Space filling curves for the *a priori* TSP problem

BSc project description

The traveling salesman problem (TSP) is a well studied subject in combinatorial optimization. It is $\mathcal{NP}$-hard and there are many approximation algorithms known. One of the more exotic algorithms is by Platzman and Bartholdi III [1]. They use a space-filling curve to approximate the TSP problem in the unite square with the Euclidean metric. The idea can be extended to any d-dimensional space with any l_p-norm. The goal of this project is to use the space filling curve heuristic on a special case of the TSP problem (the *a priori* TSP problem in the scenario model [2]) occurring in photolithography machines.

Photolithography is a process used by semi-conductor manufacturers to transfer the geometric pattern of a chip on a wafer. This is done by putting UV light through a photomask on a photoresistant layer on top of the wafer. The entire wafer is not exposed at one, but one square at a time. If certain parts of a square do not need to be exposed, blades are moved in to block the UV light. Moving the blades is a time consuming process. Since it often influences the total processing time of a wafer in the lithography machine, minimizing the distance will reduce processing time. The blading positions are defined in a file. The blading positions are obtained from this file by reading it from top to bottom and the positions are used by the machine in order of appearance. A product will visit the photolithography machine multiple times during its fabrication. Every time it will use the same file that defines its blading positions, but it will not use all blading positions defined in the file in every visit. So per position it is also defined when in the production of the wafer it is used. Hence minimizing the blading comes down to finding an ordering of the blading positions such that the total distance between the positions is minimized over the sum of all visits.

Project layout

1. Read the article by Platzman and Bartholdi III [1] and reproduce the $O(\log(n))$ deterministic proof.
2. Adjust the algorithm proposed to 4 dimensions.
3. Implement the algorithm and test it on the real data of the semi-conductor manufacturer.
4. Compare its results to the optimal solutions for this problem.

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References

[1] Loren K Platzman and John J Bartholdi III. Spacefilling curves and the planar travelling salesman problem. *Journal of the ACM (JACM)*, 36(4):719–737, 1989.

[2] Frans Schalekamp and David B Shmoys. Algorithms for the universal and a priori tsp. *Operations Research Letters*, 36(1):1–3, 2008.