

Explainable AI model for Stock trading

Team C [Coturnix]

Ban Seonghyun, Choi Dongyoung, Lee Minseung



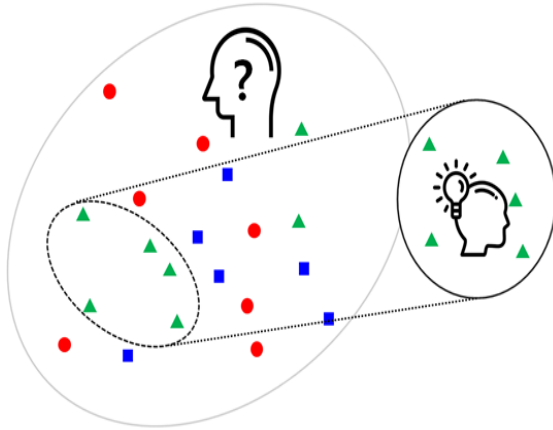
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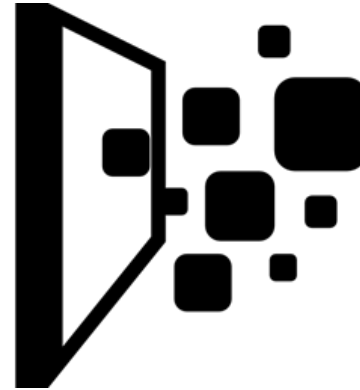
..... 01. Objective & Motivation

1) Divide & Conquer



=> lower difficulty of the task!

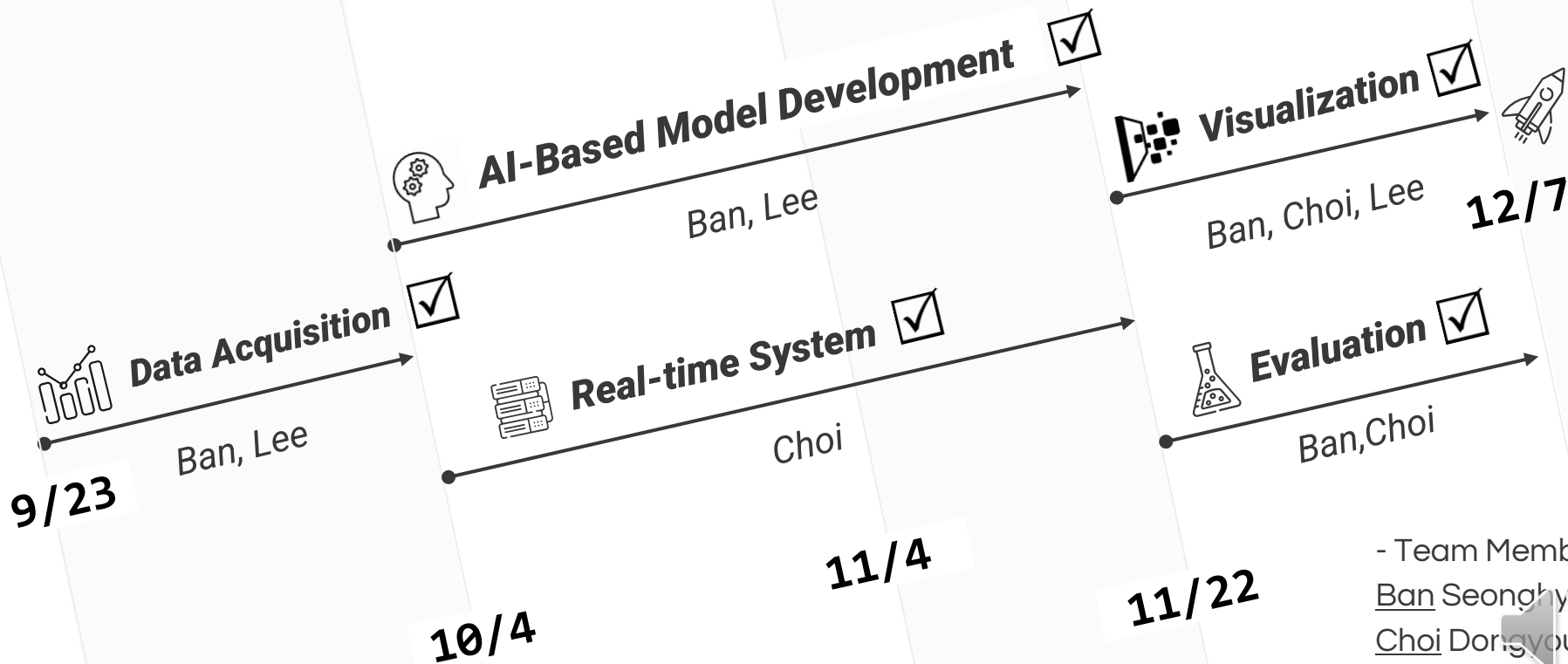
2) Model Visualization



=> get 'Explainability'!



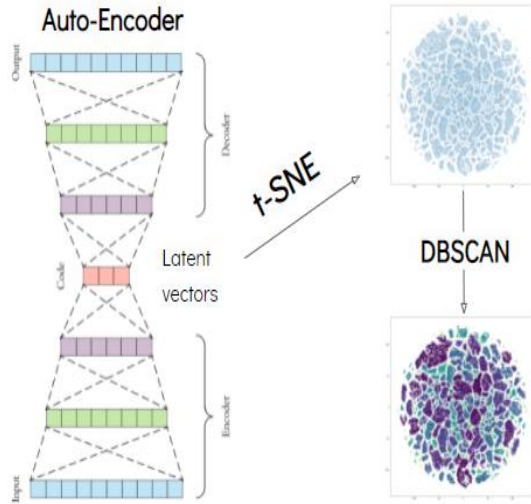
02. Project Progress



- Team Member
Ban Seonghyun
Choi Dongyoung
Lee Minseung

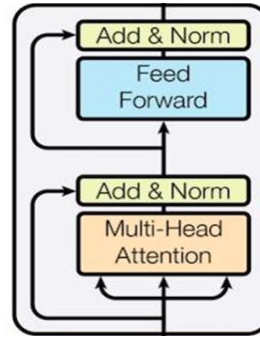
03. Final Design

Subdividing Trading situation



AI model development

- **Transformer**

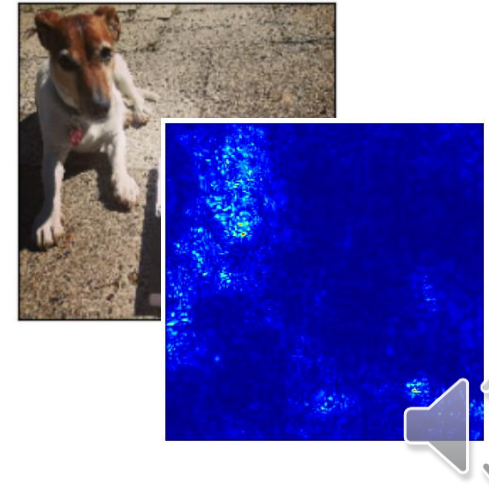


Real time
data processing

- Kiwoom API

Evaluation & Explainability

- Mock investment (모의투자)
- Gradient Saliency

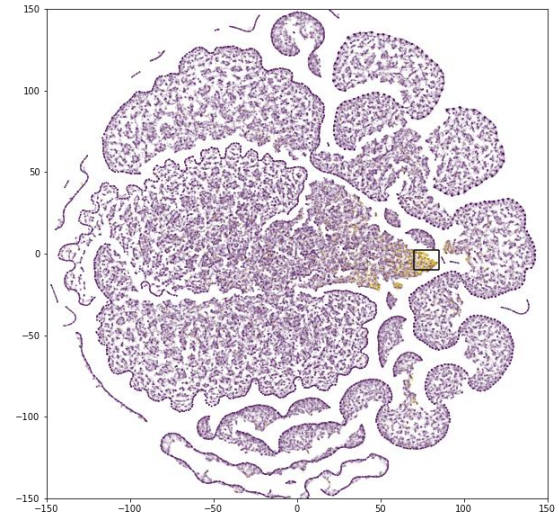


04. Challenges

➤ Analyzing trading pattern



GPU accelerated t-SNE



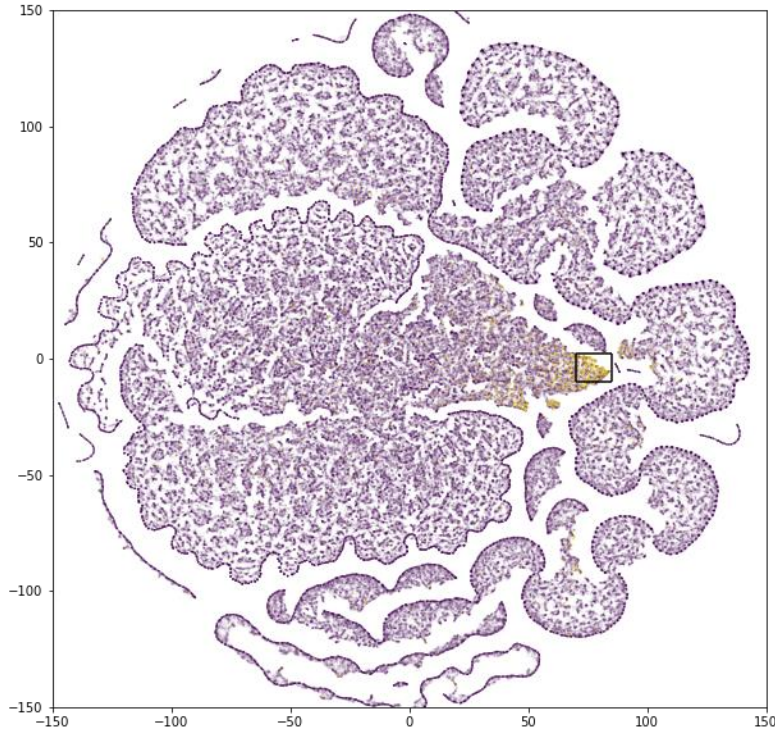
- Total 1,000,000 data
Randomly sampled
from population

➤ 1,000,000 X 2



04. Challenges

➤ Analyzing trading pattern



➤ Yellow Points :

6 X 5 data labeled as **hard fluctuation**

➔ Track this data

❑ Most noticeable discovery

: The distribution of (yellow) data has a particularly **high volume of transactions.**

(With Z-score : 9.09)

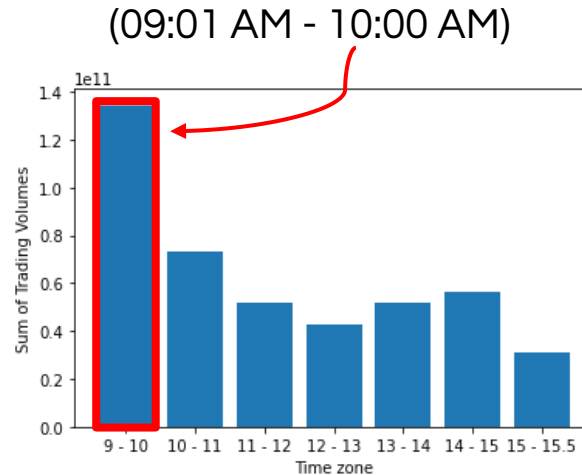


04. Challenges

➤ Analyzing trading pattern

Therefore, we select data with high transaction volumes for training AI model.

- Choose **the time zone with the highest trading volume** during the day.

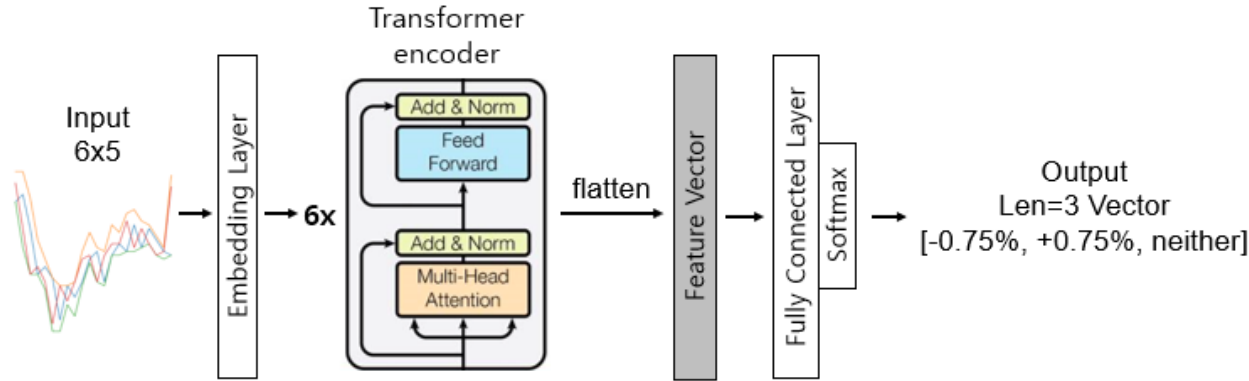


We expected that model can easily learn the winning pattern among the fluctuating data.



..... 05. Final implementation (AI model)

❑ Transformer-based Classification model



- ❑ Dataset : Kosdaq 1 minute candlestick data (2020~2021)
5 features - 4 kinds of stock price (start,end,high,low) & transaction volume
Total amount of selected data = 600,428 (train : valid : test = 8 : 1 : 1)

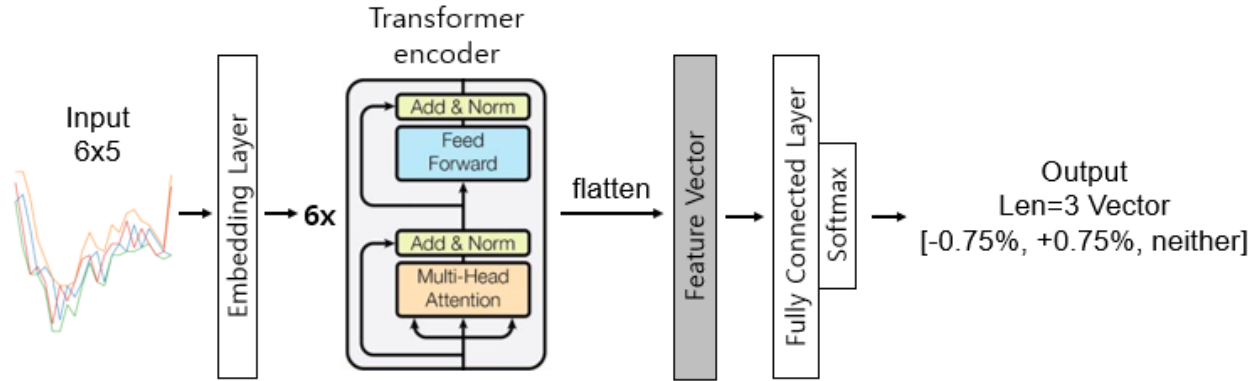
❑ Training Parameters

- Cross Entropy Loss, Adam optimizer, $lr = 0.001$, Batch size = 1024.



05. Final implementation (AI model)

Transformer-based Classification model



Performance (precision) according to model capacity

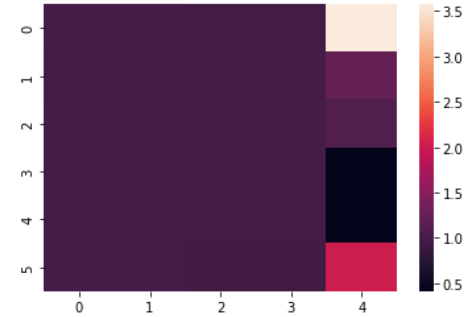
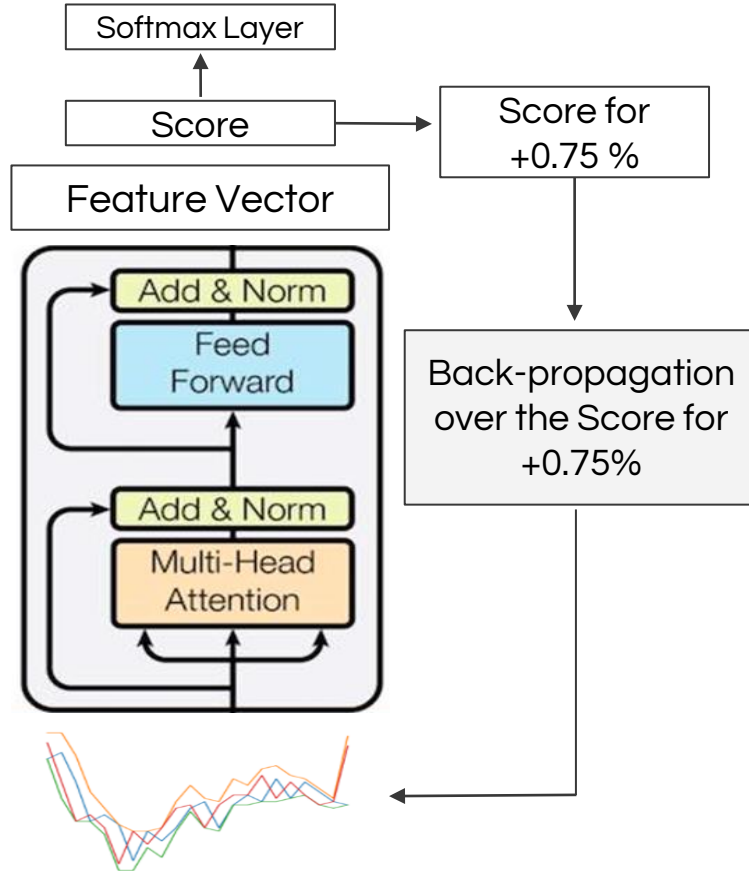
# of encoder layers =	1	2	6	12
Embedding dim = 35	0.6298	0.6432	0.6553	0.6522
70	0.6648	0.6701	0.6763	0.6562
140	0.6443	0.6697	0.6583	0.6581

When model decide to buy,
stock price will increase
0.75% with a 67.63% chance.

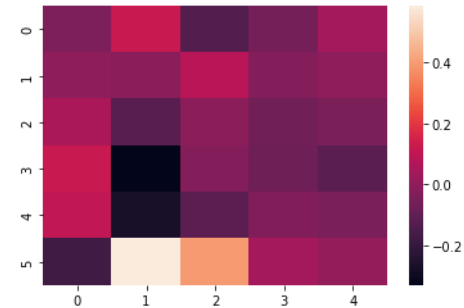


05. Final implementation (Visualization)

□ Gradient-based Saliency map



➤ Input data (6 X 5)



➤ Its gradient



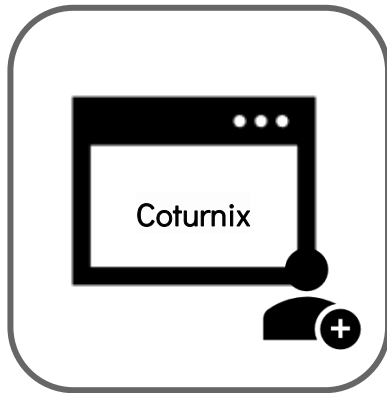
..... 05. Final implementation (Client)

- ❑ Python-Pyqt5 Based Client
- ❑ Real-time Trading (Mock & Real)
- ❑ Send data to AI model server
- ❑ Visualize Confidence Intensity

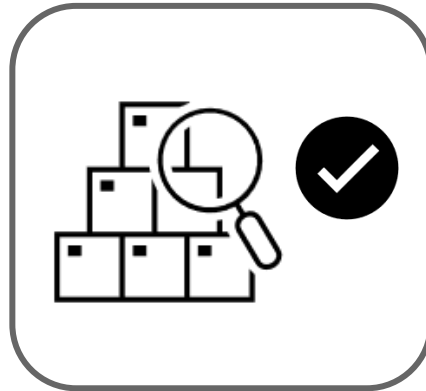


05. Final implementation (Client)

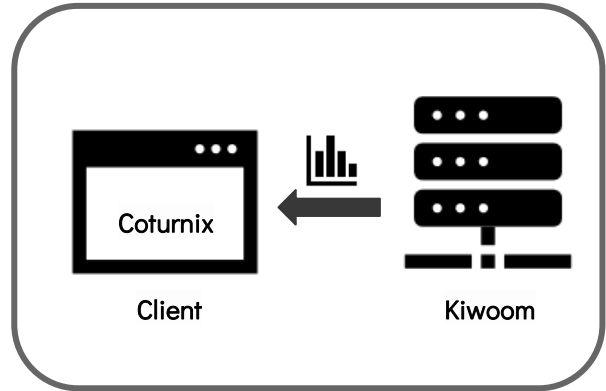
❏ Connect & Data Receiving Process



Connect Kiwoom
Account to Client



Search and
Subscribe Stocks

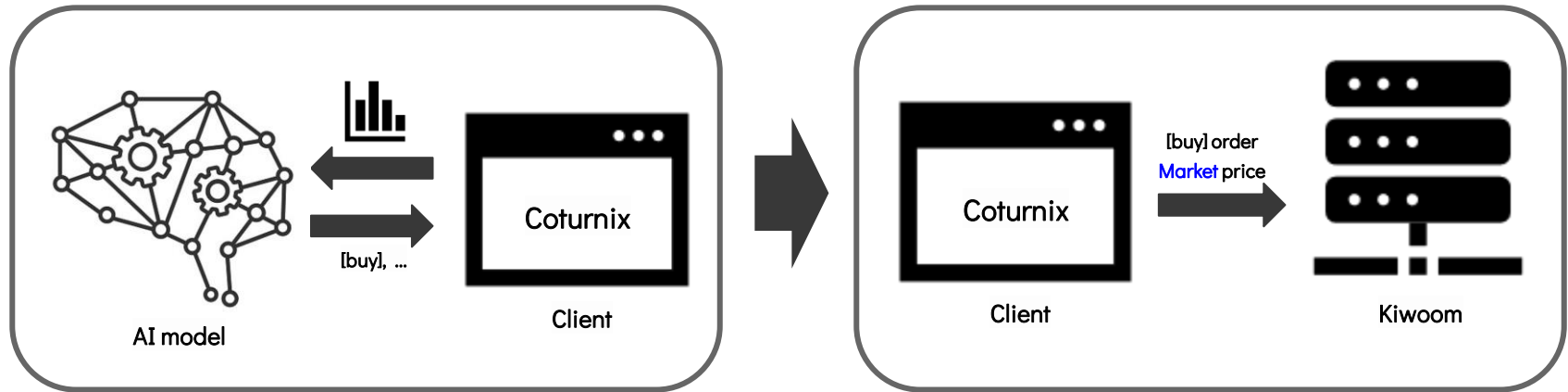


Receive Subscribed data
from Kiwoom Server



05. Final implementation (Client)

❑ Trading Process



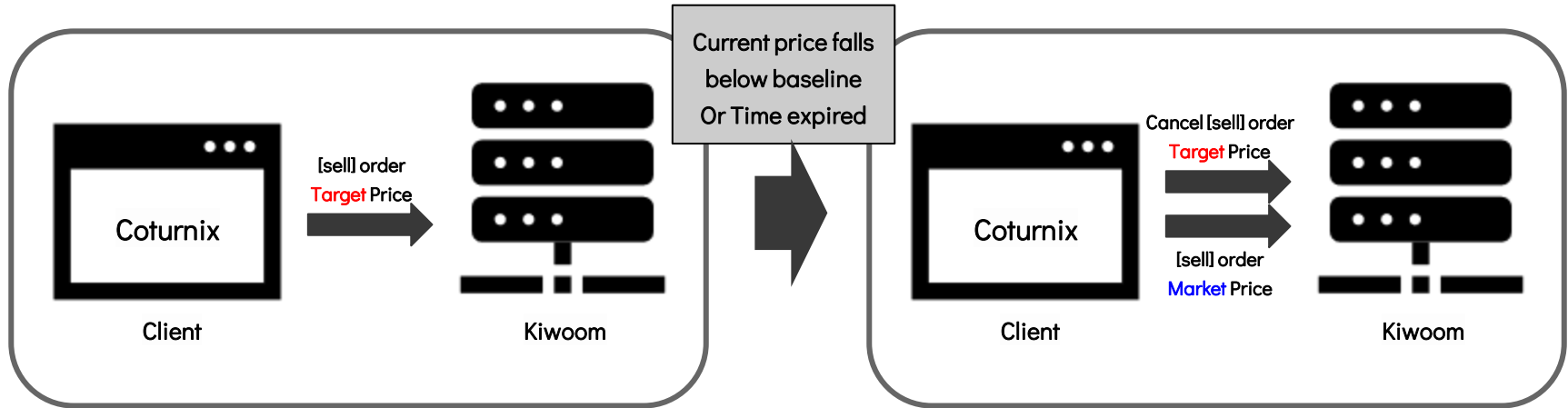
Send data to AI model
& Receive Judgement

Send buy order to
Kiwoom server



05. Final implementation (Client)

Trading Process (Conti.)



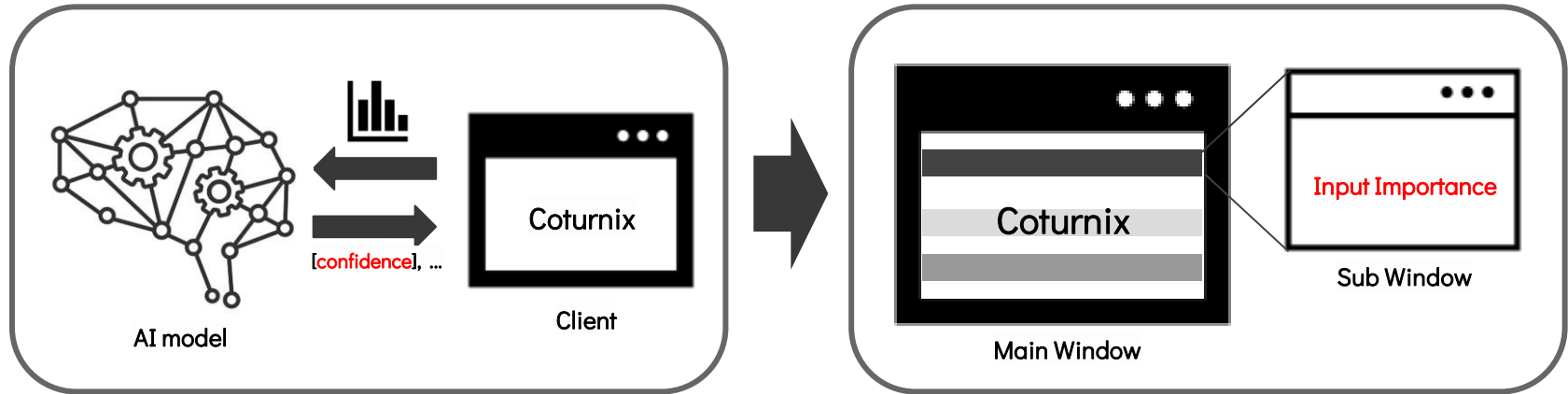
After Buy order completed,
place a sell order at the target price

Cancel the previous order and
Change the sell order at market price



05. Final implementation (Client)

Visualizing Process



AI model send **confidence** and **input gradient** to client when sending buy code

Show Confidence and Importance based on received data



05. Final implementation (GUI)

Coturnix

Account: 8012504311 Deposit: 1338878

Code	Name	Start	High	Low	End	Volume
016600	큐계리알	567	577	556	557	3314027
019770	서연담해탈	7590	8280	7300	7630	7061814
034940	조아제약	3490	4020	3485	3660	3088262
048410	현대바이오	31050	32950	26350	27350	7586539
049480	오른베이스	3620	4235	3605	4010	20115413
064550	바이오니아	45600	54600	45250	53400	6560694
066410	비젟스튜디오	6350	7100	6290	6540	19066665
081150	티클렉스	4365	4500	4295	4375	4053642
086980	소맥스	5460	5840	5440	5580	2620954
094170	동문아나맥	7610	8480	7520	8080	2294692
108860	셀바스AI	8050	8850	7700	7930	3981788
121600	나노신소재	65400	78000	64500	75100	2557147
128540	메코캡	7790	8370	7610	7670	3420708
206560	엑스티	36900	36950	31800	32150	2249523
263800	테이더솔루션	6030	7800	6030	7800	3839849
272290	이녹스첨단소재	41750	47550	41600	46450	3662327

System Log

[12:32:56] [Update] 바이오니아 064550
 [12:32:56] [Update] 엑스티 206560
 [12:32:56] [Update] 바이오니아 064550
 [12:32:56] [Update] 현대바이오 048410
 [12:32:57] [Update] 엑스티 206560
 [12:32:57] [Update] 비두텍 307670
 [12:32:57] [Update] 비두텍 307670
 [12:32:57] [Update] 서연담해탈 019770
 [12:32:57] [Update] 현대바이오 048410
 [12:32:57] [Update] 현대바이오 048410
 [12:32:57] [Update] 바이오니아 064550
 [12:32:57] [Update] 비두텍 307670
 [12:32:57] [Update] 현대바이오 048410

Trading Log

[12:31:44] [매수] 메코캡 128540
 체결가: 7701 체결수량: 7749/8550
 [12:31:45] [매수] 메코캡 128540
 체결가: 7701 체결수량: 7755/8550
 [12:31:49] [매수] 메코캡 128540
 체결가: 7701 체결수량: 7765/8550
 [12:31:50] [매수] 메코캡 128540
 체결가: 7700 체결수량: 7971/8550
 [12:31:50] [매수] 메코캡 128540
 체결가: 7700 체결수량: 7989/8550
 [12:31:50] [매수] 메코캡 128540
 체결가: 7699 체결수량: 8175/8550
 [12:31:50] [매도 주문] 메코캡 128540
 [지정가] 주문수량: 8550



키움증권

Real Time
Stock Data

AI based
Decision



Trading Model



05. Final implementation (GUI)

□ Main Window

Coturnix

Account: 8012504311 Deposit: 1338878

Code	Name	Start	High	Low	End	Volume
	큐캐피탈	567	577	556	557	3314027
	서연탑메탈	7590	8280	7300	7630	7061814
	조야채약	3490	4020	3485	3660	3088262
048410	현대바이오	31050	32950	26350	27350	7586539
049480	오픈베이스	3620	4235	3605	4010	20115413
064550	바이오니아	45600	54600	45250	53400	6560694
066410	버킷스튜디오	6350	7100	6290	6540	19066665
081150	티플렉스	4365	4500	4295	4375	4053642
086980	쇼박스	5460	5840	5440	5580	2620954
	동운아나텍	7610	8480	7520	8080	2294692
	셀바스AI	8050	8850	7700	7930	3981788
	나노신소재	65400	78000	64500	75100	2557147
	에코캡	7790	8370	7610	7670	3420708
	텍스터	36500	36950	31800	32150	2249523
263800	데이타솔루션	6030	7800	6030	7800	3839849
272290	이녹스첨단소재	41750	47550	41600	46450	3662327

System Log

[12:32:56] [Update] 바이오니아 064550
 [12:32:56] [Update] 텍스터 206560
 [12:32:56] [Update] 바이오니아 064550
 [12:32:56] [Update] 현대바이오 048410
 [12:32:57] [Update] 텍스터 206560
 [12:32:57] [Update] 비두맨 307870
 [12:32:57] [Update] 비두맨 307870
 [12:32:57] [Update] 비두맨 307870
 [12:32:57] [Update] 서연탑메탈 019770
 [12:32:57] [Update] 현대바이오 048410
 [12:32:57] [Update] 현대바이오 048410
 [12:32:57] [Update] 바이오니아 064550
 [12:32:57] [Update] 바이오니아 064550
 [12:32:57] [Update] 비두맨 307870
 [12:32:57] [Update] 현대바이오 048410

Trading Log

[12:31:44] [매수] 에코캡 128540
 체결가:7701 체결수량:7749/8550
 [12:31:45] [매수] 에코캡 128540
 체결가:7701 체결수량:7755/8550
 [12:31:49] [매수] 에코캡 128540
 체결가:7701 체결수량:7765/8550
 [12:31:50] [매수] 에코캡 128540
 체결가:7700 체결수량:7977/8550
 [12:31:50] [매수] 에코캡 128540
 체결가:7700 체결수량:7989/8550
 [12:31:50] [매수] 에코캡 128540
 체결가:7700 체결수량:8175/8550
 [12:31:50] [매수] 에코캡 128540
 체결가:7699 체결수량:8550/8550
 [12:31:50] [매도주문] 에코캡 128540
 [지정가] 주문수량:8550

System Log
shows the
Update &
Subscribe info.

Account number
& Deposit

Main table shows
recommended level
through brightness

Trading Log shows
current status of
buy and sell order



05. Final implementation (GUI)

Sub Window

Last 60 Minutes data
& Trading volume

Last 6 Minutes data
& Trading volume



Gradient for each Input
Data is indicated by the
difference of marking size

Gradient of volume
data is expressed
through brightness

06. Evaluation

Mock Investment Result Log

(Supported by Kiwoom)

주식채권	주문번호	원주문번호	종목번호	매매구분	주문유형구분	주문수량	주문단가	확인수량	체결번호
주문일자	종목명	접수구분	신용거래구분	체결수량	체결평균단가	정정/취소	통신	예약/반대	체결시간
주식	63239		258830	시장가	현금매도	14,254	0	14,254	
2021/12/01	세종메디칼	접수		14,254	5,391		오픈API	일반	09:52:54
주식	63235	58650	258830	지정가	현금매도	14,254	0	14,254	
2021/12/01	세종메디칼	접수				취소	오픈API	일반	
주식	60805		189980	지정가	현금매도	478	3,275	478	
2021/12/01	홍국에프엔비	접수		478	3,275		오픈API	일반	09:50:16
주식	60796		189980	시장가	현금매수	478	0	478	
2021/12/01	홍국에프엔비	접수		478	3,250		오픈API	일반	09:50:01
주식	60064		025880	시장가	현금매도	555	2,795	555	
2021/12/01	케이씨피드	접수		555	2,797		오픈API	일반	09:49:59
주식	60044		025880	시장가	현금매수	555	0	555	
2021/12/01	케이씨피드	접수		555	2,770		오픈API	일반	09:49:02
주식	59398		299900	시장가	현금매도	32	0	32	
2021/12/01	위지웍스튜디오	접수		32	48,223		오픈API	일반	09:48:05
주식	59394	59389	299900	지정가	현금매도	32	0	32	
2021/12/01	위지웍스튜디오	접수				취소	오픈API	일반	
주식	59389		299900	지정가	현금매도	32	48,650	32	
2021/12/01	위지웍스튜디오	접수					오픈API	일반	
주식	59377		299900	시장가	현금매수	32	0	32	
2021/12/01	위지웍스튜디오	접수		32	48,250		오픈API	일반	09:48:01
주식	58650		258830	지정가	현금매도	14,254	5,480	14,254	
2021/12/01	세종메디칼	접수					오픈API	일반	
주식	58611		258830	시장가	현금매수	14,254	0	14,254	
2021/12/01	세종메디칼	접수		14,254	5,436		오픈API	일반	09:47:04

Predict Success

Predict Success

Predict Failed

Time Expired
(Predict Failed)



06. Evaluation

Total Mock Investment Result

- ❑ Evaluation Period: 11/22 ~ 12/5
- ❑ Evaluation Time: 9:00 ~ 10:00

# of Success	# of Time Expired	# of Failure	Success Rate
39	6	11	69.64%

Estimated Annual Profit: 27%



$$\begin{aligned}
 & \left[\underbrace{0.5}_{\text{Deposit Management Ratio}} \times \left(1 + \underbrace{0.0075}_{\text{Profit Rate}} - \underbrace{0.0026}_{\text{Tax+Fe e}} \right) + 0.5 \right] \times \underbrace{250}_{\text{Trading Day per Year}} \times \underbrace{0.7}_{\text{Success Rate}} \times \left\{ \underbrace{0.5}_{\text{Deposit Management Ratio}} \times \left(1 - \underbrace{0.0075}_{\text{Loss Rate}} - \underbrace{0.0026}_{\text{Tax+Fe e}} \right) + 0.5 \right\} \times \underbrace{250}_{\text{Trading \# per day}} \times \underbrace{0.3}_{\text{Failure Rate}} \\
 & \quad \text{Profit Rate} \quad \text{Tax+Fe e} \quad \text{Trading Day per Year} \quad \text{Loss Rate} \quad \text{Tax+Fe e} \quad \text{Trading \# per day} \quad \text{Failure Rate}
 \end{aligned}$$

..... 07. Limitations

Mock investment vs Real investment

- Overestimation?...
 - 1) In mock investment, your order will always be considered to have *highest priority* regardless of actual priority.
 - 2) Also, your order will *not affect actual stock price*.
- Both of 1), 2) could be advantages to short-term stock trading...

Tax, Fee (0.26% per order)

- Major obstacles to achieve higher profit rate...



Appendix

Mock investment result

주식채권	주문번호	원주문번호	종목번호	매매구분	주문유형구분	주문수량	주문단가	확인수량	체결번호
주문일자	종목명	접수구분	신용거래구분	체결수량	체결평균단가	정정/취소	통신	예약/반대	체결시간
주식	42568		208710	시장가	현금매도	12,216	0	12,216	
2021/11/23	바이오로그디	접수		12,216	3,807		오픈API	일반	09:29:14
주식	42567	42447	208710	지정가	현금매도	12,216	0	12,216	
2021/11/23	바이오로그디	접수			취소		오픈API	일반	
주식	42447		208710	지정가	현금매도	12,316	3,820	12,316	
2021/11/23	바이오로그디	접수		100	3,820		오픈API	일반	09:29:11
주식	42393		208710	시장가	현금매수	12,316	0	12,316	
2021/11/23	바이오로그디	접수		12,316	3,792		오픈API	일반	09:29:04
주식	23331		189860	지정가	현금매도	539	8,230	539	
2021/11/23	서전기전	접수		539	8,230		오픈API	일반	09:10:02
주식	23181		189860	시장가	현금매수	539	0	539	
2021/11/23	서전기전	접수		539	8,177		오픈API	일반	09:09:09

주식채권	주문번호	원주문번호	종목번호	매매구분	주문유형구분	주문수량	주문단가	확인수량	체결번호
주문일자	종목명	접수구분	신용거래구분	체결수량	체결평균단가	정정/취소	통신	예약/반대	체결시간
주식	56528		048550	지정가	현금매도	1,049	4,475	1,049	
2021/11/22	SM C&C	접수		1,049	4,475		오픈API	일반	09:48:51
주식	56478		048550	시장가	현금매수	1,049	0	1,049	
2021/11/22	SM C&C	접수		1,049	4,446		오픈API	일반	09:48:02
주식	52845		204630	지정가	현금매도	1,436	3,255	1,436	
2021/11/22	스튜디오오산타	접수		1,436	3,256		오픈API	일반	09:45:26
주식	52714		204630	시장가	현금매수	1,436	0	1,436	
2021/11/22	스튜디오오산타	접수		1,436	3,235		오픈API	일반	09:43:03