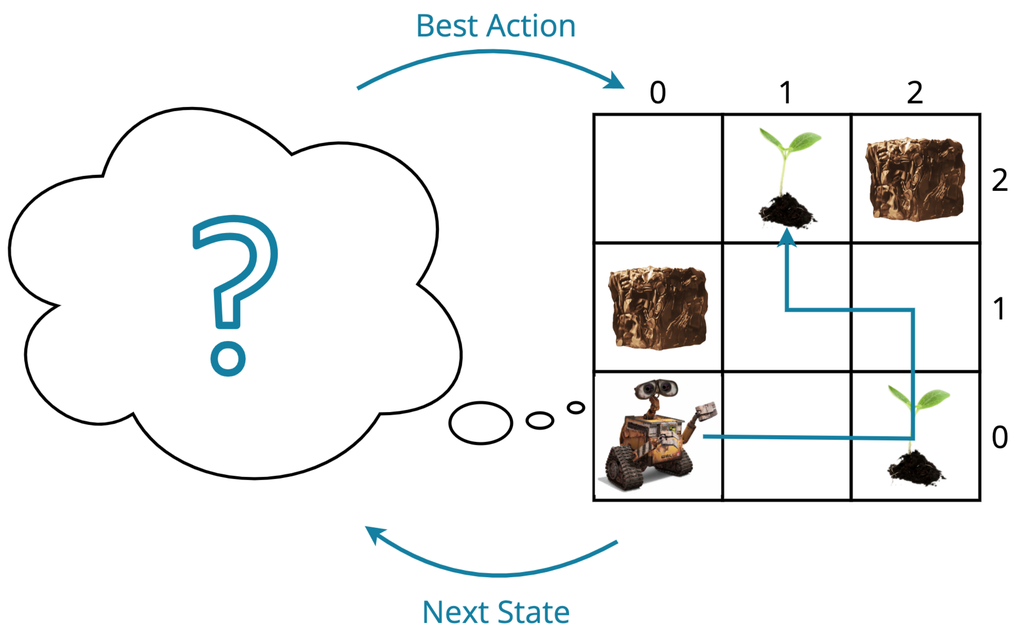
Towards Tractable Dynamic Decision Making With Circuits

Gabriele Venturato, Vincent Derkinderen, Pedro Zuidberg Dos Martires, Luc De Raedt

I. Problem Setting

Dynamic Decision Problems

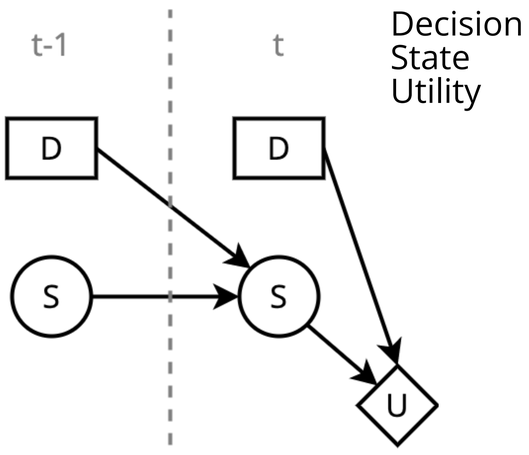


- Unreliable actions (uncertainty)
- Discrete time steps (dynamic)
- Maximise the expected utility

GOAL: Find a *representation* of the dynamic decision problem to perform fast and exact *decision making*.

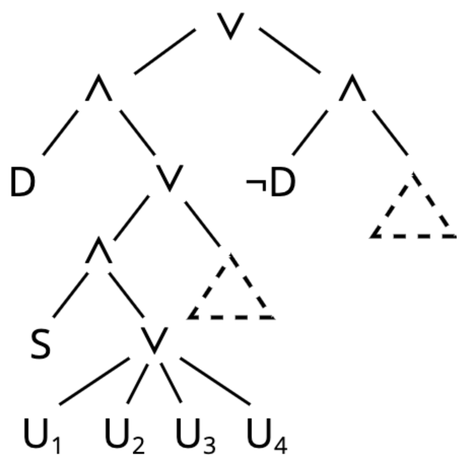
II. Proposed Representation: DDCs

Input: Dynamic Decision Network (DDN)



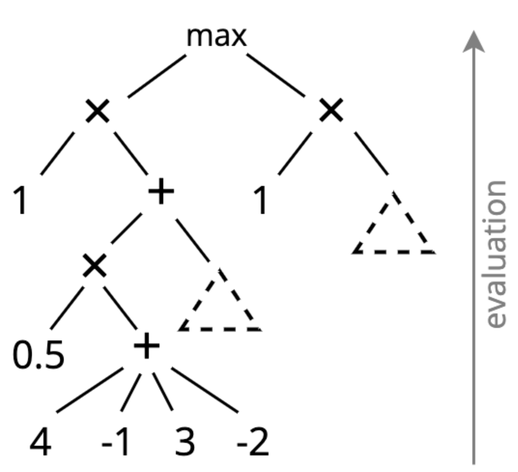
Knowledge Compilation

Logic Theory



Algebraic Model Counting (AMC)

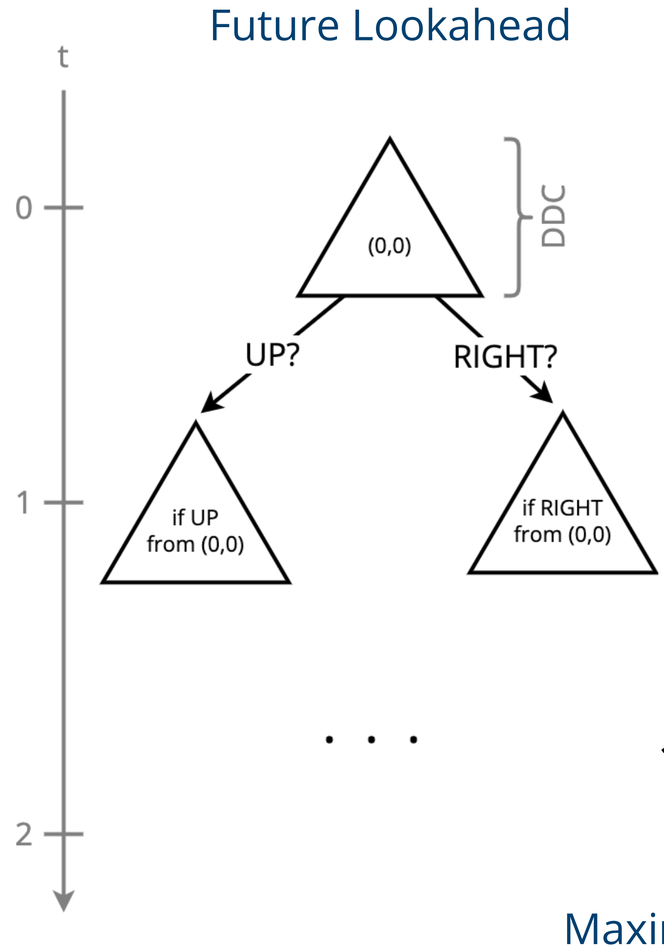
Dynamic Decision Circuit (DDC)



Labelling associates logic symbols to the numerical parameters

III. Decision Making With DDCs

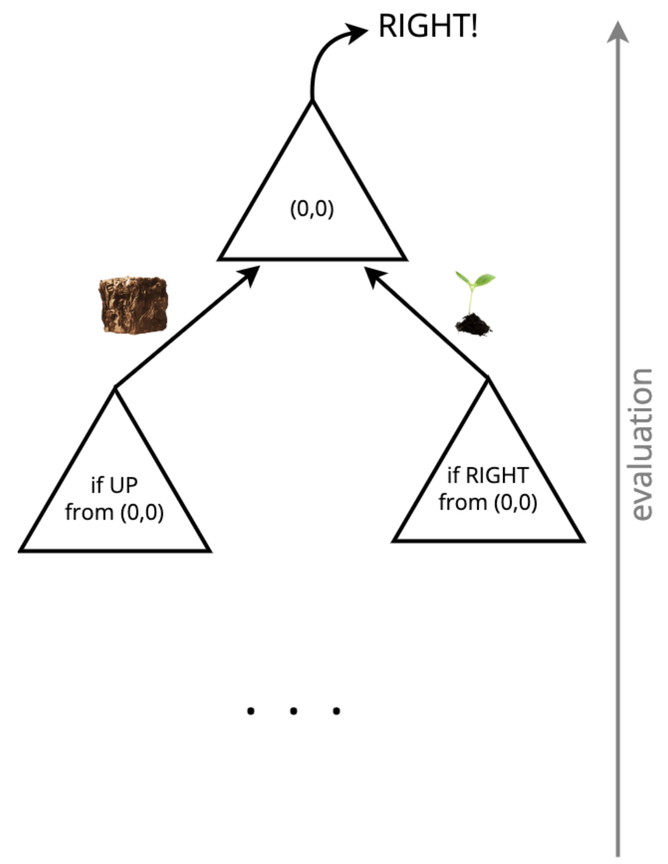
Future Lookahead



- Starting location (0,0)
- Condition the DDC on the current location and decision
- Explore only the reachable states

Maximum Expected Utility

Thanks to AMC we can re-use the same circuit, evaluating it multiple times, just updating the labels!



IV. Contributions

1. Introduction of Dynamic Decision Circuits: how to obtain a DDC from a DDN, and perform inference on it
2. Development of an online planning algorithm which exploits DDCs to find the best next action

V. Future Challenges

- Approximate the decision making process (MCTS-like)
- Add the support for parameter learning, which is almost for free thanks to the AMC framework

gabriele.venturato@kuleuven.be
@GabVenturato

DTAI Declarative Languages & Artificial Intelligence

KU LEUVEN