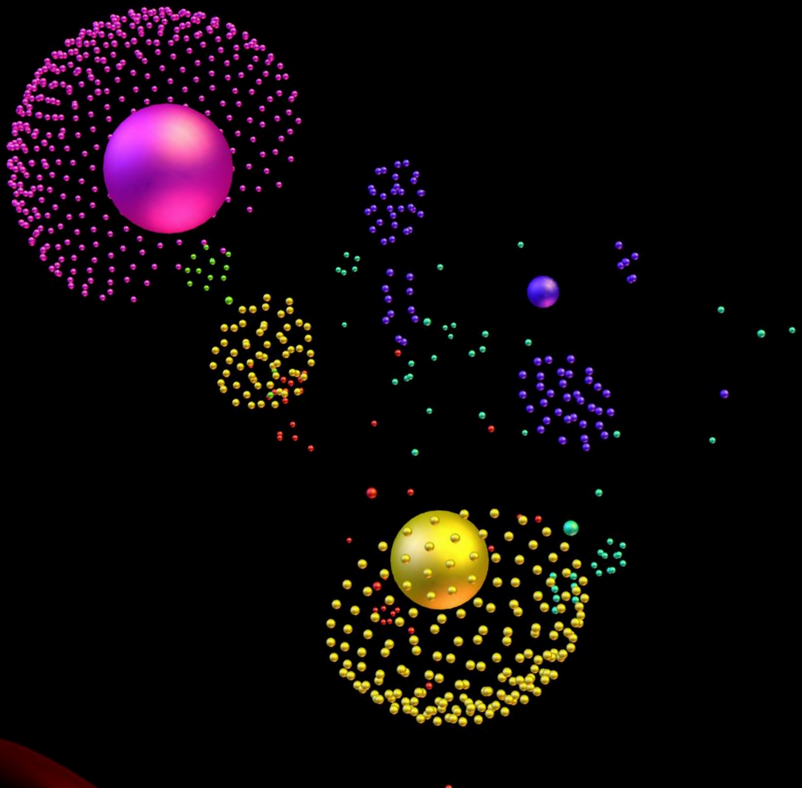
INTERACTIVE VISUAL ANALYTICS:

FROM CHARTS AND MAPS TO 3D DATA TERRAIN



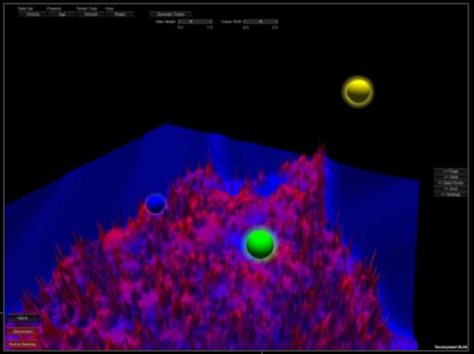
Jacob L. Cybulski

SAS Visual Analytics Collaboratory
Dept of Info Sys and Bus Analytics

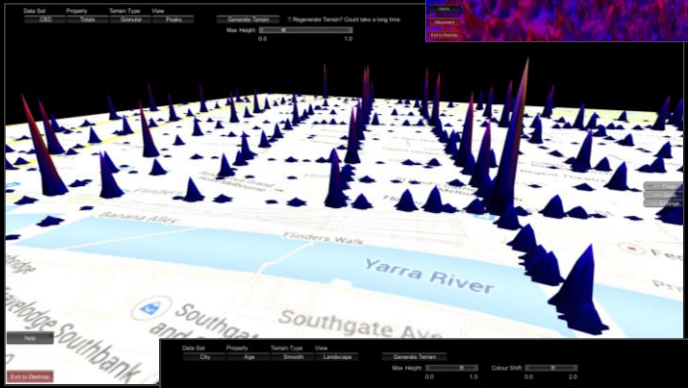
Deakin Business School
Faculty of Business and Law
Deakin University

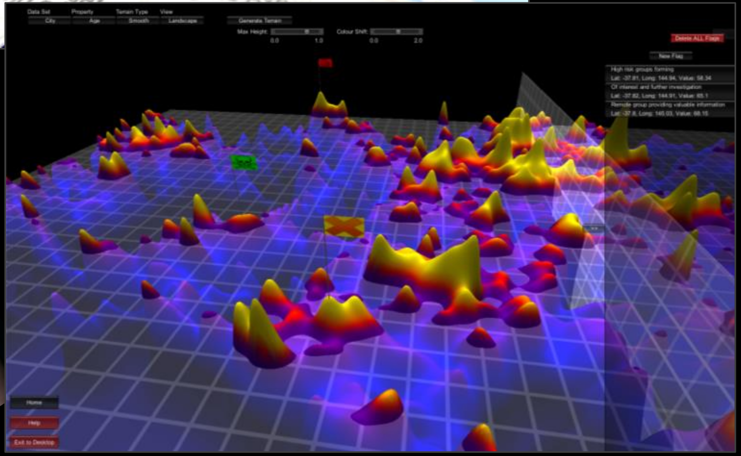
To capture the essence of
information in the moment of time

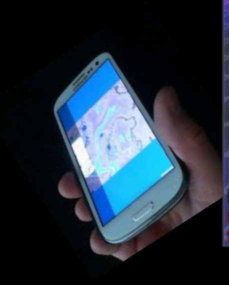
VISUAL ANALYTICS COLLABORATORY
@ DEAKIN



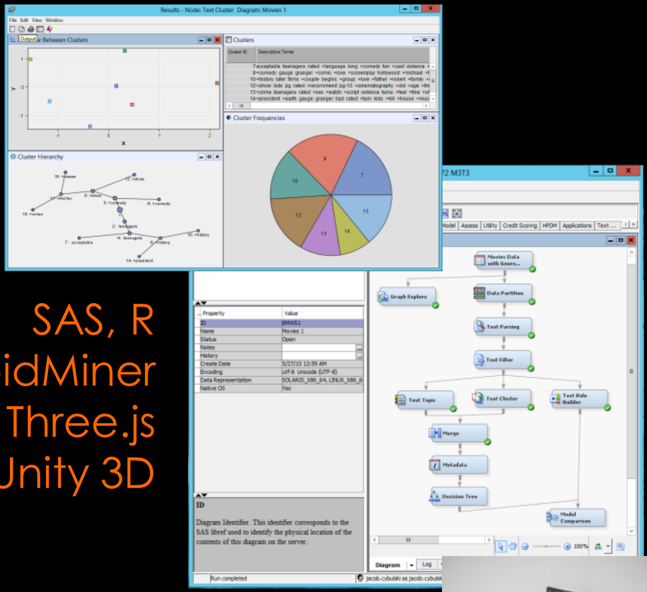
Research







Collaborative & Interactive
3D Visual Analytics



SAS, R
RapidMiner
D3.js Three.js
Unity 3D

Immersive
Visual Analytics

Exploration
Interactivity &
Collaboration

Devices

Education

MAKING SENSE OF REALITY

WITH DATA ANALYTICS AND VISUALISATION

The map created by Muhammad al-Idrisi, in 1154 for Norman King Roger II of Sicily
The modern copy of the Tabula Rogeriana, upside-down with North oriented up
Wikimedia Commons

QUESTION

How can analytics and data visualization assist making sense of data to support insight generation and decision making?

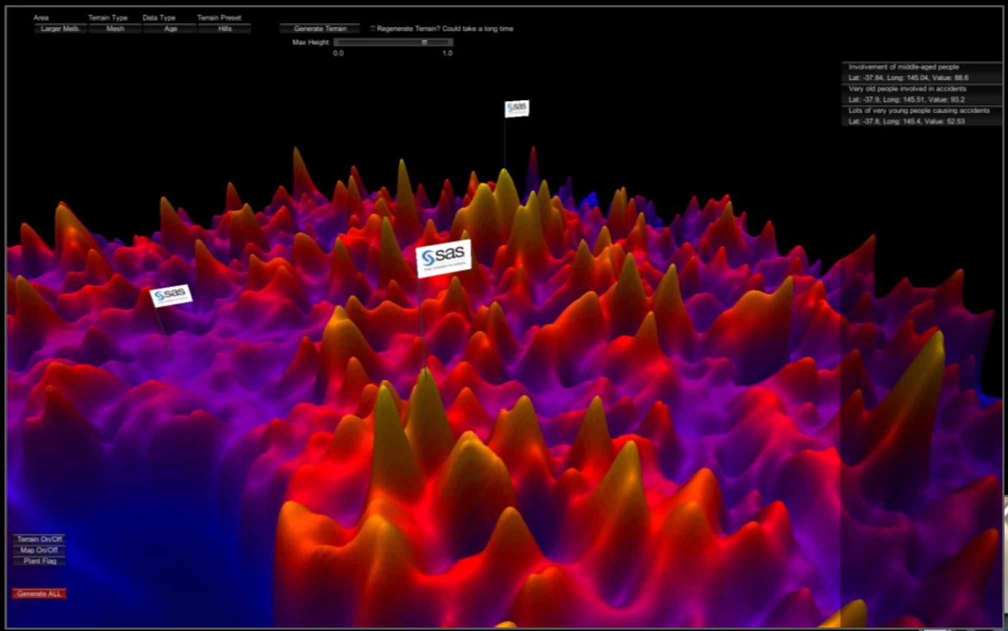
Interactive
Visual
Analytics

In 3D

MAKING SENSE WITH
INTERACTIVE VISUAL ANALYTICS

IVA = data analysis by means of interactive manipulation of visual data representation

Allows engaging instinctively with complex data

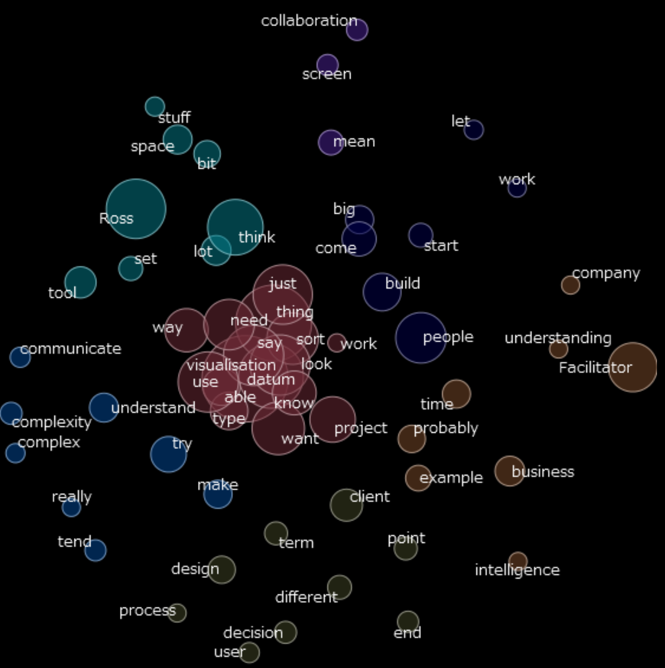


Assist gaining and communicating insights and turning them into decisions and actions with little preparation or training

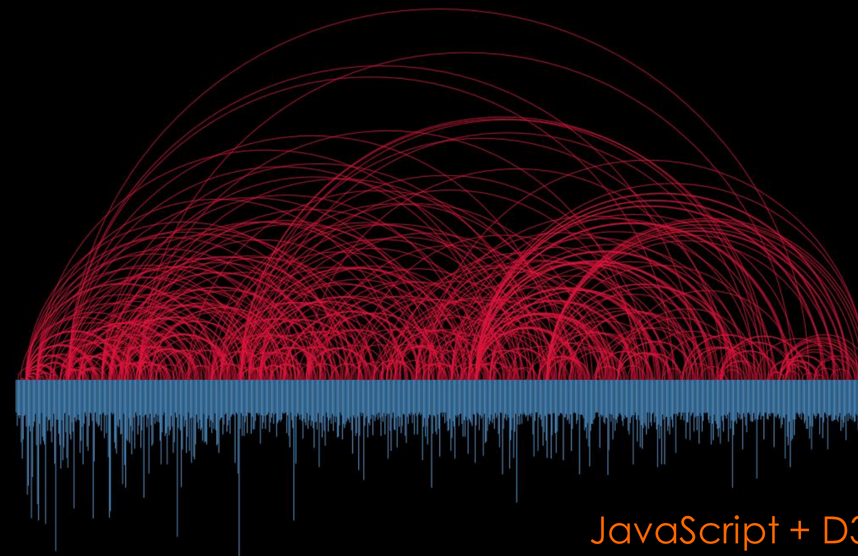
Relies on human innate abilities of perception and cognition

Aim: Passer-by analytics

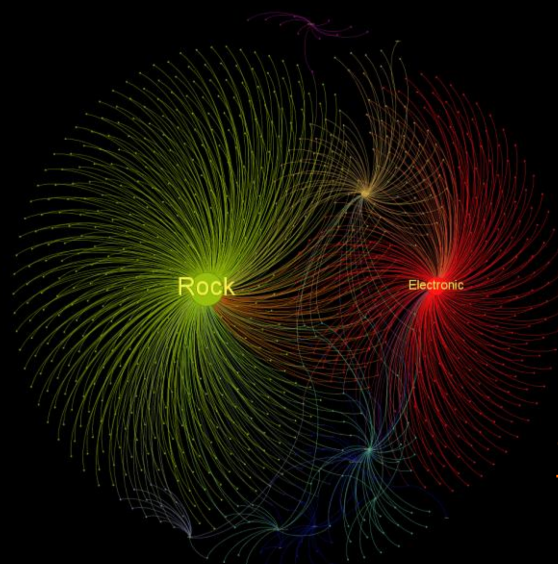
IN SEARCH OF ABSTRACTION



KH Coder
The Analyst's Mind
(Views of 27 BI Practitioners)



JavaScript + D3
Persistence of Music
Discogs (1000 Best Songs)

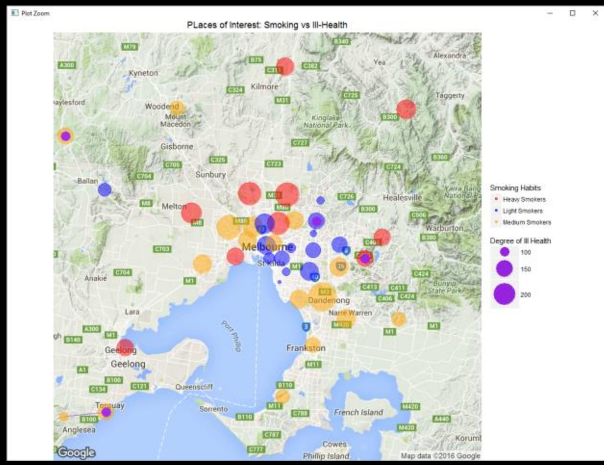


Gephi
The Web of Musical Genres
Discogs (1000 Best Songs)

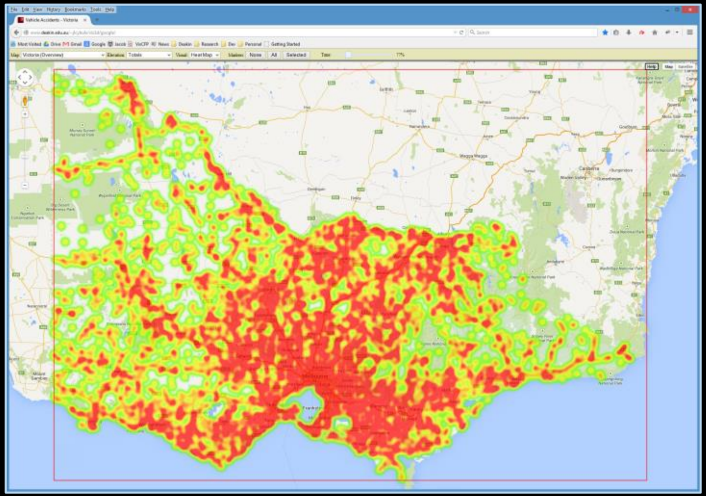
IVA helps with
reduction of
data complexity

IN SEARCH OF INTUITION

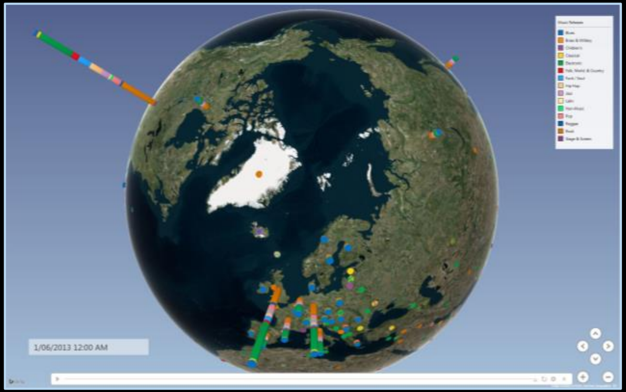
R
Smoking Habits



WWT/Layerscape
Sale of Movie Tickets



JavaScript + Google Maps
Motor-Vehicle Accidents



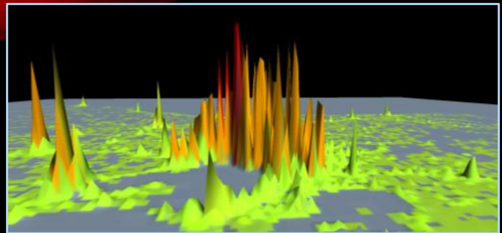
Maps provide an intuitive bridge between data and reality

IVA helps with the exploration of data and the phenomena it represents

PowerMap
Music Distribution

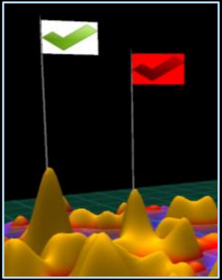
METAPHORS OF
3D DATA TERRAIN

Experiments with Peaks and Elevation

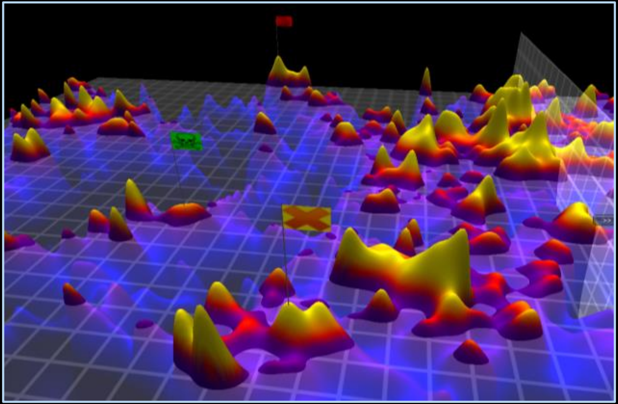


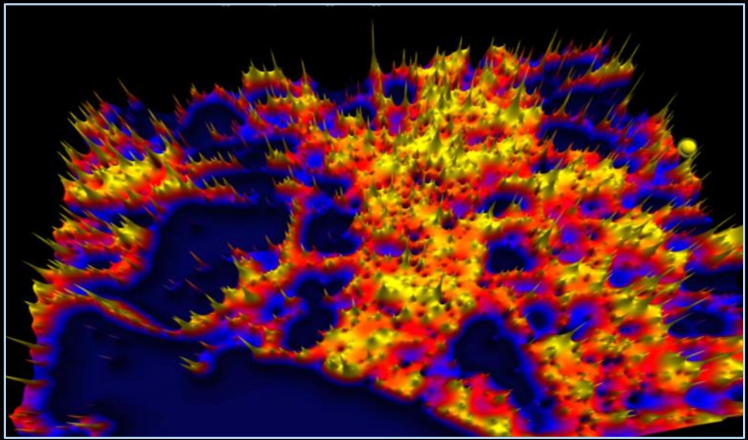
Experiments with Terrains

Markers

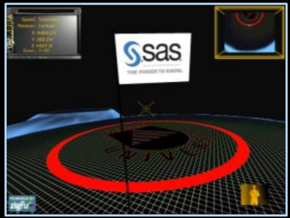


Grids Surfaces



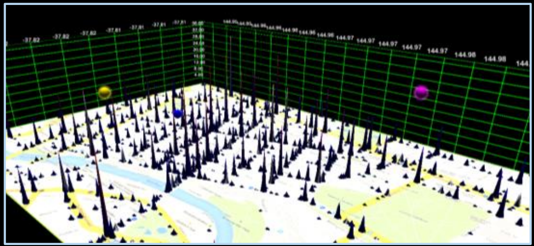


Experiments with heat, colour and 3D meat maps

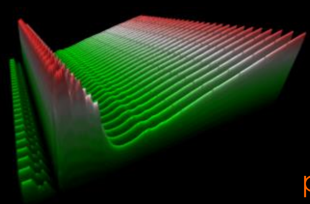


Landing spots

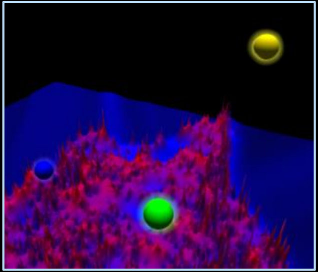
Maps & Coordinates

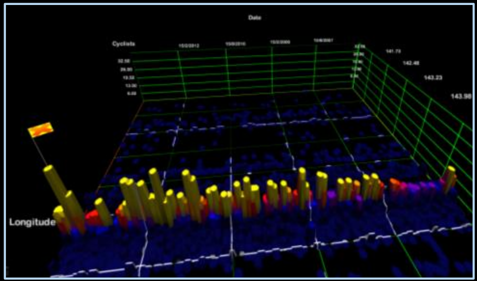


Time-Space

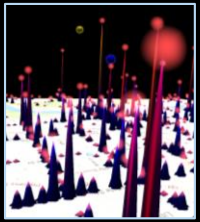


Multiuser presence





Time

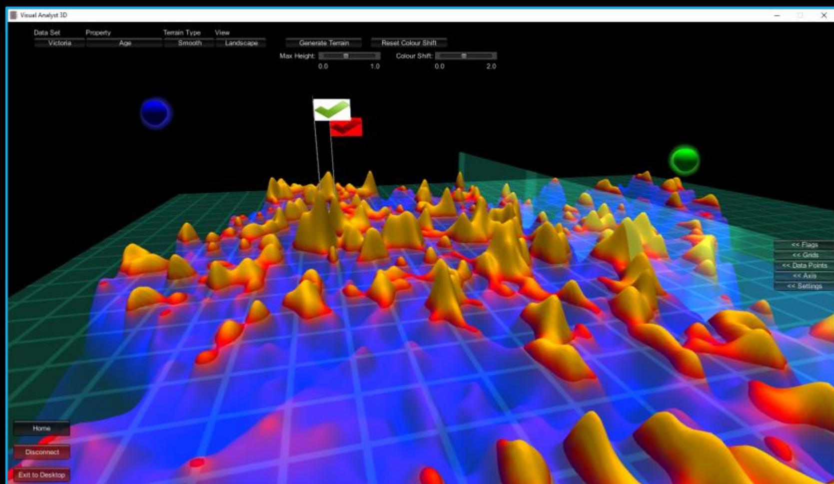


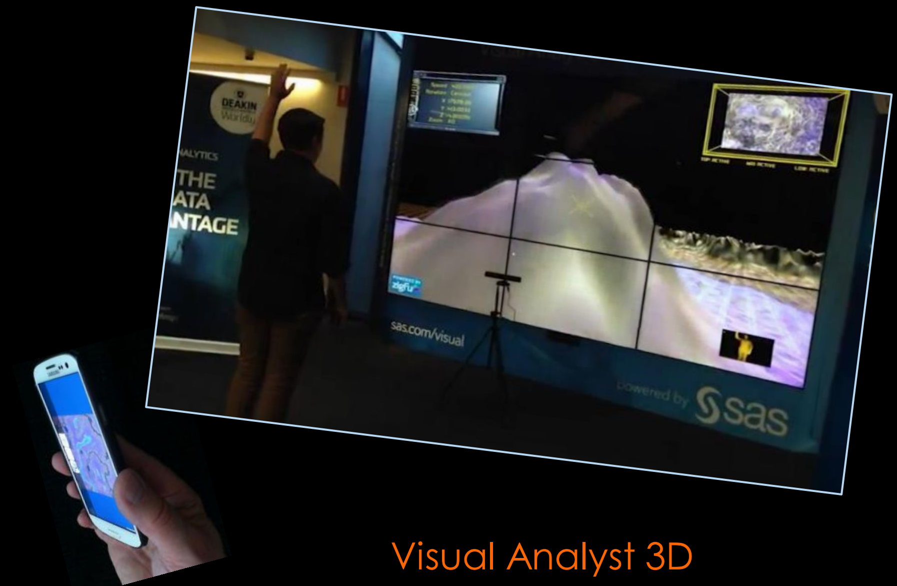
Lights

And more:
Traces
Beacons
Navigation
Etc.

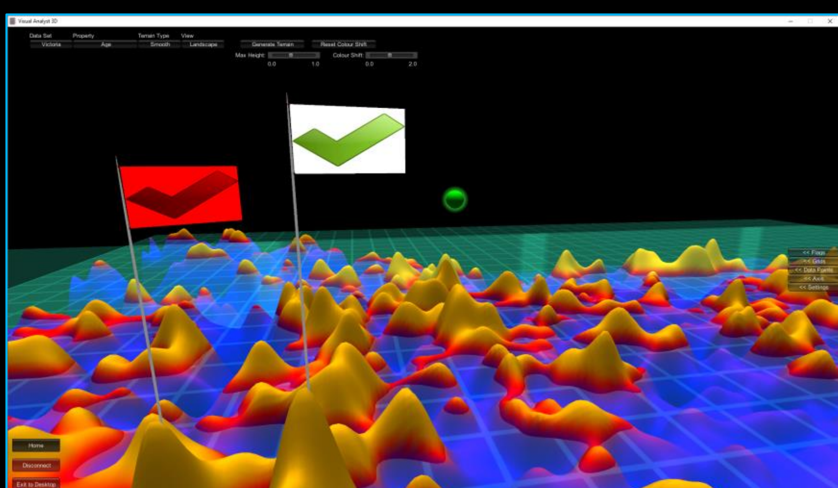
IN SEARCH OF
INTERACTIVITY AND COLLABORATION

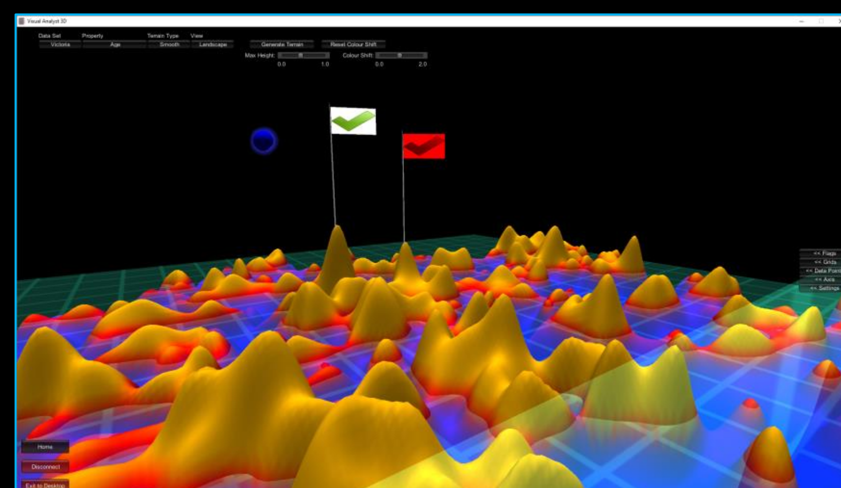
Average Age of Accident Victims in Victoria



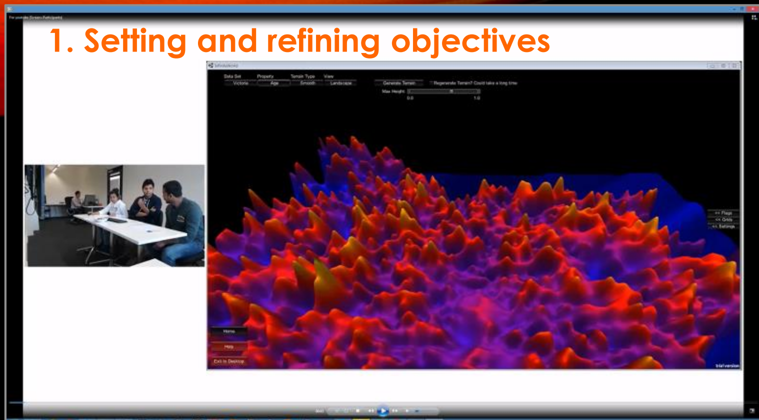


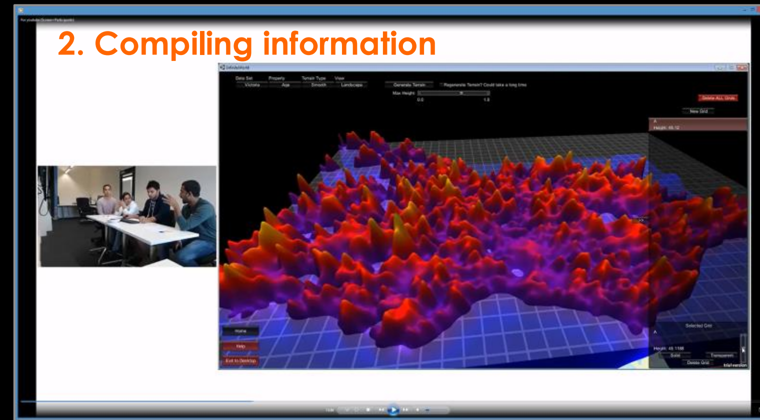
Visual Analyst 3D

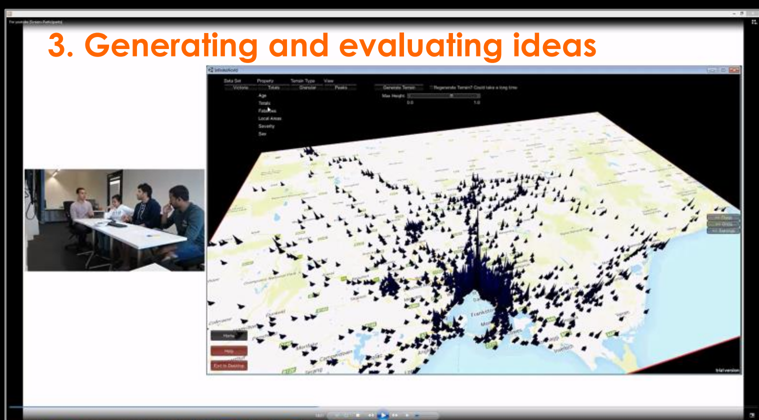


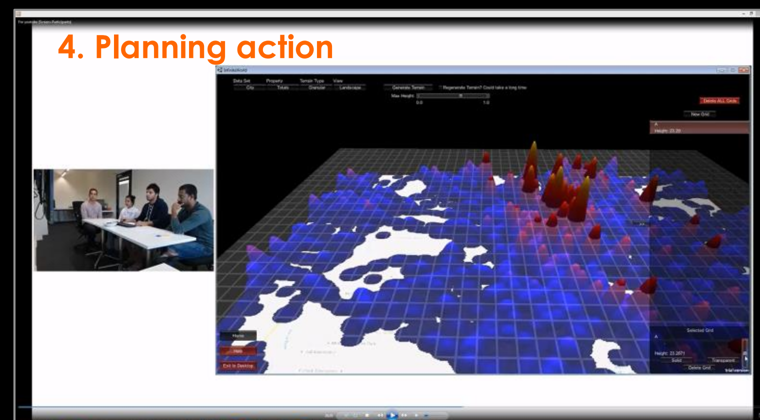


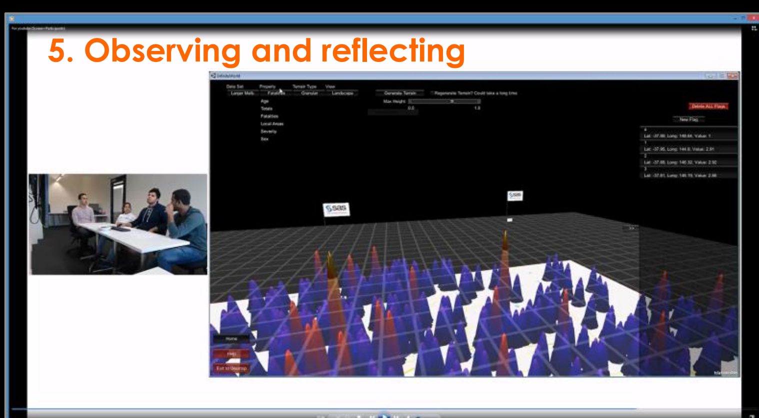
IN SEARCH OF PROCESS





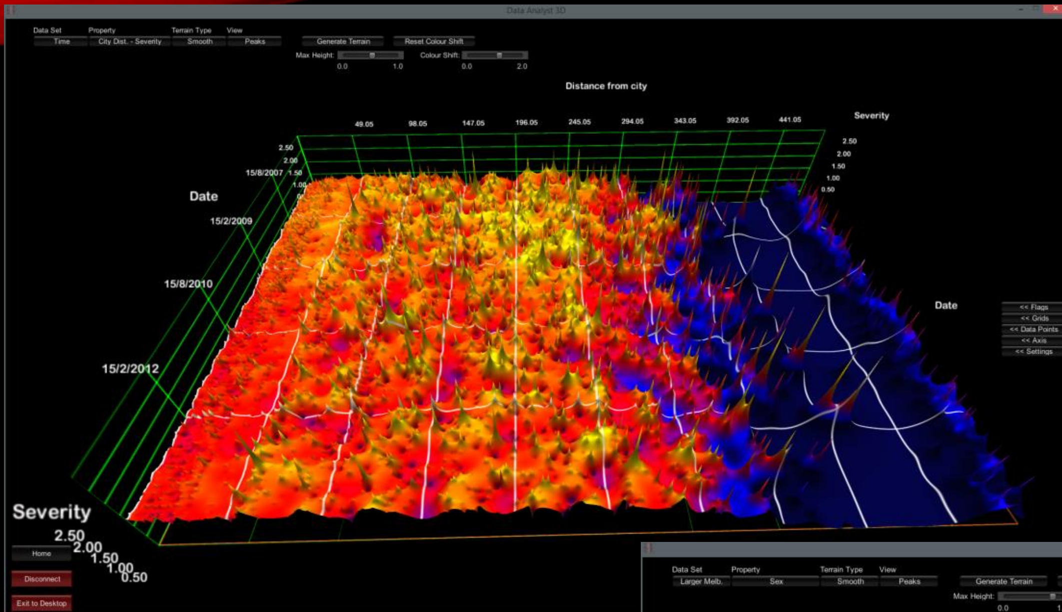




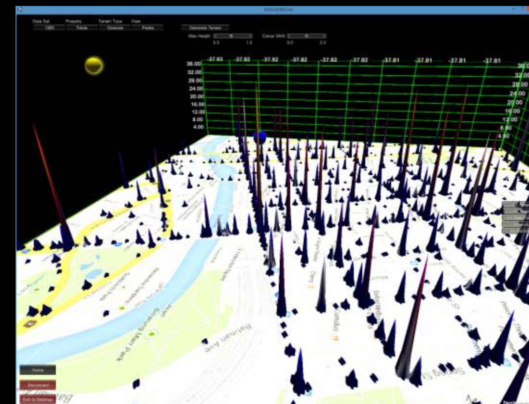


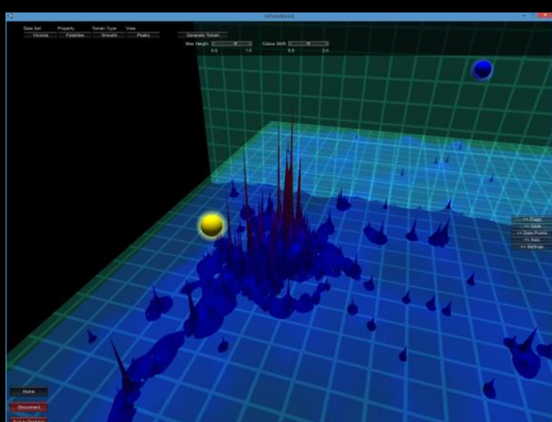
IVA IN ACTION

Severity vs. Distance from the City

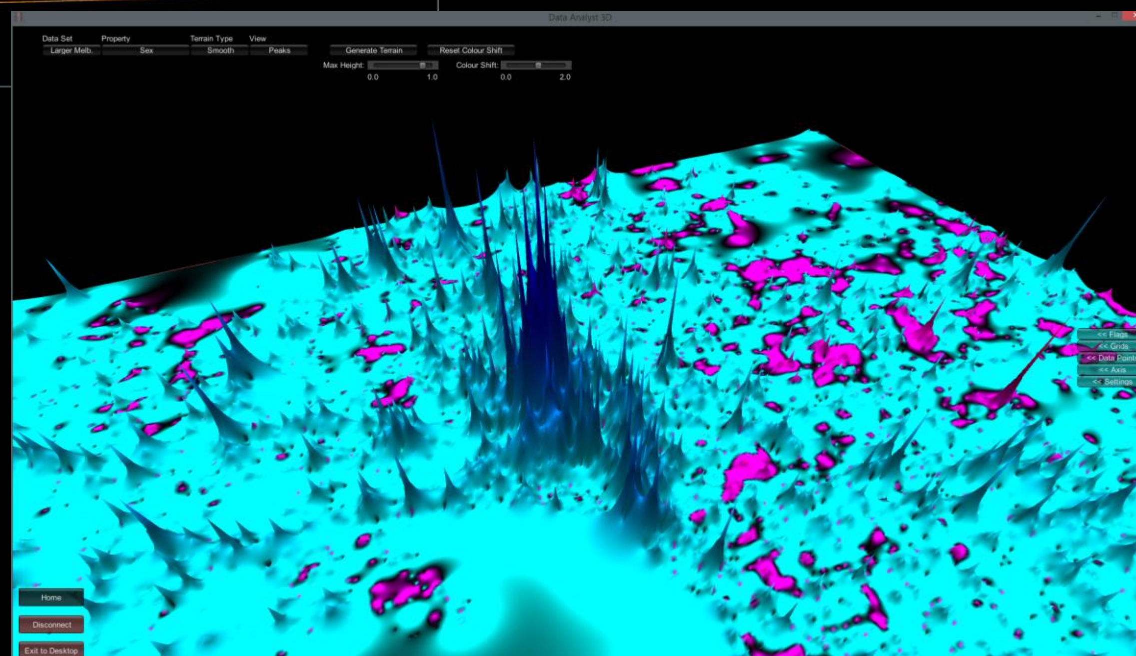


Dangerous Intersections





Victorian Fatalities



Women Drivers

SUMMARY & REFLECTION

The main purpose of interactive data visualisation is to make sense of the presented data and the the past or current events it represents.

Data visualization provides opportunities to simplify complex data and to establish a link between data abstraction and the familiar parts of reality. In this research we rely on the metaphor of terrain, landscape and maps to provide data with its visual form and methods of its manipulation.

Visual Analyst 3D provides tools for extracting data features from visual cues in 3D, such as colour, elevation and proximity. In addition, visual analysts can rely on metaphors of immersion in the terrain, its navigation and exploration, planting of markers for future reference, using grids to section the terrain, relying on filters to hide uninteresting data, as well as, its annotations and retracing.

Visual cues can be adjusted to support different levels of data aggregation, so that insights could range from developing of mere intuition about data to producing precise measurement of individual data points.

Analytics is a social activity and team analysts need to be able to collaborate on joint development of insights and reports. Visual Analyst 3D provides facilities for multiplayer exploration of data terrains and supporting a team-based analytic process which starts with setting objectives, compiling information, generating and evaluating ideas, planning action, observing and reflecting, and finally crystallizing insights and their reporting.

Recent projects

Teaching Data Analytics (OLT)
Sensemaking and Legitimisation (ICAA)
Oil and Gas Exploration Project (SAS)

Data sets

Sales of movie tickets
Music distribution
Motor vehicle accidents
Oil exploration data
Share market dynamics

Current and future work

Larger study of IVA sensemaking
Study comparing 2D and 3D IVA
Collaborative analytics
Shared and private analytic spaces
Passer-by analytics
Virtual reality analytics
Dynamic data and text

References

Cybulski, J.L., Keller, S., Nguyen, L. and Saundage, D. (2015). Creative Problem Solving in Digital Space Using Visual Analytics. Computers in Human Behavior 42: 20–35.

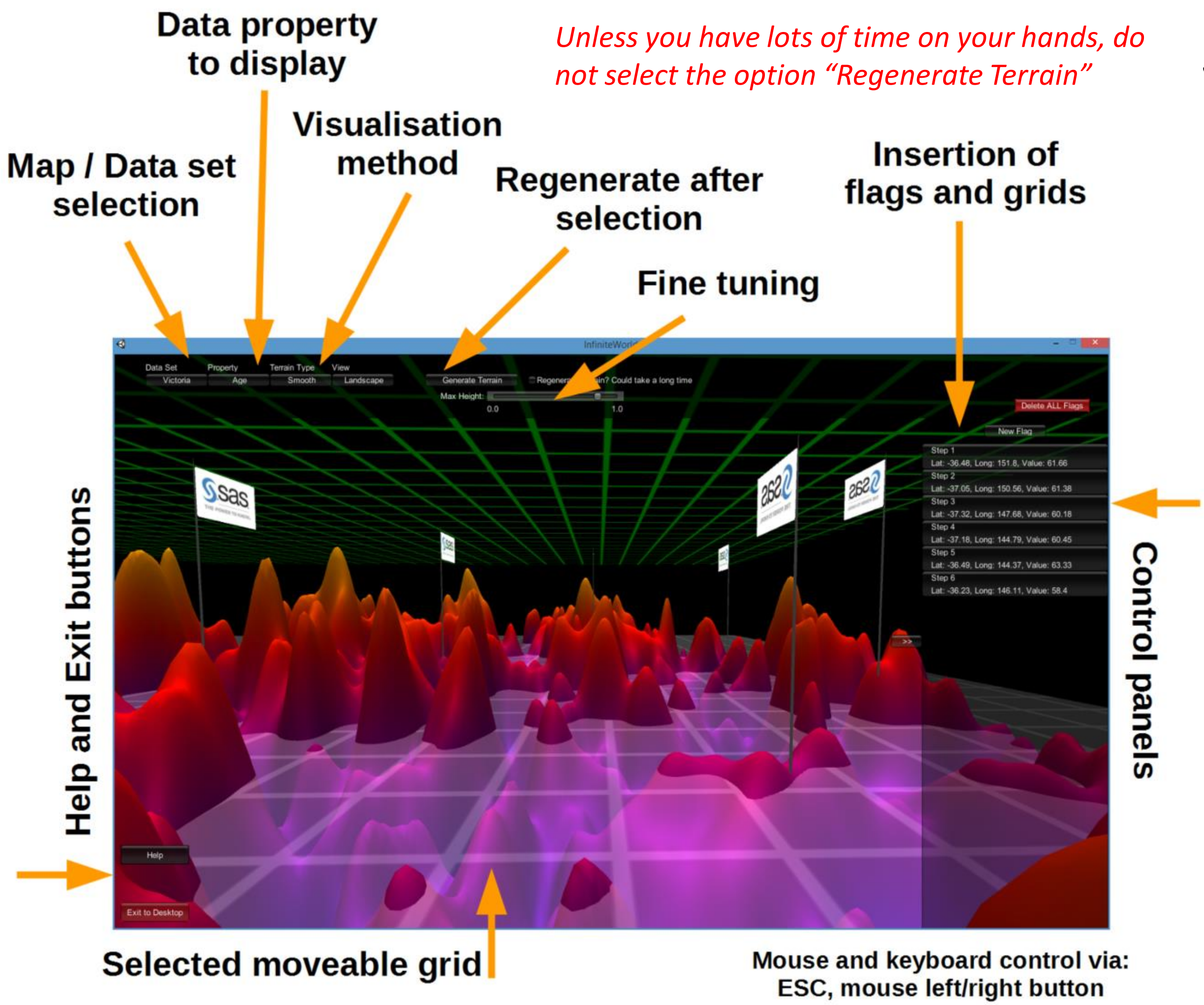
Cybulski, J.L., Keller, S. and Saundage, D. (2015). Interactive Exploration of Data with Visual Metaphors. International Journal of Software Engineering and Knowledge Engineering 25, no. 02, 231–52.

Visual Analyst 3D with Accidents Data - Gender balance

Visual Analyst 3D

A summary of the system functionality

Unless you have lots of time on your hands, do not select the option "Regenerate Terrain"



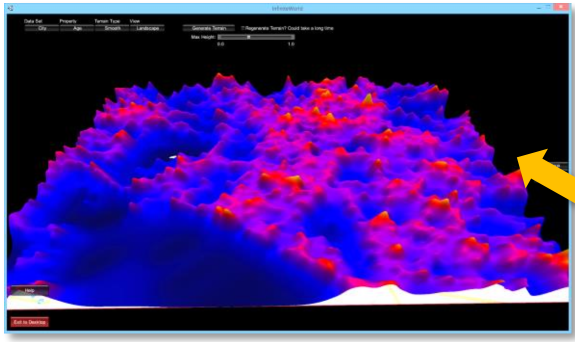
Data comes in the form of a terrain! Such a terrain visualizes values of data points, which aggregate some aspects of accidents that occurred in geographical areas of Victoria. The areas are defined by splitting a map into a segments arranged in rows and columns (e.g. 16x16, 128x128, etc).

To load a data terrain, select a data set and the property to be displayed, pick the required terrain type (smooth or granular) and its view (peak or landscape) and then press the button "Generate Terrain".

Maps and Data Terrain

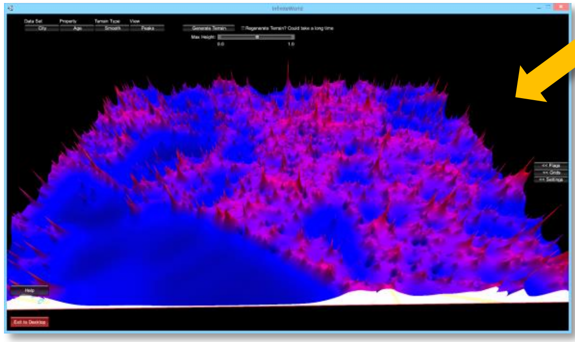
Granular landscape peaks have accurate values at the very tip which, but it may be hard to locate

Smooth Landscape



Smooth landscape may not indicate peaks accurately

Smooth Peaks



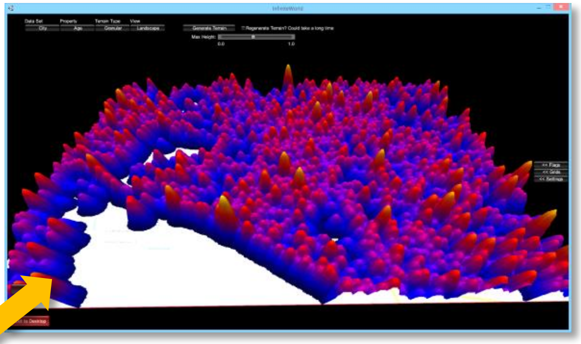
Present your data in the right form
We have a number of terrain types with distinct features, i.e. terrain type and its view.

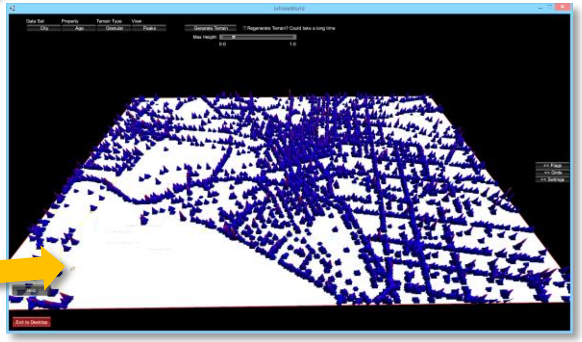
Landscape terrains emphasize the features of data point groups. Smooth terrains blend and blur these groups, whereas granular ones separate them.

Peak terrains identify single terrain values - individual or aggregate. When smoothed they also highlight similarity of neighboring data points.

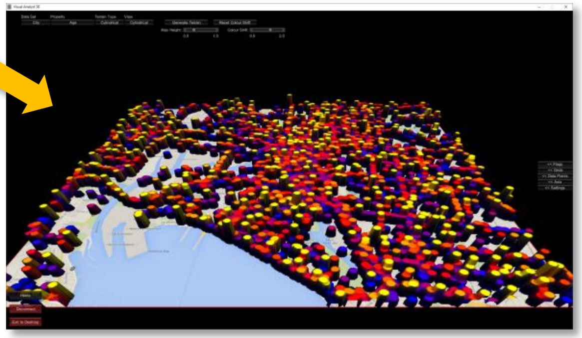
Cylindrical terrains present a traditional 3D column chart in a data terrain.

Adjust terrain height with a slider, press “Generate Terrain” to update the view.





Granular Landscape or Peaks

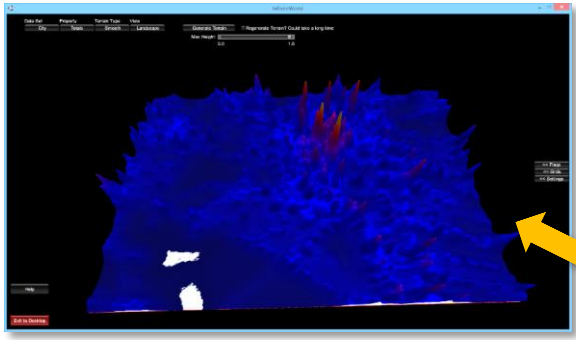


Cylindrical

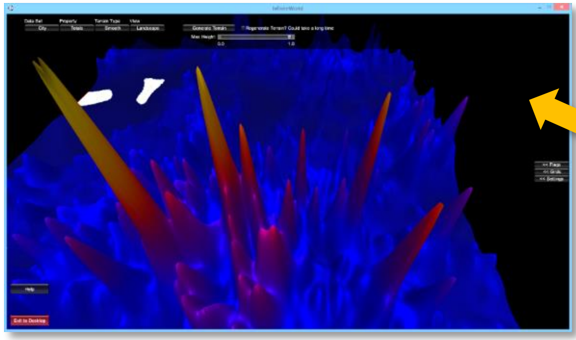
Navigating Data Terrains

If you get lost, view the terrain from above, or hide the terrain, or press "Home" button to go to the initial position.

1. Press ESC to activate navigation



3. Pause navigation by pressing ESC



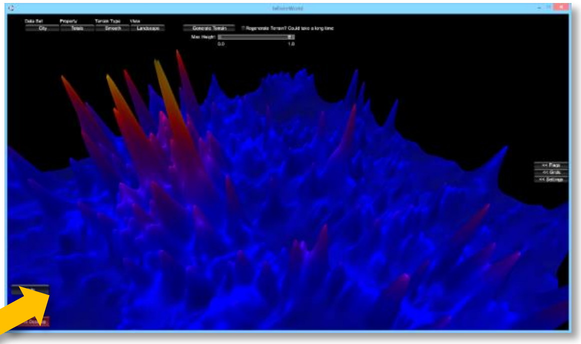
Terrain can be explored as in a game

When a data terrain is loaded it seems static. However, when you press ESC key you start terrain navigation until you pause it by pressing ESC again.

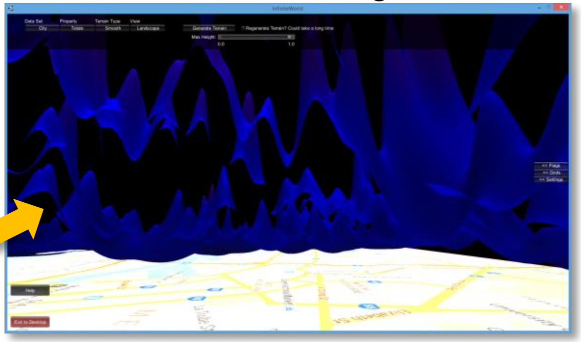
On the left we show the total number of motor vehicle accidents in the city. After pressing ESC you can use the mouse to look around, left and right mouse buttons to move forward and backwards – like in a game.

Select the best view to analyze your data and move around to reanalyze it. You can even go through the hills and end up underneath the terrain, in which case just move back and around to explore the data.

2. Use the mouse to navigate terrain



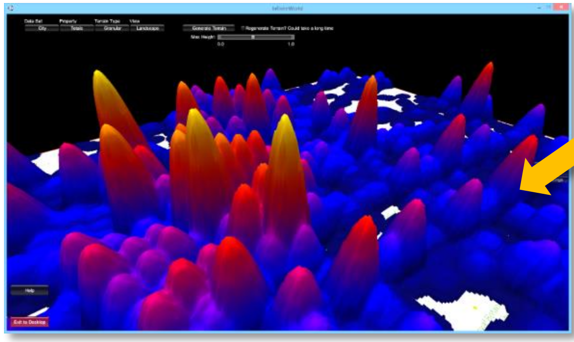
4. You can walk through the terrain



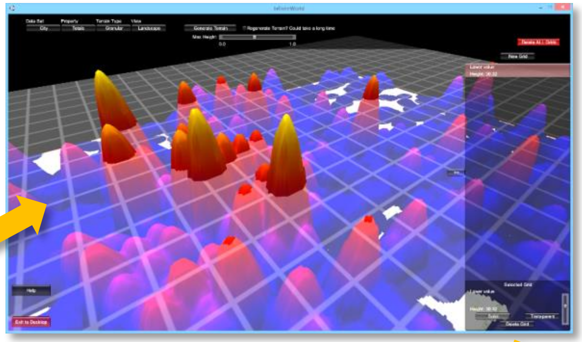
Analyzing and Discovering

Smooth landscape terrain does not represent the peaks' elevation or their distance accurately due to approximation.

1. Landscape works well with grids



2. Open grids panel and create a grid



Options of the currently selected grid can be adjusted

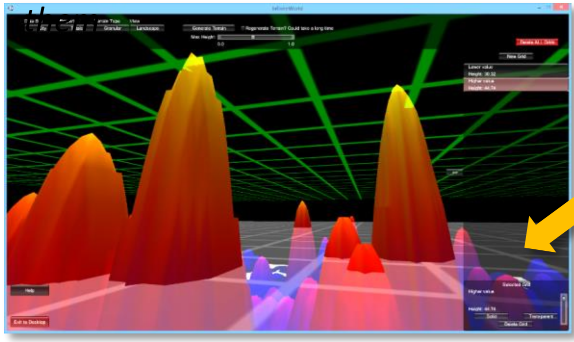
Grids can be used to filter visible data (above certain level) and to compare the heights of data peaks.

Display your terrain in landscape form - works best with grids.

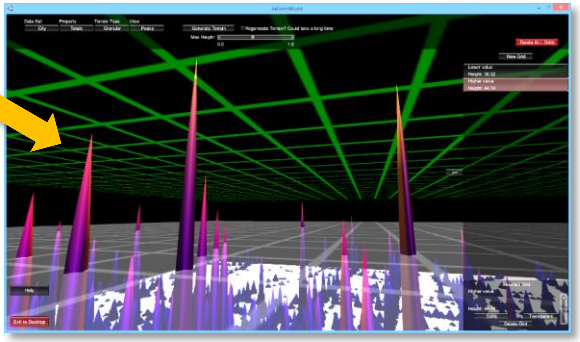
If you were in the navigation mode pause it by pressing ESC. Open the grids panel by pressing a small button "<< Grids" on the right. Create a new grid and name it.

Area at the bottom of the panel allows adjusting the grid position and selecting between grid options. As the "solid" grid moves up, it hides terrain peaks underneath. It is now easy to compare visible peaks.

3. Add more grids and position



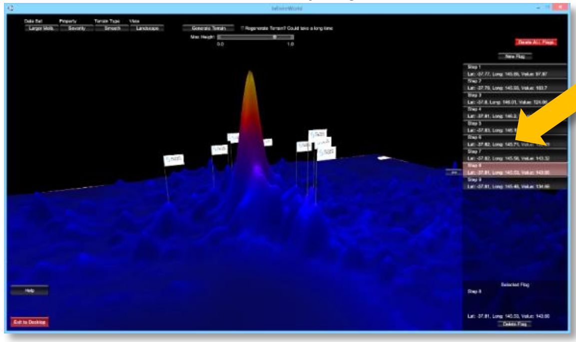
4. Grids are adjusted on terrain change



Observing and Reporting

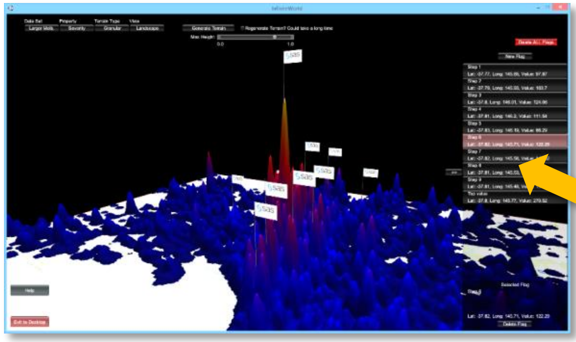
Terrains are built algorithmically to define elevation of data points, which is used as a flag value at point's geo-location

1. Mark out landscape for orientation



Changing terrain options will change existing flag elevation but not its value

3. Create flag list for reporting

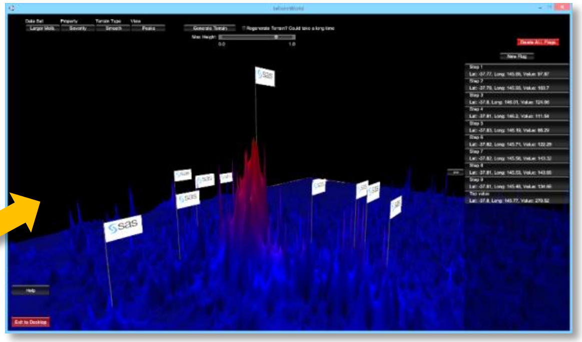


Use flags to record observations
Use flags with landscape terrains for general orientation of where are the highs and lows of your data. Use peak terrains for precision of point elevation as recorded on a flag.

If you were in the navigation mode pause it by pressing ESC. Open the flags pane by pressing a small button "<< Flags". Create a flag and position it on the terrain, then enter its text annotation. A list of flags will appear in the flags pane, useful for reporting of observations. Flags selected from the list will oscillate to easily identify them in the terrain.

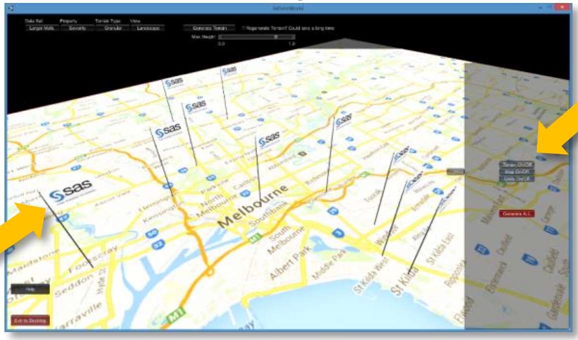
For flags' geo-locations, hide the terrain from the "<< Settings" pane.

2. Place flags on peaks for accuracy



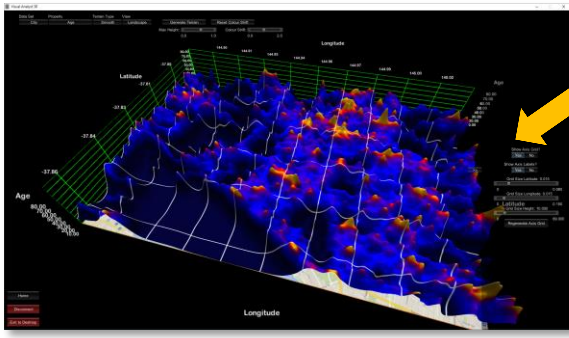
Flag and Settings panes appear by pressing small "<<" buttons on the right.

4. Hide terrain to geo-locate markers



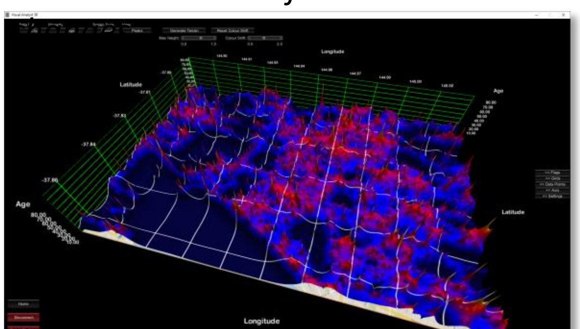
Increasing Visual Precision

1. Add axes and labels for precision



Axes and data points settings can be adjusted on their settings panes.

3. Axes lines are adjusted with

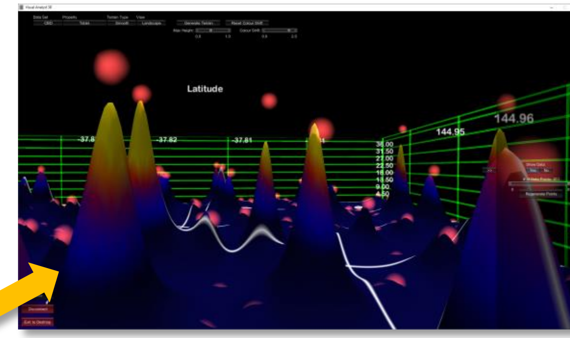


Axes can be activated to plot data coordinates. The terrain will be ruled with lines and the labels placed on axes for identification of value ranges in the terrain. These lines accentuate the terrain shape.

In smooth data terrains, where the terrain surface only approximates the data, the real data points can be displayed to assess the accuracy of the surface spanning the points.

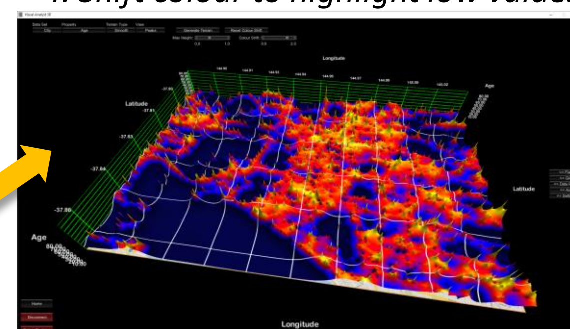
When the distances between data points are small so that visual distinction between terrain features is also difficult, the sliders can be used to increase the terrain elevation and to shift the colour spectrum to highlight differences.

2. Place points on smooth terrains



Axes and Data Points panes appear by pressing small "<<" buttons on the right.

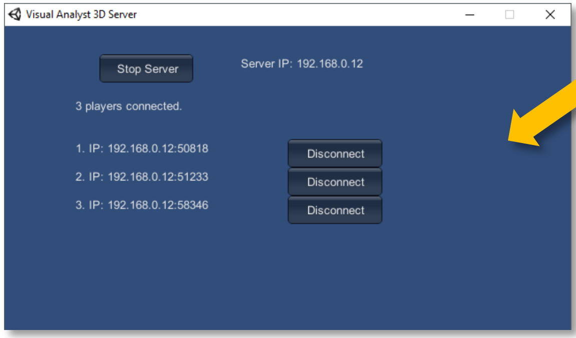
4. Shift colour to highlight low values



Multiplayer Option

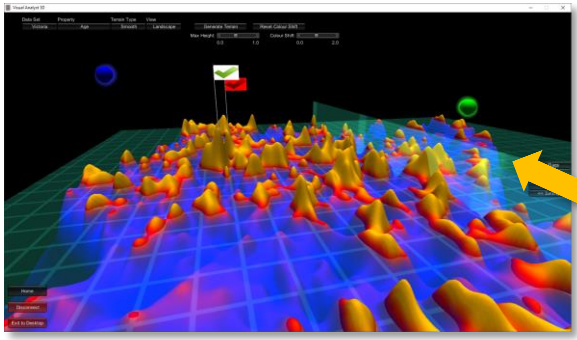
When a multiplayer option has been enabled (requires a Visual Analyst 3D server) then several concurrent users can analyse the same data.

1. Run VA3D server



Terrain options are stored in the server. Users have distinct views of the terrain.

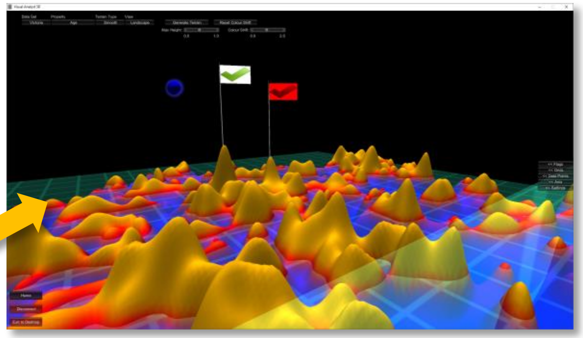
3. View of the purple user



If need to work with other analysts
Start a VA3D server and name the session with a unique ID. Each (possibly remote) user will then have to select a multiplayer mode and pick the same (agreed upon) server ID from the list of all currently available servers.

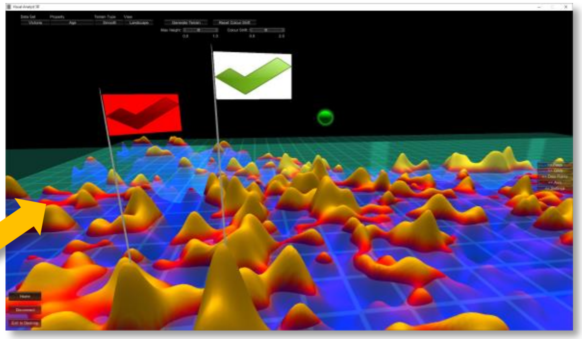
All users in the terrain will be identified with a colour sphere. Each person can independently navigate the terrain and assume different viewpoint. However, all changes to the data terrain will be synchronized and displayed in the same fashion to all users. At this point in time, voice and message communication are supported only via third party products, e.g. Skype.

2. View of the green user



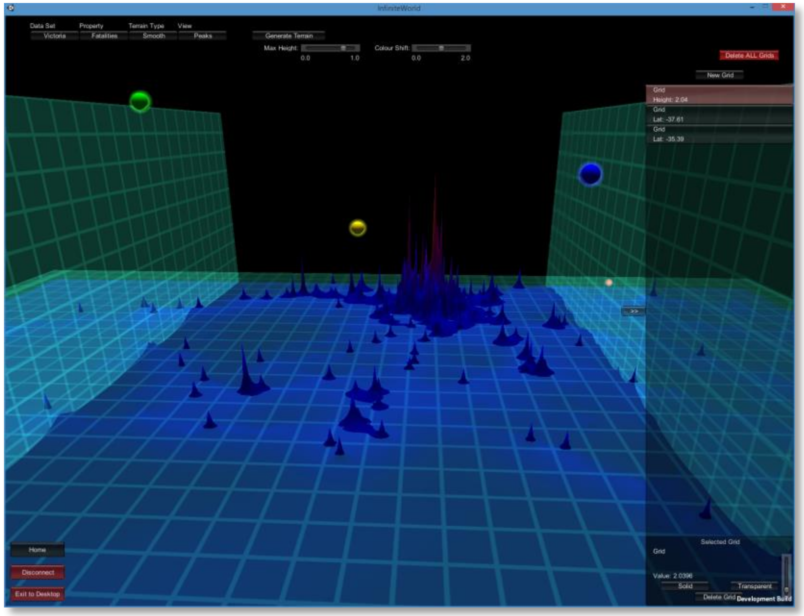
Flag and Settings panes appear by pressing small "<<" buttons on the right.

4. View of the blue user



Acknowledgements

The Visual Analyst 3D was initially developed by A/Prof. Jacob Cybulski in the Department of Information Systems and Business Analytics at Deakin University, as part of the project "Enhancing collaborative learning in information systems business analytics using data visualisation and manipulation techniques".



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