Project Notes:

Project Title: Developing non-Machine Learning Algorithms for determining when to buy and sell on the stock market

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Note Well: There are NO SHORT-cuts to reading journal articles and taking notes from them. Comprehension is paramount. You will most likely need to read it several times, so set aside enough time in your schedule.

Contents:

Knowledge Gaps:

This list provides a brief overview of the major knowledge gaps for this project, how they were resolved and where to find the information.

Knowledge Gap	Resolved By	Information is located	Date resolved
Creating new algorithms			
Which stocks will provide a good overview			
Where to find accurate stock market information			

Literature Search Parameters:

These searches were performed between (Start Date of reading) and XX/XX/2019.
List of keywords and databases used during this project.

Database/search engine	Keywords	Summary of search
Google Scholar	Buy and Hold, Algorithms	Interesting articles, good baseline information
Google	determining when to buy and sell on the stock market	Not very much information on the topic, a lot of psychological studies
Google Scholar, Patent Search	Algorithms determining when to buy and sell on the stock market	Some more results closer to topic, but almost all are machine learning and most focus on selecting which stocks to buy not when

Tags:

Tag Name	
Buy and Hold	
Algorithms	

Article #1 Notes: Article discusses vision in baseball players

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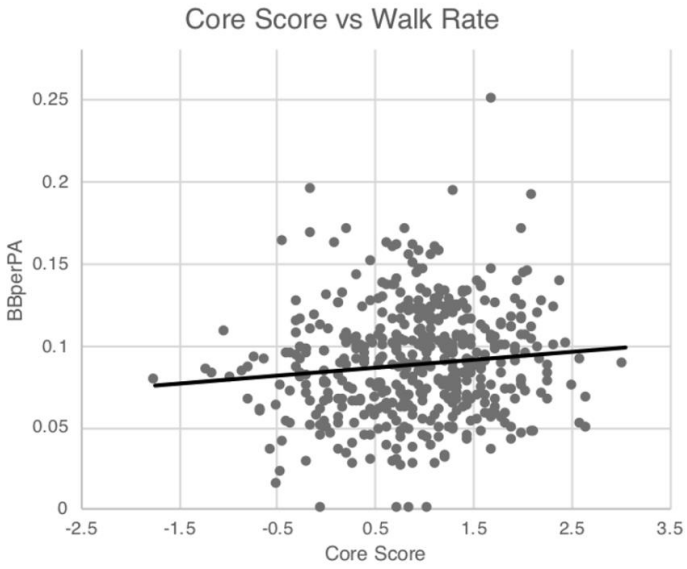
Source Title	The Effect of Visual Function on the Batting Performance of Professional Baseball Players
Source citation (APA Format)	Laby, D.M., Kirschen, D.G., Govindarajulu, U. (2019) The Effect of Visual Function on the Batting Performance of Professional Baseball Players. *Scientific Reports, 9*, 16847 https://doi.org/10.1038/s41598-019-52546-2
Original URL	https://doi.org/10.1038/s41598-019-52546-2
Source type	Article
Keywords	Baseball batting
#Tags	
Summary of key points + notes (include methodology)	This study discusses how parameters of eye function influence the ability of professional baseball players at bat. The study worked by performing vision tests on a group of 595 professional baseball players, and then examining their batting averages. The study showed that higher visual ability tended to correspond to higher batting averages and better batting statistics across the board. This was done by using an iPad and having the user swipe on it in the indicated direction in order to measure visual acuity. One eye of the user was covered, and all players used only their right eye to measure data.
Research Question/Problem/ Need	Does better visual acuity in professional baseball players correspond to better batting performance?

Important Figures	**Figure 2** From: The Effect of Visual Function on the Batting Performance of Professional Baseball Players  Scatter plot of CoreScore vs BBperPA, with best fit linear trendline. Note that as visual ability increases, so does the walk rate. This line of best fit demonstrates the relation between better vision, and a better score on this test.
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	Does this relationship extend to other sports? How effective would visual training exercises be at improving averages? Could high visual ability correspond to a different factor the study failed to consider, which causes both it and the averages to be high, although solid statistical evidence for correlation, no evidence necessarily for causation?

Article #2 Notes: Saving a penalty: How science helps predict the score

Article notes should be on separate sheets

Source Title	Saving a penalty: How science helps predict the score
Source citation (APA Format)	Kamp, J., Dicks, M., Navia, J., Noël, B. (2018). Goalkeeping in the soccer penalty kick, *German Journal of Exercise and Sport Research, 48,* 169-175 DOI: 10.1007/s12662-018-0506-3
Original URL	https://phys.org/news/2018-04-penalty-science-score.html
Source type	Article
Keywords	
#Tags	Soccer Penalties
Summary of key points + notes (include methodology)	This article discusses a lot of the calculations that soccer goalkeepers must perform about exactly when, where, and how to dive.to stop a penalty kick. Due to the extremely close distance from which a penalty kick is taken, goalkeepers have little time to react, and thus must look at the movement of the shooter prior to the kick for clues about the direction of the ball and at what moment the kick will occur. This helps them have a good idea of where the shooter is aiming beforehand meaning they often begin their movement before the shot, as some areas of the goal take time they won't have after the ball is kicked to cover. The use of visual cues was observed by playing videos of past shots as videos and observing goalkeeper's natural instincts to understand the deciphering of the clues. This study combines physics and statistics to improve understanding of how goalkeepers react to penalties and the visual cues they use.
Research Question/Problem/ Need	How soccer goalkeepers decide when, where and how to dive.
Important Figures	
VOCAB: (w/definition)	Gaze trackers- technology that tracks where an individual is looking
Cited references to follow up on	John van der Kamp et al, Goalkeeping in the soccer penalty kick, *German Journal of Exercise and Sport Research* (2018). DOI: 10.1007/s12662-018-0506-3
Follow up Questions	How does the type of player that is taking the penalty change the goalkeeper's approach? Are in game penalties approached differently from penalties in shootouts?

	Are there significant differences between levels?

Article #3 Notes: Researchers develop 'envy-free' algorithm for settling disputes

Article notes should be on separate sheets

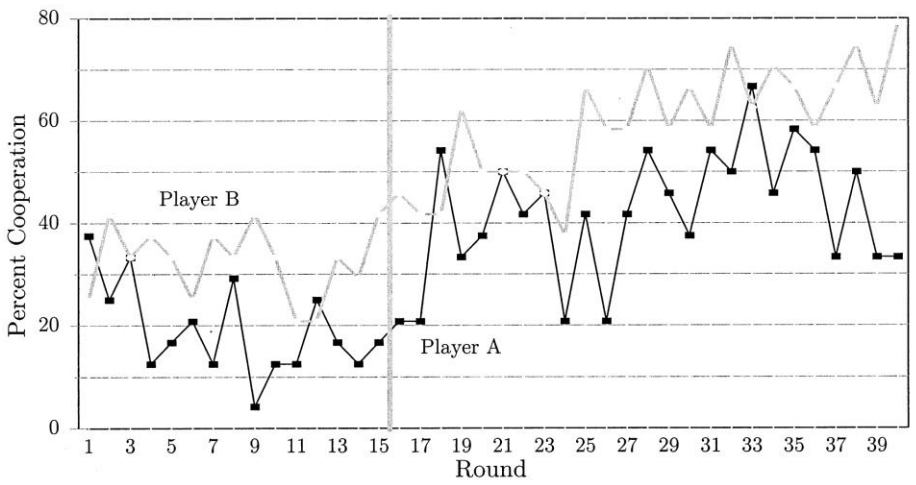
Source Title	Researchers develop 'envy-free' algorithm for settling disputes
Source citation (APA Format)	Brams, S. (2014, February 3). *Researchers develop "envy-free" algorithm for settling disputes*. Phys.org. https://phys.org/news/2014-02-envy-free-algorithm-disputes.html
Original URL	https://phys.org/news/2014-02-envy-free-algorithm-disputes.html
Source type	Article
Keywords	
#Tags	Fair division algorithms
Summary of key points + notes (include methodology)	This article discusses fair-division algorithms, which are mathematical functions that allow you to divide individual items of property as fairly as possible. This article focuses on a simple but effective method of envy free division. Envy free division focuses on making every person think they got more than all other people from their valuations. This algorithm tells the players to make an ordered list and then go down each list taking one item each simultaneously (skipping those already taken) in order to divide fairly. This strategy gets slightly more complex for some edge cases, but overall is very simple and effective.
Research Question/Problem/ Need	How effective is this new simple fair division algorithm and how does it handle unusual circumstances?

Important Figures	
VOCAB: (w/definition)	Envy-free: every individual would rather have their part than anyone else's
Cited references to follow up on	Bridging Two Worlds (2011) and Mathematics and Democracy: Designing Better Voting and Fair-Division Procedures (2008)
Follow up Questions	How does this algorithm deal with conflicts in those cases where this sorting is imperfect? Can this algorithm be expanded to work on more than two people? How practical is this in the real world?

Article #4 Notes: Preplay contracting in the Prisoners' Dilemma

Article notes should be on separate sheets

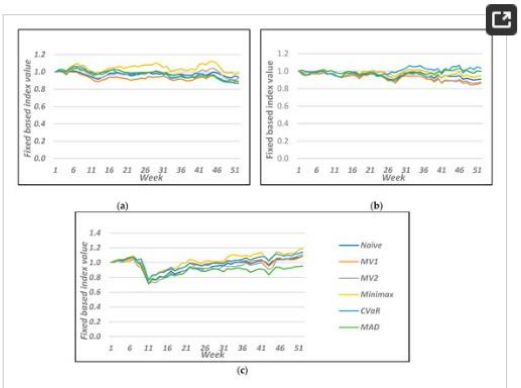
Source Title	Preplay contracting in the Prisoners' Dilemma
Source citation (APA Format)	Andreoni, J., & Varian, H. R. (1999). Preplay contracting in the Prisoners' Dilemma. *Proceedings of the National Academy of Sciences, 96*(19), 10933–10938.
Original URL	https://doi.org/10.1073/pnas.96.19.10933
Source type	Research article
Keywords	
#Tags	Prisoners' dilemma, game Theory
Summary of key points + notes (include methodology)	This study focuses on the Prisoner's Dilemma and the effect a chance to bribe your opponent before the game influences the outcome. In this paper, many variations on the prisoner's dilemma and other similar games are discussed, as the authors examine how different tweaks in the rules affect the way the game is played and the cooperation rates of players. This game provides an exceptionally good insight both into human psychology and especially game theory. Although this may seem like an abstract problem, it has many real-world parallels in many topics.
Research Question/Problem/ Need	This study focuses on the changes in behavior in the prisoner's dilemma if one player can offer a bribe to the other before the game.
Important Figures	This figure shows the push rate for the two players as the time goes on, and after round 15 we introduce the pay mechanic

	
VOCAB: (w/definition)	A Nash equilibrium is a situation where no player could gain by changing their own strategy (holding all other players' strategies fixed)
Cited references to follow up on	
Follow up Questions	What happens if a bribe can be offered once by each player? How do other factors about participants affect their decision-making? How much does the number of repeated games change the play of players?

Article #5 Notes: Efficient Asset Allocation: Application of Game Theory-Based Model for Superior Performance

Article notes should be on separate sheets

Source Title	Efficient Asset Allocation: Application of Game Theory-Based Model for Superior Performance
Source citation (APA	Sikalo M., Arnaut-Berilo A., Zaimovic A. (2022). Efficient Asset Allocation: Application of Game Theory-Based Model for Superior Performance. *International Journal of Financial*

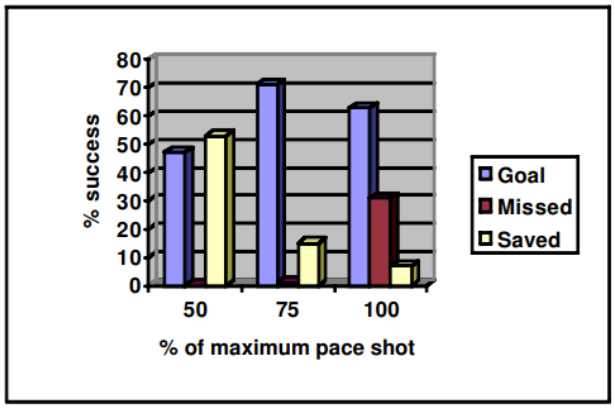
Format)	*Studies,10*(1), 20. https://doi.org/10.3390/ijfs10010020
Original URL	https://doi.org/10.3390/ijfs10010020
Source type	Paper
Keywords	
#Tags	
Summary of key points + notes (include methodology)	This is an important topic as it can help create more optimal investment strategies, especially those that may help minimize loss, something that is especially important for less wealthy investors. The data the paper was trying to find were the expected returns of each portfolio picked by the algorithms and potential risks. Using a variety of these algorithms to create portfolios and then measuring the performance of those portfolios using historic European Stock Market data. Various models were used to compare the effectiveness of the different algorithms, and we obtained information about the financial performance of these algorithms and how they stack up to each other. The game theory strategy using minimax was shown to have the best performance, thus suggesting that implementing game theory strategies to build portfolios could be successful.
Research Question/Problem/ Need	Optimization of portfolio diversification for higher stock market margins using game theory strategies.
Important Figures	This graph shows how the value of the portfolio changes under each of the models  **Figure 2.** Weekly calculated fixed based index for portfolio value by year for a period of market decline: (**a**) 2007, (**b**) 2008, (**c**) 2020.

VOCAB: (w/definition)	Minimax is a decision rule used in artificial intelligence, decision theory, game theory, statistics, and philosophy for minimizing the possible loss for a worst case (maximum loss) scenario.
Cited references to follow up on	
Follow up Questions	How well would this work in other markets? Are there differences based on the size of the portfolio? What are some other potential algorithms that could have been tried?

Article #6 Notes: Analysis of penalties taken in shoot-outs

Article notes should be on separate sheets

Source Title	Analysis of penalties taken in shoot-outs
Source citation (APA Format)	Hughes, M. & Wells, J. (2002). Analysis of penalties taken in shoot-outs. *International Journal of Performance Analysis in Sport, 2,* 55-72. 10.1080/24748668.2002.11868261.
Original URL	https://www.tandfonline.com/doi/abs/10.1080/24748668.2002.11868261
Source type	Paper
Keywords	

#Tags	#penalties #soccer
Summary of key points + notes (include methodology)	• The data was taken of 129 penalty kicks was taken from the knockout phases of the World Cup and the Euros • The next step was to examine each of these shoots and add to them several features such as the % power, placement in the net and others. • The data was then broken down into a variety of comparisons based on these features, with each kick also being labeled as saved missed or scored • This shows us that 75% power appears to be optimal • Many players appear to be aware as this is the most common category of shots • In general, the most often used tactics were the most effective • Certain teams, notably Germany appear to practice penalties as their conversion percentages are much higher
Research Question/Problem/ Need	What features about the players' shots predict the likelihood of a soccer player scoring a penalty during a shootout?
Important Figures	 Fig. 3. Frequency of the different outcome at different pace of shot expressed as percentages of the total of each set.. Shows how 75% power is optimal with most goals scored on this chart of shot power and outcome
VOCAB: (w/definition)	Placement- Where the shot is aimed in the goal
Cited references to follow up on	
Follow up Questions	How do the goalkeepers faced by the players affect their shooting decisions? Were there any other features that demonstrated a strong correlation with shot success? How well do the results of this study work in club play?

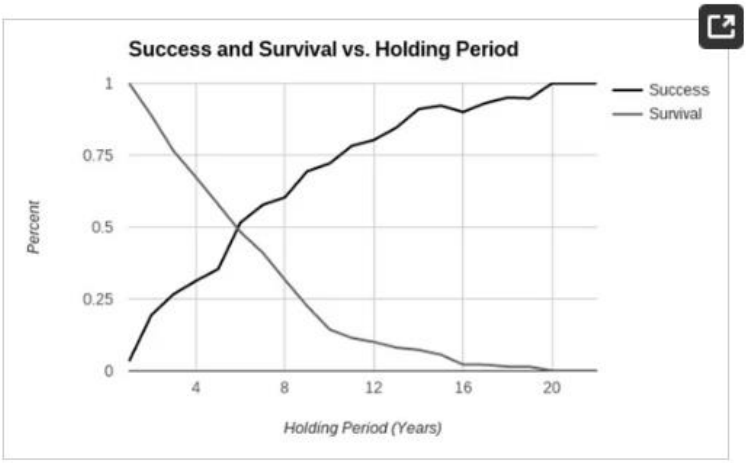
Article #7 Notes: Buy, sell, or hold? A sense-making account of factors influencing trading decisions

Source Title	Buy, sell, or hold? A sense-making account of factors influencing trading decisions
Source citation (APA Format)	Sobolev D., Chan, B., Harvey, N. (2017), Buy, sell, or hold? A sense-making account of factors influencing trading decisions, *Cogent Economics & Finance, 5.* http://dx.doi.org/10.1080/23322039.2017.1295618
Original URL	https://www.tandfonline.com/doi/epdf/10.1080/23322039.2017.1295618?needAccess=true
Source type	Research Article
Keywords	
#Tags	Buy and Hold
Summary of key points + notes (include methodology)	• 60 individuals each given 12 shares of a virtual stock • 30 western and 30 eastern individuals • Everyone periodically given news articles and previous price graphs • Could decide to buy or hold at any of the data points • Participants were tested based on their character to determine their level of openness • Found that western individuals made decisions based on less data and had less return dispersion than eastern individuals • It was found that people relied more heavily on the information given to them by news rather than the charts • Those more open to new ideas tended to make more rapid decisions • Overall, this study found that investors look to build stories that make sense for them, and this affects their investment strategy
Research Question/Problem/ Need	Investigating the effect of news information, and previous trends on the decisions of individuals when to buy and sell on the stock market?
Important Figures	
VOCAB: (w/definition)	Trading latencies- How much time it takes an individual to react to changes in stock market trends
Cited references to follow up on	
Follow up Questions	Was there a certain length of downward trend that caused nearly all individuals to sell and vice versa buy? Could an objective algorithm have been developed which showed solid results on this

	test? Were the reactions to negative news stronger than those to positive news?

Article #8 Notes: Buy and Hold in the New Age of Stock Market Volatility: A Story about ETFs

Source Title	Buy and Hold in the New Age of Stock Market Volatility: A Story about ETFs
Source citation (APA Format)	Sanderson, R., & Lumpkin-Sowers, N. (2018). Buy and hold in the New Age of Stock Market Volatility: A story about etfs. *International Journal of Financial Studies*, *6*(3). https://doi.org/10.3390/ijfs6030079
Original URL	**https://doi.org/10.3390/ijfs6030079**
Source type	Article
Keywords	
#Tags	BuyandHold
Summary of key points + notes (include methodology)	The article looked in particular at ETF stocks, as these index stocks appear well suited to the buy and hold strategy. The first step was to collect data, and it was decided to use the data from 1364 ETFs over their lifetime. The next step was to test various lengths of buy and hold methods for all rolling periods of a certain length. The length of time would be increased until it was observed that over any such length of time there would be an overall gain from the principal. The data was then analyzed, to find that the length of time required for ETF to return a gain over time with over 95% probability was around 10 years. This in turn means that buy and hold stops being an attractive method even for safer investors, due to the more volatile current market. • Buy and hold not really viable • Leaves the door open for new methods
Research Question/Problem/ Need	How well does the buy and hold strategy work over various lengths of time in the current market?

Important Figures	 **Figure 1.** Success and Holding Period. This figure represents the success and survival rate of ETFs over time
VOCAB: (w/definition)	The exchange-traded fund (ETF) was designed in 1993 as a vehicle for index investing with the added benefit of tradability throughout the day.
Cited references to follow up on	
Follow up Questions	Are the same issues with ETF occurring in other stocks? Has the volatility of the market continued increasing as time goes on? How significant are the impacts of this volatile market on investors?

Article #9 Notes: An Empirical Re-Investigation on the ‘Buy-and-hold Strategy' in Four Asian Markets: A 20 Years’ Study

Source Title	An Empirical Re-Investigation on the ‘Buy-and-hold Strategy' in Four Asian Markets: A 20 Years’ Study
Source citation (APA Format)	Ling, F., Ng, D., Muhamad, R. (2014). An Empirical Re-Investigation on the ‘Buy-and-hold Strategy' in Four Asian Markets: A 20 Years’ Study. *World Applied Sciences Journal, 30*(30). 10.5829/idosi.wasj.2014.30.icmrp.30.

Original URL	https://www.researchgate.net/publication/263969347_An_Empirical_Re-Investigation_on_the_%27Buy-and-hold_Strategy%27in_Four_Asian_Markets_A_20_Years%27_Study?enrichId=rgreq-ee3c76b3fba4d7b0d8561139ed36c341-XXX&enrichSource=Y292ZXJQYWdlOzI2Mzk2OTM0NztBUzoxMTk4MzM2MzUwNjk5NTNAMTQwNTU4MTk3NDc2NQ%3D%3D&el=1_x_3
Source type	Article
Keywords	
#Tags	Buy and Hold
Summary of key points + notes (include methodology)	A large part of the paper is a long introduction defending the buy and hold strategy in general, and particularly for small investors. It is however important to note that the rate of return from this strategy observed in previous studies begins to decrease as we move forward in time. The data in this study was taken from various indexes across various East Asian markets. The rolling return and total risk were then analyzed between the years 1990-2009. The risk-return curve appeared to apply, with yearly return falling sharply as the holding period increased, but risk also decreased. • Less negative about buy and hold • Focuses on a market very different from the US
Research Question/Problem/ Need	Is buy and hold a viable strategy in the current Asian market?
Important Figures	
VOCAB: (w/definition)	A buy-and-hold strategy is a passive investment strategy and also a very conservative approach with which investors buy-and-hold stocks for a long period regardless of fluctuations in the market
Cited references to follow up on	
Follow up Questions	How would the exact same study work in the US? How is the time during which the study affected the results, how would it work a decade earlier or later? What happens if investor panic is introduced?

Article #10 Notes: Algorithmic trading for a buy-sell platform: study and comparison

Source Title	Algorithmic trading for a buy-sell platform: study and comparison
Source citation (APA Format)	Sakhare, A., Mhaskar, N., Mishra, V., Chavan, M. (2021). Algorithmic trading for a buy-sell platform: study and comparison. *ITM Web of Conferences,40,* 03020. 10.1051/itmconf/20214003020.
Original URL	https://www.researchgate.net/publication/353774801_Algorithmic_trading_for_a_buy-sell_platform_study_and_comparison
Source type	Article
Keywords	
#Tags	Trading Algorithms
Summary of key points + notes (include methodology)	This article focuses on machine learning algorithms for predicting prices, which isn't necessarily a direction I'm planning to move into, but it presents an interesting idea. This model discusses how LSTMs, a type of neural networks designed for processing time series can be used to try and predict future stock market prices based on historical data. It also discusses the usefulness of adding technical indicators to this to improve accuracy. • Not necessarily a direction of interest for me but an interesting idea to contrast the static algorithms I am planning on using
Research Question/Problem/ Need	How to create neural network models to predict stock prices and their effectiveness?
Important Figures	
VOCAB: (w/definition)	LSTM networks are a type of recurrent neural network (RNN) with the capability of learning order dependence in sequence prediction problems
Cited references to follow up on	
Follow up Questions	Does this model give insight into a general static formula that could work? How accurate is this model in different markets? How well does this model perform during times of extreme market instability?

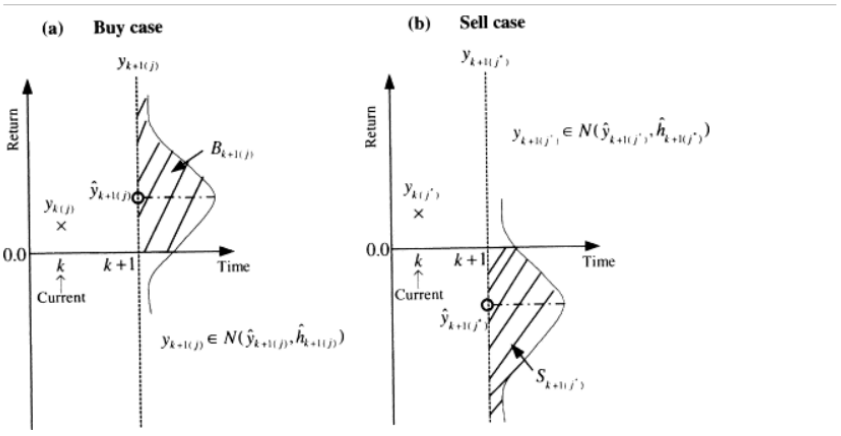
Article #11 Notes: Building Intelligent Moving Average-Based Stock Trading System Using Metaheuristic Algorithms

Source Title	Building Intelligent Moving Average-Based Stock Trading System Using Metaheuristic Algorithms
Source citation (APA Format)	Kuo, S.-Y., & Chou, Y.-H. (2021). Building intelligent moving average-based stock trading system using metaheuristic algorithms. *IEEE Access, 9*. https://doi.org/10.1109/ACCESS.2021.3119041
Original URL	**https://ieeexplore.ieee.org/abstract/document/9565877**
Source type	Article
Keywords	
#Tags	Trading Algorithms
Summary of key points + notes (include methodology)	• Trying to create an algorithm to determine when to buy and sell • Trying to improve on current algorithms that simply take MA without looking at the exact parameter settings • Trying to remove all the limits of the MA • Utilize different types of MA such as EMA and WMA • The uses the GQTS (global best-guided quantum-inspired tabu search algorithm) • Also adds a 2-phase sliding window for more accuracy • This ends up making a more flexible system • The method was shown to outperform the US and Taiwan stock markets • On addition it could outperform methods such as buy and hold
Research Question/Problem/ Need	The goal of this work was to create a metaheuristic algorithm using moving averages and quantum computing to predict when to buy and sell.

Important Figures	$$MA_t(n) = \frac{p_{t-(n-1)} + \ldots + p_{t-1} + p_t}{n}$$ Moving Average formula
VOCAB: (w/definition)	MA-Moving Average, something that tracks the average value of something over a shifting time period WMA-Weighted Moving Average EMA-Exponential moving average GQTS- global best-guided quantum-inspired tabu search algorithm
Cited references to follow up on	
Follow up Questions	How well would WMAs or EMAs work without the GQTS? How well would this algorithm work in an extremely volatile market period? What are strategies other than MA that have proved efficient?

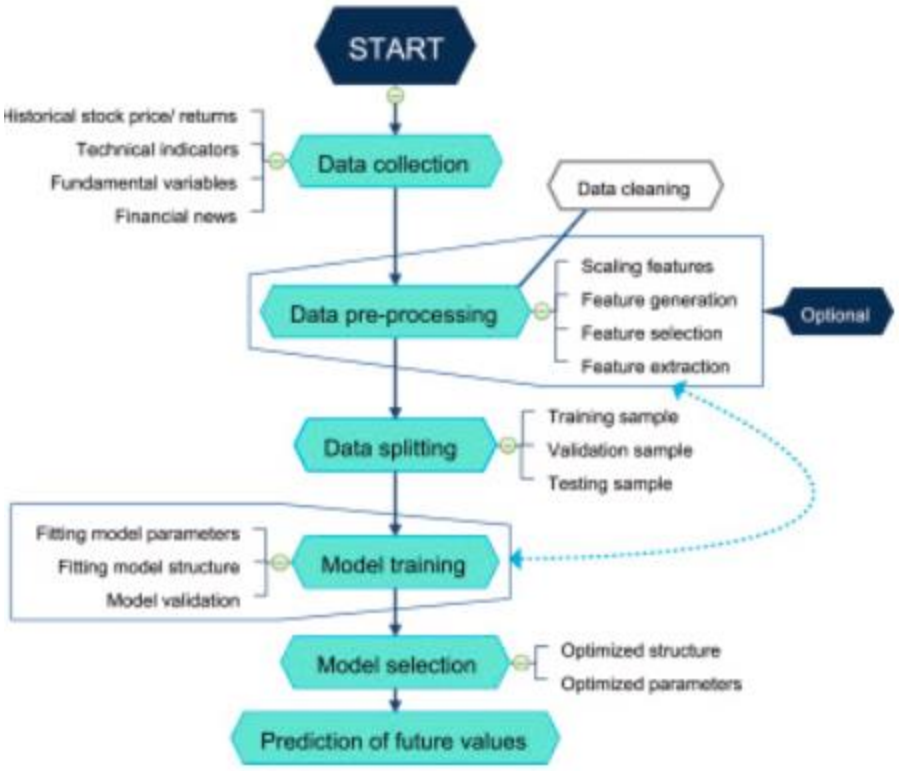
Article #12 Notes: Decision-making for stock trading based on trading probability by considering whole market movement

Source Title	Decision-making for stock trading based on trading probability by considering whole market movement
Source citation (APA Format)	Huang, W., Satoru, G., Nakamura, M., (2021). Decision-making for stock trading based on trading probability by considering whole market movement. *European Journal of Operational Research, 157*(1). https://doi.org/10.1016/S0377-2217(03)00144-9
Original URL	**https://www.sciencedirect.com/science/article/pii/S0377221703001449**
Source type	Article
Keywords	

#Tags	#Trading Algorithms #BuyandSell
Summary of key points + notes (include methodology)	• Goal of decreasing risk in different scenarios for individual decisions • Want to look at wider scale events to help the decision • Looks at overall market movement to help assess the movement of a certain stock • Based on past returns and volatility • Simulated on previous stock market data • Calculate relation between stock and the market overall • Creates a probabilistic outcome map • Demonstrated a profit in most cases
Research Question/Problem/ Need	The goal of this paper was to make and test a method for reducing risk in a decision-making process, utilizing the overall movement of the stock market to assess decisions.
Important Figures	 Download: Download full-size image Fig. 3. Decision-making for stock trading: (a) buy case, (b) sell case.
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	Would this work in other markets? How does this strategy compare to something like buy and hold? How will it work in a more volatile market?

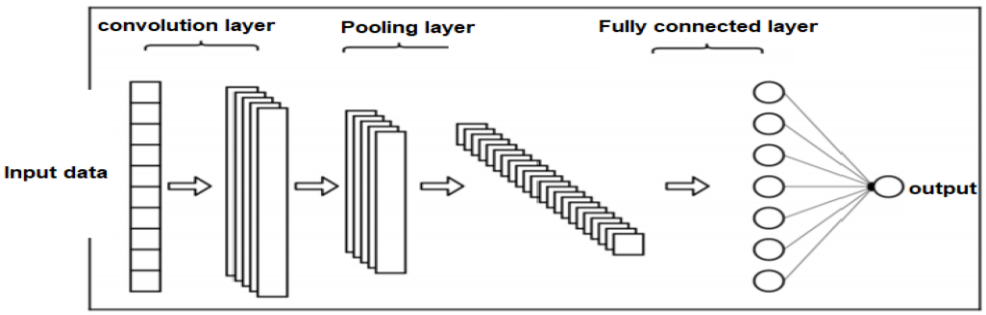
Article #13 Machine learning techniques and data for stock market forecasting: A literature review Notes:

Source Title	Machine learning techniques and data for stock market forecasting: A literature review
Source citation (APA Format)	Kumbure, M., Lohrmann, C., Luukka, P., & Porras, J. (2022). Machine learning techniques and data for stock market forecasting: A literature review. *Expert Systems with Applications, 197*. https://doi.org/10.1016/j.eswa.2022.116659
Original URL	**https://www.sciencedirect.com/science/article/pii/S0957417422001452**
Source type	Article
Keywords	
#Tags	#Trading Algorithms #Machine Learning #Model Evaluation
Summary of key points + notes (include methodology)	• This is a literature review on machine learning algorithms used for stock market investing • It first delves into a discussion of the various types of ML algorithms that are used on the stock market including Support vector machines and decision trees • It then moves onto discussing the features these machine learning models can utilize in order to make their decisions • It then moves onto discussing the performance metrics that can be used to measure the success of the model • Finally, it discusses the limitations and challenges of such models, such as overfitting and the changing nature of financial markets
Research Question/Problem/ Need	This attempted to compile previous work done about machine learning algorithms used in stock market investing.

Important Figures	 How an ML model is designed
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	How do the different types of ML algorithms compare to each other? What were the most important features based on previous work? What was the precision, recall, overall accuracy trade-off in general?

Article #14 Notes: Framework for Predicting and Modeling Stock Market Prices Based on Deep Learning Algorithms

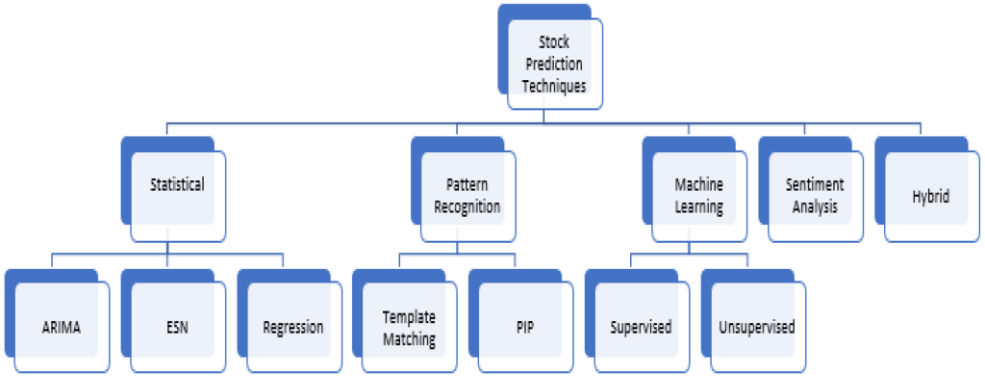
Source Title	Framework for Predicting and Modeling Stock Market Prices Based on Deep Learning Algorithms

Source citation (APA Format)	Aldhyani, T. H. H., & Alzahrani, A. (2022). Framework for Predicting and Modeling Stock Market Prices Based on Deep Learning Algorithms. *Electronics, 11*(19). https://doi.org/10.3390/electronics11193149
Original URL	**https://www.mdpi.com/2079-9292/11/19/3149**
Source type	Article
Keywords	
#Tags	Trading Algorithms
Summary of key points + notes (include methodology)	• The overall goal was to develop a time series model using deep learning algorithms to predict future stock market prices in order to assist in decision making • Issues due to stock market price correlation to one another • Deep learning somewhat helps address this important downside of other methods • The model aims to use the new technology available to reduce mitigate risk • The model is trained using historical data, and specifically time series of historical data • Aims to help investors make better-informed choices
Research Question/Problem/ Need	How can deep learning algorithms be utilized to predict stock market prices with high accuracy?
Important Figures	 Deep learning algorithm design
VOCAB: (w/definition)	
Cited references to follow up on	

Follow up Questions	What were the features that are taken from the time series? What were the bounds of the time series? How does the model handle very severe world events, especially those that specifically affect one industry?

Article #15 Notes: Stock Market Analysis: A Review and Taxonomy of Prediction Techniques

Source Title	Stock Market Analysis: A Review and Taxonomy of Prediction Techniques
Source citation (APA Format)	Shah, D., Isah, H., & Zulkernine, F. (2019). Stock Market Analysis: A Review and Taxonomy of Prediction Techniques. *International Journal of Financial Studies, 7*(2). https://doi.org/10.3390/ijfs7020026
Original URL	**https://www.mdpi.com/2227-7072/7/2/26**
Source type	Article
Keywords	
#Tags	#Trading Algorithms #Method Analysis
Summary of key points + notes (include methodology)	• Difficulties in predicting short-term price fluctuations due to incredibly large number of variables • Short term pricing is much more strongly affected by investor sentiment news interpretation with a lot of complexity • Longer term change may be more predictable even when accounting for the expected market growth • Especially emphasized are the abilities and potential of Machine learning algorithms in analysis and forecasting of stock prices • Focused on sorting different methods by the things they were strongest at • Finally discussed the need for more flexible models and a hybrid approach
Research Question/Problem/ Need	Which methods are most effective for predicting the changes in the stock market, and how can these be classified and utilized to create more reliable models?

Important Figures	 Tree of the components of stock market predictions
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	How does quality affect the infectiveness of models? How has the effectiveness of ML algorithms improved as the field has become more advanced? What are the new developments we could see that would change this field further?

Article #16 Notes: Short-Term Stock Price Forecasting using exogenous variables and Machine Learning Algorithms

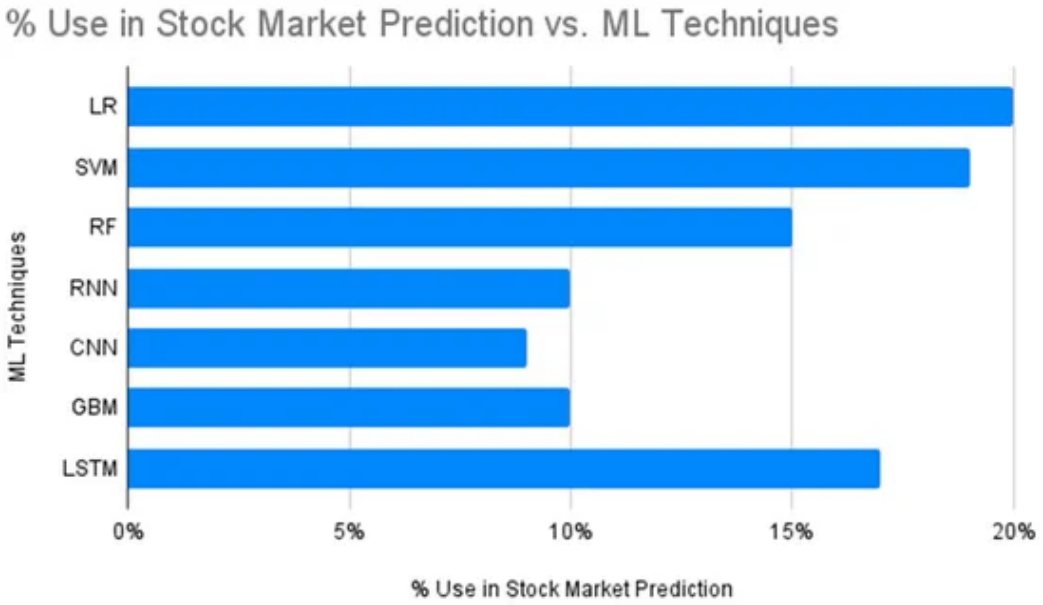
Source Title	Short-Term Stock Price Forecasting using exogenous variables and Machine Learning Algorithms
Source citation (APA Format)	Wong, A., Whang, S., Sagre, E., Sachin, N., Dutra, G., Lim, Y.-W., Hains, G., Khmelevsky, Y., & Chang Zhang, F. (2023). Short-Term Stock Price Forecasting using Exogenous Variables and Machine Learning Algorithms. *ICICyTA, 13*(4). https://doi.org/10.1109/ICICyTA60173.2023.10428814

Original URL	**https://hal.u-pec.fr/hal-04201060v1/document**
Source type	Article
Keywords	
#Tags	#Trading Algorithms #Machine Learning
Summary of key points + notes (include methodology)	• Looked at four different types of machine learning models, including XGBoost, Random Forest, MLP and SVP • The training data had 240 days of stock market activity from 2020-2022 • Attempted to account for the influence of outside(exogeneous) variables • Some examples of these variables included inflation indicators such as gold and oil prices as well as treasury bond interest rates and index values • Looked at the values to assess by and found that XGBoost was slightly outperforming other models but required far more computing resources • Models still had a lot of room for growth, both in parameter tuning and the variables used
Research Question/Problem/ Need	Which of a number of machine learning algorithms is most effective when attempting to make short term price predictions in the face of exogenous factors?
Important Figures	$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2}$$ $$MAPE = \frac{1}{n}\sum_{i=1}^{n}\frac{\lvert Y_i - \hat{Y}_i\rvert}{\lvert Y_i\rvert}$$ $$MPE = \frac{1}{n}\sum_{i=1}^{n} max(\hat{Y}_i - Y_i, 0)$$ Three different ways of measuring error
VOCAB: (w/definition)	

Cited references to follow up on	
Follow up Questions	How do these algorithms perform when the market is very volatile? How do they compare with more traditional methods that don't take into account exogenous factors? How well do the findings transfer to stocks from other exchanges?

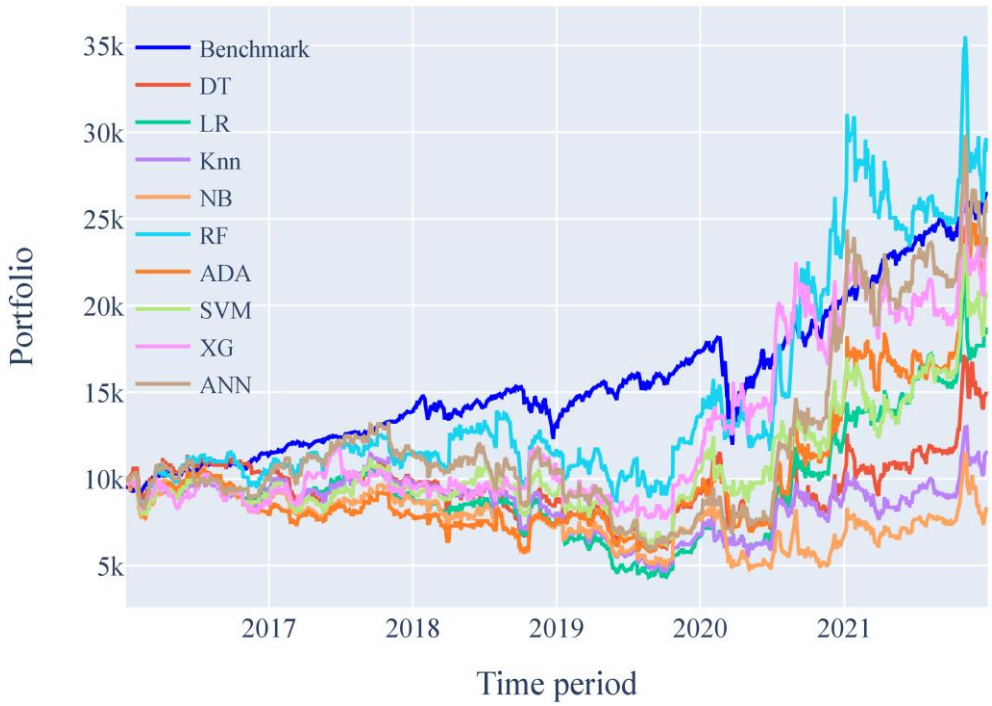
Article #17 Notes: Emerging Trends in AI-Based Stock Market Prediction: A Comprehensive and Systematic Review

Source Title	Emerging Trends in AI-Based Stock Market Prediction: A Comprehensive and Systematic Review
Source citation (APA Format)	Jain, R., & Vanzara, R. (2023). Emerging Trends in AI-Based Stock Market Prediction: A Comprehensive and Systematic Review. *Engineering Proceedings, 56*(1). https://doi.org/10.3390/ASEC2023-15965
Original URL	**https://www.mdpi.com/2673-4591/56/1/254**
Source type	Article
Keywords	
#Tags	Trading Algorithms
Summary of key points + notes (include methodology)	• This paper tries to give a comprehensive overview of the various AI techniques utilized in trading including NLP and sentiment analysis techniques • One of the tools highlighted is deep learning, which van be used to uncover multi-dimensional relationships which were difficult to uncover before • Another prevalent technique is the utilization of NLP tools for gauging the sentiment around a stock • Also, RL models can help by encouraging the model to learn from past mistakes

	• There were also a number of challenges identified with an AI approach • These included the expensive computations necessary for AI and the difficulty with making sure it doesn't overfit • There are also issues with how easy it is to make sure these algorithms are compliant with regulations
Research Question/Problem/ Need	The goal of this work was to evaluate the current AI techniques used for stock market prediction and trying to determine their strengths, weaknesses and limitations.
Important Figures	 Shows the usage of each type of ML technique as a percent of total
VOCAB: (w/definition)	CNN-Convolusional neural network LSTM- long short-term memory a DL technique SVM-Support vector machine
Cited references to follow up on	
Follow up Questions	How will using multiple AI improve the performance of the model? Could using multiple models potentially create new vulnerabilities due to their interaction? How well can AI be adjusted to radical shifts in market behavior?

Article #18 Notes: A performance comparison of machine learning models for stock market prediction with novel investment strategy

Source Title	A performance comparison of machine learning models for stock market prediction with novel investment strategy
Source citation (APA Format)	Khan, A. H., Shah, A., Ali, A., Shahid, R., Zahid, Z. U., Sharif, M. U., Jan, T., & Zafar, M. H. (2023). A performance comparison of machine learning models for stock market prediction with novel investment strategy. *PLOS ONE, 18*(9). https://doi.org/10.1371/journal.pone.0286362
Original URL	**https://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0286362**
Source type	Article
Keywords	
#Tags	Trading Algorithms
Summary of key points + notes (include methodology)	• There was a new strategy implemented in order to try to measure the efficiency of the nine ML models in the testing • ML models can help improve prediction accuracy to an extent, but anything even close to 100% is impossible due to the complexity of the market • Study proposed some techniques including merging ML models in order to improve the performance of the ML models
Research Question/Problem/ Need	The goal of this study was to predict which types of ML models most accurately predict the movement of the stock market.

Important Figures	 Performance of some of the models when compared to the benchmark
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	How would testing this in real-life impact performance? Can it be integrated with non-ML strategies for better asset management? How do outside sources affect the performance of the model in extreme circumstances?

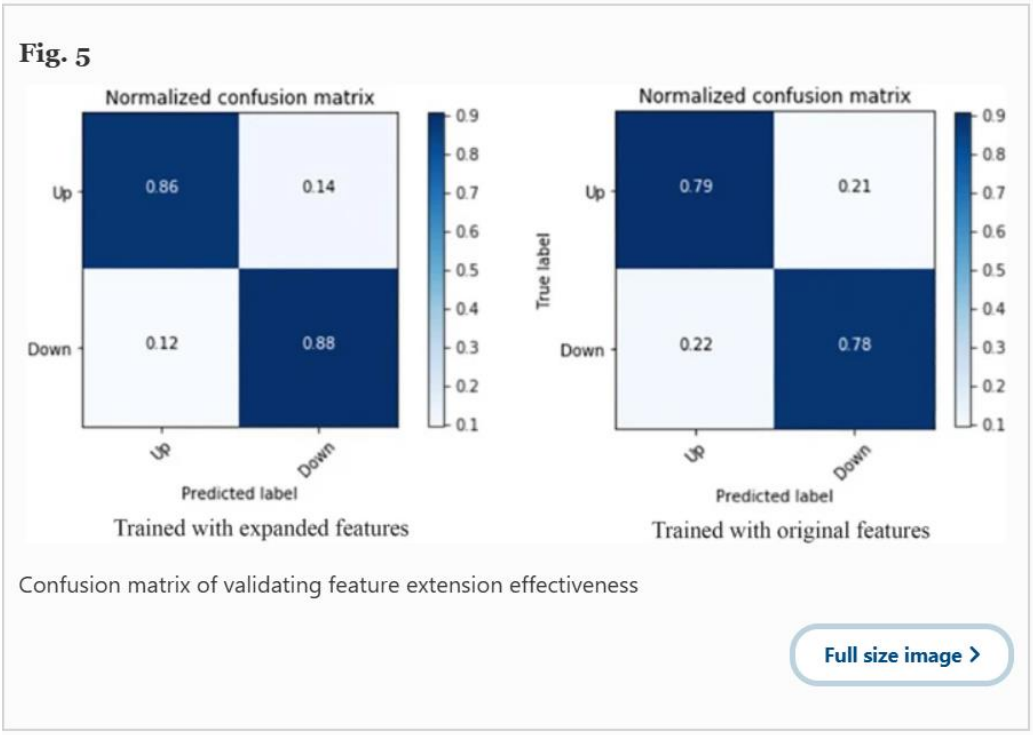
Article #19 Notes: Forecasting Stock Market Prices Using Machine Learning and Deep Learning Models: A Systematic Review, Performance Analysis and Discussion of Implications

Source Title	Forecasting Stock Market Prices Using Machine Learning and Deep Learning Models: A Systematic Review, Performance Analysis and Discussion of Implications

Source citation (APA Format)	Sonkavde, G., Dharrao, D. S., Bongale, A. M., Deokate, S. T., Doreswamy, D., & Bhat, S. K. (2023). Forecasting Stock Market Prices Using Machine Learning and Deep Learning Models: A Systematic Review, Performance Analysis and Discussion of Implications. *International Journal of Financial Studies, 11*(3). https://doi.org/10.3390/ijfs11030094
Original URL	**https://www.mdpi.com/2227-7072/11/3/94**
Source type	Article
Keywords	
#Tags	Trading Algorithms
Summary of key points + notes (include methodology)	• A large scale analysis based mainly on previous research of different ML models • Showed that even more complex DL models often outperformed traditional ML models • Prediction quality was also heavily impacted by the quality and quantity of the data that was inputted, suggesting that more features of data may improve performance significantly • Although ML is rapidly getting stronger, overfitting, resource costs and sudden variations in the stock market can still demonstrate some incompleteness
Research Question/Problem/ Need	The goal of this study was to evaluate different ML algorithms, specifically trying to see what conditions are better for the performance of which models.
Important Figures	
VOCAB: (w/definition)	Deep Learning methods- These are methods that are used often in science, and can be used to handle very complex patterns and large sets of data
Cited references to follow up on	
Follow up Questions	How were the algorithms and datasets in this article chosen? What were the biggest limitations of DL models? How could the black box of these algorithms open up?

Article #20 Notes: Short-term stock market price trend prediction using a comprehensive deep learning system

Source Title	Short-term stock market price trend prediction using a comprehensive deep learning system
Source citation (APA Format)	Shen, J., & Shafiq, M. O. (2020). Short-term stock market price trend prediction using a comprehensive deep learning system. *Journal of Big Data*, *7*(1). https://doi.org/10.1186/s40537-020-00333-6
Original URL	**https://journalofbigdata.springeropen.com/articles/10.1186/s40537-020-00333-6**
Source type	Article
Keywords	
#Tags	Trading Algorithms
Summary of key points + notes (include methodology)	• This model was focused on working with the Chinese stock market which is different from other research • A lot of different features were taken from the data through a variety of different techniques • The model mainly used LSTM networks in order to train on the dataset • The model was evaluated against other machine learning methods, where it demonstrated superior performance to traditional models
Research Question/Problem/ Need	The main goal of this project was to develop a deep learning model that predicts the short-term price change of the stock market by using a very large number of features.

Important Figures	 Shows two different precision/recall charts for stock price movement
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	How does the inclusion or exclusion of certain indicators impact the model? What are some of the challenges this model will face in the real world? Could other deep-learning methods preform better?

Patent #1 Notes: AUTOMATED STRATEGIES FOR INVESTMENT MANAGEMENT

Article notes should be on separate sheets

Source Title	AUTOMATED STRATEGIES FOR INVESTMENT MANAGEMENT
Source citation (APA Format)	O'Shaughnessy, J. (1999). *AUTOMATED STRATEGIES FOR INVESTMENT MANAGEMENT* (U.S. Patent No. 5,978,779). U.S. Patent and Trademark Office. https://patentimages.storage.googleapis.com/62/4f/32/4d55d840dc8f0e/US5978778.pdf

Original URL	https://patentimages.storage.googleapis.com/62/4f/32/4d55d840dc8f0e/US5978778.pdf
Source type	Article
Keywords	
#Tags	
Summary of key points + notes (include methodology)	This invention uses a model to select 50 corporate stocks from the market to invest in. The stocks are bought in equal proportion and based on two different models. The growth model picks based on growth over the last year, and the value model picks based on dividends paid out to shareholders. After the end of a certain time frame (1 year) the money is collected and then reinvested by the same exact algorithm, making it a recursive algorithm. The algorithm appears to show some pretty good investment results even without ML. • Actual working algorithm • Interesting results • A bit outdated
Research Question/Problem/ Need	Creating a model for making a diverse and profitable market portfolio.
Important Figures	
VOCAB: (w/definition)	A rolling average, also known as a moving average, is a statistical calculation that continuously updates the average of a data set to include all of the data up to that point
Cited references to follow up on	
Follow up Questions	How well would the same algorithm work today? Could using only one of the models be more efficient? What are the potential risks with this method?

Patent #2 Notes: Stock Market Trading Systems Creation Algorithm

Article notes should be on separate sheets

Source Title	Stock Market Trading Systems Creation Algorithm
Source citation (APA Format)	Serpico, V. & Brunner, M. (2005) *Stock Market Trading Systems Creation Algorithm* (U.S. Patent Application Publication No. 0086150). U.S. Patent and Trademark Office. https://patentimages.storage.googleapis.com/41/3f/f7/c6af66b5362e39/US20050086150A1.pdf
Original URL	https://patentimages.storage.googleapis.com/41/3f/f7/c6af66b5362e39/US20050086150A1.pdf
Source type	Article
Keywords	
#Tags	
Summary of key points + notes (include methodology)	This is mainly a general algorithm used for creating a specific algorithm for trading a certain security. This idea focuses on iteratively discarding features that cause unprofitable decisions repeatedly, until you are left with an effective model for that security. This algorithm is more effective than other searches for an optimal algorithm because it quickly discards any unprofitable features.
Research Question/Problem / Need	Developing a way for profitably trading a certain security.
Important Figures	
VOCAB: (w/definition)	Trading system - a set of rules that formulate buy and sell signals without any ambiguity or any subjective elements
Cited references to follow up on	
Follow up Questions	How efficient would it be at trading things other than securities? What is the chance of a very impractical model being created? How much computation is required to find this model?