Traffic 3.1, Introducing Roads

Semester Thesis

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1. Introduction

1.1 Scope of the work
The aim of this project is to introduce the concept of “road” into the TRAFFIC library. A road is the physical link on which trams, busses, trains and even walkers move along. There are several types of road. The type implies what kinds of vehicles can travel on the roads.

1.2 Initial Situation
In the initial situation only lines of the public transportation system were implemented in the TRAFFIC library. Trams, busses and trains operate on these lines. The problem with this model was that these lines did not represent the real connections between places in a city. In effect, with this model two places are connected by more than one line section while usually exactly one road (and at most one light rail segment) connects two different places. Roads should make the model more realistic and allow us to introduce physical links even where no busses, trams or trains operate.

2. Model and implementation

2.1 The first idea: streets
The first idea was to introduce the notion of street in the TRAFFIC library. A street should exactly represent what a street in the real city is. This idea was not the best one because of several reasons. One of these is that trams and busses generally do not travel along the entire street but move along several parts of different streets. Moreover, the concept of street would have been difficult to integrate into the already existing TRAFFIC library unless one makes the model more complex to adapt to the new requirements. Due to these problems, the decision is taken not to introduce streets but to introduce roads instead. The difference between the two concepts is that roads are in general short links and they connect two nearby places while streets are longer and can connect several places.
2.2 The concept of road

As already explained above, the TRAFFIC library uses TRAFFIC_LINE to model the lines on which public transportations operate. A TRAFFIC_LINE object has a list of TRAFFIC_LINE_SECTION objects. A line section represents the connection between two places and can be associated to (at most) one line. A line section contains a list of points that are used to display lines on the map and to allow vehicles to move along these lines. Since the concept of road is similar to the concept of TRAFFIC_LINE_SECTION we have decided to create an ancestor class for these two notions: the TRAFFIC_CONNECTION. As the name suggests, this class represents a connection between two places of the city. The TRAFFIC_ROAD and TRAFFIC_LINE_SECTION classes extend the concept of TRAFFIC_CONNECTION.

In order to adapt the library to the new model we have extended the concept of type: the classes TRAFFIC_TYPE_LINE and TRAFFIC_TYPE_ROAD were introduced representing the type of line sections and roads respectively. TRAFFIC_TYPE_LINE and TRAFFIC_TYPE_ROAD extend the TRAFFIC_TYPE class that was already present in the TRAFFIC library. Figures 1 and 2 show the descendents of these two new classes.

![Fig 1: class hierarchy for TRAFFIC_TYPE_ROAD](image)
Fig 2: class hierarchy for TRAFFIC_TYPE_LINE

Thank to roads all the vehicles do not move along line sections anymore but along roads instead (see figures 3 and 4). Line sections are still used as conceptual model to build TRAFFIC_LINE objects and to calculate shortest paths in the city.

Fig 3 (left): trams move along different line sections (old model)
Fig 4 (right): trams move along the same street (new model)
2.3 Visualization

Roads are now displayed in the default visualization of the city map. The visualization is simple and similar to the visualization of the lines except for the fact that, as already stated, only one road can connect two places. At the moment roads are displayed in grey while railroad are displayed in black. In a further step one could improve the visualization of the roads depending on their type. For example roads on which trams operate could be wider than roads on which only cars travel. Additionally, roads on which trams drive should contain the light rail tracks in the center.

Note that it is still possible to show the line sections on the map. This is done when the user checks the appropriate control in the menu: a boolean variable of class TRAFFIC_3D_MAP_WIDGET is set to true and line sections instead of roads are visualized.

Fig 5 and 6: The visualization for roads (left) and line sections (right)
2.4 XML and parser

In order to introduce roads and to associate them to line sections, we adapted the XML files. Figure 7 is a piece of the XML file (taken from zurich_little.xml). Now there is a list containing all the roads of the map and additionally each line section has a list of all the roads that belong to it (remember that a road can be associated to one or more line sections). A special thanks to Michela Pedroni that has done the huge work of adapting the XML file of the big map to the new requirements.

In addition to the changes of the XML also a new parser for the roads has been implemented.

```
<!-- roads -->
<roads>
  <road id="1" from="Paradeplatz" to="Boersenstrasse" direction="undirected">
    <point x="660" y="235"/>
    <point x="740" y="315"/>
  </road>
  <road id="2" from="Boersenstrasse" to="Buerkliplatz" direction="undirected">
    <point x="740" y="315"/>
    <point x="744" y="320"/>
    <point x="750" y="320"/>
  </road>
  <!-- more roads here -->
</roads>

<!-- tram lines -->
<lines>
  <line name="9" type="tram">
    <color red="102" green="102" blue="153"/>
    <line_section from="Paradeplatz" to="Boersenstrasse" direction="undirected">
      <onroad id="1"/>
      <point x="660" y="235"/>
      <point x="740" y="315"/>
    </line_section>
    <line_section from="Boersenstrasse" to="Buerkliplatz" direction="undirected">
      <onroad id="2"/>
      <point x="740" y="315"/>
      <point x="744" y="320"/>
      <point x="750" y="320"/>
    </line_section>
    <!-- more line sections here -->
  </line>
</lines>
```

Fig 7: a piece of the XML file
Conclusion

I have found this semester project an attractive challenge and I have always worked at it with pleasure. Unexpectedly, the most interesting aspect of the work was to think which solution could be the better one. Up to now I have only done small projects where it was sufficient to have a clear starting idea and to implement it. In this semester thesis I have discovered that often the first idea is not the best one and that finding a good abstraction is generally the most difficult thing, while programming becomes much easier if it is based on a good design. I have also to thank Michela Pedroni for the interesting discussion about the best model to use.

Future work

Introducing roads is only the first step in order to enhance the realism of the TRAFFIC framework. Now that roads are part of the library one can:

- improve the visualization of these roads on the map as described before.
- add other roads to the map, even if they do not belong to any line section (for example roads can be added between buildings).
- implement a traveler that moves around on roads of the map in a random way.
- add the roads to the graph of connections (up to now only line sections are added) allowing to calculate the shortest path between two places also using roads.