

HEURISTICS AND GENERATE AND TEST

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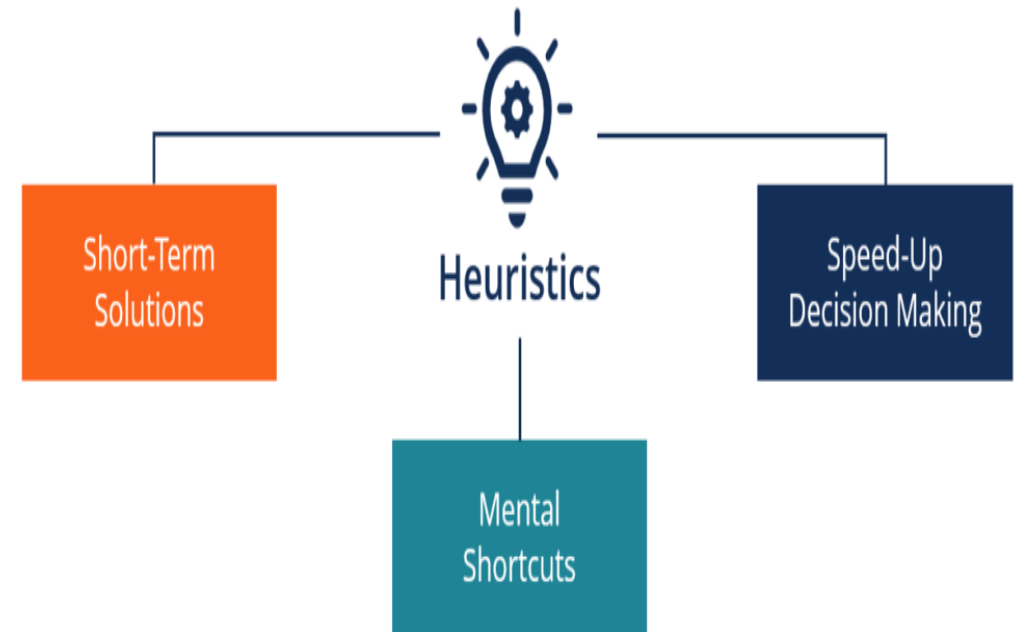
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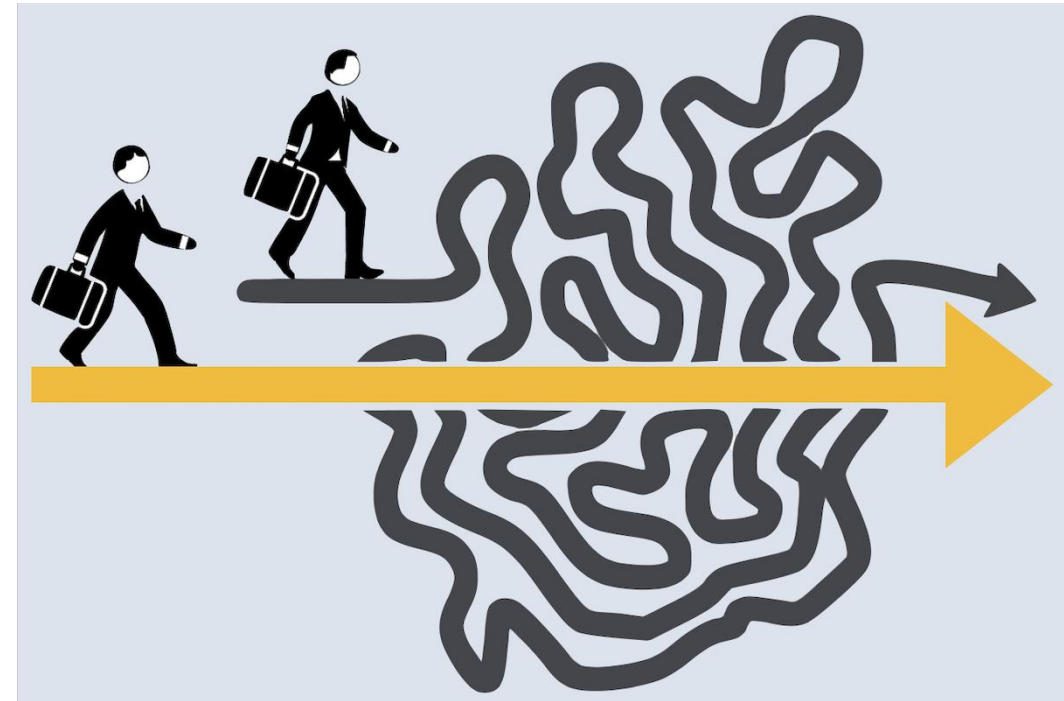
HEURISTICS

- A heuristic is a method that improves the efficiency of the search process
- These are like tour guides
- They are good to the level that they may neglect the points in general interesting directions
- They are bad to the level that they may neglect points of interest to particular individuals
- Some heuristics help in the search process without sacrificing any claims to entirety that the process might previously had
- Others may occasionally cause an excellent path to be overlooked
- By sacrificing entirety it increases efficiency
- Heuristics may not find the best solution every time but guarantee that they find a good solution in a reasonable time
- These are particularly useful in solving tough and complex problems, solutions of which would require infinite time, i.e. far longer than a lifetime for the problems which are not solved in any other way

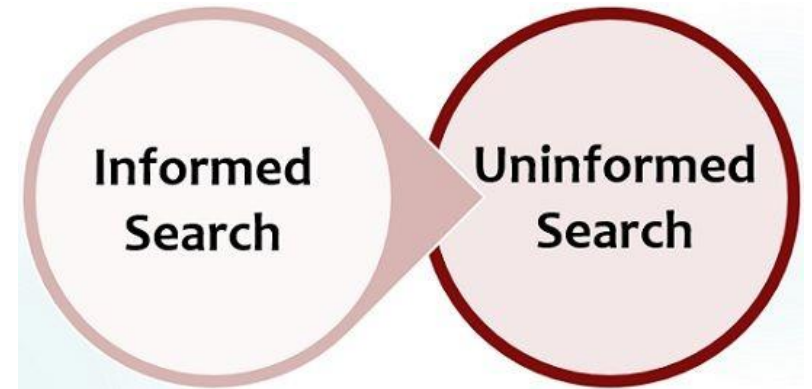


HEURISTIC SEARCH TECHNIQUES

- Many traditional search algorithms are used in AI applications
- For complex problems, the traditional algorithms are unable to find the solutions within some practical time and space limits
- Consequently, many special techniques are developed, using *heuristic functions*.
- The algorithms that use *heuristic functions* are called *heuristic algorithms*
- Heuristic algorithms are not really intelligent; they appear to be intelligent because they achieve better performance
- • Heuristic algorithms are more efficient because they take advantage of feedback from the data to direct the search path.




- **Uninformed search algorithms** or *Brute-force algorithms*, search through the search space all possible candidates for the solution checking whether each candidate satisfies the problem's statement.
- **Informed search algorithms** use heuristic functions that are specific to the problem, apply them to guide the search through the search space to try to reduce the amount of time spent in searching
- A good heuristic will make an informed search dramatically outperform any uninformed search
- for example, the Traveling Salesman Problem (TSP), where the goal is to find is a good solution instead of finding the best solution
- In such problems, the search proceeds using current information about the problem to predict which path is closer to the goal and follow it, although it does not always guarantee to find the best possible solution
- Such techniques help in finding a solution within reasonable time and space (memory)

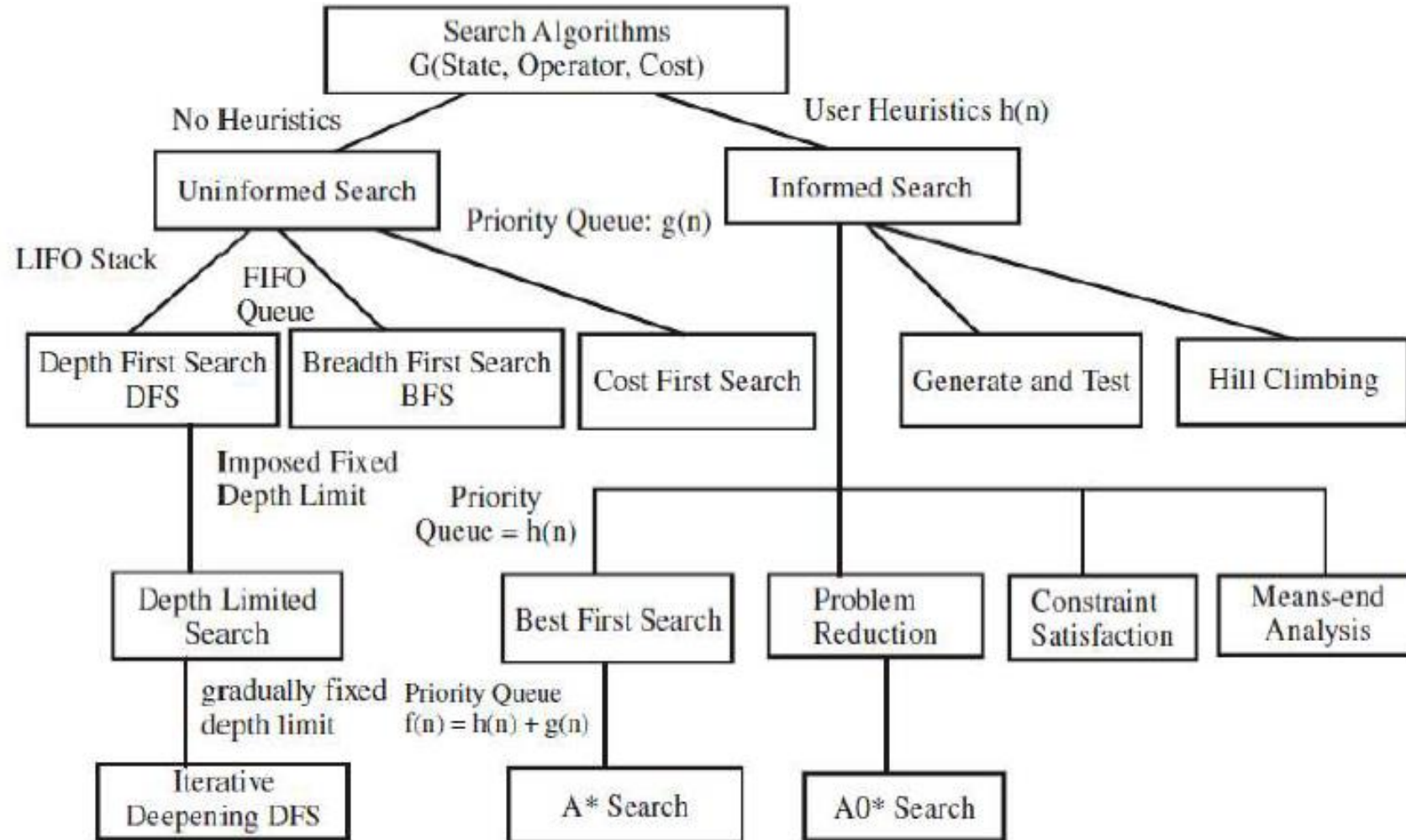


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- Some prominent intelligent search algorithms are stated below:
 - *1. Generate and Test Search*
 - *2. Best-first Search*
 - *3. Greedy Search*
 - *4. A* Search*
 - *5. Constraint Search*
 - *6. Means-ends analysis*

DIFFERENT SEARCH ALGORITHMS



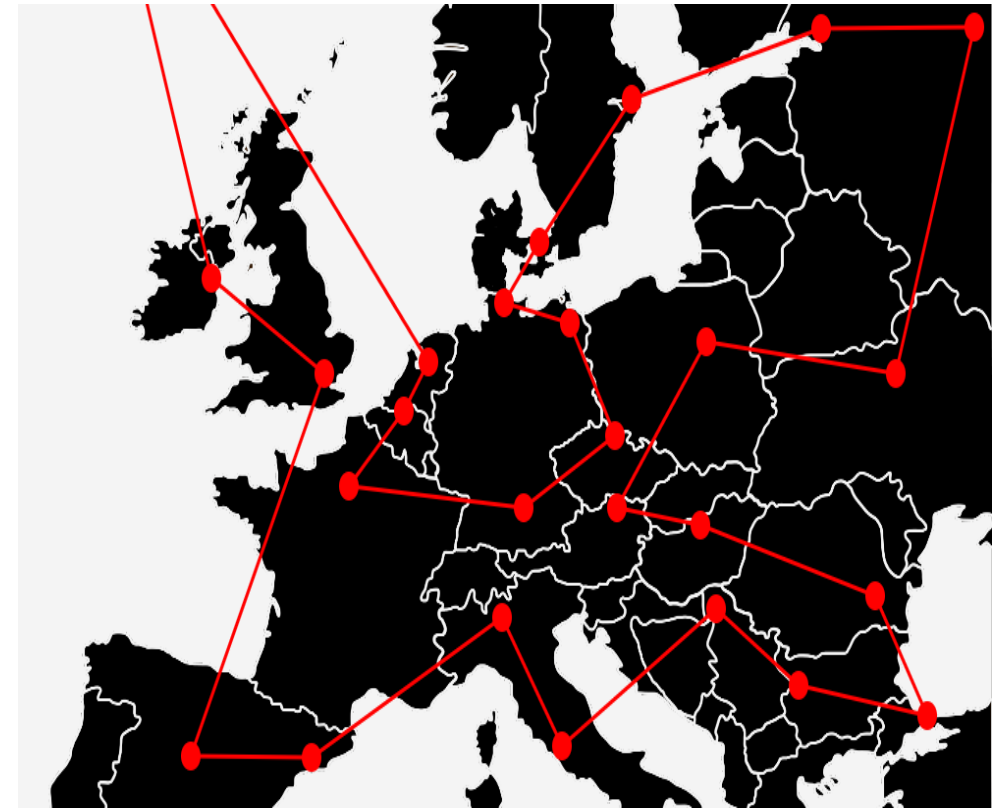
HEURISTIC SEARCH

- To find a solution in proper time rather than a complete solution in unlimited time we use heuristics
- A heuristic function is a function that maps from problem state descriptions to measures of desirability, usually represented as numbers
- Heuristic search methods use knowledge about the problem domain and choose promising operators first
- These heuristic search methods use heuristic functions to evaluate the next state towards the goal state

- For finding a solution, by using the heuristic technique, one should carry out the following steps:
 - 1. Add domain—specific information to select what is the best path to continue searching along.
 - 2. Define a heuristic function $h(n)$ that estimates the ‘goodness’ of a node n .
 - Specifically, $h(n)$ = estimated cost(or distance) of minimal cost path from n to a goal state.
 - 3. The term, heuristic means ‘serving to aid discovery’ and is an estimate, based on domain specific information that is computable from the current state description of how close we are to a goal

- Finding a route from one city to another city is an example of a search problem in which different search orders and the use of heuristic knowledge are easily understood
- 1. State: The current city in which the traveler is located.
- 2. Operators: Roads linking the current city to other cities.
- 3. Cost Metric: The cost of taking a given road between cities.
- 4. Heuristic information: The search could be guided by the direction of the goal city from the current city, or we could use airline distance as an estimate of the distance to the goal

- Heuristics are *rules of thumb*; they do not guarantee a solution to a problem.
- Heuristic Search is a weak technique but can be effective if applied correctly; it requires domain specific information.



HEURISTIC SEARCH COMPARED WITH OTHER SEARCH

- **Brute force / Blind search**
- Can only search what it has knowledge about already
- No knowledge about how far a node node from goal state

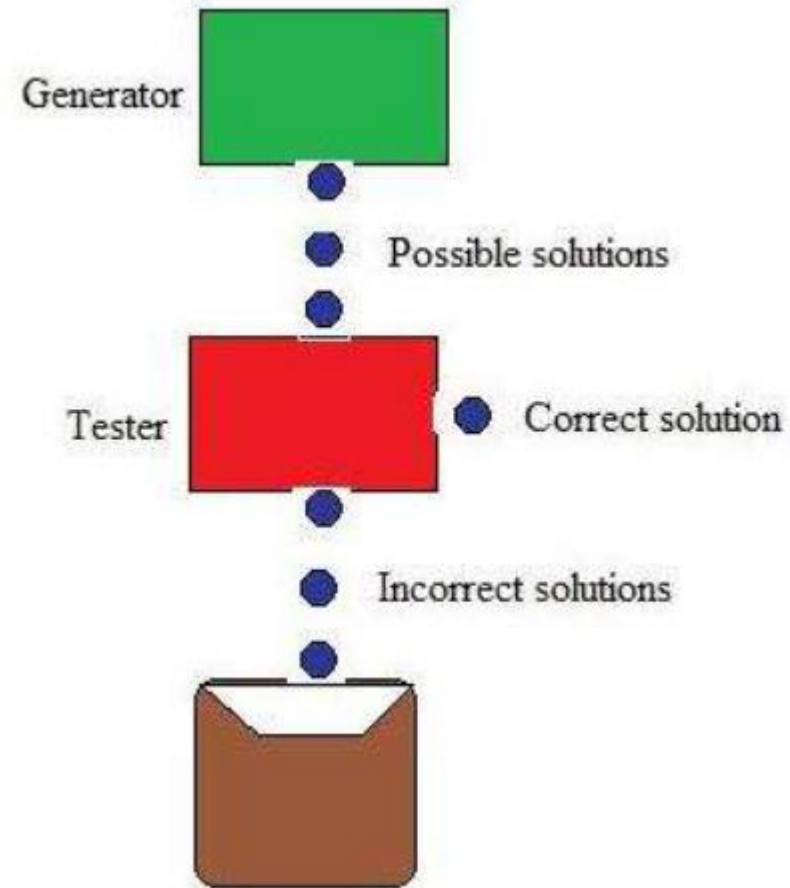



- **Heuristic search**
- Estimates 'distance' to goal state through explored nodes
- Guides search process toward goal
- Prefers states (nodes) that lead close to and not away from goal state



GENERATE AND TEST

- Generate-and-test search algorithm is a very simple algorithm that guarantees to find a solution if done systematically and there exists a solution.
- **Algorithm: Generate-And-Test**
 - 1. Generate a possible solution.
 - 2. Test to see if this is the expected solution.
 - 3. If the solution has been found quit else go to step 1.

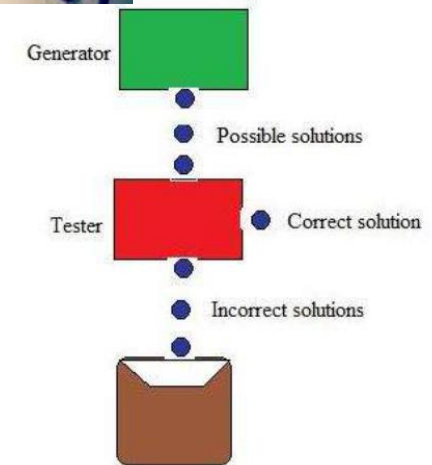


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- Potential solutions that need to be generated vary depending on the kinds of problems
 - For some problems the possible solutions may be particular points in the problem space and for some problems, paths from the start state

 - Generate-and-test, like depth-first search, requires that complete solutions be generated for testing
 - In its most systematic form, it is only an exhaustive search of the problem space.
 - Solutions can also be generated randomly but solution is not guaranteed
 - This approach is what is known as British Museum algorithm: finding an object in the British Museum by wandering randomly.

SYSTEMATIC GENERATE AND TEST

- While generating complete solutions and generating random solutions are the two extremes there exists another approach that lies in between
- The approach is that the search process proceeds systematically but some paths that unlikely to lead the solution are not considered
- This evaluation is performed by a heuristic function
- Depth-first search tree with backtracking can be used to implement systematic generate-and-test procedure
- As per this procedure, if some intermediate states are likely to appear often in the tree, it would be better to modify that procedure to traverse a graph rather than a tree



GENERATE AND TEST AND PLANNING

- First, the planning process uses constraint-satisfaction techniques and creates lists of recommended substructures
- Then the generate-and-test procedure uses the lists generated and required to explore only a limited set of structures
- Constrained in this way, generate-and-test proved highly effective



