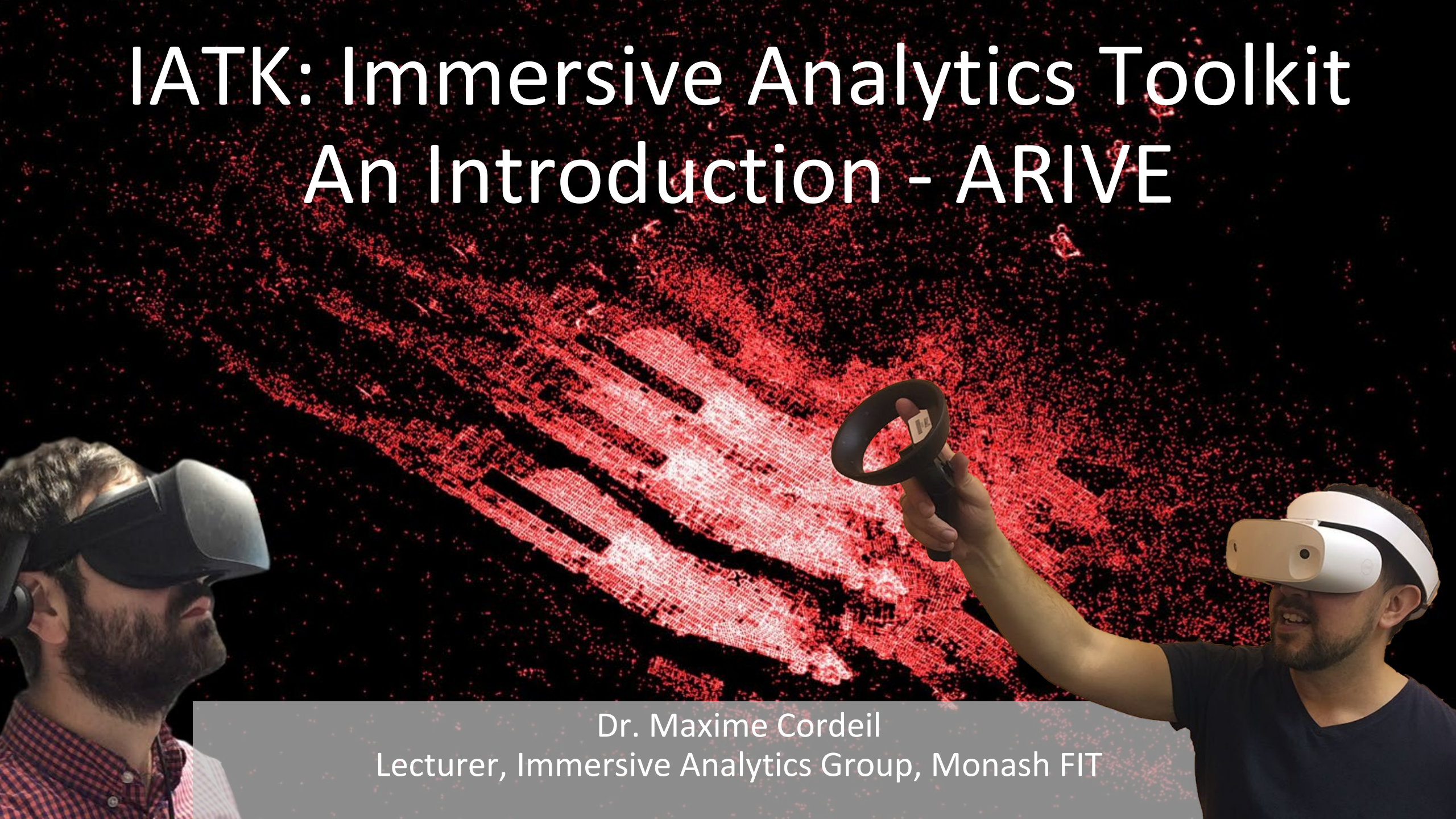
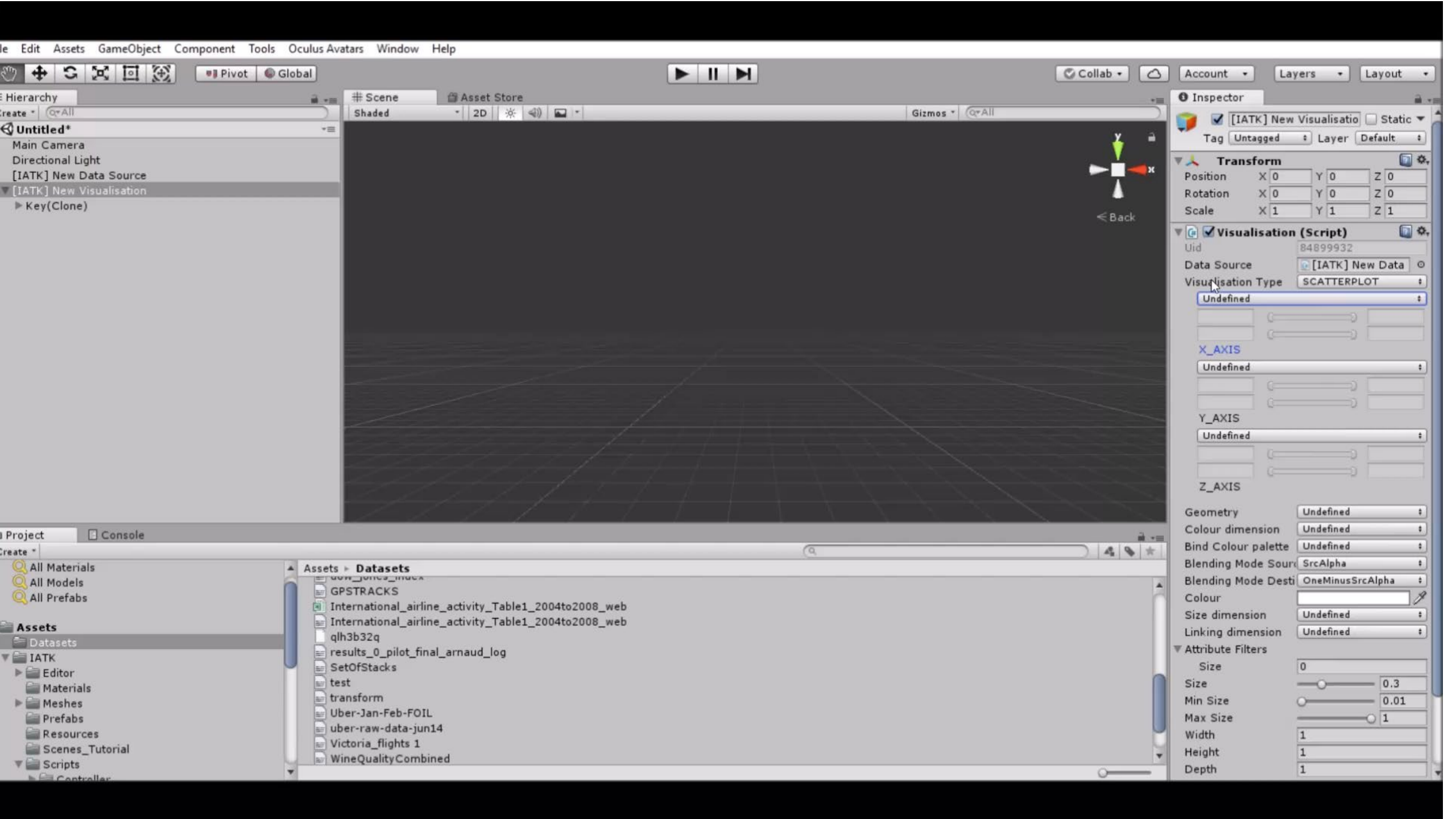
IATK: Immersive Analytics Toolkit
An Introduction - ARIVE



Dr. Maxime Cordeil
Lecturer, Immersive Analytics Group, Monash FIT


Edit Assets GameObject Component Tools Oculus Avatars Window Help
Pivot Global
Collab Account Layers Layout
Hierarchy
Create
Untitled*
Main Camera
Directional Light
[IATK] New Data Source
[IATK] New Visualisation
Key(Clone)
Scene
Asset Store
Shaded 2D Gizmos
Back
Inspector
[IATK] New Visualisatio
Static
Tag Untagged Layer Default
Transform
Position X 0 Y 0 Z 0
Rotation X 0 Y 0 Z 0
Scale X 1 Y 1 Z 1
Visualisation (Script)
Uid 84899932
Data Source [IATK] New Data
Visualisation Type SCATTERPLOT
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X_AXIS
Undefined
Y_AXIS
Undefined
Z_AXIS
Geometry Undefined
Colour dimension Undefined
Bind Colour palette Undefined
Blending Mode Sour SrcAlpha
Blending Mode Desti OneMinusSrcAlpha
Colour
Size dimension Undefined
Linking dimension Undefined
Attribute Filters
Size 0
Size 0.3
Min Size 0.01
Max Size 1
Width 1
Height 1
Depth 1
Project
Console
Create
All Materials
All Models
All Prefabs
Assets
Datasets
IATK
Editor
Materials
Meshes
Prefabs
Resources
Scenes_Tutorial
Scripts
Assets ▸ Datasets
GPSTRACKS
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SetOfStacks
test
transform
Uber-Jan-Feb-FOIL
uber-raw-data-jun14
Victoria_flights 1
WineQualityCombined

Immersive Analytics: FIT & externals


Tim Dwyer


Kim Marriott


Bernie Jenny


Sarah Goodwin


Maxime Cordeil


Tobias Czauderna


Peter Hoghton


Domenico Mazza


Arnaud Prouzeau


Barrett Ens

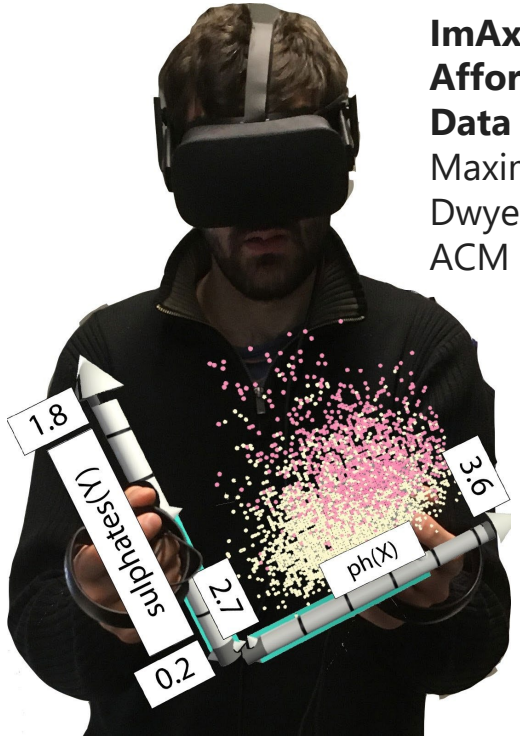

Matthias Klapperstueck


Yalong Yang

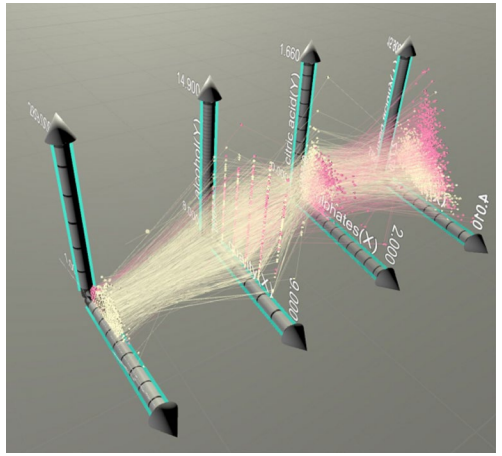

Benjamin Bach


Bruce Thomas
UniSA


Andrew Cunningham
UniSA



ImAxes: Immersive Axes as Embodied Affordances for Interactive Multivariate Data Visualisation
Maxime Cordeil, Andrew Cunningham, Tim Dwyer, Bruce H. Thomas and Kim Marriott
ACM UIST 2017

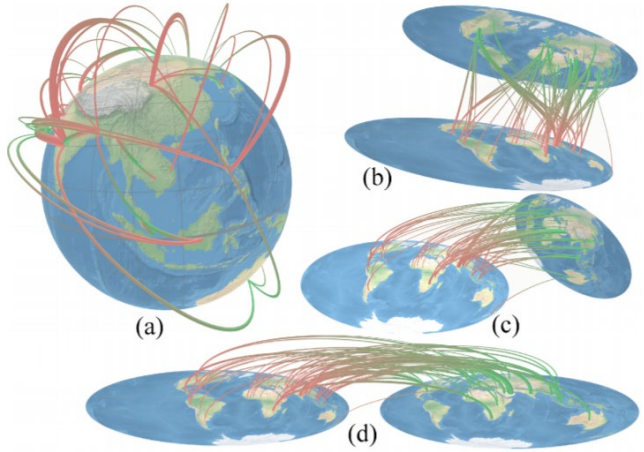


FibreClay – Immersive 3D curves exploration
Hurter, Riche, Drucker, Cordeil, Alligier, Vuillemot
IEEE InfoVis (TVCG) 19

Maps Around Me: 3D Multiview Layouts in Immersive Spaces
Satriadi, Ens, Cordeil, Czauderna, Jenny
ACM ISS 2020, to appear

Origin-Destination Flow Maps in Immersive Environments

Yalong Yang, Tim Dwyer, Bernhard Jenny, Kim Marriott, Maxime Cordeil and Haohui Chen



IEEE VIS, InfoVis/TVCG 18

ImAxes: Immersive Axes as Embodied Affordances for Interactive Multivariate Data Visualisation

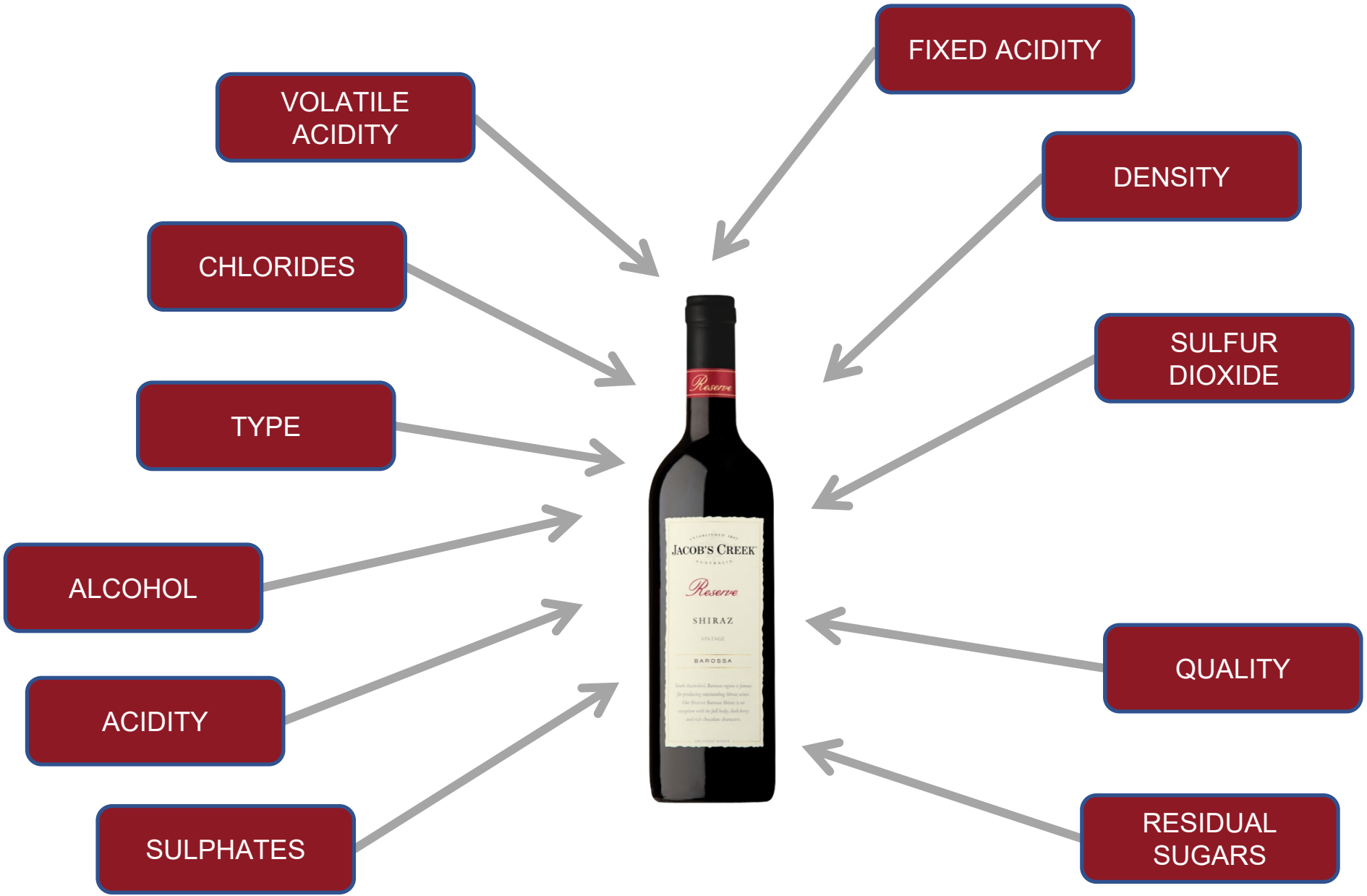
Maxime Cordeil
Andrew Cunningham
Tim Dwyer
Bruce H. Thomas
Kim Marriott

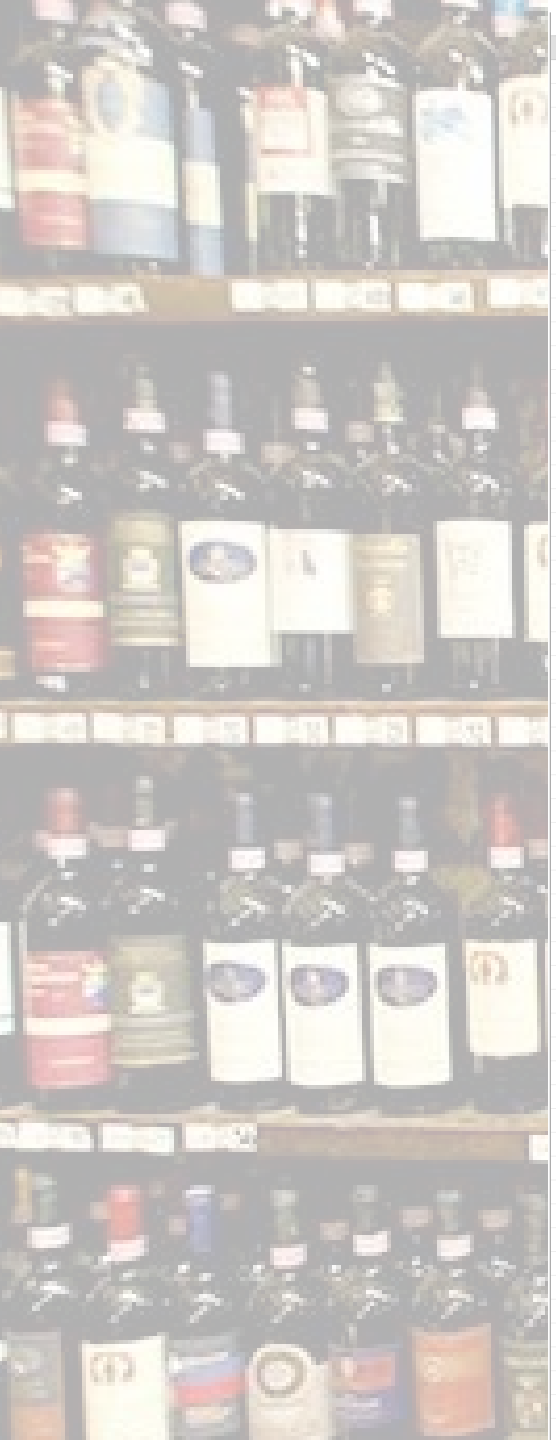
MONASH University

UIST 2017

University of South Australia

Multidimensional data





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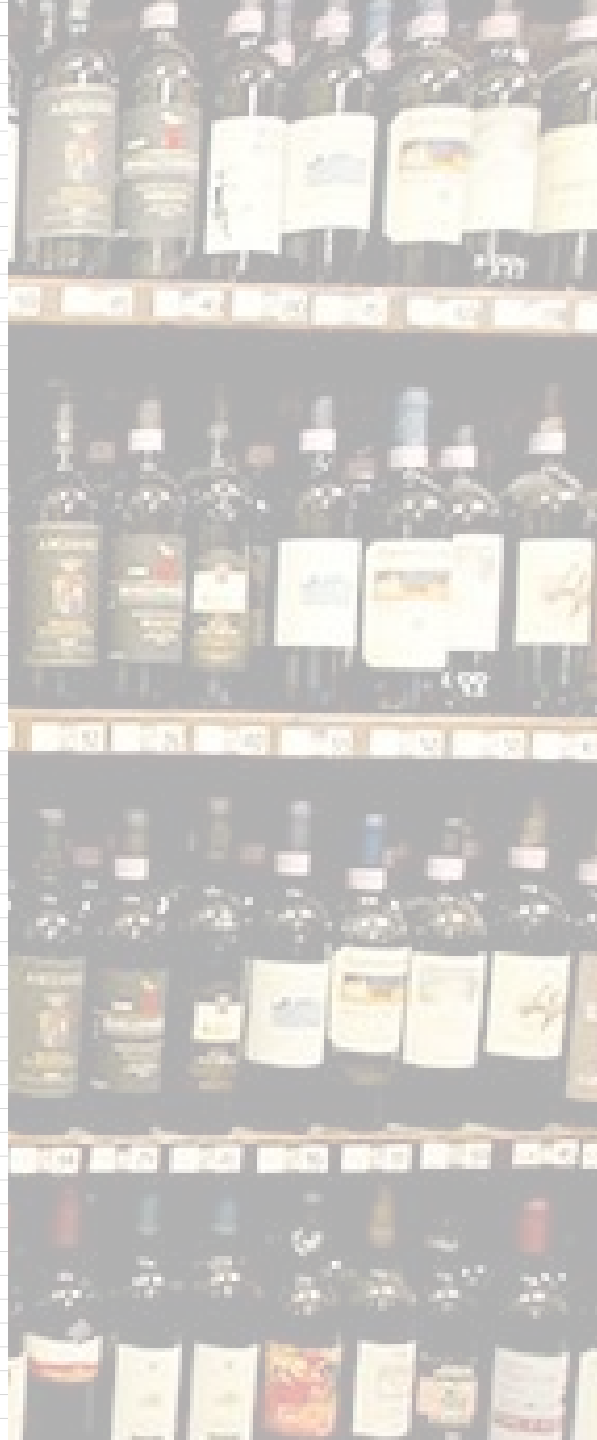
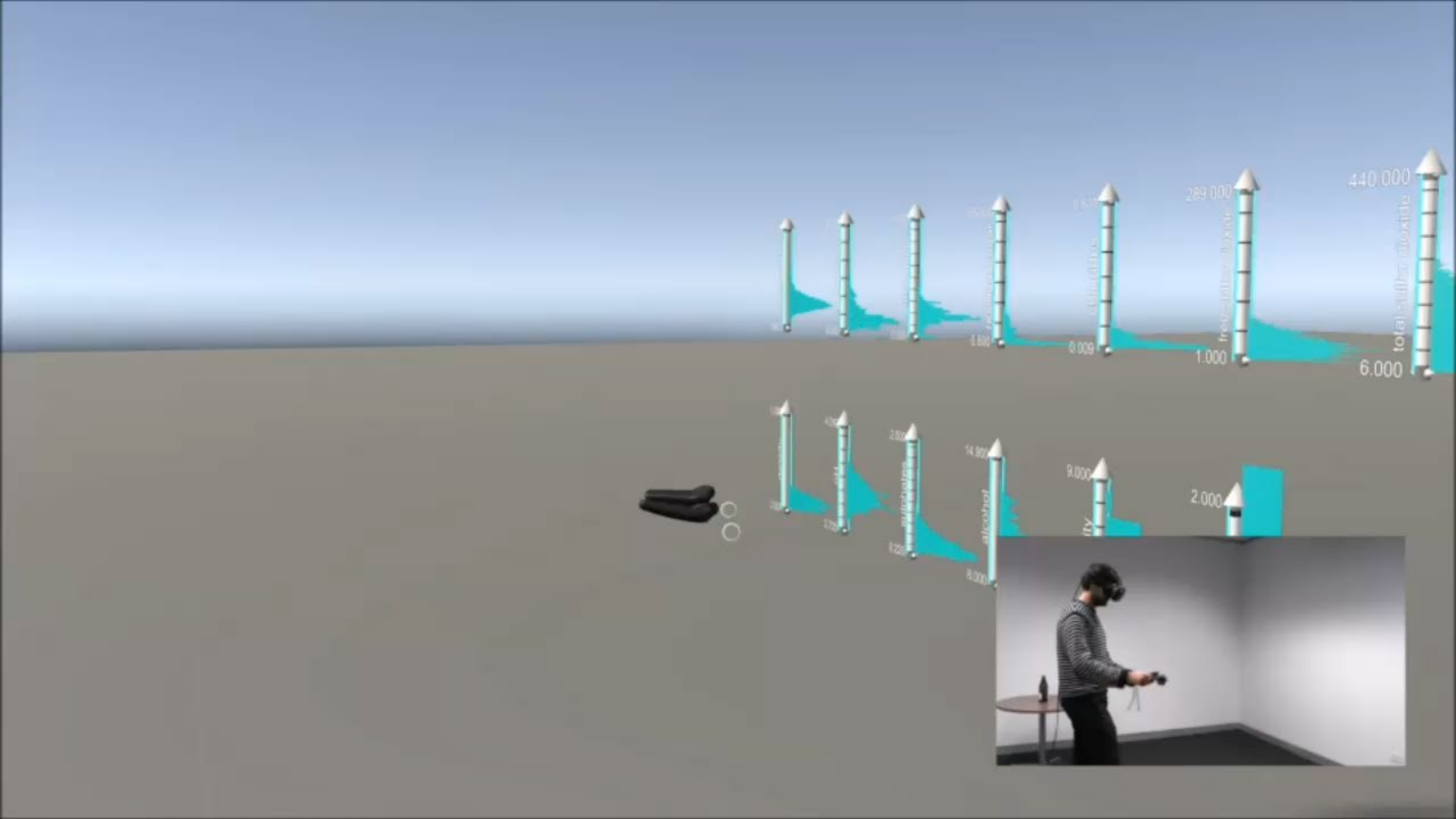
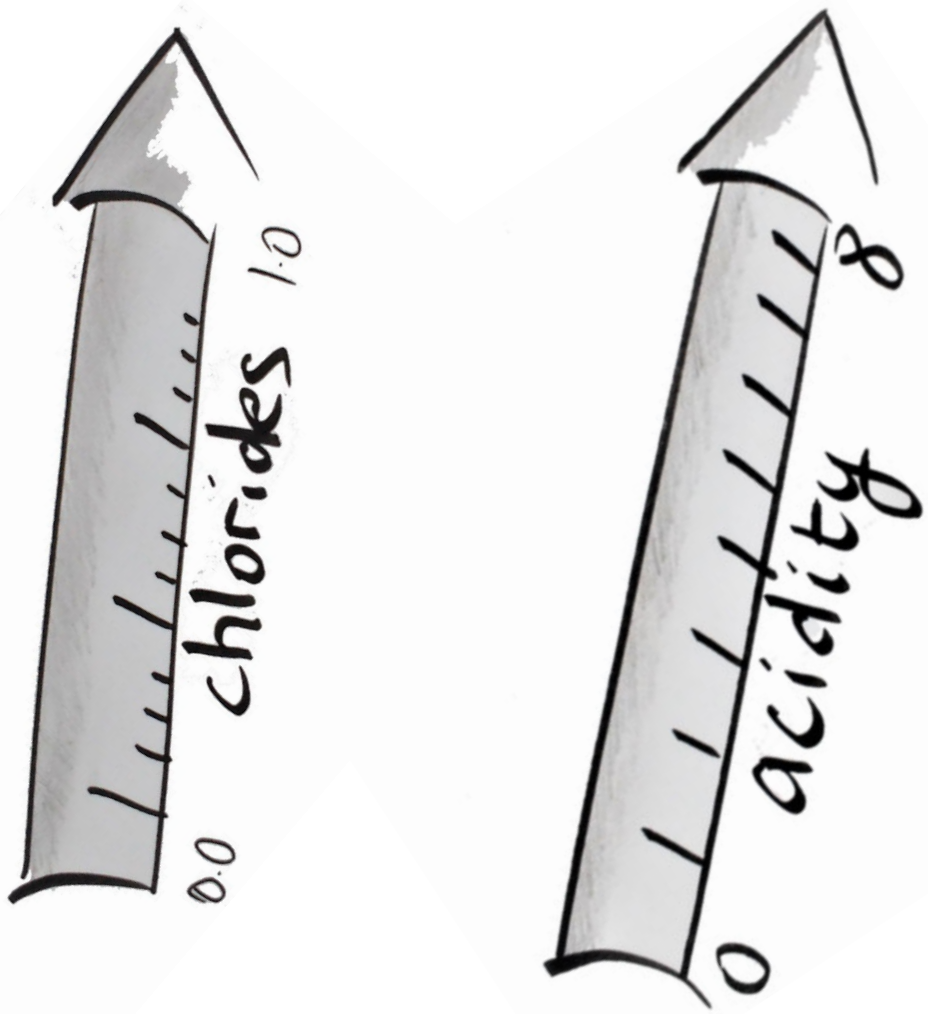
1	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality	Type
2	7	0.27	0.36	20.7	0.045	45	170	1.001	3	0.45	8.8	6	White
3	6.3	0.3	0.34	1.6	0.049	14	132	0.994	3.3	0.49	9.5	6	White
4	8.1	0.28	0.4	6.9	0.05	30	97	0.9951	3.26	0.44	10.1	6	White
5	7.2	0.23	0.32	8.5	0.058	47	186	0.9956	3.19	0.4	9.9	6	White
6	7.2	0.23	0.32	8.5	0.058	47	186	0.9956	3.19	0.4	9.9	6	White
7	8.1	0.28	0.4	6.9	0.05	30	97	0.9951	3.26	0.44	10.1	6	White
8	6.2	0.32	0.16	7	0.045	30	136	0.9949	3.18	0.47	9.6	6	White
9	7	0.27	0.36	20.7	0.045	45	170	1.001	3	0.45	8.8	6	White
10	6.3	0.3	0.34	1.6	0.049	14	132	0.994	3.3	0.49	9.5	6	White
11	8.1	0.22	0.43	1.5	0.044	28	129	0.9938	3.22	0.45	11	6	White
12	8.1	0.27	0.41	1.45	0.033	11	63	0.9908	2.99	0.56	12	5	White
13	8.6	0.23	0.4	4.2	0.035	17	109	0.9947	3.14	0.53	9.7	5	White
14	7.9	0.18	0.37	1.2	0.04	16	75	0.992	3.18	0.63	10.8	5	White
15	6.6	0.16	0.4	1.5	0.044	48	143	0.9912	3.54	0.52	12.4	7	White
16	8.3	0.42	0.62	19.25	0.04	41	172	1.0002	2.98	0.67	9.7	5	White
17	6.6	0.17	0.38	1.5	0.032	28	112	0.9914	3.25	0.55	11.4	7	White
18	6.3	0.48	0.04	1.1	0.046	30	99	0.9928	3.24	0.36	9.6	6	White
19	6.2	0.66	0.48	1.2	0.029	29	75	0.9892	3.33	0.39	12.8	8	White
20	7.4	0.34	0.42	1.1	0.033	17	171	0.9917	3.12	0.53	11.3	6	White
21	6.5	0.31	0.14	7.5	0.044	34	133	0.9955	3.22	0.5	9.5	5	White
22	6.2	0.66	0.48	1.2	0.029	29	75	0.9892	3.33	0.39	12.8	8	White
23	6.4	0.31	0.38	2.9	0.038	19	102	0.9912	3.17	0.35	11	7	White
24	6.8	0.26	0.42	1.7	0.049	41	122	0.993	3.47	0.48	10.5	8	White
25	7.6	0.67	0.14	1.5	0.074	25	168	0.9937	3.05	0.51	9.3	5	White
26	6.6	0.27	0.41	1.3	0.052	16	142	0.9951	3.42	0.47	10	6	White
27	7	0.25	0.32	9	0.046	56	245	0.9955	3.25	0.5	10.4	6	White
28	6.9	0.24	0.35	1	0.052	35	146	0.993	3.45	0.44	10	6	White
29	7	0.28	0.39	8.7	0.051	32	141	0.9961	3.38	0.53	10.5	6	White
30	7.4	0.27	0.48	1.1	0.047	17	132	0.9914	3.19	0.49	11.6	6	White
31	7.2	0.32	0.36	2	0.033	37	114	0.9906	3.1	0.71	12.3	7	White
32	8.5	0.24	0.39	10.4	0.044	20	142	0.9974	3.2	0.53	10	6	White
33	8.3	0.14	0.34	1.1	0.042	7	47	0.9934	3.47	0.4	10.2	6	White
34	7.4	0.25	0.36	2.05	0.05	31	100	0.992	3.19	0.44	10.8	6	White
35	6.2	0.12	0.34	1.5	0.045	43	117	0.9939	3.42	0.51	9	6	White
36	5.8	0.27	0.2	14.95	0.044	22	179	0.9962	3.37	0.37	10.2	5	White
37	7.3	0.28	0.43	1.7	0.08	21	123	0.9905	3.19	0.42	12.8	5	White
38	6.5	0.39	0.23	5.4	0.051	25	149	0.9934	3.24	0.35	10	5	White
39	7	0.33	0.32	1.2	0.053	38	138	0.9906	3.13	0.28	11.2	6	White
40	7.3	0.24	0.39	17.95	0.057	45	149	0.9999	3.21	0.36	8.6	5	White
41	7.3	0.24	0.39	17.95	0.057	45	149	0.9999	3.21	0.36	8.6	5	White
42	6.7	0.23	0.39	2.5	0.172	63	158	0.9937	3.11	0.36	9.4	6	White
43	6.7	0.24	0.39	2.9	0.173	63	157	0.9937	3.1	0.34	9.4	6	White
44	7	0.31	0.26	7.4	0.069	28	160	0.9954	3.13	0.46	9.8	6	White
45	6.6	0.24	0.27	1.4	0.057	33	152	0.9934	3.22	0.56	9.5	6	White
46	6.7	0.23	0.26	1.4	0.06	33	154	0.9934	3.24	0.56	9.5	6	White
47	7.4	0.18	0.31	1.4	0.058	38	167	0.9931	3.16	0.53	10	7	White
48	6.2	0.45	0.26	4.4	0.063	63	206	0.994	3.27	0.52	9.8	4	White
49	6.2	0.46	0.25	4.4	0.066	62	207	0.9939	3.25	0.52	9.8	5	White
50	7	0.31	0.26	7.4	0.069	28	160	0.9954	3.13	0.46	9.8	6	White
51	6.9	0.19	0.35	5	0.067	32	150	0.995	3.36	0.48	9.8	5	White
52	7.2	0.19	0.31	1.6	0.062	31	173	0.9917	3.35	0.44	11.7	6	White
53	6.6	0.25	0.29	1.1	0.068	39	124	0.9914	3.34	0.58	11	7	White
54	6.2	0.16	0.33	1.1	0.057	21	82	0.991	3.32	0.46	10.9	7	White
55	6.4	0.18	0.35	1	0.045	39	108	0.9911	3.31	0.35	10.9	6	White
56	6.8	0.2	0.59	0.9	0.147	38	132	0.993	3.05	0.38	9.1	6	White
57	6.9	0.25	0.35	1.3	0.039	29	191	0.9908	3.13	0.52	11	6	White
58	7.2	0.21	0.34	11.9	0.043	37	213	0.9962	3.09	0.5	9.6	6	White
59	6	0.19	0.26	12.4	0.048	50	147	0.9972	3.3	0.36	8.9	6	White



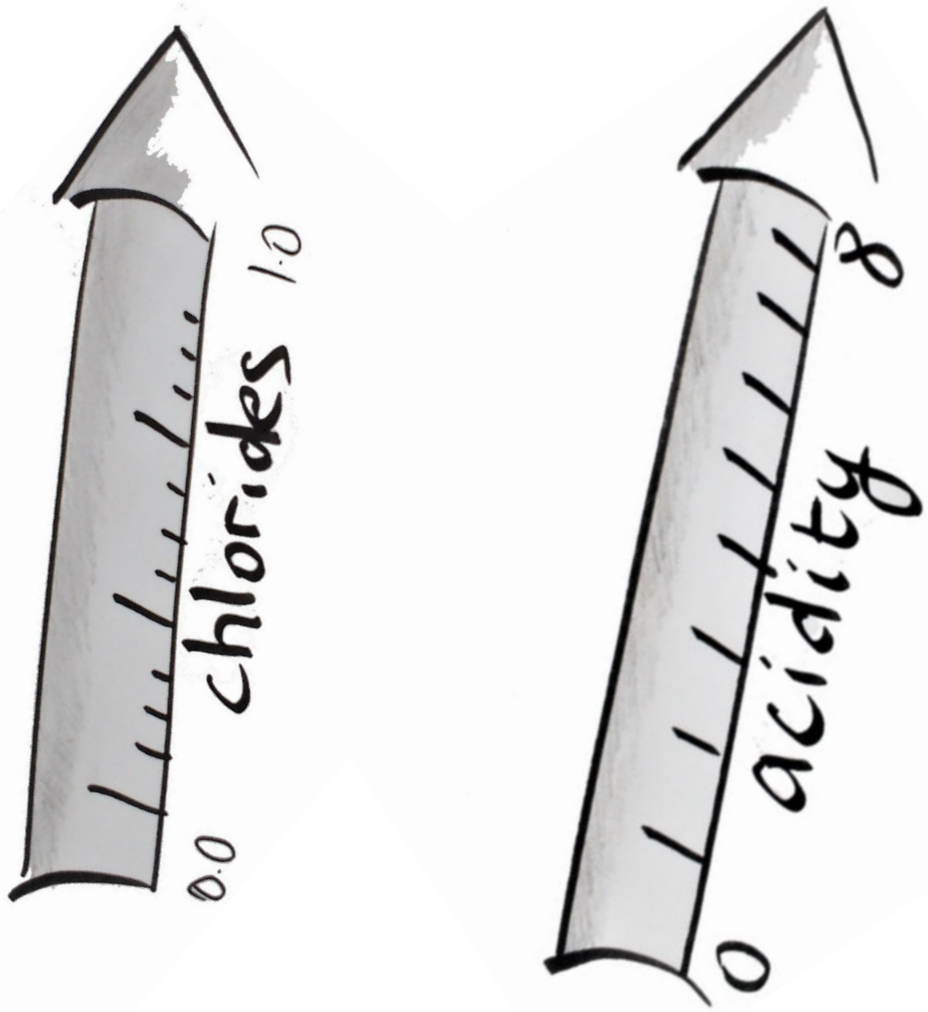

440.000
289.000
6.000
1.000
0.009
9.000
2.000

Axes as embodied* affordances**

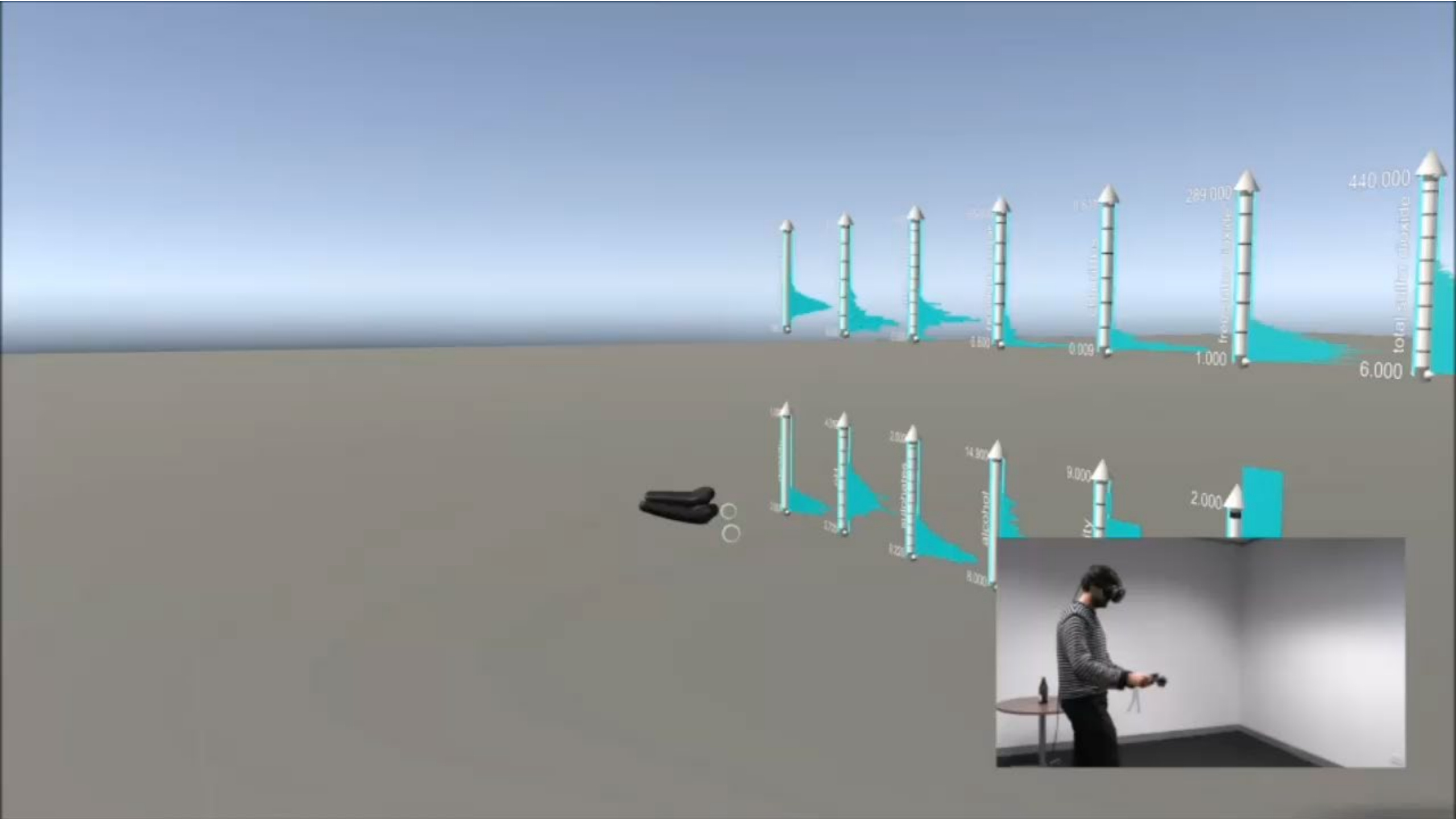


* Dourish, P. (2004)
** DA Norman (2002)

Axes as embodied* affordances**



* Dourish, P. (2004)
** DA Norman (2002)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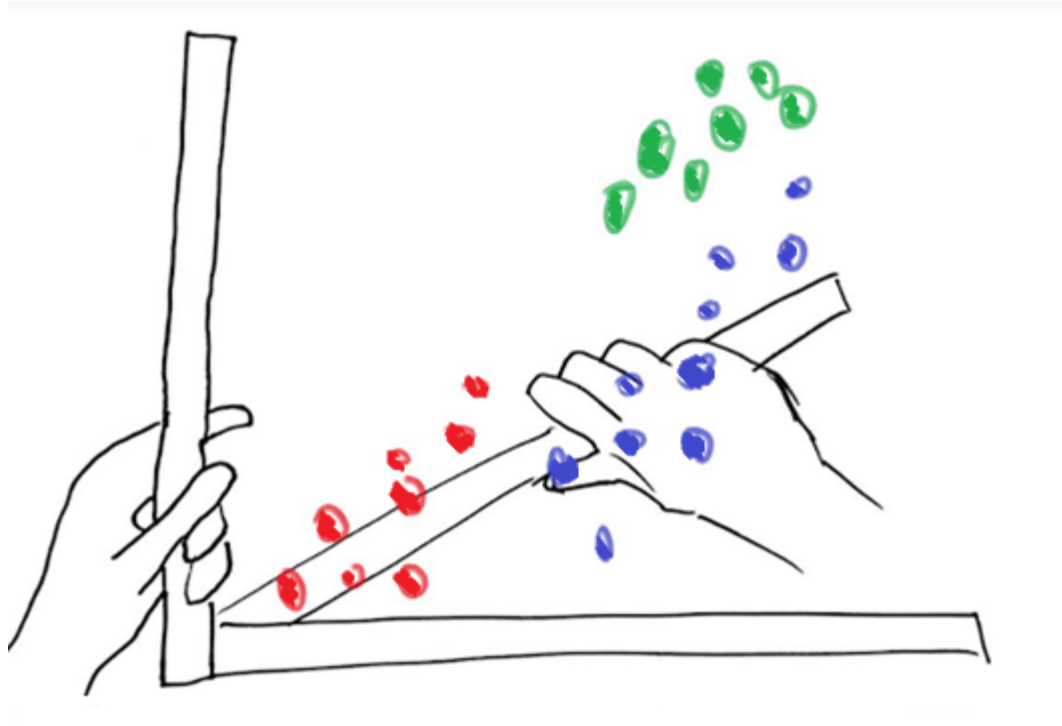
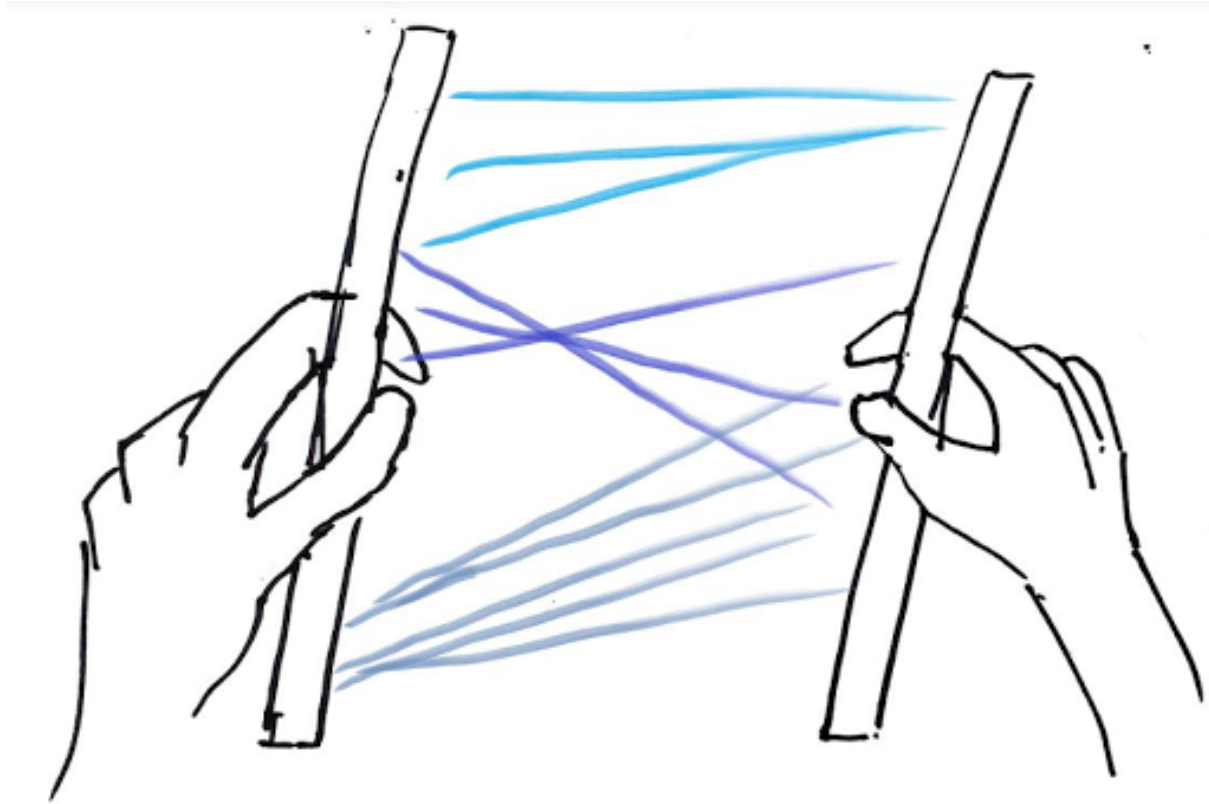
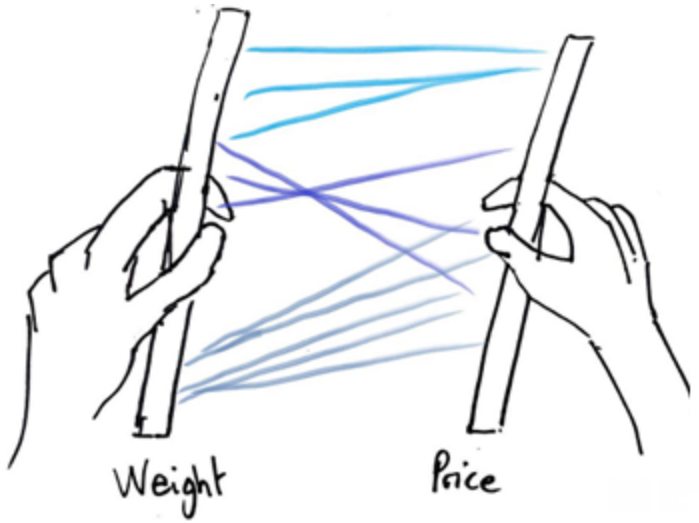
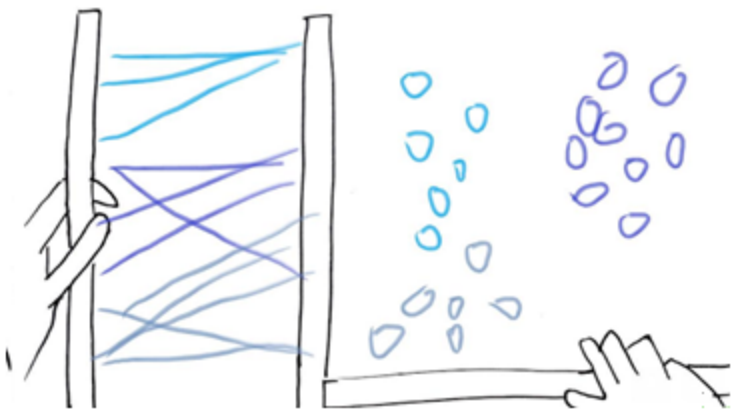
2.000

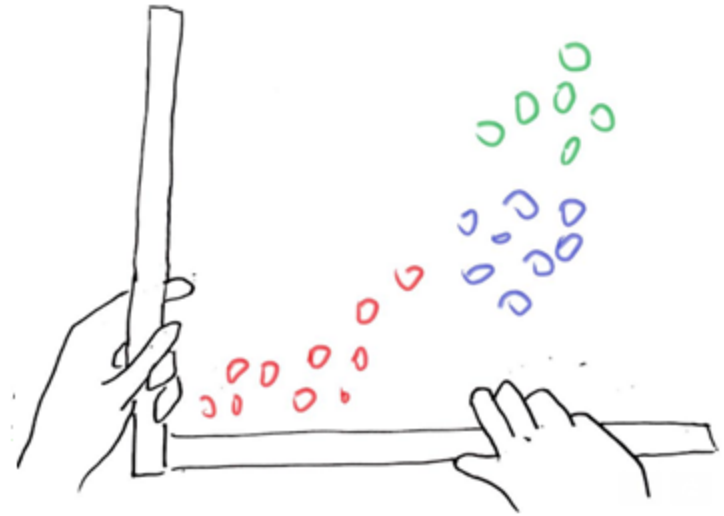
ImAxes design

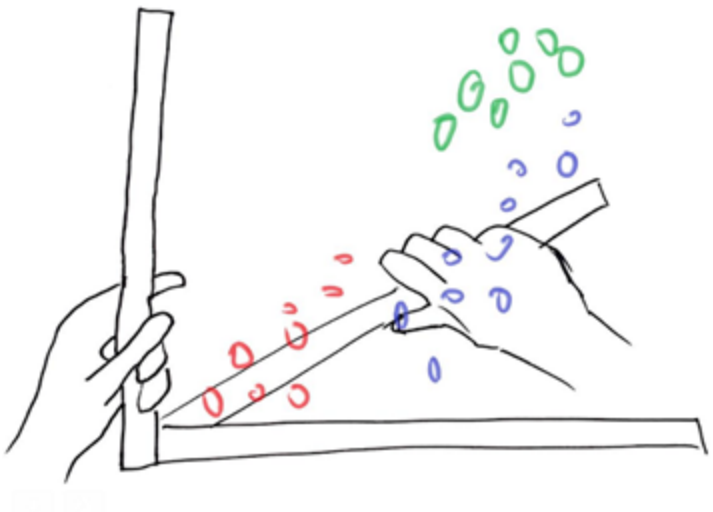


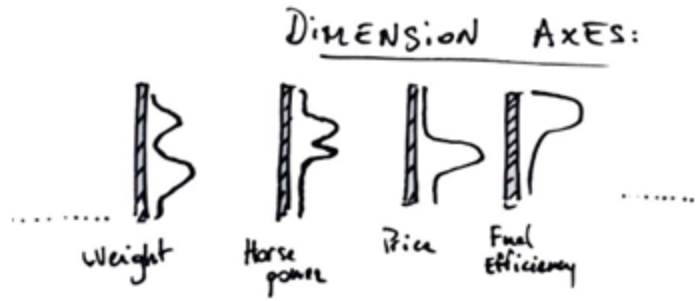


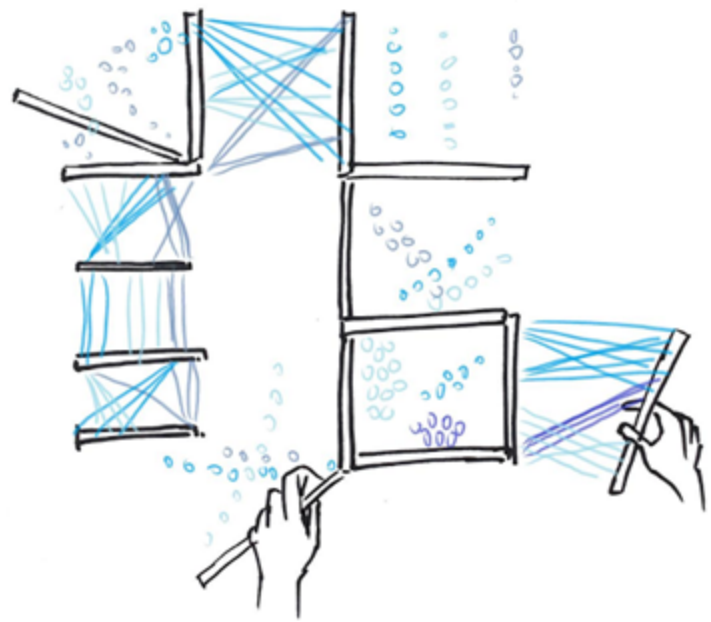

Weight
Price



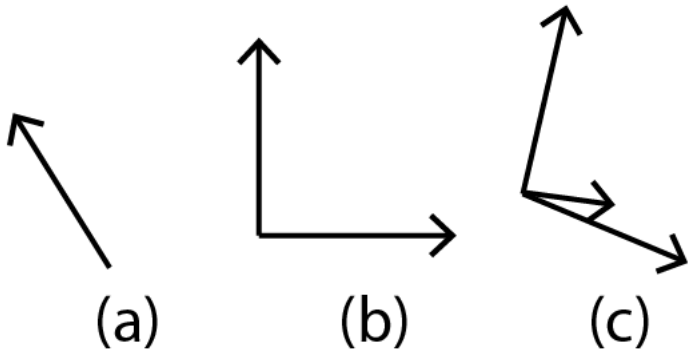





DIMENSION AXES:
Weight
Horse power
Price
Fuel Efficiency

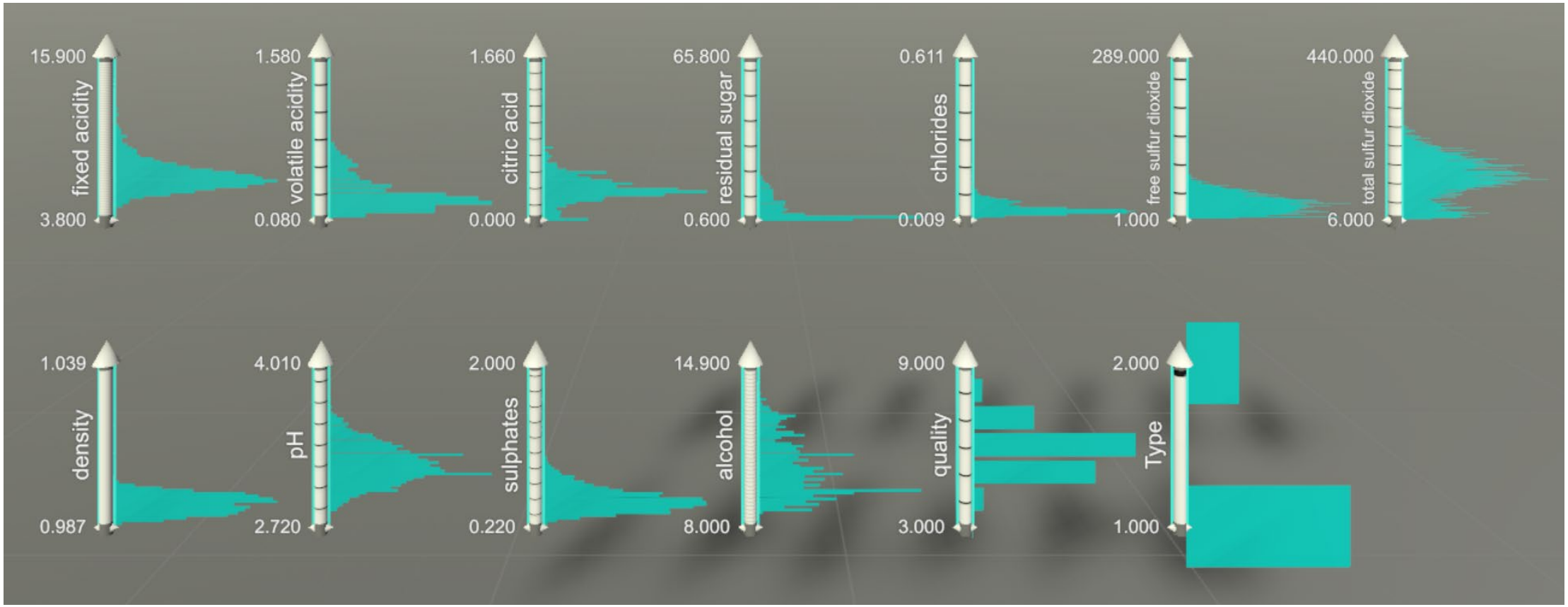


spatial grammar

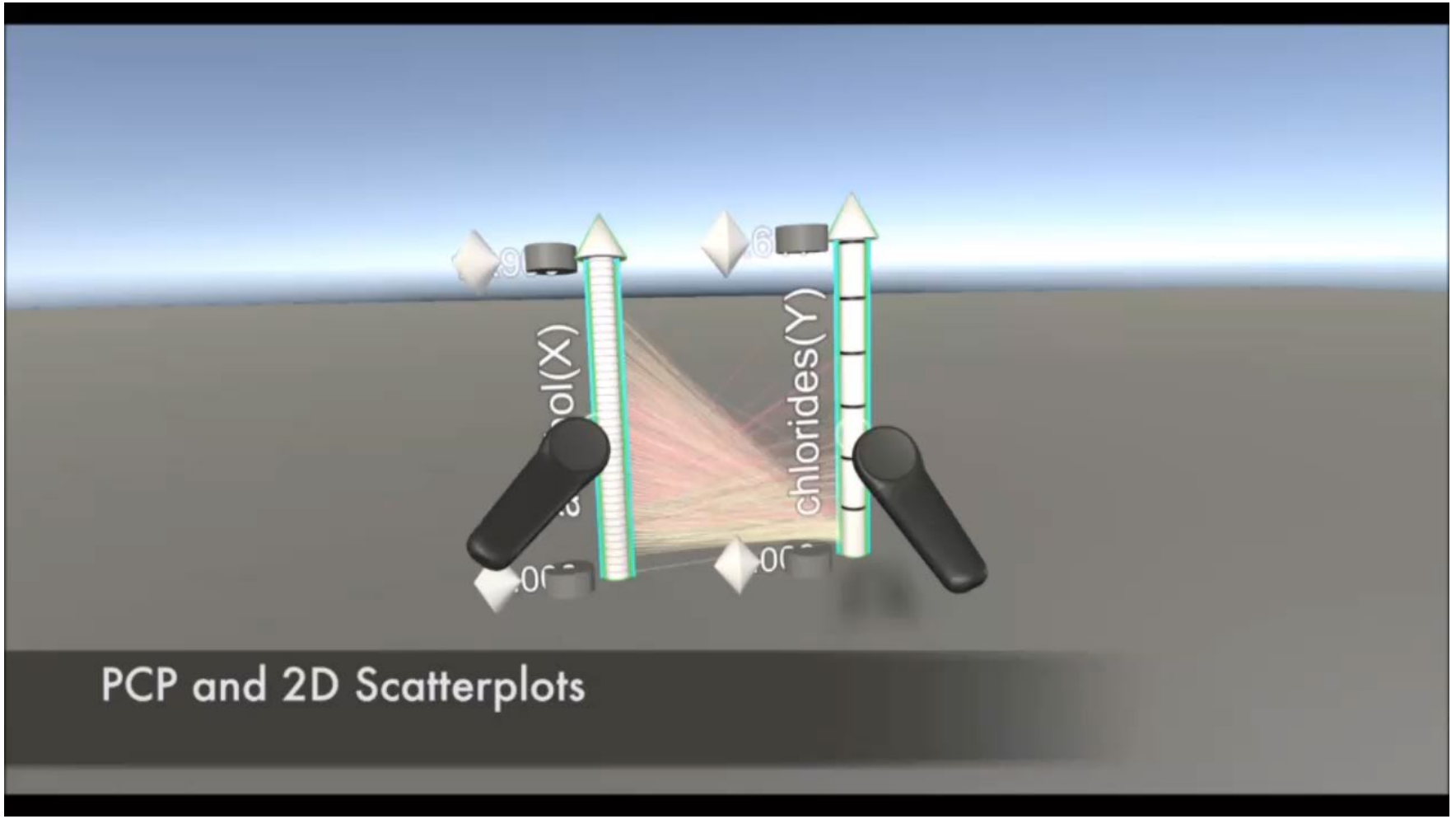


- direction, orthogonal, parallel, contact
- S1,S2,S3

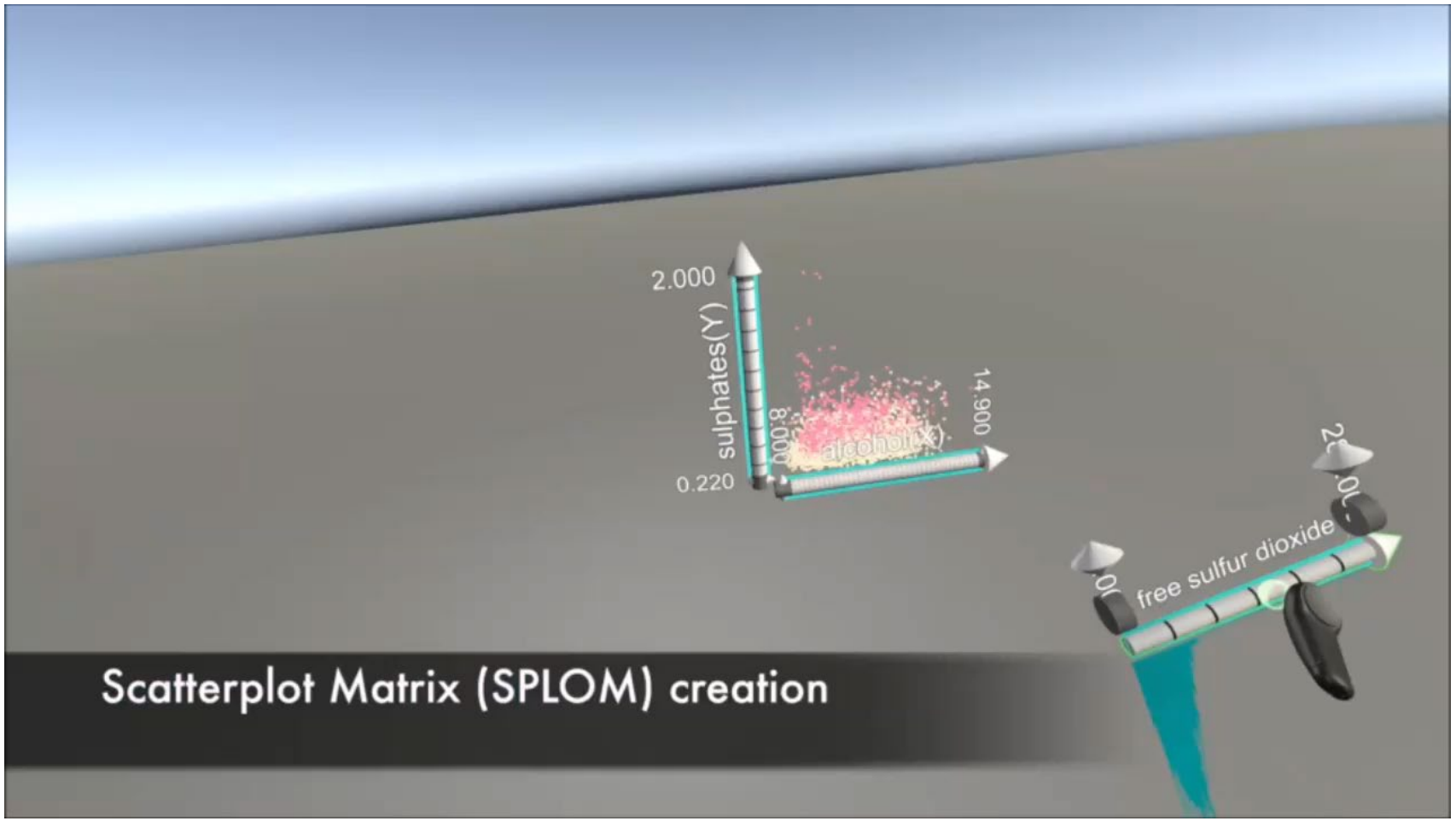
$$S_1(dir(s,e),\{axis(s,e,d)\}) \quad \leftarrow \quad axis(s,e,d)$$



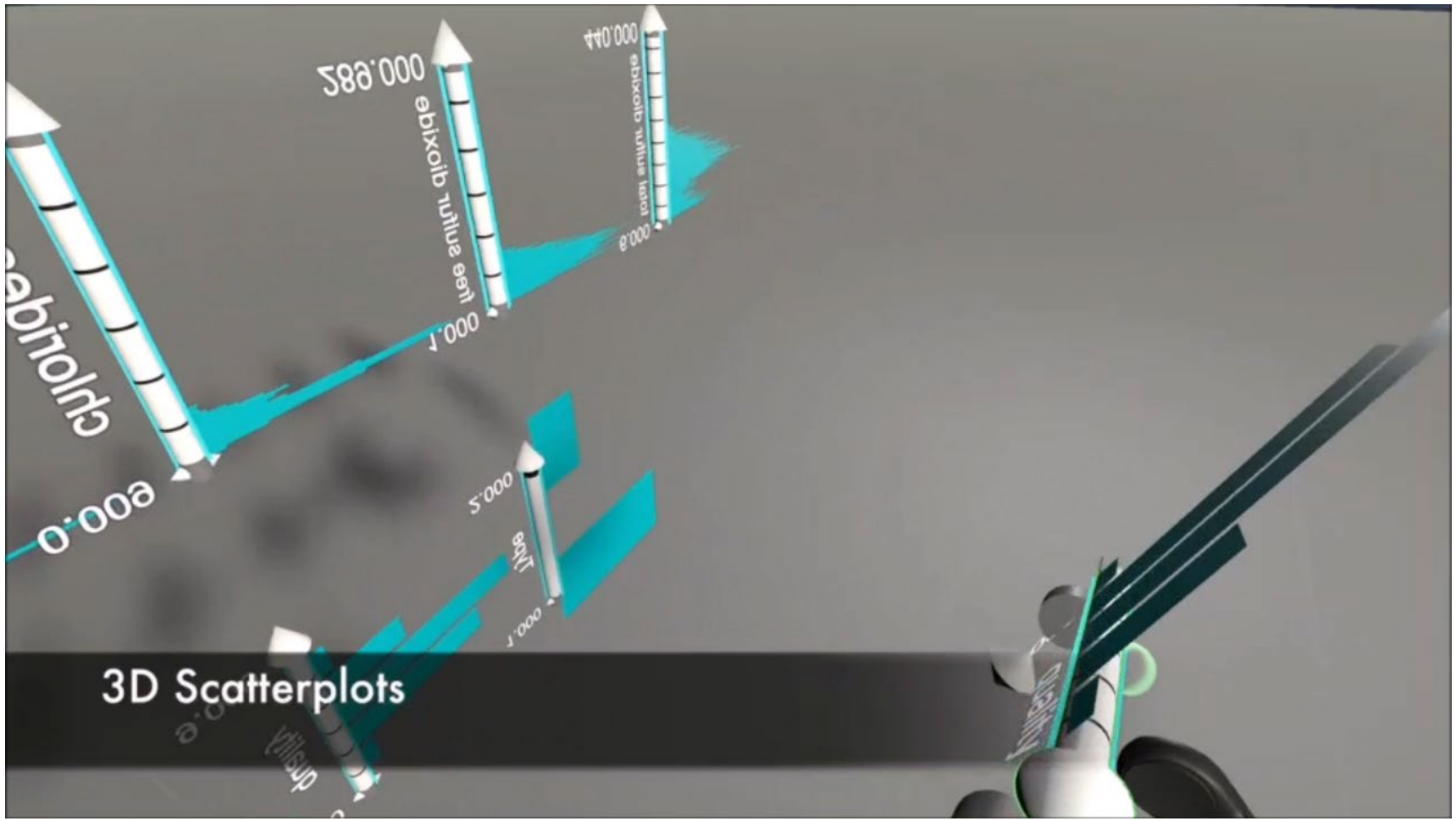
$$S_2(\vec{v}_1, \vec{v}_2, A_1, \{a\}) \quad \leftarrow \quad S_1(v_1, A_1), S_1(\vec{v}_2, \{a\}) \qquad \perp(\{\vec{v}_1, \vec{v}_2\}) \wedge \otimes(A_1, \{a\})$$

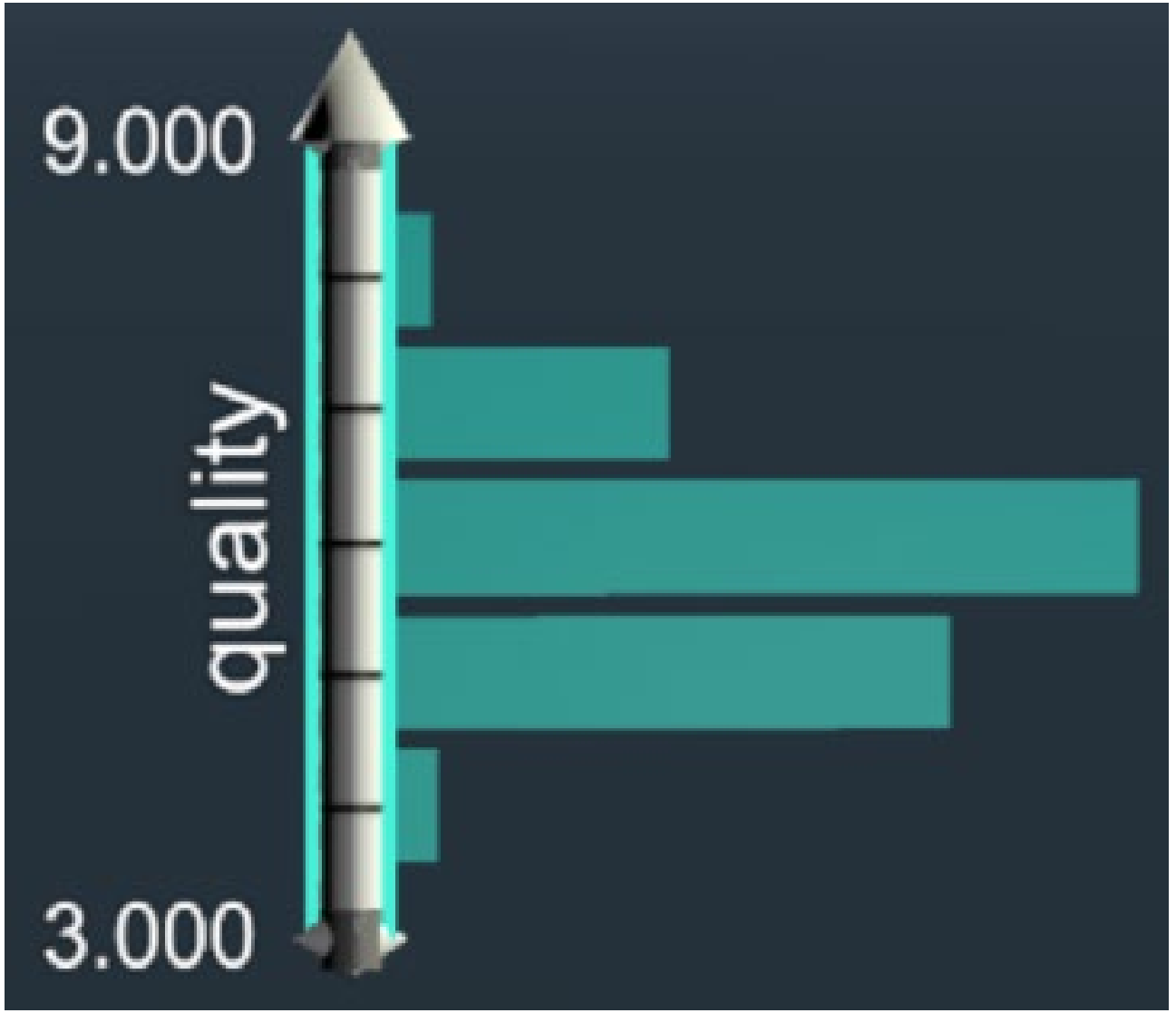


$$S_2(v_1, v_2, A_1, A_2 \cup \{a\}) \leftarrow \quad S_2(\vec{v_1}, \vec{v_2}, A_1, A_2), S_I(v, \{a\}) \quad \| \ (\vec{v_2}, \vec{v}) \wedge \otimes (A_1, A_2 \cup \{a\})$$



$$S_3(\vec{v}_1,\vec{v}_2,\vec{v}_3,A_1,A_2,\{a\}) \leftarrow S_2(\vec{v}_1,\vec{v}_2,A_1,A_2), S_1(\vec{v}_3,\{a\}) \quad \perp(\{\vec{v}_1,\vec{v}_2,\vec{v}_3\}) \wedge \otimes(A_1,A_2,A_3 \cup \{a\})$$

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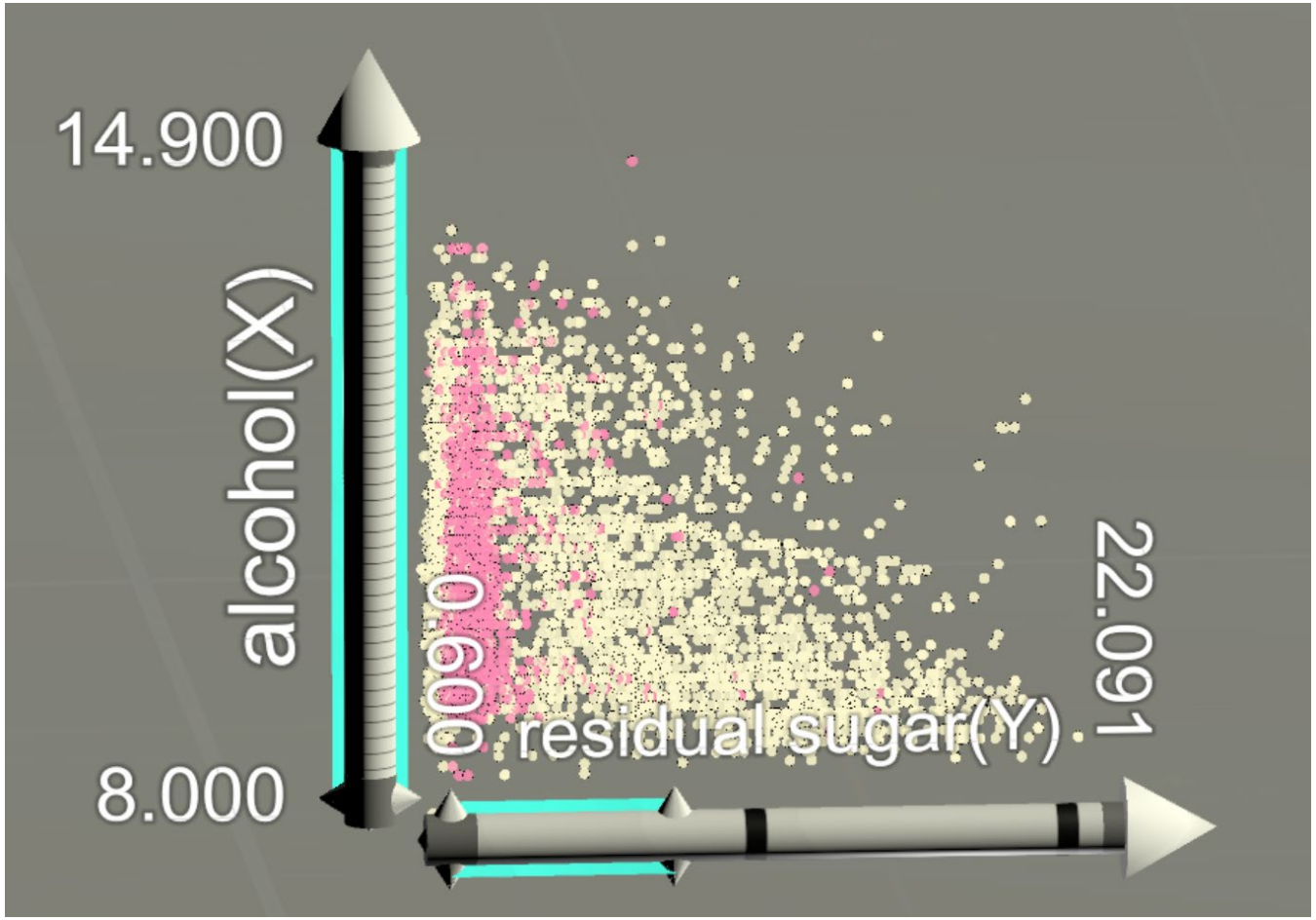
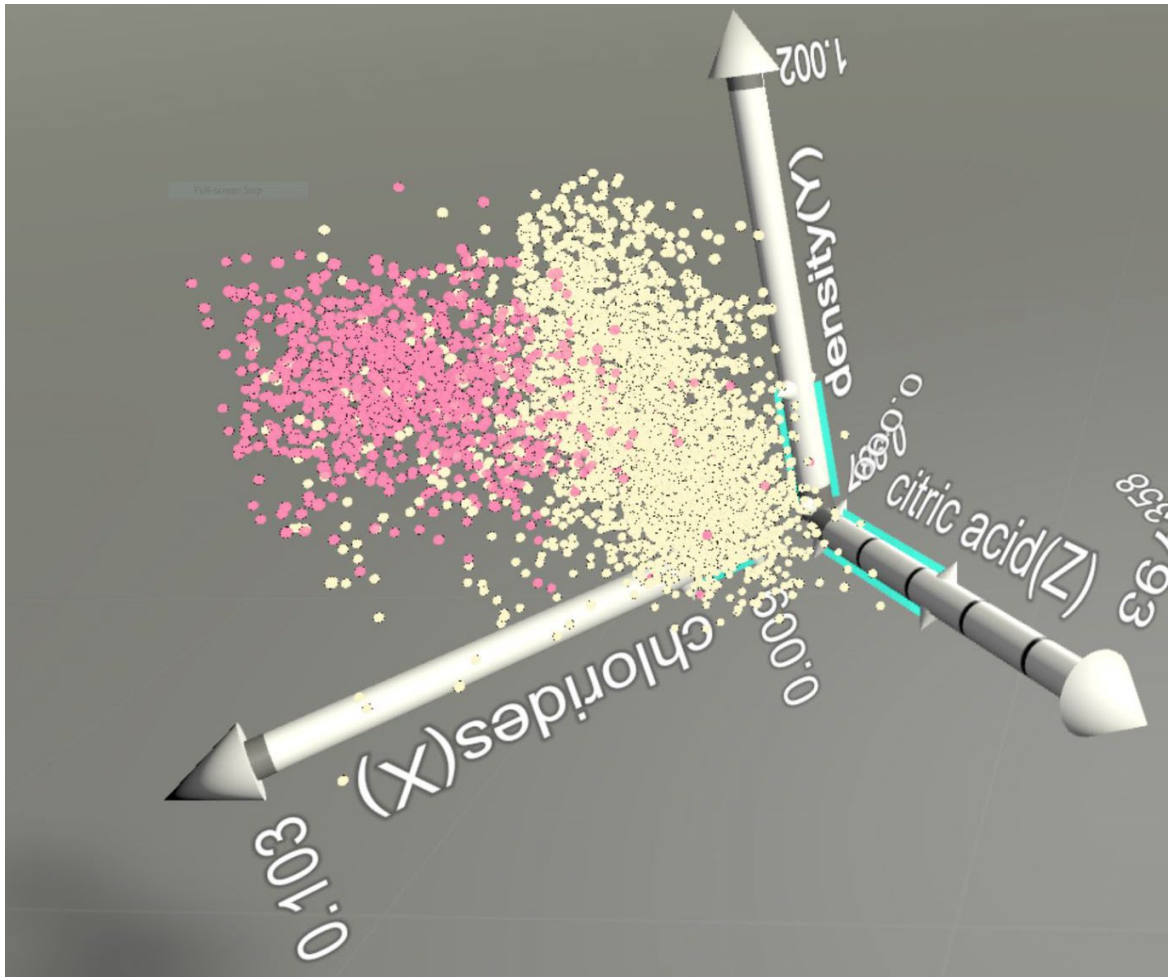
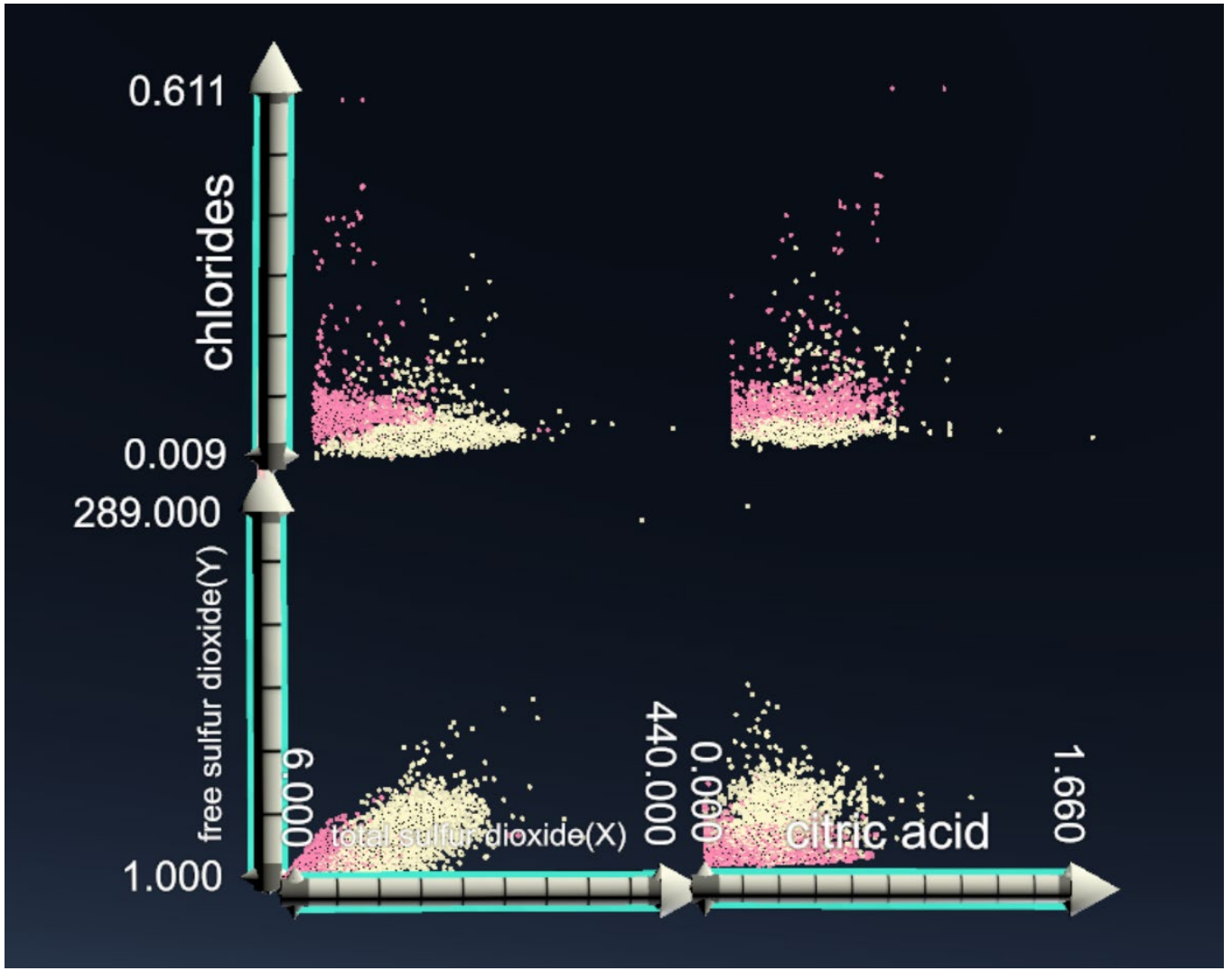
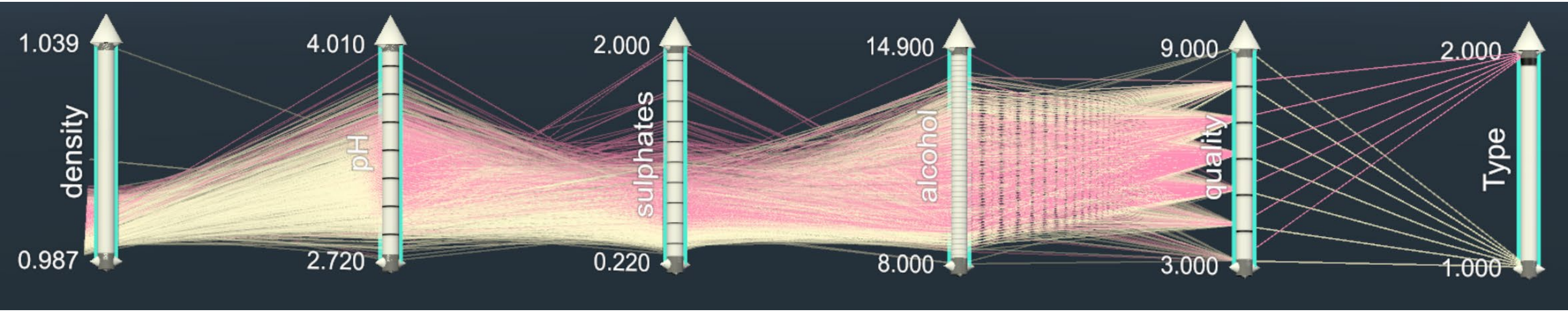
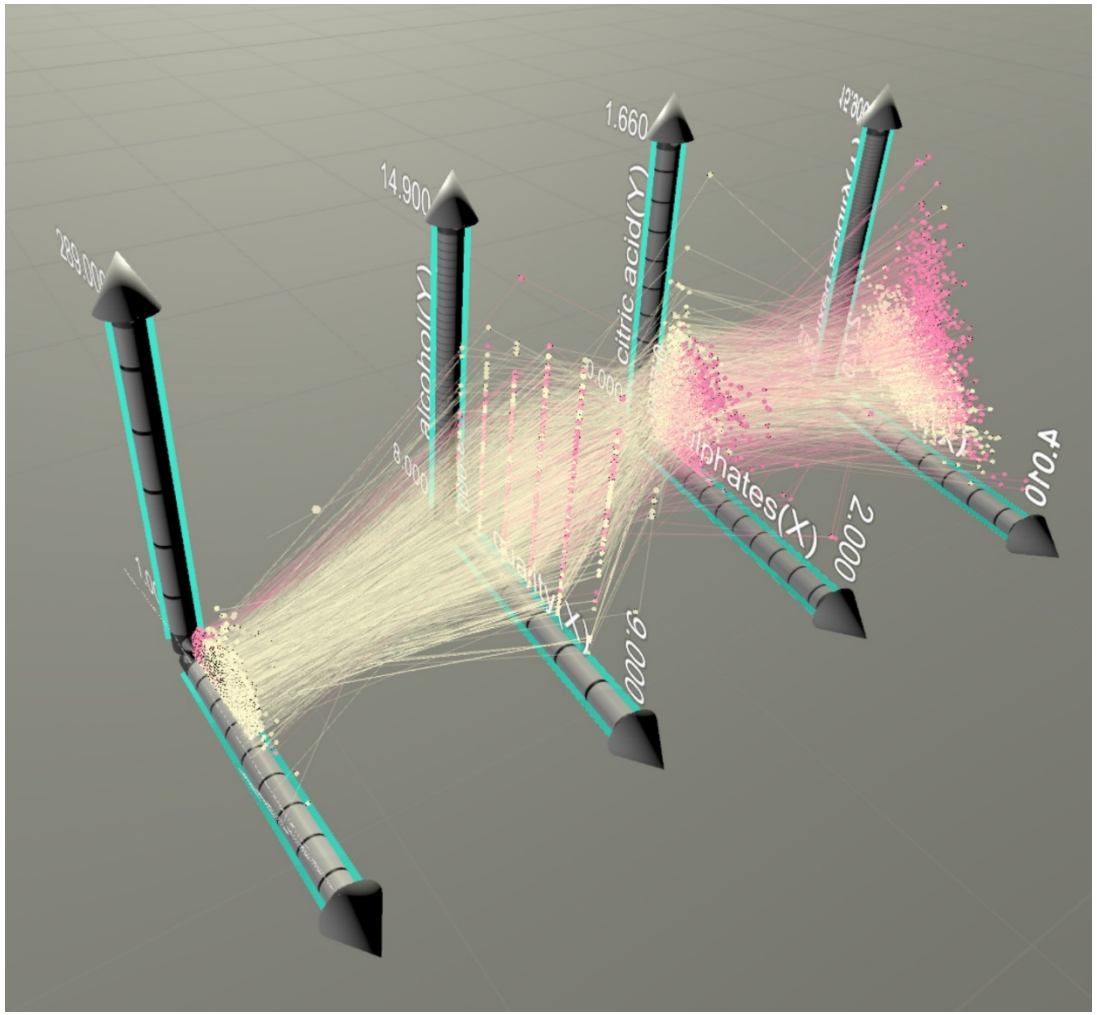
quality
3.000


14.900
alcohol(X)
8.000
0.600
residual sugar(Y)
22.091

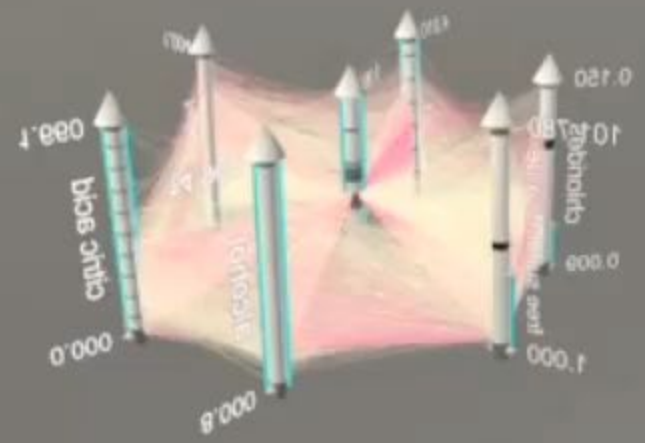

1.002
density(Y)
0.000
citric acid(Z)
0.358
0.000
chlorides(X)
0.103


0.611
chlorides
0.009
289.000
free sulfur dioxide(Y)
1.000
6.000
total sulfur dioxide(X)
440.000
0.000
citric acid
1.660

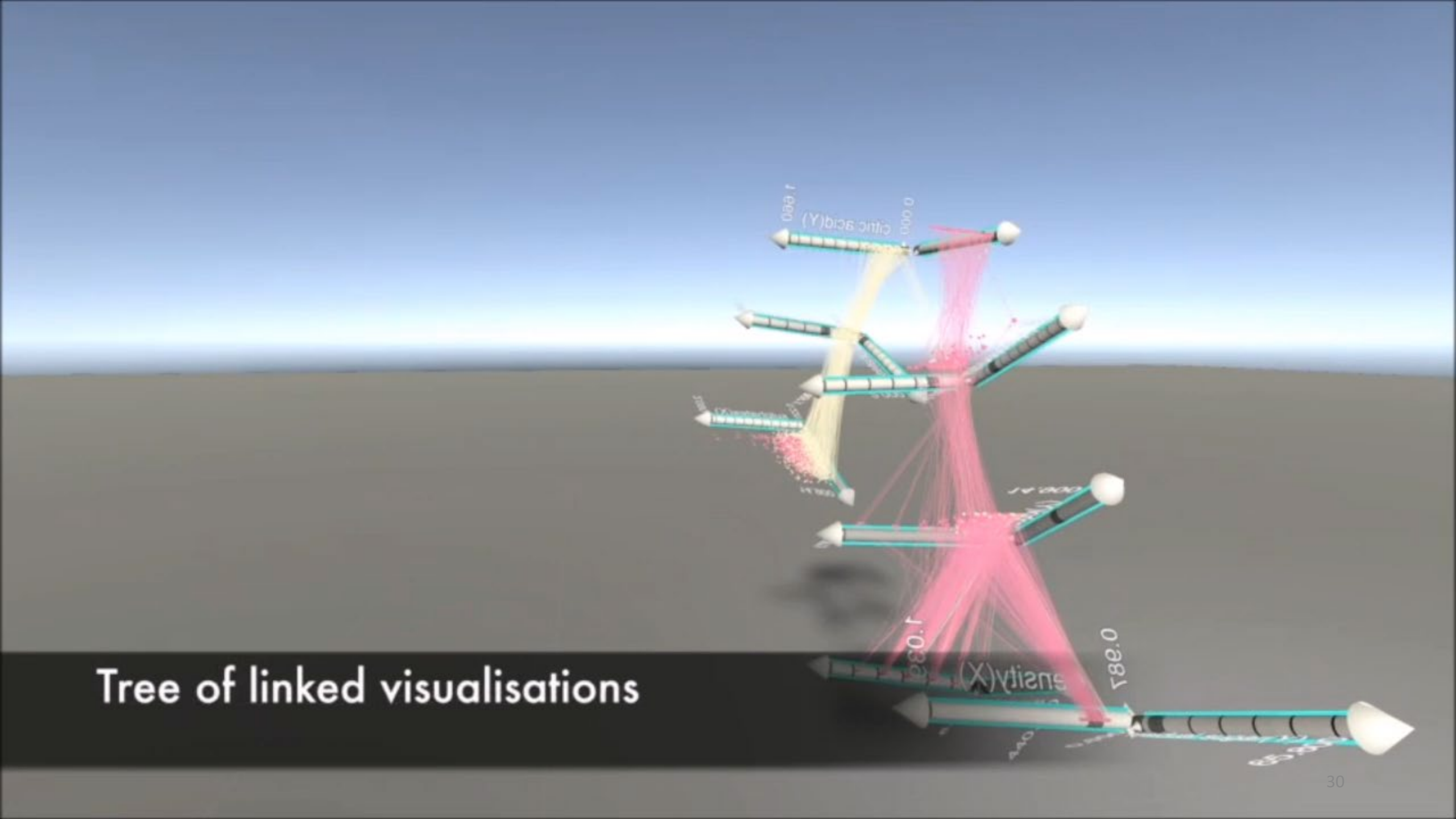

1.039
density
0.987
4.010
pH
2.720
2.000
sulphates
0.220
14.900
alcohol
8.000
9.000
quality
3.000
2.000
Type
1.000

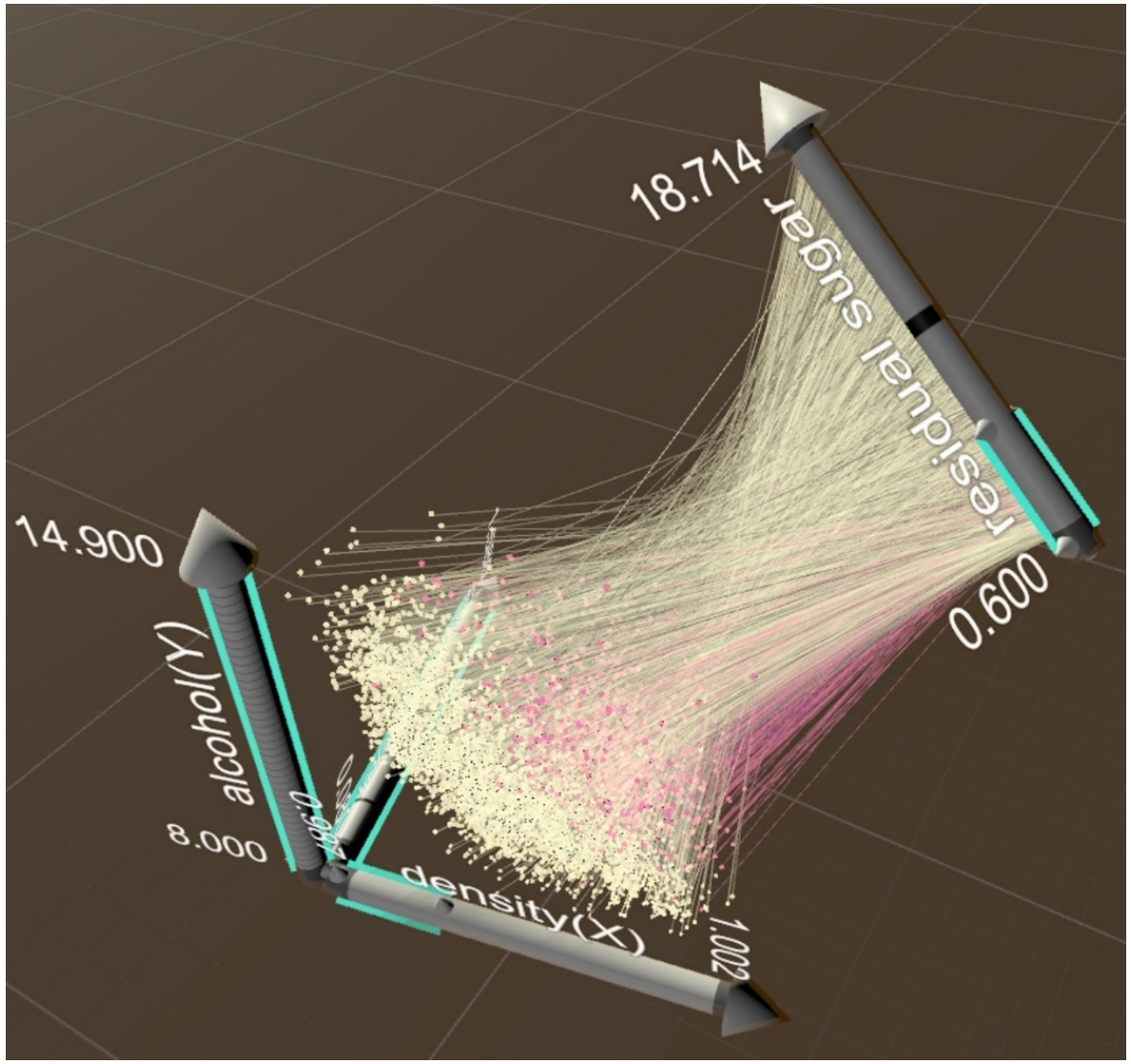

14.900
1.660
alcohol(Y)
citric acid(Y)
lphates(X)
2.000
9.000
0.0.4

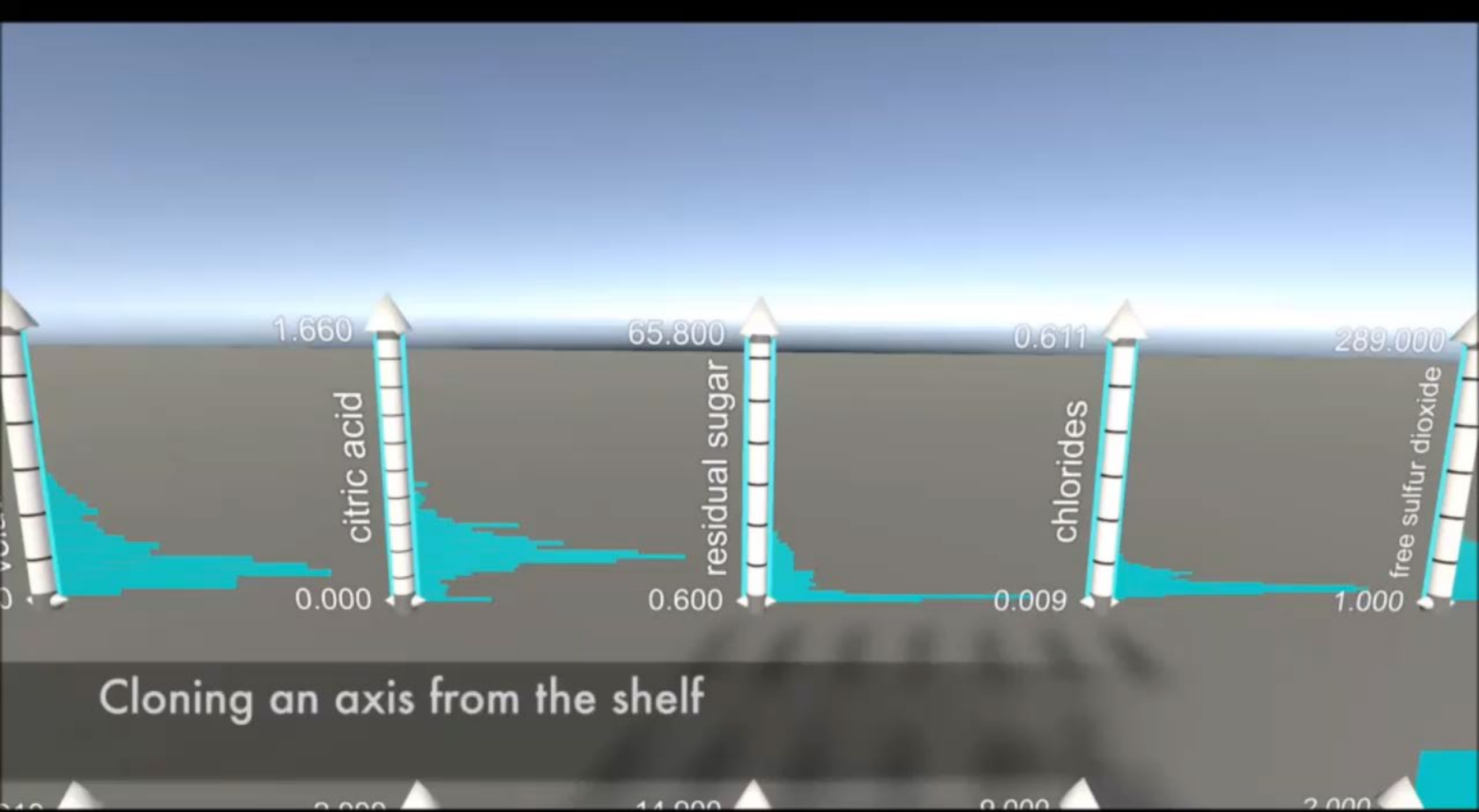
emerging visualisations



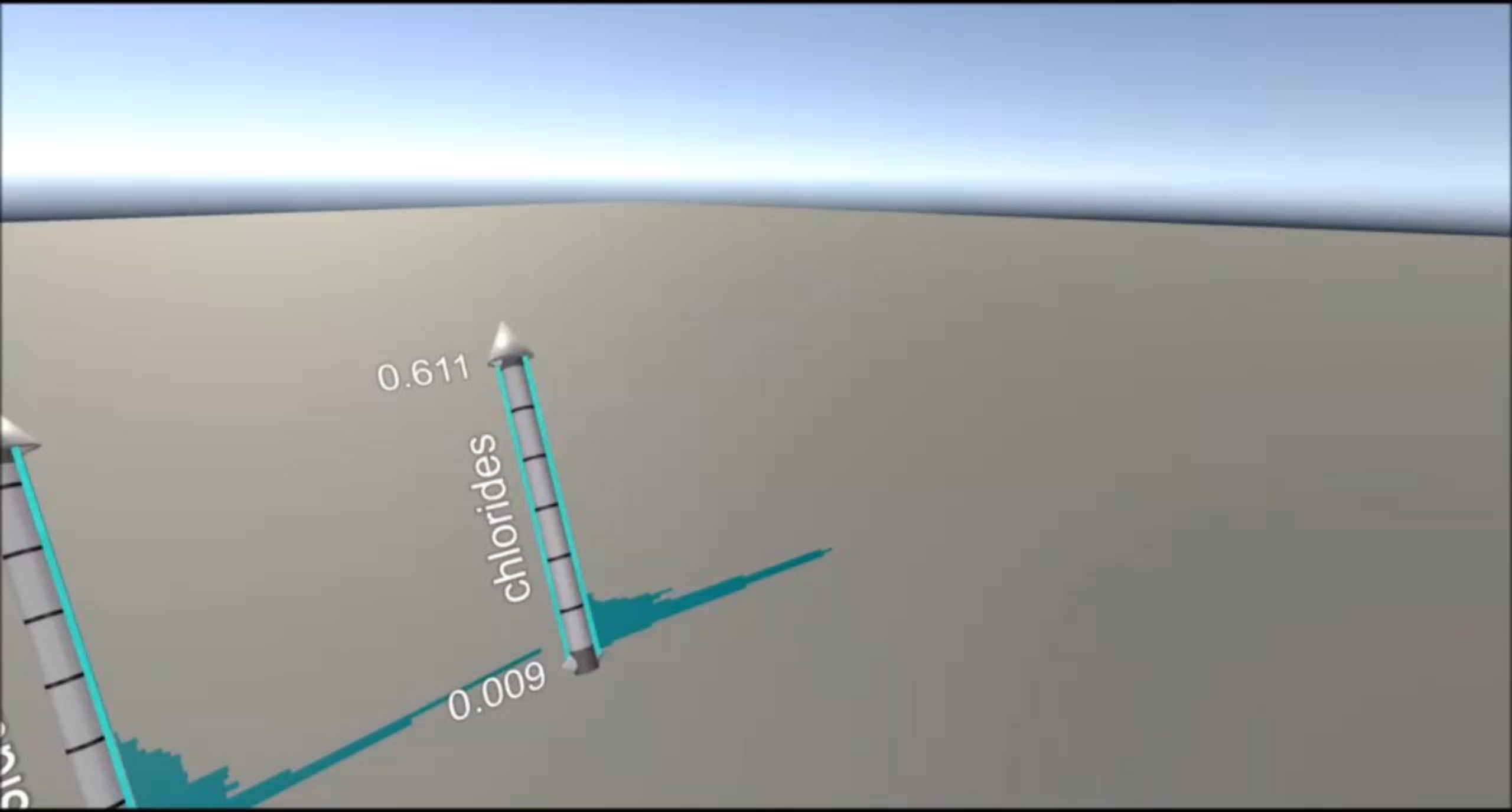
3D Circular connected PCPs


Tree of linked visualisations


18.714
residual sugar
0.600
14.900
alcohol(Y)
8.000
density(X)
1.002



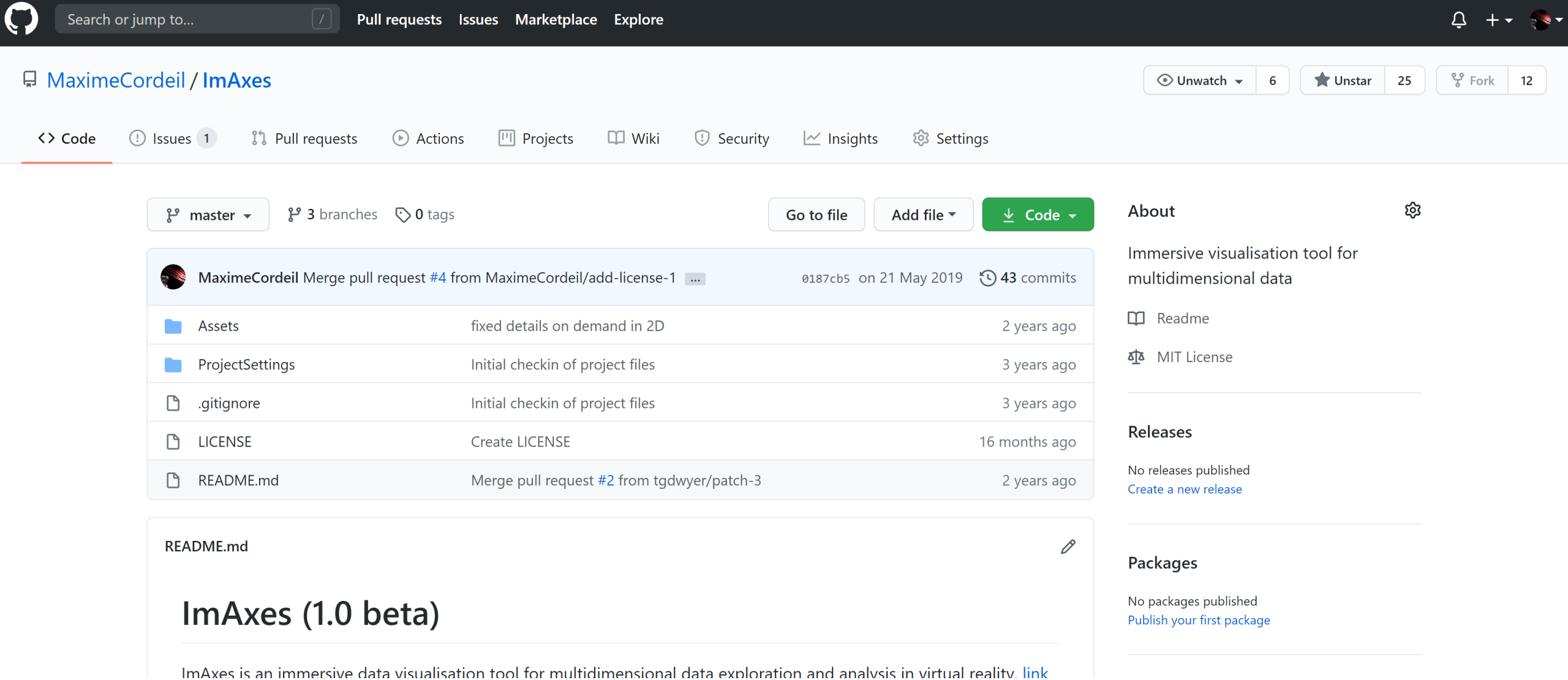
Cloning an axis from the shelf


0.611
chlorides
0.009

There Is No Spoon: Evaluating Performance, Space Use, and Presence with Expert Domain Users in Immersive Analytics

Andrea Batch, Andrew Cunningham, Maxime Cordeil, Niklas Elmqvist, *Senior Member, IEEE*,
Tim Dwyer, Bruce H. Thomas, *Senior Member, IEEE*, Kim Marriott

Fig. 1: Macroeconomics analysis in the ImAxes immersive analytics tool [11]. (Photo by Samuel Zeller on Unsplash.)



https://github.com/MaximeCordeil/ImAxes

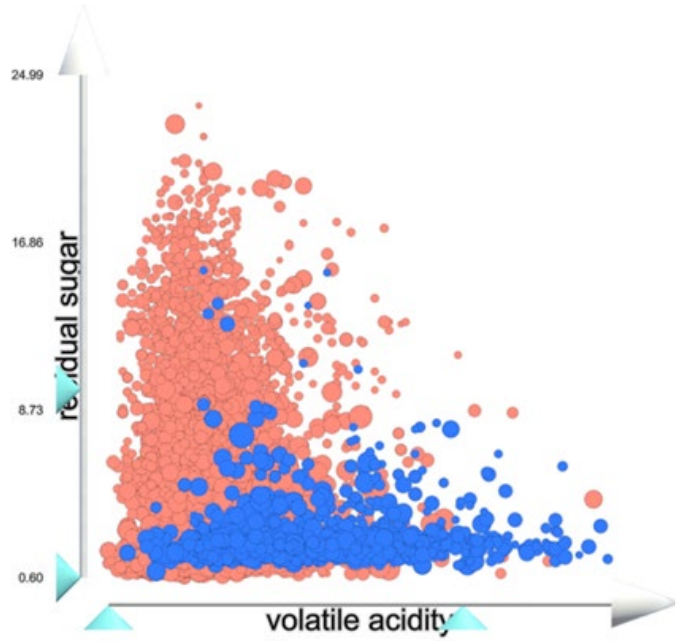
FibreClay – Immersive 3D curves exploration
Hurter, Riche, Drucker, **Cordeil**, Alligier, Vuillemot
IEEE InfoVis (TVCG) 19

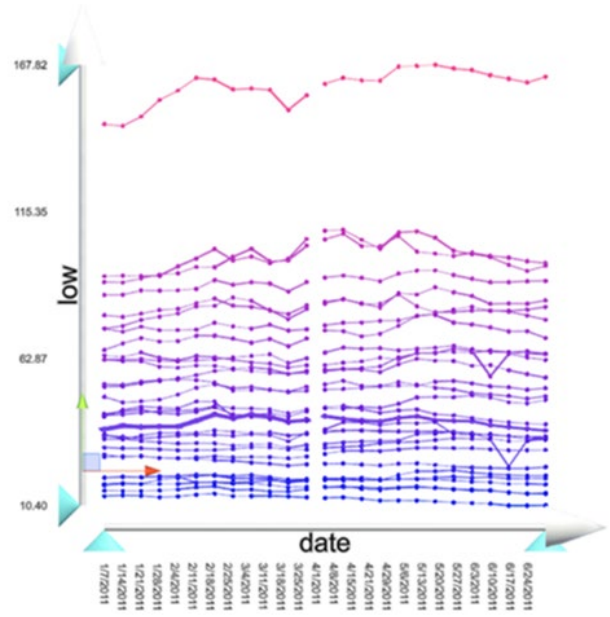
Microsoft ENAC MONASH University Information Technology

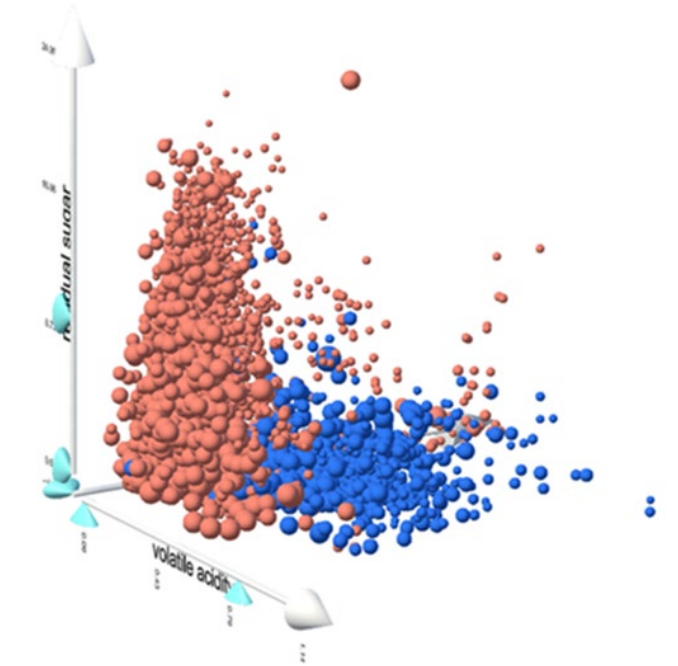
VIS library for immersive dev?

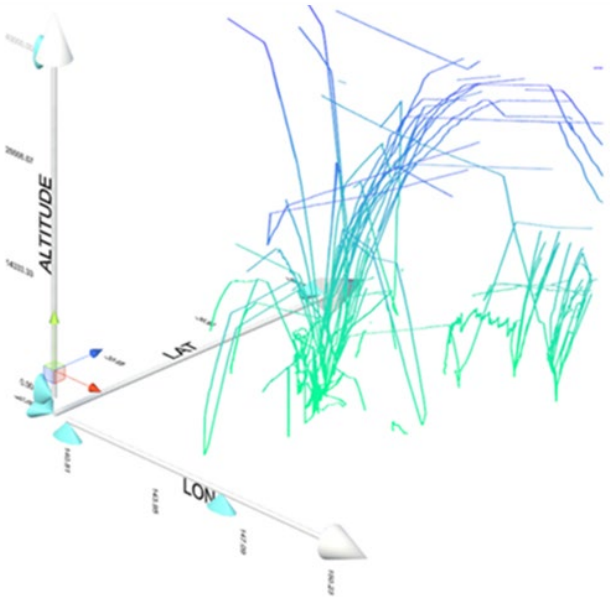
- No library readily available for InfoVis/VA in AR/VR
- Need for support of real dataset (i.e. support potential large datasets)
- Support standard VIS interactions/tasks (filtering, brushing, selection…)
- Default approach: instantiate GameObjects with default primitives… performance issues…

D³ data-driven documents, M Bostock, V Ogievetsky, J Heer
VIS 2011

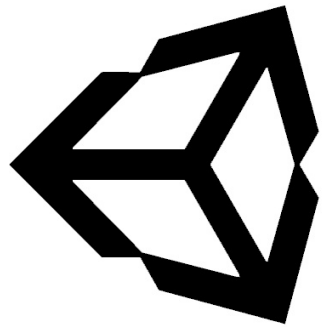

24.99
16.86
8.73
0.60
residual sugar
volatile acidity


167.82
115.35
62.87
10.40
low
date


residual sugar
volatile acidity


ALTITUDE
LAT
LON

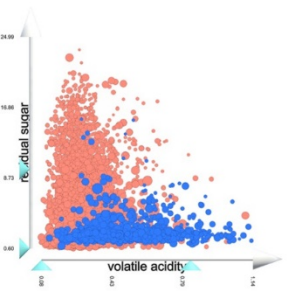
IATK

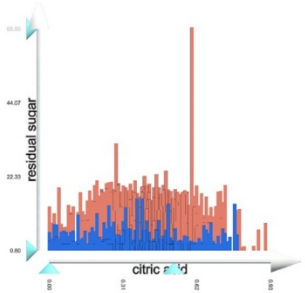


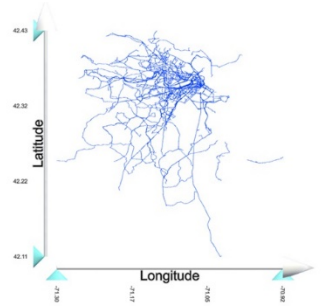
IATK design

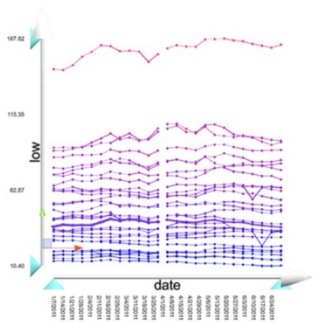
+ expressiveness

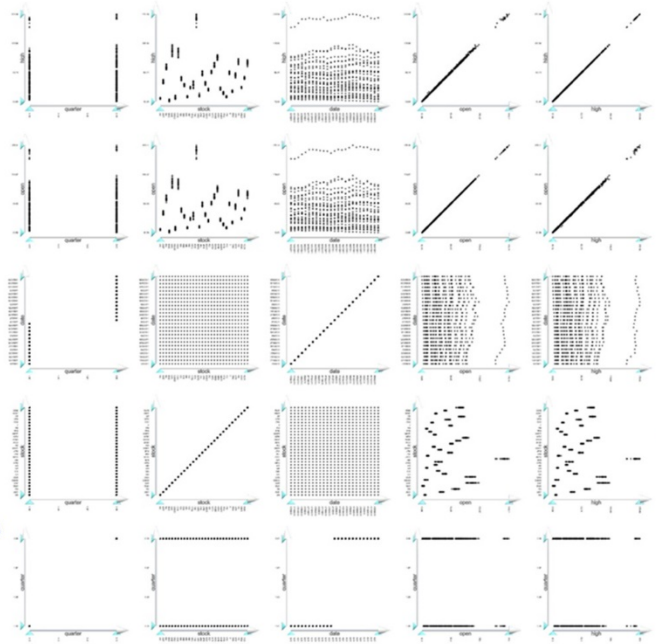
expressiveness: grammar of graphics

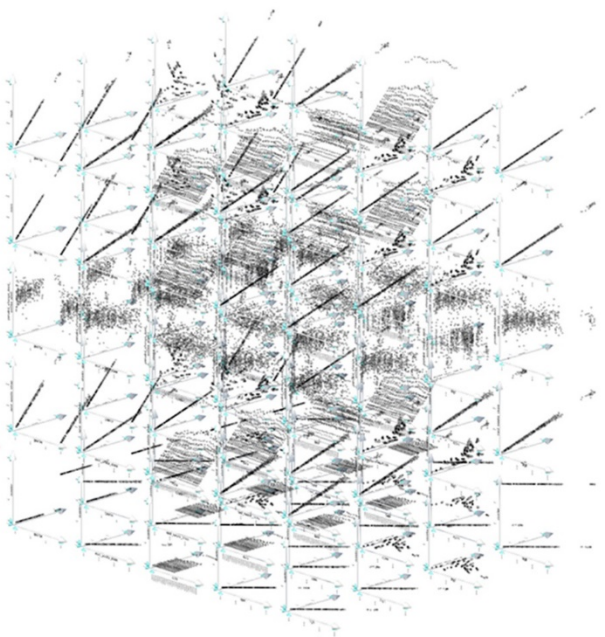


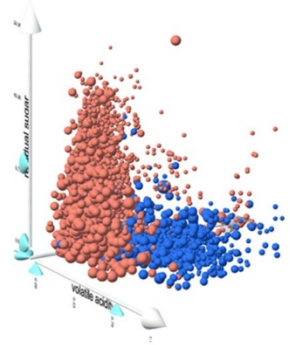


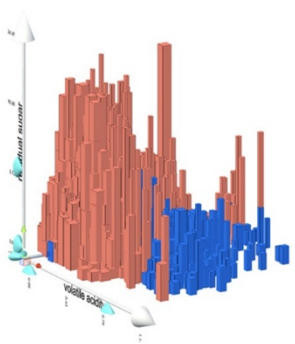


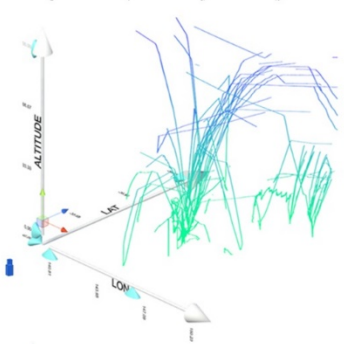


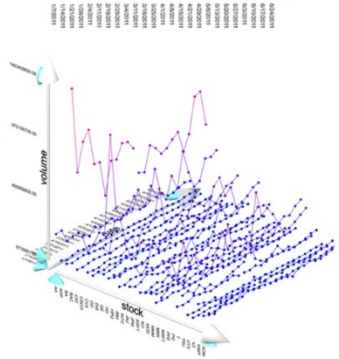


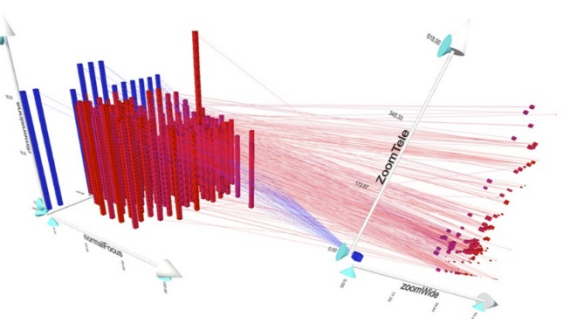


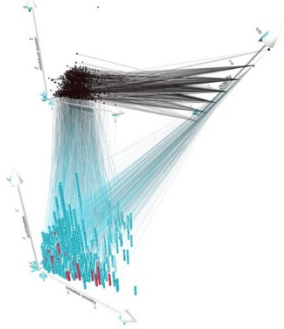


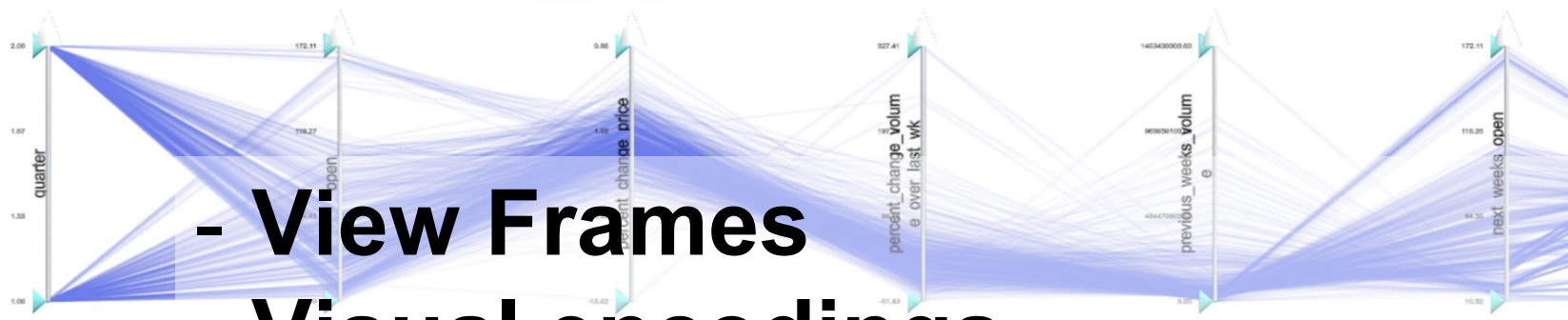










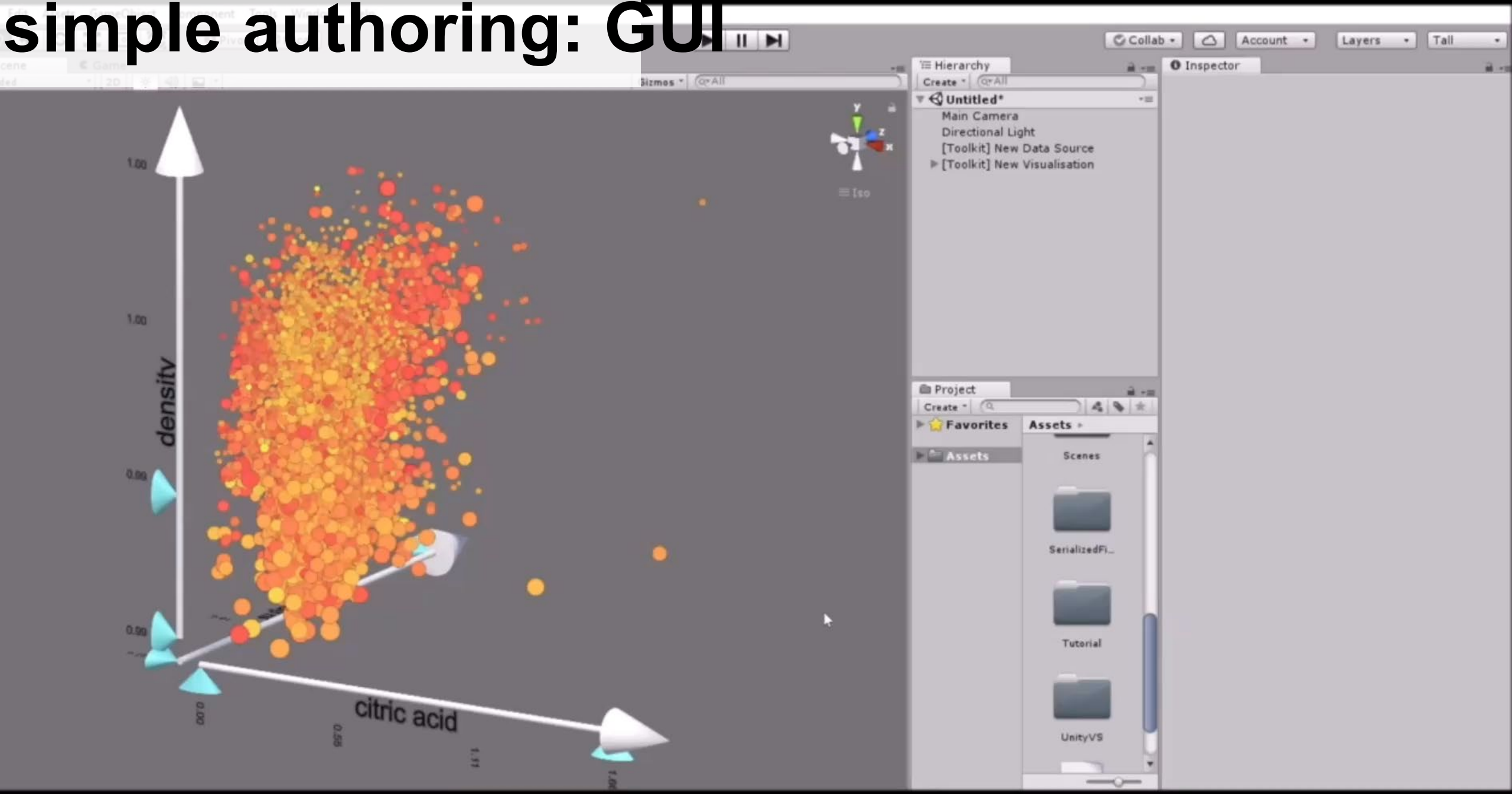


- **View Frames**
- **Visual encodings**
- **Visual linking**

The grammar of Graphics, Wilkinson, 2005

+ expressiveness
+ simple authoring

simple authoring: GUI



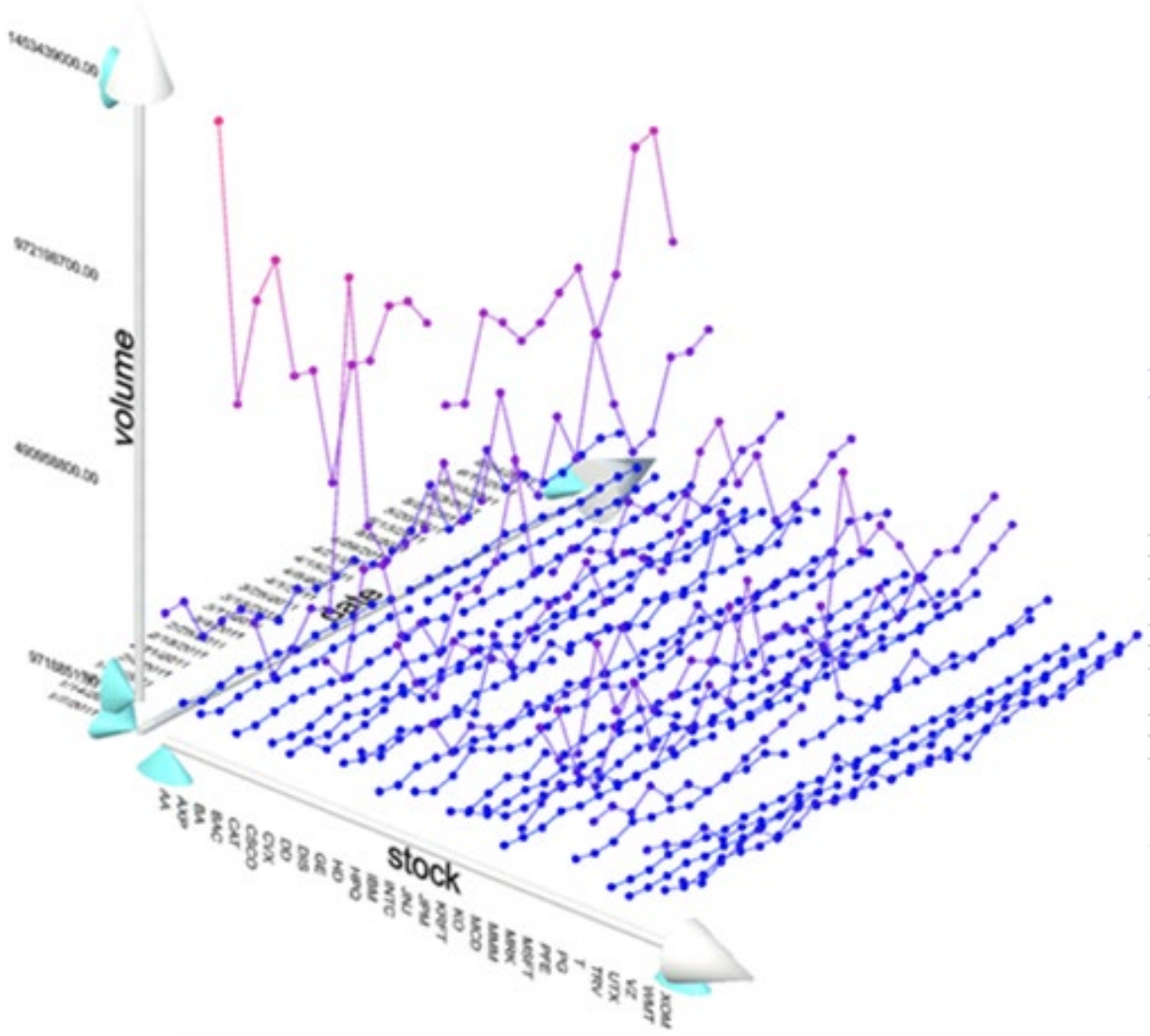
simple authoring: API

```
// create a view builder with the point topology
ViewBuilder vb = new ViewBuilder (geometry, ”visualisation name”).
        initialiseDataView(number_of_points).
```

simple authoring: API

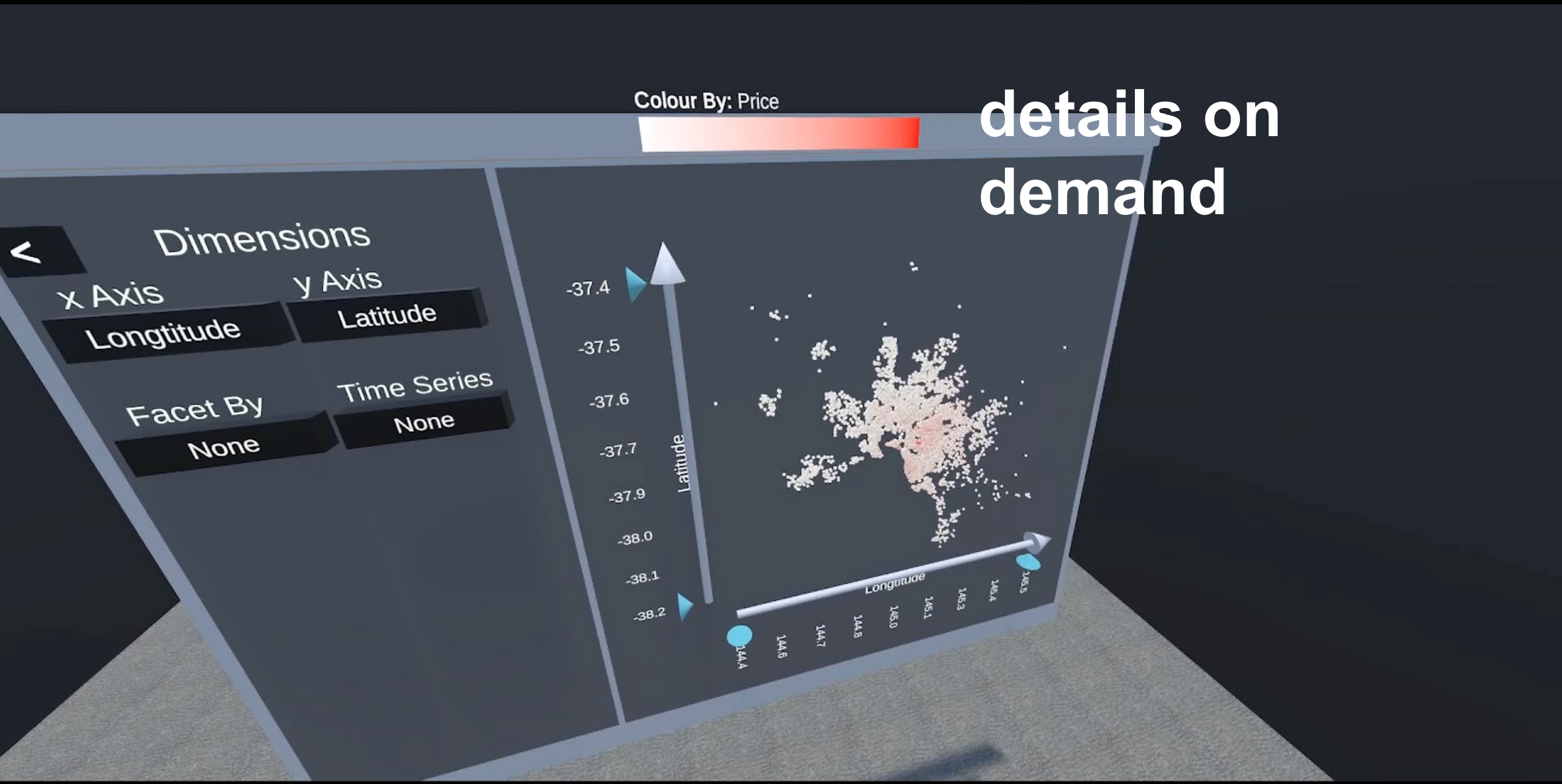
```
// create a view builder with the point topology
ViewBuilder vb = new ViewBuilder (geometry, ”visualisation name”).
        initialiseDataView(number_of_points).
        setDataDimension(data_array_x, ViewBuilder.VIEW_DIMENSION.X).
        setDataDimension(data_array_y, ViewBuilder.VIEW_DIMENSION.Y).
        setDataDimension(data_array_z, ViewBuilder.VIEW_DIMENSION.Z).
```

simple auth

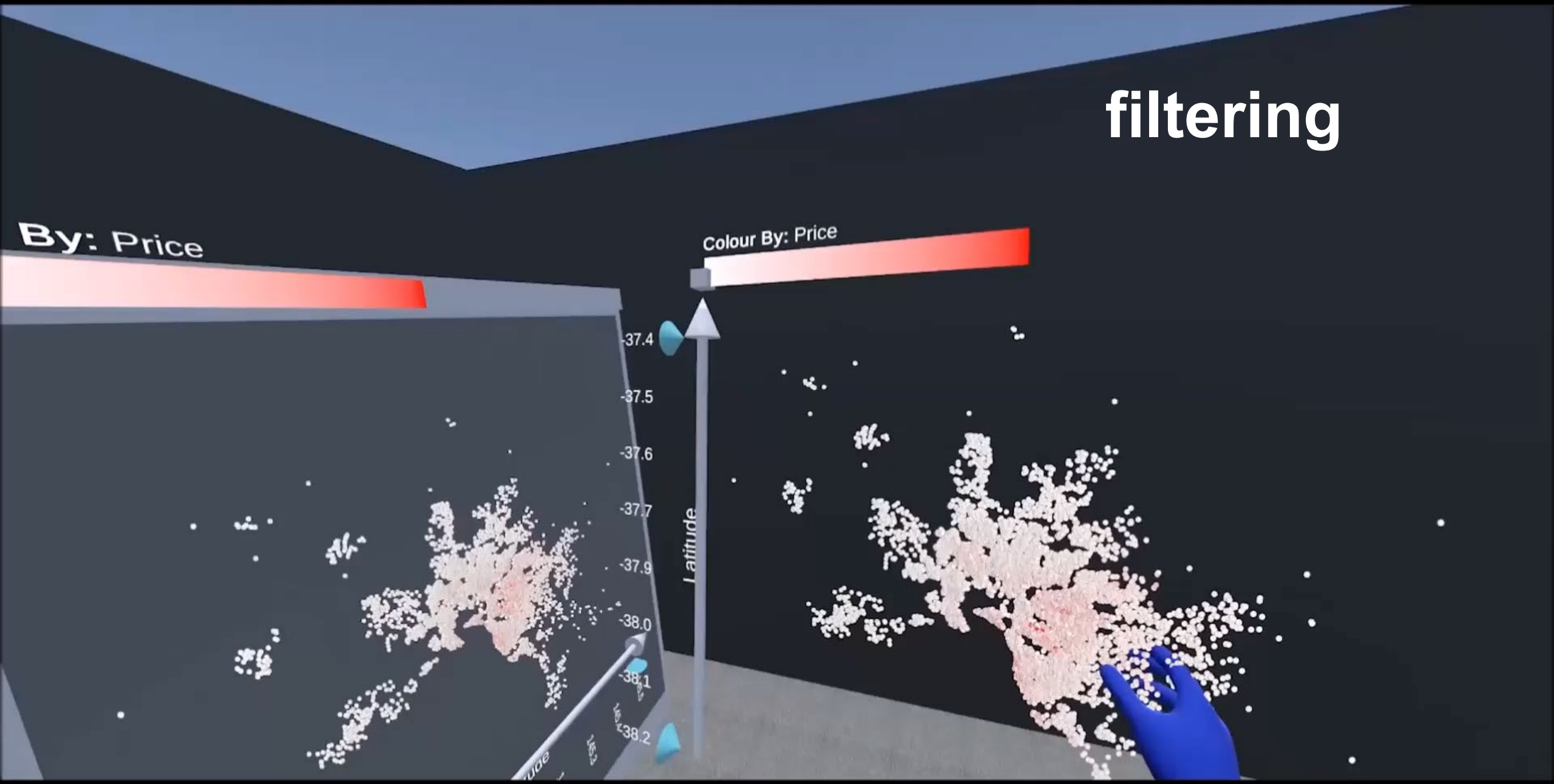



```
// create a view b                                                    
ViewBuilder vb =                                                   ion name”).
        initialise
        setDataI                                                   EW_DIMENSION.X).
        setDataI                                                   EW_DIMENSION.Y).
        setDataI                                                   EW_DIMENSION.Z).
        setSize(                                                   a point
        setColor                                                   h data point
```

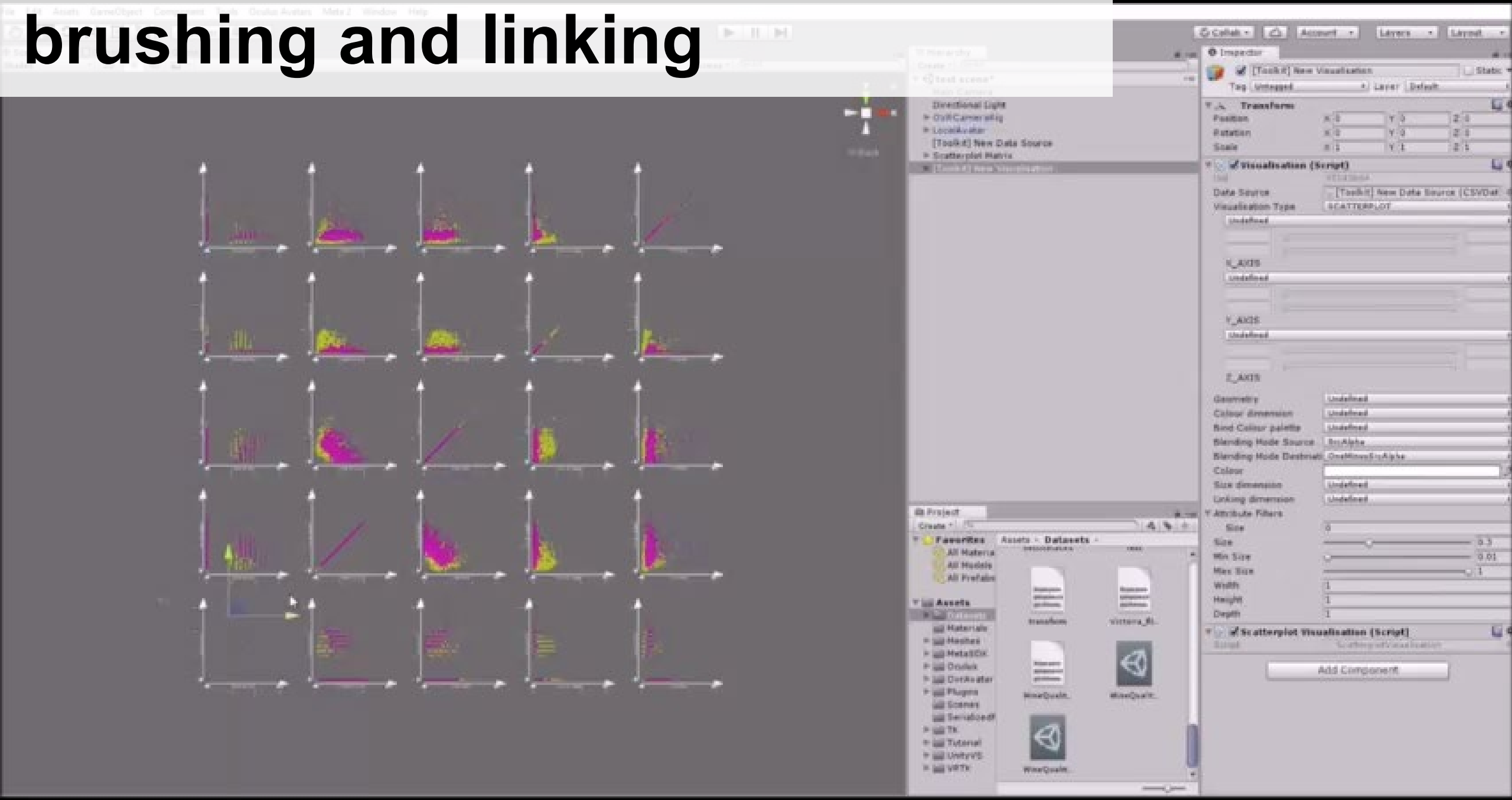
+ expressiveness
+ simple authoring
+ interaction



details on demand

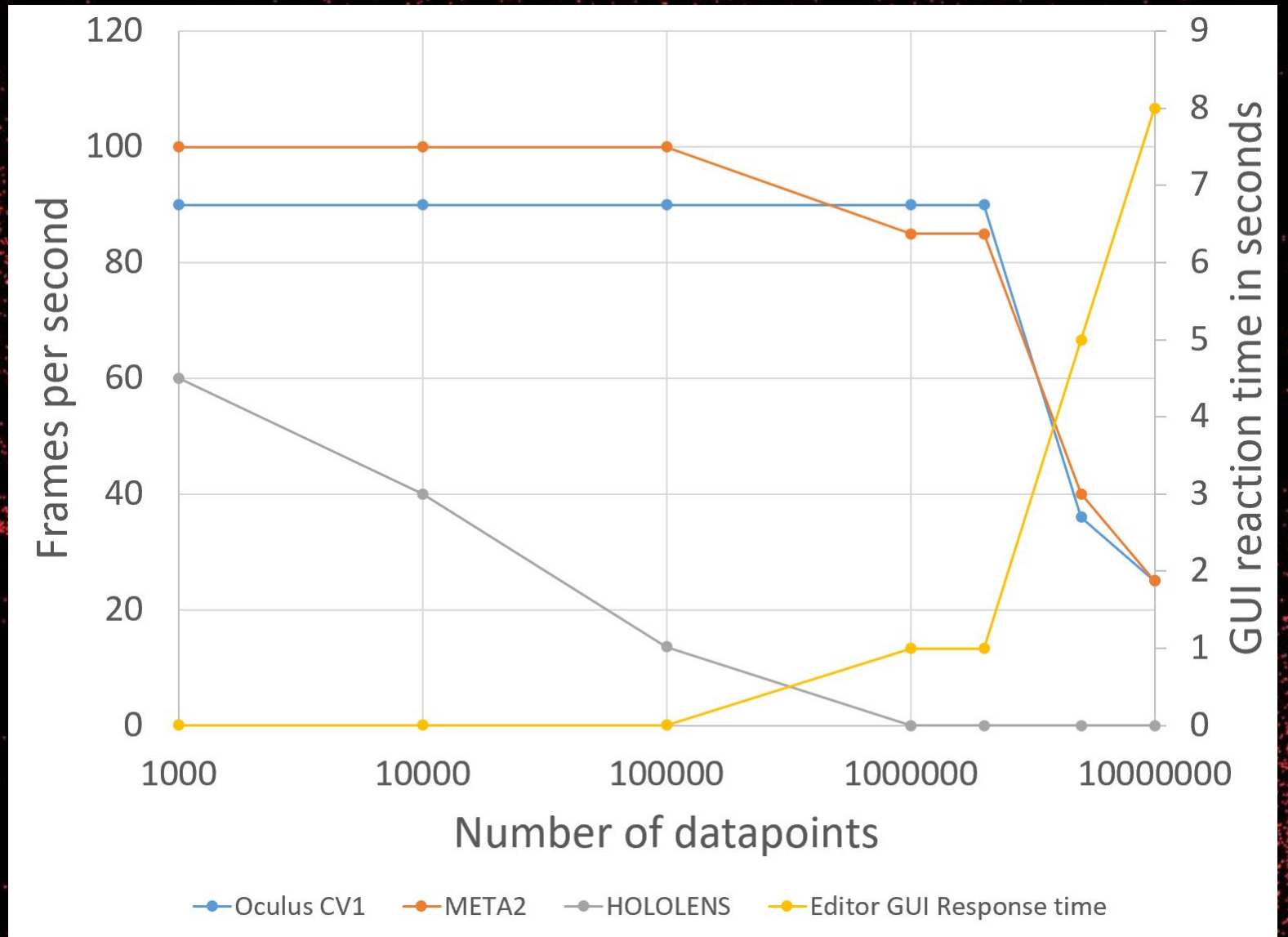

filtering
By: Price
Colour By: Price
-37.4
-37.5
-37.6
-37.7
-37.9
-38.0
-38.1
-38.2
Latitude

brushing and linking



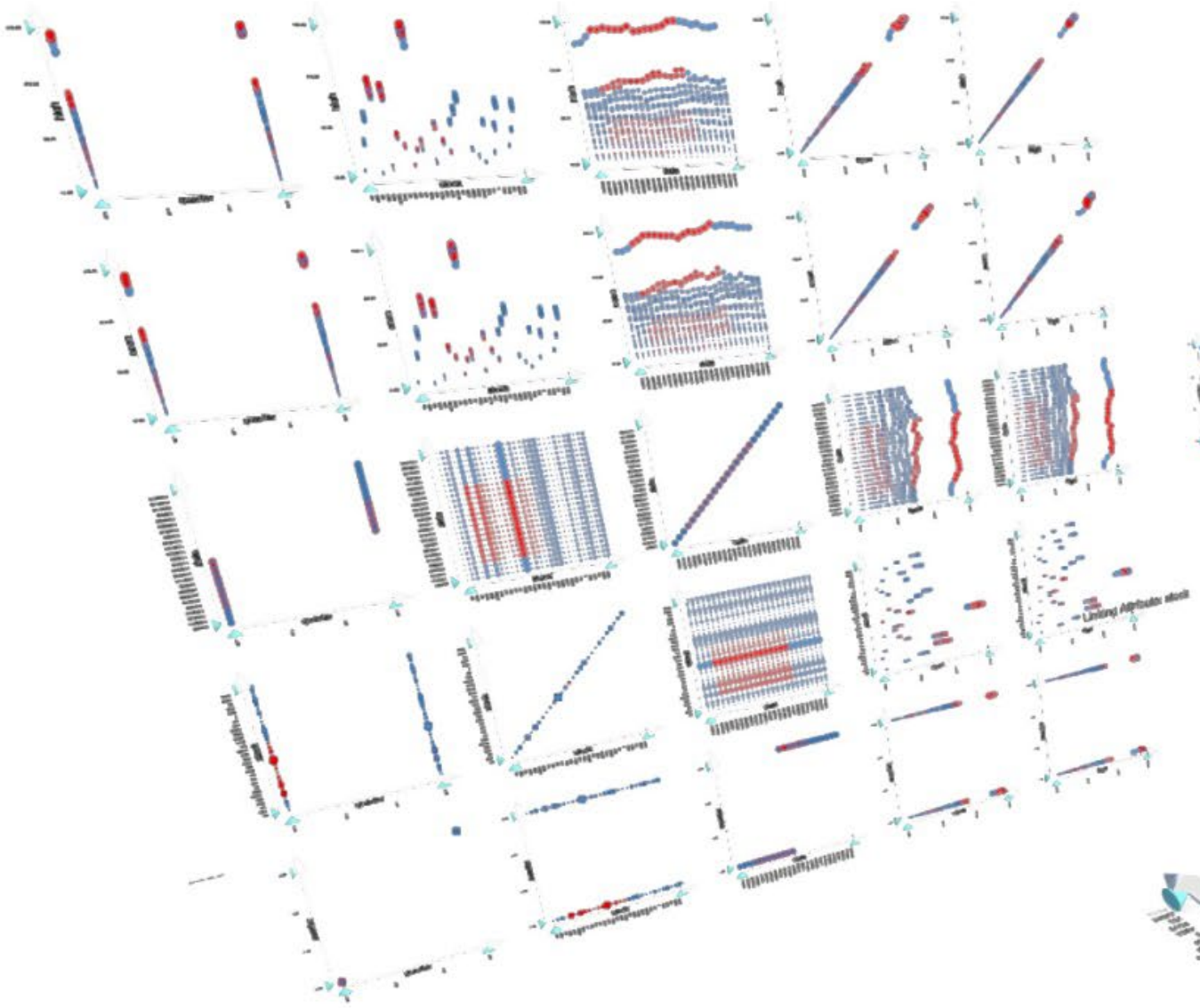
+ expressiveness
+ simple authoring
+ interaction
+ scalability

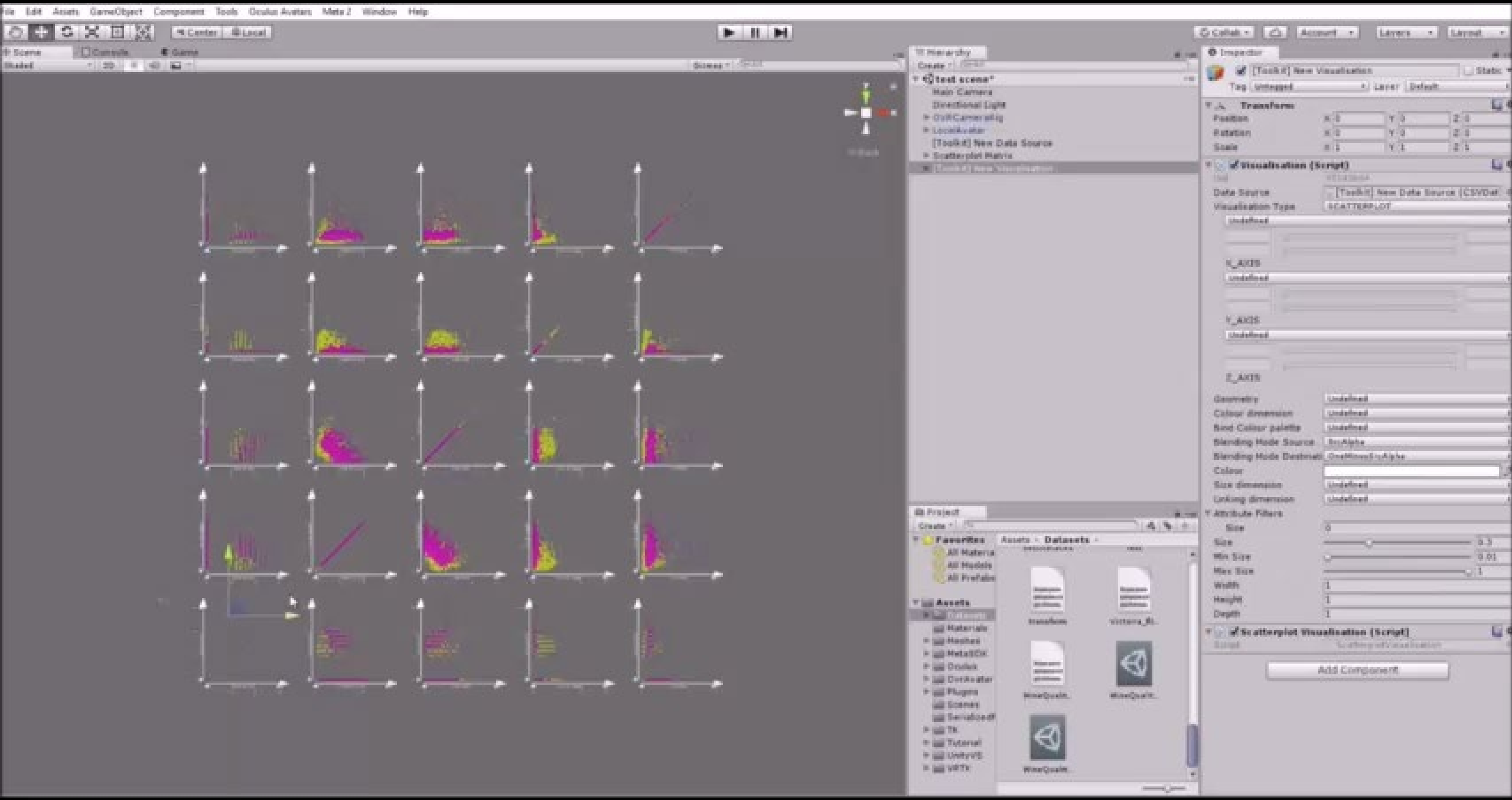
scalability



use case examples

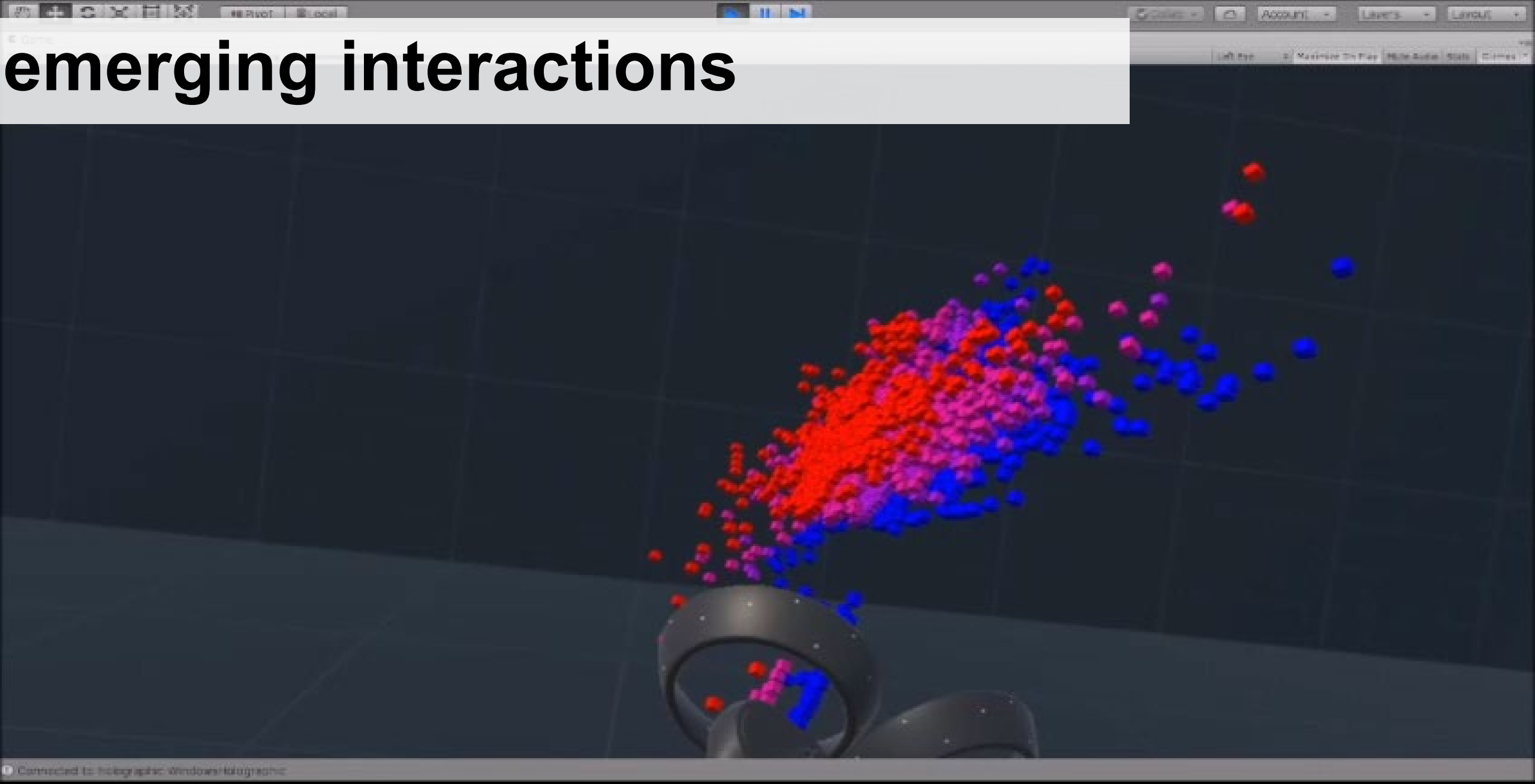
multivariate visualisation in VR




File Edit Assets GameObject Component Tools Oculus Avatars Meta 2 Window Help
Hierarchy
test scene*
Main Camera
Directional Light
Inspector
Transform
Visualisation (Script)
Data Source
Visualisation Type
SCATTERPLOT
X_AXIS
Y_AXIS
Z_AXIS
Add Component
Project
Assets
Datasets

AR desktop for geoviz

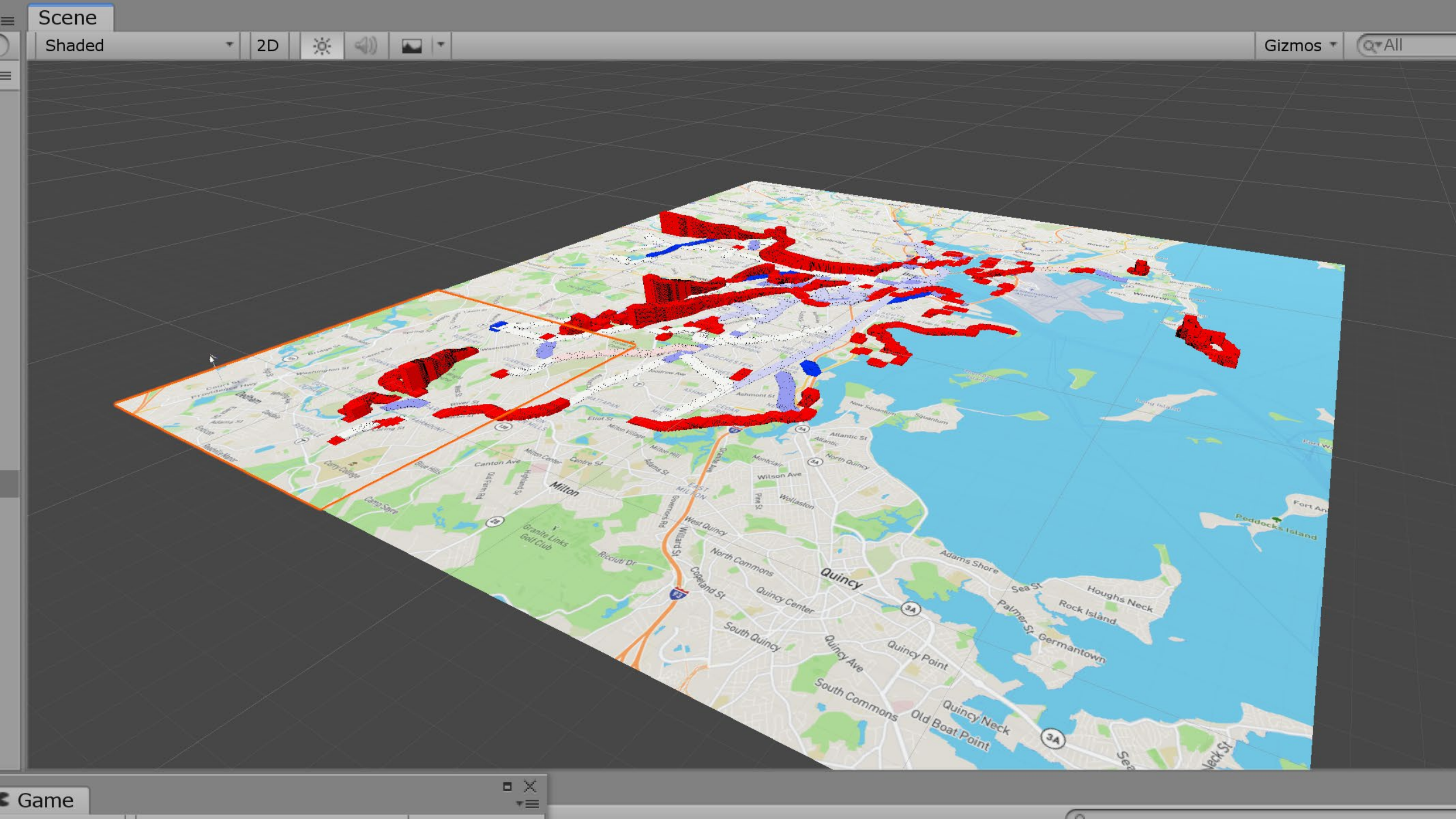
emerging interactions



Simple Interaction

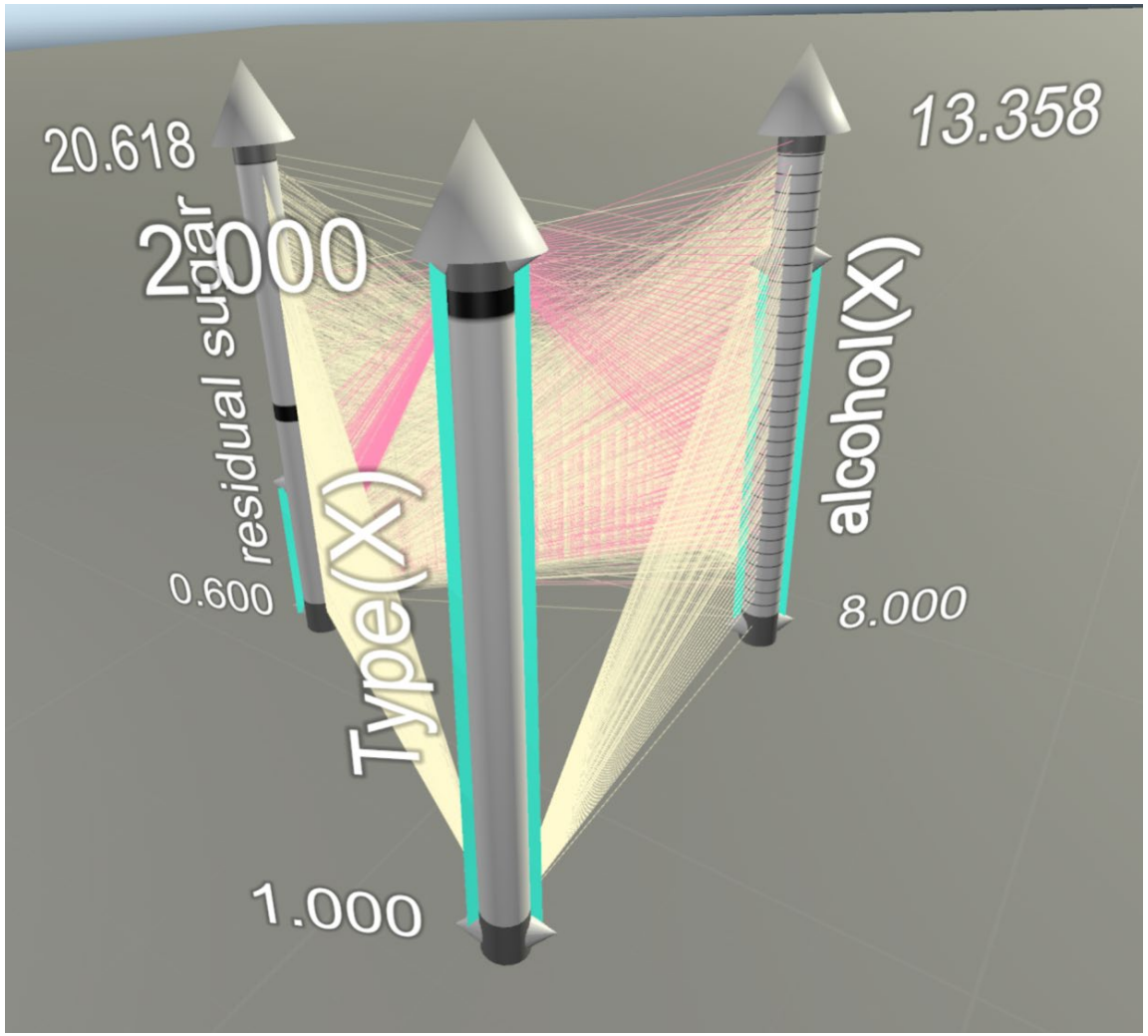
- Attach a visualisation to a controller

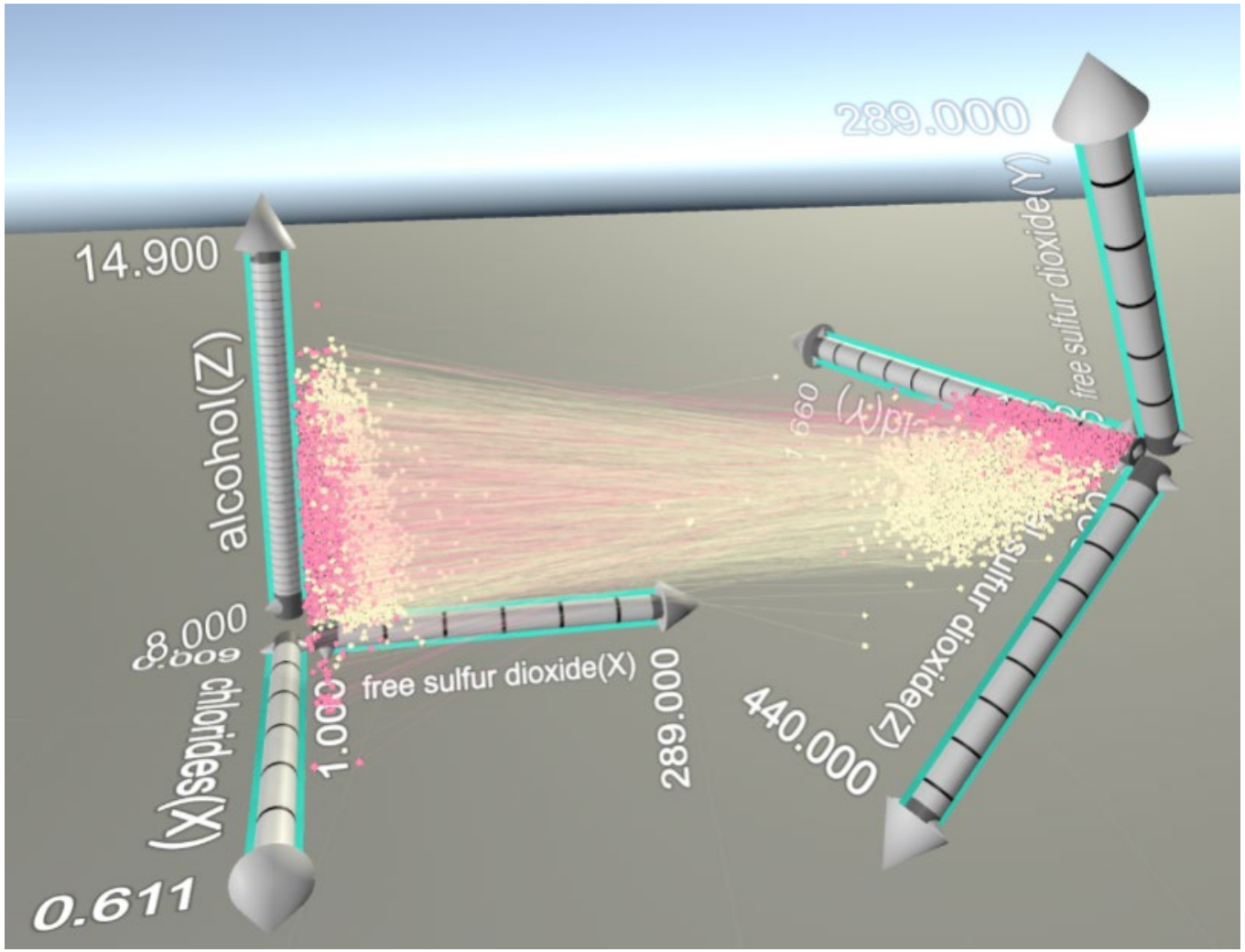
MapBox integration


Scene
Shaded
2D
Gizmos
All
Milton
Quincy
Wilson Ave
Wollaston
West Quincy
North Commons
Quincy Center
South Quincy
Quincy Ave
Quincy Point
South Commons
Old Boat Point
Quincy Neck
Adams Shore
Sea St
Houghs Neck
Rock Island
Germantown
Peddocks Island
Granite Links Golf Club
Canton Ave
Centre St
Willard St
Copeland St
Atlantic St
North Quincy
Squantum
Winthrop
Ashmont St
Milton Village
Milton Hill
Blue Hills
Ricciuti Dr
Pine St
Governors Rd
Old Farm Rd
Holland St
Adams St
Elliot St
Montclair
Palmer St
Game

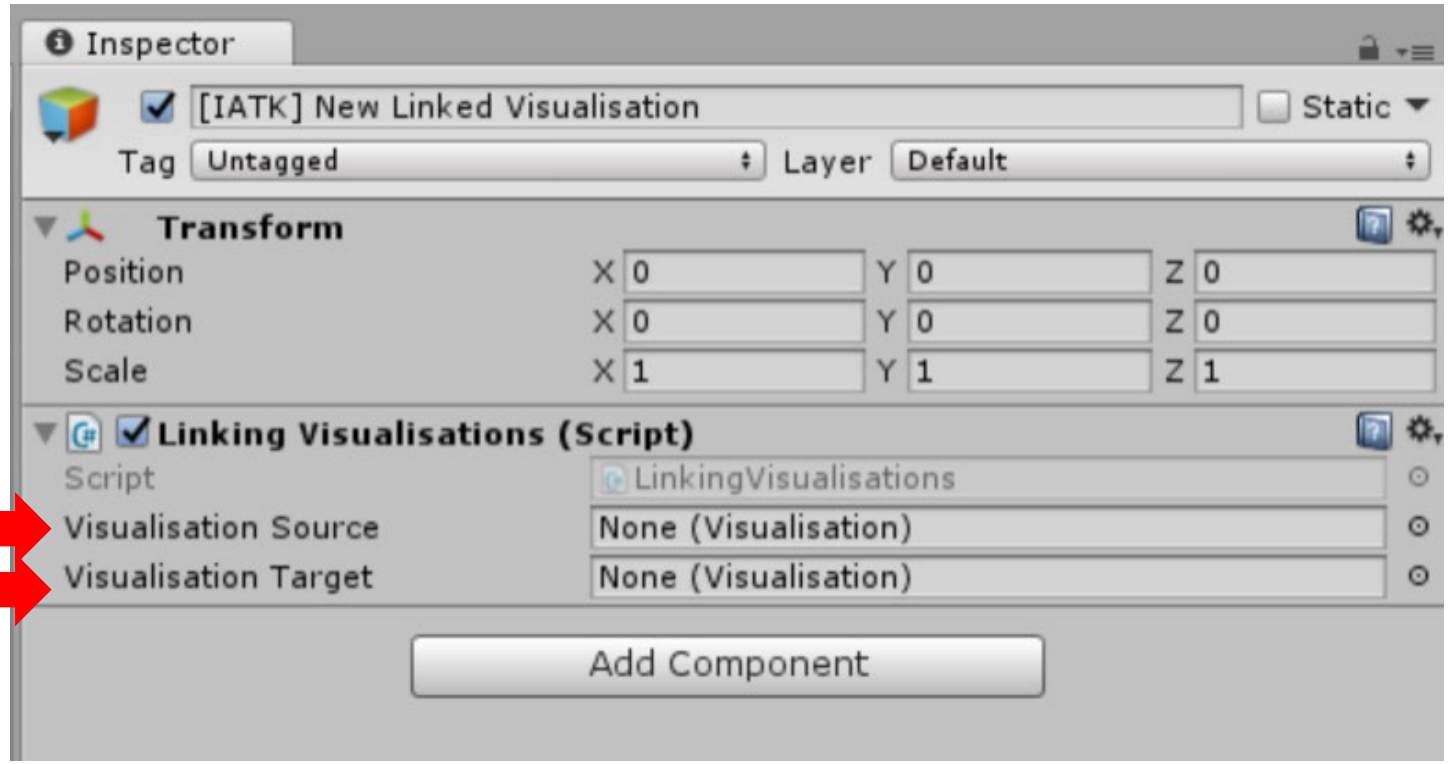
- Visualise geo data
- Bike path boston -> build the visu
- Add a Map Visualisation IATK component
- Make sure X,Z (planar) dimensions correspond to lat/lon
- Drag and drop:
  - The visualisation reference
  - The datasource reference

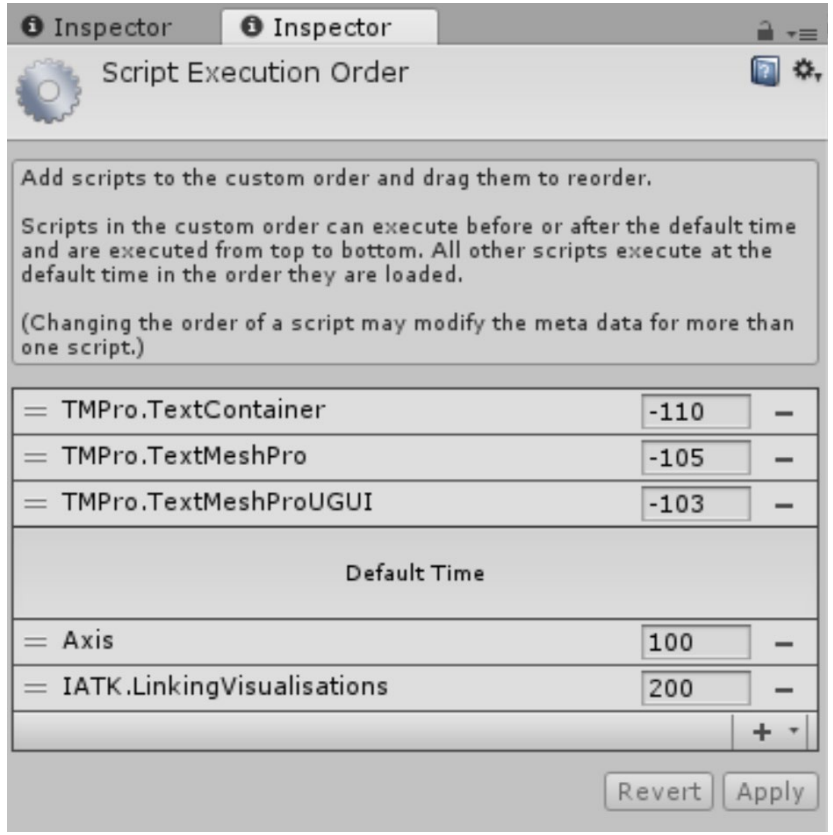
Linked visualisations


20.618
residual sugar
0.600
Type(X)
1.000
alcohol(X)
13.358
8.000


14.900
alcohol(Z)
8.000
chlorides(X)
0.611
free sulfur dioxide(X)
1.000
289.000
free sulfur dioxide(Y)
289.000
total sulfur dioxide(Z)
440.000

[IATK] *Linked Visualisation* component

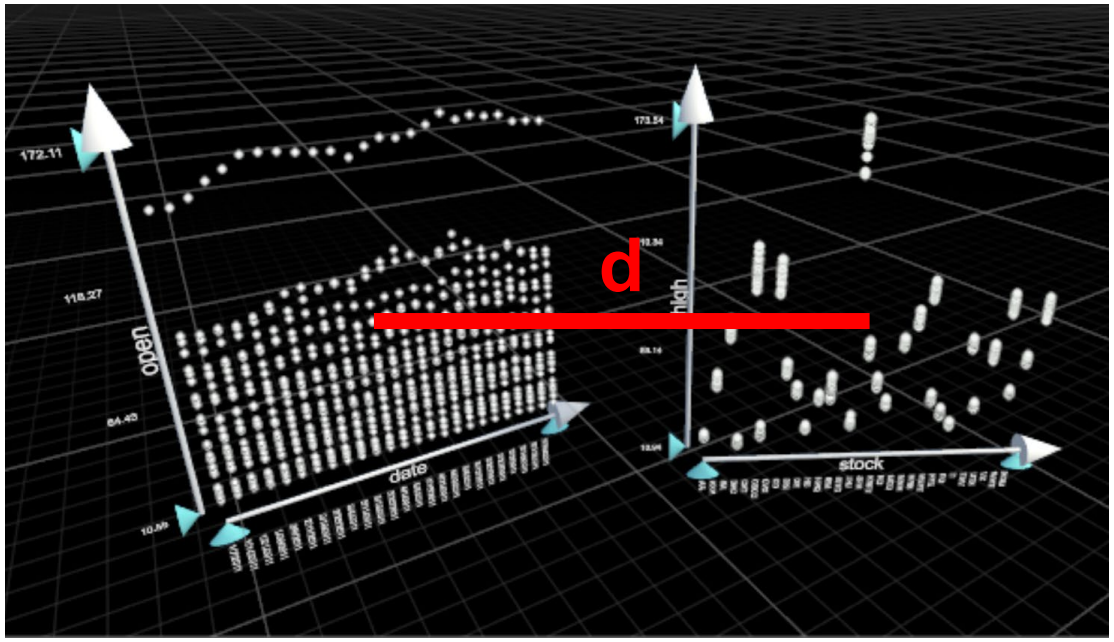


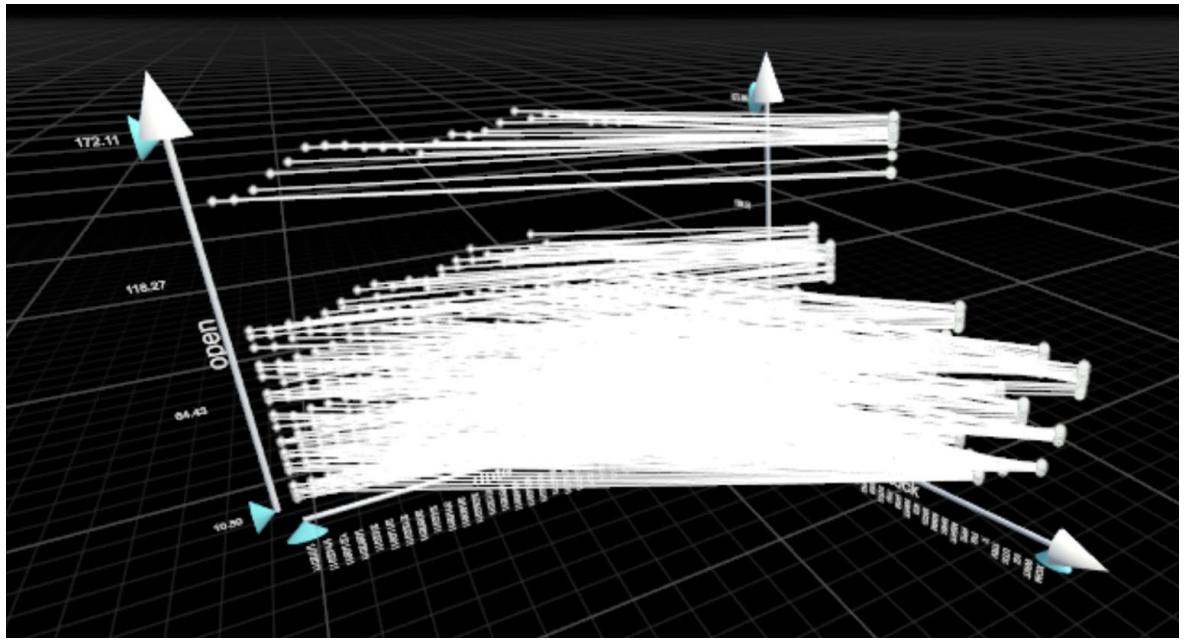


Edit > Project Settings > Script Execution Order

Activity 5: Linked visualisations

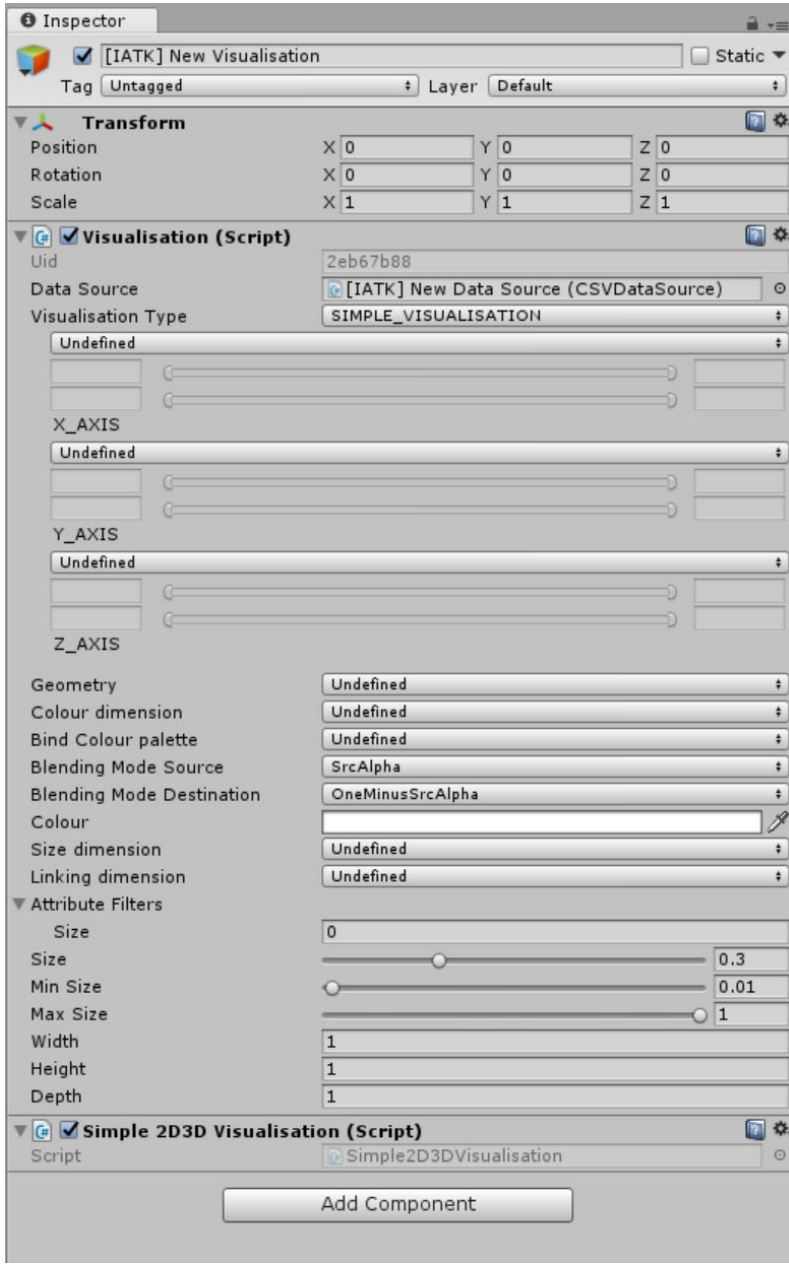
make a simple script that links the visualisations when they are below a certain distance d.





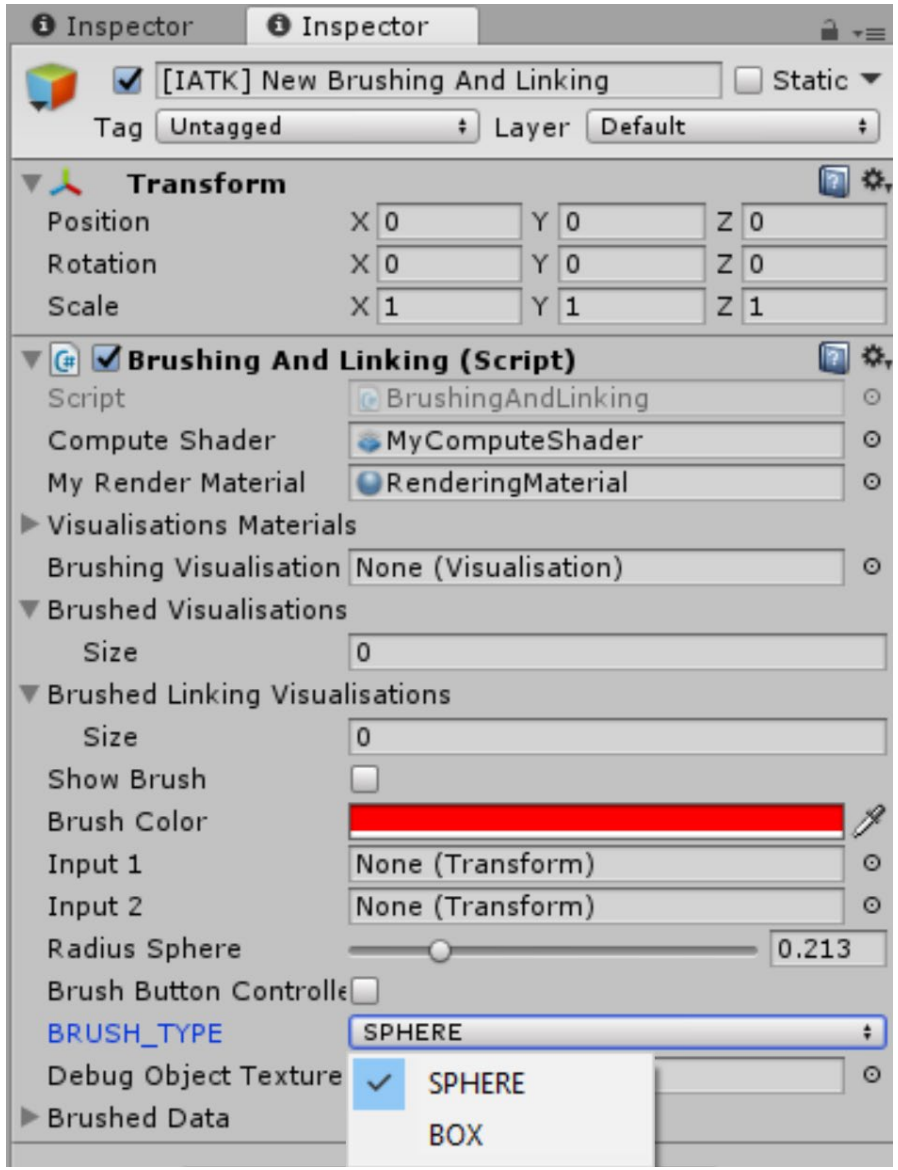
Activity 6: Attribute Animation

write a custom *MonoBehaviour*
script to control a *Visualisation* component

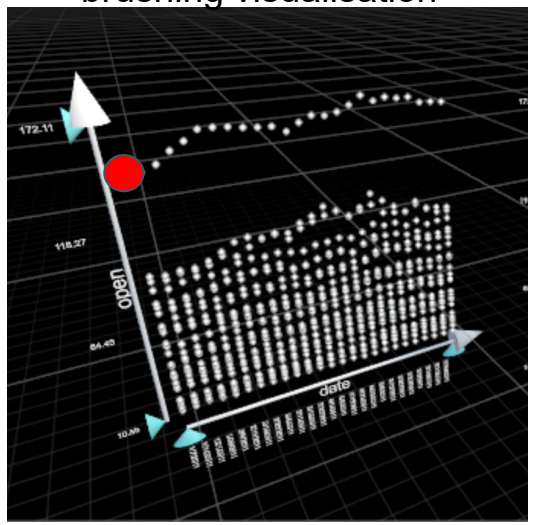


Brushing and linking

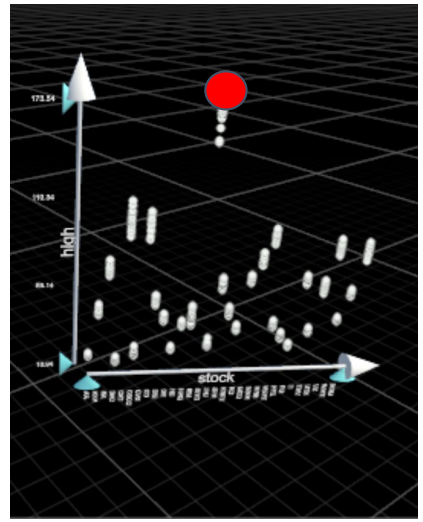
[IATK] *Brushing And Linking* component



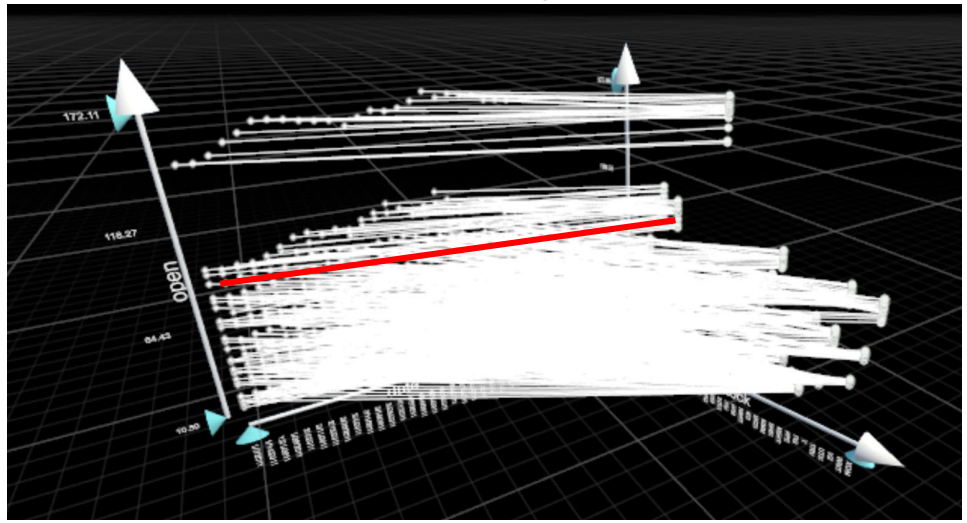
brushing visualisation



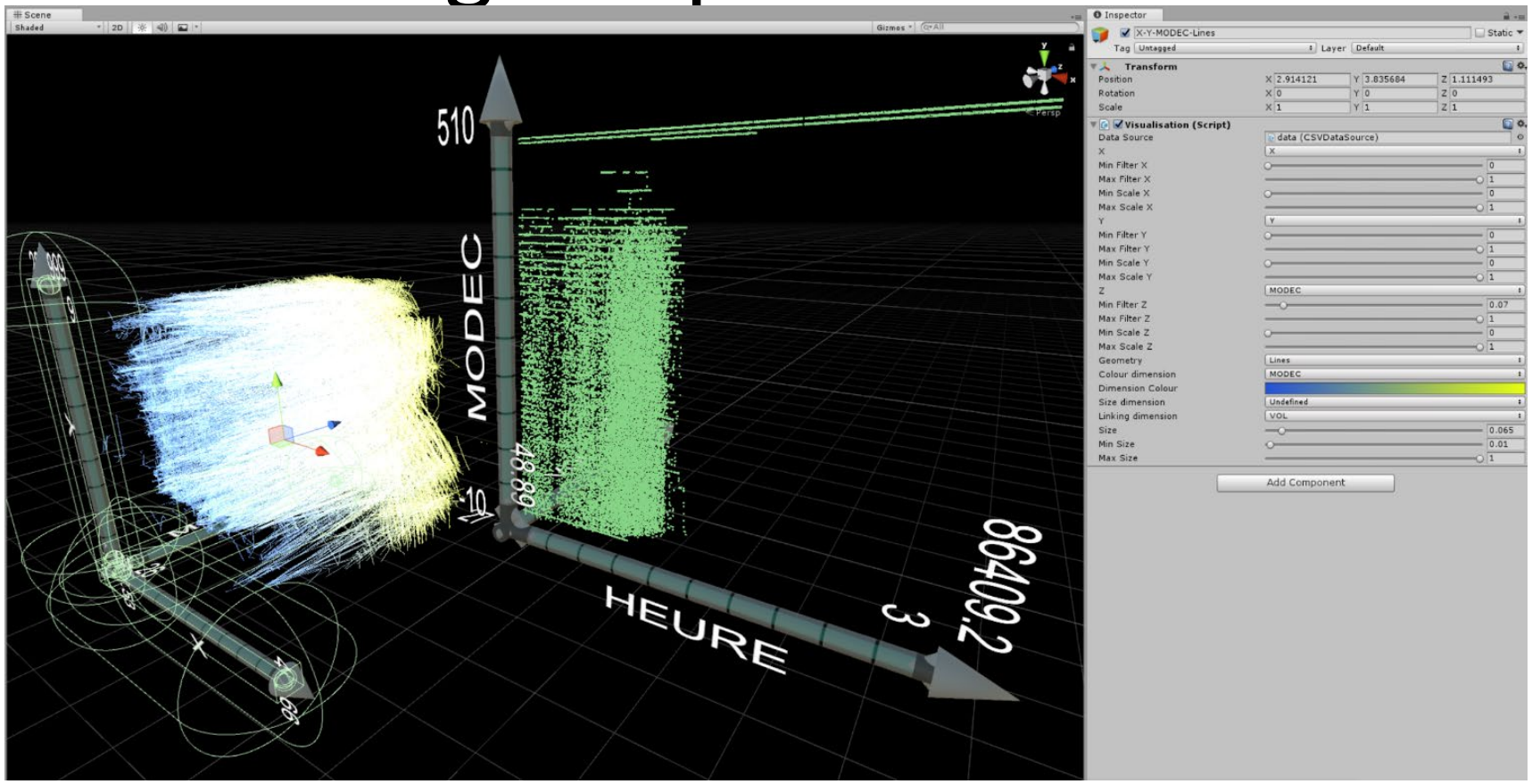
brushed visualisation



Brushed Linking Visualisation



Demo: brushing 1M points



Dataset from Hurter, Christophe, Benjamin Tissoires, and Stéphane Conversy. "FromDaDy: Spreading data across views to support iterative exploration of aircraft trajectories." *IEEE TVCG* 15.6 (2009): 1017-1024.

[IATK] core code

In this section, you'll...

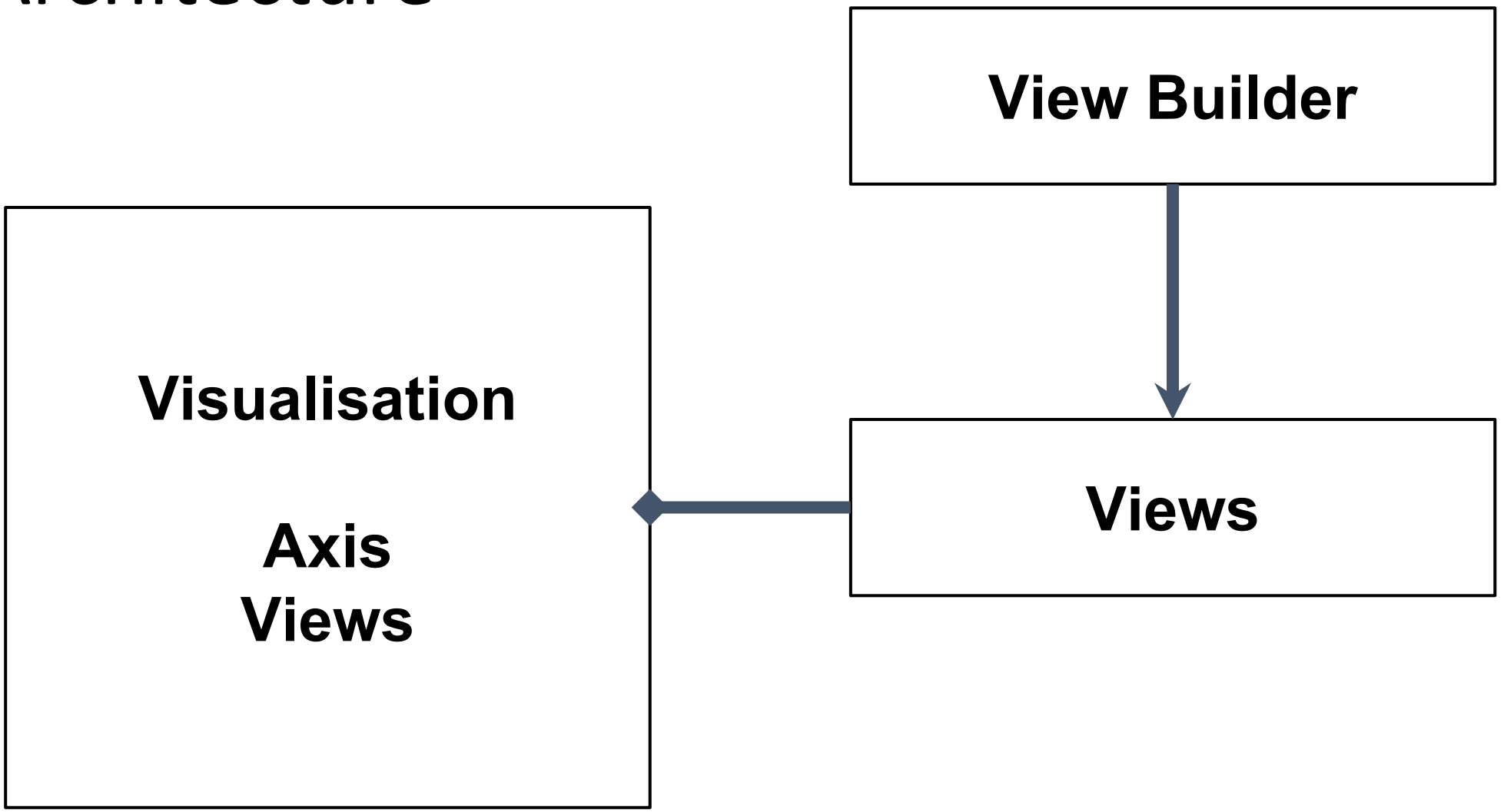
Learn the underlying architecture of IATK

Build a scatterplot visualisation using code

Facet data and build multiple views

Create a novel accordian interaction

Architecture



[IATK] ViewBuilder.cs and View.cs

- ViewBuilder.cs: fluent interface design pattern (d3-like)
- Chain design commands

```
object.DoSomething().
       DoSomething2().
       DoSomething3();
```

C# LINQ facility

- transform input data (e.g. on dimensions, sizes …)
- map data to colours
- map data to categories
- filters, set operations

CSVDatasource - code snippet

```
// Use Unity Test assets to import text data (e.g. csv, tsv etc.)
public TextAsset uberData;
CSVDataSource csvdata;
csvdata = createCSVDataSource(uberData.text);


CSVDataSource createCSVDataSource(string data)
{
    CSVDataSource dataSource = gameObject.AddComponent<CSVDataSource>();
    dataSource.load(data, null);
    return dataSource;
}
```

ViewBuilder - structure

```
// create a view builder with the point topology
ViewBuilder vb = new ViewBuilder (a topology, a name).
        initialiseDataView(number of points).
        setDataDimension(data array  x, ViewBuilder.VIEW_DIMENSION.X).
        setDataDimension(data array y, ViewBuilder.VIEW_DIMENSION.Y).
        setDataDimension(data array z, ViewBuilder.VIEW_DIMENSION.Z).
        setSize(data array size).
            setColors(data array color);
```

ViewBuilder - basic code snippet (points)

```
// create a view builder with the point topology
ViewBuilder vb = new ViewBuilder (MeshTopology.Points, "Uber pick up point visualisation").
        initialiseDataView(csvds.DataCount).
        setDataDimension(csvds["Lat"].Data, ViewBuilder.VIEW_DIMENSION.X).
        setDataDimension(csvds["Base"].Data, ViewBuilder.VIEW_DIMENSION.Y).
        setSize(csvds["Base"].Data).
                setColors(csvds["Time"].Data.Select(x => g.Evaluate(x)).ToArray());

// create a view builder with the point topology
View view = vb.updateView().apply(gameObject, mt);
```

ViewBuilder - basic code snippet (points)

```
// create a view builder with the point topology
ViewBuilder vb = new ViewBuilder (MeshTopology.Points, "Uber pick up point visualisation").
        initialiseDataView(csvds.DataCount).
        setDataDimension(csvds["Lat"].Data, ViewBuilder.VIEW_DIMENSION.X).
        setDataDimension(csvds["Base"].Data, ViewBuilder.VIEW_DIMENSION.Y).
        setDataDimension(csvds["Lon"].Data, ViewBuilder.VIEW_DIMENSION.Z).
        setSize(csvds["Base"].Data).
              setColors(csvds["Time"].Data.Select(x => g.Evaluate(x)).ToArray());

// create a view builder with the point topology
View view = vb.updateView().apply(gameObject, mt);
```

ViewBuilder - basic code snippet (line chart)

```
// create a view builder with the point topology
        ViewBuilder vb = new ViewBuilder(MeshTopology.Lines, "Uber pick up point visualisation").
        initialiseDataView(csvds.DataCount).
        setDataDimension(csvds["stock"].Data, ViewBuilder.VIEW_DIMENSION.X).
        setDataDimension(csvds["date"].Data, ViewBuilder.VIEW_DIMENSION.Y).
        setDataDimension(csvds["open"].Data, ViewBuilder.VIEW_DIMENSION.Z).
        setSize(csvds["volume"].Data).
        setColors(csvds["volume"].Data.Select(x => g.Evaluate(x)).ToArray()).
        createIndicesLinkedTopology(csvds["stock"].Data);
        // create a view builder with the point topology
        Material mt = IATKUtil.GetMaterialFromTopology(AbstractVisualisation.GeometryType.Lines);
        mt.SetFloat("_MinSize", 0.01f);
        mt.SetFloat("_MaxSize", 0.05f);
        View view = vb.updateView().apply(gameObject, mt);
```

ViewBuilder - filtering with Linq

```
// use delegate to filter data
delegate float[] Filter(float[] ar, CSVDataSource csvds, string fiteredValue, string filteringAttribute);


// filters the array on a particular value in another dimension
Filter baseFilter = (array, datasource, value, dimension) =>
{
    return array.Select((b, i) => new { index = i, _base = b })
    .Where(b => datasource.getOriginalValuePrecise(csvds[dimension].Data[b.index],dimension).ToString() == value)
    .Select(b => b._base).ToArray();
};
```

ViewBuilder - apply filter

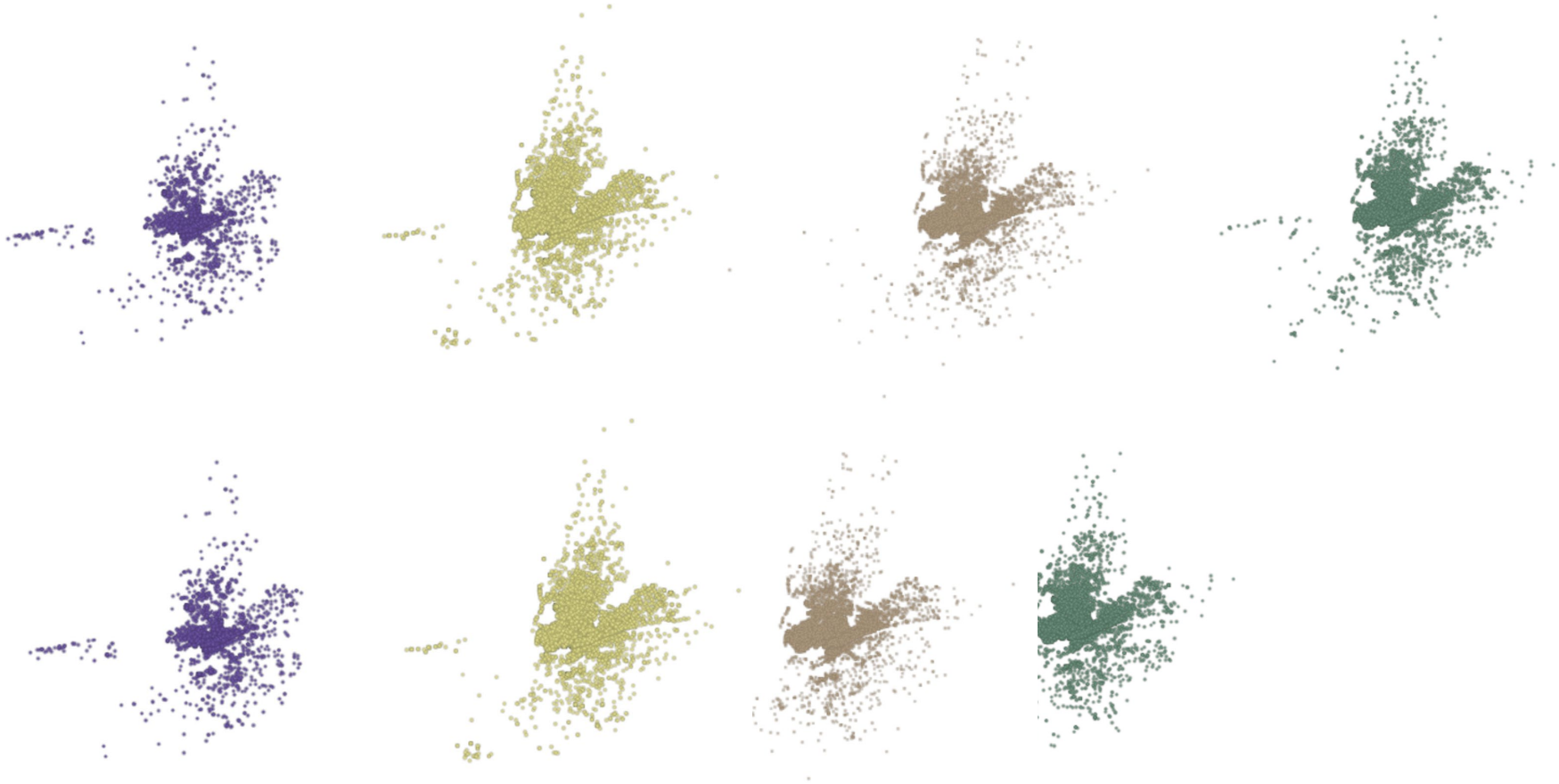
```
var xData = baseFilter(csvds["Lat"].Data,csvds, _fv);
var yData = baseFilter(csvds["Lon"].Data, csvds, _fv);
var zData = baseFilter(csvds["Base"].Data, csvds, _fv);

ViewBuilder vb = new ViewBuilder(MeshTopology.Points, "Uber pick up point visualisation").
        initialiseDataView(xData.Length).
        setDataDimension(xData, ViewBuilder.VIEW_DIMENSION.X).
        setDataDimension(yData, ViewBuilder.VIEW_DIMENSION.Y).
        setDataDimension(zData, ViewBuilder.VIEW_DIMENSION.Z).
        setSize(baseFilter(csvds["Date"].Data,csvds, _fv)).
        setColors(xData.Select(x => color).ToArray());
```

Activity - faceting

- use filters to create faceted data
- control faceted objects positions

Activity - accordion faceting!



Built with IATK

Embodied Axes: Tangible, Actuated Interaction for 3D Augmented Reality Data Spaces

Maxime Cordeil[1], Benjamin Bach[2], Andrew Cunningham[3], Bastian Montoya[3], Ross T. Smith[3], Bruce H. Thomas[3], Tim Dwyer[1]

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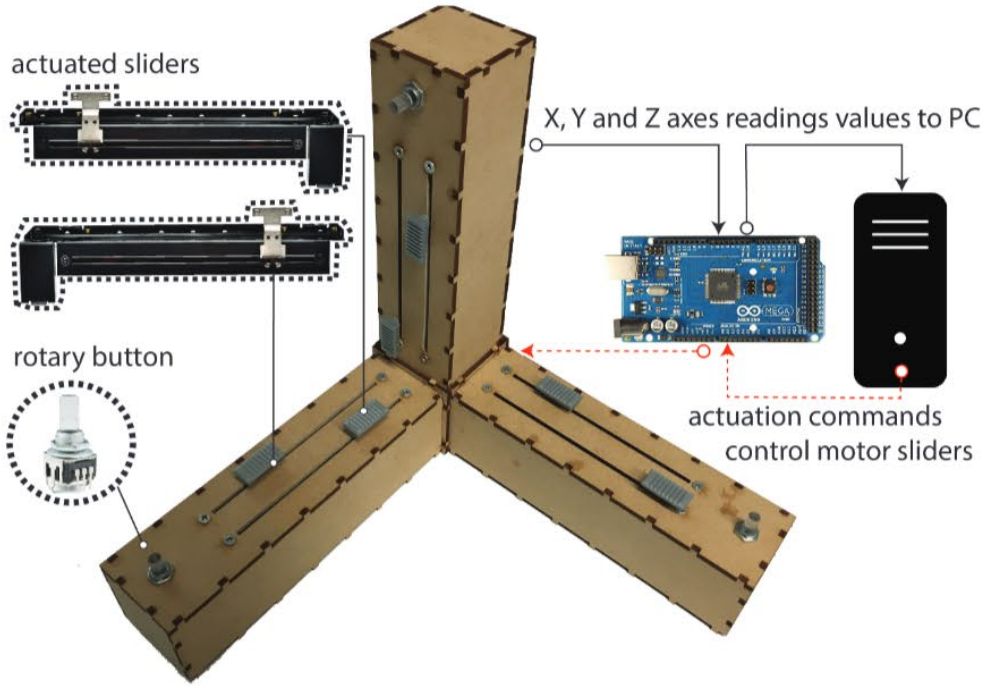

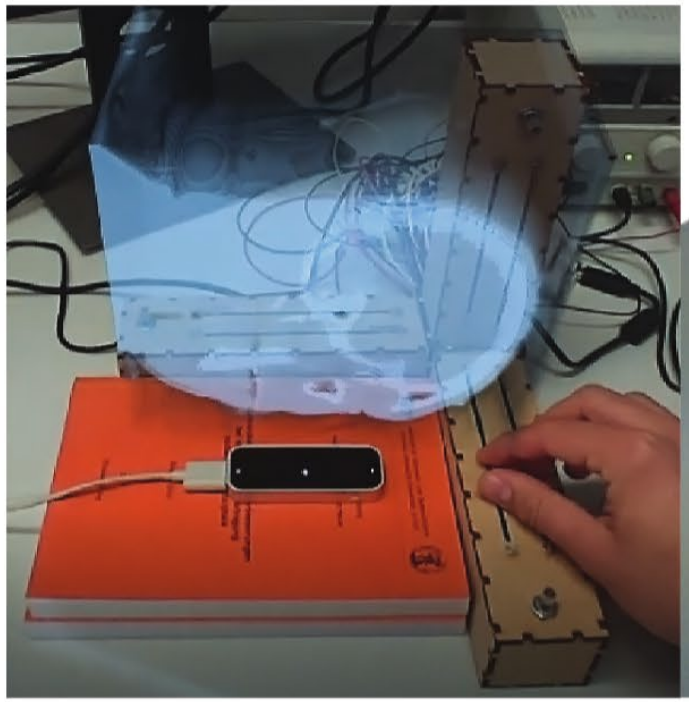

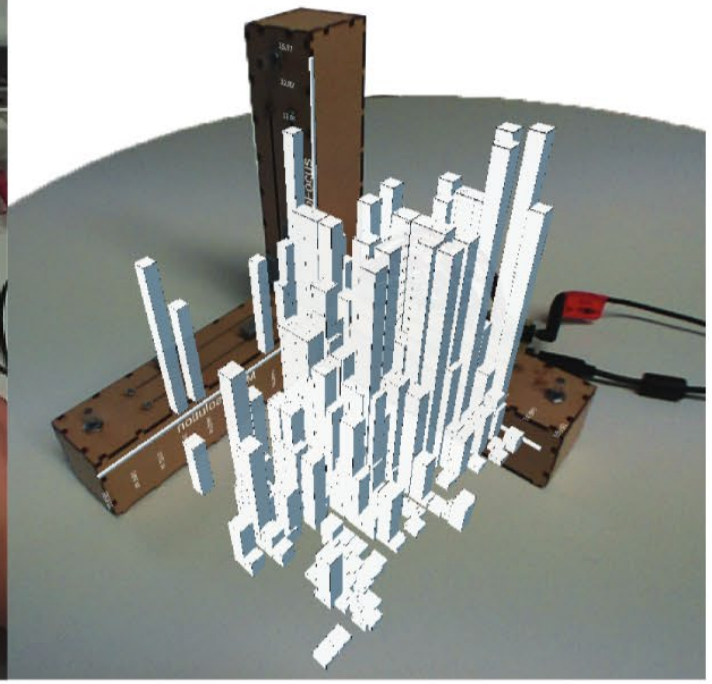

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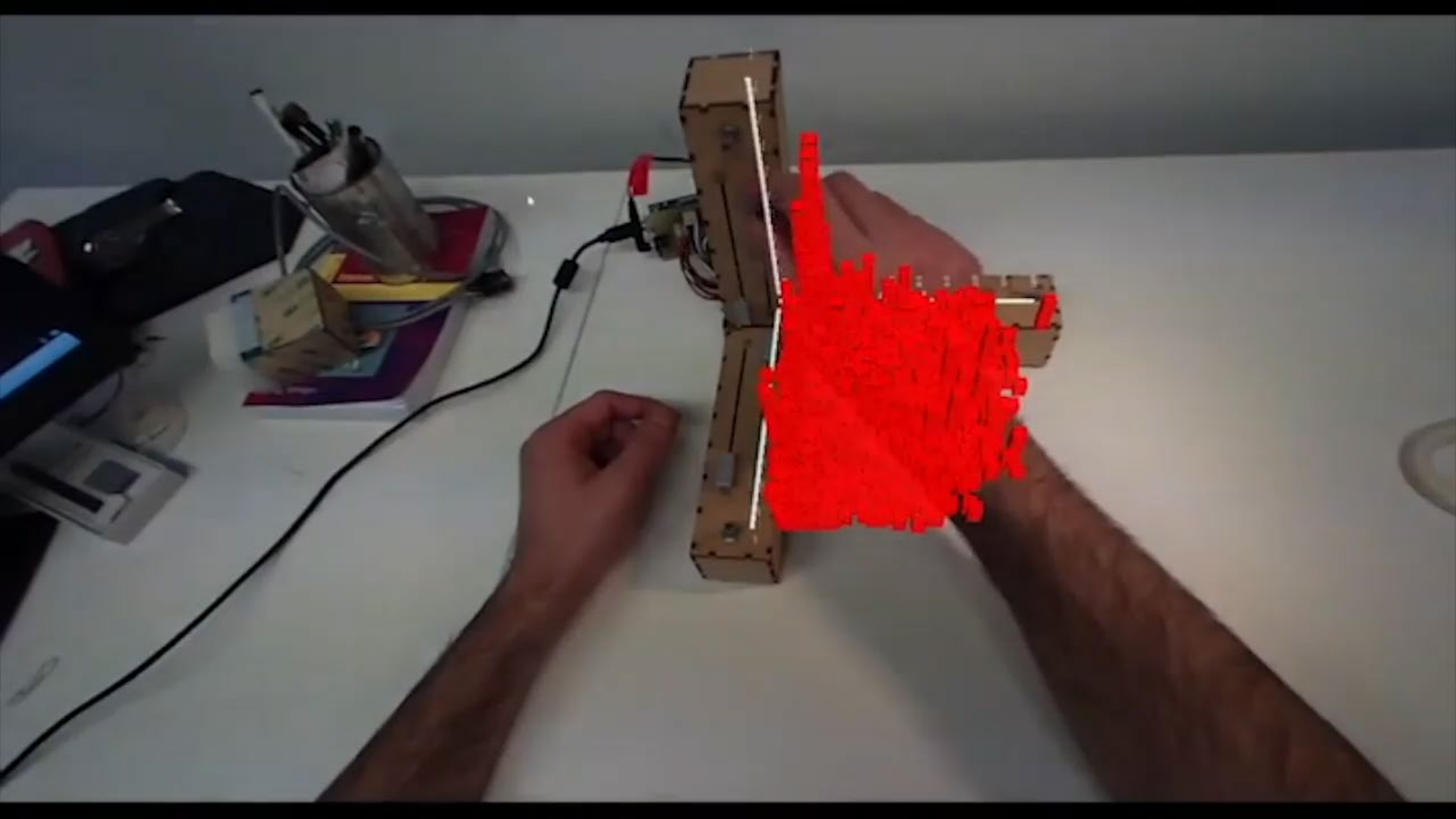
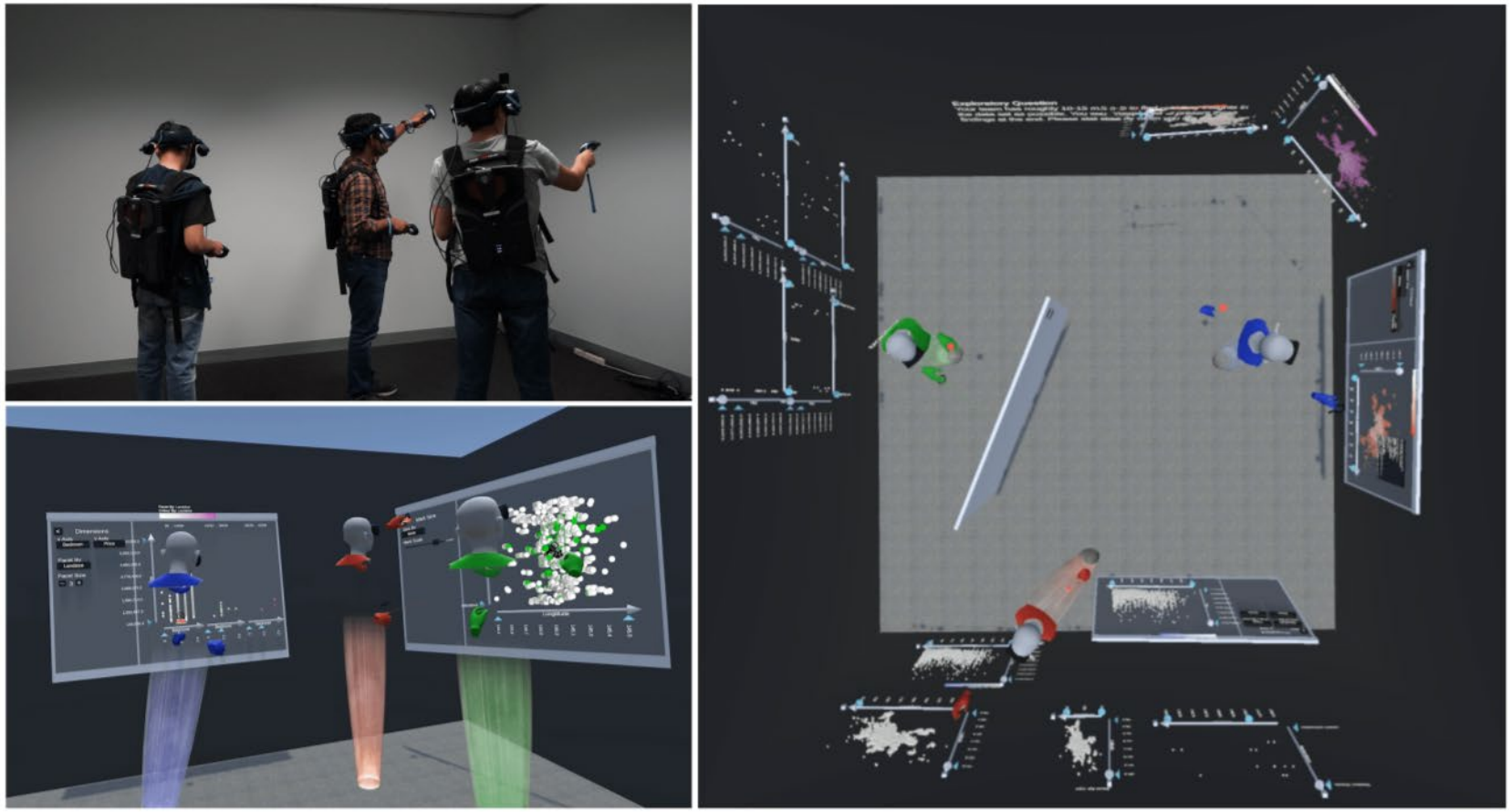


Shared Surfaces and Spaces: Collaborative Data Visualisation in a Co-located Immersive Environment

Benjamin Lee, Xiaoyun Hu, Maxime Cordeil, Arnaud Prouzeau, Bernhard Jenny and Tim Dwyer



IEEE VIS 2020
https://github.com/benjaminchlee/FIESTA

Shared Surfaces and Spaces: Collaborative Data Visualisation in a Co-located Immersive Environment

Benjamin Lee, Xiaoyun Hu, Maxime Cordeil, Arnaud Prouzeau, Bernhard Jenny, and Tim Dwyer

Accompanying Video
IEEE VIS 2020

Design and Evaluation of Interactive Small Multiples Data Visualisation in Immersive Spaces

Jiazhou Liu* Arnaud Prouzeau† Barrett Ens‡ Tim Dwyer§

Monash University

IEEE VR2020
https://github.com/JiazhouLiu/ImmersiveSmallMultiples

Scaptics and Highlight-Planes: Immersive Interaction Techniques for Finding Occluded Features in 3D Scatterplots

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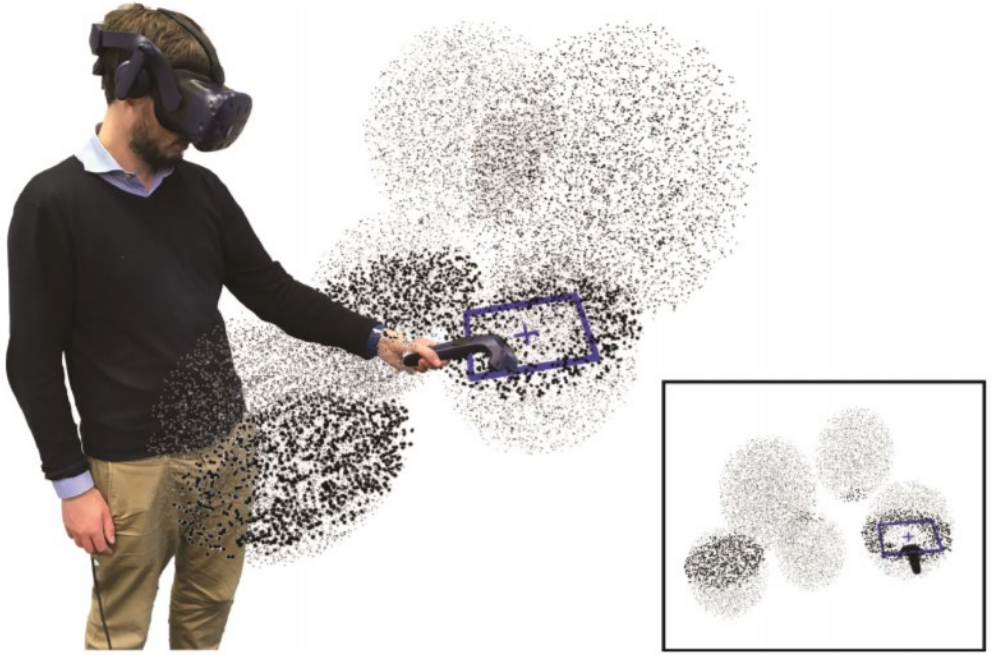

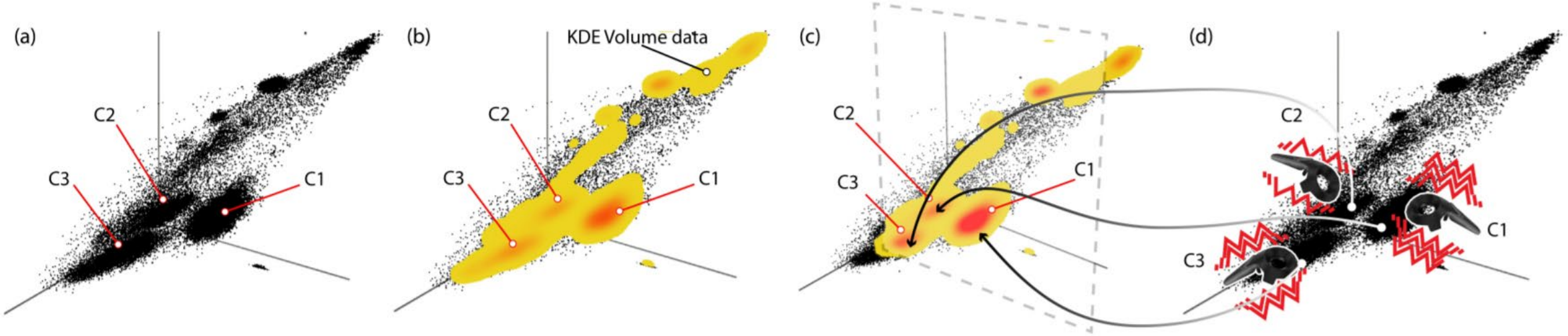

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Take aways

- IATK scales with the number of points to visualise
  - Be considerate of the number of visualisations
- Use 3rd party Python, R, Excel to clean, order and transform your data to make them ready to visualise in IATK
- IATK is a toolkit – designed to integrate with other packages (e.g. VRTK, MapBox)
- Open source project!

Thank you

github.com/MaximeCordeil/IATK