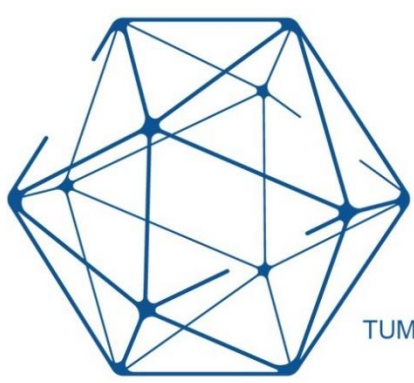




TUM International Graduate School of
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Where Do LLMs Get Lost? A Multi-Scale Diagnostic Benchmark for Spatial Navigation

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Project Outline/Mission

1. What spatial representations best support LLM navigation?
2. Where do LLMs fail when navigating across spatial scales?
3. What levels of spatial decision-making should be delegated to LLMs in hybrid navigation agents?

Key Figures

Human: from O to D, the overall direction is **down and to the left**. First go **left** until you **reach the end**, then go **down**. At that point, the only available path goes to the **right**. Although this seems to go against the overall direction, there were no other intersections before, so you try it...

ChatGPT : Start from O, go **left** along the **top corridor** to the end. Then go **down** into the **middle area**, continue **down** to the **lower corridor**, turn **right** briefly, and then go **down** to the bottom. Finally, go **left** along the bottom corridor until you **reach D**.

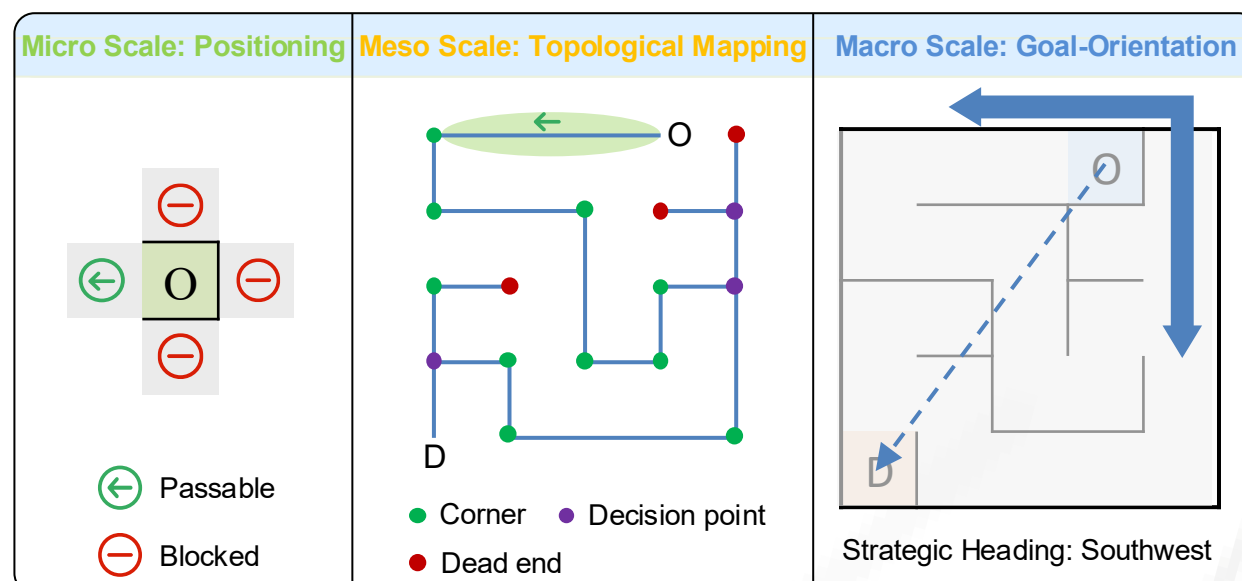
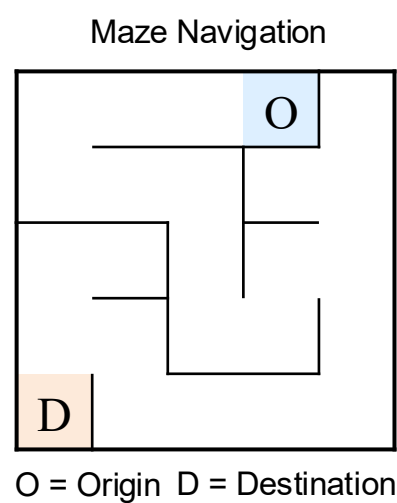


Fig 1. Decomposing maze navigation into micro, meso, and macro scale spatial reasoning

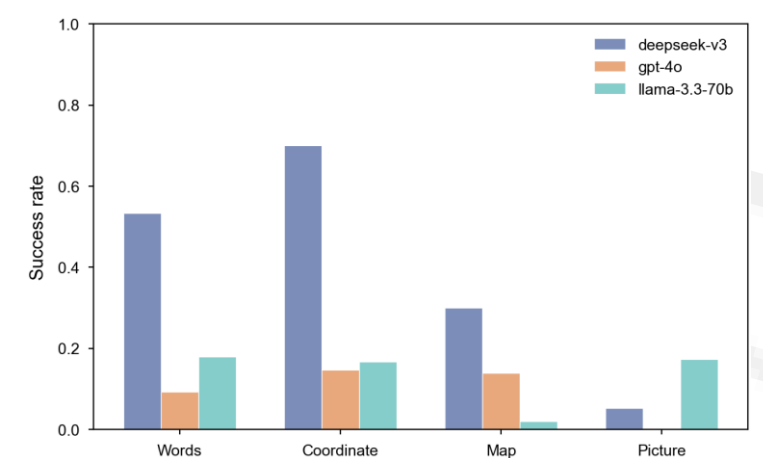


Fig 2. Success rate across four input representations on small mazes

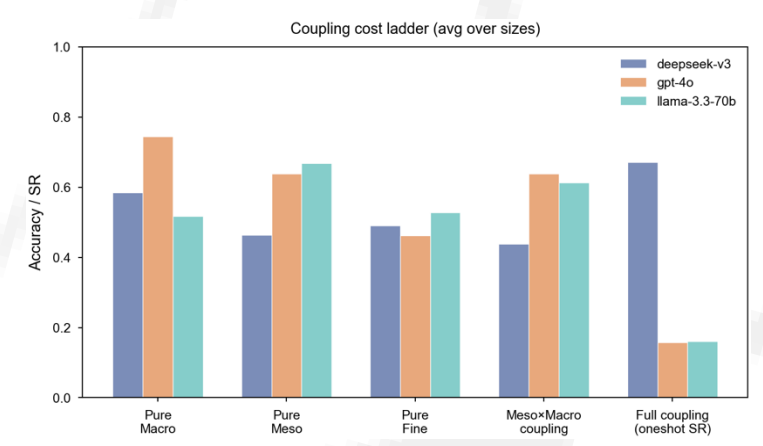


Fig 3. Performance under Cross-Scale Coupling

Conclusion

1. Coordinate-based representations achieved the most consistent performance in our maze navigation benchmark, outperforming maps, text, and images.
2. LLMs possess spatial abilities at individual scales, but fail when decisions must be coordinated across Micro, Meso, and Macro spatial scales.
3. Hybrid navigation agents should delegate high-level spatial decisions to LLMs, while low-level path execution is handled by deterministic algorithms.

Team

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