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Department of Artificial Intelligence and Data Science

Course Name – Introduction to Artificial Intelligence

II Year / III Semester

Unit 1 Problem spaces and Searches

Contents

- Defining the problem as a State Space Search
- Production Systems
- Control Strategies
- Breadth First Search
- Depth First Search
- Heuristic Search

To build a system to solve a problem Define the problem precisely

- Analyse the problem
- Isolate and represent the task knowledge that is necessary to solve the problem
- Choose the best problem-solving techniques and apply it to the particular problem.
- Defining the problem as State Space Search . The state space representation forms the basis of most of the AI methods.

- Its structure corresponds to the structure of problem solving in two important ways
- It allows for a formal definition of a problem as the need to convert some given situation into some desired situation using a set of permissible operations.
- It permits us to define the process of solving a particular problem as a combination of known techniques (each represented as a rule defining a single step in the space) and search, the general technique of exploring the space to try to find some path from current state to a goal state.
- Search is a very important process in the solution of hard problems for which no more direct techniques are available.

Example Playing

- Chess To build a program that could play chess, we could first have to specify the starting position of the chess board, the rules that define the legal moves, and the board positions that represent a win for one side or the other.
- In addition, we must make explicit the previously implicit goal of not only playing the legal game of chess but also winning the game, if possible,

•Playing chessThe starting position can be described as an 8 by 8 array where each position contains a symbol for appropriate piece.
•We can define as our goal the check mate position.
•The legal moves provide the way of getting from initial state to a goal state.
•They can be described easily as a set of rules consisting of two parts
•A left side that serves as a pattern to be matched against the current board position.
•And a right side that describes the change to be made to reflect the move
•However, this approach leads to large number of rules 10120 board positions !!
•Using so many rules poses problems such as
•No person could ever supply a complete set of such rules.
•No program could easily handle all those rules. Just storing so many rules poses serious difficulties.
•Defining chess problem as State Space searchWe need to write the rules describing the legal moves in as general a way as possible.

For example
•White pawn at Square(file e, rank 2) AND Square(File e, rank 3) is empty AND Square(file e, rank 4) is empty, then move the pawn from Square(file e, rank 2) to Square(file e, rank 4).
•In general, the more succintly we can describe the rules we need, the less work we will have to do to provide them and more efficient the program.

Production Systems consists of

•A set of rules, each consisting of a left side that determines the applicability of the rule and a right side that describes the operation to be performed if that rule is applied.
•One or more knowledge/databases that contain whatever information is appropriate for the particular task. Some parts of the database may be permanent, while other parts of it may pertain only to the solution of the current problem.
•A control strategy that specifies the order in which the rules will be compared to the database and a way of resolving the conflicts that arise when several rules match at once.
•A rule applier

•Production system In order to solve a problem
•We must first reduce it to one for which a precise statement can be given. This can be done by defining the problems state space (start and goal states) and a set of operators for moving that space.
•The problem can then be solved by searching for a path through the space from an initial state to a goal state.
•The process of solving the problem can usefully be modelled as a production system.

Control Strategies

- How to decide which rule to apply next during the process of searching for a solution to a problem?
- The two requirements of good control strategy are that
- it should cause motion.
- It should be systematic

Breadth First Search

- Algorithm
- Create a variable called NODE-LIST and set it to initial state
- Until a goal state is found or NODE-LIST is empty do
- Remove the first element from NODE-LIST and call it E. If NODE-LIST was empty, quit
- For each way that each rule can match the state described in E do
- Apply the rule to generate a new state
- If the new state is a goal state, quit and return this state
- Otherwise, add the new state to the end of NODE-LIST

Depth First Search

•If the initial state is a goal state, quit and return success
•Otherwise, do the following until success or failure is signaled
•Generate a successor, E, of initial state. If there are no more successors, signal failure.
•Call Depth-First Search, with E as the initial state
•If success is returned, signal success. Otherwise continue in this loop.

Backtracking

•In this search, we pursue a singal branch of the tree until it yields a solution or until a decision to terminate the path is made.
•It makes sense to terminate a path if it reaches dead-end, produces a previous state. In such a state backtracking occurs
•Chronological Backtracking Order in which steps are undone depends only on the temporal sequence in which steps were initially made.
•Specifically most recent step is always the first to be undone.
•This is also simple backtracking.

Heuristic Search

- A Heuristic is a technique that improves the efficiency of a search process, possibly by sacrificing claims of completeness.

Heuristics are like tour guides
They are good to the extent that they point in generally interesting directions
They are bad to the extent that they may miss points of interest to particular individuals.
On the average they improve the quality of the paths that are explored.
Using Heuristics, we can hope to get good (though possibly nonoptimal) solutions to hard problems such asa TSP in non exponential time.
There are good general purpose heuristics that are useful in a wide variety of problem domains.
Special purpose heuristics exploit domain specific knowledge

Example:
Simple Heuristic functionsChess The material advantage of our side over opponent.
TSP the sum of distances so far
Tic-Tac-Toe 1 for each row in which we could win and in we already have one piece plus 2 for each such row in we have two pieces.