

# Optimization of Snake Game Algorithms

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# Agenda

- Introduction of Problem
- Mathematics and Goal
- Algorithms
- Demo
- Regression Analysis
- Conclusion

# Intro

- Snake game is simple in nature, but complex in practice
- Path Finding Algorithm: a computer process that is followed in problem solving operations, aiming to find the shortest/most efficient path between 2 points
- Project: Optimization of snake game to increase success, minimize time



# Mathematical Problem

Mathematical Algorithms

$\text{Alg}_1(\ell_i) \begin{cases} \leftarrow s_1(\ell_i) \\ \leftarrow t_1(\ell_i) \end{cases}$

$\text{Alg}_2(\ell_i) \begin{cases} \leftarrow s_2(\ell_i) \\ \leftarrow t_2(\ell_i) \end{cases}$

$\min_{a_1, a_2} \text{time} = a_1 t_1(\ell) + a_2 t_2(\ell)$

subject to  $s = a_1 s_1(\ell_i) + a_2 s_2(\ell_i) \geq x$  ( $x = \# \text{ less than } z$ )

$a_1 + a_2 = 1$

$a_i \in \{0, 1\}$

- Goal: minimize processing time, maximize success probability across a span of games
  - Regression for convexity



# Algorithms

## 3 Pathfinding Algorithms:

- A\* Algorithm
- Breadth First Search Algorithm
- Dijkstra Algorithm

Each Algorithm follows 2 protocols. Each frame, the algorithm searches for the shortest viable path between the head of the snake and the fruit. If no such path exists, the snake will perform the second protocol and swap to searching for the shortest viable path between the head of the snake and the tail of the snake. In either case, the snake then follows the direction the algorithm is instructing the snake to follow. If both protocols fail, the snake gives up on the run and restarts.

These are not the most sophisticated algorithms. Instead, these algorithms were crafted to provide more interesting data for the convex optimization regression to solve.



# Demonstration

A\*



BFS



Dijkstra



To collect data for the regression analysis, each program was ran for 200 attempts and 5 different sized maps: 6x6, 9x9, 12x12, 15x15, and 18x18. Well over 2 million calculations were performed and nearly 100,000 data points were collected to create the dataset.

# Regression Analysis for Algorithms

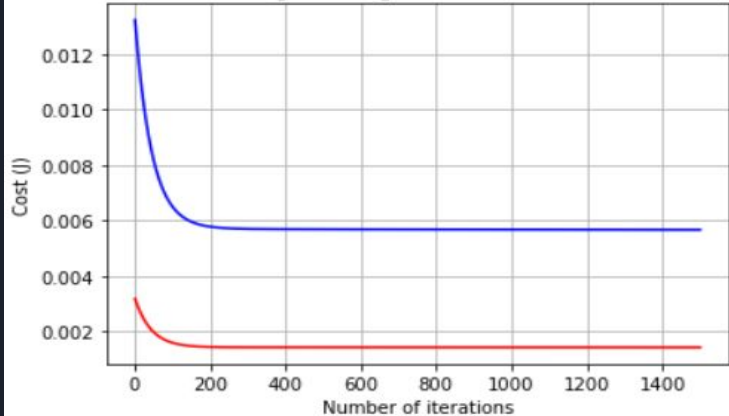
thetas after gradient decent are:

[0.11814326]

[0.018039]

(None, None, None)

Convergence of gradient descent for A\*



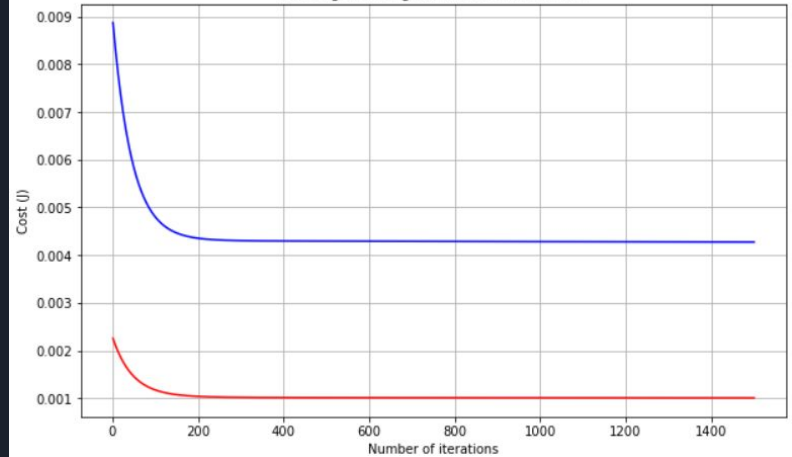
thetas after gradient decent are:

[0.09355117]

[0.00940786]

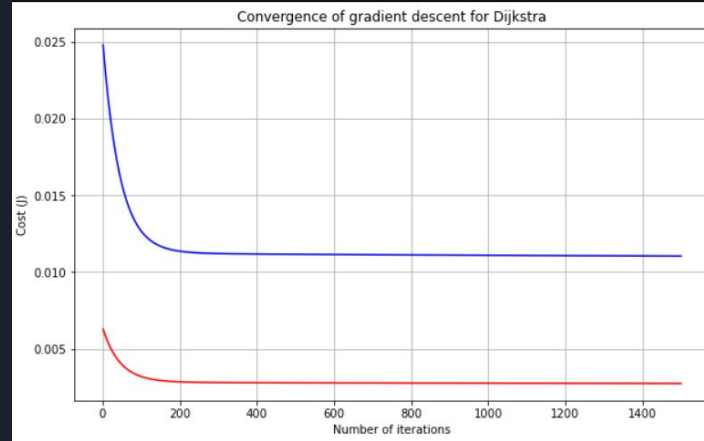
(None, None, None)

Convergence of gradient descent for BSF



# Regression Analysis Cont.

```
thetas after gradient decent are:  
[0.16621662]  
[0.00142269]  
(None, None, None)
```







# Conclusion

- Success rates were maximized using this method, and time trials showed significant decrease in processing time
- Various methods of further optimization, through path finding or other machine learning algorithms
  - Solution is workable, but not complete/perfect
  - Addition of minimization variables
  - Increase in complexity



# References

- Sébastien Bubeck (2015), "Convex Optimization: Algorithms and Complexity", Foundations and Trends® in Machine Learning: Vol. 8: No. 3-4, pp 231-357.  
<http://dx.doi.org/10.1561/22000000050>
- Practical machine learning lecture: Convex optimization. (n.d.). Retrieved December 14, 2022, from <https://people.eecs.berkeley.edu/~jordan/courses/294-fall09/lectures/optimization/>
- Wikimedia Foundation. (2022, December 4). Machine learning. Wikipedia. Retrieved December 14, 2022, from [https://en.wikipedia.org/wiki/Machine\\_learning](https://en.wikipedia.org/wiki/Machine_learning)
- EE392O: Optimization projects. (n.d.). Retrieved December 14, 2022, from <https://web.stanford.edu/class/ee392o/>
- What is linear regression? Statistics Solutions. (2021, August 10). Retrieved December 14, 2022, from <https://www.statisticssolutions.com/free-resources/directory-of-statistical-analyses/what-is-linear-regression/>

Any Questions?

