Filtering mechanisms for the visualization of non-geometrical and geometrical data

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Abstract

The paper describes a fundamental feature in a prototype for the visualization of both geometrical and non-geometrical data: filtering mechanisms. The information class is a basic concept of this prototype. Each class combines a set of attributes associated to the same spatial reference with a list of graphical representations. Information filtering can be accomplished using the following mechanisms: limiting the variation domain of information class attributes, suppressing the visualization of one or more information classes, using the degree of interest function, selecting specific graphical representations accordingly both to the scale of representation and to the degree of interest function, displaying the data by levels of interest.

Keywords: visualization, filtering mechanisms, degree of interest function

1. Introduction

Our goal is to provide a generic system to visualize geometrical and non-geometrical data, in particular structured data with a flat structure (tabular or relational) using the terminology proposed in [1]. In order to visualize data, a graphical representation and a location in space must be associated to the data. Geometrical data have an intrinsic spatial reference and an associated list of geometries. However, for non-geometrical data there is a need to define graphical elements to represent the data and a spatial reference must be explicitly defined.

The concept of information class was introduced as a convenient mechanism to combine data associated to a given spatial reference with a list of graphical representations [3]. Information classes may contain geometrical or non-geometrical data or combine both types of data. Basically, an information class can be composed of several attributes, a grid, a list of representations and a list of geometries. All the attributes share the same spatial reference, a grid. An element of the class, that is, the set of attribute values associated with a point of the grid define an element of information. The list of representations includes one or more representations with different levels of detail; one of these representations will be displayed for each element of the class. The list of geometries describes the geometrical information.

As a main feature, the prototype provides different mechanisms to reduce the amount of information displayed, which we call filtering mechanisms and that are described in the following section.

The prototype includes also a zoom mechanism following the model proposed in [6] and [4]. In this model the zoomed area is magnified without distortion and preserving the global context.

To make the prototype independent of the data to be represented, a file format was defined. Different data formats can be dealt with simply by providing a conversion module for each one.

2. Filtering mechanisms

The visualization of large volumes of information requires mechanisms to reduce the amount of

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information displayed. Some of the filtering mechanisms provided in the prototype involve the value of the degree of interest function (DOI). This function, as defined in [5], assigns to each data point a number which is a measure of the user's interest in seeing the data associated with that point. The value of the function in a point x depends on the *a priori* importance of the point, API(x), and on the distance between x and the current focus, y: DOI(x|y)=API(x)-D(x,y). Only the points whose DOI exceeds a given threshold are displayed. This means that the amount of information effectively displayed depends on the value of this threshold.

We have extended the use of a degree of interest function to situations where a focus is not specified. In this case it is assumed that the distance function is equal to zero everywhere, i.e., the DOI function exactly matches the *a priori* importance. A DOI function can be associated with geometries as well as elements of information. One of the attributes of an information class can be chosen as an *a priori* importance attribute. By default the *a priori* importance is equal to one.

Filtering mechanisms are described in the following sections.

2.1 Domain restrictions

Limits for the variation of one or more data attributes can be established and these restrictions can be interactively combined using the and and or operators. In order to use both operators in the same class, derived information classes were created [3]. Derived classes are copies of base classes but subjected to different restrictions. By default, in each information class the elements that satisfy simultaneously all the domain restrictions are selected. This corresponds to the elements that verify the conjunction of the conditions defined for each attribute. The final result is the union of the sets of elements selected in all active classes and corresponds to the disjunction of the conditions defined in each class. Therefore, with the introduction of derived classes, the elements of a given class may be submitted to different conditions and the elements selected verify the disjunction of these conditions.

2.2 Suppression of information classes

The user can interactively suppress the representation of one or more classes marking them as inactive. By default, all the information classes are active and will be displayed.

2.3 Degree of interest function

The user can interactively select the use of the degree of interest function and specify the focus and the threshold. Only the elements whose value of the degree of interest function is above the threshold are displayed.

2.4 Selection of graphical representations

The representation of each element in the class is automatically chosen from the list of representations of the information class. The criteria that can be used to select the representation are the current scale and the value of the degree of interest function of the element [2]. This allows the use of simplified representations for less relevant information which is in fact a mechanism to reduce the amount of information effectively displayed without complete suppression.

2.5 Levels of interest

The range of the degree of interest function can be divided into a given number of intervals called levels of interest. The elements of each information class are then split according to the value of the degree of interest function. The user can interactively decide if the data is displayed by class (one class at a time) or by level (one level at a time). In the second case, the elements in the same level of all the active classes are displayed, starting with levels of higher degree of interest. The user can either control the display level by level (level_next mode) or allow the automatic display of all the levels until a stop button is pressed (levels mode). In this way, the user controls the density of information displayed and the information represented is, at any time, the most relevant one. Display by level is available only if the degree of interest function is in use.

To illustrate the concept, we will consider the representation of public buildings in a city map. In this example four symbolic representations are used to represent the buildings. The simplest representation uses a single letter to indicate the type and location of the building. The remaining three symbols are obtained by drawing up to three ellipses around the basic symbol. The representation is determined by the current scale and the value of the degree of interest function. In the example the representation selected by the current scale is the letter with three ellipses. Elements in the level with higher degree of interest are displayed with this representation. For elements in levels with lower degree of interest the representation is simplified. In both figures the degree of interest function is in use and the display mode is level_next.

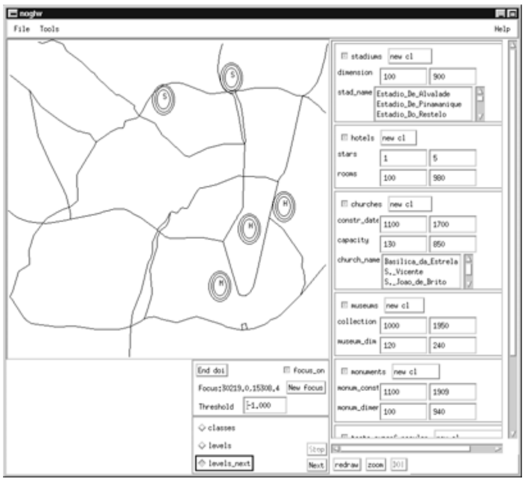

Figure 1: *level 1*

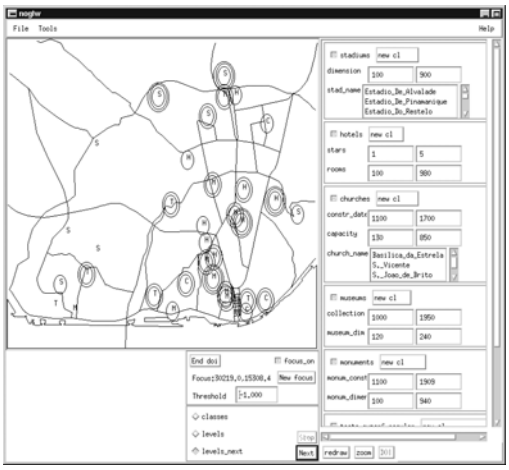

Figure 2: *1evels 1 through 4*

Fig. 1 shows the output after display of the elements in the level with higher degree of interest (level 1). Pressing the Next button 3 times, levels 2, 3 and 4 are displayed in succession. The final result is shown in Fig. 2.

3. Conclusions

Filtering mechanisms are a valuable tool to select information mainly when dealing with large volumes of data.

Our prototype combines total suppression of information classes with partial selection mechanisms: limiting the domain of variation of the attributes and using semantic criteria expressed by a degree of interest function.

The introduction of the concept of levels of interest supports user control of the volume of information displayed, always ensuring that the most relevant information is visible.

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