

# Advanced Statistics: Homework 2

## Travelling Salesman with Simulated Annealing

### Problem

The task is to find the optimal traveling salesman route through 30 most populated cities in Russia using simulated annealing.

### Dataset

Dataset contains information about Russian cities with their geo-coordinates (latitude, longitude) and population.

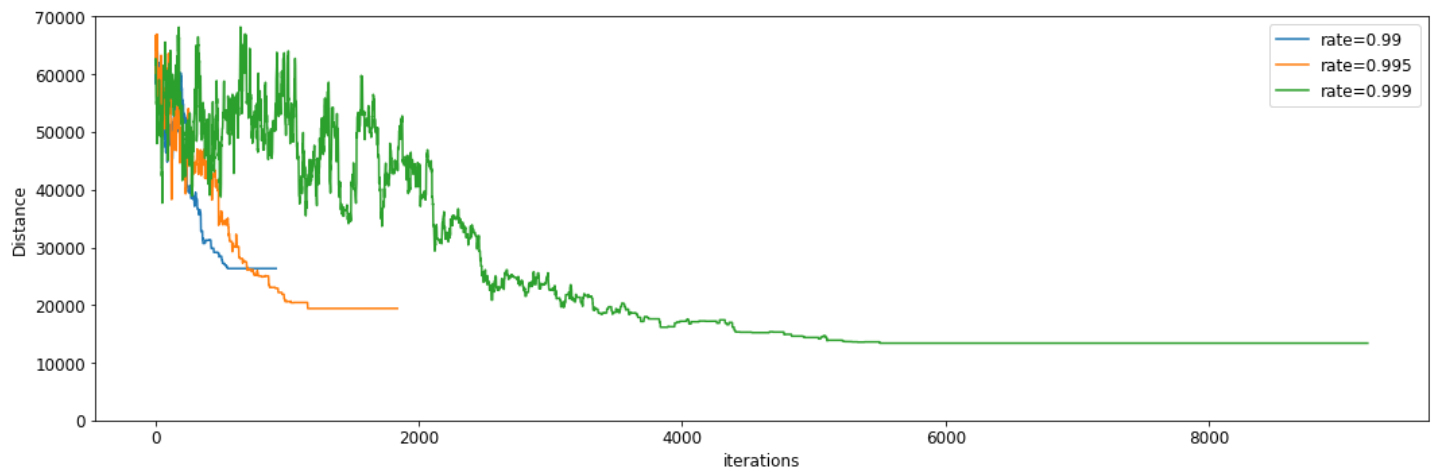
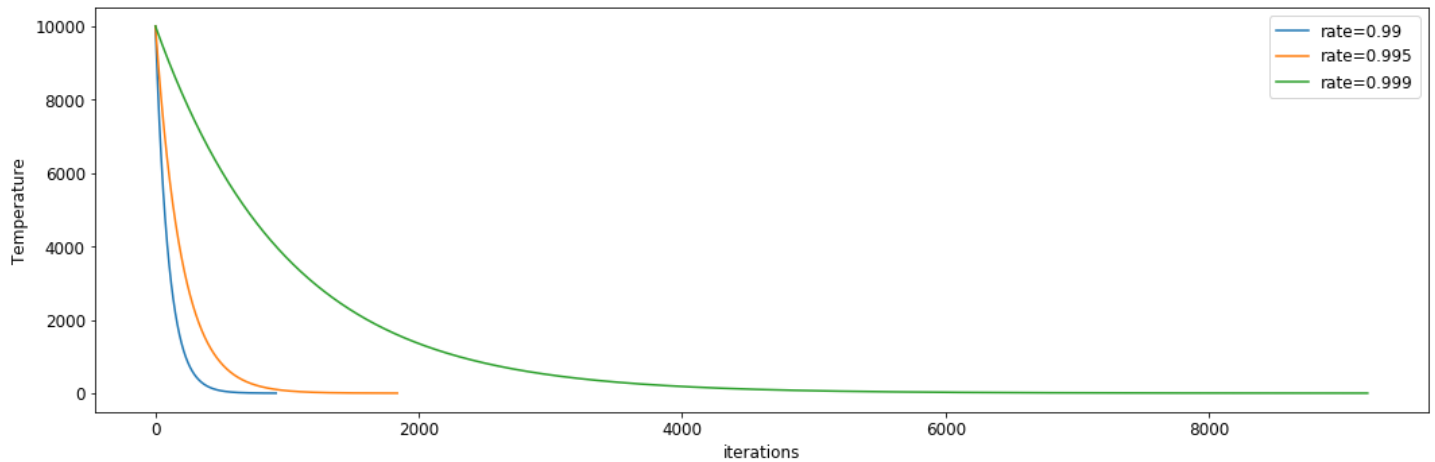
### Solution

1. Select top 30 cities by population
2. Calculate pairwise distance between cities. I've used python library [geopy](#) to calculate distances (in km) by Vincenty's formulae.
3. Start with random path through all 30 cities, calculate initial total distance, assign initial temperature  $T$ .
4. Run simulated annealing algorithm, trying to minimize total distance. At each iteration:
  - a. Pick two cities in the path
  - b. Exchange their positions in the path
  - c. Calculate new total distance
  - d. New path is accepted if  $u \leq \frac{P^*(new\_distance, T)}{P^*(old\_distance, T)}$ 
    - $u \sim U(0,1)$
    - $P^*(dist, T) = e^{-dist/T}$
  - e. Decrease current temperature (exponential decay):  $T \leftarrow T * annealing\_rate$

### Experiments and results

For all 3 experiments initial temperature was 10000.0. The system is considered to be cooled down when the temperature falls below 1.0 (distance stops changing at  $T \approx 10$ )

Experiment	<i>annealing_rate</i>	# of iterations to cool down	Resulting distance (km)
1	0.99	917	≈26331
2	0.995	1838	≈19408
3	0.999	9206	≈13391



Please check out the github repository:

[https://github.com/and-kul/salesman\\_simulated\\_annealing](https://github.com/and-kul/salesman_simulated_annealing)