# 緒論

表 1：股票預測文獻彙整

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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. [10] | SSEC,  NASDAQ | Stock price | 2011-2012 | SVM, EMD | RMSE, MAE, MAPE |
| Xi, Muzhou, Lee, Li, Wei, Hai and Wu [13] | Chongqing Iron & Steel | Stock price | 01.04.2012-  10.08.2012 | RBF | RMSE |
| Bas, Yolcu, Egrioglu and Aladag [14] | BIST,  TAIFEX | Stock price | 10. 01.2010- 12. 23.2010 | FFANN | RMSE |
| Ye and Wei [15] | SSEC | Stock price | 2012 -2014 | WNN | RMSE, MAPE |
| Khuat, Le, Nguyen and Le [16] | Apple,  Yahoo,  Google | Stock price | 2009-2013  2013-2014  2014-2015. | MLP | RMSE |
| Qiu and Song [7] | Nikkei 225 | Stock price | 2007-2013 | GA-ANN | Hit ratio |
| Chen, Cheng, Chiu and Huang [17] | TAIEX  HSI | Stock price | 1998-2006 | ANFIS-based | RMSE,  Wilcoxon test, Profitable unit |
| Zhang, Zhang, Zhang, Yu and Huang [18] | SSEC,  TAIEX | Stock price | 2000-2006  1990-1999 | Type-2 FTS | RMSE, MAPE |
| Wei, Lou and Lei [19] | SSEC | Stock price | 2009-2014 | 2RS-WNN | RMSE, MAD, MAPE, DS% |
| Chong, Han and Park [20] | KOSPI | Stock return | 2010-2014 | DNN | NMSE, RMSE, MAE, MI |
| Liu et al. [8] | 000573: Shenzhen | Stock volatility | 2015-2016 | RNNs | Accuracy |
| Chatzis, Siakoulis, Petropoulos, Stavroulakis and Vlachogiannakis [21] | 39 Countries | Stock direction | 1996-2017 | LogR, RF, SVMs,  NNs, CART, XG- Boost, MXNET | Accuracy |
| Pang et al. [9] | SHASHR, TMSE,  TMBA,  SINOPEC | Stock price | 2006 -2016 | ALSTM,  ELSTM | MSE, DA |
| Lei [22] | 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, Roy and Mittal [23] | Apple | Stock price | 2013 - 2016 | ANN | MAPE,  Accuracy |

1. **研究方法**

表 2：單目標預測資料矩陣

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

其中*s*為使用者設定的候選特徵的個數，**f**為候選特徵變數，**t**為欲進行預測的目標變數，*x*為原始數據進行差分後的值。

表 3：多目標預測資料矩陣

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Candidate features | | | | | | | | Targets | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Data matrix |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

其中目標變數的集合以*TS*表示之，且，為目標變數的個數。這些候選特徵的集合則被稱作候選特徵池（Candidate feature pool），以*CP*標記之，且，為所有候選特徵變數的個數。

表 4：影響資訊矩陣

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

其中為第j個目標變數，且j=1,2,…,|*TS*|。

1. **實驗內容**
   1. **特徵的擷取與影響**

表 5：四目標預測特徵多寡之效能比較（RMSE）

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

表 6：實驗2單目標預測實驗設定

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
| Number of original data | 259 | 245 | 260 | 260 | 261 | 259 | 240 |
| Number of data pairs | 229 | 215 | 230 | 230 | 231 | 229 | 210 |
| Number of training data | 191 | 179 | 191 | 191 | 192 | 191 | 175 |
| Number of rules | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Number of premise parameters | 24 | 10 | 36 | 40 | 38 | 6 | 24 |
| Number of consequent parameters | 33 | 9 | 33 | 33 | 33 | 15 | 33 |

表 7：實驗2 SSEC之效能比較（RMSE）

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | RMSE | | | | | | | |
|  | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | Average |
| Huarng and Yu (2005) | 23.9147 | 31.9274 | 31.9575 | 21.9938 | 21.7138 | 14.6053 | 75.0643 | 31.5967 |
| Cheng et al.  (2008) | 29.4617 | 33.5855 | 33.4515 | 21.6367 | 32.0092 | 12.3227 | 64.0943 | 32.3659 |
| Chen  (2002) | 40.768 | 43.009 | 57.6315 | 32.2600 | 28.4259 | 16.4664 | 62.6612 | 40.1746 |
| Lee et al.  (2006) | 30.5366 | 48.4292 | 45.2494 | 24.1420 | 22.3151 | 12.0581 | 82.0055 | 37.8194 |
| Egrioglu et al.  (2011) | 17.9911 | 24.0736 | 26.3361 | 18.1261 | **12.5963** | **5.9938** | 114.9601 | 31.4396 |
| Wang et al.  (2013) | 43.0975 | 34.0014 | 26.4196 | 17.8860 | 20.1084 | 11.8674 | 379.5415 | 75.9888 |
| Bas et al.  (2015) | 35.1766 | 55.1909 | 55.0887 | 66.6560 | 37.5188 | 27.9020 | 221.1243 | 71.3955 |
| Yolcu et al.  (2016) | 34.0485 | 51.7665 | 56.8118 | 65.4207 | 33.7176 | 24.0424 | 226.9612 | 70.3955 |
| Zhang et al. [18] | **16.2662** | **20.3227** | 18.0470 | 17.7821 | 13.7292 | 9.0226 | 36.5687 | 18.8198 |
| Proposed  method | 17.3292 | 22.1362 | **15.4426** | **12.467** | 15.4890 | 13.8235 | **22.7848** | **16.8633** |

* 1. **中國與國際市場的相互作用**

表 8：實驗3-1四目標預測實驗設定

|  |  |  |
| --- | --- | --- |
|  | 2002 | 2003 |
| Number of original data | 227 | 226 |
| Number of data pairs | 197 | 196 |
| Number of training data | 158 | 163 |
| Number of rules | 3 | 3 |
| Number of premise parameters | 36 | 32 |
| Number of consequent parameters | 33 | 33 |

表 9：實驗3-1四目標預測之效能比較（RMSE）

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | RMSE | | | |
|  |  | Hsieh et al. [6] | Chen et al. [17] | Zhang et al. [18] | Proposed method |
| 2002 | SSEC | - | - | **18.0470** | 20.0474 |
| HSI | - | 118.27 | - | **103.4150** |
| Nikkei 225 | 141 | - | - | **135.8836** |
| DJI | 132 | - | - | **130.0239** |
| 2003 | SSEC | - | - | 17.7821 | **15.0176** |
| HSI | - | 132.67 | - | **99.6090** |
| Nikkei 225 | 177 | - | - | **125.0855** |
| DJI | 89 | - | - | **75.3401** |

表 10：模型平均之效能比較（RMSE）

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | RMSE | | | |
|  | Hsieh et al. [6] | Chen et al. [17] | Zhang et al. [18] | Proposed method |
| SSEC | - | - | 17.9146 | **17.5325** |
| HSI | - | 125.4700 | - | **101.5120** |
| Nikkei 225 | 159.0000 | - | - | **130.4845** |
| DJI | 110.5000 | - | **-** | **102.6820** |

* + 1. **多目標與單目標預測之差異性**

表 11：實驗3-2單目標預測實驗設定

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | SSEC | HSI | Nikkei 225 | DJI |
| Number of original data | 242 | 245 | 245 | 249 |
| Number of data pairs | 212 | 215 | 215 | 219 |
| Number of training data | 176 | 179 | 179 | 182 |
| Number of rules | 3 | 3 | 3 | 3 |
| Number of premise parameters | 10 | 10 | 10 | 10 |
| Number of consequent parameters | 9 | 9 | 9 | 9 |

表 12：實驗3-2四目標預測實驗設定

|  |  |
| --- | --- |
| Number of original data | 217 |
| Number of data pairs | 187 |
| Number of training data | 156 |
| Number of rules | 3 |
| Number of premise parameters | 40 |
| Number of consequent parameters | 33 |

表 13：單目標與多目標預測之效能比較（RMSE）

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | RMSE | | | |
|  | SSEC | HSI | Nikkei 225 | DJI |
| 1 Target | 32.3685 | 324.9142 | 230.5450 | 247.3453 |
| 4 Targets | **31.36052** | **317.4276** | **199.5029** | **237.711** |