Model-free Automated Planning Using Neural Networks

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Classical planning

+ efficient methods for general problem solving
- explicit model necessary

Neural networks

+ can learn model from large unstructured datasets
- no problem-solving abilities

OUR WORK

= planning system without a provided explicit model

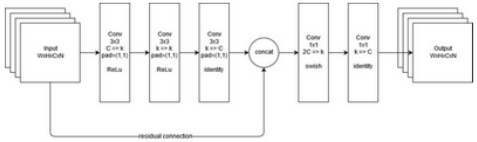
Instead of replacing the whole algorithm -> **replace its parts**

Transition function
- takes current state on the input
- returns successor states

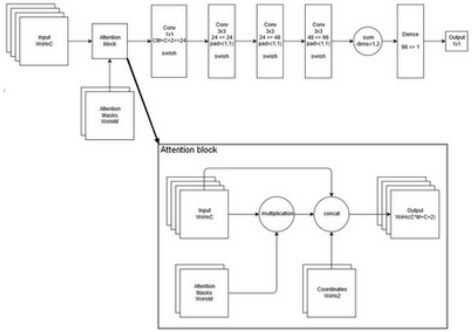
Heuristic function
- takes current state on the input
- returns estimate of distance to goal

Expansion network

- convolutional NN + residual connection
- Input: current state
- Output: probability distribution over possible steps



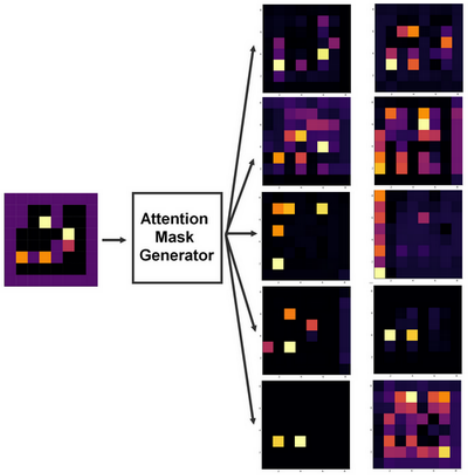
Architecture of the heuristic network



Architecture of the expansion network

Heuristic network

- convolutional NN + attention masks
- Input: current state
- Output: heuristic value estimate



Example of generating the attention masks

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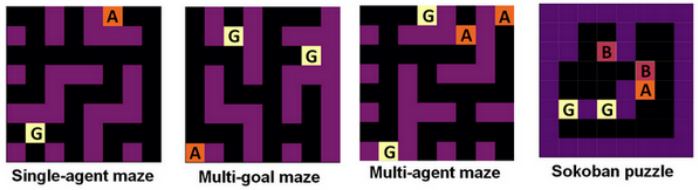
Problem domains

- four domains
- increasing difficulty
- grid representation
- one-hot encoding of cell type
- movement in 4-neighborhood
- all free spaces accessible



Examples of all domains; A = agent, G = goal, B = box, black tiles are free, purple tiles are walls

Experiments

- networks evaluating experiments
  - training and comparing different configurations of proposed architectures
- planning experiments
  - comparing performance of the networks against classical planning approaches
  - greedy best first search, best first search, multi-heuristic search
  - evaluated by average solution costs, average number of expanded states, coverage
  - 50 problem instances for each domain

Conclusions

- there wasn't a great difference in the results when using the expansion network
  - in maze, multi-goal maze and multi-agent maze
- the heuristic network performed better in single-agent domains
  - probably because of complexity of the multi-agent maze domain
- results for maze and multi-goal maze were comparable to the other heuristics
- in Sokoban domain, the coverage was better due to computation time of the heuristic network
- impressive results in multi-heuristic search