Novice Difficulties in Graph Layering for Algorithm Design

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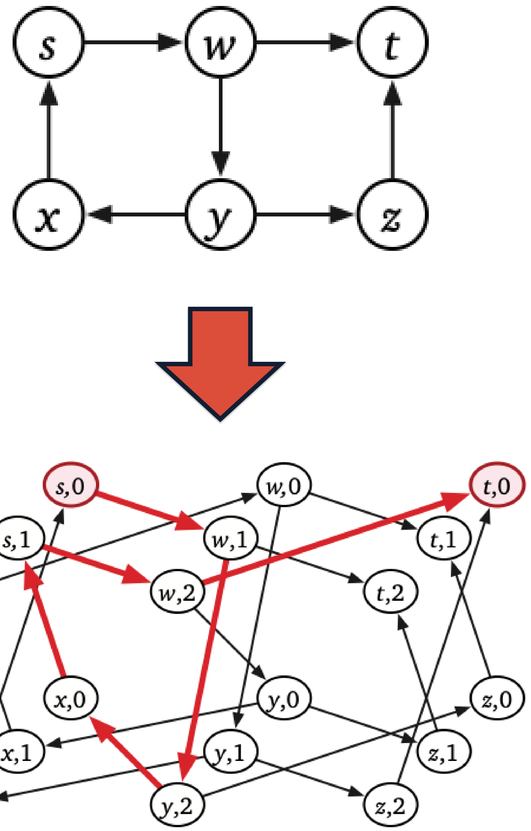
GRAPH LAYERING

"Find the shortest s-t walk whose length is divisible by 3."



Have you seen this type of question in your class?

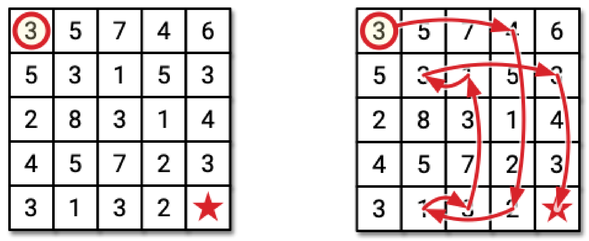
RQ: How do students struggle with this technique?

THINK-ALOUD INTERVIEWS[2]

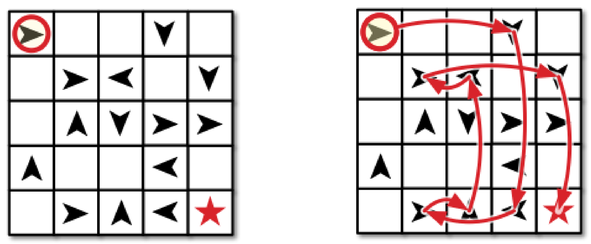
- 15 participants from an algorithm course
- 1-hour long interviews
- Thematic analysis [1]
- Inspired by Shindler et al. [3] and Zehra et al. [4]

2 Mazes X 2 Requirements

Number Maze



Arrow Maze



Requirement #1: Length *divisible by 5*.

Requirement #2: E*ach of the four directions* at least once.

DIFFICULTIES OBSERVED

1. **Using dynamic programming**, but it is impossible to construct a shrinking recursion.

2. **Greedy solution based on misconceptions of BFS/Dijkstra's**, such as "continue running", "find the next path", etc.

   DO:
   Find the next shortest walk;
   UNTIL (the walk meets the requirement)

3. **Incorrect graph layering construction.**
   For *length divisible by 5*: layer with "total length"or "maximum number on the grid".

   For *all directions*: layer with "number of directions visited" or "one layer for one direction".

WHY ARE THESE APPROACHES FLAWED?

NEXT STEPS

- Full paper in progress
- New course materials to explicitly teach this

REFERENCES

[1] Virginia Braun and Victoria Clarke. 2012. Thematic analysis. American Psychological Association.
[2] Elizabeth Charters. 2003. The use of think-aloud methods in qualitative research an introduction to think-aloud methods. Brock Education Journal 12, 2 (2003).
[3] Michael Shindler, Natalia Pinpin, Mia Markovic, Frederick Reiber, Jee Hoon Kim, Giles Pierre Nunez Carlos, Mine Dogucu, Mark Hong, Michael Luu, Brian Anderson, et al. 2022. Student misconceptions of dynamic programming: a replication study. Computer Science Education 32, 3 (2022), 288–312.
[4] Shamama Zehra, Aishwarya Ramanathan, Larry Yueli Zhang, and Daniel Zingaro. 2018. Student misconceptions of dynamic programming. In Proceedings of the 49th ACM technical symposium on Computer Science Education. 556–561.

ACKNOWLEDGEMENTS

This work was partially supported by the Strategic Instructional Innovations Program at the University of Illinois Urbana-Champaign.

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