Distances between cars in traffic, visualization of influences and dependencies

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Abstract

This paper will present an approach to the visualization of quantitative dependencies. It will do this on the basis of an examination of factors, which determine the distance a driver will keep to the car in front in real world traffic situations. Though common sense poses that the proposed model is fundamentally valid it should not be understood as an attempt to predict real world behaviour and is not the core of this paper. It is rather a medium to give meaning to the proposed approach of visualization. The paper will discuss advantages of the given approach and discuss the application of EM for its implementation.

1 Introduction

The rules, which are provided by driving schools to apprentices for driving licences, for finding the right distance to the car driving in front are fairly simple. It equates down to something like "keeping a distance of about half the reading of the speedometer in meters". Though this might be good to have as a guideline and might describe something like the "ideal distance", it hardly describes, what is happening on the roads in real world traffic situations.

The actually observable distances in the real world are created by dependencies between factors, which are deeply rooted in human psychology, hard to grasp fully and hidden to most automobile travellers. Many different factors such as weather conditions, social norms, traffic regulations, former experiences of the drivers, the current mood of the drivers and even the properties of the actual cars are likely to have an influence on the distance a driver will finally apply.

This paper will therefore describe the attempt to visualize and intuitively convey a model of dependencies determining the distance. The suggested dependencies are to be seen basically as qualitative in nature. The application of detailed empiric research is necessary to achieve a realistic model, which can yield realistic predictions.

It will nevertheless be shown, that the nature of the model itself and the approach to the visualization are well suited for the application of definitive principals.

The paper will conclude with an outlook on what the model might be used for.

2 Underlying distance model

This chapter will describe the model of distance prediction, which will be made exemplary use of to show the visualization approach.

2.1 Basic idea

As mentioned briefly in the introduction there are many factors, which determine the distance a driver will keep to the car in front of him in real world traffic situations. The dependencies between these factors can be considered to be very complex and beyond the scope of this study. Therefore the model at hand, concentrates on only a few of these and greatly simplifies the quantitative aspects. The latter will be discussed in more detail in the next section.

The following factors are considered in the given model:
Roadwidth: Whether the road is rather narrow (and intimidating) or wide and open
Cartype: Whether the car rather invites to cruise along or encourages to sportive endeavours
Perceiption of danger: Whether the car gives a hightened sense of security or not
Haste: Whether or not the driver is in a hurry to get somewhere at a certain time
Relaxation: Whether the driver is stressed in general or not
Family: Whether there are people, which care about the driver and which he cares about or not
Accident history: Whether or not there are memories, which make the driver more cautious in traffic

Some factors (e.g. Haste) are more obvious to consider than others (e.g. Family), but as far as common sense goes, they should all be considered when determining the perspective the driver takes on the distance. In the visualization these factors will group into others, which could then again be considered as atomic factors, dependent on the level of detail one is looking for.

2.2 Quantitative aspects

As mentioned before, the quantitative aspects in this model are greatly simplified. At first it is assumed that all the given factors have the same influence on the overall outcome, there is no weighting between them. Furthermore the numbers, which are to be given for the individual factors are very subjective in nature and are thus not based on any kind of empiric evidence. Finally the relationships between the factors and the overall outcome are linear, which is probably not suitable for mapping real world dependencies.

Viewing the relationships only as tendencies and considering the mathematical connections and the numbers merely as an information, which is to be conveyed through the visualization, the model can be considered as adequately consistent though.

The underlying mathematical dependencies are as follows: In general the value of a parent node is calculated by the average of the values of its child nodes. For the leafs of the tree the values have to be explicitly given. The displayed values (between -100 and 100, exclusive) are linearly mapped onto values between 0 and 2 (exclusive) internally. The resulting distance and thus the value of the root node is determined by multiplying the calculated average of the internal values of the children of the root with the recommended distance, which is turn is determined by the chosen speed.

3 Approach to visualization

In this chapter the approach to the visualization will be introduced and discussed.

3.1 Visualization support by animation

On the left of the screen a very simple animation of two cars following each other in traffic can be seen. The perception of motion is basically achieved by moving hypothetic trees down the display and by slightly vibrating the cars to create a sensation of dynamic. Despite its simplicity the animation should be able to deliver the facts that two cars are following each other along a road at a certain distance at a certain speed.

This animation basically helps to convey the resulting distance to the user. Without it the result of the prediction would be merely a number which *stands* for a distance. With the help of the animation the goal of actually creating the *experience* of driving at the given distance can be enhanced. It will thus probably be more memorable.

3.2 Tree structure for dependency visualization

Intuitively a tree conveys the message of categorization and organization to the user. It is automatically assumed that the child elements, will have an influence on their parents and that eventually all elements, will somehow contribute to the value of the root node. It is therefore well suited for the visualization of dependencies, if they can be organized appropriately.

3.3 Intuitive visualization of effects

To visualize numbers it is advisable to use means of visualization, which have as close a semantic resemblance to the message, which is to be conveyed as possible. That means, for example, to visualize a number, which represents a certain area the most natural approach would be map the value onto the size of an 2D object. Mapping the value onto the brightness of an object, for example, would semantically convey the same message, but at the disadvantage of a far less intuitive understanding.
As the values of the factors in the given model are considered to be a deviation from some kind of 'normal' or average state it follows that their visualization is as well a deviation from the middle of the nodes.

Furthermore it is possible to subtly imply evaluations in the applied visualization. In Western societies it is a widely established convention to use the color green to indicate something good and the color red to indicate something that is to be avoided. This fact was used to make the values in the given visualization more understandable. It should be mentioned though that in some cultures certain colors do have a completely different meaning. This approach thus has to be carefully considered prior to application.

4 Suitability for EM approach

In this chapter it will be discussed how suitable the EM approach of modeling is for implementing the given endeavour.

4.1 Suitability for distance prediction

As the given model can be arranged as a tree of factors, which only influence the according parent or child elements and as there is no dynamic aspect to the given model the EM approach is well applicable for the implementation. Changes in the leafs of the tree will simply, by means of dependency maintenance, propogate upwards in the tree and yield influence on the outcome.

4.2 Suitability for visualization

With a few restrictions the same holds true for the visualization of the underlying model. As the changes propagate through the tree the according elements of visualization update themselves on the basis of dependency maintenance as well.

As the animation does have time dependent aspects to it, it was nevertheless necessary to use conventional event based and procedural programming techniques. Also in some instances the richness of the given languages for definitve notations was not vast enough to base the visualization fully on definitions. Mouse triggered redefinitions had to be used to achieve some of the functionality.

An example of where this could have been avoided is the following:

If it was possible in DONALD to test for the existence and the values of EDEN list elements directly it would be possible to define the fact whether a certain node is displayed or not simply based on DONALD definitions. For example definitions like

```
%donald
point center8
center8 = (tree[8][1]  = “ ”)
   ? center8 = {100, 100}
   : center8 = @
```

(this is pseudocode and a mixture of DONALD and EDEN)

could make the function *updateElements* obsolete. In the given implementation this function takes care of redefining DONALD values in accordance to which nodes need displaying when the tree elements are changed and thus slightly violates the pure definitive approach.

5 Conclusion

The model for the prediction of occuring distances in traffic can at the current stage not be considered realistic or applicable. But it can nevertheless educate about some basic dependencies and might be the trigger for subsequent more elaborate empiric research on the topic.

The visualization approach should be seen as an proposal for the visualization of qualitative dependencies in general. Whereas it is difficult to convey a certain qualitative connection statically by merely displaying a picture the same goal can rather easily be achieved by providing an environment, which enables the user to play with certain observables and experience the effects at first hand. Also the mentioned principles for increasing the effectiveness of visualizations should be considered not only when visualizing dependencies.

Possible applications of this kind of model could reside in the adult education sector, where it is the goal to increase self reflection of behavior in traffic. This in turn could possibly lead to a decrease in accident likelihood for those educated individuals through more proper application of road safety principles due to enhanced awareness and understanding of influential factors.

More information on general issues in visualization can be found in (Krumbein, 2006) or (Mueller, 2000b). For background information on distances in traffic see (Mueller, 2000a).

References

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