

A Survey of Designs for Combined 2D+3D Visual Representations

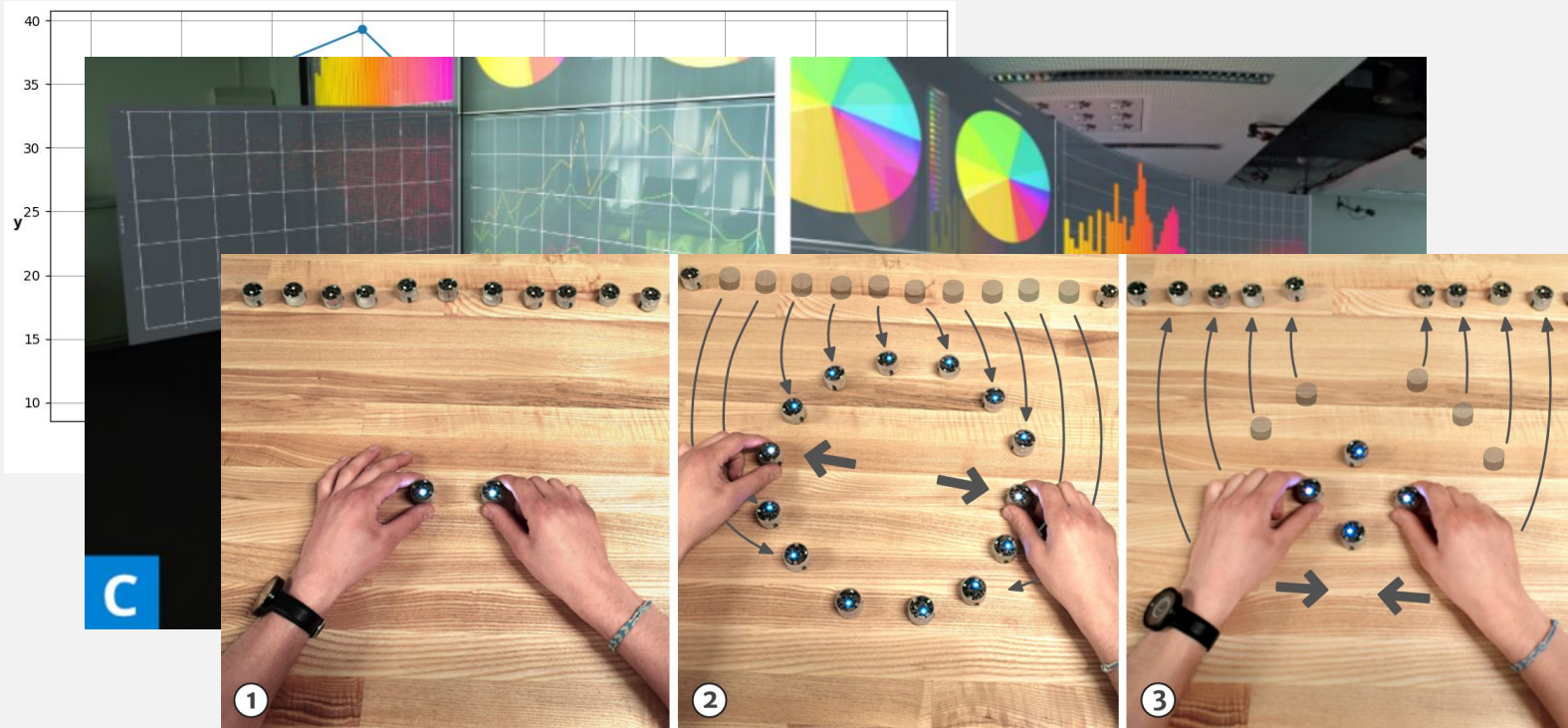
Jiayi Hong



Rostyslav Hnatyshyn Ebrar A. D. Santos Ross Maciejewski Tobias Isenberg



01 Background *Of 2D and 3D visual representations*



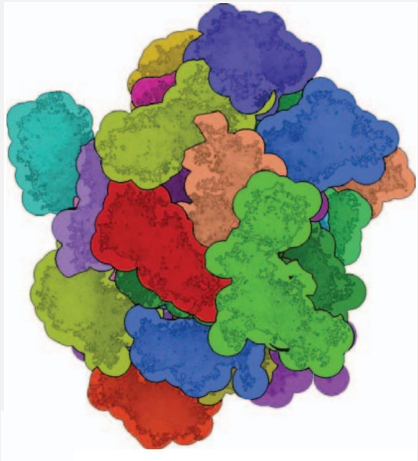
(Goc et al., 2016)

2D Visual
Representation

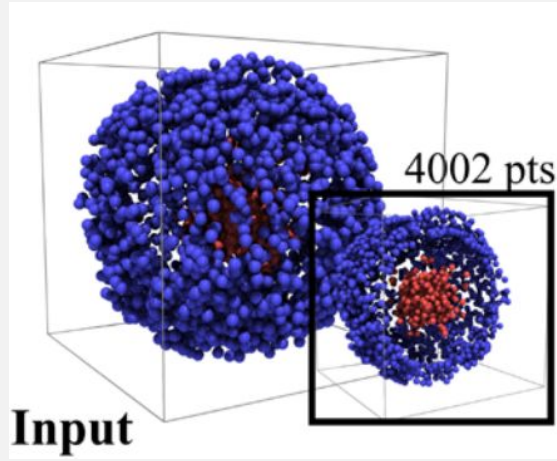


01

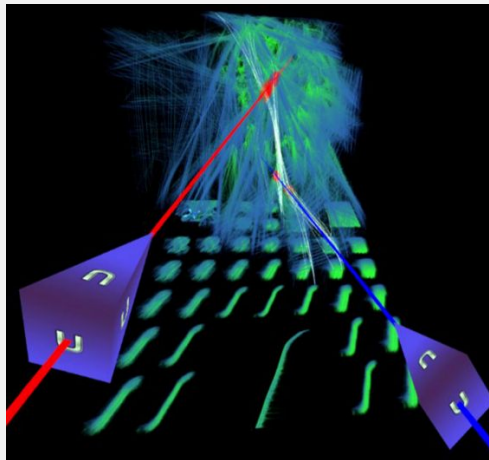
Background *Of 2D and 3D visual representations*



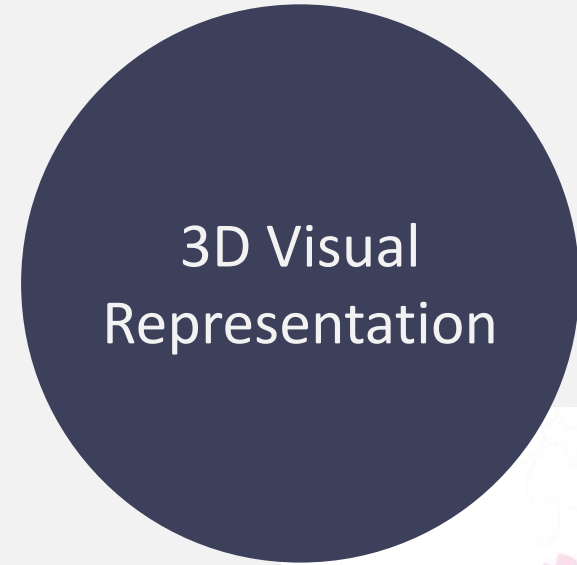
DNA structure
(Halladjian et al., 2020)



High-Dimensional Data
(Doraiswamy et al., 2021)



VR
(Hurter et al., 2019)



01

Background *Of 2D and 3D visual representations*

2D Visual
Representation

3D Visual
Representation



01

Background *Of 2D and 3D visual representations*

2D Visual
Representation

3D Visual
Representation



01 **Background** *Of 2D and 3D visual representations*

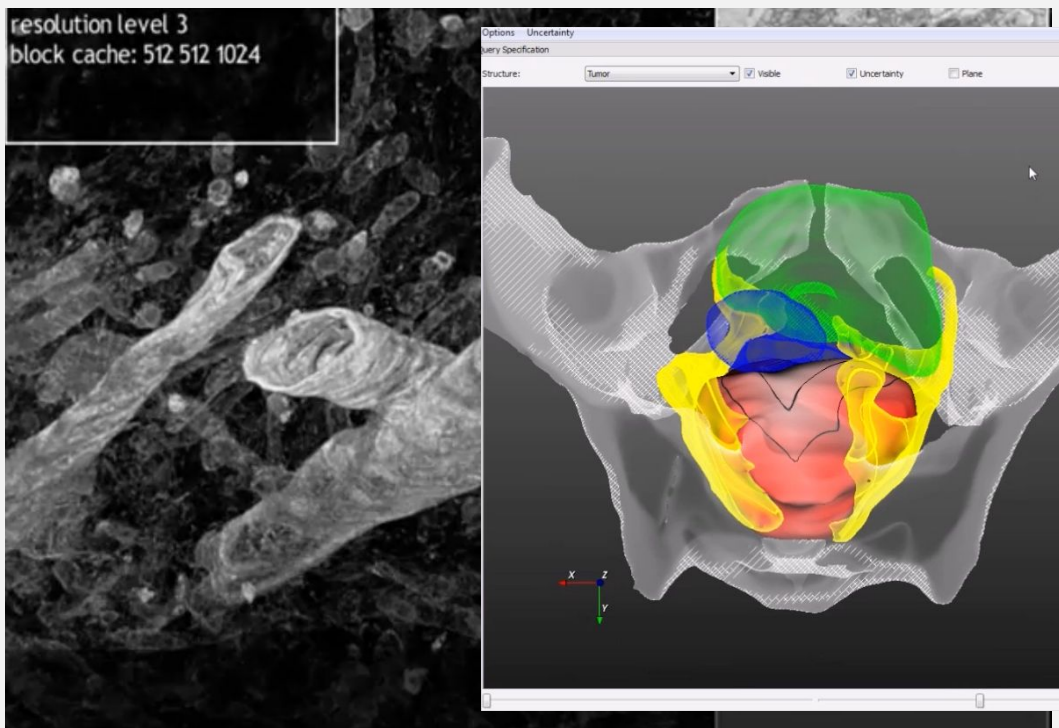
2D Visual
Representation

3D Visual
Representation

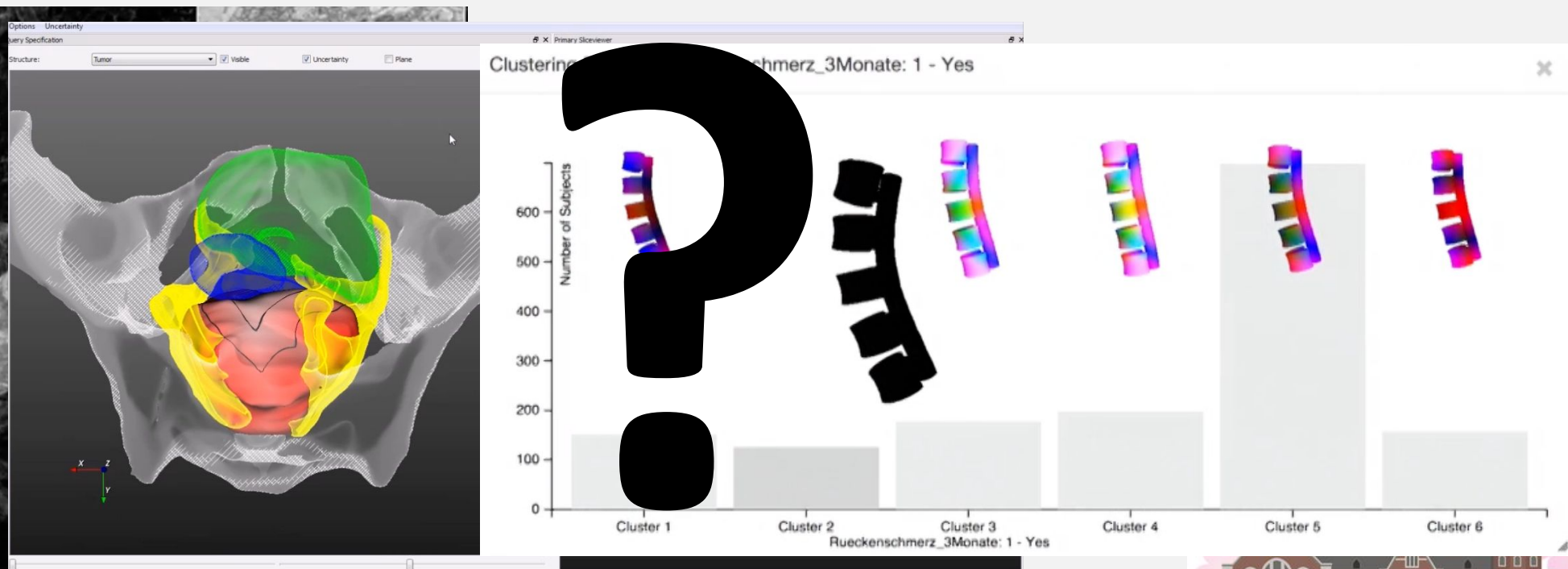


2D Visual
Representation

3D Visual
Representation



(Hadwiger et al., 2012)



(Smit et al., 2017)

(Klemm et al., 2014)





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Papers from 2012 to 2022

Why

Where

How





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Why
Motivation

For linking representations

Where

How





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Motivation

For linking representations

Display Environment

To contain representations

How





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Motivation

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Display Environment

To contain representations

Layout

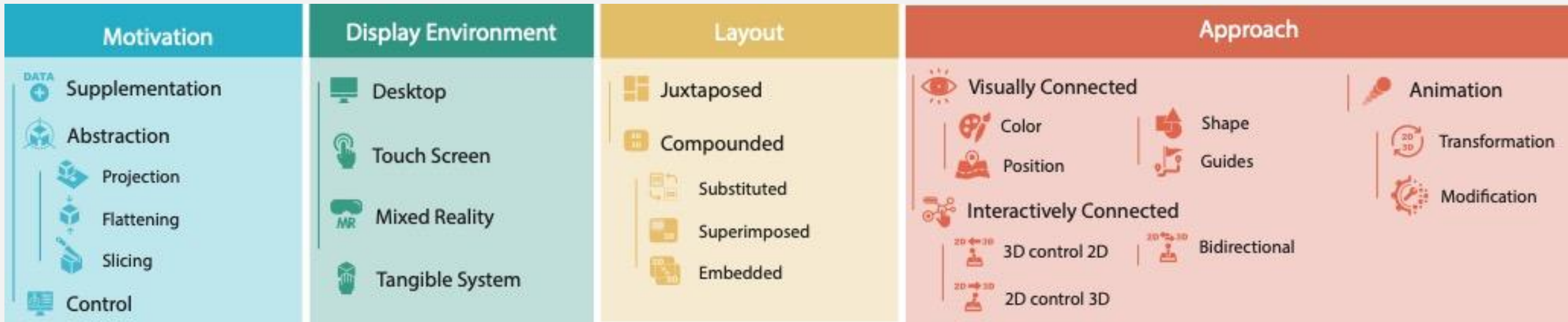
Of representations

Approach

For interacting with the links



2D+3D Design Space





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Motivation

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Supplementation



Abstraction



Control

Display Environment

To contain representations

Layout

Of representations

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02

Design Space

Of combining 2D and 3D visualizations

Motivation

For linking representations

DATA



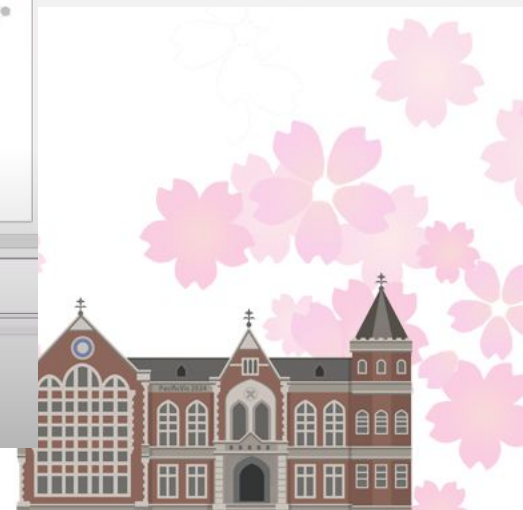
Supplementation

Add information to one representation

The screenshot shows a software interface for neuroanatomical data analysis. On the left is a 'Set Creator' panel with a 'Predicate/Operator' dropdown set to 'is Connected'. Below it are 'Input Sets' for 'Axons', 'Red Dendrite', and 'Synapses'. A 'New Set Name' field contains '[is Connected] (Axons, Red Dendrite, Synapses)'. The main window is split into two views: a 2D microscopy image of neurons with colored segments (red, green, blue, yellow) and a graph representation of the same neurons with nodes and edges. Below the main window is an 'Axon Inspector' table with columns for Axon Id, Axon Name, Axon Mylenated, Axon Voxels, an Transmitter T_i, Dendrite Id, Dendrite Name, Dendrite Voxels, Inite Transmitter, Synapse Id, and Synapse Name.

Axon Id	Axon Name	Axon Mylenated	Axon Voxels	an Transmitter T _i	Dendrite Id	Dendrite Name	Dendrite Voxels	Inite Transmitter	Synapse Id	Synapse Name
23	Segment 4+ AE+	No	2663571	Excitatory	18	Bobbys Dendrit...	278752288	Excitatory	697	697
24	Segment 4+ AE+	No	2663571	Excitatory	18	Bobbys Dendrit...	278752288	Excitatory	279	279
25	Segment 4+ AE+	No	2663571	Excitatory	18	Bobbys Dendrit...	278752288	Excitatory	698	698
26	Segment 4+ AE+	No	2663571	Excitatory	18	Bobbys Dendrit...	278752288	Excitatory	275	275
27	Segment 31_AE+	No	2851966	Excitatory	18	Bobbys Dendrit...	278752288	Excitatory	377	377

(Beyer et al., 2013)



02

Design Space

Of combining 2D and 3D visualizations

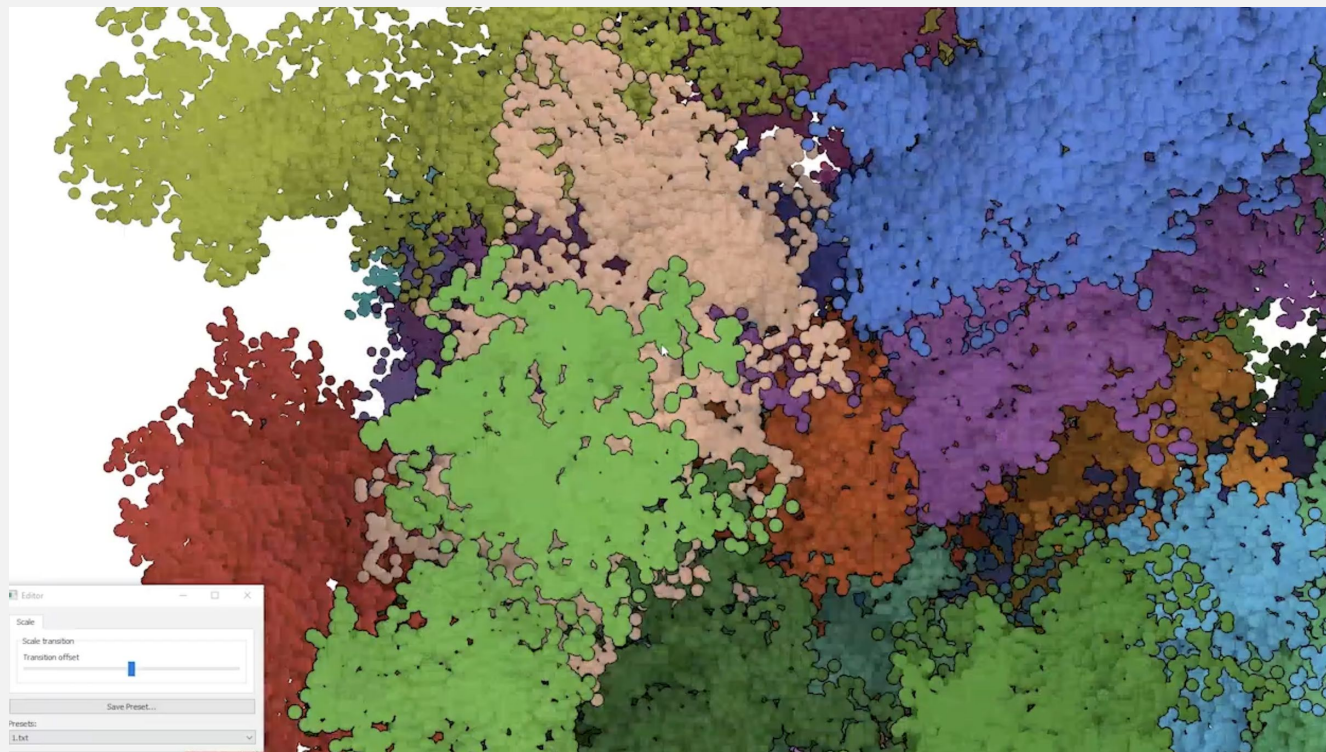
Motivation *For linking representations*



Abstraction *Where the 2D representations are abstraction of 3D visualizations*



Projection *Reduces the dimension count*



(Halladjian et al., 2020)



02

Design Space

Of combining 2D and 3D visualizations

Motivation

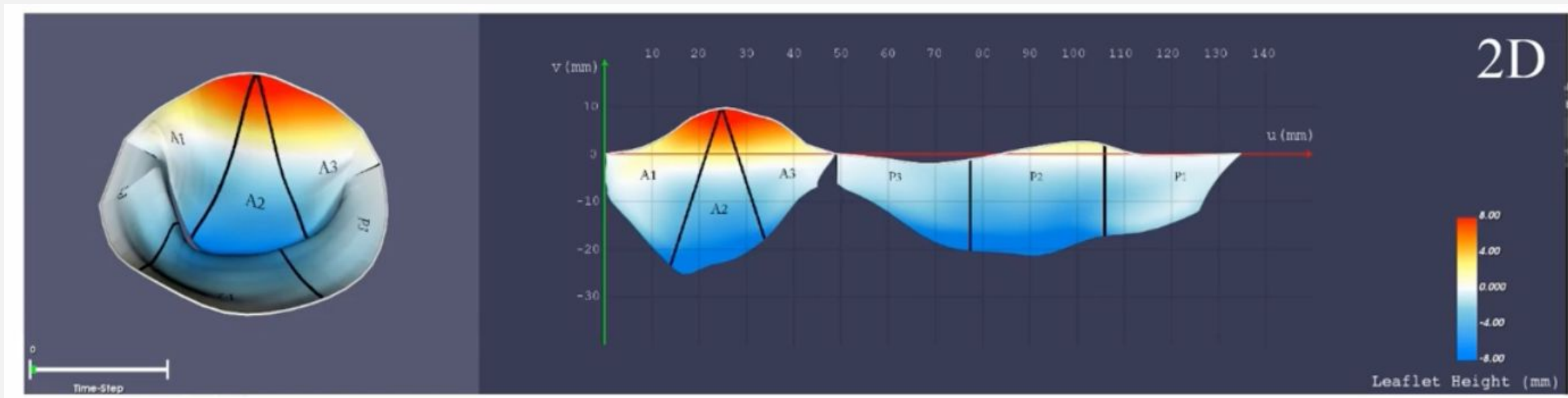
For linking representations



Abstraction Where the 2D representation are abstraction of 3D visualization



Flattening Uses techniques to map 3D objects on a 2D plane



(Eulzer et al., 2020)



02

Design Space

Of combining 2D and 3D visualizations

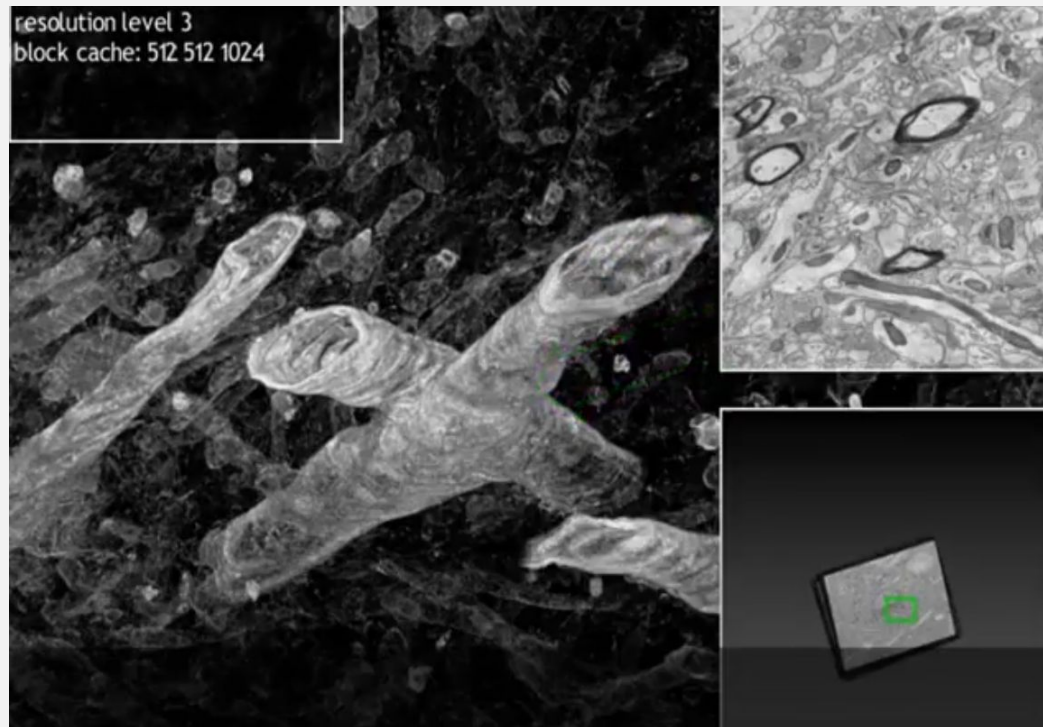
Motivation For linking representations



Abstraction Where the 2D representation are abstraction of 3D visualization



Slicing Where 2D images are cross-section views of 3D objects or slices from microscopes



(Hadwiger et al., 2012)



02

Design Space

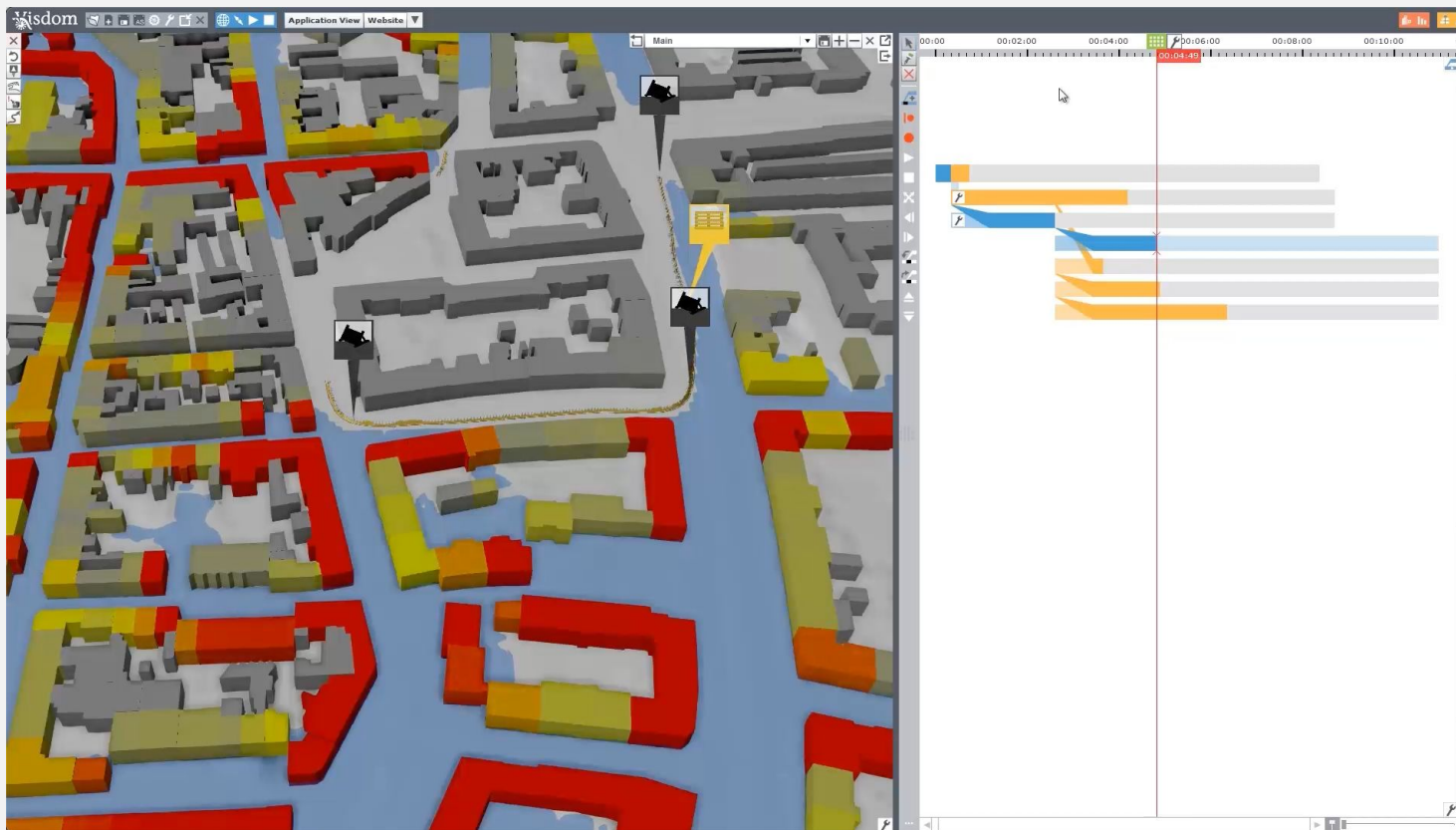
Of combining 2D and 3D visualizations

Motivation *For linking representations*



Control

Where one representation was designed to control other representations



(Waser et al., 2014)





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Motivation

For linking representations

Display Environment

To contain representations

Layout

Of representations

Approach

For interacting with the links





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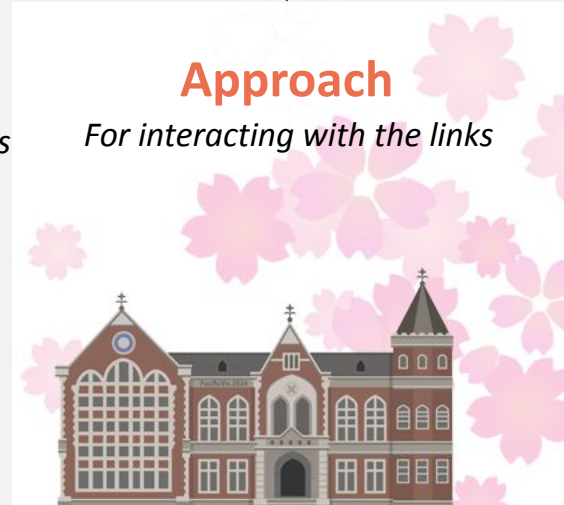
-  Desktop
-  Mixed Reality
-  Touch Screen
-  Tangible System

Layout

Of representations

Approach

For interacting with the links



02

Design Space

Of combining 2D and 3D visualizations

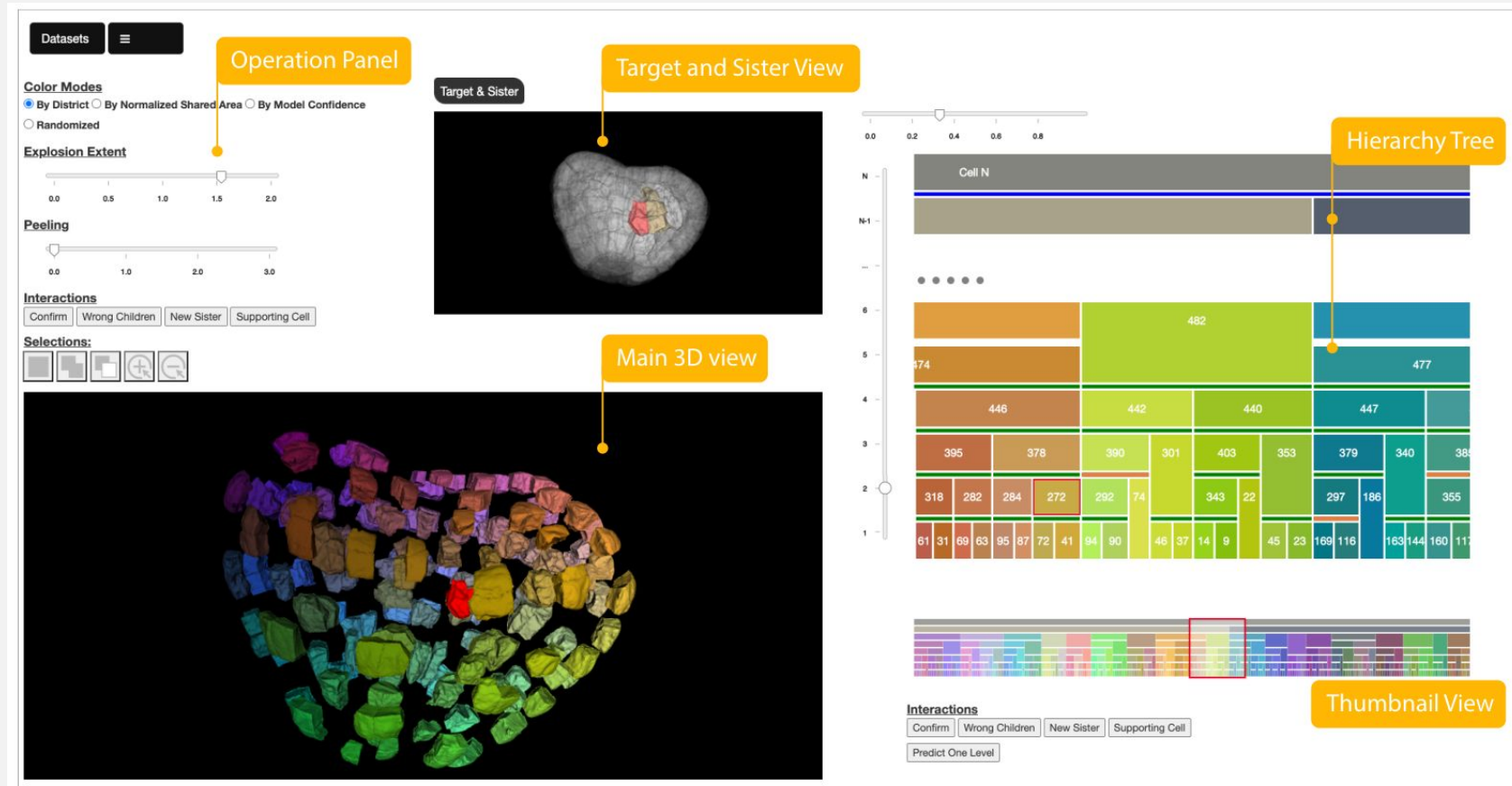
Display Environment

To contain representations

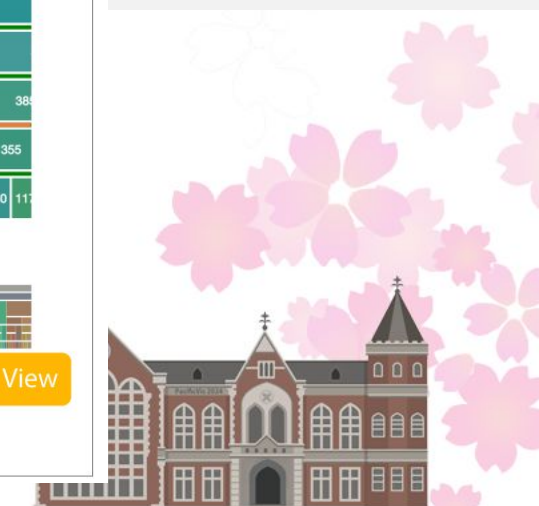


Desktop

Where input is mice and keyboards, and output is displayed on computer monitors



(Hong et al., 2022)



02

Design Space

Of combining 2D and 3D visualizations

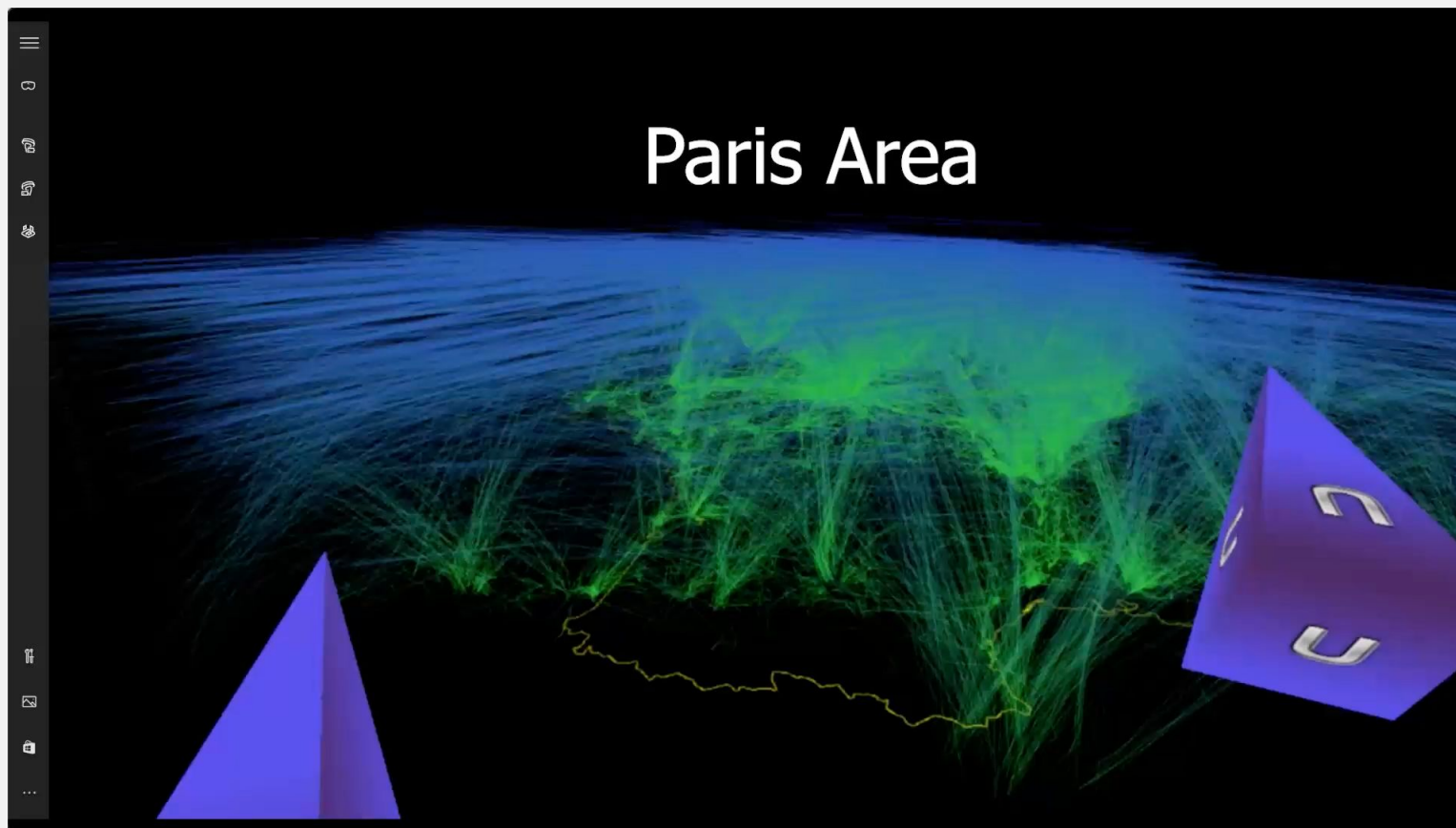
Display Environment

To contain representations



Mixed Reality

Where 2D and 3D representations are embedded in immersive environments



(Hurter et al., 2019)



02

Design Space

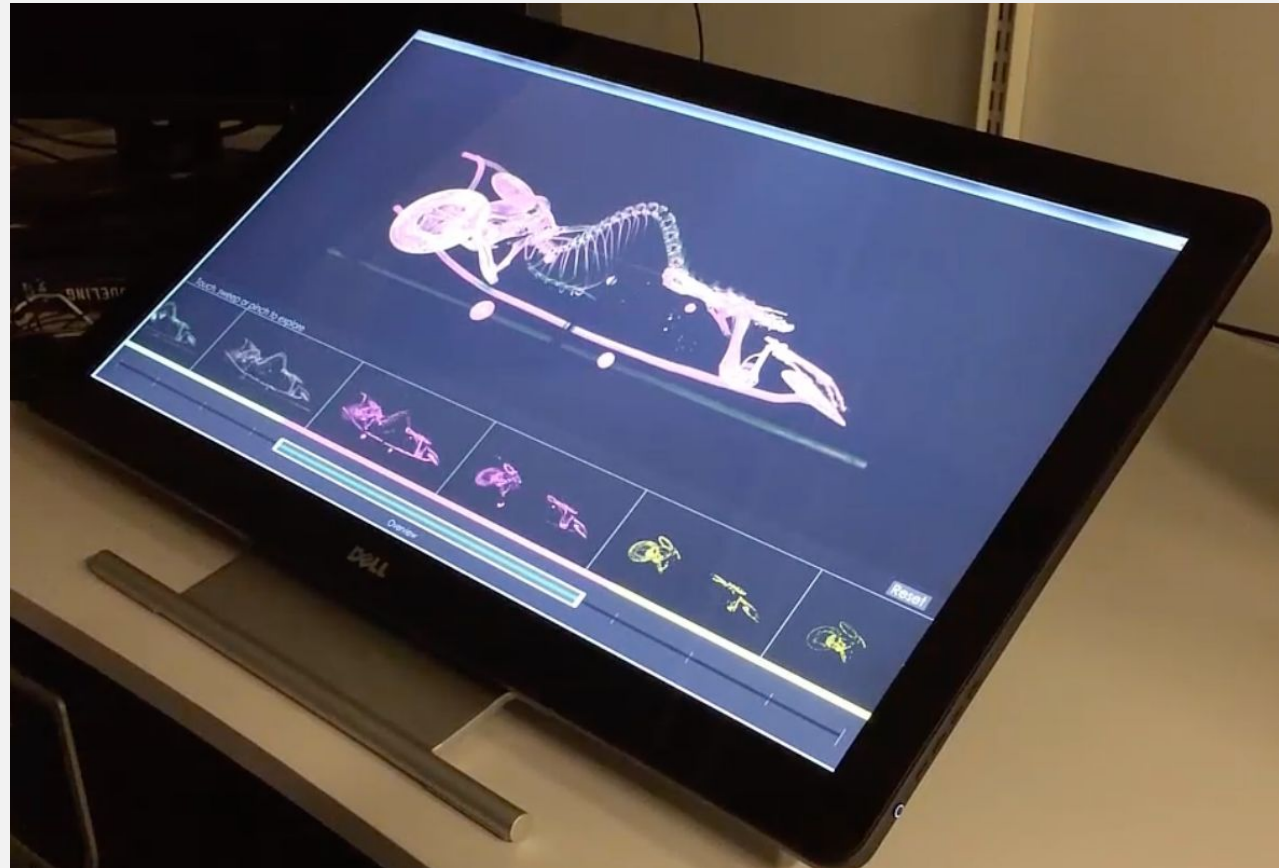
Of combining 2D and 3D visualizations

Display Environment

To contain representations



Touch Screen *Where the input is provided by a person's fingers or hands*



(Jonsson et al., 2016)



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Design Space

Of combining 2D and 3D visualizations

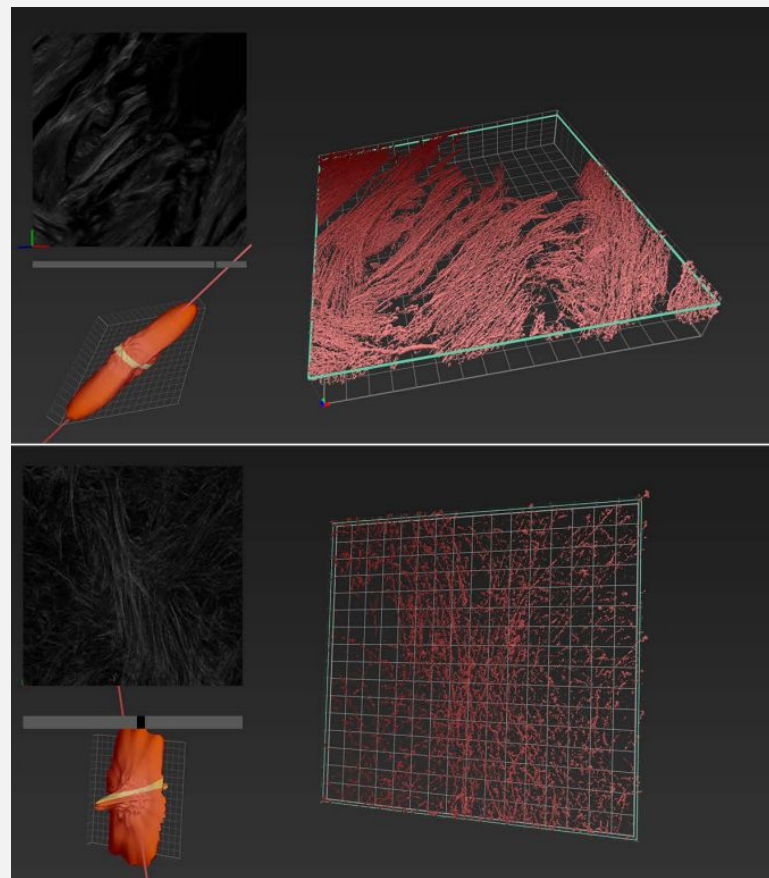
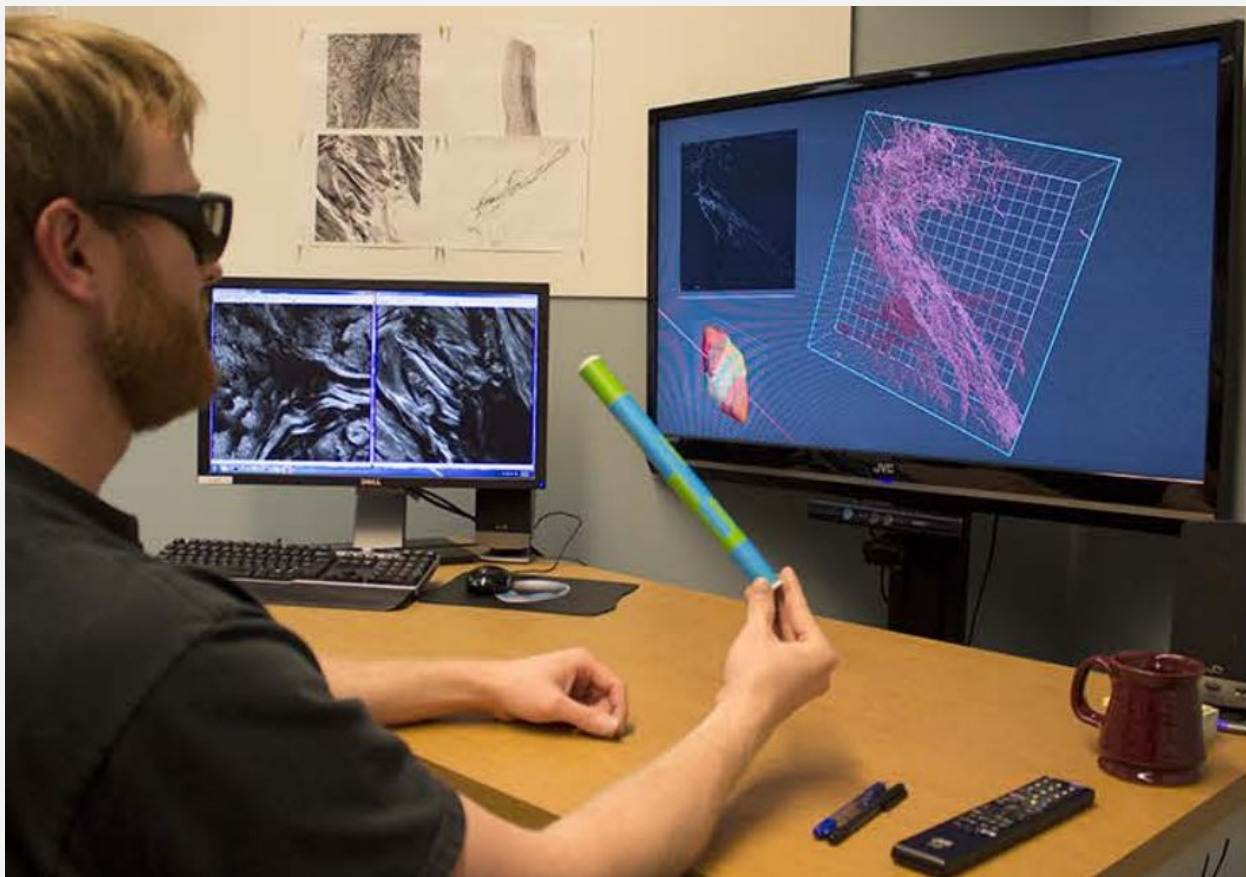


Tangible System

Where physical objects are used to control or form visualizations

Display Environment

To contain representations



(Jackson et al., 2013)



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To contain representations

Layout

Of representations

 Juxtaposed

 Compounded

Approach

For interacting with the links



02

Design Space

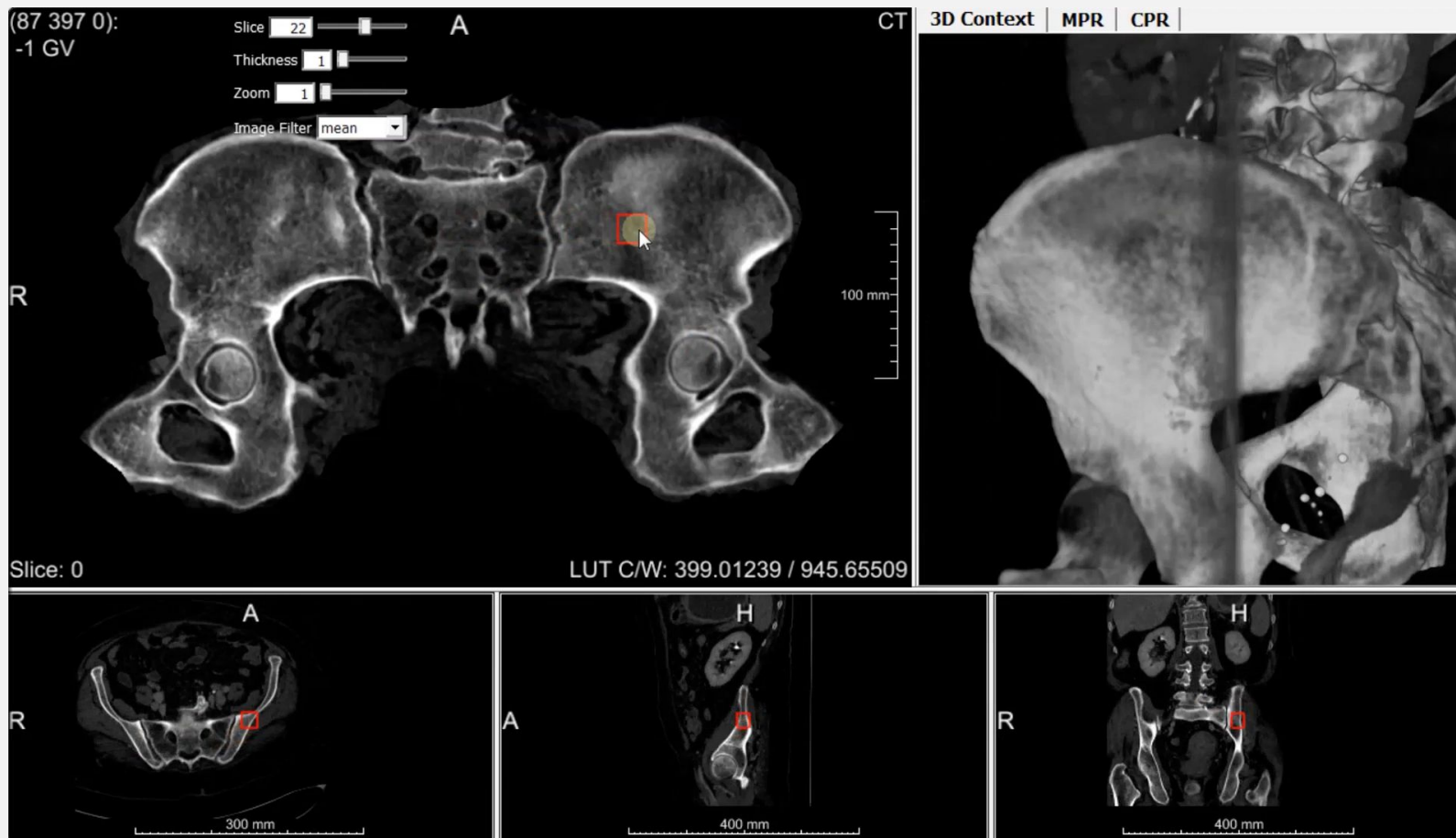
Of combining 2D and 3D visualizations



Juxtaposed

Layouts place representations side-by-side

Layout Of representations



(Kretschmer et al., 2014)



02

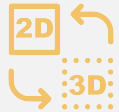
Design Space

Of combining 2D and 3D visualizations

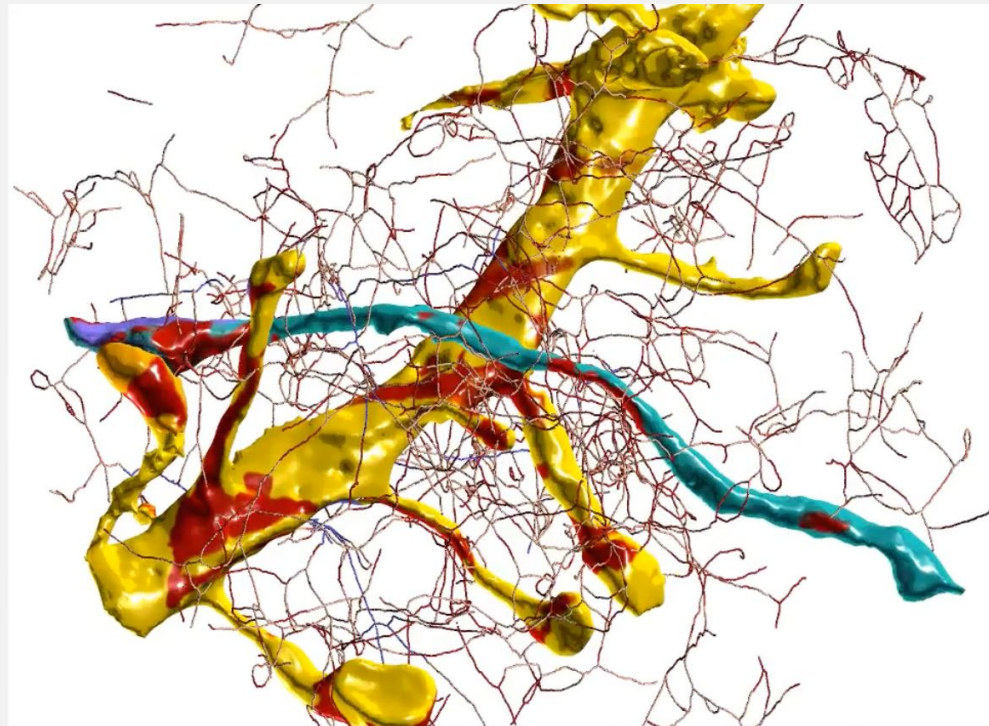
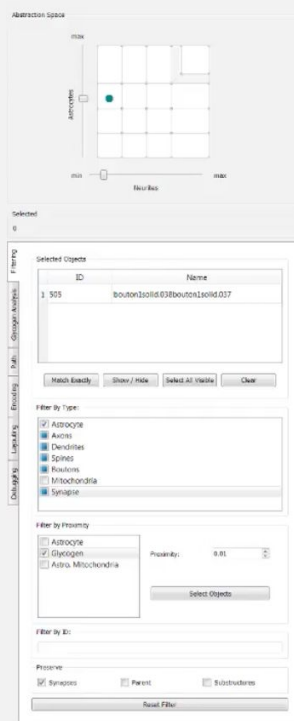
Layout Of representations

2D
3D

Compounded Layouts use the same display space



Substituted Layouts where representations are rendered in the same position at different times



(Mohammed et al., 2018)



02

Design Space

Of combining 2D and 3D visualizations

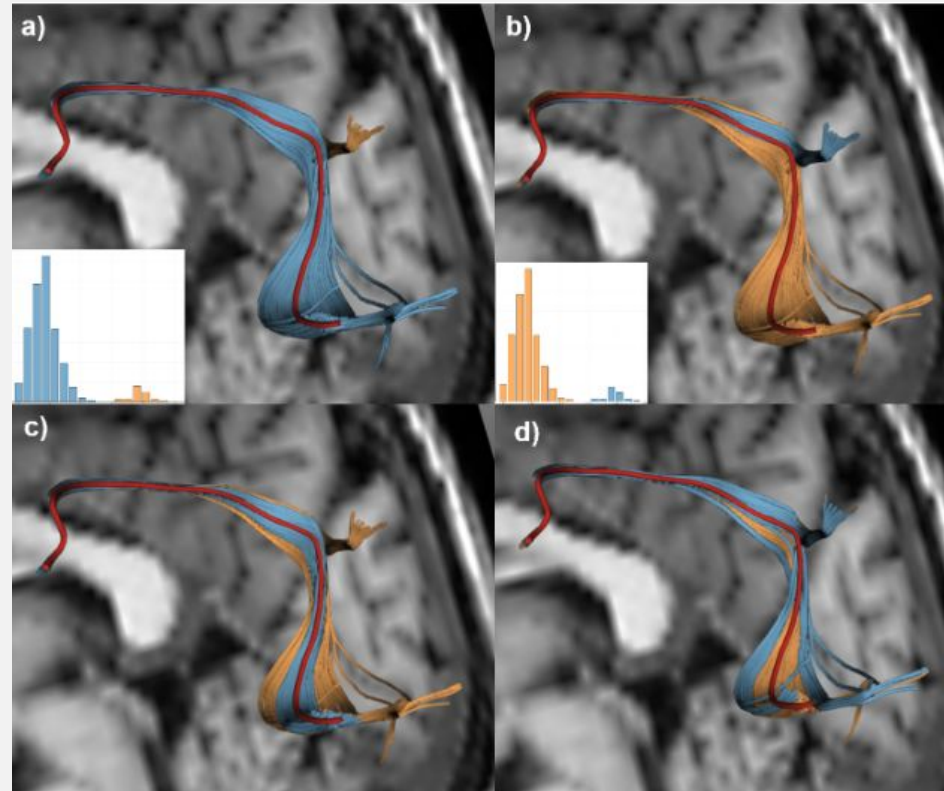
Layout *Of representations*

2D
3D

Compounded *Layouts use the same display space*

2D
3D

Superimposed *Layouts where representations are rendered on top of one another*



(Siddiqui et al., 2021)



02

Design Space

Of combining 2D and 3D visualizations

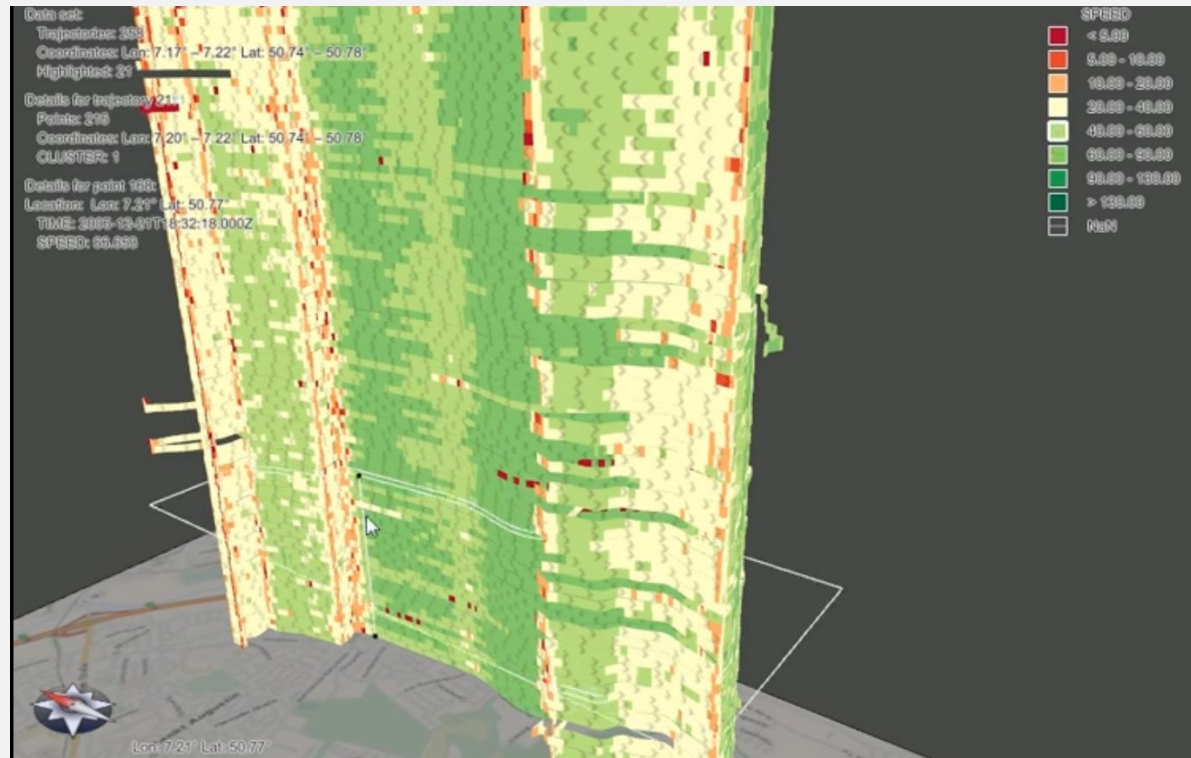
2D
3D

Compounded *Layouts use the same display space*

2D
3D

Embedded *Layouts position two representations in the exact same place*

Layout *Of representations*



(Tominski et al., 2012)





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Visually Connected



Interactively Connected



Animated



02

Design Space

Of combining 2D and 3D visualizations

Approach *For designing the links*

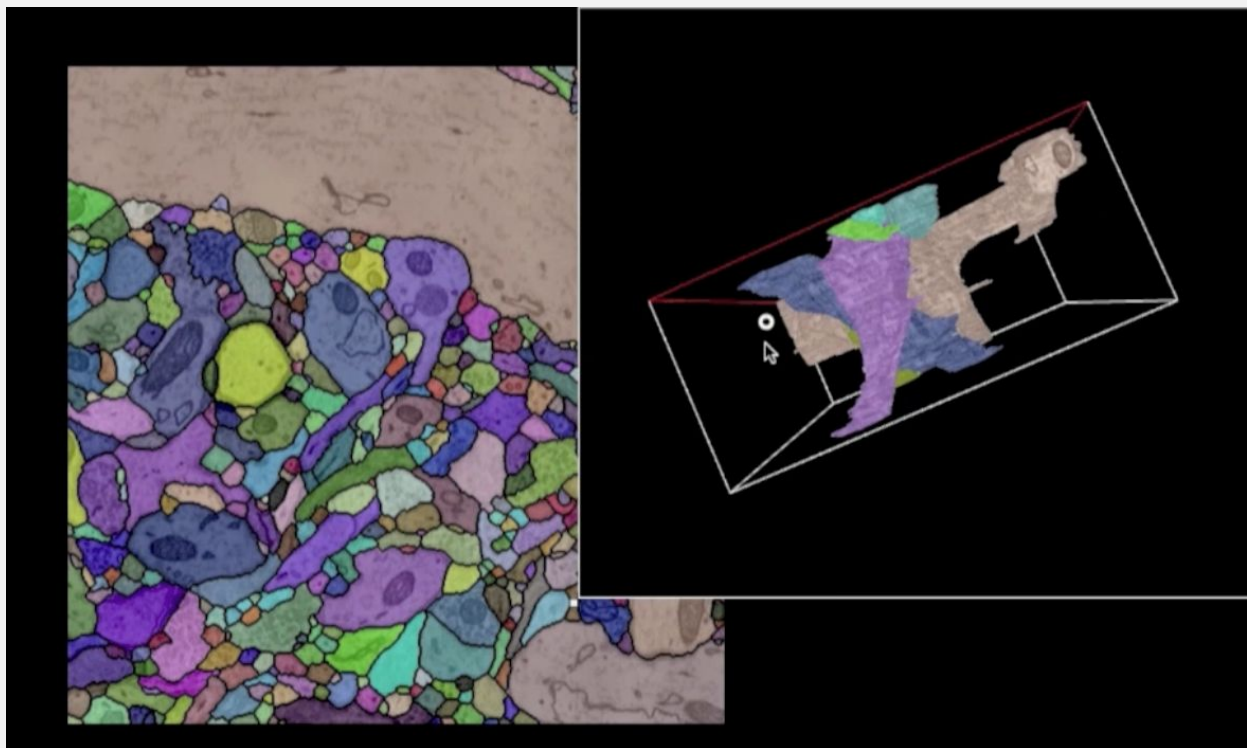


Visually Connected

Approaches highlight the relationships between representations visually



Color



(Haehn et al., 2014)



02

Design Space

Of combining 2D and 3D visualizations

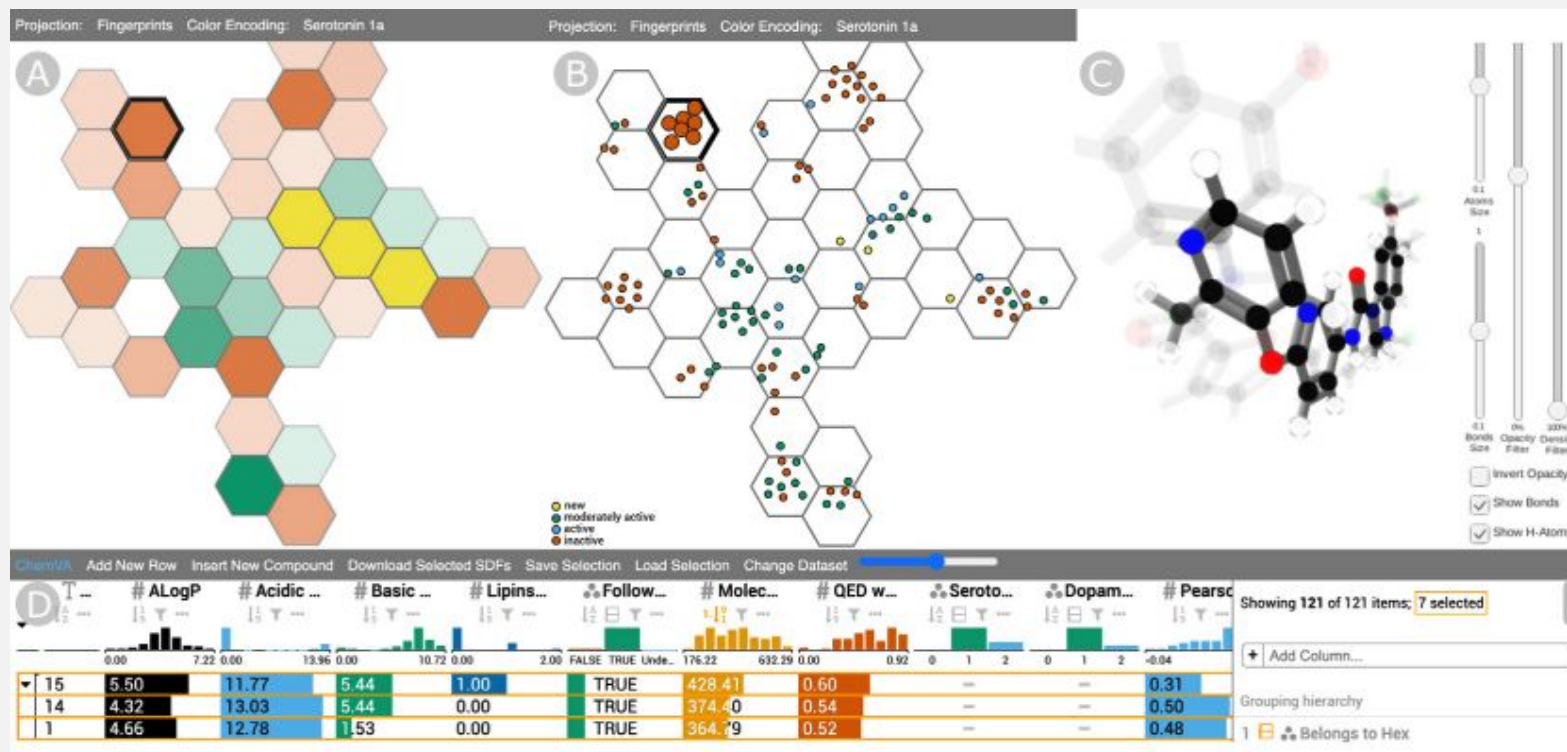
Approach For designing the links



Visually Connected Approaches highlight the relationships between representations visually



Position



(Sabando et al., 2021)



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Design Space

Of combining 2D and 3D visualizations

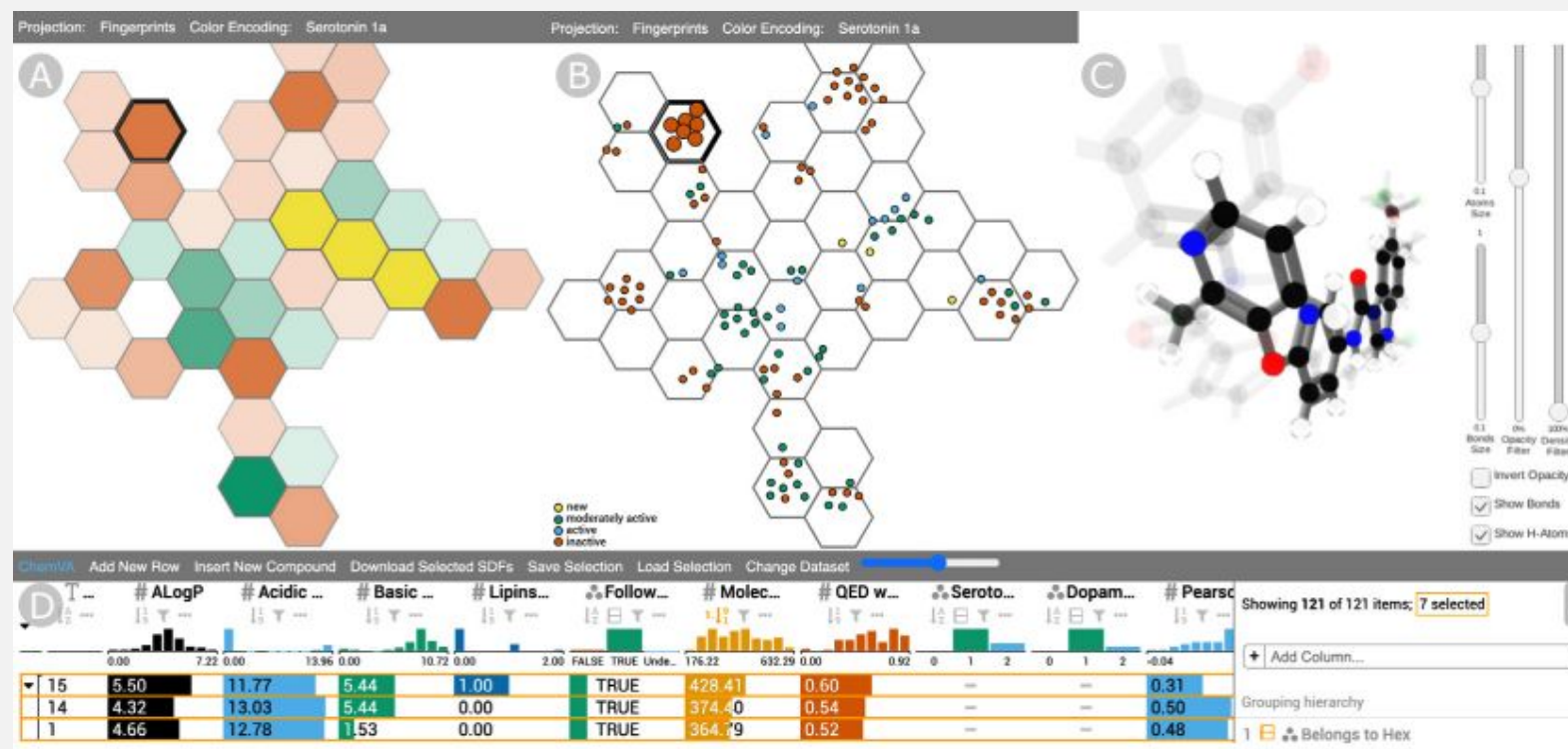
Approach For designing the links



Visually Connected Approaches highlight the relationships between representations visually



Shape



(Sabando et al., 2021)



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Design Space

Of combining 2D and 3D visualizations

Approach For designing the links

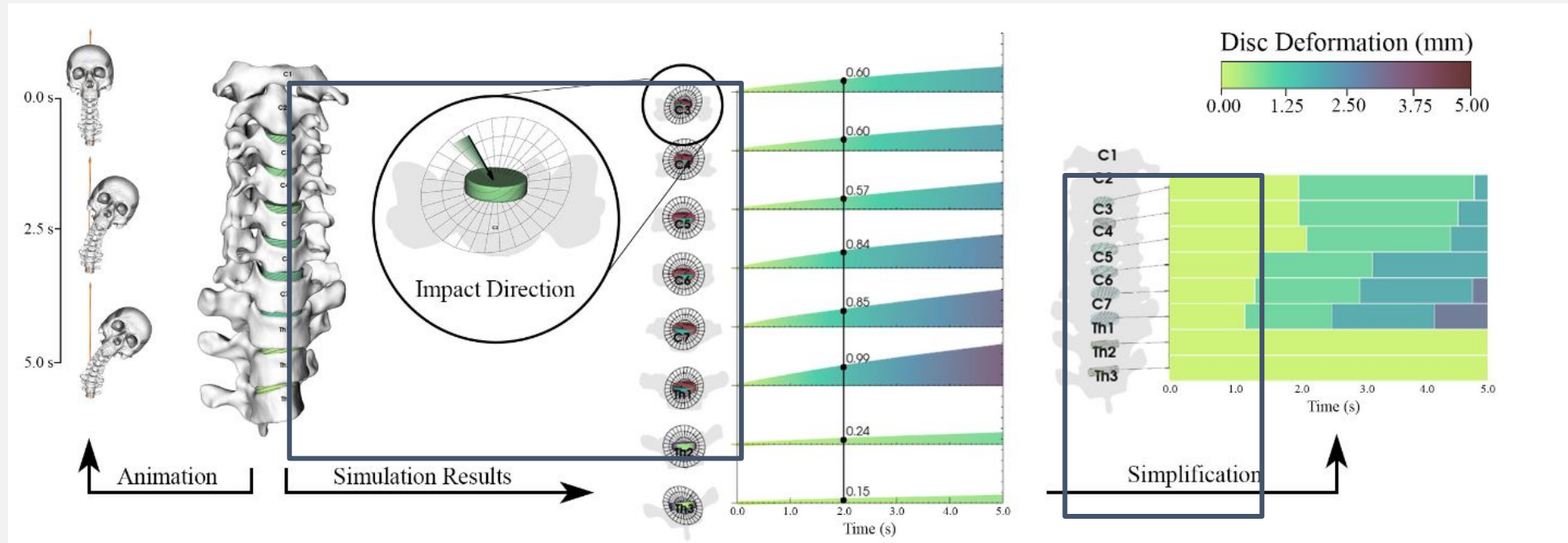


Visually Connected

Approaches highlight the relationships between representations visually



Guides



(Eulzer et al., 2021)



02

Design Space

Of combining 2D and 3D visualizations

Approach For designing the links



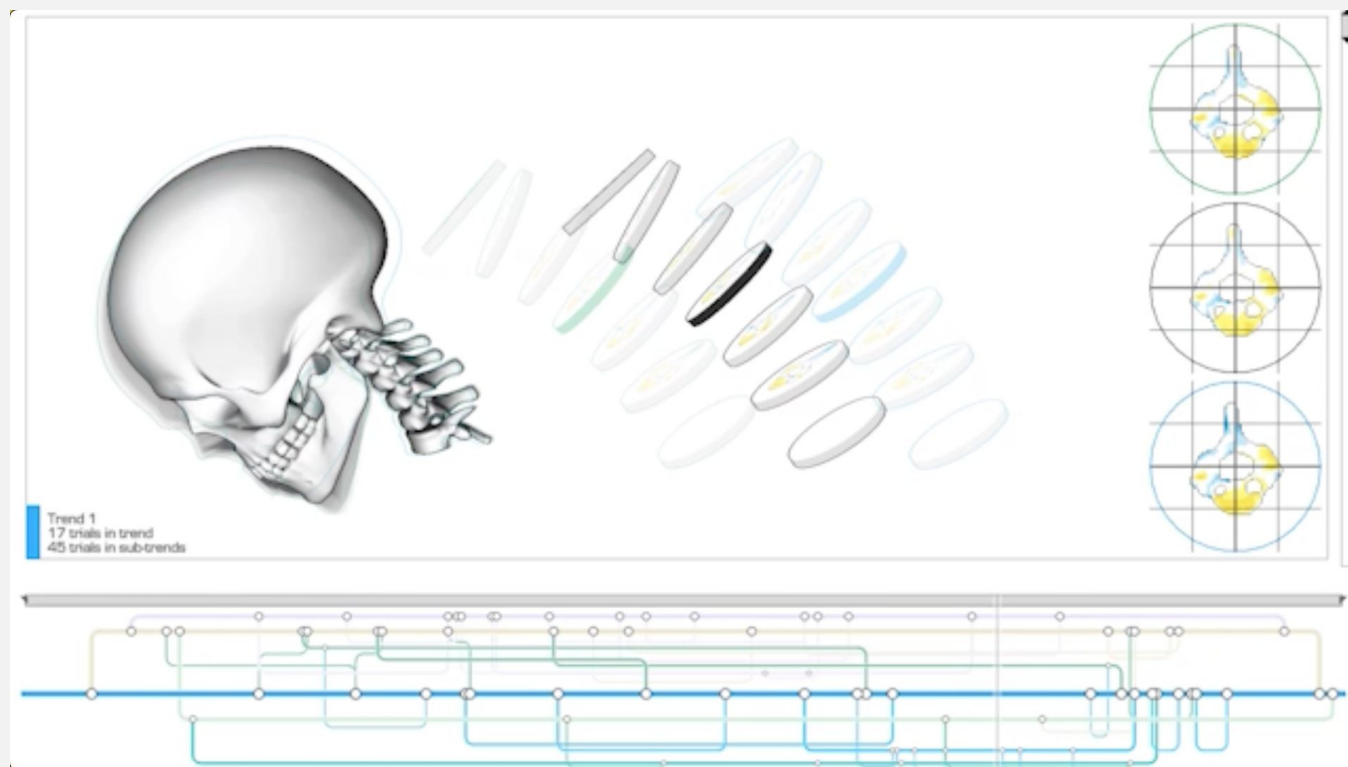
Interactively Connected

Approaches allow viewers to interact with one representation and get feedback from another

2D → 3D



2D Control 3D



(Schroeder et al., 2014)



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02

Design Space

Of combining 2D and 3D visualizations

Approach For designing the links



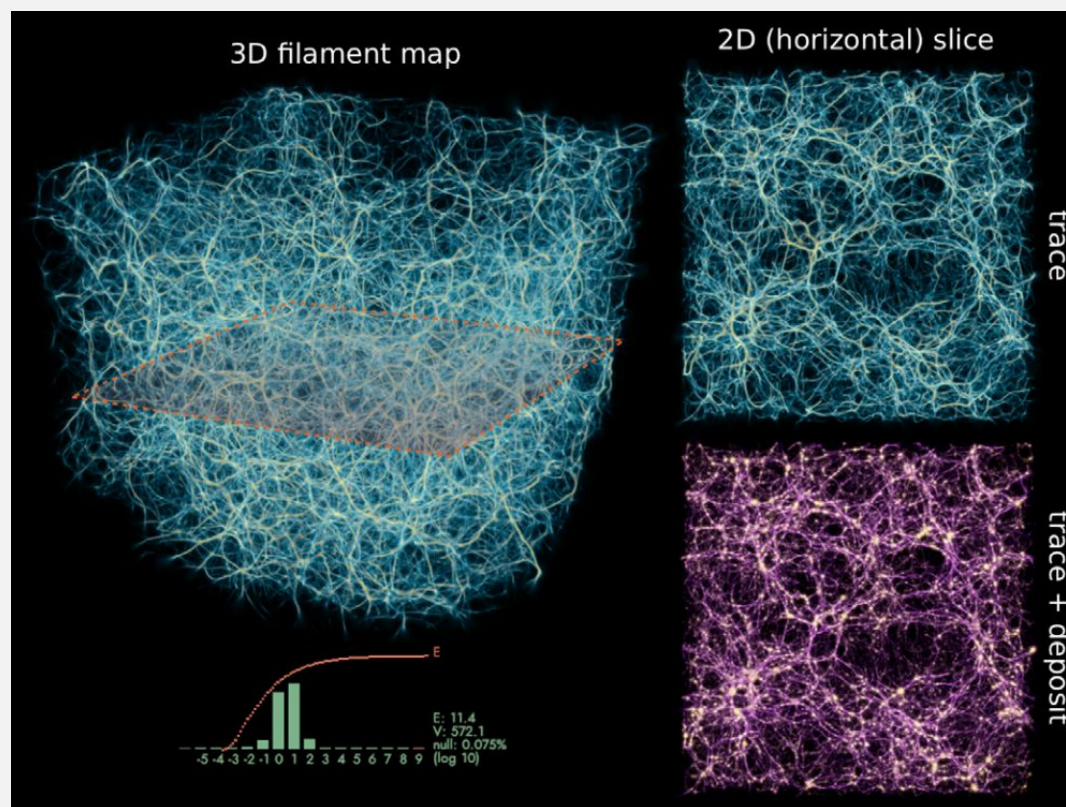
Interactively Connected

Approaches allow viewers to interact with one representation and get feedback from another

2D ← 3D



3D Control 2D



(Elek et al., 2021)



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02

Design Space

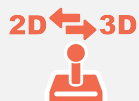
Of combining 2D and 3D visualizations

Approach For designing the links

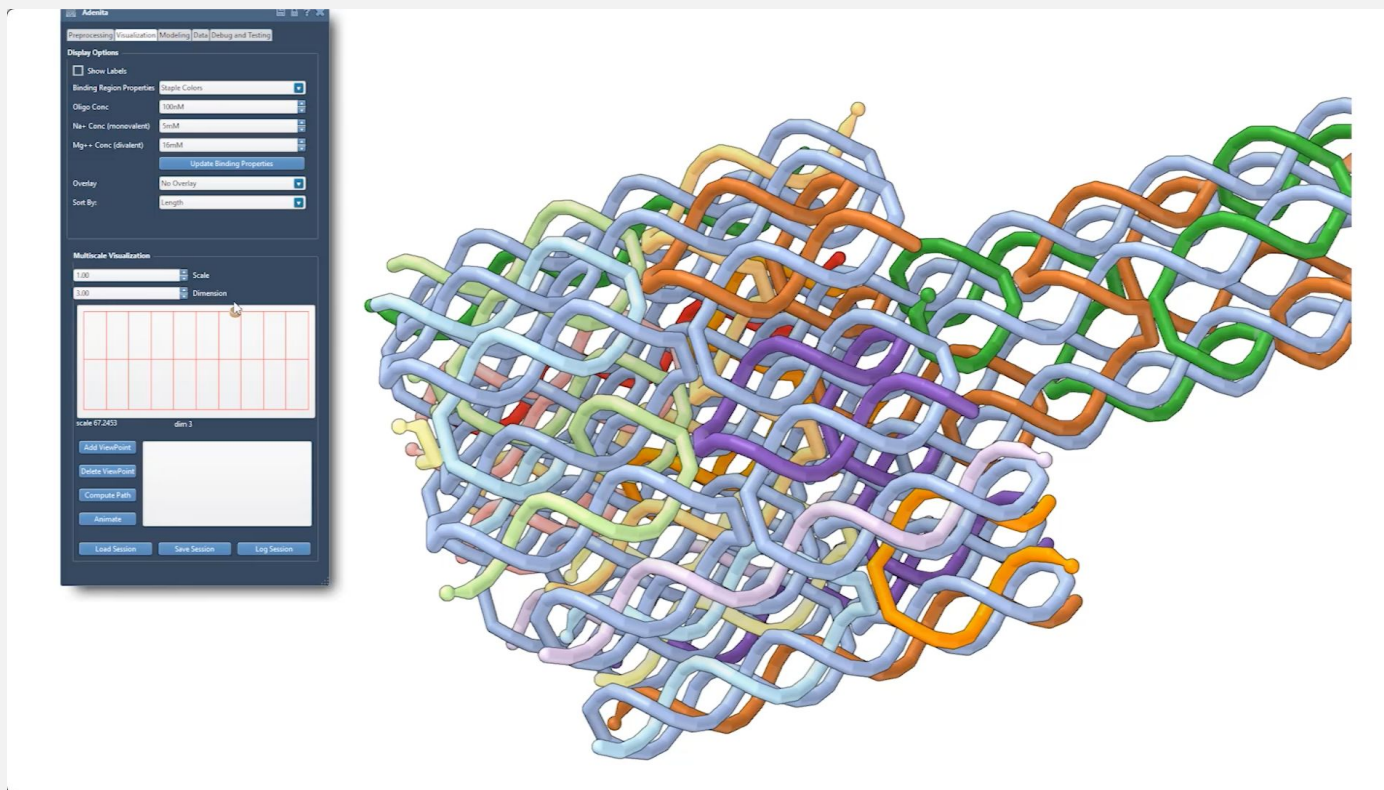


Interactively Connected

Approaches allow viewers to interact with one representation and get feedback from another



Bidirectional



(Miao et al., 2018)



02

Design Space

Of combining 2D and 3D visualizations

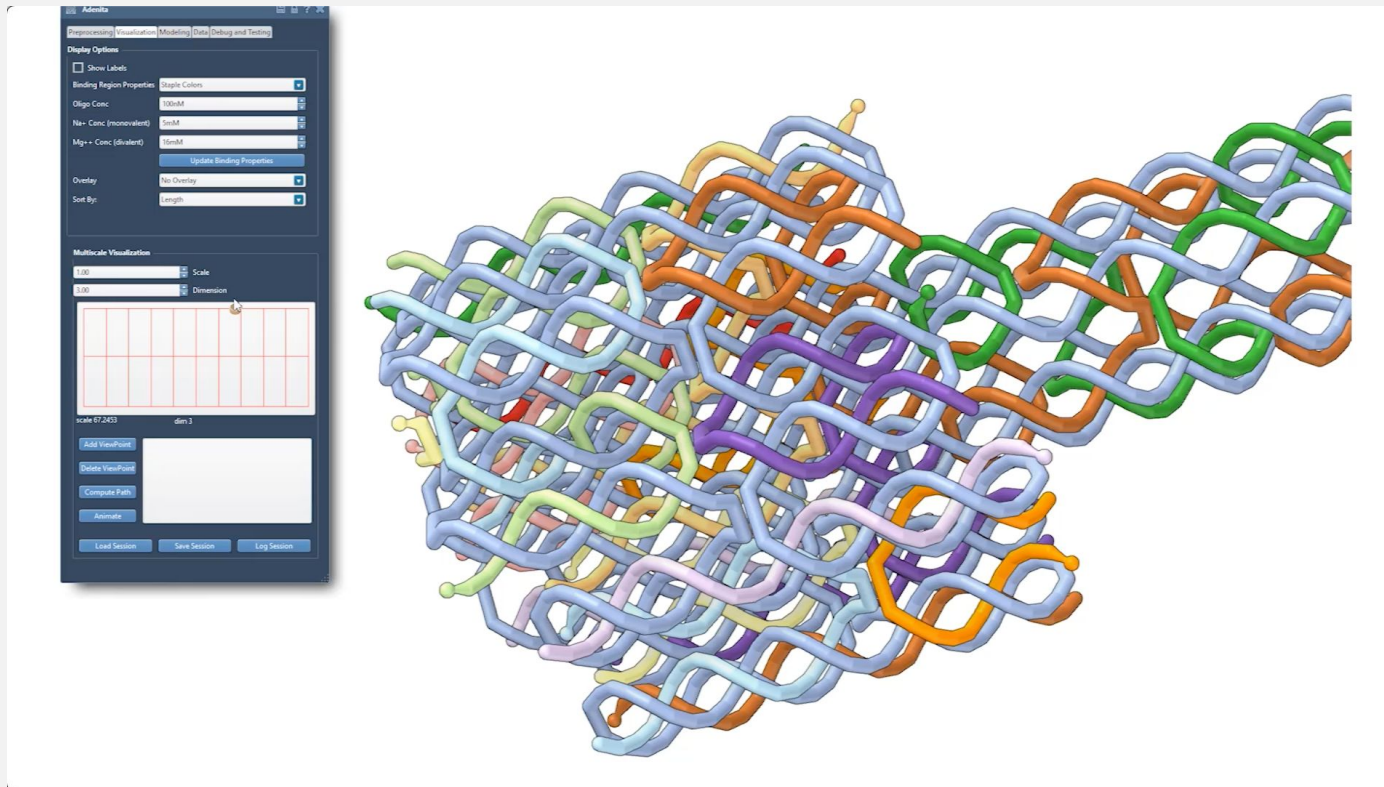
Approach For designing the links



Animated Linked approaches via animation



Transformation Animated approaches transit one representation to another



(Miao et al., 2018)





02

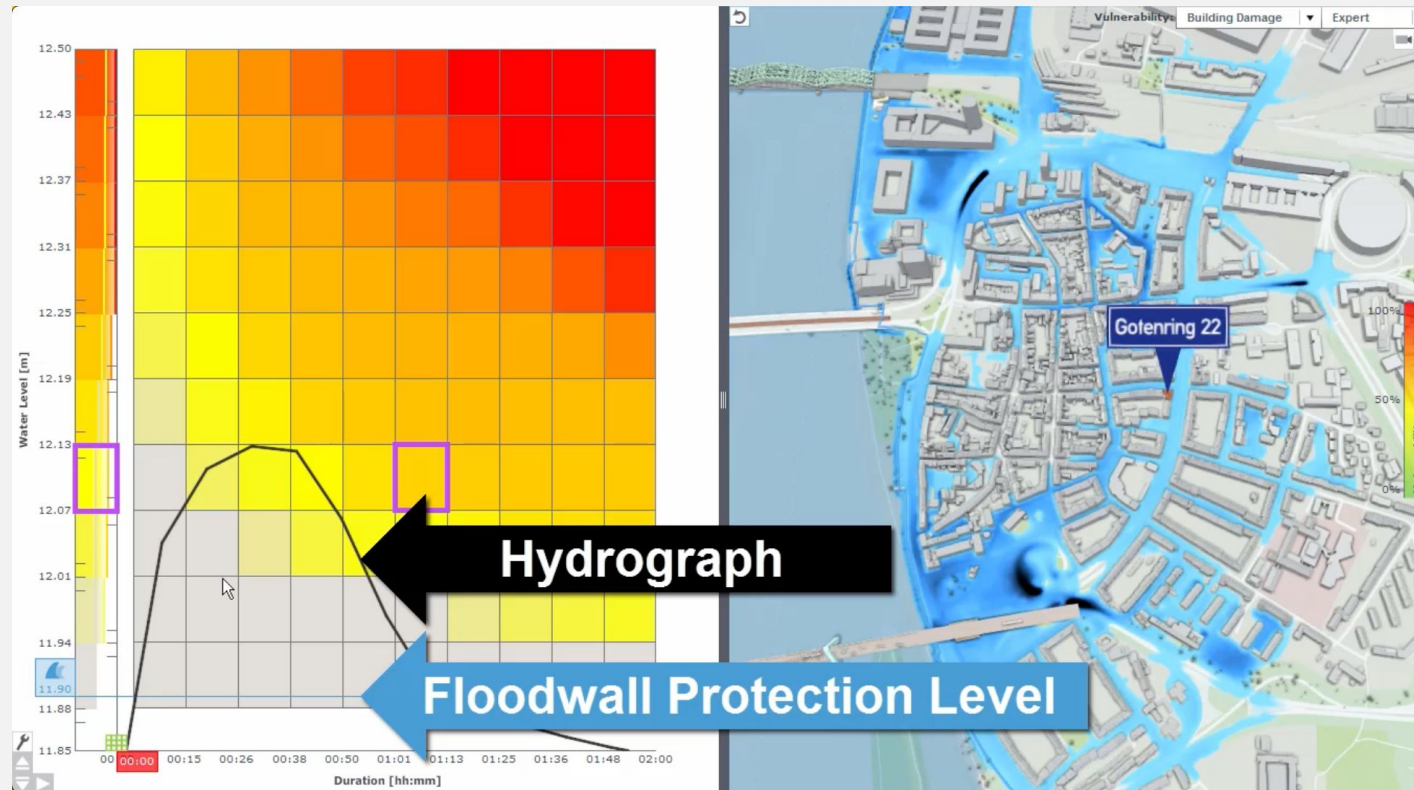
Design Space

Of combining 2D and 3D visualizations

Approach For designing the links

 **Animated** Linked approaches via animation

 **Modification** Animated approaches allow viewers to interact with one component



(Cornel et al., 2015)



03

Takeaways *From our work*

Determine if the proposed link is the best for the current display environment.



- Desktop & Mixed Reality Large 3D Spatial Datasets
- Desktop & Tangible System Edutainment Purposes
- Mixed Reality & Tangible System Enhance Data Understanding




03

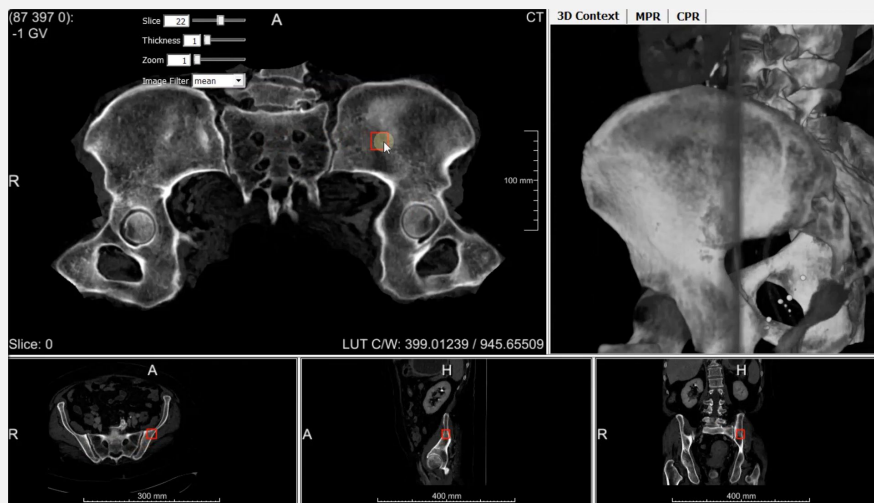
Takeaways *From our work*

Design an appropriate Layout.


Both representations are needed for tasks.

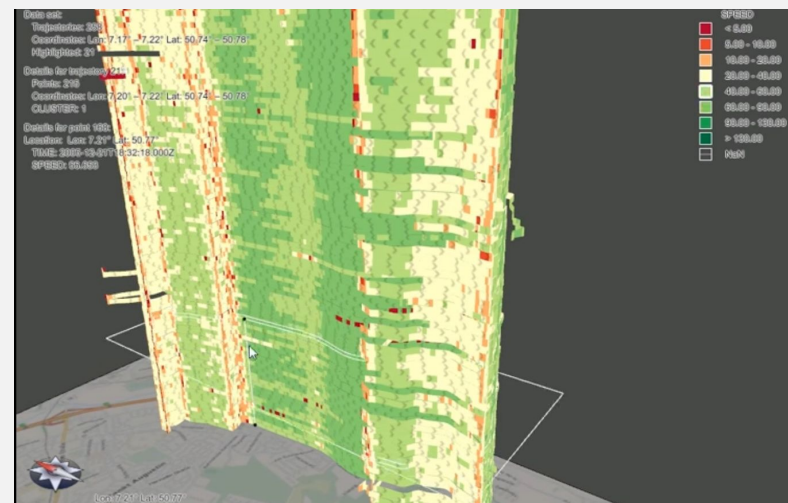
Emphasize the position.

 Juxtaposed



(Kretschmer et al., 2014)

 Embedded



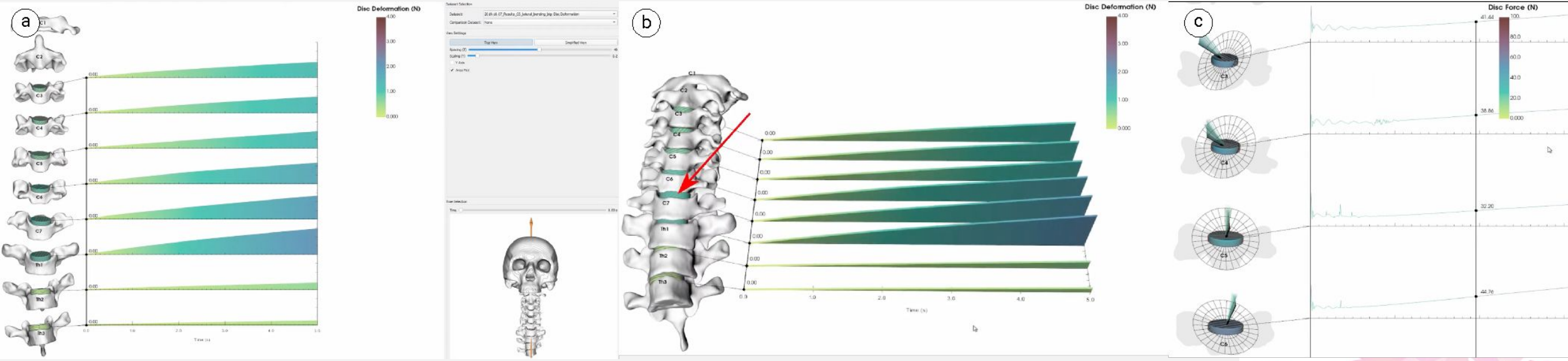
(Tominski et al., 2012)



03

Takeaways From our work

Adding multiple approaches to link 2D and 3D representations



(Eulzer et al., 2021)



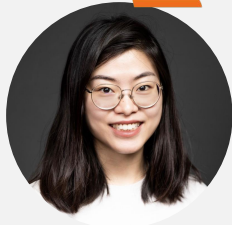
A Survey of Designs for Combined 2D+3D Visual Representations



Thank You for Your Attention!

- Examine whether one representation is enough for the tasks.
- Determine if the proposed link is the best for the current display environment.
- Design an appropriate Layout.
- Adding multiple approaches to link 2D and 3D representations.

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