Predictions in Financial Time Series

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Data

- Financial Data - time series
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- UK, Germany, France, US, Japan, Australia

OHLC Data

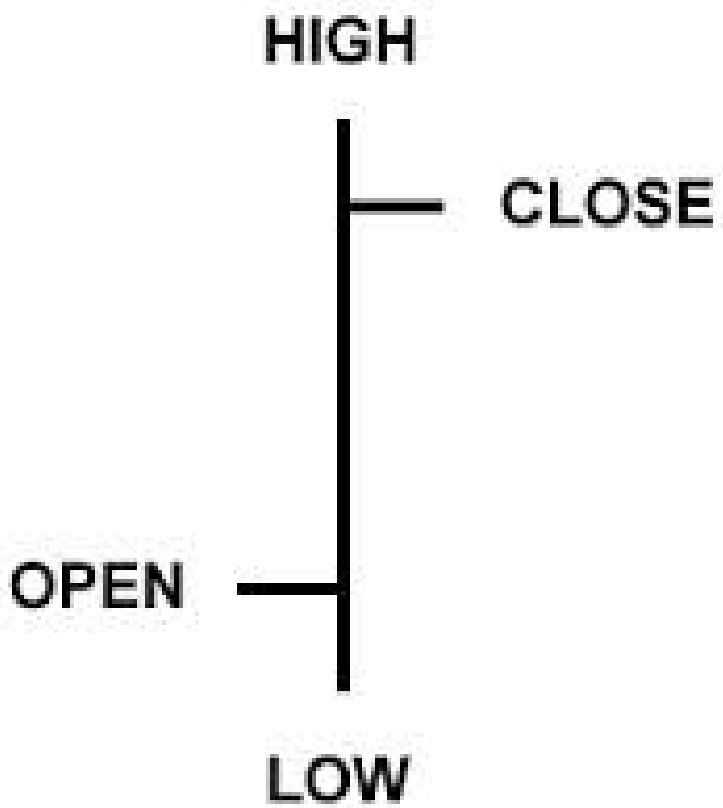

Figure: A schematic representation of open, high, low and closing prices (OHLC)

German Dax

Table: Final 6 rows of the Dax data set

Date	Open	High	Low	Close
13/12/2013	9017	9047	8991	9006
16/12/2013	9005	9188	8998	9164
17/12/2013	9143	9162	9085	9085
18/12/2013	9145	9191	9122	9182
19/12/2013	9280	9352	9257	9336
20/12/2013	9371	9413	9353	9400

German Dax 2000 to 2013

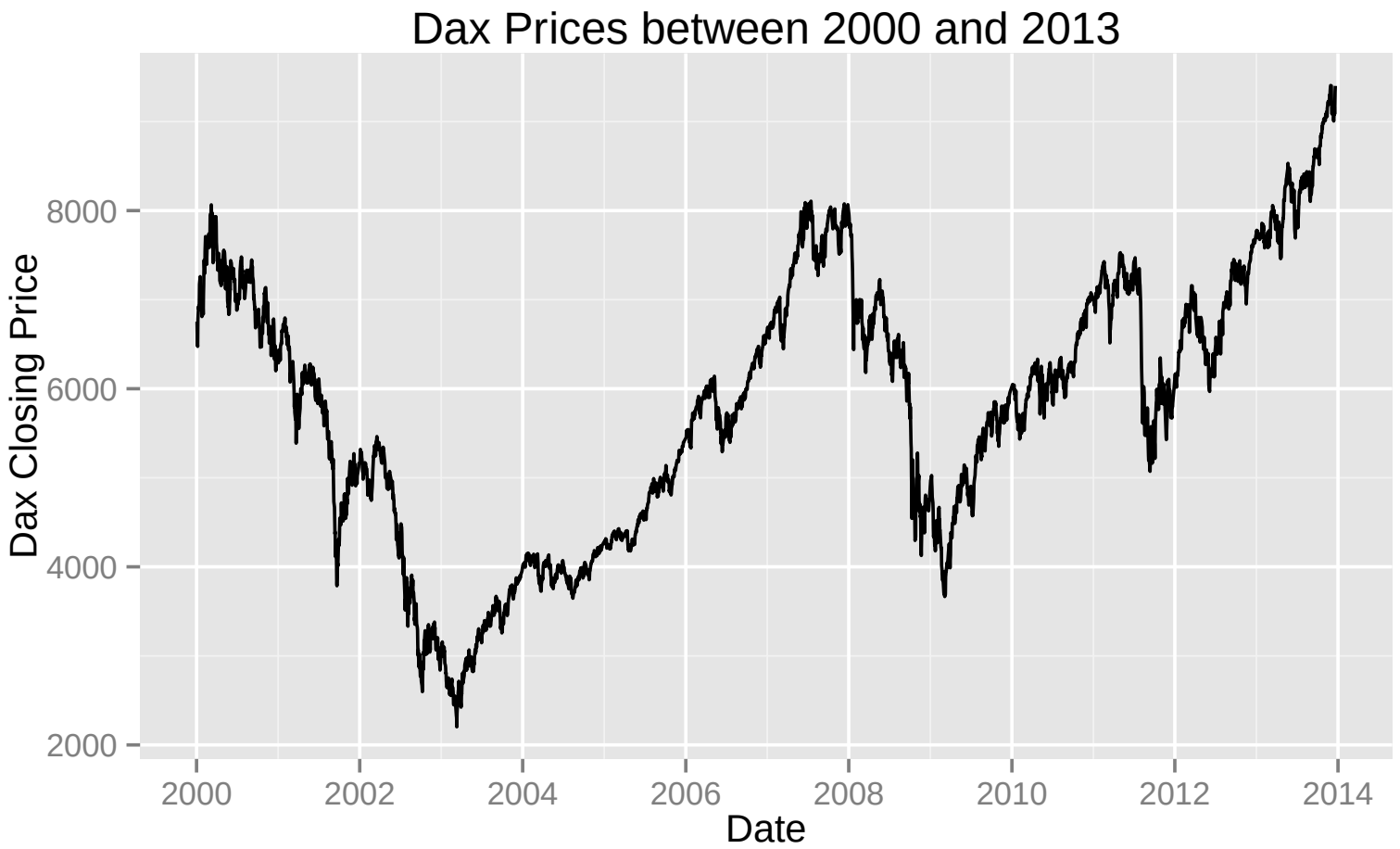

Figure: Graph of German Dax in 2013.

Technical Analysis

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- All that was needed to know about a particular market was contained in its pricing chart

Technical Analysis

"Obviously I am biased against the chartist. This is not only a personal predilection, but a professional one as well. Technical Analysis is anathema to the academic world. We love to pick on it. Our bullying tactics are prompted by two considerations: (1) the method is patently false; and (2) it's easy to pick on. And while it may seem a bit unfair to pick on such a sorry target, just remember: it is your money we are trying to save."

Malkiel, B.G. (1999)
A Random Walk Down Wall Street: Including a Life-cycle Guide to Personal Investing

Technical Indicators

- Moving Average Convergence Divergence (MACD)

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Moving Average Convergence Divergence (MACD)

The EMA is calculated as follows:

$$EMA(n)_t = \frac{2}{n+1}(P_t - EMA_{t-1}) + EMA_{t-1}$$

Where P_t is the closing price of a market on day t and n is the number of periods used in calculating the moving average. MACD itself is calculated as:

$$MACD_t = EMA(s)_t - EMA(l)_t$$

where $EMA(s)_t$ is the short moving average and $EMA(l)_t$ is the long one. In addition an EMA of the MACD itself is calculated in order to generate trade signals and is often referred to as the "trigger line".

Moving Average Convergence Divergence (MACD)

Figure: Graph of Financial Data with MACD Added.

Time Series

Time Series

- ARIMA
- Hybrid ARIMA

ARIMA

$$
\begin{aligned}
r(t) = c + & \\
& b_1 * r_{t-1} + b_2 * r_{t-2} \ldots b_p * r_{t-p} + \\
& a_1 * ma_{t-1} + a_2 * ma_{t-2} \ldots a_q * ma_{t-q} \\
& d_1 * diff_{t-1} + d_2 * diff_{t-2} \ldots d_d * diff_{t-d} \\
& + err
\end{aligned}
$$

where:
c is the intercept, which is often zero and the mean of the time series.
$b_1 - b_p$ are the independent variables, the previous values in the auto-regression term.
$a_1 - a_p$ are parameters of the moving average model.
$d_1 - _p$ are the parameters of the differencing term. ε is random noise.

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- Test the chosen model(s), using the AICc to determine if a better model is available.
- Check the residuals from the best model by plotting the ACF, and doing a portmanteau test on them. If the results from these tests do not look like white noise, a modified model may be required.
- Finally, once the residuals have a similar pattern to white noise, the model can be used to generate forecasts.

Hybrid ARIMA Models

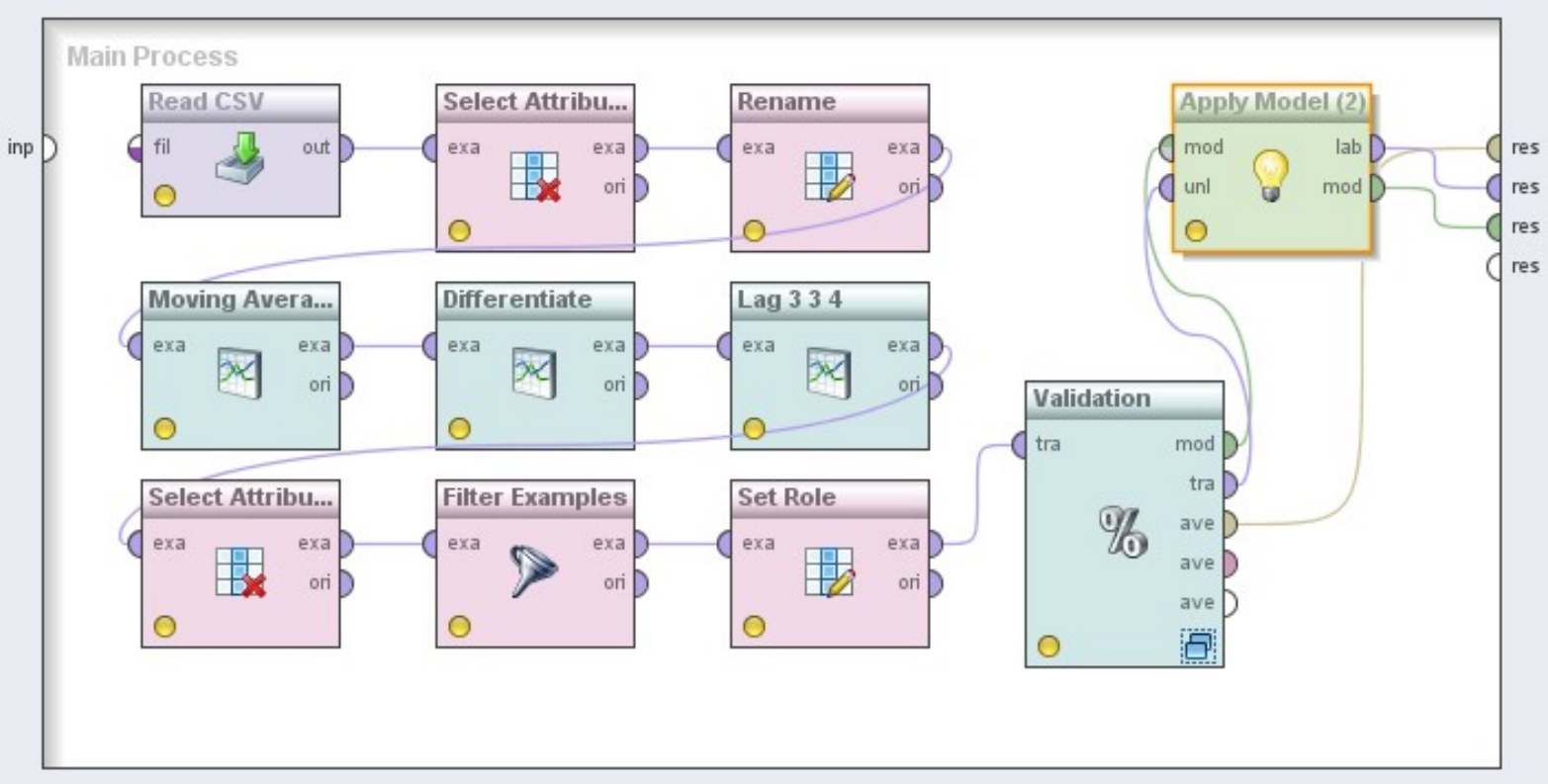

Figure: Rapid Miner Hybrid ARIMA Model

Results

Results

- Baseline Systems - for comparisons.
  - Buy and Hold
  - Reversing System
- Technical Analysis
  - Trend Detection Indicators
  - Reversal Indicators
  - Momentum Indicators
  - Break-out Systems
  - Candlesticks
- ARIMA and Hybrid ARIMA
  - Predicting closing price
  - Predicting Up or Down

Buy and Hold Reversing System

Results - Baseline Buy and Hold

Table: Naive Long System changed such that the trading period is the previous close price minus today's close.

Mkt	LongPL	L Win %	Av L PL
Dax	2649	53	1
CAC	-1667	51	0
FTSE	86	51	0
Dow	5219	53	1
Nikkei	-2712	51	-1
AORD	2229	53	1

Results - Baseline Daily Reversal

Table: Naive system which reverses the previous day's trade direction.

Mkt	LongPL	ShortPL	L Win %	Av L PL	S Win %	Av S PL
Dax	947	3131	53	1	49	2
CAC	940	7810	53	1	53	4
FTSE	4284	4115	53	3	50	2
Dow	15799	6047	56	10	49	3
Nikkei	2324	20486	51	1	54	12
AORD	1264	237	53	1	48	0

Technical Analysis

Aroon
Break-out System

Results - Aroon Technical Indicator

Table: Aroon trend indicator.

Mkt	LongPL	ShortPL	L Win %	Av L PL	S Win %	Av S PL
Dax	5308	5257	56	3	51	4
CAC	-1638	4919	50	-1	52	4
FTSE	3042	5715	52	2	51	5
Dow	12131	3811	55	7	49	3
Nikkei	-4852	12013	49	-3	52	10
AORD	3735	3540	55	2	50	3

Results - Break-out Indicator

Table: Results from Daily High / Low Breakout System.

Mkt	LongPL	ShortPL	L Win %	Av L PL	S Win %	Av S PL
Dax	21073	21229	58	11	56	13
CAC	14252	20176	58	8	59	12
FTSE	13239	18614	59	7	59	12
Dow	-19355	-27334	42	-11	38	-17
Nikkei	74600	81645	64	44	64	49
AORD	19347	21244	67	11	65	14

Results - Break out compared to Reversing System

Table: Results from Daily High / Low Breakout System compared with Naive Reversing System

Mkt	LongPL	ShortPL	L Win %	Av L PL	S Win %	Av S PL
Dax	20126	18098	5	10	7	11
CAC	13312	12366	5	7	6	8
FTSE	8955	14499	6	4	9	10
Dow	-35154	-33381	-14	-21	-11	-20
Nikkei	72276	61159	13	43	10	37
AORD	18083	21007	14	10	17	14

Hybrid ARIMA Models

Predicting Closing Price
Predicting Up or Down

Results - Predicting closing Price with ARIMA

Table: Auto.arima models passed to the System 1 trading algorithm

Mkt	LongPL	ShortPL	L Win %	Av L PL	S Win %	Av S PL
Dax	-644	-1881	50	-3	41	-7
CAC	1555	850	59	6	51	3
FTSE	531	-708	53	2	46	-2
Dow	3130	-1766	58	14	48	-6
Nikkei	41	-1157	48	0	45	-5
AORD	679	-204	55	3	49	-1

Results - Predicting closing Price with Hybrid ARIMA/k-NN

Table: Predicting Close Price - Arima/k-NN predictions compared with Naive Reversing System.

Mkt	LongPL	ShortPL	L Win %	Av L PL	S Win %	Av S PL
Dax	7323	6769	3	3	3	4
CAC	5344	4787	1	2	2	3
FTSE	13321	12911	5	6	6	8
Dow	14531	14502	3	7	4	9
Nikkei	13050	12880	3	8	3	8
AORD	6394	6401	4	3	5	4

Results - Predicting Up/Down Categorical Label with Hybrid ARIMA/k-NN

Table: Results from Naive Reversing System subtracted from results generated from predicting Up/Down categorical label using Arima/k-NN.

Mkt	LongPL	ShortPL	L Win %	Av L PL	S Win %	Av S PL
Dax	14745	14226	8	7	11	10
CAC	9221	8777	7	5	6	5
FTSE	11269	10845	7	5	10	8
Dow	14548	14577	6	4	11	12
Nikkei	24882	24545	9	17	6	12
AORD	8447	8514	7	4	11	6

Results - Predicting Up/Down Numerical Label Hybrid ARIMA/k-NN

Table: Results from Naive Reversing System subtracted from results generated from predicting Up/Down Numerical label using Arima/k-NN.

Mkt	LongPL	ShortPL	L Win %	Av L PL	S Win %	Av S PL
Dax	13175	12656	11	10	6	5
CAC	10175	9730	12	9	4	3
FTSE	13872	13448	12	11	6	6
Dow	12307	12336	10	10	6	6
Nikkei	19400	19063	12	24	3	3
AORD	8343	8410	12	6	8	4

Conclusions

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- Technical Analysis Indicators - generally not good
- Break-out system - very good
- ARIMA - not good
- Hybrid ARIMA models - good with k-NN

The End