Project Notes:

Project Title:

Name: Andrew Brown

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
How does machine learning work?	https://www.youtube.com/watch?v=hfMk-kjRv4c	Youtube.com	9-14-2024

Literature Search Parameters:

These searches were performed between 8/20/2024 and XX/XX/2019.
List of keywords and databases used during this project.

Database/search engine	Keywords	Summary of search

Tags:

Tag Name	

Article #1 Notes: AI Stock Market Prediction Model

Article notes should be on separate sheets

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Source Title	**A Novel AI-Based Stock Market Prediction Using Machine Learning Algorithm**
Source citation (APA Format)	M, I., Ahmad, S., Jha, S., Alam, A., Yaseen, M., & Abdeljaber, H. A. M. (2022). A Novel AI-Based Stock Market Prediction Using Machine Learning Algorithm. *Scientific Programming*, *2022*, 1–11. https://doi.org/10.1155/2022/4808088
Original URL	https://onlinelibrary.wiley.com/doi/10.1155/2022/4808088
Source type	Academic Journal
Keywords	Stock market, Artificial intelligence, machine learning
#Tags	#Stock-Market #AI #Artificial Intelligence #MLA
Summary of key points + notes (include methodology)	This article discusses the creation of an AI deep learning program that uses data from the National Stock Exchange to make recommendations to a user on what stock to purchase. The data was updated on a daily basis and included the start and end prices as well as the high price, low price, average price, and many more pieces of data. Towards the end of the paper, they show the program functioning but do not conclusively analyze the program's functionality.
Research Question/Problem/ Need	Can AI be given data regarding the stock market and user preferences to make trading suggestions to the user that will benefit them in the long run?
Important Figures	Figure 1: Describes what kinds of data were needed for a program like this to run
VOCAB: (w/definition)	Neural Network: A network of interconnected nodes meant to digitally simulate a brain
Cited references to follow up on	
Follow up Questions	Could a similar program be created to analyze different trading strategies such as high versus low risk? How could this program work with other stock exchanges to analyze which is more profitable at a given time? How would this program function in the short term versus the long term?

Article #2 Notes: 2-DOF Prosthesis with able-bodied subjects

Article notes should be on separate sheets

Source Title	**Myoelectric Control Performance of Two Degree of Freedom Hand-Wrist Prosthesis by Able-Bodied and Limb-Absent Subjects**
Source citation (APA Format)	Zhu, Z., Li, J., Boyd, W., Martinex-Luna, C., Dai, C., Wang, H., Wang, H., & Huang, X. (2022b). Myoelectric Control Performance of Two Degree of Freedom Hand-Wrist Prosthesis by Able-Bodied and Limb-Absent Subjects. *IEEE Xplore*, *30*, 893–904. https://doi.org/10.1109/TNSRE.2022.3163149
Original URL	https://ieeexplore.ieee.org/document/9744113
Source type	Journal Article
Keywords	Prosthesis control, EMG-force, EMG signal processing, electromyogram, myoelectric control
#Tags	#Prosthesis, #Able-Bodied, #Orthotic
Summary of key points + notes (include methodology)	This study investigates an interesting topic which I will further discus later but the most interesting part to me is how they tested their programs on abled bodied patients, as employing similar methods may allow me to do the same. To do this, researchers connected 16 EMG sensors to the forearms of able-bodied patients, simulating the data that could be received by limb-absent patients. They then ran through a set of calibration tests to calibrate their MapCon and DirCon programs shown in figure 2 which I plan to take inspiration from for my design. They found that when only one degree of freedom was required for a task, it was much better to use the one degree of freedom program as it required less guesswork on the programs part.
Research Question/Problem/ Need	What is the best way to map a two degree of freedom prosthetic hand and when is it best to use two degree of freedom mapping?
Important Figures	Fig. 2, Fig 6
VOCAB: (w/definition)	DOF – Degree of freedom; Electromyogram – sensor that detects electrical pulses from muscle movements; Sequential Control (SeqCon) - Control method that uses pattern recognition to allow for multiple DOF control without a switch function;

Cited references to follow up on	
Follow up Questions	• How were MapCon, DurCon, and SeqCon programed to interpret muscle contractions? • How does one easily make a program that could swap mapping software for the situation? • How could a regression-based model differ in efficacy compared to a machine learning based model?

Article #3 Notes: Application of real-time machine learning to myoelectric prosthesis control: A case series in adaptive switching

Article notes should be on separate sheets

Source Title	**Application of real-time machine learning to myoelectric prosthesis control: A case series in adaptive switching**
Source citation (APA Format)	Edwards, A. L., Dawson, M. R., Herbert, J. S., Sherstan, C., Sutton, R. S., Chan, K. M., & Pilarski, P. M. (2016). Application of real-time machine learning to myoelectric prosthesis control: A case series in adaptive switching. *Prosthetics and Orthotics International*, *40*(5), 573–581. https://doi.org/10.1177/0309364615605373
Original URL	sagepub.co.uk/journalsPermissions.nav
Source type	Peer Reviewed Journal
Keywords	Upper limb prosthetics, prosthetics, prosthetic design, rehabilitation of amputees, rehabilitation
#Tags	#Machine Learning, #ML, #Prosthetic, #Below elbow
Summary of key points + notes (include methodology)	This investigates what the authors call “adaptive switching” which is a ML model that is meant to allow prosthetic users to switch between the active muscle without having to do more than state their intentions through their movement. Previously, as mapping software could not distinguish well between what muscle you intended to move, people would have to tell it to switch, typically with the contraction of a biceps muscle. This took time and made myoelectric prosthetics difficult to use. The researchers used machine learning to detect when a person was to switch muscles, allowing it to be done more intuitively. They performed two tests, using both amputees and able-bodied persons. The two tests included a test where the subjects had to close the hand, rotate it to the side, open and close the hand, and rotate it back for three minutes and a test where the subjects moved 5 balls from one side of a box to the other as fast as possible. The test revealed that adaptive

	switching allowed less switches to be made as well as less time taken per switch, proving the innovation worthy.
Research Question/Problem/ Need	Can ML help to create an adaptive switching algorithm that would allow myoelectric prosthetics to be easier and more intuitive to use.
Important Figures	Figure 1, figure 3, figure 4
VOCAB: (w/definition)	Adaptive switching: A program that switches between the muscles being used automatically without specifically expressed will from the amputee.
Cited references to follow up on	Scheme E and Englehart KB. Electromyogram pattern recognition for control of powered upper-limb prostheses: state of the art and challenges for clinical use. J Rehabil Res Dev 2011; 48(6): 643–660.
Follow up Questions	• Can machine learning be applied to more than adaptive switching? To the mapping program itself? • How was the machine learning model trained? • What type of machine learning model was used?

Article #4 Notes: Neural Networks and Deep Learning Chapter 1

Article notes should be on separate sheets

Source Title	Neural Networks and Deep Learning
Source citation (APA Format)	Nielson, M. (n.d.-b). CHAPTER 1Using neural nets to recognize handwritten digits. In *Neural Networks and Deep Learning*. essay. Retrieved from http://neuralnetworksanddeeplearning.com/chap1.html.
Original URL	http://neuralnetworksanddeeplearning.com/chap1.html
Source type	Book
Keywords	Machine Learning, back propagation,
#Tags	#Machine Learning, #ML, #Data analysis, #Image processing,
Summary of key points + notes (include methodology)	• In perceptron models, data is taken in in the form of ones and zeroes and moves through the network, taking the sum of the weight times the previous value, all being added to the bias of a perceptron. These weights and biases can be changed to affect the outcome of the model • A neural network acts the same, but each neuron can be BETWEEN one and zero, making them much shorter and more powerful • To calculate the number between one and zero, the network puts the weighted sum through a sigmoid function (This has more recently been changed to an R function in most models, many do not know why but R functions are observed getting better results • A network works by having every node in a layer connected to every node in the last, meaning every node affects every node ahead of it. This is known as a feed forward network •
Research Question/Problem/ Need	Not Applicable
Important Figures	

VOCAB: (w/definition)	Perceptron: a node that can hold a number 1 or 0 depending on what its value is closest to Neuron: Like a perceptron but hold values between 1 and 0, more flexible and useful Weighted sum: The sum of all the weights and biases going into a neuron Activation function: function done to the weighted sum to force it to show a value between 1 and 0 Sigmoid: example of an activation function Hidden layers: layers not visible to the user (not input or output layers) that perform most of the calculation. The more hidden layers, the more accurate but also more resource intensive.
Cited references to follow up on	Not Applicable
Follow up Questions	• What is back propagation and how does it work? • How do you pick the right starting point for an algorithm? • How do you choose what algorithm to use (i.e. recursive, feedforward, etc)

Article #5 Notes: Game theory can make AI more correct and efficient

Article notes should be on separate sheets

Source Title	Game Theory Can Make AI More Correct and Efficient
Source citation (APA Format)	Nadis, S. (2024, May 9). *Game theory can make AI more correct and efficient* | Quanta Magazine. Retrieved July 10, 2024, from https://www.quantamagazine.org/game-theory-can-make-ai-more-correct-and-efficient-20240509/
Original URL	https://www.quantamagazine.org/game-theory-can-make-ai-more-correct-and-efficient-20240509/
Source type	Online Source
Keywords	
#Tags	
Summary of key points + notes (include methodology)	
Research Question/Problem/ Need	
Important Figures	
VOCAB: (w/definition)	This article discusses recent research done by an MIT doctoral student, Steve Nadis, regarding the use of game theory to improve the accuracy of Large Language Models (LLMs), the backbones of AIs like ChatGPT. Nadis realized when using LLMs a different answer to questions would be given when using the generator, which is used to answer open ended questions, and the discriminator, which is used when options for the answer are provided. Nadis' strategy was to use game theory to force these two sides of the LLM to agree with each other. His game was created to reward the two sides with a point when they reached a consensus and deduct a point when they disagreed. Nadis did this by first posing a question to the generator then telling the generator to answer correctly or incorrectly. He would then provide the discriminator with the same question and ask it if the generator answered correctly, awarding a point if the discriminator guesses correctly. Each question

	would be run 1000 times to ensure the generator and discriminator could learn from their past mistakes. This is related to the areas I want to research this year as it deals with computer science, specifically in the areas of AI. Over the last year I have found myself more interested in logic and reasoning as well as computer science. Thus I would like to incorporate them into my project much like Nadis.
Cited references to follow up on	
Follow up Questions	

Article #6 Notes: Neural Networks

Article notes should be on separate sheets

Source Title	Neural Networks
Source citation (APA Format)	Munro, P. (2013). Neural Networks. In K. L. Lerner & B. W. Lerner (Eds.), Computer Sciences (2nd ed.). Macmillan Reference USA. https://link-gale-com.ezpv7-web-p-u01.wpi.edu/apps/doc/CV2642250174/SCIC?u=mlin_c_worpoly&sid=bookmark-SCIC&xid=41d2dac4
Original URL	https://link-gale-com.ezpv7-web-p-u01.wpi.edu/apps/doc/CV2642250174/SCIC?u=mlin_c_worpoly&sid=bookmark-SCIC&xid=41d2dac4
Source type	Journal article (Summer)
Keywords	
#Tags	
Summary of key points + notes (include methodology)	This article describes the basics for creating a neural network, the backbone of an AI. I discusses how neural networks are formed around nodes which are connected to each other and send signals, or data, to each other. This is meant to be a representation of how the human brains work with neurons sending inputs and outputs to each other. The article also discusses how there are some input, output, and in-between nodes. The connections between nodes can also have greater thicknesses, indicating their likeliness to occur, or they can be negative, representing a situation that cannot happen. All these tools used together can create a network of data that can be interpreted in a similar fashion to the human mind, thus creating artificial intelligence. This interests me as an area of research as I enjoy working with computers and software and want to take them to the extremes. Please note that I do not want to use AI as a tool but instead understand how it works to even possibly develop my own, researching its capabilities alongside other AI models.
Research Question/Problem / Need	
Important Figures	

VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	

Article #7 Notes: Real-Time EMG Based Pattern Recognition Control for Hand Prostheses: A Review on Existing Methods, Challenges and Future Implementation

Article notes should be on separate sheets

Source Title	Real-Time EMG Based Pattern Recognition Control for Hand Prostheses: A Review on Existing Methods, Challenges and Future Implementation
Source citation (APA Format)	Parajuli, N., Sreenivasan, N., Bifulco, P., Cesarelli, M., Savino, S., Niola, V., Esposito, D., Hamilton, T. J., Naik, G. R., Gunawardana, U., & Gargiulo, G. D. (2019). Real-time EMG based pattern recognition control for hand prostheses: A review on existing methods, challenges and future implementation. *Sensors*, *19*(20). https://doi.org/10.3390/s19204596
Original URL	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6832440/
Source type	Peer Reviewed Journal
Keywords	Machine Learning, DOF, Transradial
#Tags	#Review, #PR, #Myoelectric, #Transradial
Summary of key points + notes (include methodology)	• First extract features and reduce noise from the EMG signal • Select a window to process as a single moment is not useful data to the model, but if you make the window too long, the delay will be unpleasant. • Important features (which are defined by other code) are then extracted to be fed to the model • Data is then fed into the neural network and a classification program, to find what muscle results intend to move • As of this article being written, control was sequential and not proportional, however this has since been further researched and somewhat achieved.
Research Question/Problem/ Need	None. This is a review article.

Important Figures	Figure 1, Figure 2
VOCAB: (w/definition)	
Cited references to follow up on	Bi, L.; Feleke, A.; Guan, C. A review on EMG-based motor intention prediction of continuous human upper limb motion for human-robot collaboration. Biomed. Signal Process. Control 2019, 51, 113–127.
Follow up Questions	• How would a similar program apply to transhumeral amputations? • Do programs for transhumeral prosthetics exist? • Are there other regression models that can be tested for post processing?

Article #8 Notes: Evaluation of EMG pattern recognition for upper limb prosthesis control: a case study in comparison with direct myoelectric control

Article notes should be on separate sheets

Source Title	Evaluation of EMG pattern recognition for upper limb prosthesis control: a case study in comparison with direct myoelectric control
Source citation (APA Format)	Resnik, L., Huang, H. (Helen), Winslow, A., Crouch, D. L., Zhang, F., & Wolk, N. (2018). Evaluation of EMG pattern recognition for upper limb prosthesis control: A case study in comparison with direct myoelectric control. *Journal of NeuroEngineering and Rehabilitation*, *15*(1). https://doi.org/10.1186/s12984-018-0361-3
Original URL	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5856206/pdf/12984_2018_Article_361.pdf
Source type	Peer Reviewed Journal
Keywords	Direct Control, Pattern Recognition Control, Myoelectric, Prosthetics
#Tags	#Multi-DOF, #PR, #Patern Recognition, #DirCon, #Direct Control, Myoelectric
Summary of key points + notes (include methodology)	• Direct-control prosthetics have been the main commercial product since 1970. Pattern recognition prosthetics are now becoming more commercially available. • They want to compare the two control schemes to see if pattern recognition is actually easier to control and use for day-to-day tasks • They used 2-DOF hand prosthetics • They chose to use 2-DOF because those two degrees (hand OPN-CLS and wrist rotation) are the most often used by patients. • Each member of the study was fitted with their own prosthesis (all limb absent patients) and want to see an ocupational therapist to learn to use them • Once members began training, they were given the JTHF test to see their proficiency. Training stopped once results plateaued or 20h of training was received. • They found only a slight favor towards direct control throughout their data analysis and also found throughout training, there was more focus on retention over improvement

Research Question/Problem / Need	How do direct control algorithms compare to pattern-recognition based control algorithms in 2-DOF myoelectric prosthetics?
Important Figures	None
VOCAB: (w/definition)	Transracial amputation - Bellow the elbow amputation;
Cited references to follow up on	None
Follow up Questions	• How would these results have changed with 3-DOF? • Would 3-DOF be found useful by patients if they gained proficiency in it? • How could other tests have been used to see the effectiveness of the study?

Article #9 Notes: Myoelectric Pattern Recognition Outperforms Direct Control for Transhumeral Amputees with Targeted Muscle Reinnervation: A Randomized Clinical Trial

Article notes should be on separate sheets

Source Title	Myoelectric Pattern Recognition Outperforms Direct Control for Transhumeral Amputees with Targeted Muscle Reinnervation: A Randomized Clinical Trial
Source citation (APA Format)	Hargrove, L. J., Miller, L. A., Turner, K., & Kuiken, T. A. (2017). Myoelectric pattern recognition outperforms direct control for transhumeral amputees with targeted muscle reinnervation: A randomized clinical trial. *Scientific Reports*, *7*(1). https://doi.org/10.1038/s41598-017-14386-w
Original URL	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5653840/
Source type	Peer Reviewed Journal
Keywords	
#Tags	#amputation, #transhumeral, #PR, #TMR

Summary of key points + notes (include methodology)	• Nine male subjects with transhumeral amputations and the TMR procedure were selected but 1 had to leave due to back pain unrelated to the study
	• The 8 subjects were split into two groups, 1 testing direct control, the other testing pattern recognition control
	• Subjects took prosthetics home for a minimum of 6 weeks to train their use
	• Multiple tests were performed before and after the prosthetics were brought home (results from each denoted)
	  ○ SHAP: subjects had to grasp multiple objects
	  ▪ No different before home trial but afterwards, pattern recognition was almost twice as efficient
	  ○ Clothespin relocation: subjects had to move a clothespin from a horizontal bar to a vertical one

	▪ After home trial, 90.2 ± 39.6 seconds using pattern recognition compared to 137 ± 60.2 seconds using direct control ○ Box and Block Test: Subjects had to move blocks over a divider to another box ▪ No significant difference before or after home trial
Research Question/Problem/ Need	Is pattern recognition superior to direct control in myoelectric prosthetics for patients with transhumeral amputations and the TMR surgery.
Important Figures	Figure 2
VOCAB: (w/definition)	Transhumeral amputation – Above the elbow amputation; Targeted Muscle Reinnervation – when during an amputation, the nerve muscles are removed and then put back into better function with myoelectric prosthetics.
Cited references to follow up on	https://pubmed.ncbi.nlm.nih.gov/12048655/ (Describes standard testing practices)
Follow up Questions	• How would these results compare in abled bodied subject? • How would this PR compare to sequential control? • Is sequential control possible in transhumeral amputations?

Article #10 Notes: Movements classification system for transhumeral amputees using myoelectric signals

Article notes should be on separate sheets

Source Title	Movements classification system for transhumeral amputees using myoelectric signals
Source citation (APA Format)	Arcos Hurtado, E. F., Bermeo Varón, L. A., Sarria-Paja, M. O., Azcarate Carmona, J. A., Sarria Durán, J. C., & Villarejo-Mayor, J. J. (2024). Movements classification system for transhumeral amputees using myoelectric signals. *Biomedical Signal Processing and Control*, *98*. https://doi.org/10.1016/j.bspc.2024.106776
Original URL	https://pdf.sciencedirectassets.com/273545/1-s2.0-S1746809424X00117/1-s2.0-S1746809424008346/main.pdf?X-Amz-Security
Source type	Peer Reviewed Journal
Keywords	Myo signals, Pattern Recognition, Transhumeral amputation
#Tags	#Tranhumeral, #PR, #Limb absent
Summary of key points + notes (include methodology)	• The goal of this study was to use machine learning to classify movements for transhumeral amputees • Used a dataset from a subject to test the program • Used 4 EMGs on the bicep • Found between 60-80% accuracy for each movement
Research Question/Problem/ Need	Can ML be applied to transhumeral amputations?
Important Figures	None
VOCAB: (w/definition)	None
Cited references to follow up on	
Follow up Questions	• Could sensors placed on the triceps improve results? • Could other noise reduction methods have improved results? • Could this work with parallel control?

	• How would results differ for an abled body participant?

Article #11 Notes: Prosthetic Virtual Reality Training Interface and Related Methods

Article notes should be on separate sheets

Source Title	PROSTHETIC VIRTUAL REALITY TRAINING INTERFACE AND RELATED METHODS
Source citation (APA Format)	Hargrove, L. J., & Woodward, R. B. (n.d.). PROSTHETIC VIRTUAL REALITY TRAINING INTERFACE AND RELATED METHODS.
Original URL	https://patentimages.storage.googleapis.com/39/ef/40/8bb52ad96b76eb/US20180301057A1.pdf
Source type	Patent
Keywords	Virtual Reality, Myoelectric, Training
#Tags	#VR, #EMG, #PR, #AI
Summary of key points + notes (include methodology)	• Receives EMG signal that can then be processed • Connects to a VR headset to display a virtual arm • Virtual arm serves for training as it can show where your arm is intended to move to help map PR systems • Maps the prosthetic as a “controller” in the VR system • Includes a gamified element, turning the arm into a shooter for multiple fun games
Research Question/Problem/ Need	Given that prosthetics are hard to train and learn to use, can VR be used to help train them more efficiently?
Important Figures	Figure 3
VOCAB: (w/definition)	None
Cited references to follow up on	None
Follow up Questions	• How is the position calculated compared to the intended position while in the training process? • How could this change for a leg prosthetic?

	• How does this compare to standard training measures?

Article #12 Notes: Method of Fitting a Prosthetic Interface System Using Compliant Member

Article notes should be on separate sheets

Source Title	Method of Fitting a Prosthetic Interface System Using Compliant Members
Source citation (APA Format)	Martin, J. J. (n.d.). METHOD OF FITTING A PROSTHETIC INTERFACE SYSTEM USING COMPLAIANT MEMBERS.
Original URL	https://patentimages.storage.googleapis.com/4c/75/fa/fccb4ed14fcd6e/US20240277493A1.pdf
Source type	Patent
Keywords	
#Tags	
Summary of key points + notes (include methodology)	• Modular prosthetic sock as a cheaper and easier way to fit prosthetics • Uses modular parts that are able to be molded to the person • Modular parts include sensors that can be used by the prosthetic for control
Research Question/Problem/ Need	How can prosthetic socks be made modular to be more comfortable and cheaper for amputees to purchase?
Important Figures	
VOCAB: (w/definition)	None
Cited references to follow up on	None

Follow up Questions	

Article #13 Notes: A Systematic Review of EMG Applications for the Characterization of Forearm and Hand Muscle Activity during Activities of Daily Living: Results, Challenges, and Open Issues

Article notes should be on separate sheets

Source Title	A Systematic Review of EMG Applications for the Characterization of Forearm and Hand Muscle Activity during Activities of Daily Living: Results, Challenges, and Open Issues
Source citation (APA Format)	Jarque-Bou, N. J., Sancho-Bru, J. L., & Vergara, M. (2021). A Systematic Review of EMG Applications for the Characterization of Forearm and Hand Muscle Activity during Activities of Daily Living: Results, Challenges, and Open Issues. *Sensors*, *21*(9), 3035. https://doi.org/10.3390/s21093035
Original URL	https://www.mdpi.com/1424-8220/21/9/3035
Source type	Peer Reviewed Journal
Keywords	EMG, sEMG, synergies, activities of daily living
#Tags	#Review

Summary of key points + notes (include methodology)	• Introduces ADLs and why they are determined to be important.
	• Discusses importance of hand movement in ADLs
	• Discussed uses of EMGs
	  ○ Diagnoses of muscular diseases
	  ○ Mapping for myoelectric prosthetics
	• Muscle activations in different activities (This is the most applicable area to my project)

	○ Includes a table of all references and details on how they were used. This is where I got a significant amount of my references from. ○ To perform ADLs, thumb muscles had to contract cooperatively and only a few outlier muscles could contract independently. ▪ The studies that claimed this was very limited in the measured muscles and movements. ○ There is little difference in data received from 30 EMG pairs and 7 EMG pairs. ○ Problem with much EMG research is that EMG placement is not well defined in many articles
Research Question/Problem/ Need	None. This paper was a culmination of other research papers to provide a more concise review of their topics.
Important Figures	This papers only figure was a flowchart of their research process and not applicable to my project.
VOCAB: (w/definition)	Intrinsic Muscle: Muscle inside the object it helps to control (inside hand) Extrinsic Muscle: Muscle outside the object it helps to control (inside arm) Muscle synergies: Muscles that move together to predict motion
Cited references to follow up on	1. Johanson, M.E.; Valero-Cuevas, F.J.; Hentz, V.R. Activation patterns of the thumb muscles during stable and unstable pinch tasks. *J. Hand Surg. Am.* **2001**, *26*, 698–705. [Google Scholar] [CrossRef] [PubMed] [Green Version] 2. Winges, S.A.; Furuya, S.; Faber, N.J.; Flanders, M. Patterns of muscle activity for digital coarticulation. *J. Neurophysiol.* **2013**, *110*, 230–242. [Google Scholar] [CrossRef] [Green Version] 3. Johnson, S.S.; Mansfield, E. Prosthetic training: Upper limb. *Phys. Med. Rehabil. Clin. N. Am.* **2014**, *25*, 133–151. [Google Scholar] [CrossRef] [PubMed] 4. Jarque-Bou, N.J.; Vergara, M.; Sancho-Bru, J.L.; Roda-Sales, A.; Gracia-Ibáñez, V. Identification of forearm skin zones with similar muscle activation patterns during activities of daily living. *J. Neuroeng. Rehabil.* **2018**, *15*. [Google Scholar] [CrossRef] 5. Weiss, E.J.; Flanders, M. Muscular and Postural Synergies of the Human Hand. *J. Neurophysiol.* **2004**, *92*, 523–535. [Google Scholar] [CrossRef] [PubMed] 6.
Follow up Questions	

Article #14 Notes: A method for positioning electrodes during surface EMG recordings in lower limb muscles

Article notes should be on separate sheets

Source Title	A method for positioning electrodes during surface EMG recordings in lower limb muscles
Source citation (APA Format)	Rainoldi, A., et al. "A method for positioning electrodes during surface EMG recordings in lower limb muscles." *Journal of Neuroscience Methods*, vol. 134, no. 1, Mar. 2004, pp. 37–43, https://doi.org/10.1016/j.jneumeth.2003.10.014.
Original URL	https://www.sciencedirect.com/science/article/abs/pii/S0165027003003522?via%3Dihub
Source type	Peer Reviewed Journal
Keywords	
#Tags	
Summary of key points + notes (include methodology)	• Proper positioning of electrodes can be pivotal in proper data collection. • Positioning electrodes on different parts of the muscles result in widely different EMG readings • Make sure to claim age and SD of participants in trial. • Clean skin prior to positioning of electrode • Anatomical atlas was used in conjunction with contractions to find the muscle bellies.
Research Question/Problem	Develop a method for getting the most accurate reading from EMGs placed on lower limb muscles.

/ Need	
Important Figures	No figures corresponding to my research.
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	• How do the positions on lower limb muscles correspond to those of upper limb muscles? • Could similar techniques be applied when finding a position in my study? • Could an anatomical atlas be helpful in locating the correct muscles? •

Article #15 Notes: Placement of forearm surface EMG electrodes in the assessment of hand loading in manual tasks

Article notes should be on separate sheets

Source Title	Placement of forearm surface EMG electrodes in the assessment of hand loading in manual tasks
Source citation (APA Format)	Takala, E. P., & Toivonen, R. (2013). Placement of forearm surface EMG electrodes in the assessment of hand loading in manual tasks. *Ergonomics*, *56*(7), 1159–1166. https://doi.org/10.1080/00140139.2013.799235
Original URL	https://www.tandfonline.com/doi/full/10.1080/00140139.2013.799235
Source type	
Keywords	Electromyography, forearm, loaded tasks
#Tags	

Summary of key points + notes (include methodology)	• The subjects first did an isometric gripping test.
	  ○ Subjects held a dynamometer and squeezed with full strength.
	  ○ Subjects then squeezed with 10%, 20%, 40%, 50%, and 60% strength.
	  ○ This was repeated with the arm up, halfway up, and at rest.
	• Pushing box test
	  ○ Subjects pushed box 50cm
	  ○ Box was set to require 10, 20, 30, 40, and 50N of force
	  ○ This was done with the arm pronated and supinated
	• Lifting and Lowering
	  ○ 1, 2, 3, 4, and 5 kg dumbbells were lifted with the arm in the same 3 positions
	• Stappling
	  ○ Subjects stabled 20 pieces of paper 15 times
	  ○ Subjects perforated 20 pieces of paper 15 times
	• Isometric gripping test was repeated

	• 6 electrodes were position described in table 1 • Showed that positions of electrodes significantly changed readings between tasks • No combination of single electrodes gave a good fit for all tasks
Research Question/Problem/ Need	How does the position of EMG electrodes effect the estimation of forearm loading?
Important Figures	Table 1: Described the positions of the 6 electrode pairs used on each subject. Was used to ensure similar placement for all subjects.
VOCAB: (w/definition)	Dynameter: Device used to measure the strength of a movement, in this case a grip.
Cited references to follow up on	
Follow up Questions	

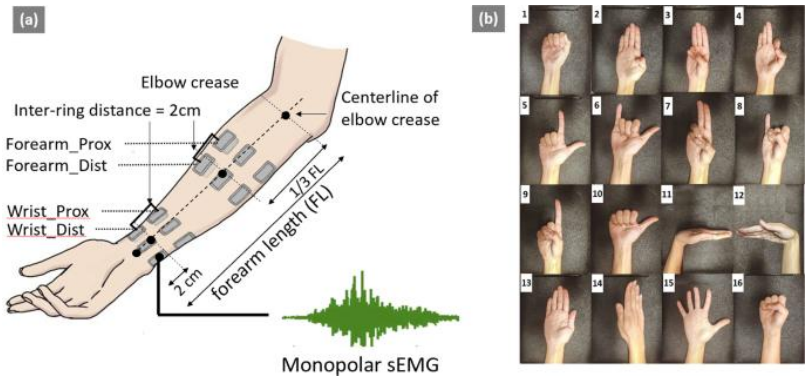
Article #16 Notes: Multi-day dataset of forearm and wrist electromyogram for hand gesture recognition and biometrics

Article notes should be on separate sheets

Source Title	Multi-day dataset of forearm and wrist electromyogram for hand gesture recognition and biometrics
Source citation (APA Format)	Pradhan, A., He, J., & Jiang, N. (2022). Multi-day dataset of forearm and wrist electromyogram for hand gesture recognition and biometrics. *Scientific Data*, *9*(1). doi:10.1038/s41597-022-01836-y
Original URL	https://www.nature.com/articles/s41597-022-01836-y
Source type	Journal Article/Database
Keywords	
#Tags	

Summary of key points + notes (include methodology)	• Acquisition Process (could be used similarly in my data acquisition)
	  ○ Subjects were sat in a comfortable chair and electrodes were placed on their arms
	  ○ TV was in front of the participant and showed visual instructions for the gestures to be made
	  ○ User did 8 runs (one to learn the motions) of all 17 positions including rest. 10-seconds of rest were given between positions
	• Signaled using “The sEMG signals were bandpass filtered between 10 Hz and 500 Hz using a fourth-order Butterworth filter. A notch filter of 60 Hz was employed to remove the powerline noise that might have affected the signal recording.”
	• This data could be used for testing of my model

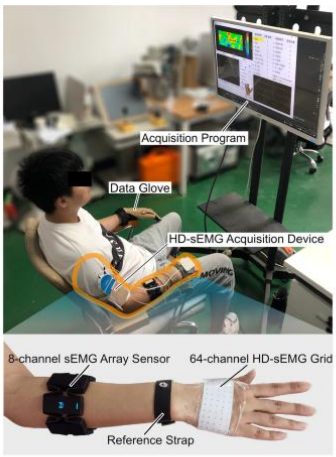
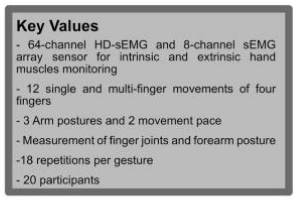
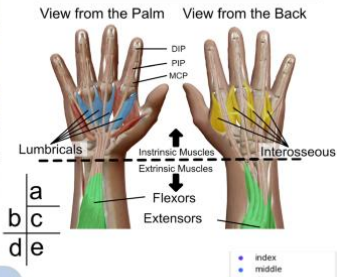
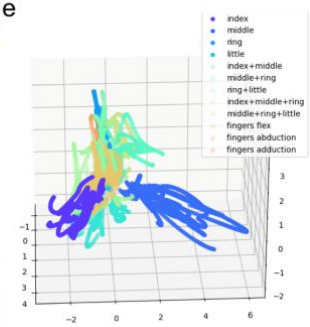
Research Question/Problem/ Need	Create a dataset of EMG readings over multiple days using many participants to make a widely applicable model

Important Figures	 Fig 1 (b): Shows a set of 16 hand gestures used to collect hand gesture EMG data. May be helpful in creating my set of training positions without wrist-based (pro-sup) movements.
VOCAB: (w/definition)	
Cited references to follow up on	Chen, L., Fu, J., Wu, Y., Li, H. & Zheng, B. Hand gesture recognition using compact CNN via surface electromyography signals. *Sensors* **20**, 672 (2020).
Follow up Questions	• Where exactly were the electrodes placed as the image does not account for them all? • Can spread still be measured without intrinsic muscles? • How were the muscle bellies located?

Article #17 Notes: Finger Movement Recognition via High-Density Electromyography of Intrinsic and Extrinsic Hand Muscles

Article notes should be on separate sheets

Source Title	Finger Movement Recognition via High-Density Electromyography of Intrinsic and Extrinsic Hand Muscles
Source citation (APA Format)	
Original URL	https://www.nature.com/articles/s41597-022-01484-2?fromPaywallRec=false
Source type	Peer reviewed journal
Keywords	
#Tags	
Summary of key points + notes (include methodology)	• Used non flat EMGs for the back of the hand (may not be as aimed towards my project) • High res sampling with 16 EMGs • Finger kinematics were tracked with glove to compare data • Data samples were cut and filtered • Data is publicly available and technically vetted (could be used for model testing?)
Research Question/Problem/ Need	Create a dataset of EMG measurements with high density EMG signals to help understand the synchronization of intrinsic and extrinsic muscles.

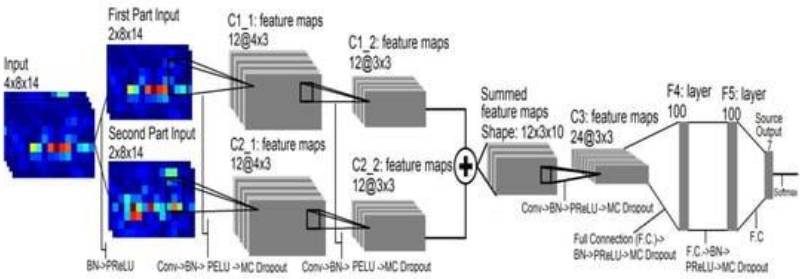
Important Figures	     I could use a similar experimentation apparatus as shows in the top left of this image.
VOCAB: (w/definition)	
Cited references to follow up on	None
Follow up Questions	

Article #19 Notes: Hand Gesture Recognition Using Compact CNN via Surface Electromyography Signals

Article notes should be on separate sheets

Source Title	Hand Gesture Recognition Using Compact CNN via Surface Electromyography Signals
Source citation (APA Format)	Chen, L., Fu, J., Wu, Y., Li, H., & Zheng, B. (2020). Hand Gesture Recognition Using Compact CNN via Surface Electromyography Signals. *Sensors*, *20*(3), 672. https://doi.org/10.3390/s20030672
Original URL	https://www.mdpi.com/1424-8220/20/3/672
Source type	Peer reviewed journal
Keywords	sEMG; convolution neural networks (CNNs); hand gesture recognition
#Tags	

Summary of key points + notes (include methodology)	• Current technology uses feature extraction
	  ○ Difficult to improve further
	• Researchers had the idea to use AI for better feature extraction
	  ○ Could do this by transforming the EMG data into an image
	• Takes in multiple feature sets from the EMG
	  ○ Time domain
	  ○ Enhanced TD
	  ○ Nina pro
	  ○ Samp en pipeline
	• Data was collected using standard methods
	• CNN was trained
	  ○ 60% of data for training, 10% for verification, 30% for testing
	  ○ 128 samples per training round
	• Model was 98% accurate
	• Shows that sEMGs can be used to recognize hand gestures
	• Shows that CNNs are an appropriate ML model to use for hand

	gesture recognition
Research Question/Problem/ Need	Can hand gestures be recognized using sEMG signals fed into a CNN?
Important Figures	 Figure 3: CNN structure. Due to its high accuracy, a similar structure could be used to classify data in my research.
VOCAB: (w/definition)	
Cited references to follow up on	None
Follow up Questions	How was the data organized into an image format? Would adding more sensors create better data or overfit the model? Do different EMGs give varying accuracies of data?

Article #20 Notes: EMG Forearm Position Prediction with OpenBCI Cyton and IDUN Dryodes using Brainflow and Tensorflow

Article notes should be on separate sheets

Source Title	EMG Forearm Position Prediction with OpenBCI Cyton and IDUN Dryodes using Brainflow and Tensorflow
Source citation (APA Format)	
Original URL	https://www.youtube.com/watch?v=y42TazR7UsU
Source type	Youtube video
Keywords	Cyton, Tensorflow, Brainflow
#Tags	#MLModel
Summary of key points + notes (include methodology)	• Data was taken in 10 second intervals at 250hz • Samples were filtered from 25hz to 130hz • Takes 4 possitions 20 times with 10 seconds of data at each • Data is put into list with overlap • Fed into tensorflow CNN model • This was the inspiration for the structure of my model and the code for the data sampling
Research Question/Problem/ Need	Creating a gesture recognition program using the cyton board and tensorflow.
Important Figures	Video
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	

Article #21 Notes:

Article notes should be on separate sheets

Source Title	
Source citation (APA Format)	
Original URL	
Source type	
Keywords	
#Tags	
Summary of key points + notes (include methodology)	
Research Question/Problem/ Need	
Important Figures	
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	

Article #22 Notes:

Article notes should be on separate sheets

Source Title	
Source citation (APA Format)	
Original URL	
Source type	
Keywords	
#Tags	
Summary of key points + notes (include methodology)	
Research Question/Problem/ Need	
Important Figures	
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	