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

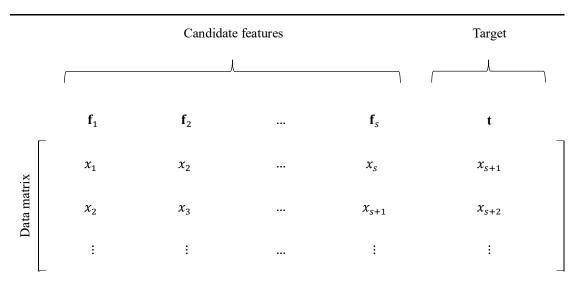
表1 股票預測文獻彙整

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.	SSEC,	Stock price	2011-2012	SVM, EMD	RMSE, MAE,
(2014)	NASDAQ				MAPE
Xi et al.	Chongqing Iron	Stock price	01.04.2012-	RBF	RMSE
(2014)	& Steel		10.08.2012		
Bas et al.	BIST,	Stock price	10. 01.2010-	FFANN	RMSE
(2015)	TAIFEX		12. 23.2010		
Ye and Wei	SSEC	Stock price	2012 -2014	WNN	RMSE, MAPE
(2015)					
Khuat et al.	Apple,	Stock price	2009-2013	MLP	RMSE
(2016)	Yahoo,		2013-2014		
	Google		2014-2015.		
Qiu and Song	Nikkei 225	Stock price	2007-2013	GA-ANN	Hit ratio
(2016)					
Chen et al.	TAIEX	Stock price	1998-2006	ANFIS-based	RMSE,
(2016)	HSI				Wilcoxon test,
					Profitable unit
Zhang et al.	SSEC,	Stock price	2000-2006	Type-2 FTS	RMSE, MAPE
(2017)	TAIEX		1990-1999		
Wei et al.	SSEC	Stock price	2009-2014	2RS-WNN	RMSE, MAD,
(2017)					MAPE, DS%
Chong et al.	KOSPI	Stock	2010-2014	DNN	NMSE, RMSE
(2017)		return			MAE, MI
Liu et al.	000573:	Stock	2015-2016	RNNs	Accuracy
(2017)	Shenzhen	volatility			

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

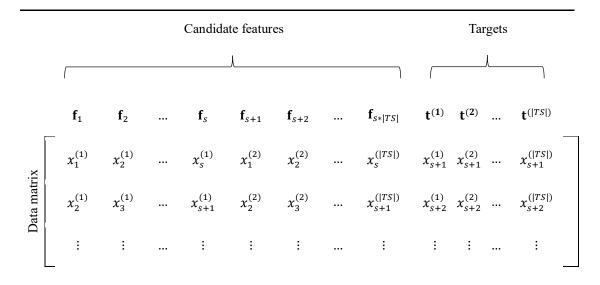
3. 研究方法

表2 單目標預測資料矩陣



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

表3 多目標預測資料矩陣



其中候選特徵所組成的集合即稱為候選特徵池(Candidate feature pool; CP), $CP = \{f_i, i=1,2,...,|CP|\}$,|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, $TS = \{t^{(j)}, j=1,2,...,|TS|\}$,|TS|為目標變數的總數。

表4 影響資訊矩陣

	f ₁	f_2		$\mathbf{f}_{ CP }$	t ^(j)	
$\mathbf{f_1}$	0	$I_{\mathbf{f_1} o \mathbf{f_2}}$		$I_{\mathbf{f_1} o \mathbf{f}_{ CP }}$	$I_{\mathbf{f_1} o \mathbf{t^{(j)}}}$	
$\mathbf{f_2}$	$I_{\mathbf{f_2} ightarrow \mathbf{f_1}}$	0		$I_{\mathbf{f_2} o \mathbf{f}_{ CP }}$	$I_{\mathbf{f_2} o \mathbf{t}^{(\mathbf{j})}}$	
:	:	:	0	ŧ	÷	
$\mathbf{f}_{ CP }$	$I_{f_{\mid CP\mid} ightarrow\mathbf{f_1}}$	$I_{f CP } \rightarrow \mathbf{f_2}$		0	$I_{f_{ CP } o \mathbf{t}^{(\mathbf{j})}}$	
t ^(j)	$I_{\mathbf{t}^{(\mathbf{j})} ightarrow \mathbf{f_1}}$	$I_{\mathbf{t}^{(\mathbf{j})} o \mathbf{f}_2}$		$I_{t^{(j)} \to f_{ \mathit{CP} }}$	0	

其中t(j)表示為第j個目標變數。

4. 實驗內容

4.1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		
		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

4.2驗證 WOA-RLSE 複合式學習演算法

表6 學習演算法效能比較(RMSE)

	RMSE				
	NASDAQ	Nikkei 225	SSEC	HSI	Average
ABC	225 7961	250 1546	297 (702	272 5590	211 0447
(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	762 0492	258.6984	381.0925	374.4953	444 2006
(Jalalinejad et al., 2007)	762.9483	238.0984	381.0923	3/4.4933	444.3086
CACO-RLSE	99.48212	239.7220	35.7084	363.7253	184.6595
SLPSO	07.1107	226.3361	39.6582	352.5358	170 0102
(Cheng and Jin, 2015)	97.1107				178.9102
SLPSO-RLSE	96.6662	213.6644	32.2050	329.7354	168.0678
WOA	107 (702	250.9400	20.0044	202.0720	107.2060
(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

4.3 國際金融市場的相互作用

表7 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		