Ai Project Proposal

Solving Problem Using AI Search Algorithms

- ## The Problem Is :

Block Stacking Problem

- ## Introduction :

This project explores and applies fundamental Artificial Intelligence search algorithms to solve the **Block Stacking Problem**, a classic planning and state-space search problem in AI.

The objective is to transform an initial block configuration into a goal configuration using valid moves while respecting predefined constraints. The project emphasizes algorithm behavior, performance trade-offs, and comparison between uninformed, informed, and optimal search techniques.

- ## Problem Description :

In the **Block Stacking Problem** a set of blocks (e.g., A, B, C) can be stacked on top of each other or placed on the table.

Objective :

Transform the initial configuration into the target goal configuration using the minimum number of valid moves.

Example :

Initial State : A on B, B on Table, C on Table
Goal State : C on B, B on A

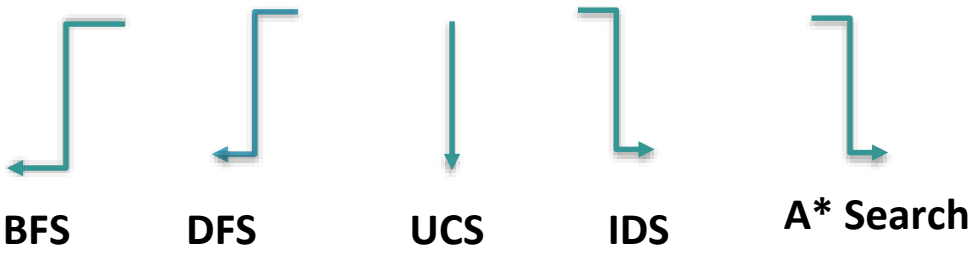
Rules and Constraints :

Only **one block** can be moved at a time
A block can be moved **only if it is clear** (no block on top of it)
A block can be placed:
On the table, or
On top of another clear block
Each move has a uniform cost = 1

• Why Block Stacking?

- It is a perfect benchmark for search algorithms
- It demonstrates the difference between optimal search and heuristic search
- Suitable for theoretical and practical comparison of algorithms

Algorithms Implemented



1 : Breadth-First Search (BFS)

BFS explores the state space **level by level** expanding all states at the current depth before moving deeper.

Why BFS fits Block Stacking ?

- Guarantees the **shortest sequence of moves**
- Simple and systematic exploration

Expected Behavior :

- Always finds the optimal solution
- Very high memory consumption for larger problems

2 : Depth-First Search (DFS)

DFS explores the search space by going **as deep as possible** along one branch before backtracking.

Why DFS fits Block Stacking ?

- Very memory-efficient
- Simple to implement

Expected Behavior :

- May find a solution quickly
- Does **not guarantee optimality**

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3 : Uniform Cost Search (UCS)

UCS expands nodes based on the **lowest cumulative path cost .**

Why DFS fits Block Stacking ?

- Guarantees optimal solutions
- Works well since all moves have uniform cost
- Serves as a baseline for optimal comparison

Expected Behavior :

- Slower than DFS and IDS
- Extremely accurate (optimal)

4 : Iterative Deepening Search (IDS)

IDS combines DFS and BFS by performing depth-limited DFS, increasing the depth limit gradually until the goal is found.

Why LDS fits Block Stacking ?

- Guarantees optimality like BFS
- Uses memory efficiently like DFS

Expected Behavior :

- Optimal solution
- Lower memory usage than BFS

5 : A* Search Algorithm

A* is an informed search algorithm combining path cost

Heuristic estimate : **f(n) = g(n) + h(n**

Heuristic Used :

- Number of blocks that are not in their goal position
- Admissible and simple

Why A* fits Block Stacking :

- Faster than UCS
- Reduces search space dramatically
- Still capable of reaching optimal or near-optimal solutions

Expected Behavior :

- Faster convergence than BFS/UCS
- Higher memory usage

• Evaluation & Expected Results :

During experimentation we will evaluate each algorithm based on:

Performance Metrics :

- Execution time
- Memory usage
- Path cost (tour length)
- Optimality vs. speed
- Scalability with number of blocks

What we expect ?

- **UCS** : Best optimal result, but slowest
- **A*** : Fast + near-optimal, depending on heuristic strength
- **DFS** : fast but not always optimal

This comparison highlights the trade-offs between uninformed search,heuristic search, and optimal search approaches.

Algorithm	*Expected Solution Quality*	*Expected Speed*	*Key Insight*
BFS	*Optimal*	*Slow*	Baseline for optimal search
DFS	*Not Guaranteed*	*Fast*	Shows depth bias
UCS	*Optimal*	*Slow*	cost based / optimal search
IDS	*Optimal*	Moderate	Best trade off
A Search*	*Optima / Near Optimal*	*Fast*	Power of heuristics

Deliverables :

The final submission will be through a single Public GitHub Repository link, which will contain the following components:

- Source Code for all five algorithms (UCS, A*, BFS,DFS,IDS).
- A README.md file providing clear instructions on how to set up, run, and test the project.
- A detailed PDF Report including implementation specifics, comprehensive results,comparison tables, and visual analysis of the performance metrics across all algorithms

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