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Traffic and Pollution in Torino

INTRODUCTION

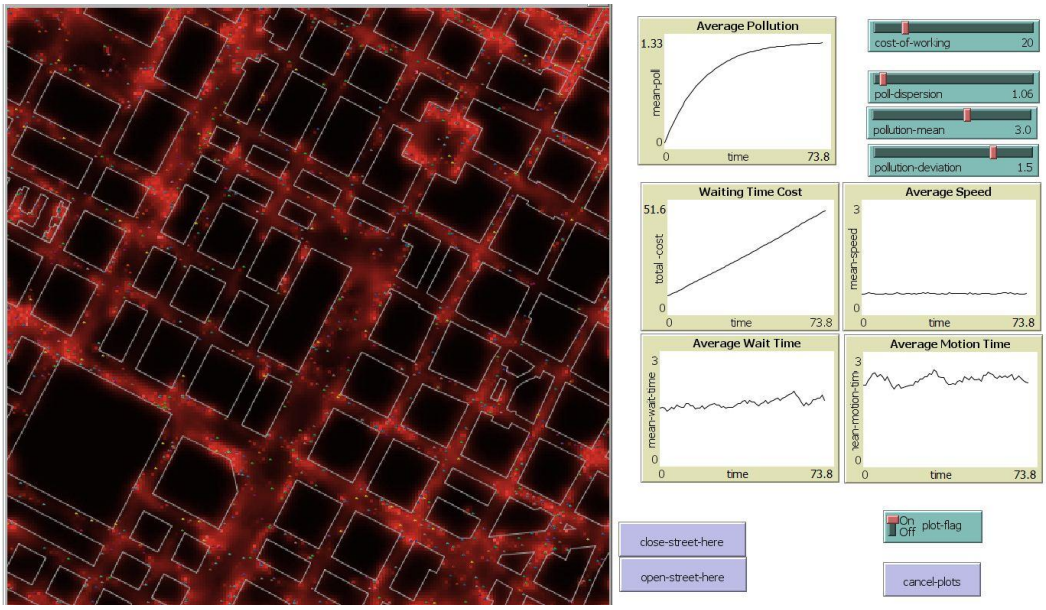
I decided to work on this project after attending a lecture about agent-based models in Economics and Social Sciences.
I thought this tool would have been perfect for a model describing traffic and some of its consequences.
This model, created with NetLogo, uses GIS extension in order to simulate traffic in the city of Torino (Italy) and it shows how traffic conditions influence pollution in the city; in addition it is possible to approximate the amount of money lost due to traffic delays.
A grateful thanks to Professor Pietro Terna for his helpfulness and his great support.

MODEL BUILDING

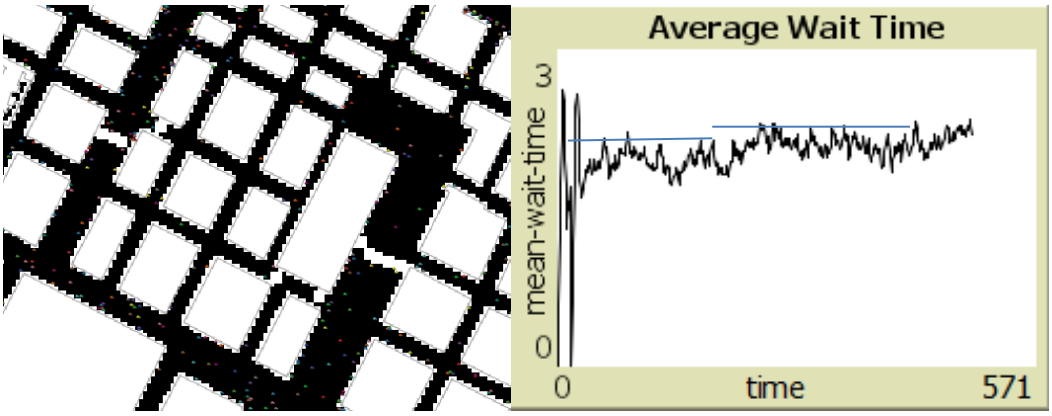
This model has been built using GIS extension of NetLogo , importing a detailed map of the whole city of Torino. The GIS shapefile is available on the website of "Geoportale del Comune di Torino".
At first NetLogo was not able to import the shapefile, so it was necessary to save it with the software gv-SIG. I used zoom and draw utilities found in a NetLogo tutorial, SantaFeStreets model and then I created the possibility to move on the map in four directions in order to visualize different areas of Torino.
The following step was to make a distinction between buildings and streets using intersection with GIS, patches variables and different colors (streets in black and buildings in white). It was important to find a suitable value for the zoom since there is a limited number of patches available.
Later I created turtles (in the shape of cars) and tried to make them move in an organized way:
If a car has a white patch in front of it stops and rotates left, while if there is a car ahead it slows and moves on the right. When a car has the same direction as the roadway, without obstacles, it speeds up and keeps on going.
At this point I added some extra functions: the possibility to follow a car and color its path, the discoloring of streets when cars pass, the option of closing or opening a street changing its color.
The final part of the work consisted in introducing some environmental and economic aspects in the model; the observer can chose the mean value of emissions and their deviation from the mean, in fact the "random" changes of the emissions are represented with a normal probability distribution. The value of pollution dispersion in the air can also be regulated with a slider (in order to simulate different weather conditions, for example).
The total amount of money lost is calculated doing the sum of the number of cars with speed 0 in every moment multiplied by the chosen cost of working.
Some indicators of model status are visible in five plots; average pollution, average time at rest and time in motion of cars, average speed and the total cost of waste of time due to traffic delays.

FIRST RESULTS – MODEL WORKING

Brighter areas are the most polluted, average pollution increased and reached a quite stable level; average speed is approximately constant while waiting time cost grows almost linearly.

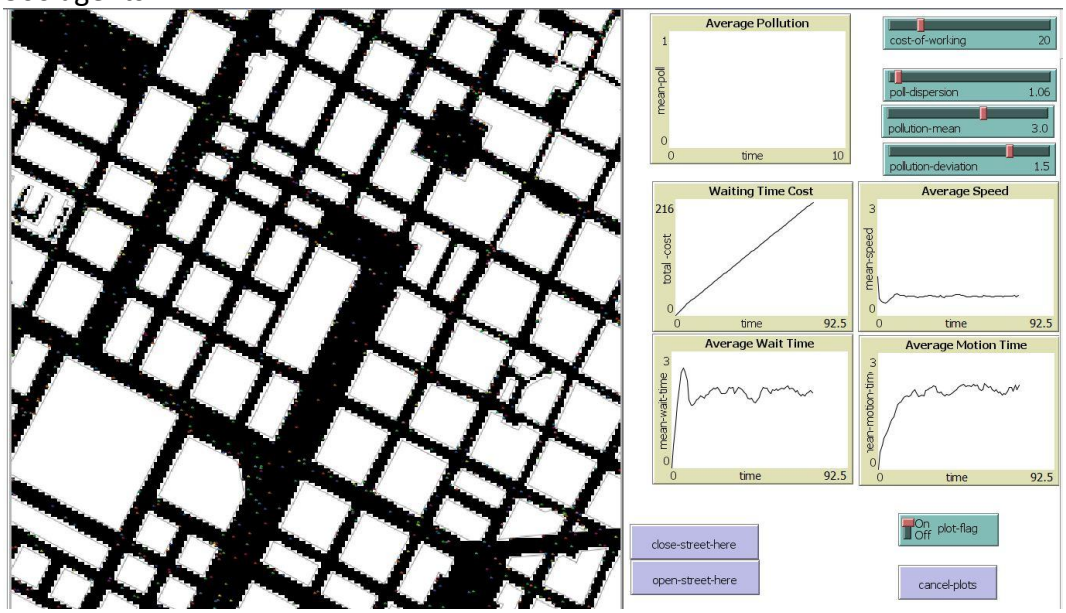


The following images show as average waiting time changes when parts of streets are closed: it lives up to expectations and slightly grows.

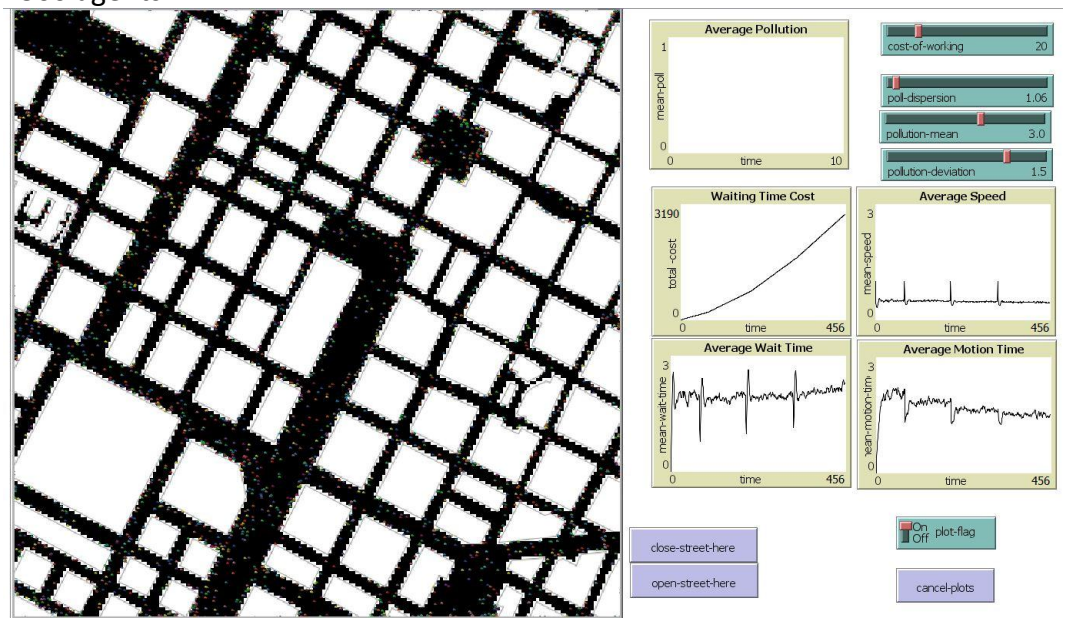


In this situation the number of cars has been increased by 2000 units in three steps: the total cost grows more rapidly while the average motion time significantly decreases.
Average speed and average wait time are not much influenced, the first one slightly reduces and the second one grows very slowly.

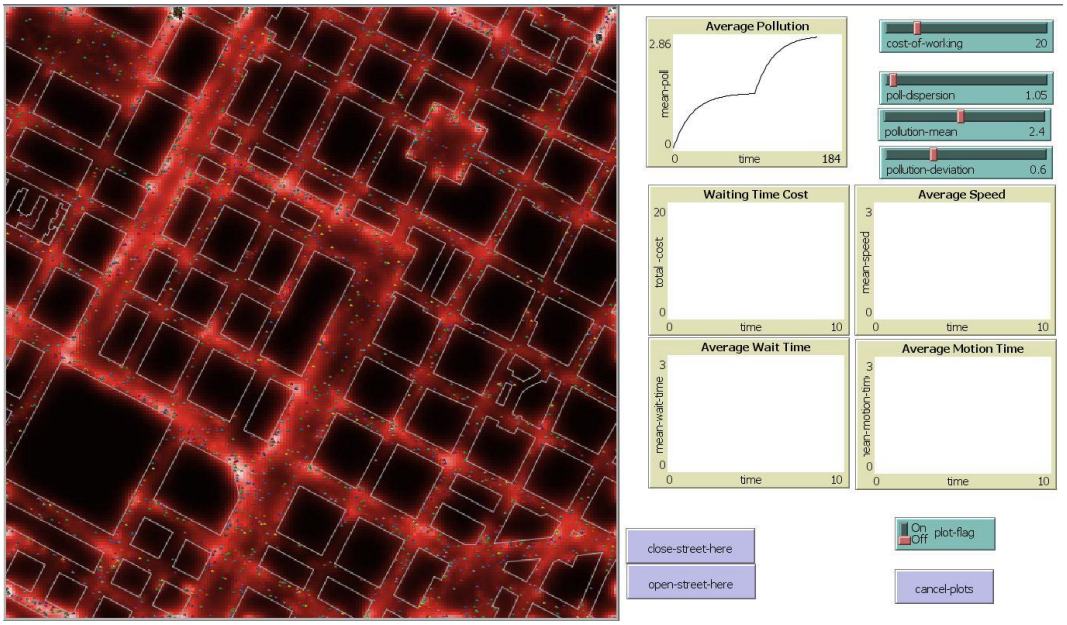
500 agents



2500 agents



Here the simulation started with 1000 turtles and then they have been redoubled; the effect on average pollution is evident and several areas have become brighter and brighter.



FUTURE DEVELOPMENTS

The city features could be improved with the addition of traffic lights and one-way streets, speed limits and so on.
It would be interesting to consider not only the cost due to waste of time but also the cost of pollution in terms of health, well-being and environmental impact.
The diffusion of pollutants could be described using a solution of two-dimensional diffusion equation and even weather should be considered.
A deeper comparison between the model and traffic or pollution data of Torino is surely convenient and could be realized in the near future.

CONCLUSION

I tried to produce a useful tool that could help understanding traffic dynamics.
It is important to check all possibilities before deciding new strategies for the road system, and agent based models can at least tell us what we should not do: if a hypothetic regulation does not work in a model, why should it work in reality?