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Assignment 2 — Search

1.

Algorithm	Time	Space	Complete?	Optimal?
BFS	$O(b^d)$	$O(b^d)$	Yes	Yes
UCS	$O(b^d)$	$O(b^d)$	Yes	Yes
DFS	$O(b^m)$	O(bm)	No	No
DLS	$O(b^l)$	O(bl)	No (if l < d)	No
IDS	$O(b^d)$	O(bd)	Yes	Yes
A*	$O(b^d)$	$O(b^d)$	Yes	Yes

b = branching factor; the maximum number of successors of any node
d = depth of the shallowest solution
m = maximum depth of the search
l = limit in depth limited search.

2. Total States Calculated:
    a. Breadth First Search: **26**
    b. Depth First Search: **9**
    c. Depth Limited Search; Limit = 7: **9**
    d. Subproblem Search: **20**

3. Total States Calculated:
    a. A*: **23**
    b. Uniform Cost Search: **32**
4. n/a
5. Deep Blue
    a. The engineering advances that contributed to the success of Deep Blue included: a single-chip chess search engine, a massively parallel system with multiple levels of parallelism, a strong emphasis on search extensions, a complex evaluation function recognizing thousands of patterns, and effective use of a Grandmaster game database.
    Some of these advances, like parallel computing, advanced search algorithms, and hardware-based evaluation functions, can be

transferred to other complex problems that involve optimization and decision-making tasks.
However, features like the chess-specific evaluation function and game database are specific to the intricacies of chess.

b. Stockfish evaluates around 70 million positions per second using handcrafted evaluation functions.
AlphaZero evaluates far fewer positions—around 80,000 per second in chess—but focuses on high-quality, “human-like” moves by using a deep neural network trained through self-play.
This network predicts move probabilities and game outcomes, allowing AlphaZero to concentrate its search on the most promising variations, effectively reducing the need to explore vast numbers of positions, as Stockfish does.