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C4 Modelling curiosity constrained by planning

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Motivation

- Planning to reach a goal relies on prior knowledge about individual planning steps and is interspersed with curiosity-driven exploration (search) into, as yet, unknown parts of the plan.
- How we combine planning knowledge with curiosity-driven search is unknown and research target of Project C4.

Preliminary work:

- Investigation in C4 can partially rely on our planning models as in [1] and [2] where we have investigated how planning progresses with exploration in an unknown environment (Fig. 1).

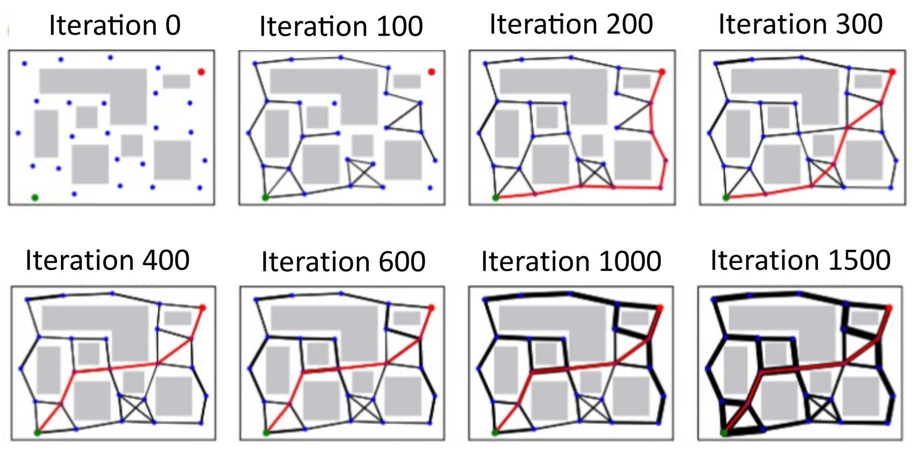

Fig. 1: Planning progress in an unknown environment with a neural network planner. Cost estimates in black, optimal plan in red.

Objectives

- Experimentally assess how planning impacts curiosity-driven exploration.
- Capture the interactions between planning and curiosity-driven exploration by ways of a model.

➢ **How are we curious?**

By the interaction of planning with prior knowledge-based exploration.

➢ **Why are we curious?**

Because, non-uniform distribution of prior knowledge drives different exploration.

? How does planning towards reaching a certain goal influence curiosity-driven exploration?

Methods

Fig. 2 shows a planning problem of how to get from an initial point I to a goal G represented as a graph. In this example, we assume that the green-marked path segments have a lower summed cost than the red ones. Dashed lines indicate lack of knowledge how to continue.

- We will investigate (i) how overt and covert cost-given biases concerning path segments 1-4 influence exploration and (ii) how experience learned from a first task influences exploration in a second, related task. This will be modelled using partially observable Markow Decision models (POMDP).

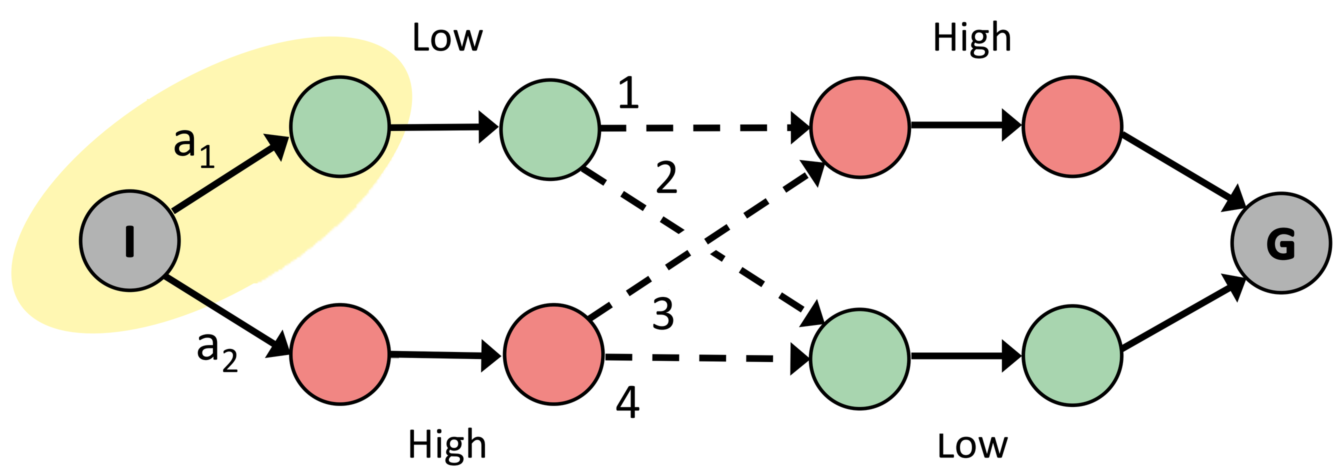

Fig. 2: Simple planning problem of how to get from an initial point I to a goal G represented as a graph. A triplet of two adjacent nodes coupled by an action (e.g. yellow ellipse) represents a "planning operator PO = (pre-condition, action post-condition).

Hypotheses:

- We expect that the agent's curiosity for exploration how to bridge this knowledge gap is driven by the costs of the different known path segments.
- We predict that the combination of relative (observed or assumed) cost biases will define the probabilities for exploring the choices of different segment connections.
- For goal (ii) the participants will learn the (hidden) contingencies of the intermediate piece sets in a first experiment. We predict here that learned contingencies lead to a conditioning of the probabilities for exploring different path connections.

Cross-project collaborations

- Research Area **A**, where meta-cognitive processes (e.g. **A1**) may take a similar role as active cogitation through planning.
- Other **C** projects connecting to the information-theoretically based representations (**C2**, **C5**).

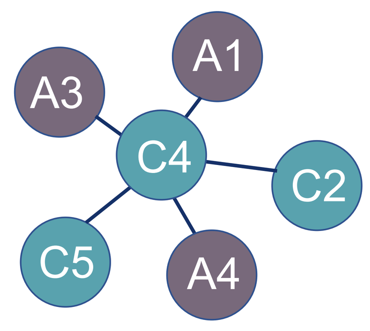

Fig. 3: Key collaboration partners of doctoral researcher working on Project C4

Potential PhD projects

Experimental and theoretical investigation of the influence of...

1. ...overt and covert biases in known segments of a planning problem on exploration behaviour of unknown segments needed to complete a plan.
2. ...prior learned planning contingencies on exploration behaviour concerning a novel planning problem with unknown segments.

References

1. Kulvicius, T., Herzog, S., Tamosiunaite, M. & **Wörgötter, F.** (2021). Finding optimal paths using networks without learning - unifying classical approaches. *IEEE Transactions on Neural Networks and Learning Systems*, 33(12), 7877-7887.
2. Agostini, A., Torras, C. & **Wörgötter, F.** (2017). Efficient interactive decision-making framework for robotic applications. *Artificial Intelligence*, 247, 187-212.