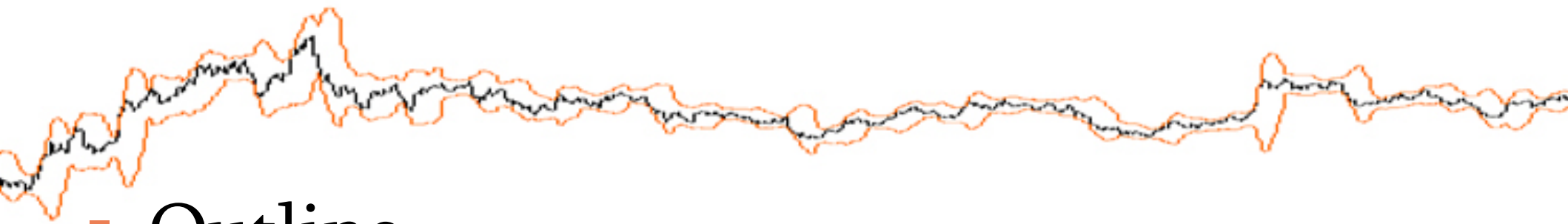




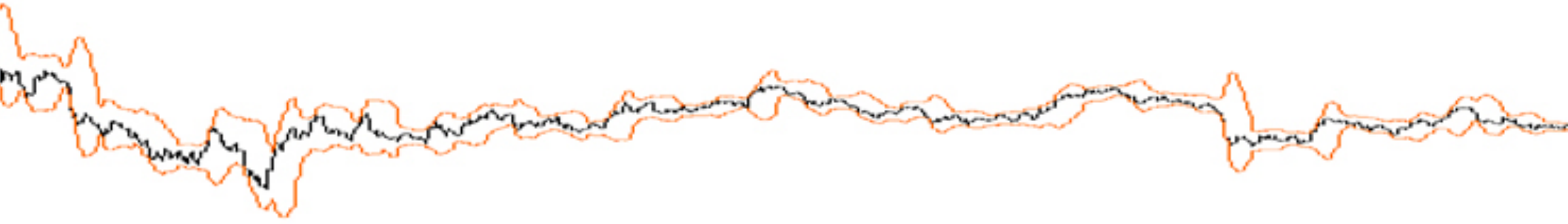
- Neural Network Predictions of Stock Price Fluctuations

By Wojciech Gryc



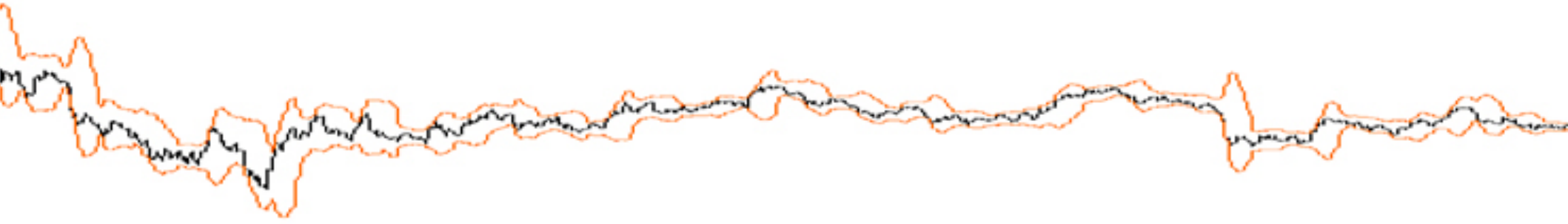
## ■ Outline

- Project Goals.
- Stock Market Psychology.
- Types of Analysis.
- Neural Networks.
- Statistical Analysis.
- Results.





## ■ Project Goals

- Within the context of short-term (1, 5, 20 business days) predictions,
    - Comparing technical and fundamental analysis.
    - Comparing the usefulness of feedforward and recurrent (Elman) networks.
- 

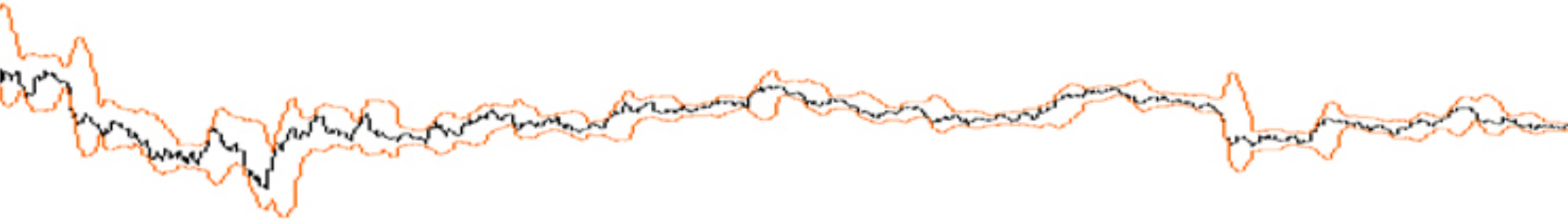


## ■ Stock Market Psychology

- Efficient Markets Hypothesis (EMH):
  - Investors are fully rational and respond rationally to all changes within the market.
  - Irrational investors trade randomly, and all random investments cancel themselves out.
  - If investors' irrational decisions do not cancel, rational investors will take advantage of these decisions to profit.



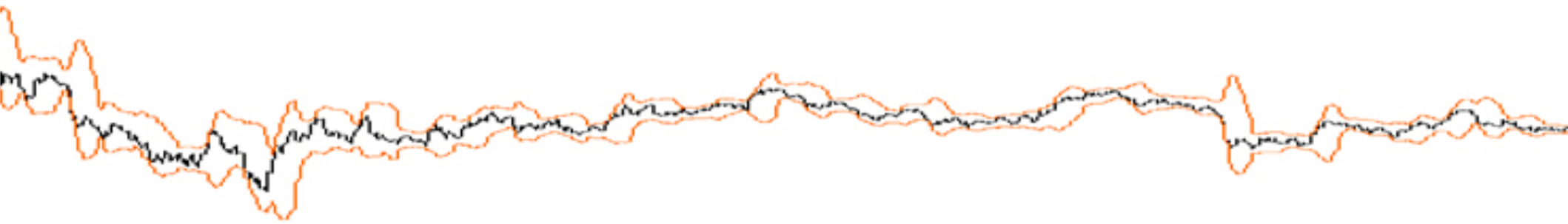
## ■ Stock Market Psychology

- Shortcomings:
    - No such thing as perfect information.
    - Naïve interpretation of available information.
    - Herd behaviour and “contrarian strategies”.
  - Generally accepted that short-term, irrational – even predictable – fluctuations and patterns appear.
- 



## ■ Types of Analysis

- Two types of analysis of stock prices exist:
  - Technical: making predictions based on past prices.
  - Fundamental: making predictions based on state of the company.

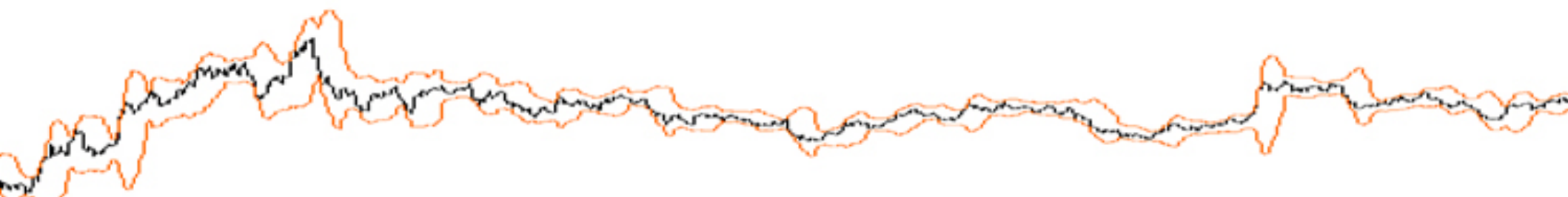




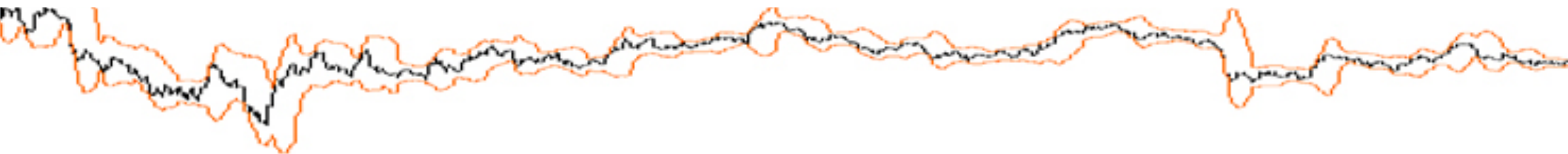
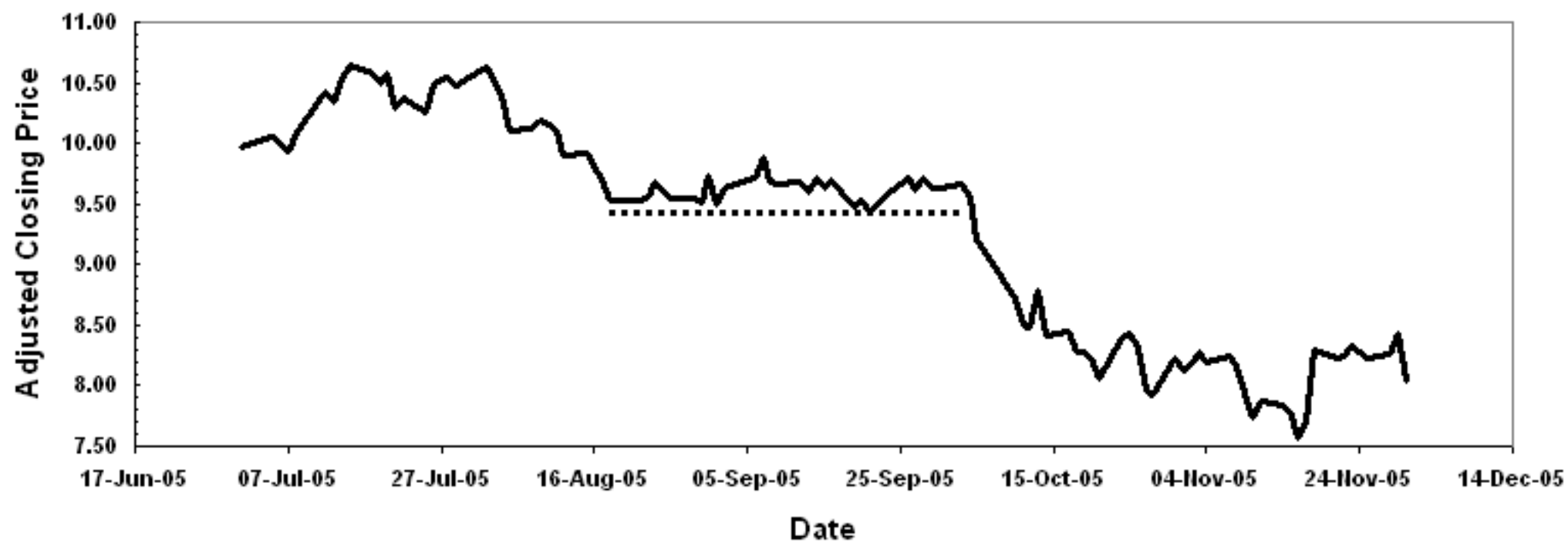
- **Types of Analysis**

- **Technical Indicators:**

- Variable Moving Average (VMA)
- Trading Range Breakout (TRB)
- Bollinger Bands
- Money Flow Index (MFI)
- Temporal Data
- Prices

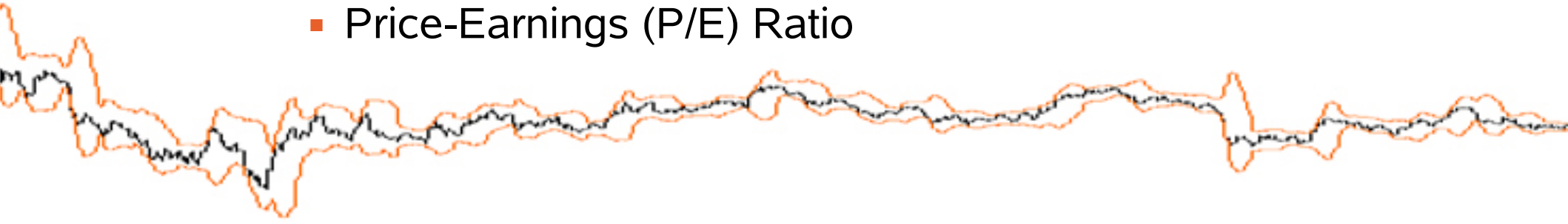


## Ford Share Prices





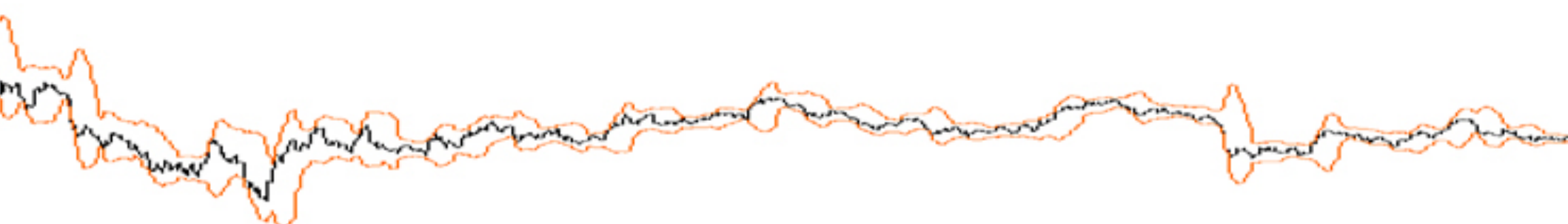
## ■ Types of Analysis

- Fundamental Indicators:
    - Consumer Price Index (CPI)
    - Consumer Sentiment Index
    - Consumer Confidence Index
    - New Orders Diffusion Index
    - Leading Indicators Index
    - Interest Rate of the 30-Year Conventional Mortgage
    - Federal Funds Rate
    - Price-Earnings (P/E) Ratio
- 



## ■ Types of Analysis

- Stocks labeled “Consumer Discretionary” in the Global Industry Classification Standard (GICS):
  - Consumer luxuries.
  - Known for its responsiveness to the business cycle.
- All companies were then analyzed to ensure similar stock characteristics.





## ■ Neural Networks

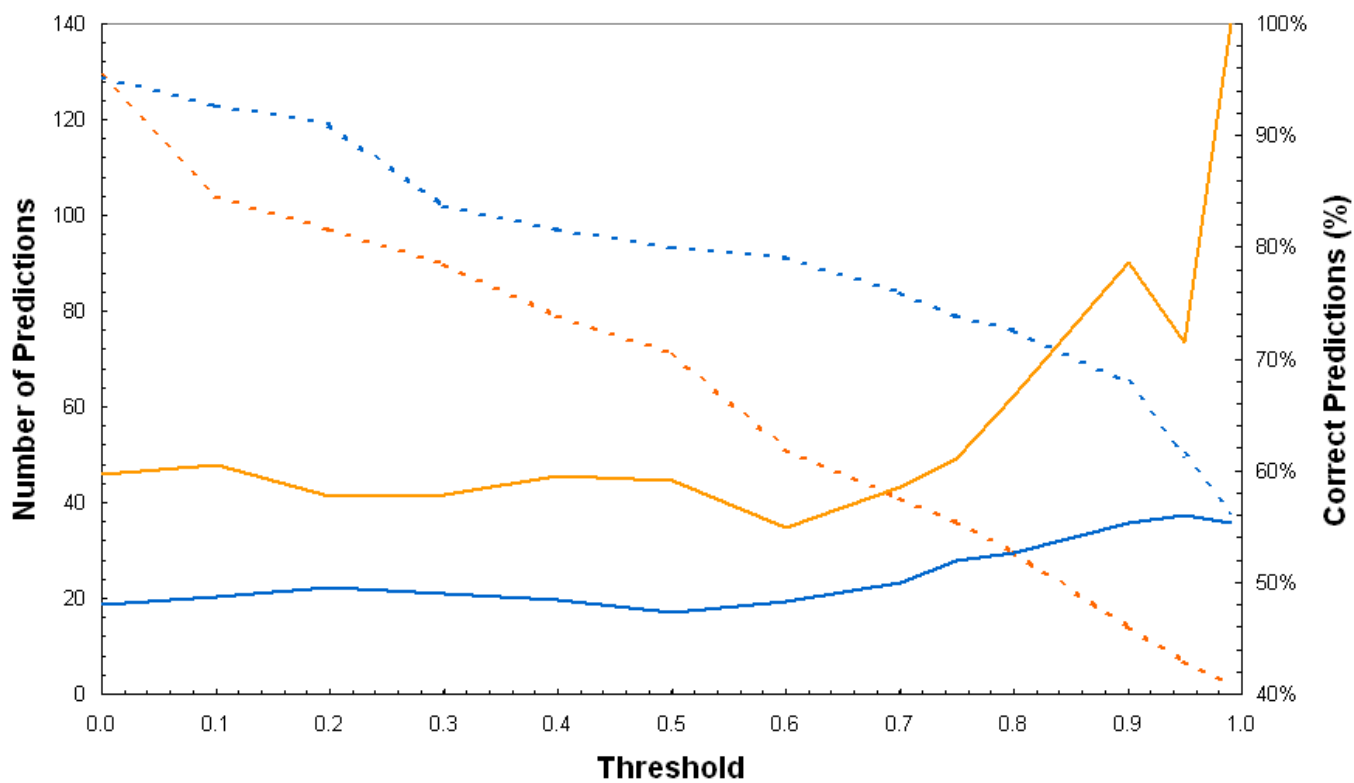
- Two types used: feedforward and Elman.
- Learning algorithms: backpropagation and Jordan-Elman backpropagation.
- Over 125 networks trained and validated in 19 different trials.
- Maximum error propagated always at 0.0.



## ■ Neural Networks

- Feedforward:
  - 1, 2, and 3 layers.
  - Short-term historical inputs for  $k$  previous days.
- Elman:
  - 1 layer with previous day's historical inputs.
- Feedforward / Elman:
  - 1 layer with historical inputs for  $k$  previous days.

## Threshold Analysis

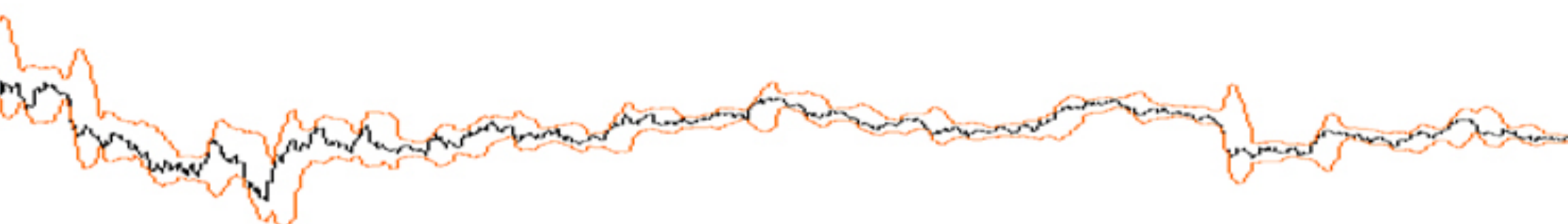


--- # of Predictions (500 Cycles) --- # of Predictions (10000 Cycles) — % Correct (500 Cycles) — % Correct (10000 Cycles)



## ■ Statistical Analysis

- Analysis of the accuracy of neural networks based on:
  - Was the prediction above the threshold value?
  - Was the total accuracy over 0.50?
  - Was the total accuracy over  $\theta$ , where the likelihood,  $S$ , that a stock price rises is  $S \sim \text{Bernoulli}(\theta)$ .
- Caveat: certain stocks seem to lend themselves to prediction better than others.





## ■ Results

Trial Name	Avg. Accuracy	$p(0.5)$	$\theta$	$p(\theta)$
Trial 3, $n = 0.0005$	55.20%	0.0324	0.5039	0.0419
Trial 5, $n = 0.0005$	56.01%	0.0096	0.5078	0.0153
Trial 15, $n = 0.01$	61.06%	0.4110	0.5465	0.6110
Trial 15, $n = 0.003$	60.39%	0.1928	0.5465	0.3278

1 day





## ■ Results

Trial Name	Avg. Accuracy	p (0.5) theta	p (theta)	
Trial 11, n = 0.01	54.93%	0.1356	0.6512	0.0144

**5 days**



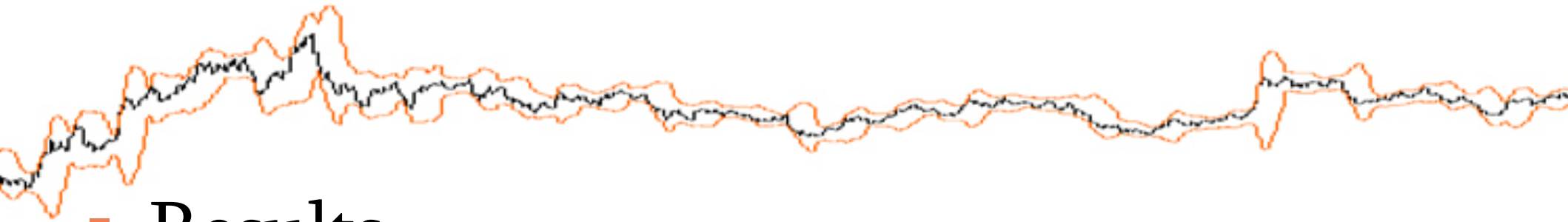


## ■ Results

Trial Name	Avg. Accuracy	$p(0.5)$	$\theta$	$p(\theta)$
Trial 12, $n = 0.01$	82.70%	0.0005	0.7000	0.0165
Trial 12, $n = 0.003$	80.33%	0.0010	0.7000	0.0423
Trial 13, $n = 0.01$	61.87%	0.0001	0.7442	0.0000
Trial 13, $n = 0.003$	57.85%	0.0299	0.7442	0.0037
Trial 17, $n = 0.003$	57.13%	0.1385	0.7442	0.0166

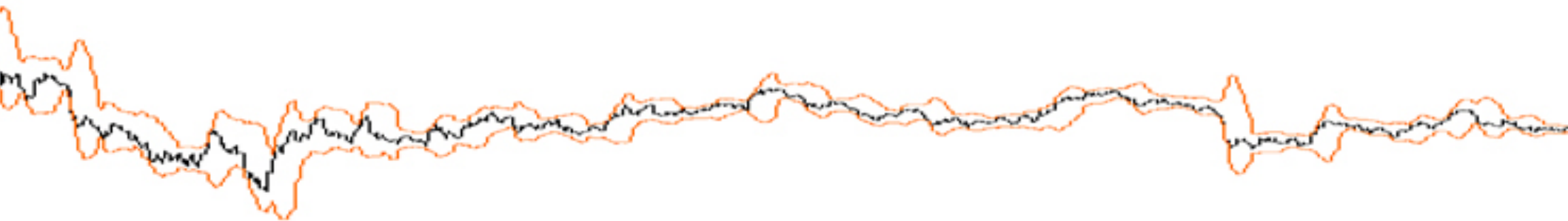
**20 days**





## ■ Results

- 1 layer feedforward networks moderately successful for 1-day predictions, as are recurrent networks with  $k$  historical inputs are effective.
- For 20-day predictions, fundamental networks are best.
- May be useful to combine multiple stocks (Trial 5 – CC and F).
- Inconclusive about combining technical and fundamental inputs.





- Thank You

Wojciech Gryc  
wojciech@i2r.org