

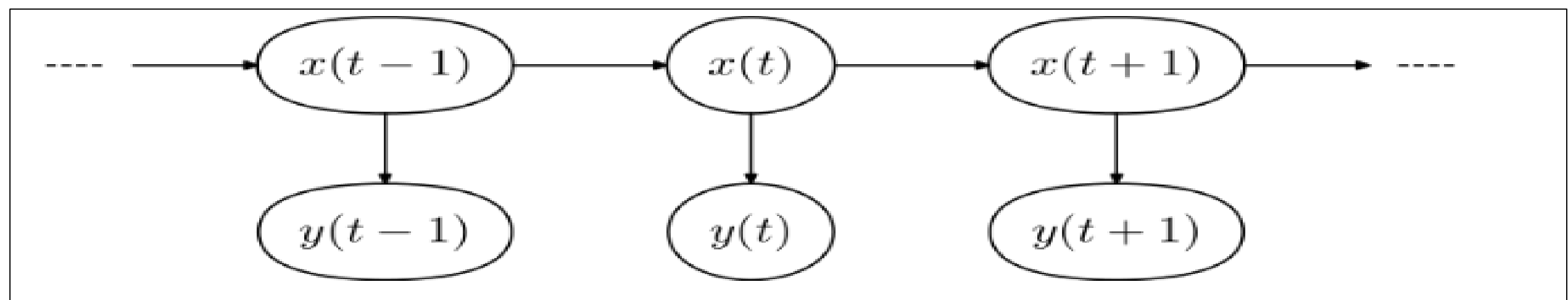
Predicting and comparing common stock and preferred stock trends through HMM data modeling

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Backgrounds

- **Hidden Markov Model (HMM)** is a statistical Markov model in which the system being modeled is assumed to be a Markov process with unobservable states. -> **Fluctuation rate prediction, with following sequence, at stock market**
- This project, hidden states are the company's (Samsung Electronics and Keyang Electric Machinery) common stock fluctuation rate and observations are preferred stock fluctuation rate. -> **Stock trend prediction by HMM**



| | Common stock | Preferred Stock |
|-----------------|----------------------------|---------------------|
| Voting Right | Have rights | None |
| Liquidation | Subordinated reimbursement | Prior reimbursement |
| Dividend | Relatively low | Relatively high |
| Amount of Issue | High | Low |
| Volume | High | Low |
| Investment | Marginal profit | Dividend |

Research Goals

- **Predict the rate of fluctuation in common stocks through a one-month analysis of preferred stocks**
 - Using 2019.05 Samsung Electronics and Keyang Electric Machinery data
 - Predict Fluctuation rate for 3 days after learning 1 month data
- **Compare Samsung Electronics and Keyang Electric Machinery Results**
 - Focus on market capitalization and accuracy
- **Accuracy analysis of predicted values and actual values**
 - Check the HMM model is practical to Stock market prediction

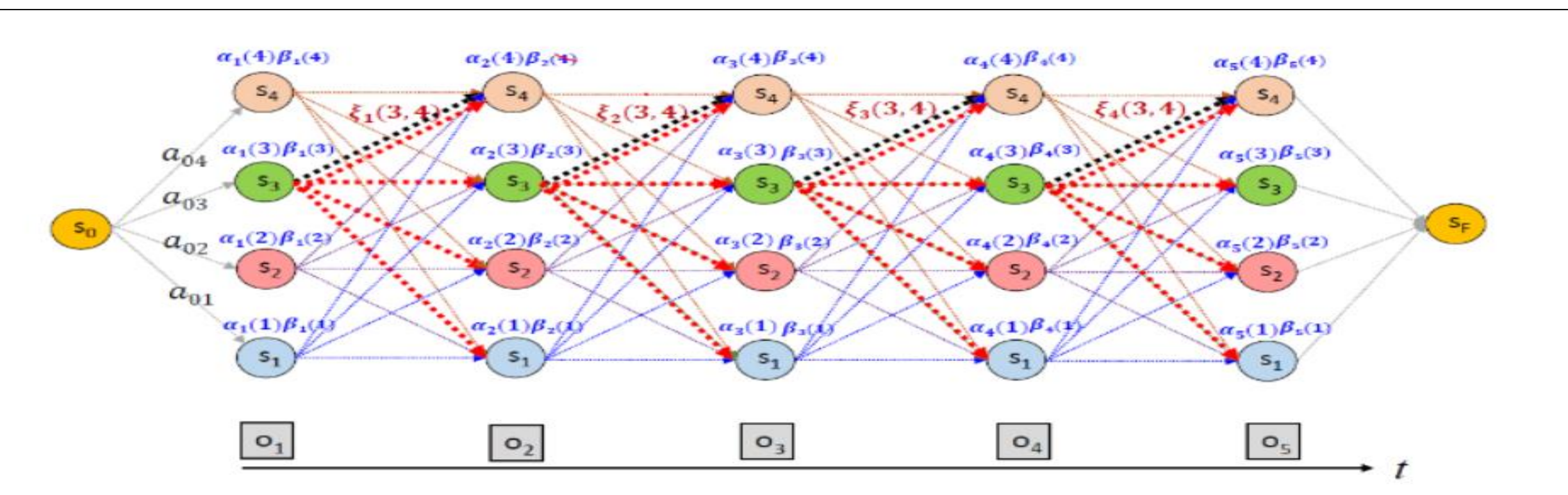
Methodology

- **Present a discrete representation of the fluctuation rate of common stock and preferred stock**
 - Fluctuation rate = ((Today(t) closing price – Yesterday(t-1) closing price)/(Yesterday(t-1) closing price))
 - Set discrete state: [1. fall, rate < -0.01], [2. stable, rate = (-0.01,0.01)], [3. rise, rate > 0.01] and compute the probability by given data

| Samsung | Start | Fall | Stable | Rise | Keyang | Start | Fall | Stable | Rise |
|---------|-------|------|--------|------|--------|-------|------|--------|------|
| Start | 0 | 0.35 | 0.47 | 0.18 | Start | 0 | 0.35 | 0.53 | 0.12 |
| Fall | 0 | 0.20 | 0.60 | 0.20 | Fall | 0 | 0.71 | 0.14 | 0.14 |
| Stable | 0 | 0.50 | 0.38 | 0.13 | Stable | 0 | 0.25 | 0.50 | 0.50 |
| Rise | 0 | 0.33 | 0.33 | 0.33 | Rise | 0 | 0.60 | 0.20 | 0.20 |

| Samsung | Fall | Stable | Rise | Keyang | Fall | Stable | Rise |
|---------|------|--------|------|--------|------|--------|------|
| 1 | 0.82 | 0.25 | 0.01 | 1 | 0.66 | 0.33 | 0.49 |
| 2 | 0.17 | 0.74 | 0.01 | 2 | 0.01 | 0.44 | 0.02 |
| 3 | 0.01 | 0.01 | 0.98 | 3 | 0.33 | 0.22 | 0.49 |

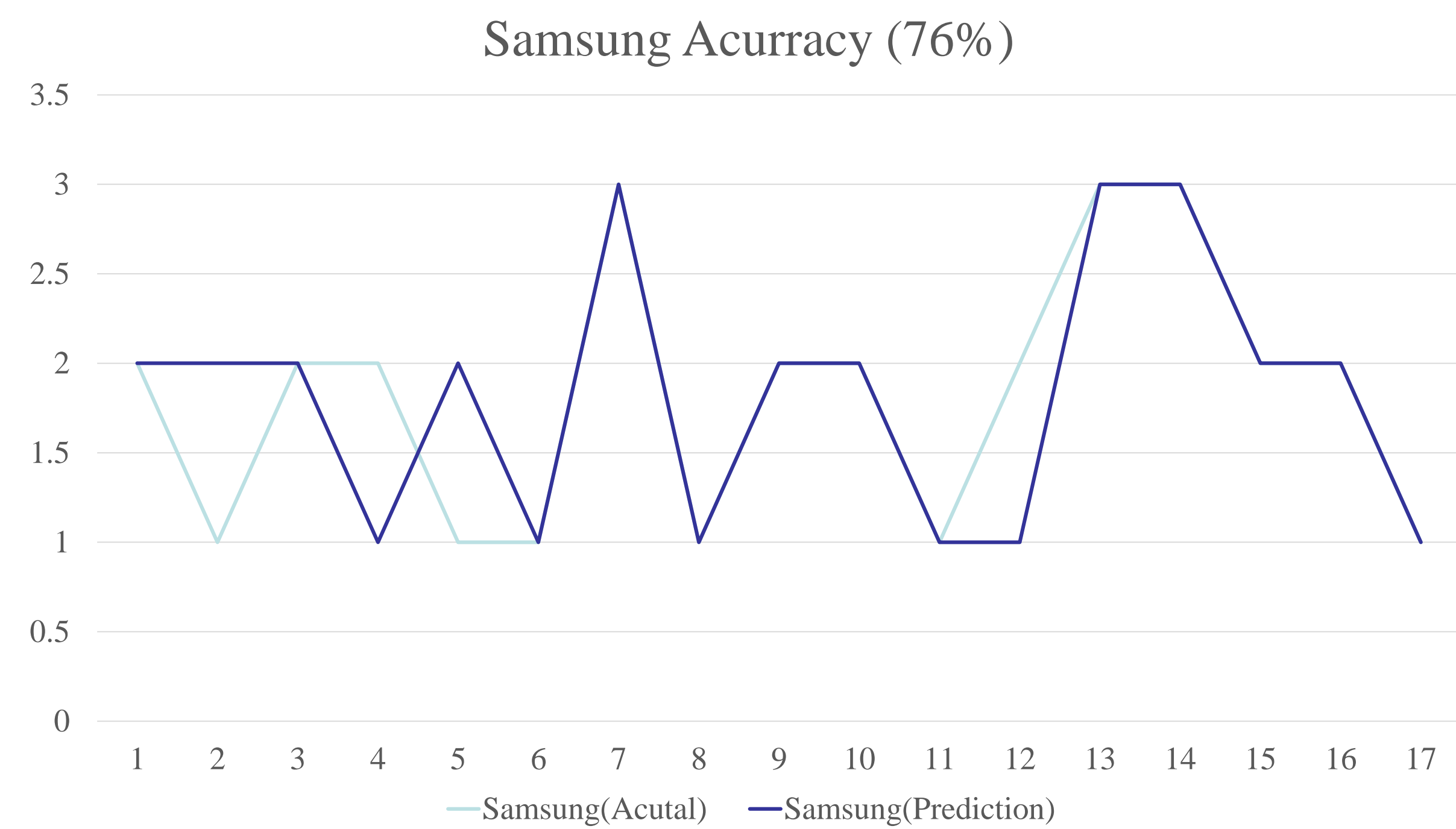
- **Hidden Markov Model (HMM)**
 - Set hidden states as common stock fluctuation rate and observation as preferred stock fluctuation rate.
 - Set 't' as date of investigations, during May 2019. Sequences are presented by discrete fluctuation rate. Do Forward, back propagation and training to compute common stock fluctuation rate sequence.



Experimental Results

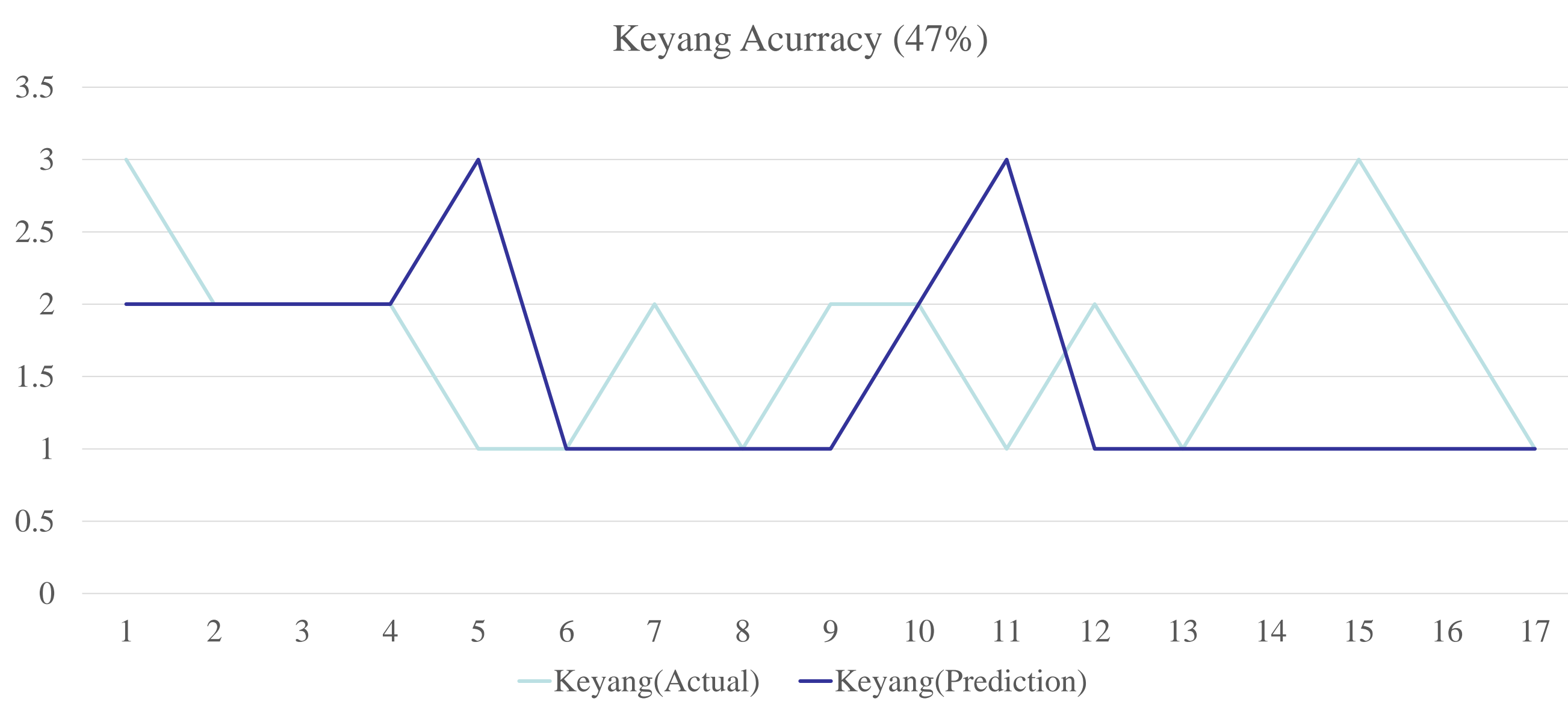
- **Samsung Electronics' common stock trend analysis through HMM, with preferred stock fluctuation rate sequence**

- **76% prediction accuracy with actual fluctuation**



- **Keyang Electric Machinery's common stock trend analysis through HMM, with preferred stock fluctuation rate sequence**

- **47% prediction accuracy with actual fluctuation**



- **HMM-based common stock & preferred stock predictions are highly dependent on market capitalization and total volume.**

- While Samsung Electronics has the large portion of market capitalization (more than 10% of market), Keyang Electric Machinery has small portion.
- This make difference in accuracy between common-preferred stock prediction.
- Samsung Electronics' actual rate flow is quite similar to the prediction while Keyang's is not.

- **3 days fluctuation prediction after learning Samsung Electronics' stock data by HMM for 1 month: 66.7% accuracy**

- Prediction sequence ['stable', 'fall', 'fall']
- Actual sequence ['stable', 'stable', 'fall']

Concluding Remarks

- **Common – Preferred Stock trend prediction based on HMM is practical**
 - When the company stock has large portion of market capitalization
 - When the company stock has high volume
- **Using HMM, Not only the fluctuation rate but also other stock technical indicator data are needed.**
 - Stochastic index, trading volume, composite stock price index
 - With only one hidden layer, fluctuation rate, the accuracy was not satisfactory

References

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