

# Candlestick Analysis: Prediction of Hong Kong and Korean Stock Market Trend

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**Introduction**

**Data preparation**

**Hypothesis Testing**

**Findings**

# Technical Analysis

- Predict price movement
- Identify trading opportunities

Historical Market  
Statistics

Technical Indicators



Win trade



## Moving Average (MA)



Trading Rule (Example)

**50-MA > 200-MA Crossover → Buy**

**200-MA > 50-MA Crossover → Sell**

# Technical Analysis

## Support & Resistance

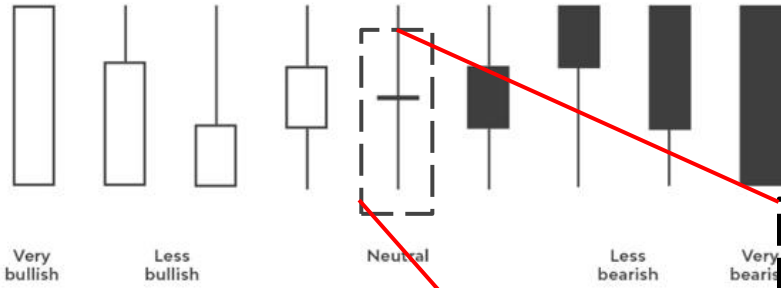


## Candlestick Pattern

Long Green Candle	Long Red Candle	Short Green Candle	Short Red Candle	Green Marubozu	Red Marubozu	Bullish Closing Marubozu	Bearish Closing Marubozu	Bullish Opening Marubozu	Bearish Opening Marubozu	Spinning Top	Spinning Top
Doji	Doji	Long Legged Doji	Long Legged Doji	Cross Doji	Inverted Cross Doji	Dragonfly Doji	Gravestone Doji	Hammer	Hanging Man	Inverted Hammer	Shooting Star
Bullish Engulfing	Bearish Engulfing	Piercing Pattern	Dark Cloud Cover	Bullish Harami	Bearish Harami	Bullish Kicker	Bearish Kicker	Morning Star	Evening Star	Bullish Abandoned Baby	Bearish Abandoned Baby
Bullish Tri Star	Bearish Tri Star	Three White Soldiers	Three Black Crows	Upside Gap Two Crows	Two Crows	Three Inside Up	Three Inside Down	Three Outside Up	Three Outside Down	Bullish Meeting Line	Bearish Meeting Line
Bullish Batteil	Bearish Batteil	Three Stars In The South	Advance Block	Bullish Stick Sandwich	Bearish Stick Sandwich	Matching Low	Matching High	Tweezer Bottom	Tweezer Top		
Bullish Breakaway	Bearish Breakaway	Downside Tasuki Gap	Upside Tasuki Gap	Falling Three Method	Rising Three Method	Bearish Separating Lines	Bullish Separating Lines	Bearish Side-By-Side White Lines	Bullish Side-By-Side White Lines		

# Candlestick

## Bullish and bearish strength



Highest price for the day

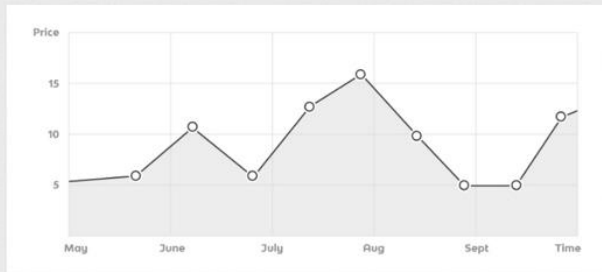
Opening or closing price

Opening or closing price

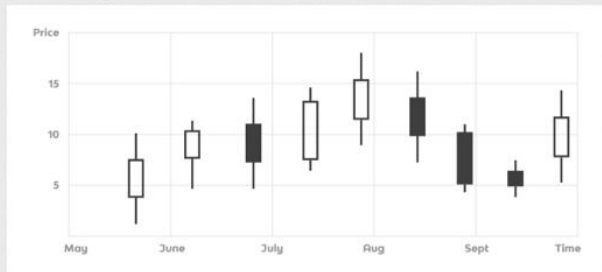
Lowest price for the day

Body is black (or red) if stock closed lower. Body is white (or green) if it closed higher.

Line graph



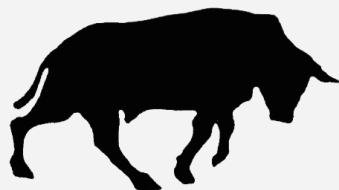
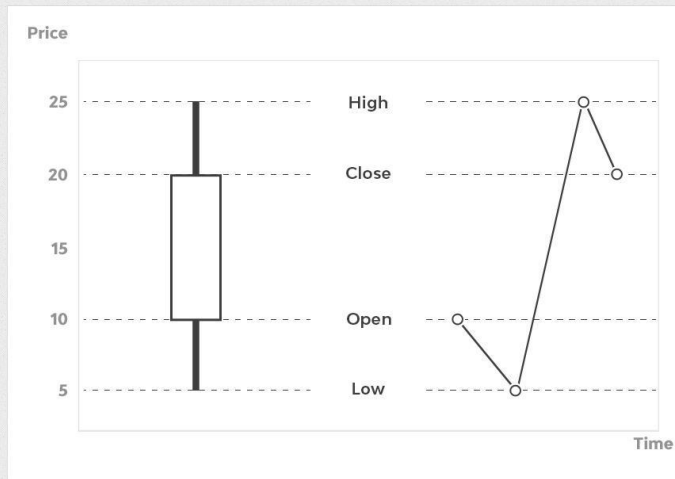
Candle graph



# Candlestick

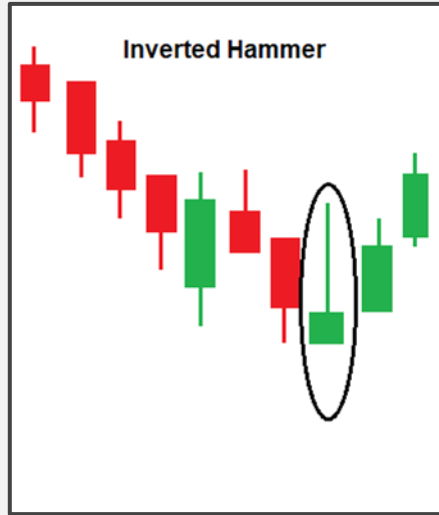


Path of price



# Candlestick Patterns

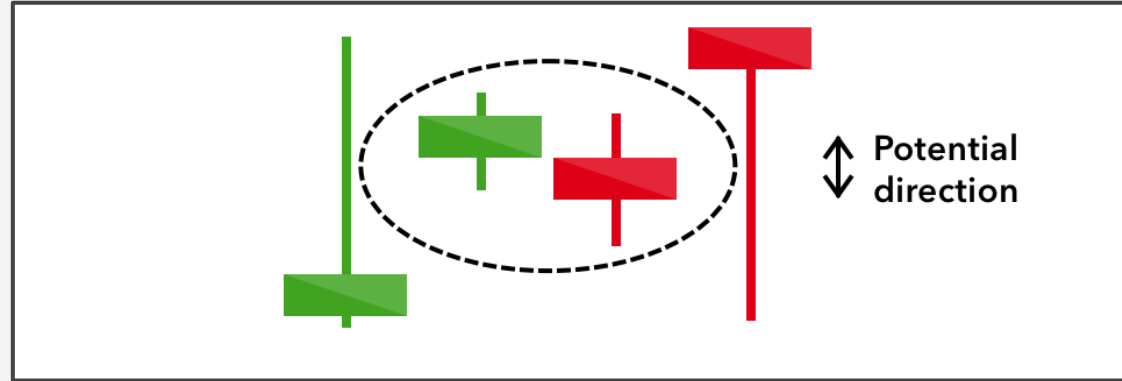
## Hammer/ Inverted Hammer



Trading Rule (Example)

**An Inverted Hammer observed → Buy**  
**A Hammer observed → Sell / Short sell**

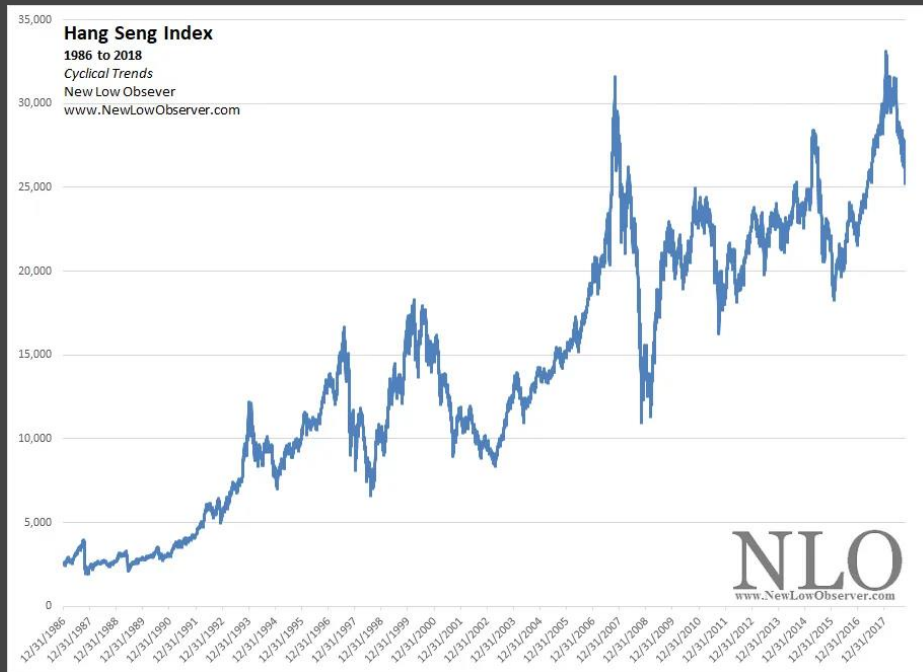
## Short Line Candle



Trading Rule (Example)

***Low Volatility***  
**Derivatives:**  
**Short straddles / Butterfly Spread**

# Hang Seng Index (HSI)



Hang Seng Index from December 1986 to December 2017

- market-value-weighted index
- record and monitor daily changes of the largest companies of the Hong Kong stock market
- Stock examples:



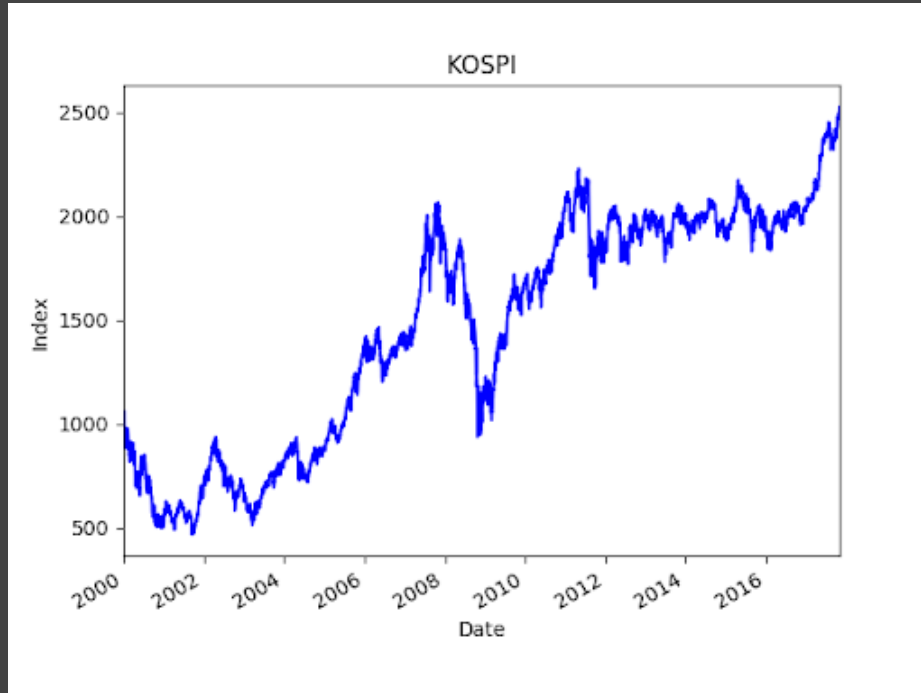
*Tencent* 腾讯



SWIRE PACIFIC



# KOSPI 50 (코스피지수)



KOSPI 50 from December 2000 to December 2016

- Korea Composite Stock Price Index 50
- market-value-weighted index
- representative stock market index of South Korea
- Stock Examples:





□ Dataframe of each index

□ Candlestick Chart

□ Candlestick Pattern

Recognition

# Data Preparation



# Base Dataframe of each Index

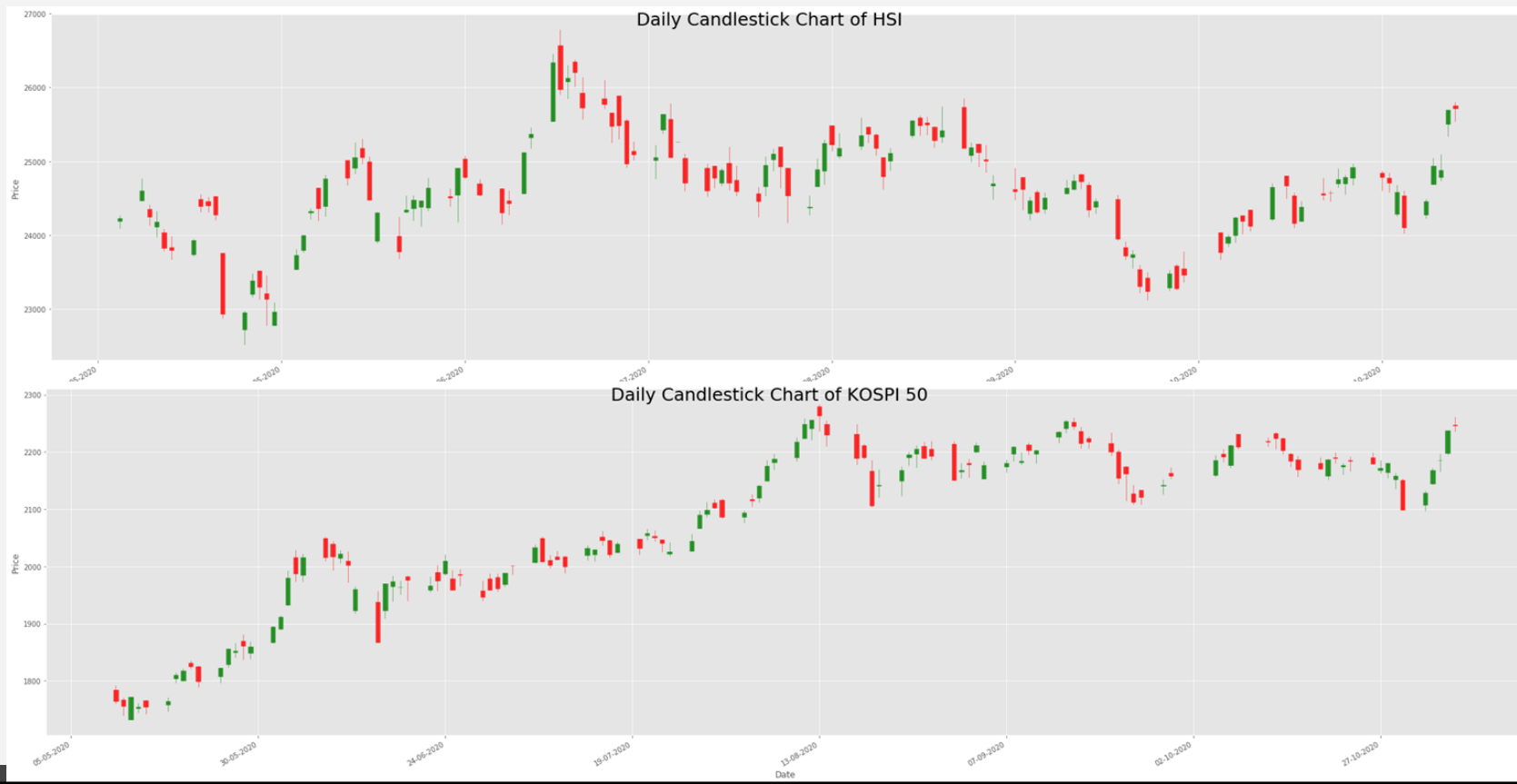
Dataframe 'hsi'

Date	Open	High	Low	Close
2020-11-06	25750.78	25799.97	25540.98	25712.97
2020-11-05	25500.91	25695.92	25343.44	25695.92
2020-11-04	24790.00	25093.72	24733.23	24886.14
2020-11-03	24689.56	25048.53	24689.51	24939.73
...	...	...	...	...

Dataframe 'kospì'

Date	Open	High	Low	Close
2020-11-06	2247.32	2260.89	2236.10	2246.10
2020-11-05	2198.19	2237.42	2195.18	2237.42
2020-11-04	2185.13	2196.21	2166.28	2185.34
2020-11-03	2107.50	2132.09	2097.53	2128.86
...	...	...	...	...

# Candlestick Charts



# Candlestick Pattern Recognition

index\_test

Date	Pattern_1	Pattern_2	Pattern_3	...
date_1	NaN	-100	100	...
date_2	100	NaN	NaN	...
date_3	-100	-100	NaN	...
date_4	NaN	-100	NaN	...
...	...	...	...	...

index\_bull

Date	Pattern_1	Pattern_3	...
date_1	NaN	100	...
date_2	100	NaN	...
date_4	NaN	NaN	...
...	...	...	...

Bullish

Bearish

index\_bear

>25 occurrence

Date	Pattern_1	Pattern_2	...
date_1	NaN	-100	...
date_3	-100	-100	...
date_4	NaN	-100	...
...	...	...	...

# Sample Size

Threshold:  $n > 25$

## HSI (Bull)

CDLBELTHOLD	56
CDLCLOSINGMARUBOZU	68
CDLDOJI	94
CDLENGULFING	46
CDLHAMMER	29
CDLHARAMI	33
CDLHIGHWAVE	34
CDLHIKKAKE	92
CDLLONGLEGGEDDOJI	88
CDLLONGLINE	77
CDLRICKSHAWMAN	64
CDLSHORTLINE	45
CDLSPINNINGTOP	75

## HSI (Bear)

CDLBELTHOLD	103
CDLCLOSINGMARUBOZU	47
CDLENGULFING	100
CDLHIGHWAVE	40
CDLHIKKAKE	93
CDLLONGLINE	81
CDLSHORTLINE	40
CDLSPINNINGTOP	77

## KOSPI (Bull)

CDLBELTHOLD	193
CDLCLOSINGMARUBOZU	207
CDLDOJI	293
CDLDRAGONFLYDOJI	28
CDLENGULFING	61
CDLHAMMER	62
CDLHARAMI	93
CDLHARAMICROSS	32
CDLHIGHWAVE	132
CDLHIKKAKE	105
CDLHOMINGPIGEON	45
CDLINVERTEDHAMMER	41
CDLLONGLEGGEDDOJI	277
CDLLONGLINE	242
CDLMARUBOZU	75
CDLMATCHINGLOW	44
CDLRICKSHAWMAN	221
CDLSHORTLINE	110
CDLSPINNINGTOP	216
CDLTAKURI	28

## KOSPI (Bear)

CDLBELTHOLD	228
CDLCLOSINGMARUBOZU	182
CDLENGULFING	95
CDLHANGINGMAN	62
CDLHARAMI	67
CDLHIGHWAVE	142
CDLHIKKAKE	87
CDLLONGLINE	224
CDLMARUBOZU	78
CDLSHORTLINE	117
CDLSPINNINGTOP	225

# Candlestick Pattern Recognition

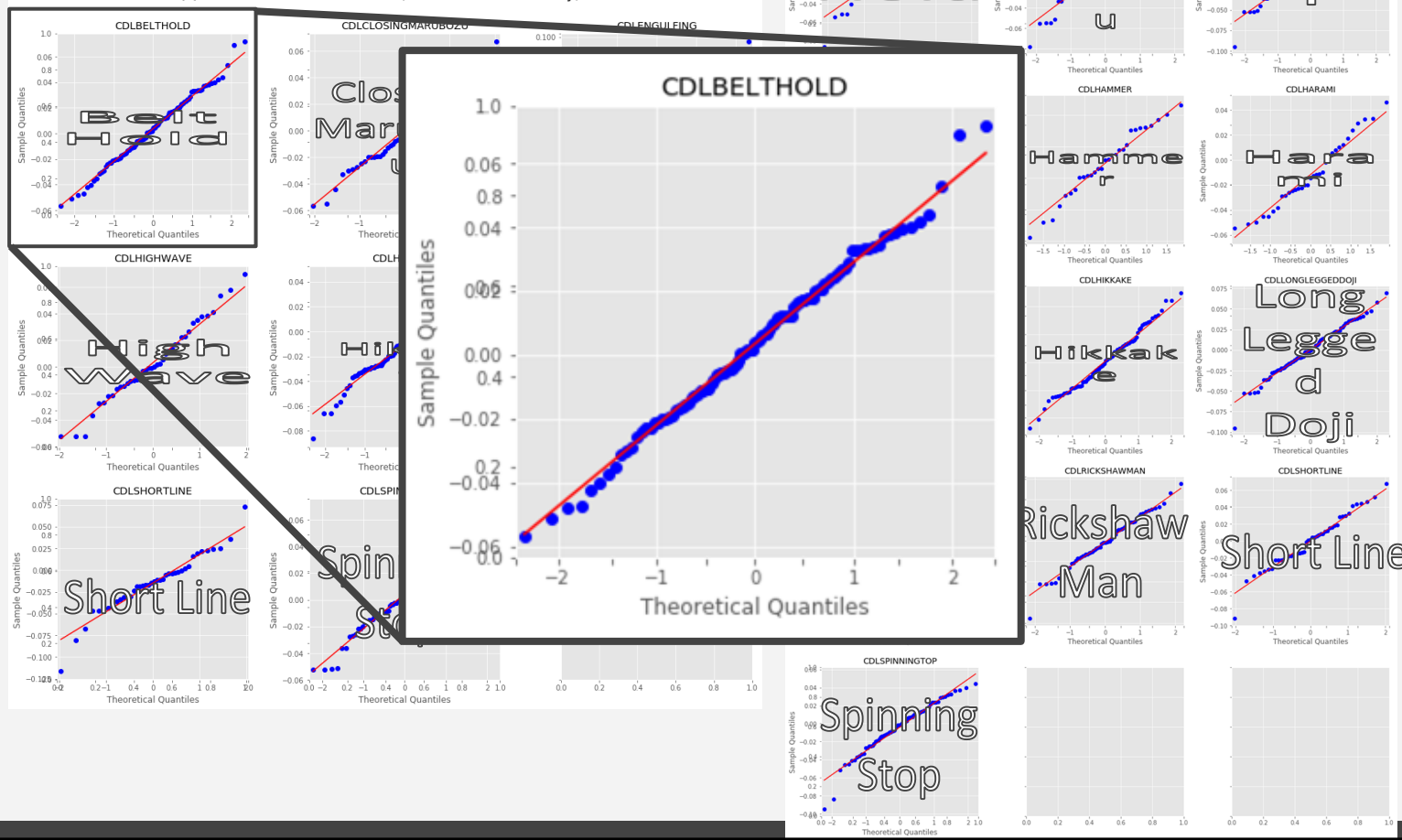
index_bul			
Date	Pattern_1	Pattern_3	...
date_1	NaN	100	...
date_2	100	NaN	...
date_4	NaN	NaN	...
...	...	...	...

$$\begin{array}{c} t_1 - t_0 \\ \downarrow \\ \text{Simple Return}(\mathbf{1}) \\ \hline \frac{P_{t_1} - P_{t_0}}{P_{t_0}} \end{array}$$

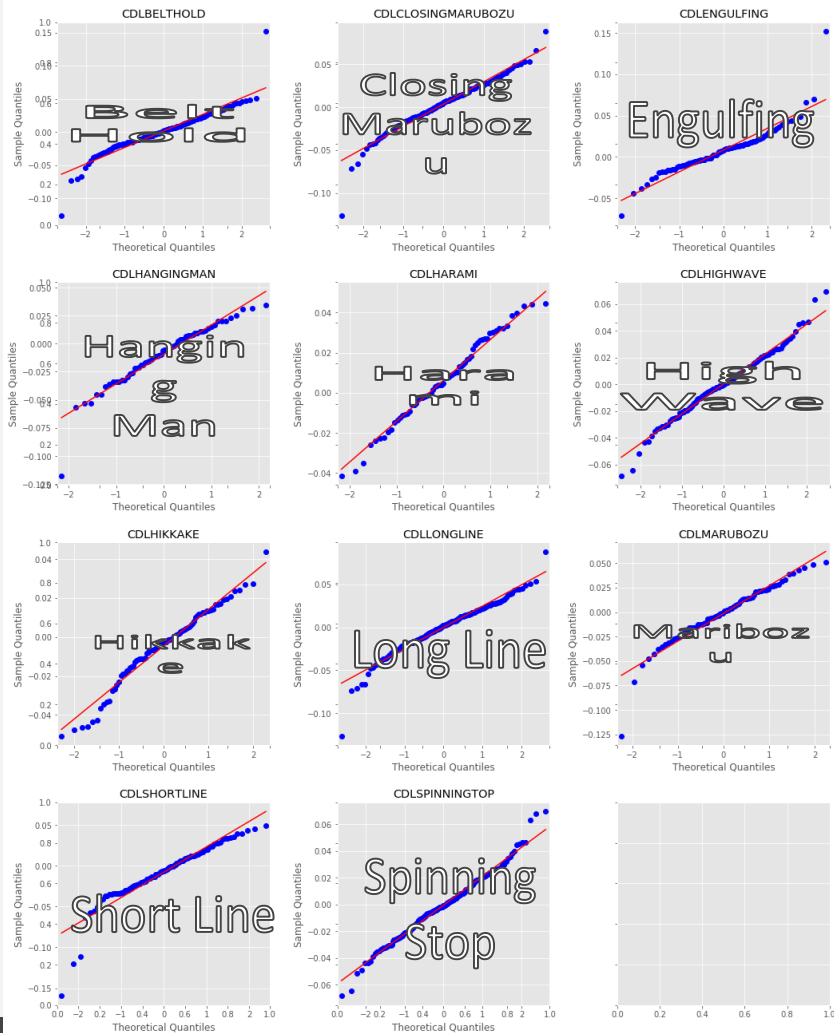
index_bullR_daily			
Date	Pattern_1	Pattern_3	...
date_1	NaN	date_1_return	...
date_2	date_2_return	NaN	...
date_4	NaN	NaN	...
...	...	...	...

HSI weekly return

QQ test on Return Ratio of HSI (Bullish Patterns, 5-day)









- ❑ Declarations
- ❑ One Sample T-Test
- ❑ Limitations

# Hypothesis Testing

# One Sample T-Test

*One tailed*



***Bullish***

$$H_0 : R = \mu$$

$$H_1 : R > \mu$$

Short term

$$t = \frac{\bar{R} - 0.001}{s/\sqrt{n}}$$

Long term

$$t = \frac{\bar{R} - 0.05}{s/\sqrt{n}}$$

$t > t_{1-\alpha, df=n-1} \Rightarrow \text{Reject } H_0$



***Bearish***

$$H_0 : R = -\mu$$

$$H_1 : R < -\mu$$

Short term

$$t = \frac{\bar{R} - (-0.001)}{s/\sqrt{n}}$$

Long term

$$t = \frac{\bar{R} - (-0.05)}{s/\sqrt{n}}$$

$t < -t_{1-\alpha, df=n-1} \Rightarrow \text{Reject } H_0$

# T-test : Assumptions

## Continuous

Simple return ratios must be continuous dependent variables



## Normality

Return ratios of each pattern must be approximately normally distributed



## Independent

Each return ratio of specific date must be independent to each other



## No outliers

There should be no outliers in the data



# Bearish Candlestick : HSI

## Short Term: 5 Days

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	103	0.003478	102	0.025580	0.002520	1.776688	-1.659930
CDLCLOSINGMARUBOZU	47	0.000790	46	0.028368	0.004138	0.432642	-1.678660
CDLENGULFING	100	0.004087	99	0.026270	0.002627	1.936635	-1.660391
CDLHIGHWAVE	40	0.002984	39	0.029388	0.004647	0.857309	-1.684875
CDLHIKKAKE	93	-0.010012	92	0.024509	0.002541	-3.545858	-1.661585
CDLLONGLINE	81	-0.000533	80	0.026295	0.002922	0.159714	-1.664125
CDLSHORTLINE	40	-0.014959	39	0.033277	0.005262	-2.653045	-1.684875
CDLSPINNINGTOP	77	0.004357	76	0.026181	0.002984	1.795336	-1.665151



Hikkake pattern, Shortline candle

## Long Term: 250 Days

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	67	-0.046756	66	0.065218	0.007968	0.407172	-1.668271
CDLCLOSINGMARUBOZU	34	-0.044867	33	0.069792	0.011969	0.428860	-1.692360
CDLENGULFING	84	0.039796	83	0.145922	0.015921	5.639935	-1.663420
CDLHIGHWAVE	26	-0.068436	25	0.071158	0.013955	-1.321062	-1.708141
CDLHIKKAKE	88	0.035519	87	0.133707	0.014253	5.999987	-1.662557
CDLLONGLINE	54	-0.050959	53	0.066336	0.009027	-0.106185	-1.674116
CDLSHORTLINE	29	-0.074793	28	0.069251	0.012860	-1.928013	-1.701131
CDLSPINNINGTOP	56	-0.070470	55	0.079352	0.010604	-1.930387	-1.673034



Shortline candle, Spinning top

# Bearish Candlestick : KOSPI 50

## Short Term: 5 Days

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	228	0.001504	227	0.024939	0.001652	1.515840	-1.651594
CDLCLOSINGMARUBOZU	182	0.003686	181	0.025924	0.001922	2.438657	-1.653316
CDLENGULFING	95	0.008234	94	0.026557	0.002725	3.388918	-1.661226
CDLHANGINGMAN	62	-0.009676	61	0.026350	0.003346	-2.592591	-1.670219
CDLHARAMI	67	0.006236	66	0.020482	0.002502	2.892016	-1.668271
CDLHIGHWAVE	142	0.000271	141	0.022386	0.001879	0.676688	-1.655732
CDLHIKKAKE	87	-0.004628	86	0.018865	0.002023	-1.794003	-1.662765
CDLLONGLINE	224	-0.000075	223	0.024881	0.001662	0.556307	-1.651715
CDLMARUBOZU	78	-0.001377	77	0.028460	0.003222	-0.117082	-1.664885
CDLSHORTLINE	117	-0.008144	116	0.031257	0.002890	-2.472274	-1.658096
CDLSPINNINGTOP	225	-0.000411	224	0.021650	0.001443	0.407934	-1.651685



Hanging man, Hikkake pattern,  
Shortline candle

## Long Term: 250 Days

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	208	0.017062	207	0.124947	0.008663	7.740800	-1.652248
CDLCLOSINGMARUBOZU	163	0.025740	162	0.135523	0.010615	7.135187	-1.654314
CDLENGULFING	83	0.027172	82	0.142679	0.015661	4.927661	-1.663649
CDLHANGINGMAN	54	0.025010	53	0.151821	0.020660	3.630659	-1.674116
CDLHARAMI	58	0.038528	57	0.141609	0.018594	4.761081	-1.672029
CDLHIGHWAVE	124	0.047239	123	0.135920	0.012206	7.966536	-1.657336
CDLHIKKAKE	78	0.007846	77	0.142523	0.016138	3.584580	-1.664885
CDLLONGLINE	205	0.008328	204	0.121114	0.008459	6.895347	-1.652357
CDLMARUBOZU	73	0.009246	72	0.103190	0.012077	4.905527	-1.666294
CDLSHORTLINE	106	0.028687	105	0.155927	0.015145	5.195563	-1.659495
CDLSPINNINGTOP	199	0.035653	198	0.140544	0.009963	8.597230	-1.652586



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# Bullish Candlestick : HSI

## Short Term: 5 Days

	n	mean	df	std	se	t ratio	t critical
<b>CDLBELTHOLD</b>	56	0.002547	55	0.027237	0.003640	0.425062	1.673034
<b>CDLCLOSINGMARUBOZU</b>	68	-0.001225	67	0.025767	0.003125	-0.711999	1.667916
<b>CDLDOJI</b>	94	0.001018	93	0.028347	0.002924	0.006052	1.661404
<b>CDLENGULFING</b>	46	-0.004548	45	0.018779	0.002769	-2.003627	1.679427
<b>CDLHAMMER</b>	29	0.009313	28	0.021541	0.004000	2.078269	1.701131
<b>CDLHARAMI</b>	33	-0.011675	32	0.026996	0.004699	-2.697148	1.693889
<b>CDLHIGHWAVE</b>	34	-0.004660	33	0.024991	0.004286	-1.320704	1.692360
<b>CDLHIKKAKE</b>	92	0.000755	91	0.019727	0.002057	-0.119335	1.661771
<b>CDLLONGLEGGEDDOJI</b>	88	0.000389	87	0.028135	0.002999	-0.203603	1.662557
<b>CDLLONGLINE</b>	77	0.003023	76	0.025219	0.002874	0.703966	1.665151
<b>CDLRICKSHAWMAN</b>	64	-0.001578	63	0.030375	0.003797	-0.678883	1.669402
<b>CDLSHORTLINE</b>	45	-0.000096	44	0.030959	0.004615	-0.237482	1.680230
<b>CDLSPINNINGTOP</b>	75	-0.003815	74	0.026670	0.003080	-1.563429	1.665707



Hammer

## Long Term: 250 Days

	n	mean	df	std	se	t ratio	t critical
<b>CDLBELTHOLD</b>	39	-0.073637	38	0.082366	0.013189	-9.374214	1.685954
<b>CDLCLOSINGMARUBOZU</b>	48	-0.070863	47	0.083145	0.012001	-10.071069	1.677927
<b>CDLDOJI</b>	63	-0.069885	62	0.075422	0.009502	-12.616452	1.669804
<b>CDLENGULFING</b>	41	0.014671	40	0.142766	0.022296	-1.584536	1.683851
<b>CDLHAMMER</b>	22	-0.085480	21	0.069901	0.014903	-9.090798	1.720743
<b>CDLHARAMI</b>	24	-0.068575	23	0.068559	0.013995	-8.472898	1.713872
<b>CDLHIGHWAVE</b>	27	-0.053955	26	0.081957	0.015773	-6.590898	1.705618
<b>CDLHIKKAKE</b>	82	0.064590	81	0.147929	0.016336	0.893148	1.663884
<b>CDLLONGLEGGEDDOJI</b>	62	-0.067746	61	0.074086	0.009409	-12.514337	1.670219
<b>CDLLONGLINE</b>	55	-0.073057	54	0.072671	0.009799	-12.558293	1.673565
<b>CDLRICKSHAWMAN</b>	44	-0.056404	43	0.074087	0.011169	-9.526673	1.681071
<b>CDLSHORTLINE</b>	26	-0.073366	25	0.085158	0.016701	-7.386816	1.708141
<b>CDLSPINNINGTOP</b>	56	-0.069703	55	0.071403	0.009542	-12.545353	1.673034



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# Bullish Candlestick : KOSPI 50

## Short Term: 5 Days

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	193	0.002733	192	0.020312	0.001462	1.184973	1.652829
CDLCLOSINGMARUBOZU	207	0.000858	206	0.021615	0.001502	-0.094499	1.652284
CDLDOJI	293	-0.000059	292	0.023916	0.001397	-0.757744	1.650089
CDLDRAGONFLYDOJI	28	-0.004233	27	0.026129	0.004938	-1.059844	1.703288
CDLENGULFING	61	-0.003885	60	0.021358	0.002735	-1.786308	1.670649
CDLHAMMER	62	0.005475	61	0.021291	0.002704	1.654818	1.670219
CDLHARAMI	93	-0.007042	92	0.019278	0.001999	-4.022946	1.661585
CDLHARAMICROSS	32	-0.004218	31	0.017000	0.003005	-1.736472	1.695519
CDLHIGHWAVE	132	0.001829	131	0.026216	0.002282	0.363423	1.656569
CDLHIKKAKE	105	-0.000778	104	0.017958	0.001753	-1.014532	1.659637
CDLHOMINGPIGEON	45	-0.005551	44	0.019911	0.002968	-2.207200	1.680230
CDLINVERTEDHAMMER	41	0.010729	40	0.018530	0.002894	3.361812	1.683851
CDLLONGLEGGEDDOJI	277	-0.000281	276	0.024140	0.001450	-0.882869	1.650393
CDLLONGLINE	242	0.002306	241	0.022171	0.001425	0.916610	1.651201
CDLMARUBOZU	75	-0.001833	74	0.022039	0.002545	-1.113400	1.665707
CDLMATCHINGLOW	44	-0.001218	43	0.021933	0.003307	-0.670789	1.681071
CDLRICKSHAWMAN	221	-0.000171	220	0.024754	0.001665	-0.703506	1.651809
CDLSHORTLINE	110	-0.004013	109	0.027526	0.002624	-1.910126	1.658953
CDLSPINNINGTOP	216	0.002086	215	0.024383	0.001659	0.654724	1.651972
CDLTAKURI	28	-0.004233	27	0.026129	0.004938	-1.059844	1.703288



Inverted Hammer

## Long Term: 250 Days

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	171	0.040722	170	0.145065	0.011093	-0.836349	1.653866
CDLCLOSINGMARUBOZU	185	0.039412	184	0.138611	0.010191	-1.038957	1.653177
CDLDOJI	266	0.040073	265	0.132043	0.008096	-1.226205	1.650624
CDLDRAGONFLYDOJI	25	0.004740	24	0.137298	0.027460	-1.648222	1.710882
CDLENGULFING	56	0.036005	55	0.131164	0.017528	-0.798456	1.673034
CDLHAMMER	54	0.016422	53	0.122482	0.016668	-2.014535	1.674116
CDLHARAMI	82	0.016106	81	0.119951	0.013246	-2.558770	1.663884
CDLHARAMICROSS	28	0.014050	27	0.128505	0.024285	-1.480333	1.703288
CDLHIGHWAVE	119	0.032425	118	0.130946	0.012004	-1.464156	1.657870
CDLHIKKAKE	91	0.046700	90	0.146869	0.015396	-0.214365	1.661961
CDLHOMINGPIGEON	38	0.011386	37	0.120644	0.019571	-1.973005	1.687094
CDLINVERTEDHAMMER	36	0.061187	35	0.132020	0.022003	0.508412	1.689572
CDLLONGLEGGEDDOJI	250	0.035694	249	0.134624	0.008514	-1.680241	1.650996
CDLLONGLINE	212	0.039580	211	0.139208	0.009561	-1.089815	1.652107
CDLMARUBOZU	70	0.033700	69	0.153985	0.018405	-0.885656	1.667239
CDLMATCHINGLOW	41	-0.014335	40	0.116886	0.018255	-3.524306	1.683851
CDLRICKSHAWMAN	199	0.039722	198	0.135535	0.009608	-1.069715	1.652586
CDLSHORTLINE	101	0.047990	100	0.128504	0.012787	-0.157169	1.660234
CDLSPINNINGTOP	194	0.024185	193	0.124453	0.008935	-2.889095	1.652787
CDLTAKURI	25	0.004740	24	0.137298	0.027460	-1.648222	1.710882



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# Findings

<Bullish>

<Bearish>

	HSI	KOSPI 50	HSI	KOSPI 50
Short term (5 days)	Hammer	Inverted Hammer	Hikkake, short line	Short line, spinning top
Long term (250 days)	---	---	Hanging man, Hikkake, Short line	---

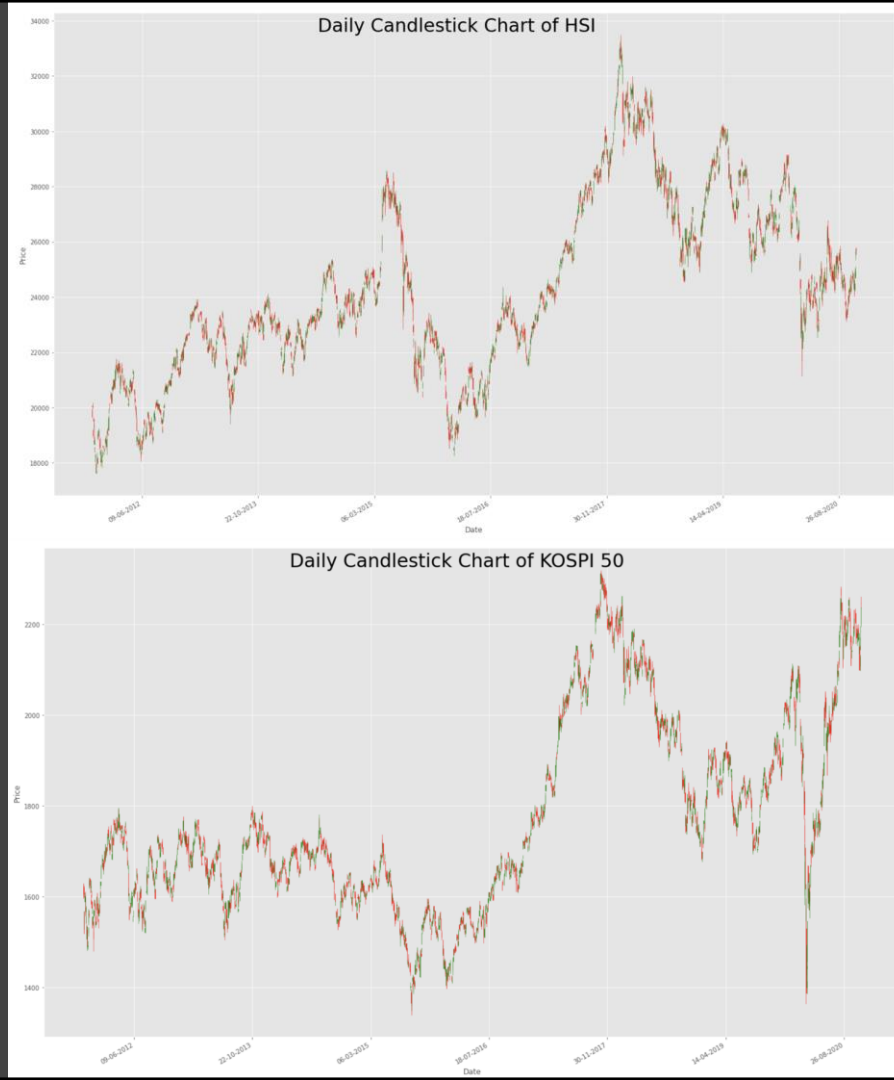


# Limitations: Candlestick reliability

Valid for :

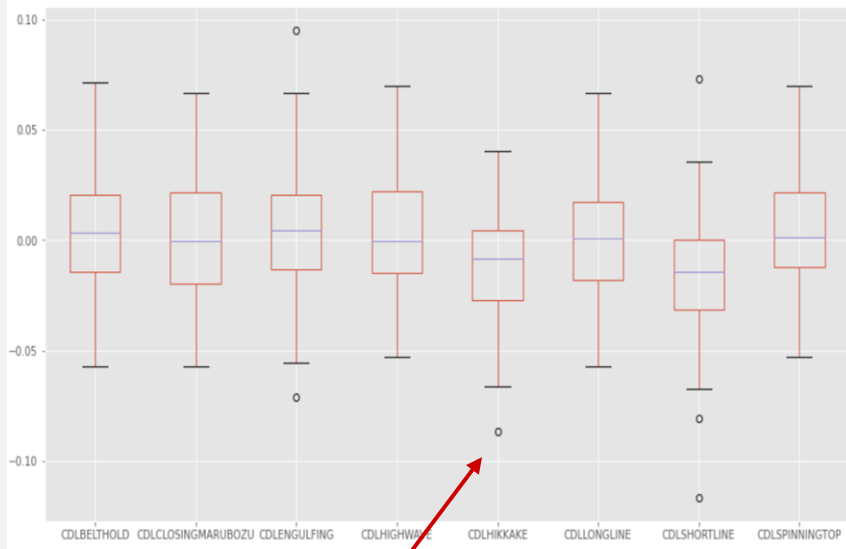
Daily review

3 - 5 bars



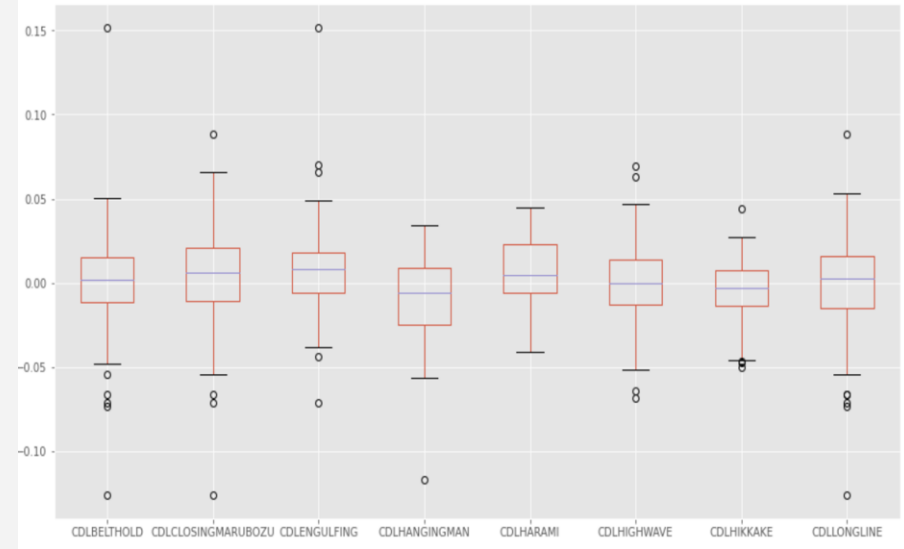
# Limitations : Outliers

HSI (Bearish) - Short Term



Outlier

KOSPI 50 (Bearish) - Short Term



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- 
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Other technical indicators or theories  
(eg. Elliott wave theory)

Quantitative analysis

Fundamental Analysis



# Other Tools for Market Trend Prediction

**QnA**