Project Proposal: Attraction-Convexity and Its Applications

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Topic Overview

This project will explore the concept of attraction-convexity, a geometric property derived from beacon attraction. Beacon attraction describes a movement system in which a point moves to minimize its Euclidean distance to a beacon (another point). If there are no obstacles, the point moves directly toward the beacon; when obstacles are present, the point either slides along them or becomes stuck. A beacon is said to attract a point if the point can ultimately reach it by following this method.

A polygon is considered *attraction-convex* if every point within it attracts every other point. These polygons, also referred to as normally visible polygons in the computational geometry literature, are discussed in the article "Attraction-Convexity and Normal Visibility" from the Computational Geometry journal [1], which forms the basis of our study. This article also presents a linear-time algorithm for recognizing *attraction-convex* polygons, which we will implement as part of this project.

Beacon attraction is not inherently symmetric, so we will also investigate *inverse attraction regions*. Like the second article said [2], these regions are more complex, as they are not always connected, making their computation more challenging compared to regular attraction regions.

Project Plan

Our project will be divided into several components:

1. **Web Page Development**

   We will develop a dedicated web page that explains *attraction-convexity* and demonstrates the algorithms we implement. This web page will provide an accessible platform for users to interact with the topic through visual demonstrations and an interactive tool. The web page will include:

   - An introduction to *attraction-convexity* and related concepts
   - Implemented algorithms
   - An interactive tool for real-time experimentation with the algorithms
   - A bibliography of all resources used

2. **Concept Definitions and Glossary**

   To ensure the project is accessible to a broader audience, we will create a glossary defining the geometric and computational concepts introduced in our explanations. This glossary will be available on the web page to clarify any technical terms that may be unfamiliar to users.

3. **Explanation of Attraction-Convex and Normally Visible Polygons**

   We will provide an in-depth explanation of *attraction-convex* polygons, also referred to as *normally visible* polygons. This section will highlight their significance in geometric proofs and algorithm design, forming the theoretical foundation for the project.

4. **Implementation of the Attraction-Convex Polygon Recognition Algorithm**

   A core component of our project is the implementation of the linear-time algorithm for recognizing *attraction-convex* polygons, as described in the article "Attraction-Convexity and Normal Visibility" [1]. This implementation will serve as our practical demonstration of the concepts and will be integrated into the interactive tool on the web page. By implementing the algorithm, we will test and solidify our understanding of *attraction-convexity*.

5. **Exploring Inverse Attraction Regions**

   In addition to *attraction-convexity*, we will explore *inverse attraction regions*, a topic examined in both the first article and another key paper, "Inverse Beacon Attraction"[2]. These regions describe areas from which beacon positions can attract a given point. The second paper demonstrates that computing these regions has a $O(n \log n)$ complexity in the case of simple polygons, and we aim to implement this computation as part of the project.

6. **Development of Visual Explanations through Code**

   To make the theoretical concepts more accessible, we will develop visualizations that demonstrate the behavior of attraction points. These visualizations will show how points move toward beacons and how obstacles influence their movement, with a particular focus on *attraction-convex* polygons and *inverse attraction regions*.

Work Distribution

The glossary will be developed incrementally as we progress through the project. Each team member will be responsible for updating and ensuring the completeness of the glossary as we encounter new concepts.

The two algorithms will be implemented by two distinct team members. The third member will alternate between assisting with both algorithms and provide support as needed. Final task assignments for the algorithm implementation will be decided later, depending on the progress of each team member.

The explanation sections will be divided between two members. The remaining team member will be responsible for designing and constructing the web page.

Conclusion

By combining theoretical exploration, algorithmic implementation, and interactive visualizations, this project will provide a thorough examination of *attraction-convexity* and its practical implications in computational geometry.

Bibliography

[1] P. Bose and T. C. Shermer, "Attraction-convexity and normal visibility," *Computational Geometry*, vol. 96, p. 101748, 2021, doi: https://doi.org/10.1016/j.comgeo.2021.101748.

[2] I. Kostitsyna, B. Kouhestani, S. Langerman, and D. Rappaport, "An Optimal Algorithm to Compute the Inverse Beacon Attraction Region," in *34th International Symposium on Computational Geometry (SoCG 2018)*, B. Speckmann and C. D. Tóth, Eds., in Leibniz International Proceedings in Informatics (LIPIcs), vol. 99. Dagstuhl, Germany: Schloss Dagstuhl – Leibniz-Zentrum für Informatik, 2018, pp. 1–14. doi: 10.4230/LIPIcs.SoCG.2018.55.