Toscana goes 3D: Using VR to Explore Life Tracks

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Abstract. Temporal Concept Analysis (TCA) has been developed with the aim to investigate conceptual structures in data with a temporal layer. Nevertheless, there are not so many tools enabling the visualization of TCA features. We propose a new approach based on virtual reality with a 3D representation of concept lattices in which life tracks of objects can be displayed and explored. This is done by exporting the well-known Toscana tool for visualizing conceptual landscapes in a virtual reality (VR) environment and then display various TCA features on the selected scales.

1 Introduction

Formal Concept Analysis (FCA) is well-known for its graphical Knowledge Representation capabilities. There are a plethora of software tools which have been developed over time, implementing various features. Over the last 30 years, almost all research groups have developed their own tools, an overview of which is maintained by U. Priss[1]. Nevertheless, there is no commercial software implementing FCA methods, and, paradoxically, exactly those FCA varieties having the most potential for real life applications are neglected: many-valued contexts and temporal FCA. Many-valued contexts are handled by the ToscanaJ suite [1], and an attempt to implement scaling features is done in `FCA Tools Bundle`[2] [3]. Besides scale building (which is done using Elba), the ToscanaJ suite includes also conceptual landscapes navigation capabilities, by defining a browsing scenario and then perform navigation [5]. Unfortunately, ToscanaJ has not been updated for a long time and there is a need to implement a more modern version.

Even if K.E.Wolff, the founder of TCA [6] presented in several workshops methods for using TCA in practice, a practical tool is missing. J. Poelmans [4] presented a series of applications of TCA and he also developed software solutions which, unfortunately, are not freely available. TCA has been developed to deal with data having a clear temporal structure. However, there are surprisingly

[1] http://www.upriss.org.uk/fca/fcasoftware.html
[2] fca-tools-bundle.com

few real world examples of data sets which are analyzed using TCA. Of course, the major reason is once more a missing software tool which is user friendly, modern and appealing.

2 The project

With the development of new technologies and game engines[3], the modern graphic capabilities of these technologies increased dramatically and it lies at hand to try to use them in new FCA software. We present a prototype for 3D visualization of concept lattices, conceptual landscapes as temporal FCA. We also expect valuable feedback from the FCA community, as well as fruitful discussions on how modern technologies can be used in various software tools for FCA and related fields.

Our research group[4] started a project, called `Toscana goes 3D` in which we use HTC VIVE VR headsets to visualize concept lattices, as well as conceptual landscapes generated by Elba from the ToscanaJ suite. The target is to implement a new kind of Toscana visualizer. Even more, while investigating conceptual structures in data with a temporal layer was previously studied, considering a new approach based on virtual reality (VR) with a 3D representation of concept lattices has not been studied yet. As a particular feature, we refer to the current work in progress aiming to enhance Temporal Concept Analysis (TCA) with a virtual reality perspective in order to study, display and explore life tracks of objects.

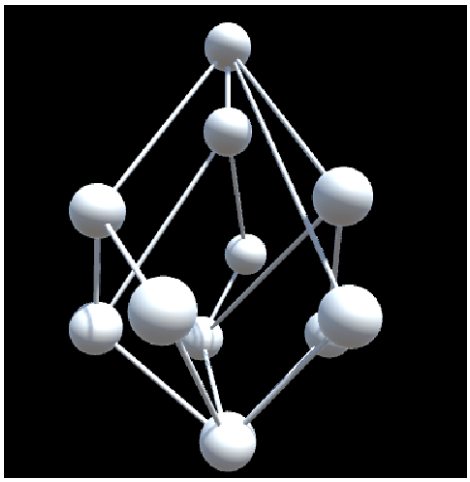

Fig. 1: 3D concept lattice

[3] https://unity3d.com/
[4] cs.ubbcluj.ro/~fca

The technologies used are Unity3D, for a compatible working space that currently supports VR Headsets, meaning that it is a cross platform (and by thus it supports HTC Vive, Oculus,etc.), and SteamVR 2D Plugin, the actual plugin that helps us with VR I/O operations. The concept lattices are represented in 3D by using a circular cone like view of the nodes which are at the same depth in the lattice. Concept lattices are computed with the NextClosure algorithm. We have implemented a series of functionalities which include:

1. Navigating 3D concept lattices: Formal contexts in *.cxt format can be uploaded and we use the Next Closure algorithm for computing concept lattices. Concept lattices are displayed in a VR 3D environment (for an example see Figure 1) and we can move and rotate them (see below for a list of actions).
2. Navigating 3D conceptual landscapes: Once a conceptual schema (.csx file) is created using Elba, the entire navigation process which is supported by ToscanaJ for many-valued data sets is moved in the VR 3D environment.
3. By combining the effectiveness of conceptual scaling with virtual reality and TCA we are able to automatize life tracks computation in the analyzed data set and to display a *timeline* of events (Figure 2, [2]).

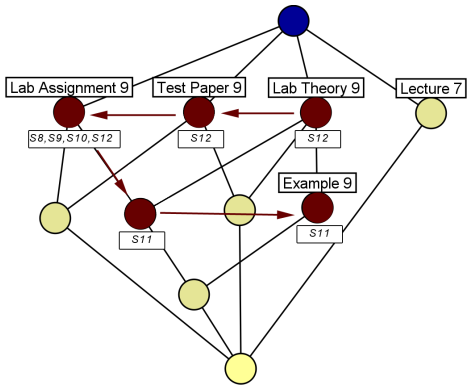

Fig. 2: 2D lifetrack in an e-learning environment

For moving nodes in the concept lattices or the entire concept lattice, you have a couple of options:

- Point-and-action (Figure 3): you can select one or more nodes and move/rotate them.
- Display a mini-lattice: A miniature lattice is shown, from where you can drag one or more nodes to the desired position, the action is mimicked to the original lattice.

Information display has also a couple of options:

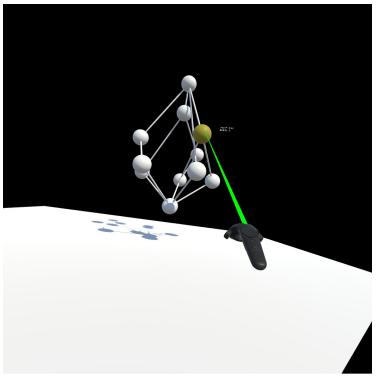

Fig. 3: Point and action

– Node information is shown in the corner as a box.
– Point-and-see: point at a node and the information is displayed nearby.
– And a couple more configurable options (see Figure 4: see the information for selected nodes only/ see intents for all nodes/ see extents for all nodes.

Controls are user-friendly:

– Each hand has a mode selected: meaning that you can drag some nodes while moving.
– Modes: Movement, Node, Lattice.
– Each mode have some sub-actions:
  • Movement: Teleport, Fly

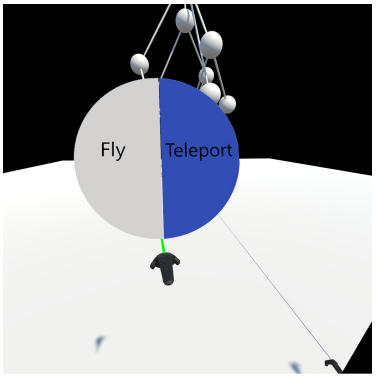

Fig. 4: Actions for a 3D concept lattice

  • Node : Select, Select More (which operate similar to CTRL + Click on an OS), Move, Rotate.

  - Lattice : Rotate, Scale.
- The trigger button - Triggers the action (teleport/rotate lattice)
- The touchpad click - Sub-action selection menu (Figure 5)

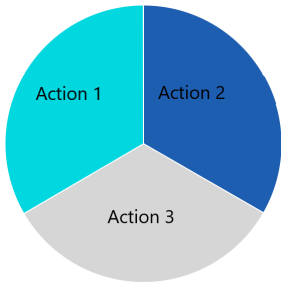

Fig. 5: Configurable selection menu

- The touchpad touch - Selecting a sub-action of the mode
- The grip click (also refered as grabbing) - Selecting of mode

3 Conclusions

We invite researchers to test the tool and to make proposals for new functionalities. The major aim of our research group[5] is to develop a series of software products which make the use of FCA tools more user friendly and appealing, and by that to contribute to the popularization of FCA.

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