

## PLANNING REVIEW

# PROM02

# MSc Dissertation

Academic Year: 2022/23

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Programme: MSc Data Science

Mode: Part Time

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# 1 Terms of Reference (50%)

## a. Project Title

A stock forecasting model for swing trading recommendations in the Hong Kong stock market

## b. Project Overview

**Aim:** To develop a LSTM forecasting model to assist optimization of swing trading investment strategy in the Hong Kong stock market by providing a visual result as a recommendation for further action.

**Objectives:**

1. Background research by evaluating different investment strategies and studying modern approaches and methods used for stock forecasting
2. Study the Hong Kong stock market landscape by performing background research and technical analysis
3. Literature review to critically evaluate available forecasting algorithms and its application
4. Discuss data collection process by Yahoo Finance
5. Identification and discussion of relevant professional, ethical, social and legal issues
6. Build, train, deploy and visualize forecasting model(s) for evaluating the one with the highest prediction accuracy and efficiency to assist optimization of swing trading in the Hong Kong stock market

**Research Question:**

1. What modern approaches are used in stock forecasting?
2. What are the model features to be considered?
3. What improvements for existing stock forecasting models can be done by applying modern machine learning methods and techniques?

**Practical outcomes:**

1. Overview of the Hong Kong stock market by focusing on Hang Seng Index (HSI) and major 3 selected stocks for model development  
It includes summary statistics and different visuals on various technical indicators to find out insights that describe the market situation.
2. Data collection and pre-processing steps by Yahoo Finance
  - Daily data on high, low, open, close, volume, etc.
  - Missing value handling
  - Derived variables management
3. Perform technical analysis by Python libraries such as numpy, pandas, matplotlib, etc.
4. Detail the experiment design as well as a baseline model by Python libraries such as scikit learnt.
  - Data to be used including features and period adopted
  - Data collection methods and pre-processing steps
  - Baseline model building, LSTM model training and it's performance metrics
5. Build and visualize forecasting model(s) based on the selected algorithms with performance measurements presentations by using Python libraries such as keras, tensorflow, matplotlib, etc. Evaluate results of developed models and select the one with highest accuracy.

### c. Underpinning research with Literature Review

| Citation   | Brief summary of paper   | Relevance to your research question   | Relevance to practical outcome of project   |
|--|--|---|---|
| [1] Manimegalai, T., Manju, J., Rubiston, M.M., Vidhyashree, B. and Prabu, R.Thandaiah. (2022). <i>Prediction of OPTIMIZED Stock Market Trends using Hybrid Approach Based on KNN and Bagging Classifier (KNNB)</i> . [online] IEEE Xplore. doi:10.1109/CSNT54456.2022.9787638           | 1. Stock market trends prediction using various approaches<br>2. Compare different algorithms and the best was a hybrid approach of KNN and bagging classifier   | The paper described a hybrid approach based on the conventional KNN to KNNB. Hybrid or ensemble approaches could be a consideration of enhancing from conventional models. Moreover, it compares a few commonly use approach as a proof of success to the newly suggested model | A few commonly use algorithms will be considered to find the best model approaches  |
| [2] Khaidem, L., Saha, S. and Dey, S. (2016). Predicting the direction of stock market prices using random forest. <i>Applied Mathematical Finance</i> , [online] 00(00), pp.1–20. Available at: <a href="https://arxiv.org/pdf/1605.00003.pdf">https://arxiv.org/pdf/1605.00003.pdf</a> | 1. Stock trend prediction can be used for devising new trading strategies<br>2. How to perform random forest ensemble classification model of predicting stock price go up after n days or vice versa<br>3. Use of technical indicators as features of the model<br>4. Use of confusion matrix and ROC curve for performance measurement | The paper opined trend prediction is better as price is affected by intrinsic volatility which can minimize forecasting errors as a classification problem  | Consider using different technical indicators as features of the model  |
| [3] Smita, M. ed., (2021). <i>Logistic Regression Model - A Review</i> . [online] Available at: <a href="https://ijisrt.com/assets/upload/files/IJISRT21MAY1050.pdf">https://ijisrt.com/assets/upload/files/IJISRT21MAY1050.pdf</a>  | 1. Stock trend prediction aimed for making better informed investment decision<br>2. Detailed what is logistic regression, including assumption, theory and its merit and limitation<br>3. LR can be used as a baseline model  | The paper illustrated a thorough review on logistic regression on assumption, methodology, parameter estimates and application area   | Logistic regression will be adopted as a baseline model in this project   |
| [4] Vijh, M., Chandola, D., Tikkiwal, V.A. and Kumar, A. (2020). <i>Stock Closing Price Prediction using Machine Learning Techniques</i> . <i>Procedia Computer</i>  | 1. Quoted machine learning techniques in stock prediction have improve efficiencies by 60-86% as compared to traditional technical or basic analysis   | The paper summarized the methodology used and demonstrated how ANN worked on better stock price prediction than RF. Moreover, it collected historical data from Yahoo   | The paper contained the end-to-end flow of an empirical study on modeling five selected stock. It showed better result from ANN than RF. More features analysis and the |

|   |  |   |   |
|---|--|---|---|
| <p><i>Science</i>, 167, pp.599–606.<br/>doi:10.1016/j.procs.2020.03.326</p>   | <p>2. Described ANN and Random Forest algorithms applied to stock price prediction in 5 selected stocks<br/>3. Features and derived new variables were used for predicting next stock closing price<br/>4. ANN showed better prediction results than random forest by RMSE, MAPE and MBE</p>   | <p>Finance and detail the new variable derivations</p>  | <p>model building process will be further studied in this project</p>   |
| <p>[5] Chimmula, V.K.R. and Zhang, L. (2020). <i>Time series forecasting of COVID-19 transmission in Canada using LSTM networks</i>. <i>Chaos, Solitons &amp; Fractals</i>, 135, p.109864.<br/>doi:10.1016/j.chaos.2020.109864</p>                              | <p>1. Covid transmission prediction by LSTM<br/>2. Detail discussion on internal mechanism of LSTM networks<br/>3. The model successfully predict Covid transmission with accuracy reach 93% yet Covid data was little at the time of performing this research</p>   | <p>The paper detailed the theory of LSTM and proven successful at predicting real time transmission</p>                         | <p>As stock trend also temporal in nature and recent event affect more on the next day stock price and LSTM will be considered as the primary model to develop in the practical study</p> |
| <p>[6] Thakkar, A. and Chaudhari, K. (2021). <i>A Comprehensive Survey on Deep Neural Networks for Stock Market: The Need, Challenges, and Future Directions</i>. <i>Expert Systems with Applications</i>, p.114800.<br/>doi:10.1016/j.eswa.2021.114800.</p>    | <p>1. Comprehensive review on deep neural network algorithms, indicated the urgency under the volatile stock market for the scientific methodology on deriving inherent patterns for quick investment decisioning<br/>2. Comparison of different models has carried out and analysed<br/>3. Discussed the challenges of DNN stock prediction</p> | <p>The paper detailed most of the ANN and DNN algorithms for stock prediction and stated the pros and cons</p>                  | <p>The analysis of different model results could be a good reference as the background of focusing on LSTM in this experiment</p>   |
| <p>[7] Chen, K., Zhou, Y. and Dai, F. (2015). <i>A LSTM-based method for stock returns prediction: A case study of China stock market</i>. <i>2015 IEEE International Conference on Big Data (Big Data)</i>. [online]<br/>doi:10.1109/bigdata.2015.7364089.</p> | <p>1. Experimental design for LSTM on China stock market using historical daily stock data from Yahoo Finance<br/>2. Progressive methods of adding features on demonstrating the different of accuracy in each method<br/>3. Case study showed LSTM is powerful in stock market by adequate features</p>   | <p>The paper described a complete structure of experimental design on testing different features used in the model training</p> | <p>Try to design the practical part into a few attempts of methods and compare for better model and results</p>   |

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|---|--|---|--|
| <p>[8] Istiaque Sunny, Md.A., Maswood, M.M.S. and Alharbi, A.G. (2020). <i>Deep Learning-Based Stock Price Prediction Using LSTM and Bi-Directional LSTM Model</i>. 2020 2nd Novel Intelligent and Leading Emerging Sciences Conference (NILES). doi:10.1109/niles50944.2020.9257950 .</p>          | <ol style="list-style-type: none"> <li>1. Experimental design for LSTM on Google stock for LSTM and BiLSTM methods</li> <li>2. Illustrated the concept of BiLSTM and its improvements from LSTM by utilizing all previous information from both directions</li> <li>3. The paper demonstrated the tuning of hyperparameters highly affect the accuracy of the result</li> <li>4. Result showed BiLSTM model had higher accuracy than LSTM model however LSTM model took lesser time to predict the data</li> </ol> | <p>The paper focused on LSTM and its variant of BiLSTM for stock prediction. Expanding the experiment could be by tuning hyperparameters and changing on algorithms</p> | <p>To be considered the experimental design could be on the aspects of tuning hyperparameters and similar algorithms</p> |
| <p>[9] Li, X., Wu, P. and Wang, W. (2020). <i>Incorporating stock prices and news sentiments for stock market prediction: A case of Hong Kong</i>. <i>Information Processing &amp; Management</i>, p.102212. doi:10.1016/j.ipm.2020.102212</p>  | <ol style="list-style-type: none"> <li>1. Using news sentiment as a complimentary to numerical stock price prediction</li> <li>2. Short-term prediction method attempted for one-step forecast with more encouraging result</li> <li>3. Long-term prediction method attempted for multi-step forecast that is more challenging with growing uncertainties</li> <li>4. Combining NLP and LSTM models to form NBA with the best result among the tested model</li> </ol>   | <p>The paper inspired the consideration of combining news sentiment analysis in literature review</p>   | <p>To be considered if the practical work will combine with news sentiment analysis after literature review</p>          |
| <p>[10] Mageswaran, G., Nagappan, S.D., Hamzah, N. and Brohi, S.N. (2018). <i>Machine Learning: An Ethical, Social &amp; Political Perspective</i>. 2018 Fourth International Conference on Advances in Computing, Communication &amp; Automation (ICACCA). doi:10.1109/icaccacaf.2018.8776702.</p> | <ol style="list-style-type: none"> <li>1. The paper detailed machine learning technology use case in various aspects including healthcare, banking and political areas</li> <li>2. Discussed on the impact to social, political and ethical considerations during machine learning application</li> </ol>  | <p>The paper reinforced the importance of social, political and ethical issues in the machine learning application process</p>  | <p>The experiment will well consider the social, political and ethical issues during development</p>                     |

## 2. Project Schedule (20%)

2.1 Table 1: Effort

| Task Id   | Task Name  | Start     | Deadline  | Hours | Deliverable   |
|---|--|-----------|-----------|-------|---|
| 1.0 Background research by evaluating different investment strategies and studying modern approaches and methods used for stock forecasting |  |           |           |       |   |
| 1.1   | Research on different investment strategies                          | 17Dec2022 | 31Dec2022 | 20    | Understand big categories of investment strategies  |
| 1.2   | Research on modern approaches and methods used for stock forecasting | 17Dec2022 | 31Dec2022 | 20    | Research pros and cons for different approaches and methods   |
| 1.3   | Summarization  | 28Dec2022 | 8Jan2023  | 5     | Identify the most suitable modern forecasting approaches and area for improvement   |
| 1.4   | Dissertation write up  | 3Jan2023  | 8Jan2023  | 5     | Write up on background and introduction   |
| 2.0 Study the Hong Kong stock market landscape by performing background research and technical analysis                                     |  |           |           |       |   |
| 2.1   | Identify data scope to be collected                                  | 9Jan2023  | 15Jan2023 | 10    | Find out the big waves of Hong Kong stock market and summarize the analysis from longest available period to zoom in to recent 2 years market situation |
| 2.2   | Perform data analysis  | 16Jan2023 | 4Feb2023  | 20    | Present the data analysis result of long, medium, short term that reflect the market situation  |
| 2.3   | Summarize analytics finding  | 30Jan2023 | 5Feb2023  | 10    | Consolidate the analytics finding and support the model building objectives   |
| 2.4   | Dissertation write up  | 4Feb2023  | 5Feb2023  | 5     | High level describe the Hong Kong stock market and summarize the exploratory data analysis finding  |
| 3.0 Literature review to critically evaluate potential forecasting algorithms and its application   |  |           |           |       |   |
| 3.1   | Literature review on logistics regression                            | 17Dec2022 | 31Dec2022 | 10    | Critically evaluate different usage by regression and its application   |
| 3.2   | Literature review on neural networks and LSTM                        | 1Jan2023  | 15Jan2023 | 10    | Critically evaluate different usage by neural networks, LSTM and their application  |
| 3.3   | Literature review on how LSTM variants to solve forecasting problems | 16Jan2023 | 31Jan2023 | 50    | Understand the theory of LSTM and its variants specific on forecasting problems   |
| 3.4   | Summarization  | 30Jan2023 | 5Feb2023  | 10    | Define the experimental design of the practical model building  |
| 3.5   | Dissertation write up  | 5Feb2023  | 11Feb2023 | 10    | Dissertation on literature review   |
| 4.0 Discuss data collection process by Yahoo Finance  |  |           |           |       |   |
| 4.1   | Research on available data collection method                         | 6Feb2023  | 11Feb2023 | 10    | Identify the available data collection method and corresponding advantages and disadvantages  |
| 4.2   | Dissertation write up  | 12Feb2023 | 12Feb2023 | 5     | State the available data collection method and reason of adoption   |

| 5.0 Identification and discussion of relevant professional, ethical, social and legal issues   |  |           |           |    |  |
|--|--|-----------|-----------|----|--|
| 5.1  | Research on social issues related to stock forecasting model                         | 15Feb2023 | 24Feb2023 | 2  | Discuss on social issue related to stock forecasting model   |
| 5.2  | Research on ethical issues related to stock forecasting model                        | 15Feb2023 | 24Feb2023 | 2  | Discuss on ethical issue related to stock forecasting model  |
| 5.3  | Research on professional issues related to stock forecasting model                   | 15Feb2023 | 24Feb2023 | 2  | Discuss on professional issue related to stock forecasting model   |
| 5.4  | Research on legal issues related to stock forecasting model                          | 15Feb2023 | 24Feb2023 | 2  | Discuss on legal issue related to stock forecasting model  |
| 5.5  | Dissertation write up  | 15Feb2023 | 24Feb2023 | 2  | Summarize and state the relevant social, ethical, professional and legal issue related to stock forecasting model                            |
| 6.0 Build, train, deploy and visualize forecasting model(s) for evaluating the one with the highest prediction accuracy and efficiency to assist optimization of swing trading in the Hong Kong stock market |  |           |           |    |  |
| 6.1  | Learning Python to code for data preprocessing                                       | 25Feb2023 | 8Apr2023  | 50 | Equip skills on Python code for data importation and preprocessing   |
| 6.2  | Learning Python to code for data modeling  | 10Apr2023 | 26May2023 | 80 | Equip skills on Python code for data modeling  |
| 6.3  | Sprint 1: Develop, finetune and finalize baseline model by logistic regression model | 29Apr2023 | 18May2023 | 40 | Develop Python code for logistic regression modeling   |
| 6.4  | Sprint 2: Develop, finetune and finalize LSTM modeling                               | 19May2023 | 7Jun2023  | 40 | Develop Python code for LSTM modeling  |
| 6.5  | Sprint 3: Research for different variants and finalize for the best data model       | 30May2023 | 18Jun2023 | 40 | Summarize model performance measures tables and charts   |
| 6.6  | Summarization  | 19Jun2023 | 22Jun2023 | 10 | Identify the model with the highest prediction accuracy and efficiency to assist optimization of swing trading in the Hong Kong stock market |
| 7.0 Wrap up work done  |  |           |           |    |  |
| 7.1  | Summarize the model building process   | 23Jun2023 | 25Jun2023 | 20 | Highlight the key steps of developing the model  |
| 7.2  | Wrap up and final evaluation of the model outputs                                    | 26Jun2023 | 30Jun2023 | 40 | Summarize and discuss the performance measures and discuss the findings from the output  |
| 7.3  | Discuss the future enhancement   | 1Jul2023  | 2Jul2023  | 10 | Discuss the future enhancement   |
| 7.4  | Dissertation write up  | 3Jul2023  | 7Jul2023  | 40 | Wrap up the practical work, conclusion and possible future enhancement   |
| 7.5  | Viva preparation   | 3Jul2023  | 7Jul2023  | 40 | Build presentation deck  |

2.2 Table 2: Deliverables

| Del. No. | Name  | Deadline  |
|----------|---|-----------|
| D1.1     | Understand big categories of investment strategies  | 31Dec2022 |
| D1.2     | Research pros and cons for different approaches and methods   | 31Dec2022 |
| D1.3     | Identify the most suitable modern forecasting approaches and area for improvement   | 8Jan2023  |
| D1.4     | Write up on background and introduction   | 8Jan2023  |
| D2.1     | Find out the big waves of Hong Kong stock market and summarize the analysis from longest available period to zoom in to recent 2 years market situation | 15Jan2023 |
| D2.2     | Present the data analysis result of long, medium, short term that reflect the market situation  | 4Feb2023  |
| D2.3     | Consolidate the analytics finding and support the model building objectives   | 5Feb2023  |
| D2.4     | High level describe the Hong Kong stock market and summarize the exploratory data analysis finding  | 5Feb2023  |
| D3.1     | Critically evaluate different usage by logistic regression and its application  | 31Dec2022 |
| D3.2     | Critically evaluate different usage by neural networks, LSTM and their application  | 15Jan2023 |
| D3.3     | Understand the theory of LSTM and its variants specific on forecasting problems   | 31Jan2023 |
| D3.4     | Define the experimental design of the practical model building  | 5Feb2023  |
| D3.5     | Dissertation on literature review   | 11Feb2023 |
| D4.1     | Identify the available data collection method and corresponding advantages and disadvantages  | 11Feb2023 |
| D4.2     | State the available data collection method and reason of adoption   | 12Feb2023 |
| D5.1     | Discuss on social issue related to stock forecasting model  | 24Feb2023 |
| D5.2     | Discuss on ethical issue related to stock forecasting model   | 24Feb2023 |
| D5.3     | Discuss on professional issue related to stock forecasting model  | 24Feb2023 |
| D5.4     | Discuss on legal issue related to stock forecasting model   | 24Feb2023 |
| D5.5     | Summarize and state the relevant social, ethical, professional and legal issue related to stock forecasting model                                       | 24Feb2023 |
| D6.1     | Equip skills on Python code for data importation and preprocessing  | 8Apr2023  |
| D6.2     | Equip skills on Python code for data modeling   | 26May2023 |
| D6.3     | Develop Python code for logistic regression modeling  | 18May2023 |
| D6.4     | Develop Python code for LSTM modeling   | 7Jun2023  |
| D6.5     | Summarize model performance measures tables and charts  | 18Jun2023 |
| D6.6     | Identify the model with the highest prediction accuracy and efficiency to assist optimization of swing trading in the Hong Kong stock market            | 22Jun2023 |
| D7.1     | Highlight the key steps of developing the model   | 25Jun2023 |
| D7.2     | Summarize and discuss the performance measures and discuss the findings from the output   | 30Jun2023 |
| D7.3     | Discuss the future enhancement  | 2Jul2023  |
| D7.4     | Wrap up the practical work, conclusion and possible future enhancement  | 7Jul2023  |
| D7.5     | Build presentation deck   | 7Jul2023  |

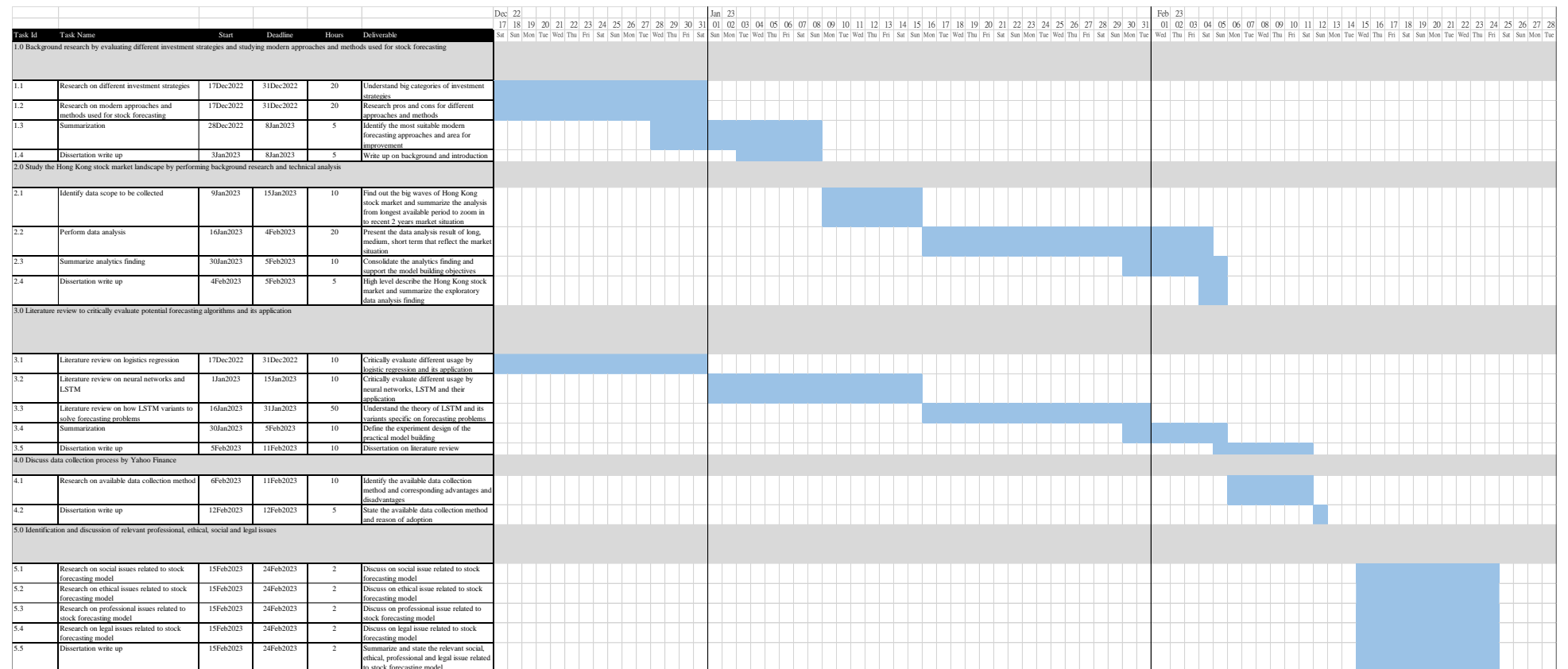


2.3 Table 3: Milestones

| Milestone | Name   | Deadline  | Evidence   |
|-----------|--|-----------|--|
| M1        | Background research by evaluating different investment strategies and studying modern approaches and methods used for stock forecasting  | 8Jan2023  | List, describe and discuss at least three investment strategies and modern approaches that can assist for decisioning    |
| M2        | Study the Hong Kong stock market landscape by performing background research and technical analysis  | 5Feb2023  | Use of summary statistics and various charts for technical analysis that able to articulate the market situation in 2022 |
| M3        | Literature review to critically evaluate potential forecasting algorithms and its application  | 11Feb2023 | Summarize literature review findings and lay down experimental design  |
| M4        | Discuss data collection process by Yahoo Finance   | 12Feb2023 | Document the process flow with corresponding consideration   |
| M5        | Identification and discussion of relevant professional, ethical, social and legal issues   | 24Feb2023 | Document the study and discussion of relevant professional, ethical, social and legal issues                             |
| M6        | Build, train, deploy and visualize forecasting model(s) for evaluating the one with the highest prediction accuracy and efficiency to assist optimization of swing trading in the Hong Kong stock market | 22Jun2023 | Develop Python coding of the model building and evaluation process   |
| M7        | Wrap up work done  | 7Jul2023  | Wrap up dissertation and build presentation deck   |

## 2.4 Table 4: Outline Schedule / Gantt chart

Detail Gantt chart refer to appendix



## PLANNING REVIEW

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### 3. Evaluation Plan (10%)

Guidance: Complete the following table - one page maximum.

|  | Evaluation Approach   | Evidence   |
|--|---|--|
| Background research by evaluating different investment strategies and studying modern approaches and methods used for stock forecasting  | Criticize on different investment strategies and modern approaches for stock forecasting. Then define the data problem and expected deliverables correspondingly  | List, describe and discuss at least three investment strategies and modern approaches that can assist for decisioning    |
| Study the Hong Kong stock market landscape by performing background research and technical analysis  | Perform exploratory data analysis of long term, mid-term and short-term study in Hong Kong stock market. Describe the market situation in 2022 and set the foundation of prediction model building      | Use of summary statistics and various charts for technical analysis that able to articulate the market situation in 2022 |
| Literature review to critically evaluate potential forecasting algorithms and its application  | Research relevant literatures that can provide directions on potential forecasting algorithms, such as logistic regression, neural network algorithms and their experiment results on stock predictions | Summarize literature review findings and lay down experimental design  |
| Discuss data collection process by Yahoo Finance   | Describe the data collection process with reasons on data period, collection method, pre-processing method and corresponding consideration on each step   | Document the process flow with corresponding consideration   |
| Identification and discussion of relevant professional, ethical, social and legal issues   | Elaborate the consideration on relevant professional, ethical, social and legal issues during data collection, application adoption process   | Document the study and discussion of relevant professional, ethical, social and legal issues                             |
| Build, train, deploy and visualize forecasting model(s) for evaluating the one with the highest prediction accuracy and efficiency to assist optimization of swing trading in the Hong Kong stock market | Iteratively develop, evaluate and fine tune a model using the selected algorithm by data collected, ie. Logistic regression and LSTM  | Develop Python coding of the model building and evaluation process   |

## 4. Social, Ethical, Legal and Professional issues (20%)

### 4.1 Social, Ethical, Legal and Professional Issues Table

|                     |   |
|---------------------|---|
| Social issues       | <p>This project aims to develop a LSTM forecasting model to assist optimization of swing trading in the Hong Kong stock market. With the machine learning technologies, decision making process will be faster and interfered by the model recommendation. In case the model will be widely adopted by a lot of investors, the investment decisions will be fed in to as the data inflow then form the cycle of looping back to the model and eventually disrupted the stock market.</p> <p>However, this project is an academic study and can be use as recommendation only.</p> |
| Ethical issues      | <p>While the developed machine learning algorithms may affect human decision, it is important to ensure the usage maintained at fair situation in general public terms. General refers to not personal identifiable and unbiased to any individual or groups such as age, gender, religion, races, etc.</p> <p>This project uses data from stock market and are publicly available therefore no ethical issues in this context.</p>   |
| Professional issues | <p>Professional modeling building focused on quality data and adequate methodology to be used. This project adopted data collected from Yahoo Finance which guarantee the data quality. Data cleansing and verification during exploratory analysis will be performed to ensure again the data quality. Data model will be built by iterative evaluation process to ensure the best among results will be selected and adopted.</p>   |
| Legal Issues        | <p>The data source of this project comes from Yahoo Finance web site. It allows data download as well as using API like Python yfinance library. There is a disclaimer clause in yfinance that “It is an open-source tool that uses Yahoo’s publicly available APIs, and is intended for research and educational purposes”. In this case, there is no legal concern as this project is for academic purposes only.</p>   |

### 4.2 Ethics Approval

*Guidance: If your proposal requires ethical approval attach approval (or submission if not yet approved) from the Research Ethics Committee as an appendix.*

## 5. Appendices



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