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Visual analytics of visitors' trajectories for designing an effective exhibition

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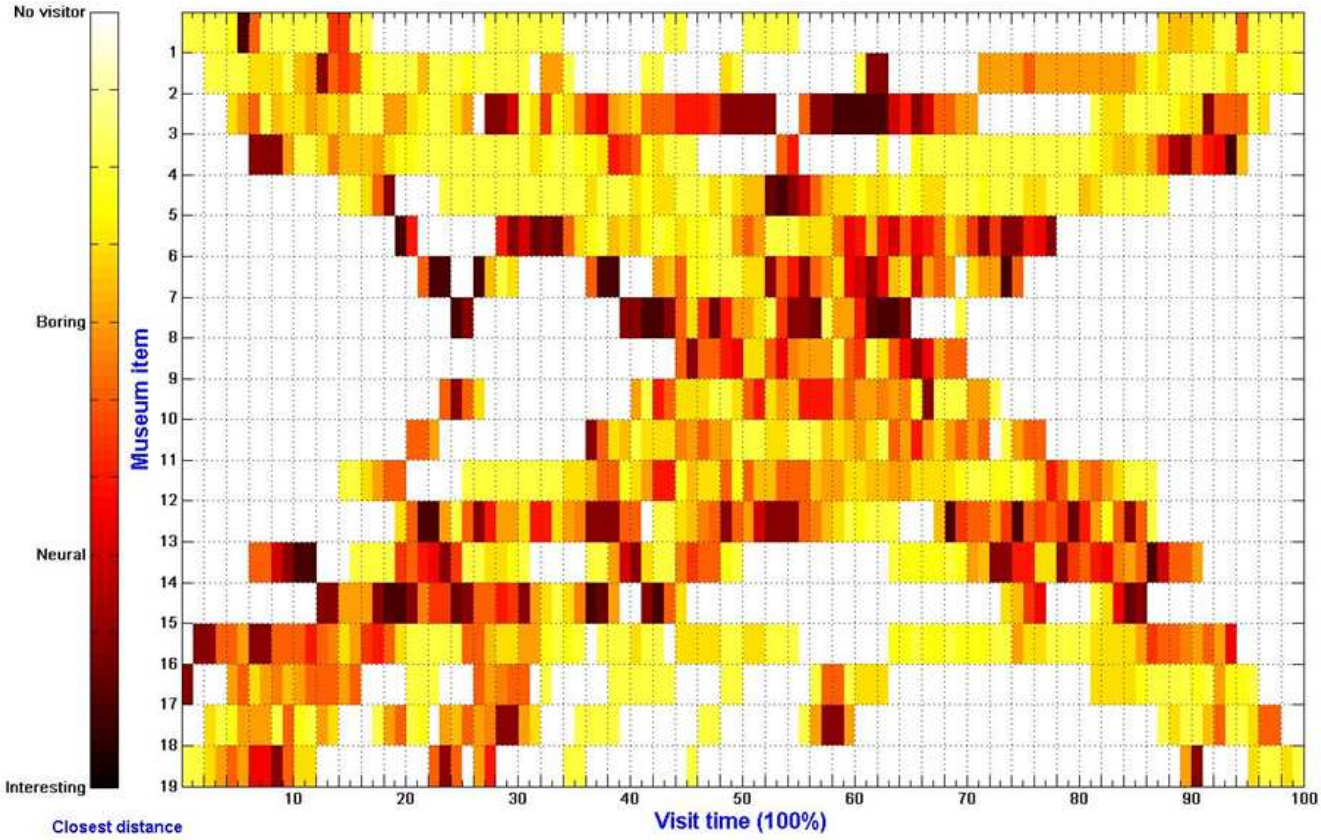

Figure 1: *Global visualization of average closest distance to each item. This visualization displays the total items of 19 in RADP in the vertical axis. The order of items was arranged following the expected museum circulation. The horizontal axis is the visiting time, of which trajectories were rescaled in the percentage. The spectrum color illustrates the median of closest distance to each item of 36 synthesized trajectories.*

Abstract

In this paper, we consider the visual analysis of visitors' trajectories and propose a novel visualization approach in order to analyze their interests. In the experiments, we synthesized 36 visitors' trajectories in a virtual gallery and extracted their interest by our proposed approach. Then, we presented the global information of multiple visitors in our visualization. The visualization shows the interesting degree at a particular item and/or within a specific time and/or in a given area. Both real museums and 3D virtual museums (such as Second Life) can use our visualization to design an effective exhibition.

CR Categories: K.6.1 [Management of Computing and Information Systems]: Project and People Management—Life Cycle; K.7.m [The Computing Profession]: Miscellaneous—Ethics

Keywords: visitor's interest, Second Life, visualization, spatio-temporal data, space design.

1 Introduction

Visual analytics is a field of systhemetic data analysis consisting of information visualization and analytical reasoning techniques. Major challenges in this field include the data representation and

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linkage of large scale multivariate data sets. A solution of handling large scale multivariate data sets is interactive visual interfaces. In this paper, we focus on how to visualize the global information of visitors' trajectories.

We propose a novel visualization approach of visitors' trajectories in order to analyze their interests during a museum visit period. The proposed visualization illustrates the global information of multiple visitors addressed in [Bohnert et al. 2008; Sparacino 2003] such as 1) the most interesting items within one-third of their visit period in a particular exhibit room, and 2) the most crowded time in a given area. Both real museums and 3D virtual museums (such as Second Life) can use our visualization to design an effective exhibition.

2 Methodology and Results

2.1 Methodology

Tracing the user movement in Second Life was achieved by using Linden Second Life embedded tools. The sensor functions detects and reports the user position (x,y) within the particular range. It repeats every particular time interval. In this paper, the considered data consist of the 2D position, the distance closest to an item, and its corresponding time spent of an individual visitor.

The approach of generating our visualization consists of the following steps:

1. Conversion from the movement trajectory to Voronoi-based proximity distance.

2. Nearest-based rescaling of time series.

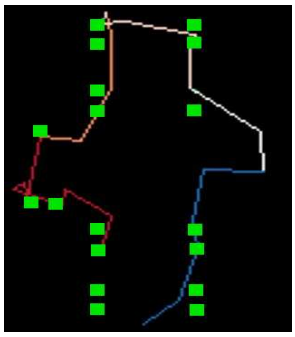
3. Symbolic Aggregate approXimation (SAX) of the proximity distance.

The mentioned approach is illustrated by an example of the visitor who started his/her visit from the exhibit item 17, then followed the reverse route, and ended at the item 1. Figure 2 (a)-(d) shows the approach starting from the step 1 to 3. Figure 2 (d) is the output representing as a degree of the visitor's interest.

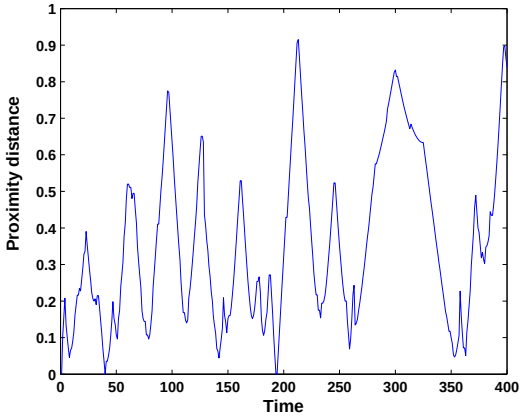
2.2 Synthetic Data

To validate our visualization approach, the avatar movements of 36 visitors were synthesized. Our synthesized data were in RDAP (Ritsumeikan Digital Archiving Pavilion), a virtual gallery displaying the kimono textiles of 19 objects. At all locations, kimono textiles were hung against the wall. Associated with the visiting styles investigated in real galleries by Veron and Levasseur (1983) [Sookhanaphibarn and Thawonmas. 2009a; Chittaro and Ieronutti 2004], the synthesized data followed their findings [Chittaro and Ieronutti 2004] consisting of four stereotypical movements.

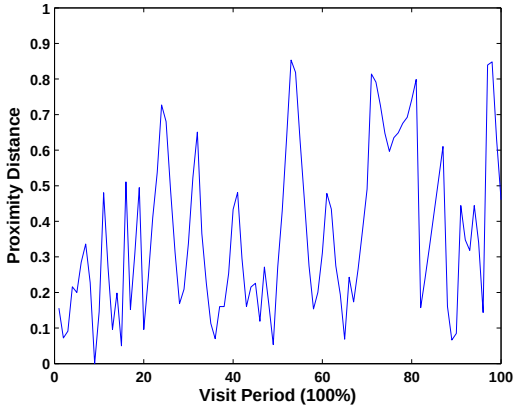
Regarding of four stereotypical movements, visitors must stand close to the exhibit to indulge their passion of cultural arts. In case of a real exhibition, some large items can be seen from the particular range. Therefore, the most common positions of visitors who stopped for observing the exhibit can be examined. The appropriate position corresponding to each item depends on its size. For simplicity, the distance closest to an item is calculated by using Voronoi diagram. In RDAP, positions closest to an exhibit imply greater interest in that exhibit by visitors.



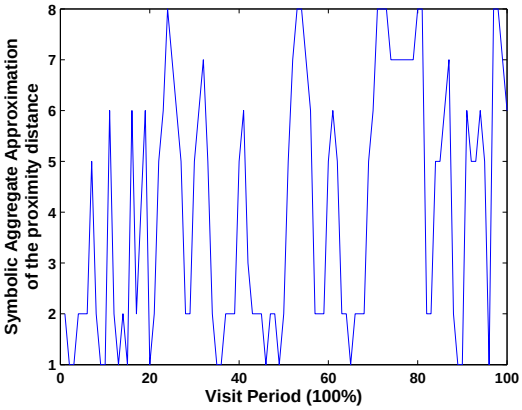
(a) A visitor trajectory directly moving from red to blue lines.



(b) Proximity distance from the closest item (as denoted by green squares).



(c) Rescaling the whole time series to 100 units



(d) Interesting degree of the visitor (a).

Figure 2: *Our approach to calculate the interesting degree of a visitor.*

2.3 Our visualization

Figure 1 shows the global visualization of all synthesized trajectories in their whole visiting periods. In this visualization, there are 19 row stripes corresponding to the number of items and 100 column stripes can be shown corresponding to the visiting time. Using the visual analytics, the mentioned questions of how to design the most efficient museum space will be answered as the followings:

1. the most interesting items are possibly associated with the darkest row stripes.
2. the most crowded periods are inferred by observing the column stripe having the lowest color density.

3 Conclusion

Our visualization represents the global information of visitors' trajectories and assists the curators in managing their exhibition. Our visualization apporach can be implemented in virtual worlds where a million of users have participated (as was recorded in the Second Life official Website). In Second Life, the virtual visitors are easily detected by the embeded SL sensor functions. In the other hand, the visitors' trajactories in the real world can be tracked by using the wireless technology [Eagle and Pentland 2006] or a computer-supported methodology introduced by [Bohnert and Zukerman 2009]. In the future work, we will extend this approach into a field of the user modeling and recommendation systems (as introduced by [Sookhanaphibarn and Thawonmas 2009b]).

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