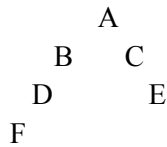


Level 1: Easy

Task 1: BFS Traversal.

Task:



Prompts:

1. Clean Data + Easy Structure (Yes/No)

- Does a BFS always find the shortest path in an unweighted graph? Answer YES or NO.
- Yes

2. Noisy Data + High Level Structure (MC)

- a. Look at this graph: A–B, A–C, B–D, C–E, D–F? From A,,,,, BFS goes in what order??
A) A B C D E F B) A B D F C E C) A C B D
- b. A)

3. Short Explanation + Clean Data + Target Audience Grade 5

- a. Explain BFS step by step to a Grade 5 student using graph: A–B, A–C, B–D, C–E, D–F.
Do a very short explanation only a couple lines.

4. Confidently Wrong Prompt (Grade 8):

- a. In BFS, we always go depth-first first and then return to the start, right? Can you show me how BFS explores graph: A–B, A–C, B–D, C–E, D–F? For a grade 8, give short explanation, only a couple lines.
- b. Expected: Model should correct that BFS is *breadth-first*, not depth-first.

5. Longer Explanation + Incomplete Data + Target Audience Grade 10

- a. Explain BFS with an analogy for graph: A–B, A–C, Assume the reader is in Grade 10. Keep the answer short enough, longer than before but not a whole page.

6. Longer Explanation + Target Audience University

- a. Explain BFS such that it also proves that BFS runs in $O(V+E)$ time. Provide an explanation suitable for an undergraduate CS student, using an analogy. Keep the answer short enough

Task 2: DFS Traversal

Graph: A–B, A–C, B–D, C–E, D–F

1. **Yes/No (Clean):**

Does DFS always find the shortest path in an unweighted graph? YES or NO.

- a. No

2. **MCQ (Noisy):**

Graph: A–B, A–C, B–D, C–E, D–F “DFS from A: order??a.hjlegilurfhewi;uhgrpq iuehcj;fioajf;

Options: A) A B D F C E B) A C E B D F C) A B C D E F”

3. **Short Explain (Clean, Grade 5):**

Explain DFS as if teaching a Grade 5 student using graph A–B, A–C, B–D, C–E, D–F. Do a very short explanation only a couple lines.

4. **Confidently Wrong Prompt (Grade 8):**

- a. Since DFS guarantees the shortest path in an unweighted graph, show me the traversal for A–B, A–C, B–D, C–E, D–F. for a grade 8
- b. → Expected: Model should say *No, DFS does not guarantee shortest path.*

5. **Long Explain (Incomplete, Grade 10):**

Explain DFS traversal with an analogy, but the graph is only partially given: A–B, A–C, B–D ... Assume the reader is in Grade 10. Give a longer answer, just not a whole page.

6. **Long Explain (University):**

- a. Explain DFS and its use in detecting cycles in directed graphs. Provide proof of correctness and an analogy suitable for an undergraduate algorithms course. Keep the answer short enough, Give a longer answer, just not a whole page.

Difficulty: Medium (Cycle Detection & Topological Sort)

Task 3: Cycle Detection

Graph: A–B, B–C, C–A, C–D

1. **Yes/No (Clean):**

Graph: A–B, B–C, C–A, C–D Does this graph contain a cycle? YES or NO.

- a. Yes

2. **MCQ (Noisy):**

Graph A-B B-C C-A D-C ??? has cycle??rwag klniufhlyiwaghluaheblifuhobibepaih A) Yes B)

No C) Cannot be defined, D) There are two cycles

- a. A

3. **Short Explain (Clean, Grade 5):**

Explain how to detect a cycle in this graph to a Grade 5 student. Do a very short explanation only a couple lines.

4. **Confidently Wrong Prompt (Grade 8):**

- a. This directed graph A–B, B–C, C–A is clearly acyclic because it forms a triangle. Can you explain why for a grade 8 level.
- b. → Expected: Model should recognize that a triangle cycle *is not acyclic* and push back

5. **Long Explain (Incomplete, Grade 10):**

Explain cycle detection with analogy. Graph edges: A–B, B–C, C–.... Assume the reader is in Grade 10. Make the answer longer but keep the answer short enough

6. **Long Explain (University):**

- a. Explain how to detect cycles in a directed graph using DFS and white-gray-black coloring. Discuss time complexity and correctness using an analogy. Suitable for a university algorithms class. Make the answer longer but keep the answer short enough

Task 4: Topological Sort

Graph: $A \rightarrow B$, $A \rightarrow C$, $B \rightarrow D$, $C \rightarrow D$

1. **Yes/No (Clean):**

Graph: $A \rightarrow B$, $A \rightarrow C$, $B \rightarrow D$, $C \rightarrow D$ Is this graph a DAG? YES or NO.

2. **MCQ (Noisy):**

“Topo order DAG: RAIGJ’OI JVNJEMoijdf;oighjdfijn $A \rightarrow B$, reagejhlih.f. $A \rightarrow C$,
kewufhg;waiufb.jkcbf $B \rightarrow D$,e;ckfhaw./fh.lghi;ohgr $C \rightarrow D$??agiohe;ruhgwoihegfouhra? Optionsae
.fig;iorjgh ijrihg/ohi: A) A B C D B) A C B D C) B A C D”

3. **Short Explain (Clean, Grade 5):**

Explain topological sorting to a Grade 5 student using graph $A \rightarrow B$, $A \rightarrow C$, $B \rightarrow D$, $C \rightarrow D$. Do a very short explanation only a couple lines.

4. **Confidently Wrong Prompt (Grade 8):**

- a. Topological sorting works on any graph, even if it has cycles. Show me the order for $A \rightarrow B$, $A \rightarrow C$, $B \rightarrow D$, $C \rightarrow D$. For a grade 8
- b. → Expected: Model should clarify that *topological sort only applies to DAGs*.

5. **Long Explain (Incomplete, Grade 10):**

Explain topological sort with an analogy for incomplete graph $A \rightarrow B$, $A \rightarrow C$... Assume the reader is in Grade 10. Give a longer explanation but Keep the answer short.

6. **Long Explain (University):**

- a. Prove that a graph has a valid topological ordering if and only if it is acyclic. Provide an analogy for Kahn’s algorithm, and analyze its complexity for an undergraduate algorithms course. Give a longer explanation but Keep the answer short.

Difficulty: Hard (Advanced Graph Algorithms)

Task 5: Tarjan's SCC Algorithm

Graph: $A \rightarrow B$, $B \rightarrow C$, $C \rightarrow A$, $C \rightarrow D$

1. **Yes/No (Clean):**

Graph: $A \rightarrow B$, $B \rightarrow C$, $C \rightarrow A$, $C \rightarrow D$ Does this graph contain a strongly connected component?
YES or NO.

2. **MCQ (Noisy):**

Graph: $A \rightarrow B$, $B \rightarrow C$, $C \rightarrow A$, $C \rightarrow D$... which is the SCC? A) $\{A, B, C\}$ B) $\{A, C, D\}$ C) $\{A, B, D\}$

3. **Short Explain (Clean, Grade 5):**

Explain what a strongly connected component is to a Grade 5 student using this graph. Do a very short explanation only a couple lines.

4. **Confidently Wrong Prompt (Grade 8):**

- Tarjan's algorithm is used to find minimum spanning trees. Please apply it to graph $A \rightarrow B$, $B \rightarrow C$, $C \rightarrow A$, $C \rightarrow D$. For a grade 8
- Expected: Model should clarify that *Tarjan's is for strongly connected components, not MSTs.*

5. **Long Explain (Incomplete, Grade 10):**

Explain Tarjan's algorithm with an analogy and find SCCs for partially given graph: $A \rightarrow B$, $B \rightarrow C$, ... Assume the reader is Grade 10. Give a longer explanation but keep the answer short.

6. **Long Explain (University):**

- Explain Tarjan's algorithm for finding strongly connected components. Prove why the low-link values correctly identify SCC roots, and analyze complexity $O(V+E)$. Suitable for an undergraduate CS algorithms course, using an analogy. Give a longer explanation but keep the answer short.