# Traveling Salesman and General Optimization

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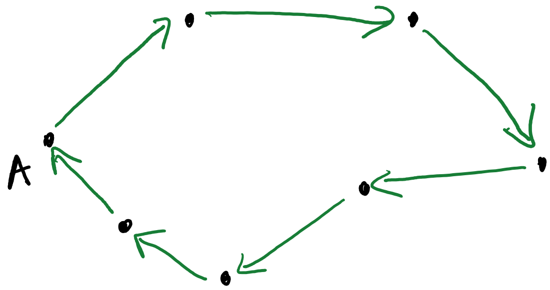



N cities

Optimal (Shortest Distance) Tour over all cities.

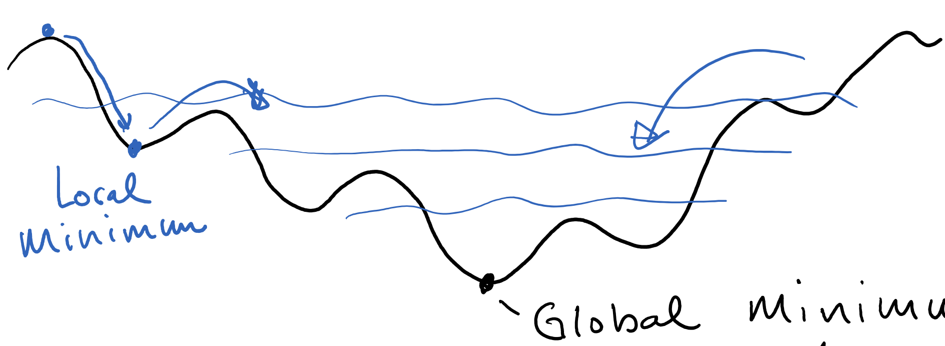
$\cancel{\Theta(N^k)}$ $\Theta(2^N)$

$$E \equiv L_{tour} = \sum_{i=1}^{N} \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}$$

Spin Flips moves $\longrightarrow$

- Swap 2 random cities
- Choose a random segment of the tour and reverse it's direction.
- Choose a random segment and cut it out and insert it into a new random position.

$$P(E, E', T) = \begin{cases} 1, & E' < E \\ \exp\left(\frac{(E-E')}{T}\right), & E' \geq E \end{cases}$$




Initial $T_0$ : use 100 Random Moves and take

Initial $T_0$: use 100 random Moves and take the largest $\Delta E \rightarrow$ make this our temperature.
$(k_B = 1)$

Make $O(1000)$ Moves at $T_0$
keep the best E tour

$T_{n+1} = 0.9\, T_n$

$C_i \longrightarrow C_j$ in $O(N^k)$ Moves
any any

Our Moves have to allow us to "easily" explore all of Configuration space.

Using Euclidean distance to define the length there are some heuristics that can improve the speed of the solution and set good upper and lower bounds on the path length.

Some very large N benchmark problems for which the true optimum is known.
$\longrightarrow$ 100'000 cities

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www.iwr.uni-heidelberg.de/groups/comopt/software/TSPLIB95/

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