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# Task 07

# A\* Search Algorithm - Theory

The A\* (A-star) Search Algorithm is one of the most efficient and widely used pathfinding and graph traversal algorithms in computer science and artificial intelligence. It is used to find the shortest path from a start node to a goal node.  
  
A\* uses a combination of two factors to decide which path to take:  
1. g(n): The actual cost from the start node to the current node.  
2. h(n): The estimated cost (heuristic) from the current node to the goal.  
  
The total cost function is represented as:  
f(n) = g(n) + h(n)  
  
This function helps A\* to choose the path that appears to be the best, balancing both the actual distance and the estimated distance to the goal.  
  
### Working of A\* Algorithm:  
1. Start from the initial node.  
2. Add it to an open list (nodes to be evaluated).  
3. Select the node with the lowest f(n) value.  
4. Move this node to the closed list (already evaluated nodes).  
5. For each neighboring node:  
 - Calculate g(n), h(n), and f(n).  
 - If a better path is found, update the node’s cost.  
6. Repeat until the goal node is reached or no more nodes remain.  
  
### Heuristic Function:  
The heuristic is a way to estimate how close the current node is to the goal. Common heuristics include:  
- Euclidean Distance  
- Manhattan Distance  
  
### Advantages of A\* Search:  
- Guarantees the shortest path if the heuristic is admissible.  
- Efficient and flexible for many applications.  
- Can handle complex maps or graphs.  
  
### Disadvantages:  
- Requires more memory.  
- Performance depends on the accuracy of the heuristic.  
  
### Applications of A\* Algorithm:  
- GPS Navigation Systems  
- Game AI Pathfinding  
- Robot Motion Planning  
- Network Routing  
  
In simple terms, A\* search intelligently explores possible paths and finds the best one by combining the cost of the path so far and the estimated distance to the goal.