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Means Ends Analysis

How would you use **Means-Ends Analysis** to design an agent that can answer Raven's progressive matrices?

Means Ends Analysis is a problem solving method that is based on reducing the distance (or difference) from the current state to the goal state. At any state there are some number of operators that can be applied to the current state where each operator will reduce, increase or not change the distance to the goal state. With this method it is possible to find a path through the possible states to reach the goal state in the fewest number of state changes (or operators).

In designing an agent that can answer Raven's progressive matrices 2x1 problems the Means-Ends Analysis method could be used to define the transformation from figure A to figure B as a series of operators. Each operator would instruct how one attribute should change. For instance, an operator could instruct to change the shape of object x to a circle. If the agent created each possible operator based on the goal state (e.g. the shapes circle, square and diamond appear in goal state) it could compare the resulting state after applying each operator and choose the operator that reduces the distance to the goal state.

The Means-Ends Analysis method would need to be applied in conjunction with Frames where a frame could be used to represent state. The agent would create a frame to contain the attributes of figure A to define the initial state and a frame to contain the attributes of figure B to define the goal state.

The agent would compare the initial state to the goal state. In this initial comparison the agent will perform object to object comparisons to determine which object in the initial state matches up with which object in the goal state best by giving each match a score. The result will be a mapping of objects in figure A to objects in figure B.

These operators could include change object x shape to square, change object x to filled, delete object x, add object z with shape circle, etc. The agent would generate frames for each resulting state after applying an operator, compare each frame to the goal frame and finally choose the operator that reduces the distance to the goal state (or frame). The result of this would be a series of operators that define the transformation from figure A to figure B.

To determine the best answer to the problem the agent will generate the transformation from figure C to each of the possible solutions by following the same process described above for finding the transformation from figure A to figure B. Once all transformations have been generated the agent will compare the transformation for figure A to figure B with each figure C to a solution transformation assigning a score. The solution with the best score will be chosen as the Means-Ends Analysis method's best answer.

The agent may determine that the best answer's score does not pass an acceptance test (e.g. must exceed 90% match). If so, the agent could change the weighting applied to attributes and repeat the process. For instance, if the first pass treated all object attributes equally, the second pass might apply a 150% weighting to the shape attribute. If the best answer gets an acceptable score, the agent could learn by remembering this change to the initial weighting rules.