Project Update Report: Extending PRRP for Spatial and Graph Partitioning

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February 24, 2025

1 Project Overview

The project aims to implement and extend the PRRP (P-Regionalization through Recursive Partitioning)[2] algorithm for both spatial regionalization and graph partitioning. The goal is to partition spatial and graph datasets while maintaining statistical significance and spatial contiguity. The implementation is structured into four phases:

1. **PRRP for Spatial Regionalization** (Completed)
2. **Extending PRRP to Graph Partitioning** (Completed)
3. **Experimental Evaluation and Comparison** (Ongoing, ∼50% complete)
4. **Project Report and Documentation** (Final Stage)

2 Progress Since the Last Update

- **Phase 2 (Graph Partitioning Extension):** *Completed*
  - Implemented final adjustments to PRRP's graph partitioning logic.
  - Conducted extensive testing on METIS-format datasets.
  - Improved handling of disconnected subgraphs and spatial constraints.
- **Phase 3 (Experimental Evaluation and Comparison):** *Ongoing*
  - Evaluated PRRP against METIS[5] and PyMETIS[6].
  - Collected preliminary performance metrics (execution time, edge cuts, contiguity).
  - Working on refining comparisons and tuning performance.
- **Phase 4 (Report and Documentation):** *Started*
  - Began structuring the final project report.
  - Initial documentation of key algorithms and experimental findings.

3 Team Contributions

Our group continues to contribute equally across all aspects:

- **Code Implementation:** Completion of graph PRRP and performance improvements.
- **Testing and Evaluation:** Running experiments, verifying correctness, and analyzing results.
- **Documentation and Reporting:** Drafting this report, preparing performance summaries, and structuring the final report.

4 Future Timeline and Milestones

With the final deliverable due on **March 12, 2025**, the remaining milestones are:

- **February 24 – March 5, 2025:** Finalize comparative evaluation, generate visualizations, and optimize PRRP's performance.
- **March 5 – March 10, 2025:** Complete the final project report and documentation.
- **March 10 – March 12, 2025:** Conduct final validation and submit deliverables.

5 Pending Tasks and Challenges

a. **Finalizing Performance Comparisons:** Refining benchmark comparisons with METIS and PyMETIS.

b. **Report Completion:** Ensuring the final document is well-structured, technically detailed, and comprehensive.

c. **Last-Stage Testing:** Validating edge cases and ensuring robustness of graph PRRP implementations.

6 Related Work

Additional relevant works that informed our approach include:

- The scalable max-P regionalization technique proposed by Alrashid et al. [1].
- The formulation of the max-P-regions problem by Duque et al. [4].
- Approaches to balanced graph partitioning as studied by Andreev and Räcke [3].

7 Conclusion

Since the last update, we have completed the graph PRRP implementation and made significant progress in evaluating its performance. The focus now shifts to refining experimental results, optimizing code efficiency, and finalizing the project report before the March 12, 2025 deadline.

References

[1] Alrashid, H., Liu, Y., and Magdy, A. Smp: Scalable max-p regionalization. In *Proceedings of the 30th International Conference on Advances in Geographic Information Systems* (New York, NY, USA, 2022), SIGSPATIAL '22, Association for Computing Machinery.

[2] Alrashid, H., Magdy, A., and Rey, S. Statistical inference for spatial regionalization. In *Proceedings of the 31st ACM International Conference on Advances in Geographic Information Systems* (New York, NY, USA, 2023), SIGSPATIAL '23, Association for Computing Machinery.

[3] Andreev, K., and Räcke, H. Balanced graph partitioning. In *Proceedings of the Sixteenth Annual ACM Symposium on Parallelism in Algorithms and Architectures* (New York, NY, USA, 2004), SPAA '04, Association for Computing Machinery, pp. 120–124.

[4] Duque, J. C., Anselin, L., and Rey, S. J. The max-p-regions problem. *Journal of Regional Science 52*, 3 (2012), 397–419.

[5] KarypisLab. Metis 5.1.x manual. `https://github.com/KarypisLab/METIS/blob/master/manual/manual.pdf`, 2023. Accessed: 2025-02-10.

[6] PyMETIS Team. Pymetis documentation. `https://documen.tician.de/pymetis/functionality.html`, 2023. Accessed: 2025-02-10.