GPU Heuristic Parallel Implementation of the Travelling Salesman Problem

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What is this poster about ?

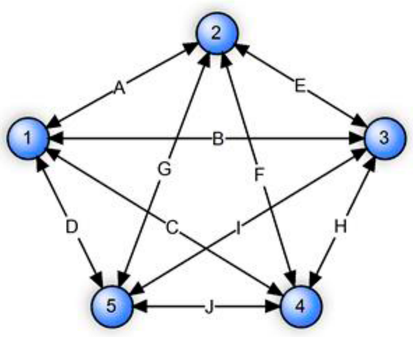
The poster illustrates and present a **novel parallel and heuristic approach implemented in GPU** which is able to validate the solution of meta-heuristics in GPUs, describing **how to use CUDA to solve the travelling salesman problem (TSP)** which is a widely studied NP-Complete problem which has efficient exact and heuristic methods for its solution.

Extended Abstract

The travelling salesman problem (TSP) is a widely studied NP-Complete problem which has efficient exact and heuristic methods for its solution. However, in spite of the use of heuristics, the **TSP remains difficult to solve, and has a high computational cost, even for relatively small datasets**.

Our approach takes beyond existing research by employing GPUs. it's predictable that a GPU approach should be expected to speed up the classic TSP. This is a challenging research, but if we are able to improve performance, we will be showing that **GPUs can actually be useful in solving real optimization problems of high computational complexity.**

Although presenting effective results, this work does not seek to overcome the existing algorithms in the literature. **We rather aim at creating new perspectives, and establish connections between GPUs and optimization problems, enabling and motivating future works.**



	01	02	03	04	05
01	0	A	B	C	D
02	A	0	E	F	G
03	B	E	0	H	I
04	C	F	H	0	J
05	D	G	I	J	0

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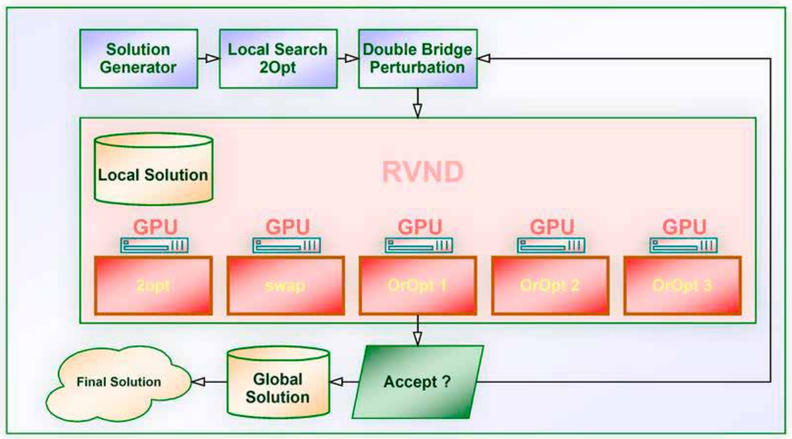
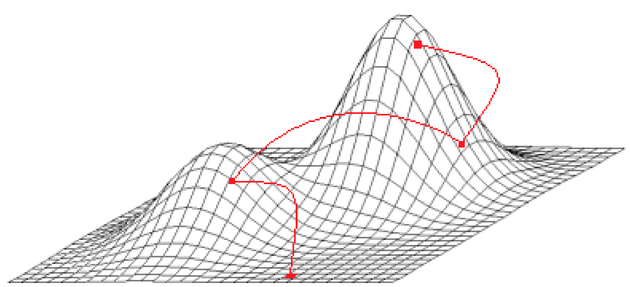
The Algorithm

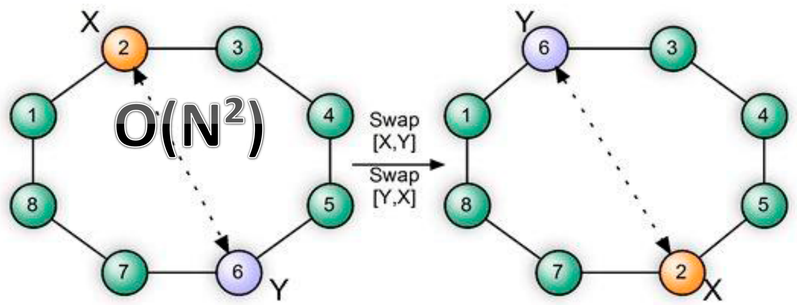
Our model replaces the ILS Local Search by the RVND method. In this work, the input data is made from a file obtained from the TSPLIB library, where can be found many instances of the TSP. We start our method running a solution generator in order to create an initial solution to the problem, which is based on the constructive procedure of the Greedy Randomized Adaptive Search Procedure (GRASP). **In this research five neighborhood were parallelized: 2Opt, Swap, OrOpt-1, OrOpt-2 and OrOpt-3. Each of them modifies the proposed solution in order to improve the costs of the solution generated**. On the right, we can see that every possible permutation is tested using the swap neighborhood and the work is divided among the cores. This is done until a certain criteria is reached.





Results

In this research a GPU heuristic Parallel Implementation of the Travelling Salesman Problem was implemented. **Five algorithms were parallelized** following the paradigm of GPU architectures and **all of them showed significant speedups, ranging from 5 to 20 times for large instances, even for just one GPU**. The whole model was tested and and proved to be effective bringing the best solutions, with **average maximum GAP of 0.33 % in all instances tested.** The implementation was also several times faster than the CPU implementation even for small instances.



N * (N-1)/2 → (8 * 7) / 2 = 28
Swaps = 28 → *Threads* = 4

i → b ← int (sqrt(2 * (i+1)) + 0.5);
a ← b -1 – (b * (b+1) / 2 – (i+1)); → a e b

Acknowledgements

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References

TALBI, E.G. Parallel Local Search on GPU, 2009. Institut National de Recherche en Informatique et en automatique.
SUBRAMANIAN, A.; DRUMMOND, L.M.A.; BENTES, C.; OCHI, L.S.; FARIAS, R. A parallel heuristic for the vehicle routing problem with simultaneous pickup and delivery. *Computers & Operations Research*, v.37. n.11, p.1899-1911, 2010.
BABIN, G.; DENEAULT, S.; LAPORTE, G. Improvements to the Or-opt heuristic for the symmetric travelling salesman problem. *Journal of the Operational Research Society*, v.58, n.3, p.402–407, 2007.