BS2200 Portfolio Report

Academic Year 2023 - 2024

List of included files:

- "BS2200_Report.pdf"
- "Crane_problems.ipynb"

Contents

1 Task A: Problem Configuration

Table 1: Problem Description

Number of containers:	6
Number of loading bays:	5
Which containers are heavy:	1, 3, 6
In the initial state, where is each container (Left is the bottom-most container whilst right is the top-most) :	Bay 1: (5) Bay 2: (1, 6) Bay 3: (4) Bay 4: (3, 2) Bay 5: ()
What is the goal condition:	Containers 1, 2, and 3 to be stacked in ascending order (container 1 at the bottom, container 2 on top of 1, and container 3 on top of 2) in bay 2 AND the crane's finishing position is over an empty bay.

2 Task B: Logic Relations

Table 2: Logic Relations

Relation name:	**Arity:**	**Explanation:**
CraneAt(X)	1	The crane is currently positioned at loading bay X.
ContainerAt(X,Y)	2	Container X is currently in loading bay Y.
HoldingContainer(X)	1	The crane is currently holding container X.
TopContainer(X, Y)	2	Container X is currently at the top of loading bay Y.
BayFull(X)	1	Loading bay X is full.
HeavyContainer(X)	1	Container X is heavy.

3 Task C: Transition Model

Table 3: Transition Model

Action Signature	Arguments	Preconditions	Effects	Cost (Minutes)
PickUp(X, Y)	X: Container Y: Bay	CraneAt(Y) AND ContainerAt(X, Y) AND TopContainer(X, Y)	TopContainer(X, Y): False HoldingContainer(X): True ContainerAt(X, Y): False	4 - (NumOfContainersInBay)
DropContainer(X, Y)	X: Container Y: Bay	CraneAt(Y) AND HoldingContainer(X) AND NOT BayFull(Y)	TopContainer(X, Y): True HoldingContainer(X): False ContainerAt(X, Y): True	2
MoveRight(X)	X: Crane Position	NOT CraneAt(5)	CraneAt(X): False	If HoldingContainer(Y) AND HeavyContainer(Y): Cost = 5 Else: Cost = 2
MoveLeft(X)	X: Crane Position	NOT CraneAt(1)	CraneAt(X): False	If HoldingContainer(Y) AND HeavyContainer(Y): Cost = 5 Else: Cost = 2

4 Task D: Chosen Algorithm

The search algorithm chosen was a standard breadth-first search algorithm that has been slightly altered. The small change made was the inclusion of a "check_unique_state" function which examines whether or not a new state has been reached previously by the algorithm before adding it to the frontier. This increases efficiency and prevents the expansion of "redundant" move sequences such as the crane moving left, then immediately back to the right, or the crane dropping a container and then picking it back up on the subsequent move etc. One benefit of using a breadth-first search is that this search algorithm is complete and therefore will always find a solution to the problem, however, a drawback of this is that with increasing complexity of the crane problem, the algorithm will take increasingly longer to come to a conclusion and may not be able to find a solution at all if a timeout function is included within the algorithm. Another drawback of using this algorithm is that whilst it is optimal at finding the solution that takes the least amount of "moves", the solution found may not complete the goal state in the least possible amount of minutes (optimal for moves made, however not for cost).

5 Task E: Problem implementation

Implementation of the chosen search algorithm and implementation of the crane problem from task A is attached in file "Crane_problems.ipynb" in cells 1 - 8. No simplifications were made.

6 Task F: Machine Learning Model

Machine learning model is included in the attached file "Crane_problems.ipynb" in cells 9 - 19

To train this machine learning model the K-nearest neighbour algorithm was opted to be used with the 10 closest neighbors to be inspected when predicting a label. First, the relevant libraries were imported and the content of "Container.csv" was extracted into a DataFrame. The "low" and "high" assignments of each container were subsequently changed to 0 and 1 respectively for more compatibility when used later to train the model. The data was then randomly split into two sets, 75% to train the model, and the remaining 25% to test the model's accuracy (a random state of 1 was used when splitting the data). The model was then trained using the "train" portion of the data and an example container with fabricated values and unknown priority was used to test the model's functionality. Next, the accuracy of the model was evaluated using the remaining "test" chunk of data. This was done by making the model predict the labels of the "test" set then comparing the predictions to the actual known labels of the containers. A score of 0.93 was given by this test, meaning that the model had a 93% accuracy. Finally, to check if there was significant variance in the model's accuracy depending on the random state given, 10 different random states were also tested (including 1) and it was found that the values of accuracy ranged between 0.91 and 0.93. Therefore it was concluded that the random state used to split the data had minimal influence over the accuracy of the model.

7 Task G: Ethical and Environmental Considerations For AI In The Workplace

Implementing AI systems into a workplace would have tremendous benefits, such as saving resources and time, however, there would also be numerous ethical and environmental consequences/considerations that must be made for implementation to take place.

To begin, one major ethical talking point would be the matter of job displacement. To expand on this, the implementation of AI systems, like automated cranes, may lead to human workers being pushed out of roles that can be completed by AI or machines (Gentili *et al.*, 2020). On the other hand, it could be said that new jobs would open up *because* of AI. For example, whilst a crane worker may be displaced from their job position by an AI crane operator, multiple positions that support the AI would be created by its implementation. (Gartner, 2017) States that "AI will create 2.3 million jobs in 2020 while eliminating 1.8 Million" meaning that a net positive of jobs will actually be created rather than taken. It is also important to state that jobs displaced by automation require less skill than new jobs generated by the latter. The new jobs require high skills therefore the portion of these jobs that actually become occupied may depend on the quality of the educational system of each country (Badet, 2021).

Another ethical consideration to be made is the concern of data privacy. AI systems, in particular machine learning models, are exceptionally data-hungry, it must be ensured that systems adhere to the relevant privacy regulations and safeguards. To give an example, If a company were to make use of an AI that collects users' personal data, the company would have to heavily regulate who can access the data collected by the AI and also ensure that the system itself cannot do anything potentially harmful or in breach of data protection laws with this data. Also, more so in relation to machine learning, large amounts of data are collected from multiple and diverse sources to train AI models. This means that it becomes easier to trace that data back to users/clients and (intentionally or unintentionally) defeat the goals of privacy (Safdar, Banja, Meltzer, 2020).

Moving on from ethical considerations, there are also numerous possible environmental consequences from implementing AI systems into areas of work, especially if AI use was to become widespread.

As a start, the environmental impact of energy consumption of AI systems would have to be considered. Deep learning models are becoming more and more complex and, as a result of this increasing complexity, are beginning to consume more and more energy, increasing their greenhouse gas emissions (Wu *et al.*, 2022). To address the rising power demand of such systems, an emphasis should be placed on optimizing energy usage without compromising operational efficiency.

Another important environmental consideration that should be made, is the matter of a system's life-cycle carbon footprint. The entire life cycle of an AI system consists of about 5 stages: Raw material acquisition, Manufacturing, Transport, Use, and End-of-life. Whilst we have already covered the "use" section of an AI's life cycle, the manufacturing and end-of-life stages are arguably equally as important or have even more significance in reducing the environmental impact of AI. The manufacturing and dismantling of systems both cost energy and it is crucial to consider the materials utilized during the manufacturing process in order to minimize waste when it comes time to dispose of a system at the end of it's life (Ligozat *et al.*, 2021).

To summarise, AI system implementation in the workplace has significant time and resource savings. Nonetheless, effort must be taken to handle ethical issues like data privacy and employment displacement as well as environmental issues like energy use and life-cycle carbon impact. For responsible deployment, it is essential to maintain a balance between the benefits of AI and reducing its ethical and environmental repercussions.

8 Task H: AI Reflection

Prior to studying BS2200, I already had an interest in AI however after learning about the field of AI to a more in-depth level during this semester, my interest has been piqued further. To be more specific, I find the application of machine learning models to strategy games, in particular chess, to be incredibly fascinating, and would love to look further into this topic. In my opinion, the best way to further my knowledge on something like this would be to start my own project and create a machine learning model that can learn and play chess. I am already aware of existing chess engines such as Stockfish and Alphazero however, I would like to research the potential of an AI that makes use of a reinforcement learning style. I believe it would be interesting to see to what extent an AI trained using this style can efficiently and effectively play chess as well as how it compares to applied AIs (such as Stockfish). There are many internet guides that I could follow along with and use to help myself in this project and I would also research articles that document the use of AI in strategy/board games to build my own AI step by step.

9 References

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