Navigation By Reinforcement Learning

3D Vision Project Proposal
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GROUP MEMBERS

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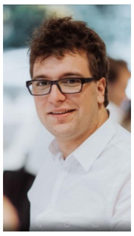

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I. DESCRIPTION OF THE PROJECT

In the Industry 4.0 the need for automation increases tremendously and thus the demand for robots with high navigation abilities in complex three-dimensional surroundings grows vastly. Especially deep learning allows an efficient approach to achieve this. Savinov *et al.* [1] used an animal inspired non-metric [2] [3] semi-parametric topological memory (SPTM) approach. With this approach, they were able to improve their success rate by a factor of three compared to their baselines. Our team will evaluate further tensorforce based baselines which follow the same evaluation procedure as introduced by Savinov *et al.* [1] and will allow to put their work on an even more solid foundation.

II. WORK PACKAGES AND TIMELINE

Timeline and project planning Our project is organized in four main parts. We will start with an orientation phase to gain some knowledge about previously done work, focused mainly on Nikolay Savinovs' paper [1]. We will then use our gathered insights to deploy the same environment [**?**]GitRepoSavinov) for training and testing of our agent within the vizdoom environment [4] and use the same evaluation methods of Reinforcement Learning baselines that were used in [1]. We go for this setup to be later able to benchmark the performance of our agent against the results of the paper. Our vizdoom agent will be trained with the AC3 algorithm [5] and if there is time left also with PPO [6]. To guarantee an efficient workflow we divide our team into two subgroups, where one team is entrusted with the infrastructural needs of the group, e.g. deploy necessary software on Leonhard. The rest of the group will be focused on the Reinforcement Learning algorithm training and evaluation.

We devide those two main tasks into the following subtasks:

- Understand previously done work by Nikolay Savinov our Tutor
- Utilize interface of Vizdoom enviorment
- Study Agent movement
- Deploy test program to Leonhard
- Prepare midterm presentation
- Understand and implement A3C
  - Implement rewards and training structure to explore efficiently the maze
  - Training: we train our agent with the A3C algorithm
  - Validation: We use the validation mazes to tune our parameters
  - Testing: testing will be done with the seven provided mazes
- If there is time left we implement, train and test our agent with the PPO algorithm additionaly
- We compare our results to previous results of Niklay Savinov
- Write the final report

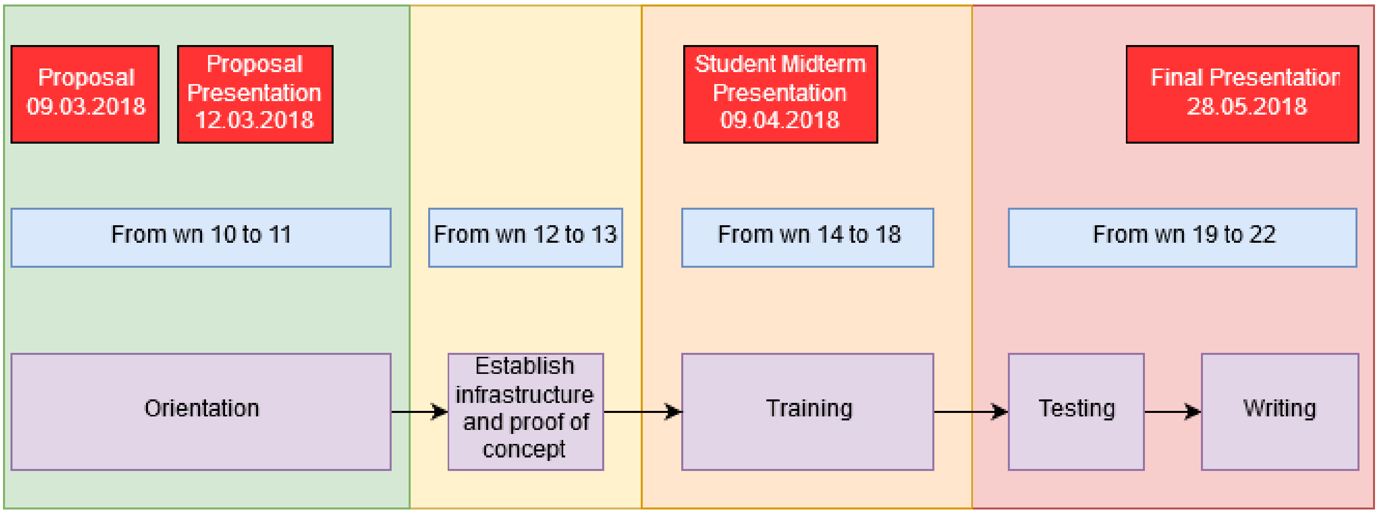

Fig. 1. Timeline and project structure

III. Outcomes and Demonstration

The expected outcome of this project is a fully functional agent, implemented with the A3C algorithm and if there is time left the PPO algorithm. Therefore, the agent needs to pass through the same training, validation and testing process as referred to in [1]. The performance of said algorithms should be similar or slightly better to the baselines in [**?**], namely in the range of 20% to 40% success rate after 5000 steps. The result will be illustrated as graphs which show the success rate over steps. Furthermore, we want to show the results of the two agents in a demonstration video.

References

[1] Nikolay Savinov, Alexey Dosovitskiy, and Vladlen Koltung. Semi-parametric topological memory for navigation. *ICLR*, 2018.

[2] S. Gillner and H. A. Mallot. Navigation and acquisition of spatial knowledge in a virtual maze. *Journal of Cognitive Neuroscience*, 10(4):445–463, 1998.

[3] P. Foo, W. H. Warren, A. Duchon, and M. J. Tarr. Do humans integrate routes into a cognitive map? map- versus landmark-based navigation of novel shortcuts. *Journal of Experimental Psychology-Learning Memory and Cognition*, 31(2):195–215, 2005.

[4] Nicolay Savinov. Sptm github repository.

[5] Alan K. Mackworth. *Consistency in Networks of Relations A2 - Webber, Bonnie Lynn*, pages 69–78. Morgan Kaufmann, 1981.

[6] Schulmann John, Wolski Filip, Dhariwal Prafulla, Radford Alec, and Klimov Oleg. Proximal policy optimization algorithms. *CoRR*, abs/1707.06347, 2017.