Draft Research Plan for Multi-Agent Path Finding with Matching using A* with OD and ID

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Title:	Multi-Agent Path Finding with Matching using A* with OD and ID
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Background of the research

The Dutch Railways (NS) is tasked with maintaining trains during the night. The trains are routed to shunting yards where they can be cleaned and receive maintenance. Here there is an NP-hard problem called the Train Unit Shunting and Servicing (TUSS) problem. One of the main questions in this problems is with regards to the capacity of these shunting yards. To try and establish an upper bound to this capacity we try to find a relaxation to the problem.

The NP-hard Multi-Agent Path Finding (MAPF) describes multiple agents on a graph, moving from a start node to a goal node while avoiding collisions. In this problem we try to minimize the sum of individual costs (SIC). To make this problem into a relaxation of the TUSS problem we also need to introduce matching, as there is no exact assignment per train for a destination but rather per class or type of train.

Description of current state of the research field to be added later

Research Question

The main question that will be answered in this paper is: How can the MAPF algorithm A* with ID and OD be used to solve a relaxation of the TUSS problem when it is expanded with matching. We can then look at the following sub-questions:

- Which matching algorithm performs best when combined with A* with OD and ID
- How does this combined algorithm perform compared to other MAPF algorithms expanded with matching?
- Under which conditions should this algorithm be used?
- Under which conditions should this algorithm not be used?

Will be expanded and improved later this week

Method

Method explanation will be added later this week

Planning of the research project

Task description: Orientation

The first week will be spent on orientation. What is the current state of the field? How does A* ID OD really work. How can I make it? etc.

During this week I will also orientate myself on the different deadlines and lectures we have. For example how to prepare for each one.

For this orientation I will also be reading quite a few papers starting with Standley's paper on A* with ID and OD [1], Stern et al. paper on Multi-Agent pathfinding[2] and Mulderij et al. paper on the TUSS problem[3]. As well as any papers that follow from that that seem relevant.

This orientation should then finally allow me to make the final version of this research plan at the end of the week. Rest of planning will be added later this week

Planning overview

Legend	Deadline	Meeting	Lecture	Start with...		
	Monday	Tuesday	Wednesday	Thursday	Friday	End of week
Q4 W1 (19-4)	First week plan; Responsible methods lecture	Information literacy; Orientation		Supervisor meeting		Research plan
Q4 W2 (26-4)				Research plan presentation	Responsible research lecture	
Q4 W3 (3-5)				Supervisor meeting	Session ACS	
Q4 W4 (10-5)	Session responsible research			Supervisor meeting		
Q4 W5 (17-5)	Session ACS		Midterm presentation	Supervisor meeting, midterm feedback		
Q4 W6 (24-5)				Supervisor meeting, reflection discussion	Session ACS	
Q4 W7 (31-5)				Supervisor meeting		
Q4 W8 (7-6)	Paper draft v1			Supervisor meeting; Peer-review draft v1		
Q4 W9 (14-6)			Paper draft v2	Supervisor meeting		
Q4 W10 (21-6)				Supervisor meeting		Submit final paper
Q4 W11 (28-6)	Session ACS	Submit final poster		Poster presentation		

Figure 1: Draft planning overview

References

[1] T. Standley, "Finding optimal solutions to cooperative pathfinding problems," in *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 24, 2010.

[2] R. Stern, N. Sturtevant, A. Felner, S. Koenig, H. Ma, T. Walker, J. Li, D. Atzmon, L. Cohen, T. K. S. Kumar, E. Boyarski, and R. Bartak, *Multi-agent pathfinding: Definitions, variants, and benchmarks*, 2019. arXiv: 1906.08291 [cs.AI].

[3] J. Mulderij, B. Huisman, D. TÃ¶nissen, K. van der Linden, and M. de Weerdt, *Train unit shunting and servicing: A real-life application of multi-agent path finding*, 2020. arXiv: 2006.10422 [cs.MA].