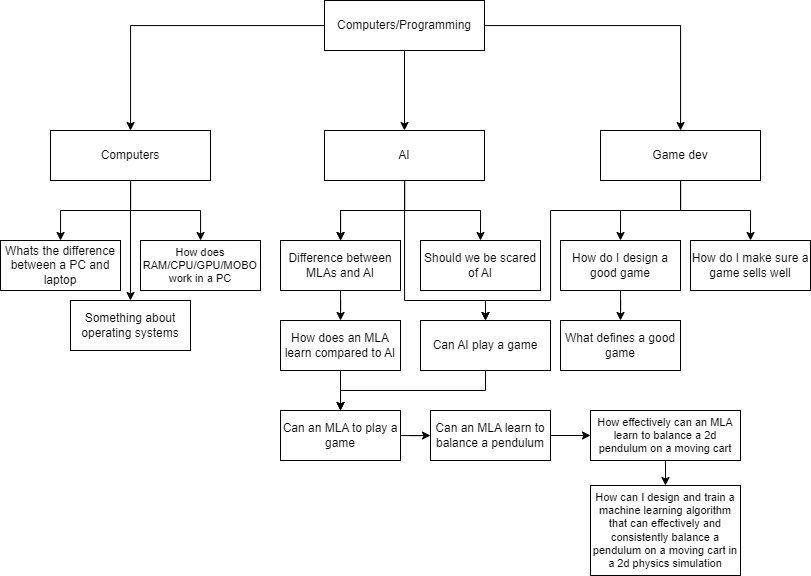
![A white background with black dots

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Description automatically generated](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAE0AAABOCAYAAABlnZseAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAJcEhZcwAADsMAAA7DAcdvqGQAAAC7SURBVHhe7dCxAYAwDMCwlP9/hg48EM/S4t3nvYaV5y8LpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpgWmBaYFpq3NfDrYBJgn4mvoAAAAAElFTkSuQmCC)When deciding on a topic for my research project, I had 3 general topics that I wanted to investigate. These were computers, AI and game design. I had decided on these because I am very interested in all 3, and have been interested in most of them since a young age.

Recently with the AI boom, I was inspired to look deeper into AI and similar digital structures. I ended up developing more questions in the AI branch of my flowchart than any others (*figure 1*). However, I incorporated game development into some of my AI questions which helped guide me to my final question.

Ultimately, I believe it was a good idea to not follow into computers or game development as computers would be either very simple (Whats the difference between a PC and laptop) or very in depth and would take far longer to make (How does an OS work). It’s a similar story for game development, as designing a “good game” is not a simple answer, no matter how specific the question is. Making sure a game sells well is also something that cannot be completed in the given time frame for the research project, as it would likely take at least 12 months of analysis to be worthwhile. (*figure 2*).

***Figure 1*** *– Thinking process and question development mindmap.*

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| --- | --- | --- |
| **General Topic** | **Strengths** | **Weaknesses** |
| Computers | * Wide range of topics * Career applicable knowledge | * Most options are either too easy or too hard to answer in a research project |
| AI | * Developing field of science * Applicable in other fields of knowledge | * Computer resource intensive * Technical knowledge barrier |
| Game development and design | * Largest interest of mine * Most creative options | * Timeframe is too large for RP * Games are difficult to develop |
| ***Figure 2*** *– Table consisting of strengths and weaknesses of general research topics* | | |

An interest in AI for me is the area of Machine Learning Algorithms (MLAs), which aren’t technically AI, but instead are closer to complex mathematical functions that turn some input values into output values.

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| **Questions** | **Strengths** | **Weaknesses** |
| Can AI learn to play games | * Combines 2 interests for me | * Closed question * Too broad, not specific |
| Can an MLA learn to balance a pendulum | * Slightly more specific * Gives me knowledge in how to apply MLAs in other situations | * Closed question * Unclear whether real world or simultaed pendulum * Requires running an MLA and potentially a physics simulation (very time and computer resource intensive) |
| How effectively can an MLA learn to balance a 2D pendulum on a moving cart | * Very specific * Gives me knowledge in how to apply MLAs in other situations | * Requires running an MLA and potentially a physics simulation * Unclear whether simulated or real world pendulum |
| **How can I design and train a machine learning algorithm that can effectively and consistently balance a pendulum on a moving cart in a 2d physics simulation** | * Very Specific * Gives me knowledge to apply in other applications * Directly explains the context of the simulation * Explains it is simulated and not real world | * Needs a physics simulation * Requires running an MLA over some times |
| ***Figure 3*** *– Table consisting of strengths and weaknesses of research question options* | | |

Learning how to apply MLAs has become a recent specific interest of mine, but they can be very indepth, and it can be difficult to apply them succesfully to have the intended result. Because of this, I have decided to ~~to~~ learn how to apply an MLA to a simple physics simulation and analyse its “learning” to figure out the best way to train an MLA for a specific use case.

Over the course of the research project, I will be developing my *Information and Communication Technology* skills and my *Critical and Creative Thinking*. This is because a significant portion of my research will be running and potentially programming a physics simulation that an MLA can learn from. Whether I use a pre-built simulation or start one from scratch, I will need to understand how an MLA works so I can pass in certain parameters so it can learn effectively. Additionally, I will have to think critically about what paramaters to pass in. I will also not be copying any code from others, meaning that I will have to think creatively about how I am going to approach a problem in the code.

My audience should be interested in learning how machine learning algorithms actually work, similar to myself. They would be interested in how they can apply this knowledge within their own programs or applications. My findings will be analytical over several different training methods, showing how each one would function and which is best for my use case. What I find will be presented in a table or a similar comparison. This is because it can easily convey what data I want to help decide on the best algorithm for my use case. The presented data will include the name of each method to train the MLA, what each method is in basic terms, the pros, cons, time to train, and a standard effectiveness based on a consistent amount of training time.This can be helpful for my target audience analyse which method they should use for their own application.

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| **Research Question** | **Sub-questions** (colour matches relevent part of the research question) |
| **How can I design and train a machine learning algorithm that can effectively and consistently balance a pendulum on a moving cart in a 2d physics simulation**  ***Figure 4*** *– A table consisting of sub questions* | How can I use or build an accurate 2D simulation that models a cart pendulum system realistically |
| What are the fundamental concepts and ideas of MLAs, and how do they learn |
| How can I choose and design the various functions of, and apply an MLA into my chosen cart pendulum simulation |
| How can I train and test an applied MLA to my cart pendulum simulation, ensuring it effectively and consistently balances the pendulum |

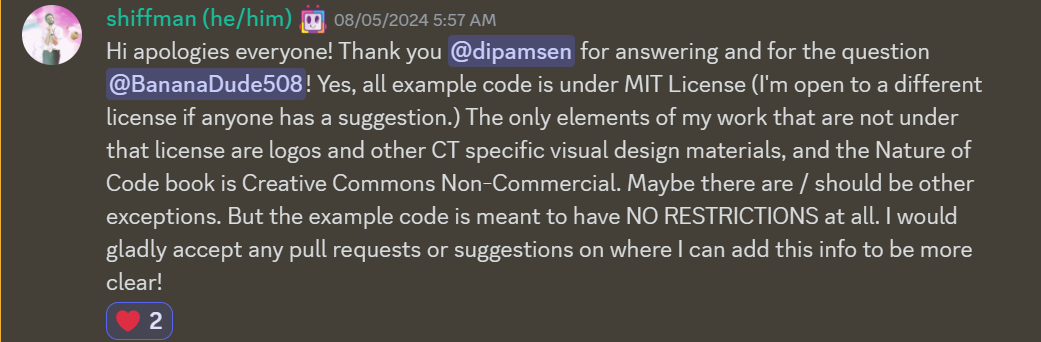
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Description automatically generatedMy 4 subquestions are derived from the main question, including how to use or build a physics simulation that accurately simulates a cart and pendulum, what is an MLA and the fundamentals behind one, how do I choose and design an MLA and its training methods, and how can I apply, train and test one. I chose these sub-questions becaues it addresses all the necessary points of my question, to help better both my and the readers understanding of what are MLAs and how to use them. Deciding on a physics simulation method is very important, because not only does my whole project rely on having one, but having one that works accurately to the real world is ideal. Researching and explaining what a machine learning algorithm is and how they work is vital to understanding how I can build them effectively. Knowing how they learn and adapt to different cases is what allows me to pass in the required and correct values for it to solve an issue. Being able to actually apply and train an MLA is very different from simply theorising about how they work, as they could evolve and develop in unexpected ways. Because of this, running the same algorithm several times could be beneficial as it could get stuck in a local minimum without looking for a global minimum. (*Figure 5*, local/global minimums will be further discussed in sub-question 3).

***Figure 5*** *– simple graph showing local and global minimums and maximums*

*https://en.wikipedia.org/wiki/Maximum\_and\_minimum*

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| **What archival sources are appropriate** | **Name of specific resource** | **Ethical Considerations** | |
| Existing physics simulations | [myPhysicsLab: Moveable Pendulum](https://www.myphysicslab.com/pendulum/moveable-pendulum-en.html) | [Linked source code](https://github.com/myphysicslab/myphysicslab/blob/master/src/sims/pendulum/MoveablePendulumApp.ts) has the [Apache-2.0](https://github.com/myphysicslab/myphysicslab/blob/master/LICENSE) license, which allows full commercial, private or patent use without trademark, or any form of liability and warranty. | |
| Youtube videos | [The Coding Train: "Coding Challenge #159: Simple Pendulum Simulation"](https://www.youtube.com/watch?v=NBWMtlbbOag) | [Linked source code](https://editor.p5js.org/codingtrain/sketches/SN-39sHAC) has no immediately visible license attatched, which means it likely falls under standard copyright. However, after talking to Daniel Shiffman (author), he said the code is under the MIT license. (Figure 7) | |
| [Pezzza's Work: "How to train simple AIs"](https://www.youtube.com/watch?v=EvV5Qtp_fYg&t) | No code used from videos. As per copyright law, unpatented ideas that are not a direct copy of someone elses IPs are free-use. This means any ideas and understanding gained from these videos have on restriction on use in the research project. | |
| [Green Code: “I Built a Neural Network from Scratch”](https://www.youtube.com/watch?v=cAkMcPfY_Ns) |
| Weights & Biases: “Introduction to machine [learning](https://www.youtube.com/playlist?list=PLD80i8An1OEHSai9cf-Ip-QReOVW76PlB)” |
| [CinemaGuess: “All Learning Algorithms Explained in 14 Minutes”](https://www.youtube.com/watch?v=BT6Aw6Q75Yg) |
| [3Blue1Brown: “Neural networks”](https://www.youtube.com/playlist?list=PLZHQObOWTQDNU6R1_67000Dx_ZCJB-3pi) |
| ***Figure 6*** *– A table consisting of archival sources and ethical considerations* | | |



***Figure 7*** *– An image confirming Shiffman’s claim of code being under the MIT license on discord.*

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| **What qualitative sources are appropriate** | **Name of specific resource** | **Credibility Considerations** | |
| Interviews | * UniSA lecturer (Talk to Prof. Stewart von Itzstein about who is best to talk to) | Need to wait for a response from Prof. Itzstein before I know who im talking to and their qualifications and credibility | |
| ***Figure 8*** *– A table consisting of qualitative sources and ethical considerations* | | |

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| --- | --- | --- |
| **What action research processes are appropriate** | **What subquestion does this help answer** | **Ethical/Compatibility Considerations** |
| Build or find a physics simulation | How can I use or build an accurate 2D simulation that models a cart pendulum system realistically | Throughout researching and developing my chosen method of simulating a 2D cart and pendulum system, I need to understand its realism to ensure its simulates accurately, and I also need to ensure that it is compatible with my chosen method of building a machine learning algorithm. |
| Design, build and train an MLA | How can I design the various function of, and apply an MLA into my chosen cart pendulum simulation  How can I train and test an applied MLA to my cart pendulum simulation, ensuring it effectively and consistently balances the pendulum | As I design my MLA, I need to keep in mind what values from the physics simulation I have available to use. Depending on my simulation method, I may not have the available variables to pass in, and I may only be able to access them through modifying the source code or physics engine. This could be illegal or otherwise un-doable ethically because my simulation could be calculated in a closed source engine. |
| ***Figure 9*** *– A table consisting of research processes and ethical considerations* | |

**How can I use or build an accurate 2D simulation that models a cart pendulum system realistically?***How can I design and train a machine learning algorithm that can effectively and consistently balance a pendulum on a moving cart in a 2d physics simulation*

**What are the fundamental concepts and ideas of MLAs, and how do they learn?***How can I design and train a machine learning algorithm that can effectively and consistently balance a pendulum on a moving cart in a 2d physics simulation*

**How can I choose and design the various functions of, and apply an MLA into my chosen cart pendulum simulation?**

*How can I design and train a machine learning algorithm that can effectively and consistently balance a pendulum on a moving cart in a 2d physics simulation*

**How can I train and test an applied MLA to my cart pendulum simulation, ensuring it effectively and consistently balances the pendulum?**

*How can I design and train a machine learning algorithm that can effectively and consistently balance a pendulum on a moving cart in a 2d physics simulation*

* The Coding Train 2021, Coding Challenge #159: Simple Pendulum Simulation, YouTube, viewed 19 July 2024, <https://www.youtube.com/watch?v=NBWMtlbbOag>. (making physics sim)
* Work, P 2024, How to train simple AIs, YouTube, viewed 19 July 2024, <https://www.youtube.com/watch?v=EvV5Qtp\_fYg>. (making physics sim)
* myPhysicsLab Moveable Pendulum 2021, Myphysicslab.com, viewed 20 July 2024, <https://www.myphysicslab.com/pendulum/moveable-pendulum-en.html>. (making physics sim)
* ‌Wikipedia Contributors 2024, Maximum and minimum, Wikipedia, Wikimedia Foundation, viewed 1 August 2024, <https://en.wikipedia.org/wiki/Maximum\_and\_minimum>. (figure 5)