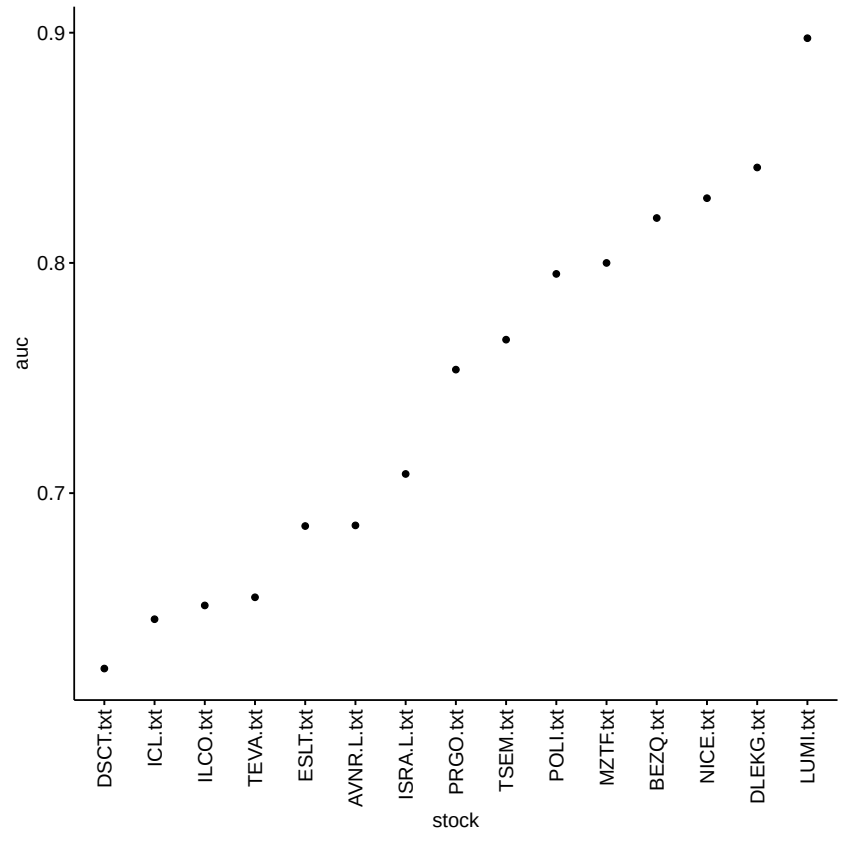




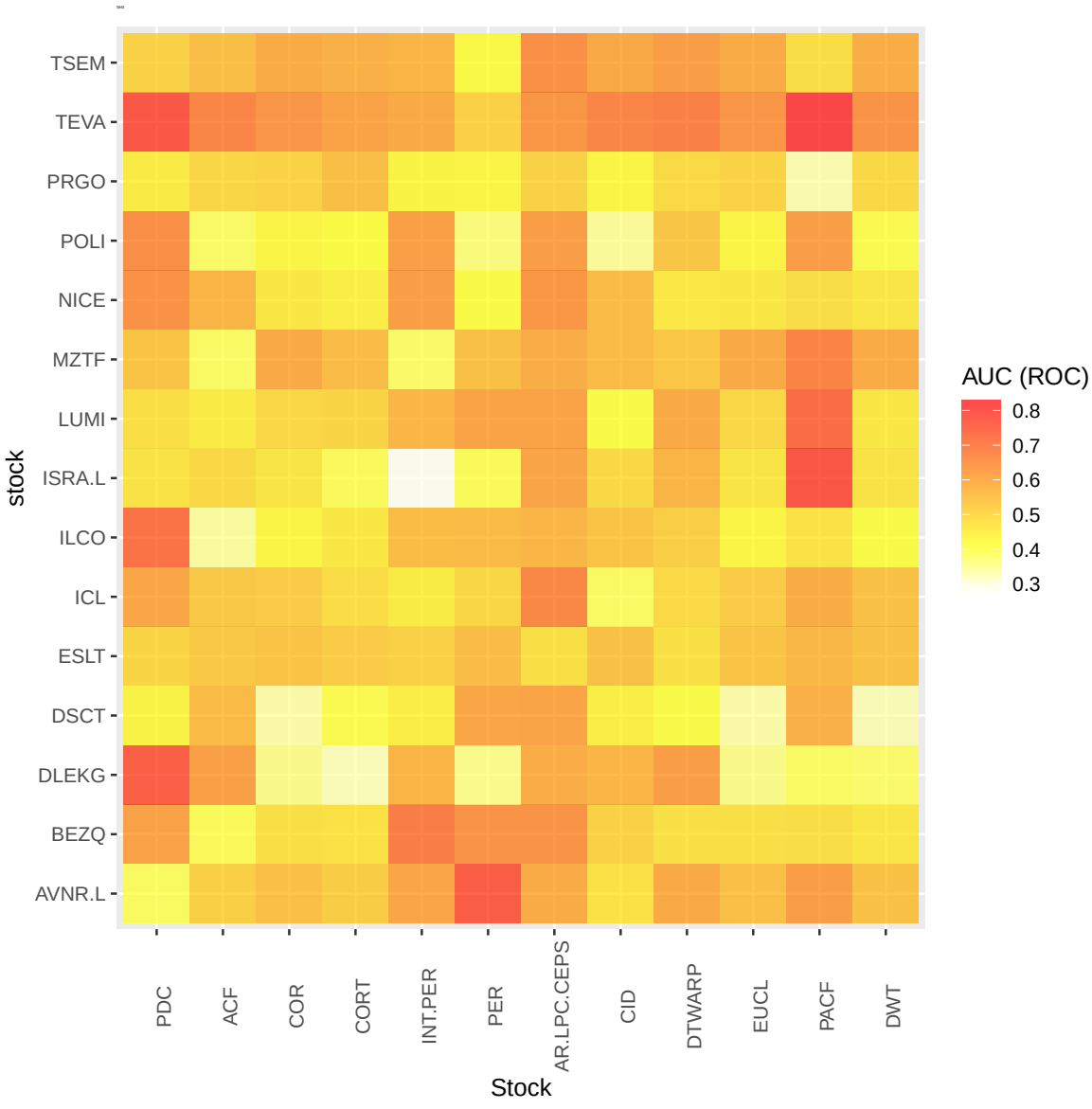


AUC by Stock and Method

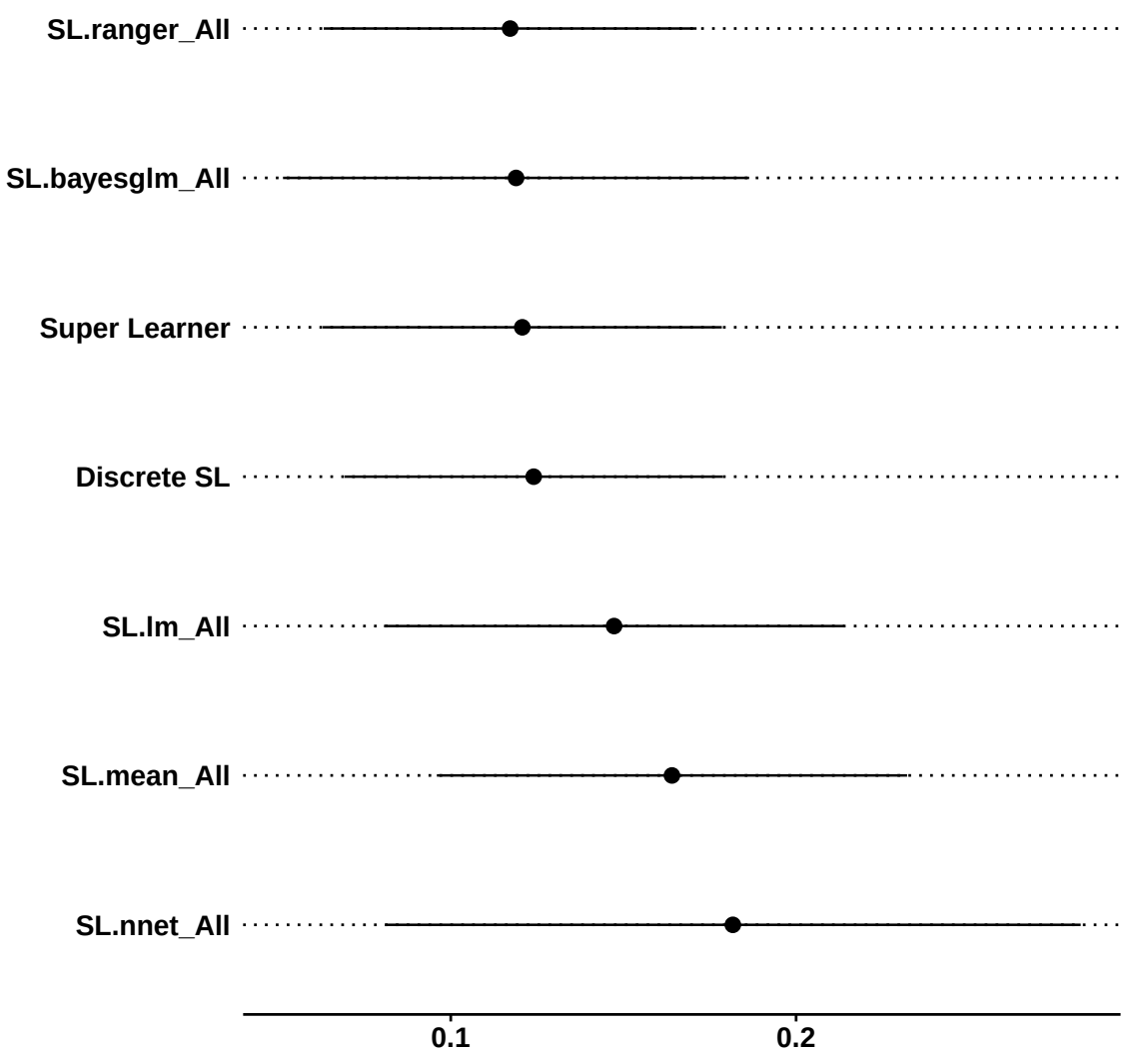




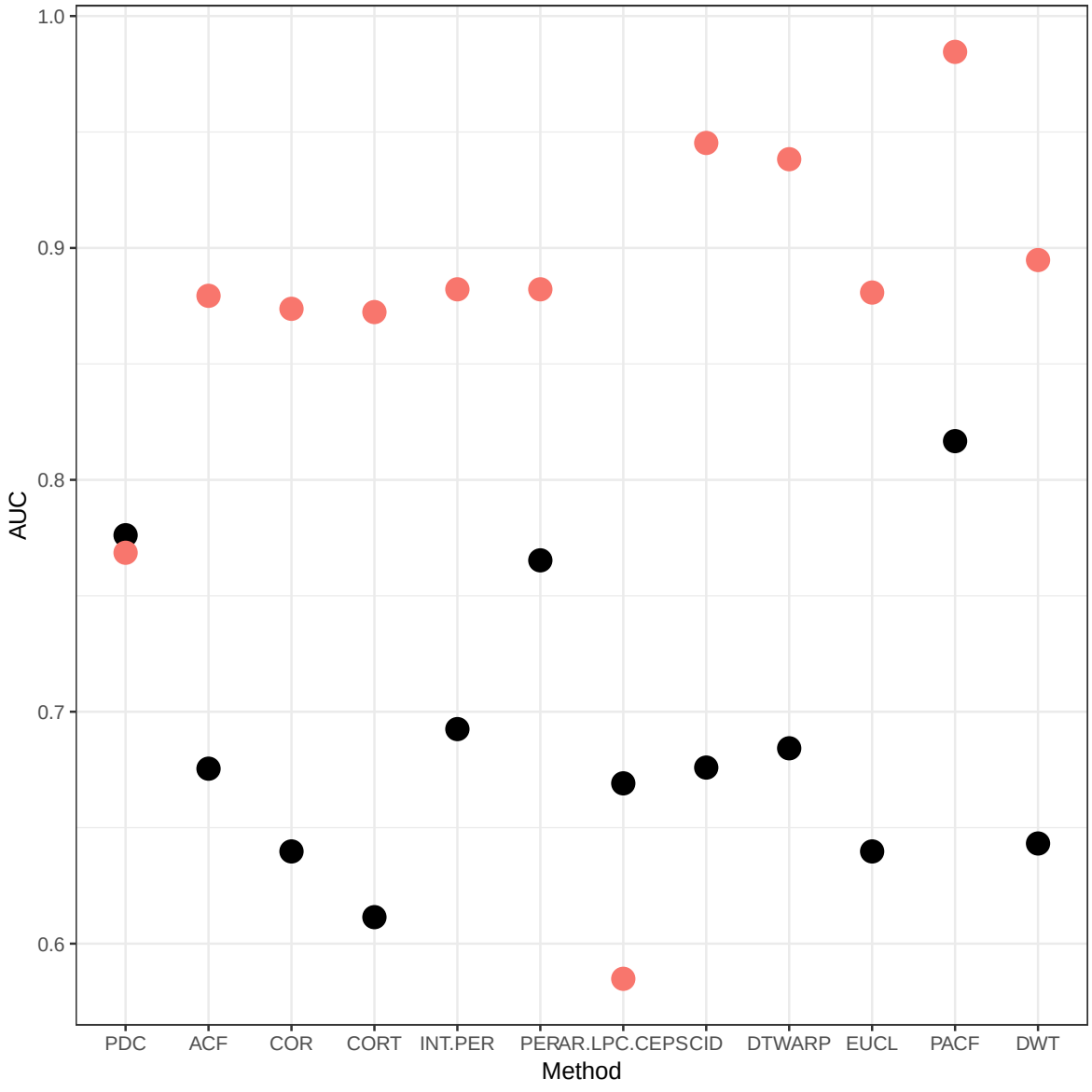
AUC by Stock and Method



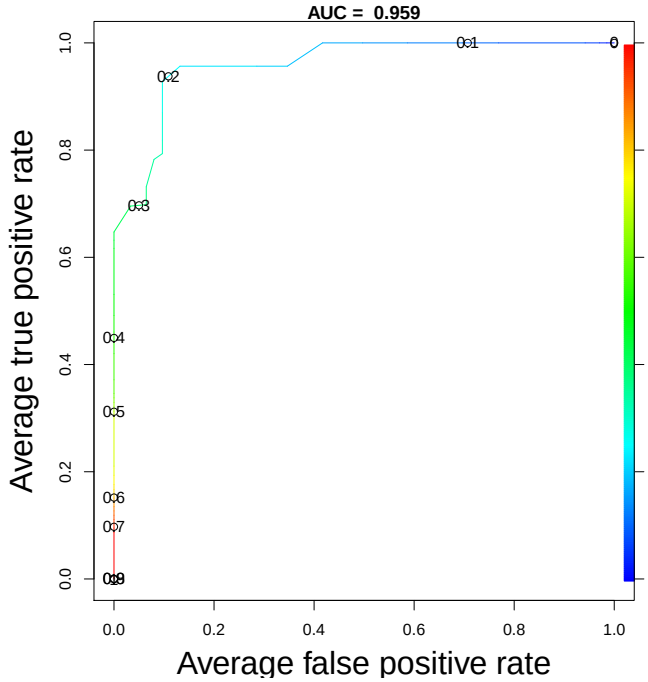
Ensemble

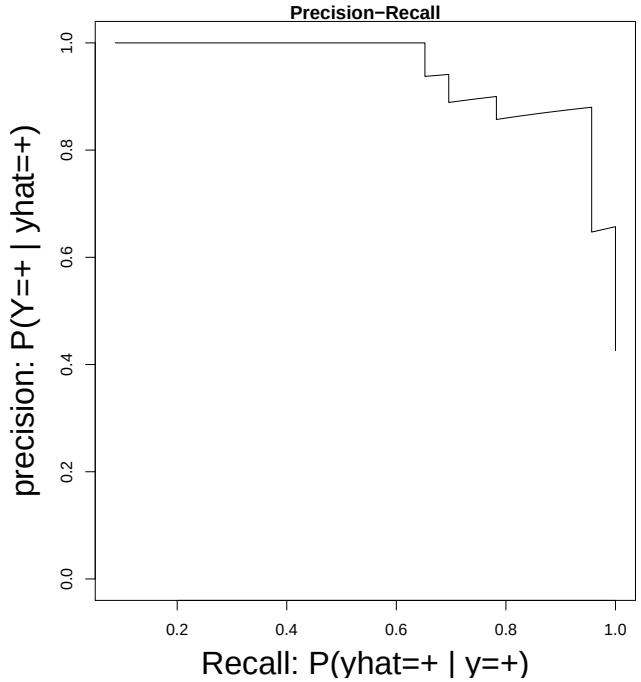

SL.ranger_All
SL.bayesglm_All
Super Learner
Discrete SL
SL.lm_All
SL.mean_All
SL.nnet_All
0.1
0.2

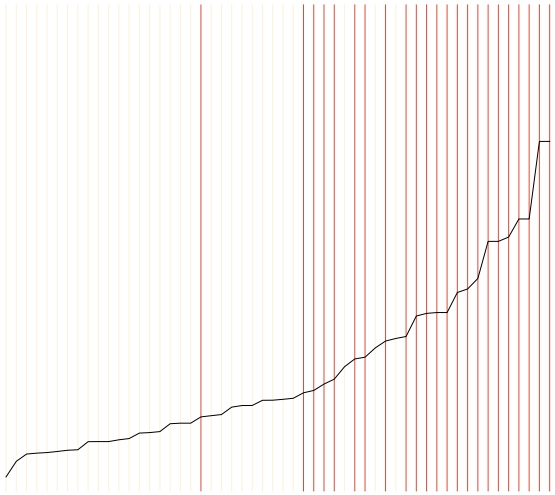
Ensemble of stock

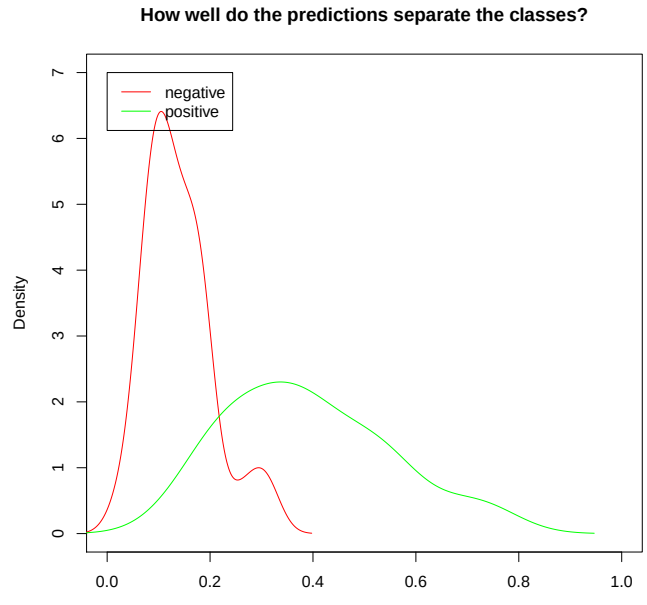


Ensemble of all stocks + algos



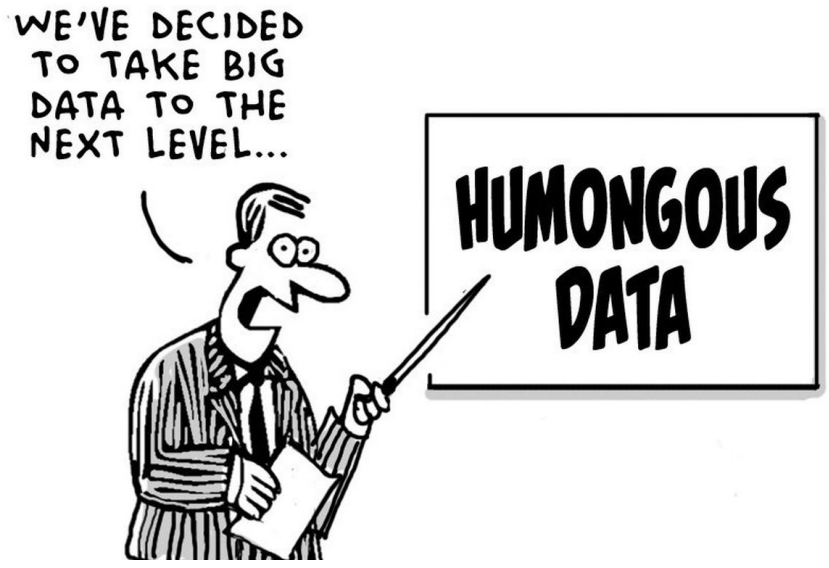






Next Steps

- More data:
  - Use open, close, high, low info
  - Use higher orders?
  - Tick-level data



- Prototyping: fundamental shapes of pre-attack (pre-conflict) time series?