基於特徵挑選之智慧型時間序列預測研究

A Study on Intelligent Time Series Prediction Based on Feature Selection

1. 緒論
2. 股票預測文獻彙整

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| 作者 （年） | 資料集來源 | 輸出目標 | 取樣期間 | 方法 | 表現指標 |
| Li et al.（2014） | SSEC,  NASDAQ | Stock price | 2011-2012 | SVM, EMD | RMSE, MAE, MAPE |
| Xi et al.（2014） | Chongqing Iron & Steel | Stock price | 01.04.2012-  10.08.2012 | RBF | RMSE |
| Bas et al.（2015） | BIST,  TAIFEX | Stock price | 10. 01.2010- 12. 23.2010 | FFANN | RMSE |
| Ye and Wei（2015） | SSEC | Stock price | 2012 -2014 | WNN | RMSE, MAPE |
| Khuat et al.（2016） | Apple,  Yahoo,  Google | Stock price | 2009-2013  2013-2014  2014-2015. | MLP | RMSE |
| Qiu and Song（2016） | Nikkei 225 | Stock price | 2007-2013 | GA-ANN | Hit ratio |
| Chen et al.（2016） | TAIEX  HSI | Stock price | 1998-2006 | ANFIS-based | RMSE,  Wilcoxon test, Profitable unit |
| Zhang et al.（2017） | SSEC,  TAIEX | Stock price | 2000-2006  1990-1999 | Type-2 FTS | RMSE, MAPE |
| Wei et al.（2017） | SSEC | Stock price | 2009-2014 | 2RS-WNN | RMSE, MAD, MAPE, DS% |
| Chong et al.（2017） | KOSPI | Stock return | 2010-2014 | DNN | NMSE, RMSE, MAE, MI |
| Liu et al.（2017） | 000573: Shenzhen | Stock volatility | 2015-2016 | RNNs | Accuracy |
| Chatzis et al.（2018） | 39 Countries | Stock direction | 1996-2017 | LogR, RF, SVMs,  NNs, CART, XG- Boost, MXNET | Accuracy |
| Pang et al.（2018） | SHASHR, TMSE,  TMBA,  SINOPEC | Stock price | 2006 -2016 | ALSTM,  ELSTM | MSE, DA |
| Lei（2018） | SSEC,  All Ords,  CSI 300,  Nikkei 225,  DJI | Stock price,  Stock direction | 2009-2014 | BP-NN,  RBF-NNAN,  FIS-NN, SVM, WNN, RS-WNN, 2RS-WNN | RMSE, MAD, MAPE, DS%,  CP%,  CD% |
| Shastri et al.（2019） | Apple | Stock price | 2013 - 2016 | ANN | MAPE,  Accuracy |

1. 研究方法
2. 單目標預測資料矩陣

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Candidate features | | | | Target |  |
|  |  |  |  |  |  | **t** |  |
| Data matrix |  |  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

其中*s*為自訂的候選特徵個數；**f**為特徵變數；**t**表示為目標變數；*x*為原始數據差分後的值。

1. 多目標預測資料矩陣

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Candidate features | | | | | | | | Targets | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Data matrix |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
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其中候選特徵所組成的集合即稱為候選特徵池（Candidate feature pool; CP），，為候選特徵池內所有候選特徵變數的總數；目標變數的集合則記為*TS*，，為目標變數的總數。

1. 影響資訊矩陣

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
|  |  | *0* |  |  |  |  |  |
|  |  | *0* |  |  |  |
|  |  |  | *0* |  |  |
|  |  |  |  | *0* |  |
|  |  |  |  |  | *0* |

其中表示為第j個目標變數。

1. 實驗內容
   1. 特徵的擷取與影響
2. 四目標預測特徵多寡之效能比較（RMSE）

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | RMSE | | | | |
|  |  | NASDAQ | Nikkei 225 | SSEC | HSI | Average |
| 2 Features | Descending | **94.1295** | **222.6781** | **35.1970** | **350.6400** | **175.6612** |
| Ascending | 94.5546 | 253.3162 | 35.7287 | 366.9145 | 187.6285 |
| 4 Features | Descending | 96.4573 | **232.2399** | **34.8774** | **328.2104** | **172.9463** |
| Ascending | **88.6865** | 242.8330 | 37.7493 | 386.4353 | 188.926 |
| 6 Features | Descending | **97.0546** | **222.2573** | **34.3217** | **325.1491** | **169.6957** |
| Ascending | 98.9589 | 249.4580 | 35.0286 | 372.4195 | 188.9663 |
| 8 Features | Descending | 92.2382 | **210.2565** | **33.3978** | **326.2835** | **165.544** |
| Ascending | **88.7380** | 252.2235 | 35.8468 | 380.9012 | 189.4274 |

* 1. 驗證WOA-RLSE複合式學習演算法

1. 學習演算法效能比較（RMSE）

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | RMSE | | | | |
|  | NASDAQ | Nikkei 225 | SSEC | HSI | Average |
| ABC （Karaboga and Basturk, 2007） | 225.7861 | 258.1546 | 387.6793 | 372.5589 | 311.0447 |
| ABC-RLSE | **92.2593** | **209.3819** | 33.7420 | 333.3150 | 167.1746 |
| CACO （Jalalinejad et al., 2007） | 762.9483 | 258.6984 | 381.0925 | 374.4953 | 444.3086 |
| CACO-RLSE | 99.48212 | 239.7220 | 35.7084 | 363.7253 | 184.6595 |
| SLPSO （Cheng and Jin, 2015） | 97.1107 | 226.3361 | 39.6582 | 352.5358 | 178.9102‬ |
| SLPSO-RLSE | 96.6662 | 213.6644 | **32.2050** | 329.7354 | 168.0678 |
| WOA （Mirjalili and Lewis, 2016） | 107.6793 | 259.8400 | 39.0044 | 383.0639 | 197.3969‬ |
| WOA-RLSE | 96.8994 | 211.1764 | 32.2788 | **324.0506** | **166.1013‬** |

* 1. 國際金融市場的相互作用

1. 四目標預測之效能比較（RMSE）

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | RMSE | | | |
|  | NASDAQ | Nikkei 225 | SSEC | HSI |
| Hsieh et al.（2011） | - | 177.0000 | - | - |
| Chen（1996） | - | - | - | 337.8200 |
| Chen & Chen（2011） | - | - | - | 197.9000 |
| Yu（2005） | - | - | - | 172.8700 |
| Chen et al.（2016） | - | - | - | 132.6700 |
| Cai et al. （2013） | 22.0500 | - | - | 129.0000 |
| Cai et al. （2015） | 21.9900 | - | - | 116.4200 |
| Ye et al.（2016） | **19.3900** | - | - | 127.2100 |
| Huarng and Yu（2005） | - | - | 21.9938 | - |
| Cheng et al. （2008） | - | - | 21.6367 | - |
| Chen（2002） | - | - | 32.2600 | - |
| Lee et al. （2006） | - | - | 24.1420 | - |
| Egrioglu et al. （2011） | - | - | 18.1261 | - |
| Wang et al.（2013） | - | - | 17.8860 | - |
| Bas et al.（2015） | - | - | 66.6560 | - |
| Yolcu et al.（2016） | - | - | 65.4207 | - |
| Zhang et al.（2017） | - | - | 17.7821 | - |
| Proposed method | 21.8518 | **124.9109** | **14.5307** | **94.5062** |