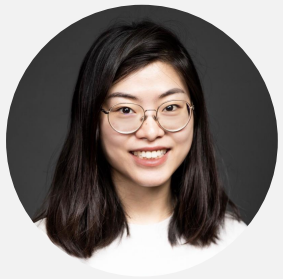
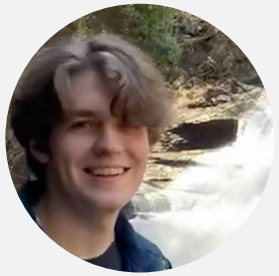
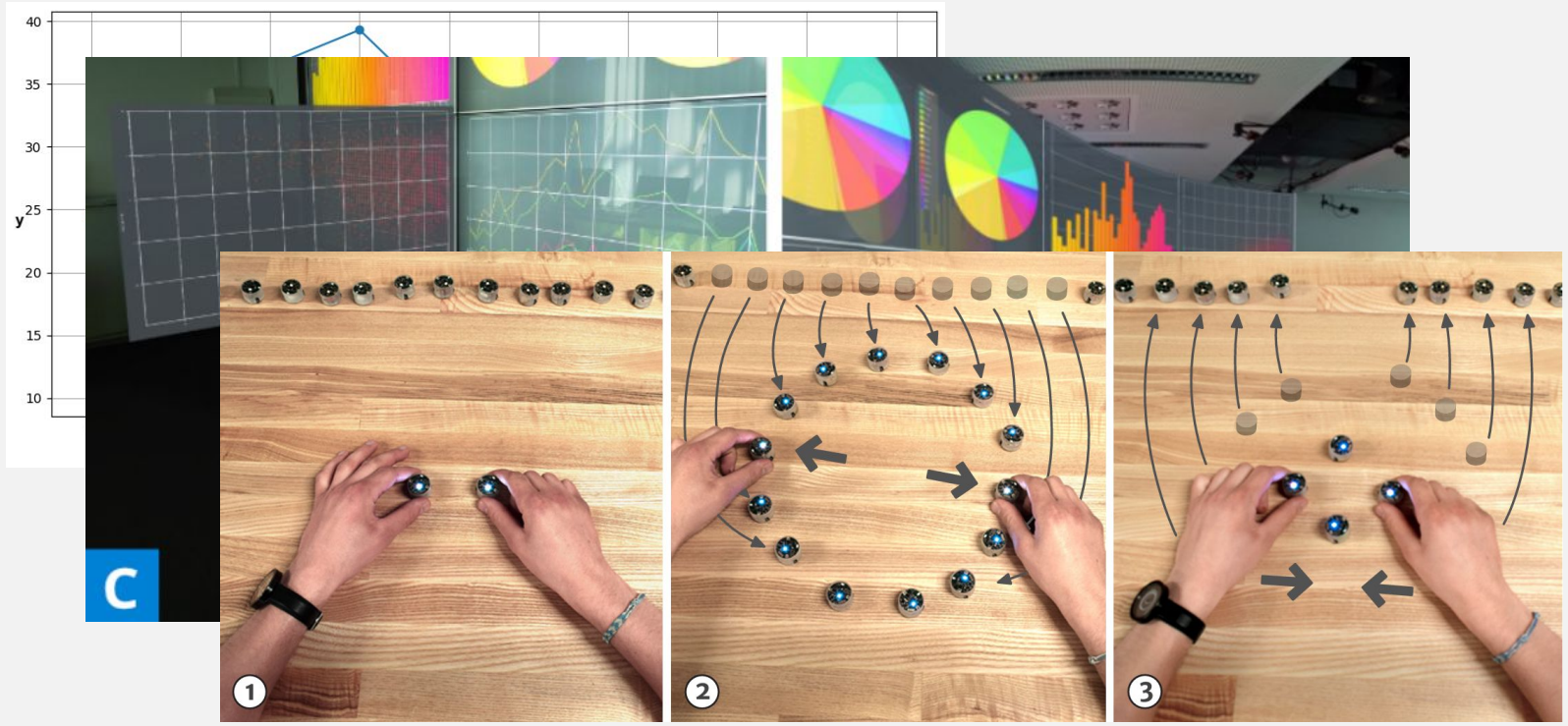
A Survey of Designs for Combined 2D+3D Visual Representations

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

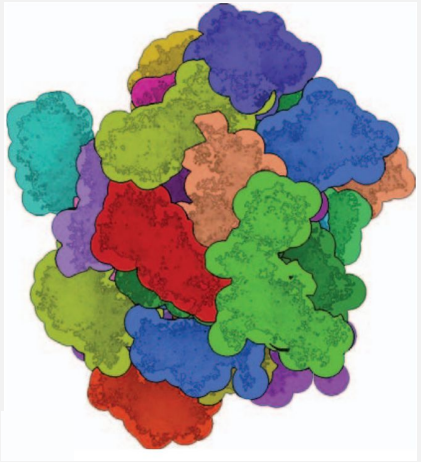
01 Background *Of 2D and 3D visual representations*



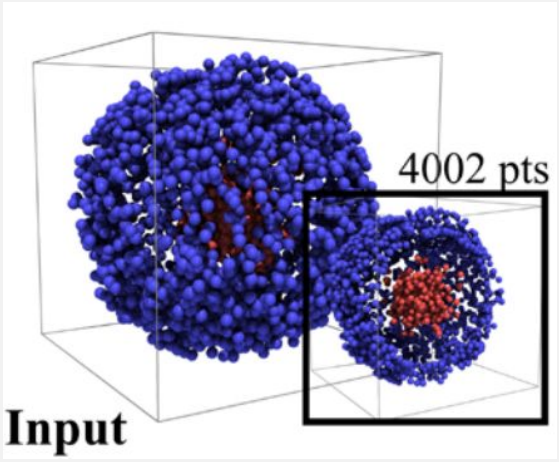
(Goc et al., 2016)

2D Visual Representation

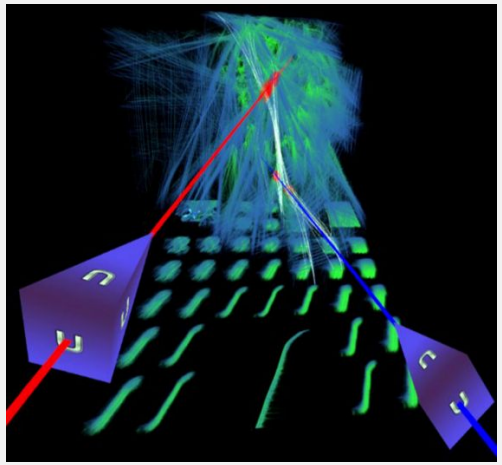
01 Background *Of 2D and 3D visual representations*



DNA structure
(Halladjian et al., 2020)



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



VR
(Hurter et al., 2019)

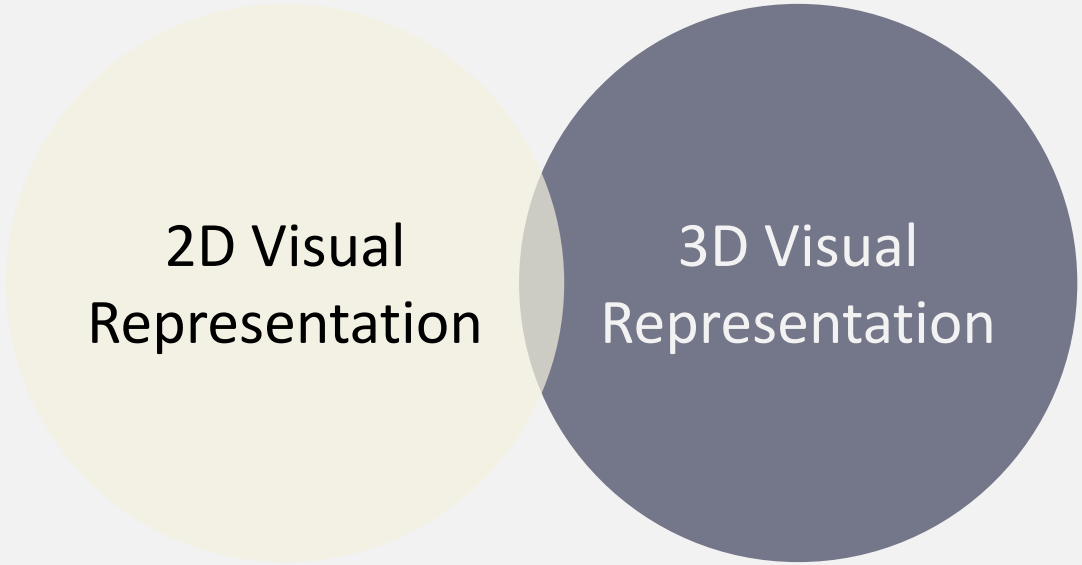
3D Visual Representation

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

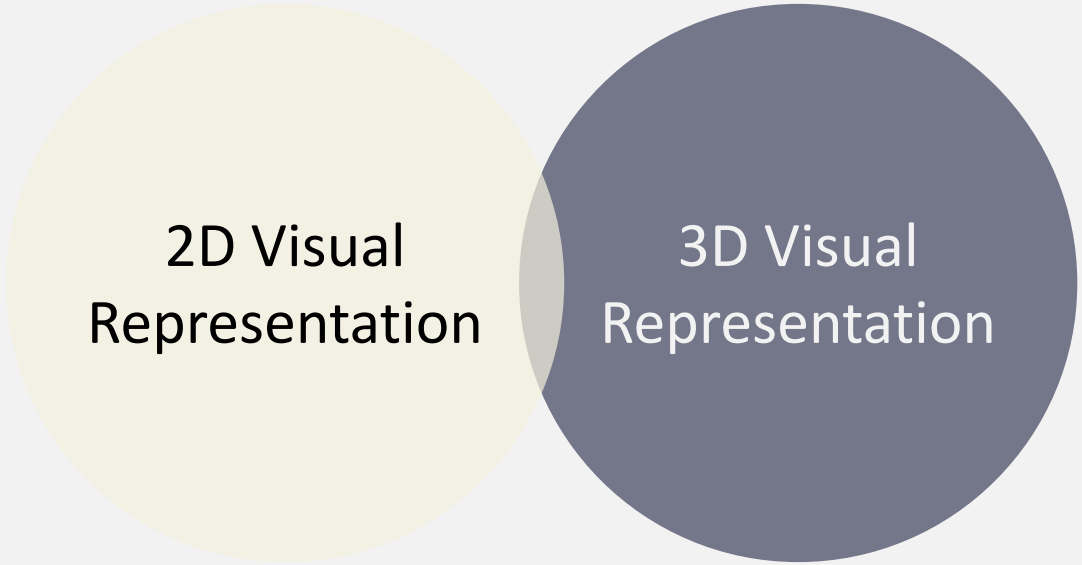
2D Visual Representation

3D Visual Representation

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

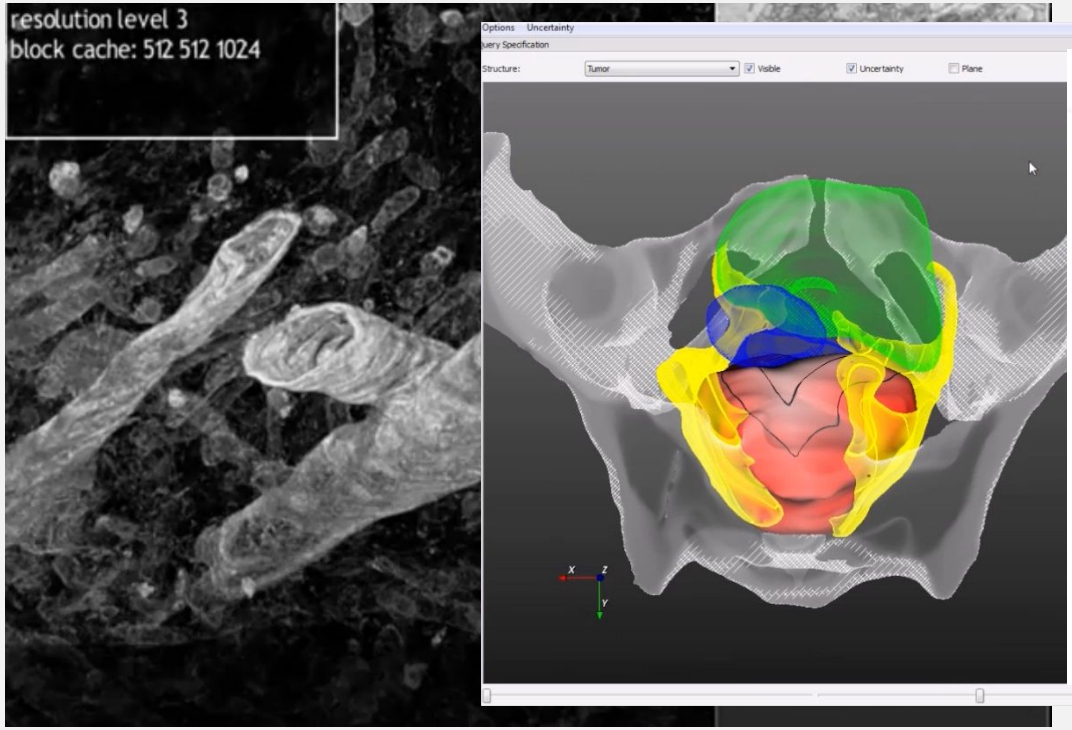


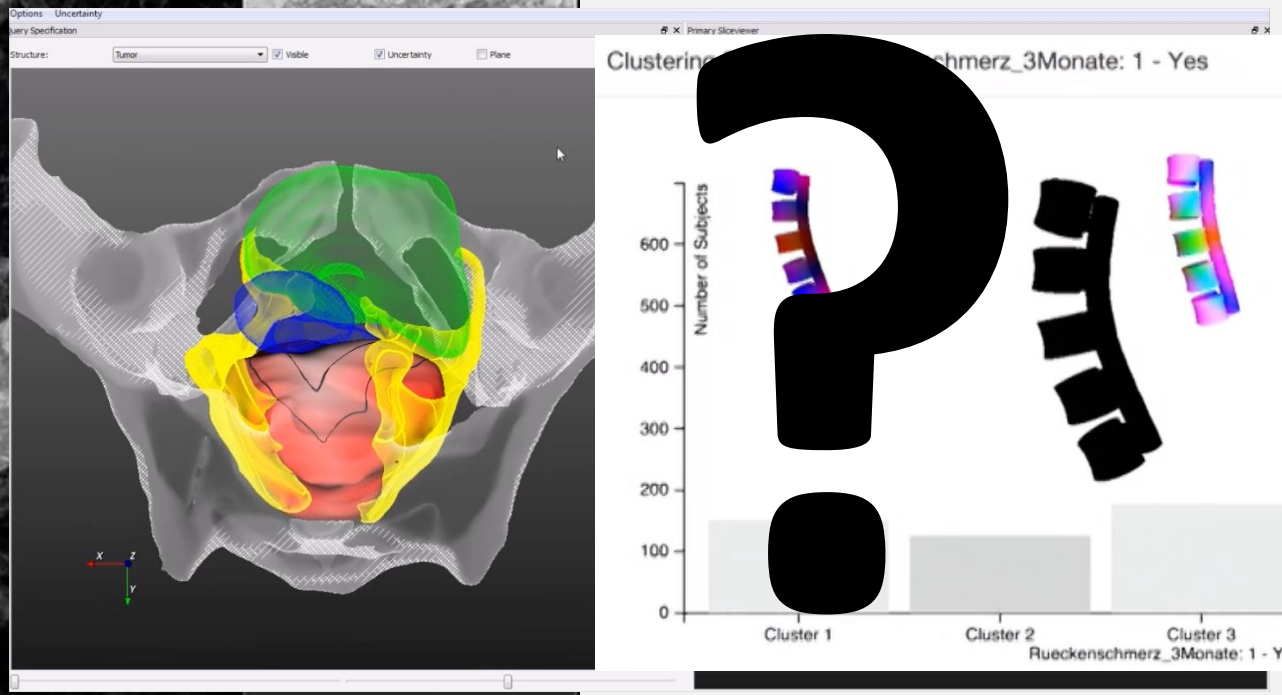
01 Background *Of 2D and 3D visual representations*



2D Visual Representation

3D Visual Representation





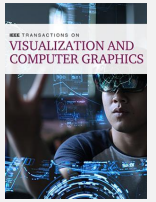
(Hadwiger et al., 2012)

(Smit et al., 2017)

(Klemm et al., 2014)

IEEE VIS

EuroVis



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Papers from ~~2012 to 2022~~

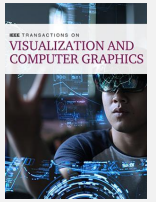
Why

Where

How

IEEE VIS

EuroVis



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105 Papers from 2012 to 2022

Why

Motivation

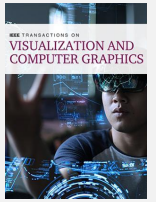
For linking representations

Where

How

IEEE VIS

EuroVis



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Motivation

For linking representations

Display Environment

To contain representations

Where

How

IEEE VIS

EuroVis

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Motivation

For linking representations

Display Environment

To contain representations

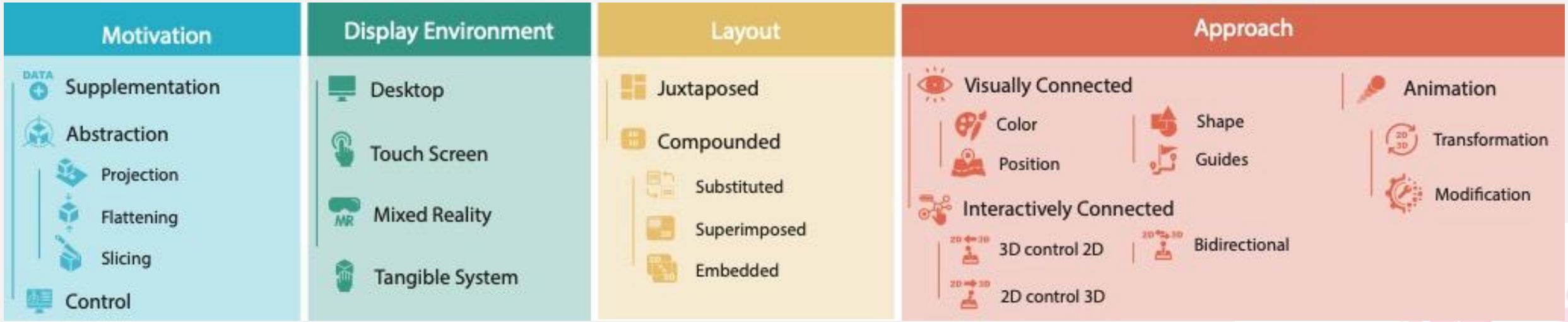
Layout

Of representations

Approach

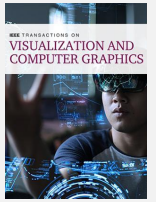
For interacting with the links

2D+3D Design Space



IEEE VIS

EuroVis



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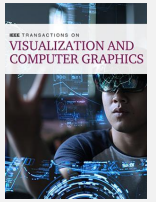
IEEE VIS

EuroVis



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Motivation

For linking representations

- Supplementation
- Abstraction
- Control

Display Environment

To contain representations

Layout

Of representations

Approach

For interacting with the links

02

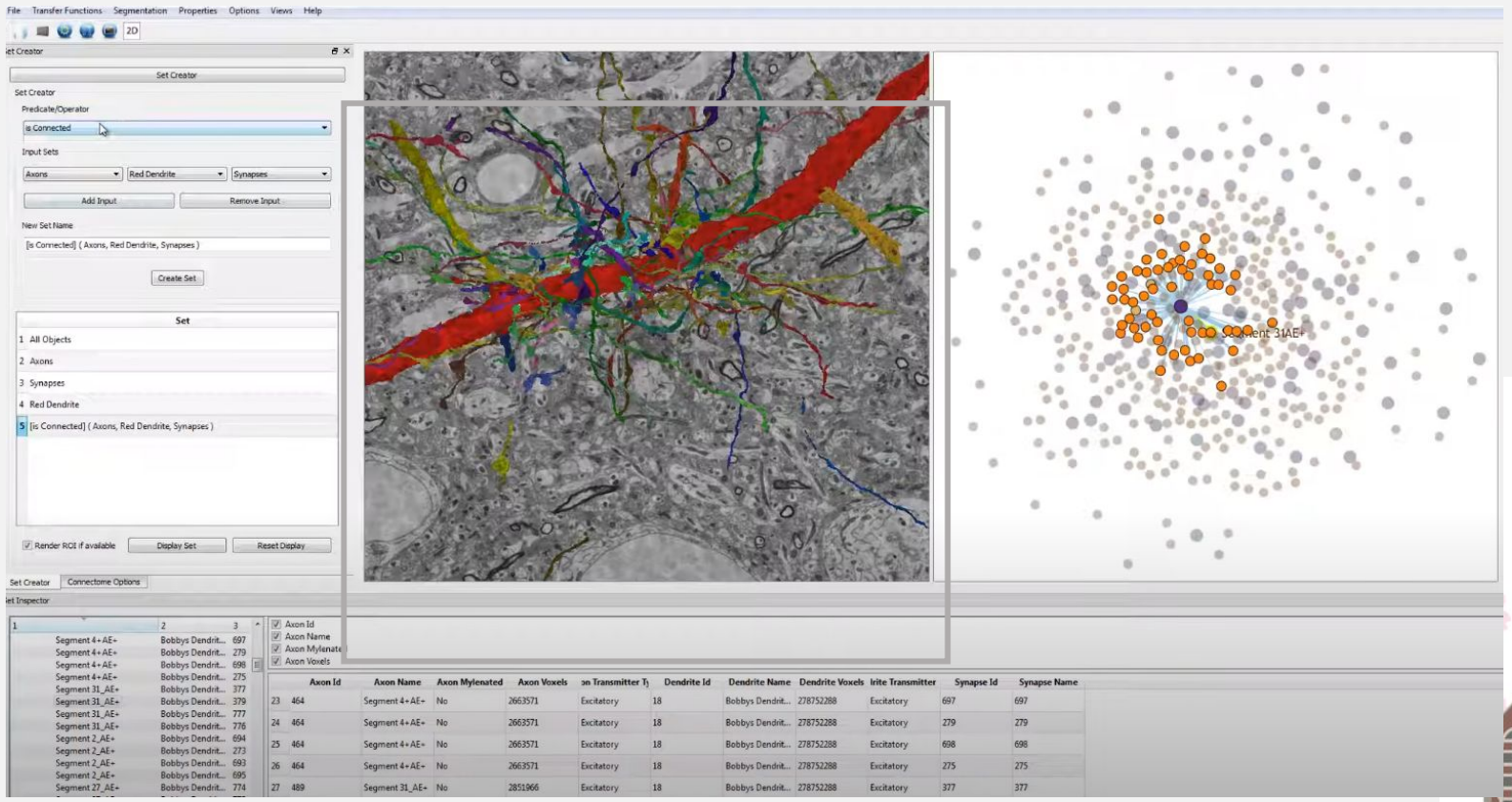
Design Space

Of combining 2D and 3D visualizations

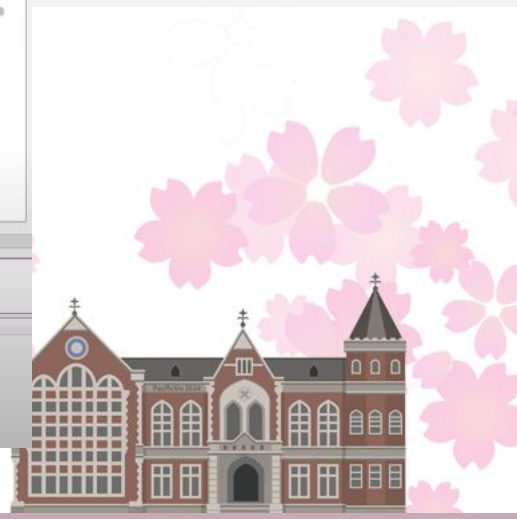
Motivation *For linking representations*

DATA +

Supplementation *Add information to one representation*



(Beyer et al., 2013)



02

Design Space

Of combining 2D and 3D visualizations

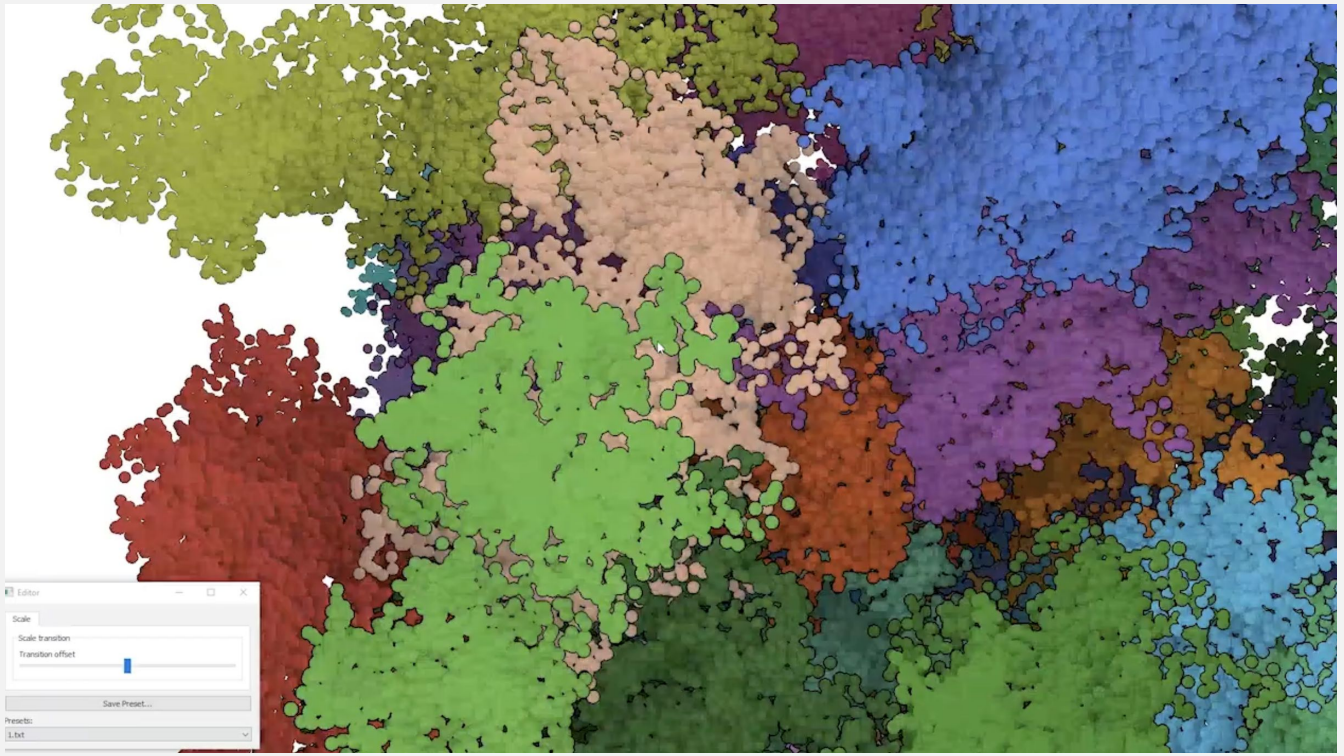
Motivation *For linking representations*

Abstraction

Where the 2D representations are abstraction of 3D visualizations

Projection

Reduces the dimension count



(Halladjian et al., 2020)

02

Design Space

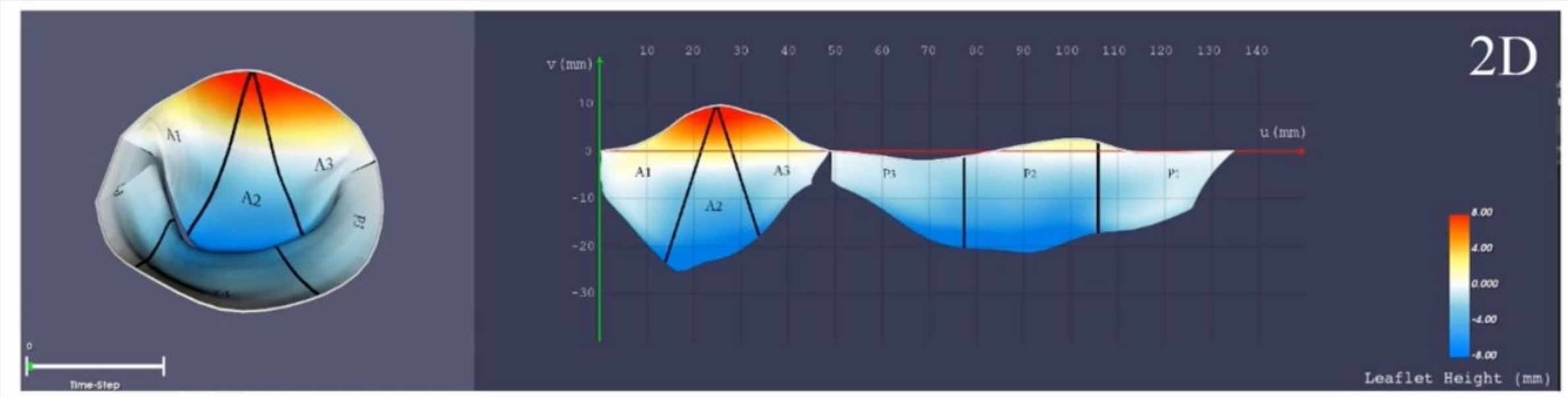
Of combining 2D and 3D visualizations

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

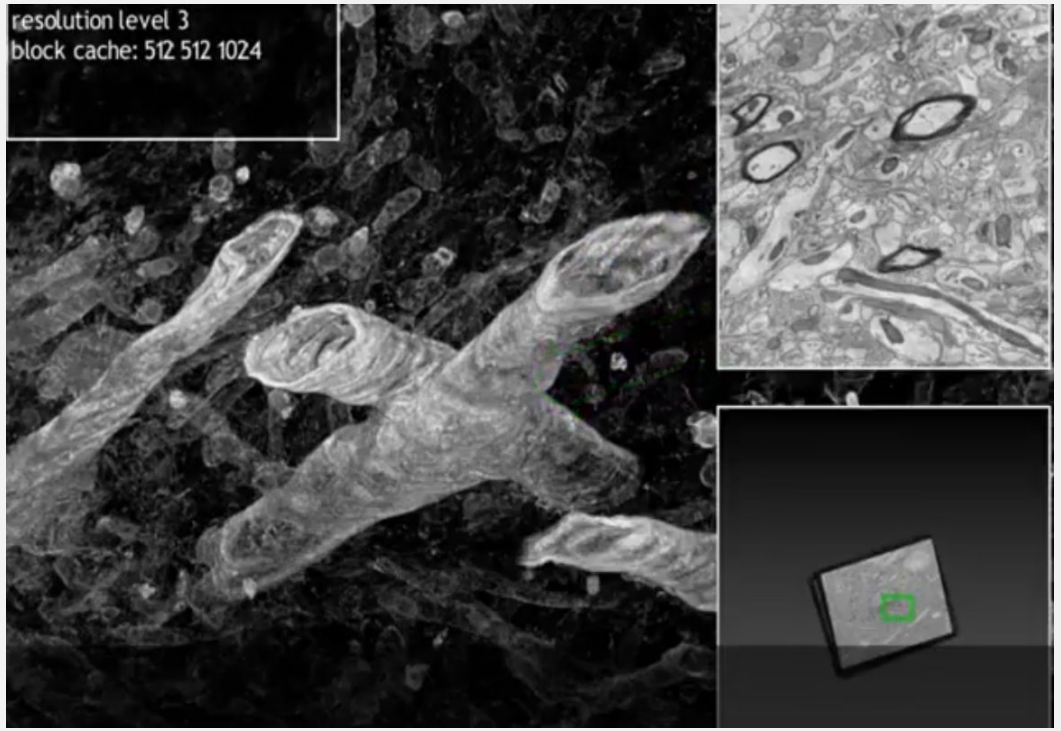
Motivation *For linking representations*

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

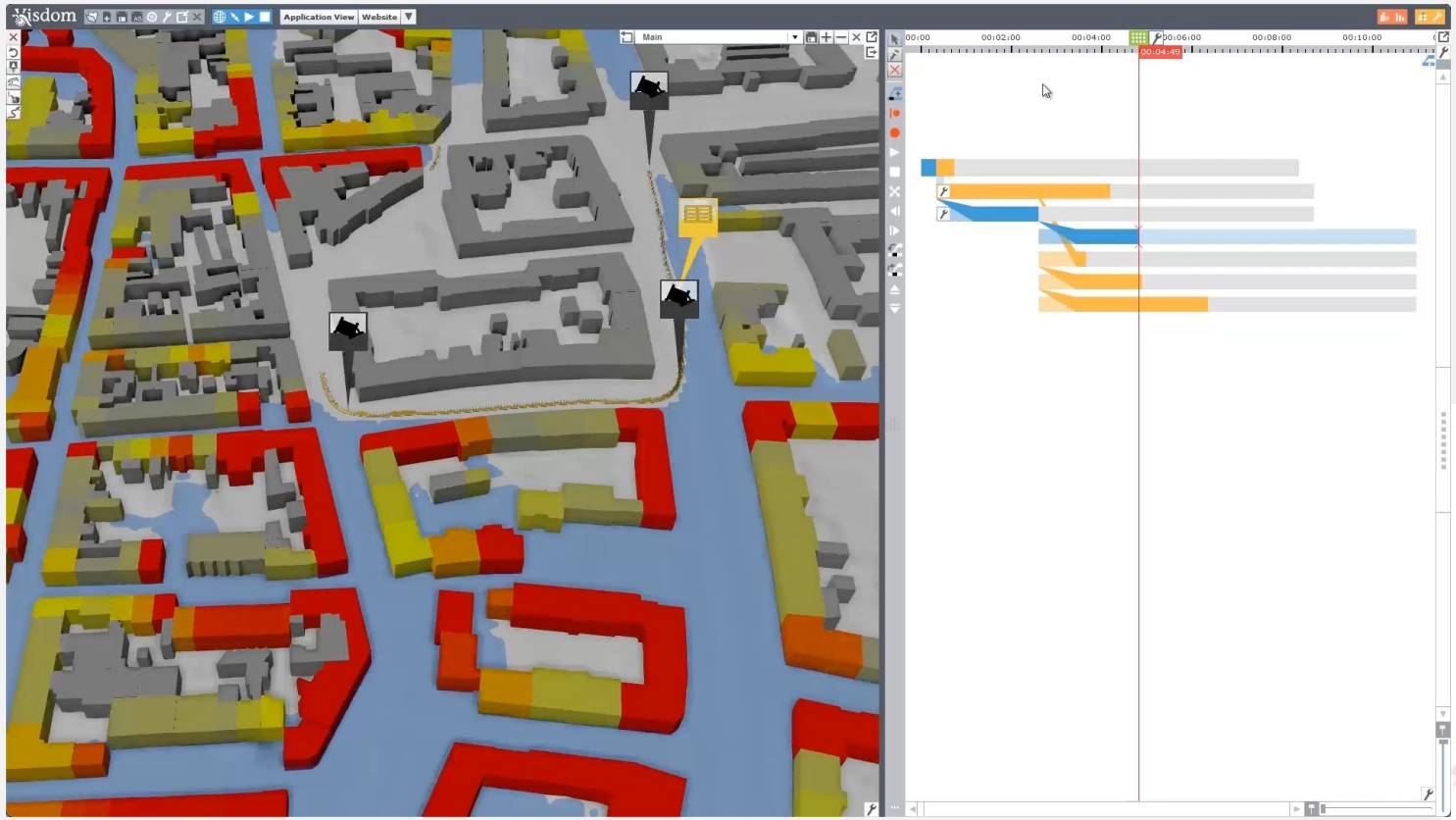
Design Space

Of combining 2D and 3D visualizations

Motivation *For linking representations*

Control

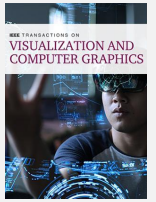
Where one representation was designed to control other representations



(Waser et al., 2014)

IEEE VIS

EuroVis



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105 Papers from 2012 to 2022

Motivation

For linking representations

Display Environment

To contain representations

Layout

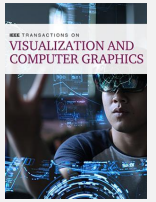
Of representations

Approach

For interacting with the links

IEEE VIS

EuroVis



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Motivation

For linking representations

Display Environment

To contain representations

- Desktop
- Mixed Reality
- Touch Screen
- Tangible System

Layout

Of representations

Approach

For interacting with the links

02

Design Space

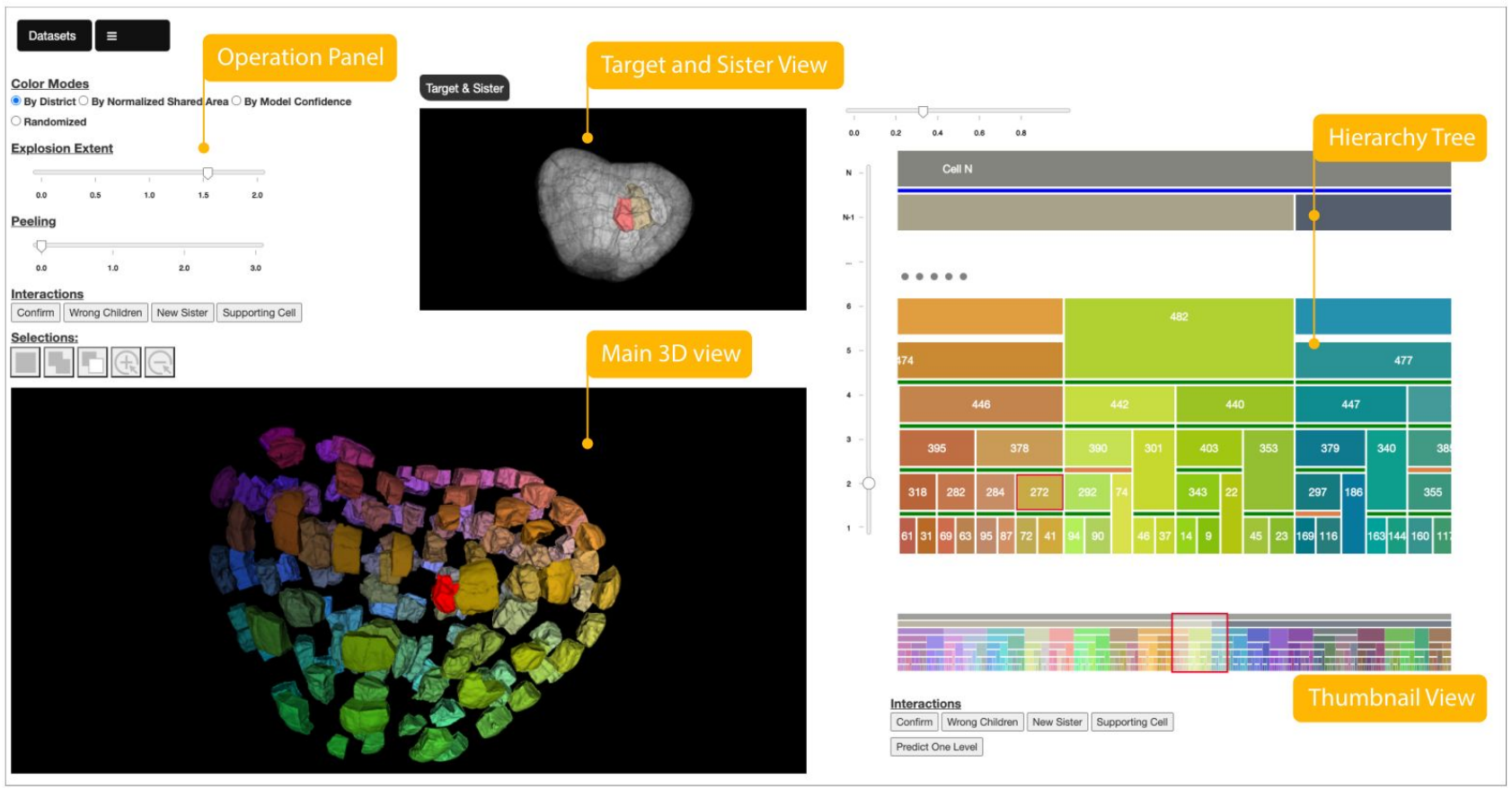
Of combining 2D and 3D visualizations

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

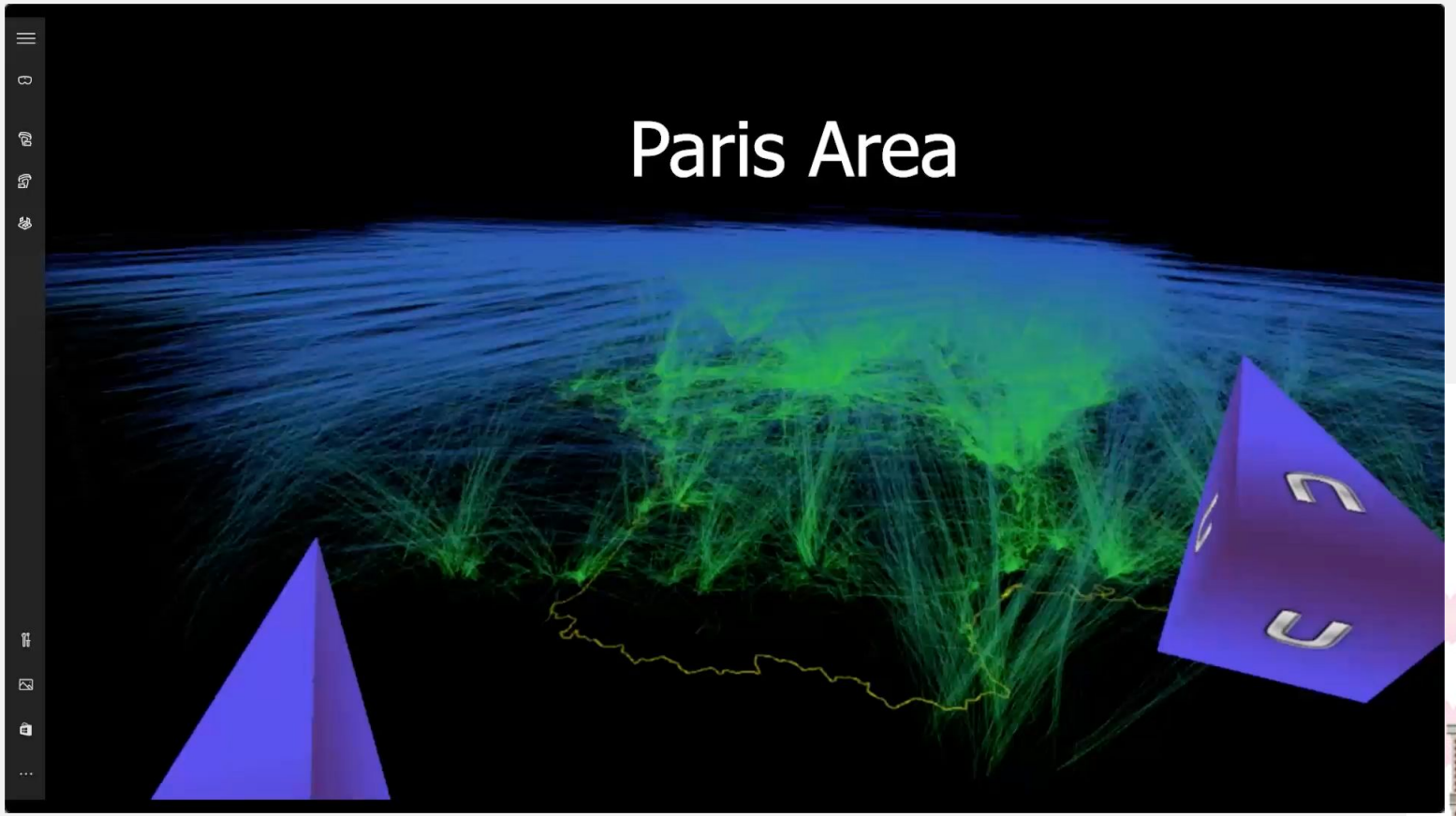
Display Environment

To contain representations

MR

Mixed Reality

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



(Hurter et al., 2019)

02

Design Space

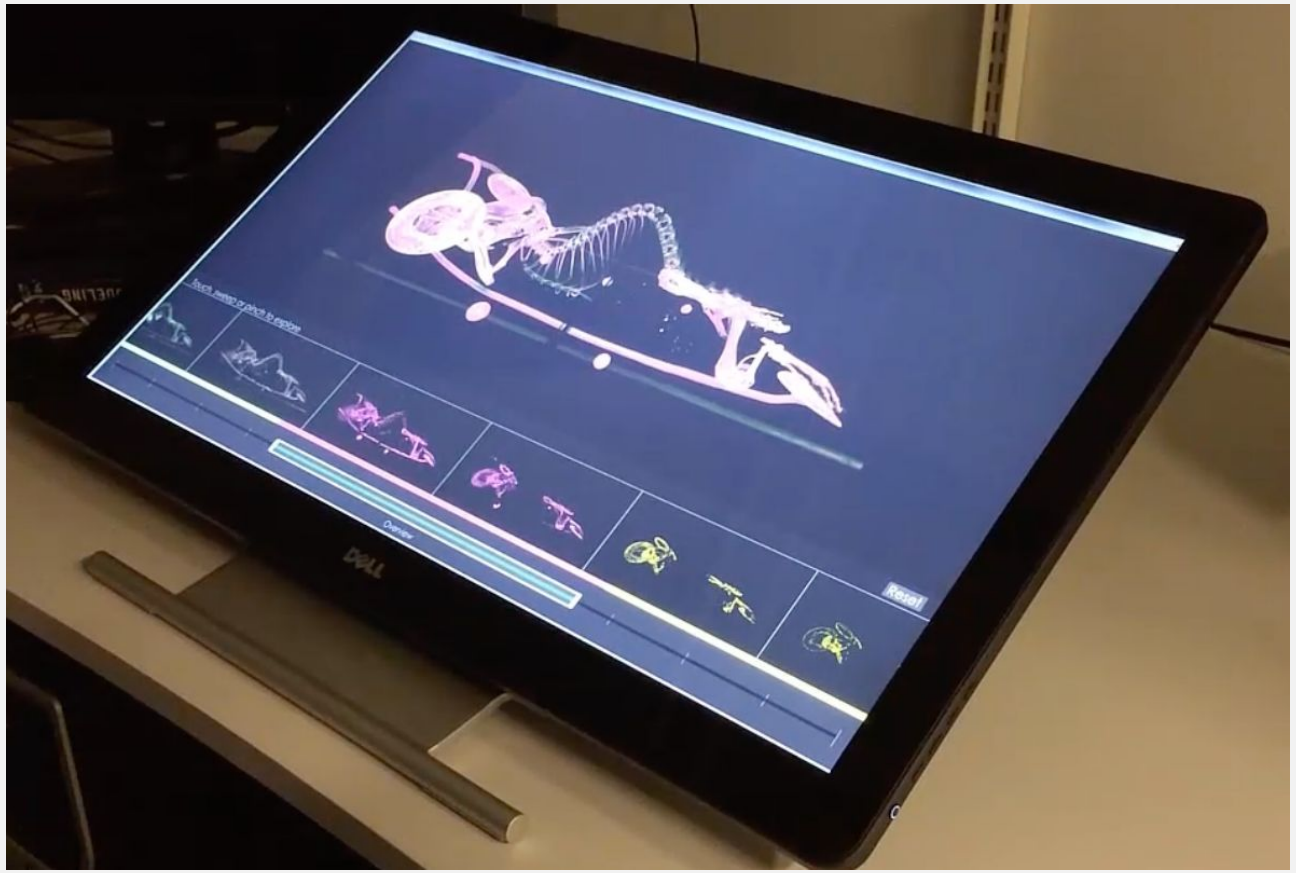
Of combining 2D and 3D visualizations

Display Environment

To contain representations

Touch Screen

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



(Jonsson et al., 2016)

02

Design Space

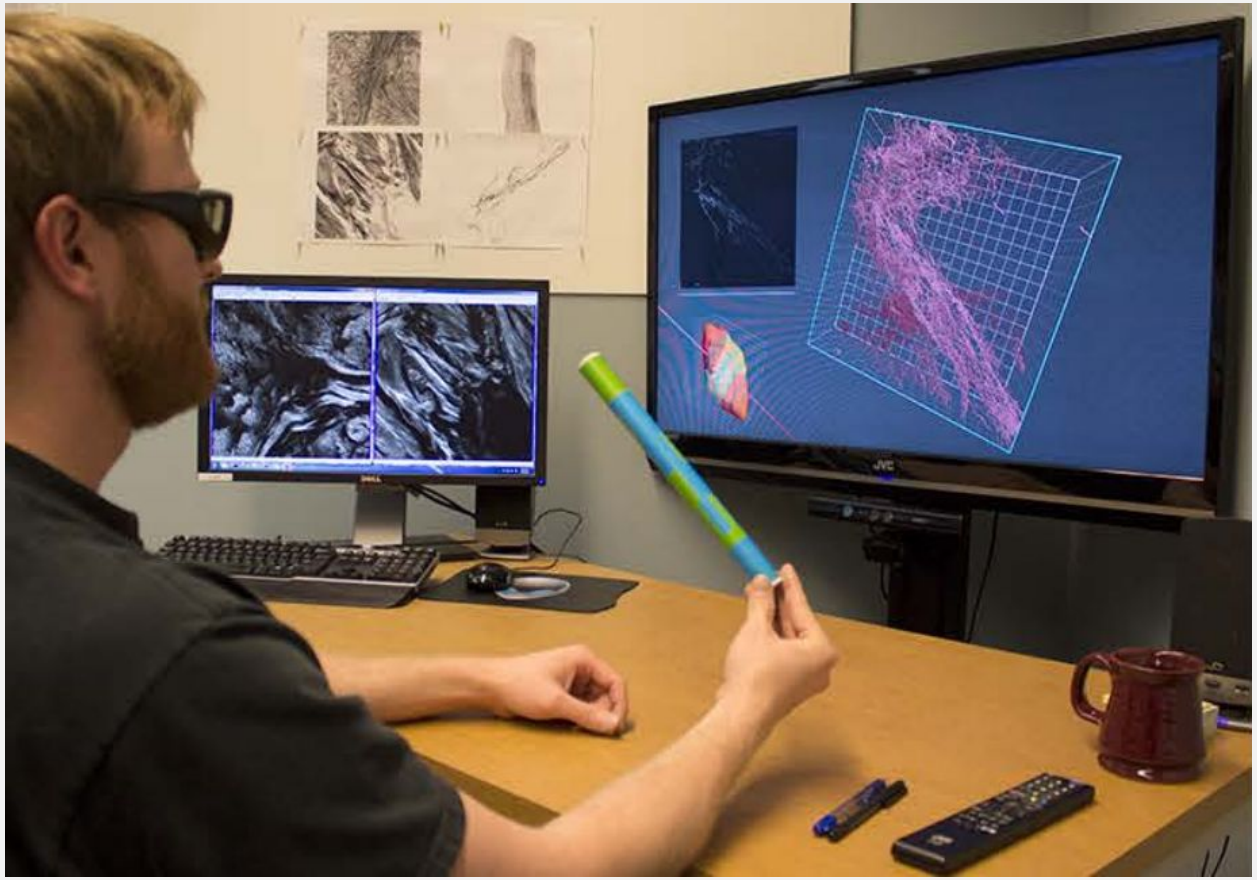
Of combining 2D and 3D visualizations

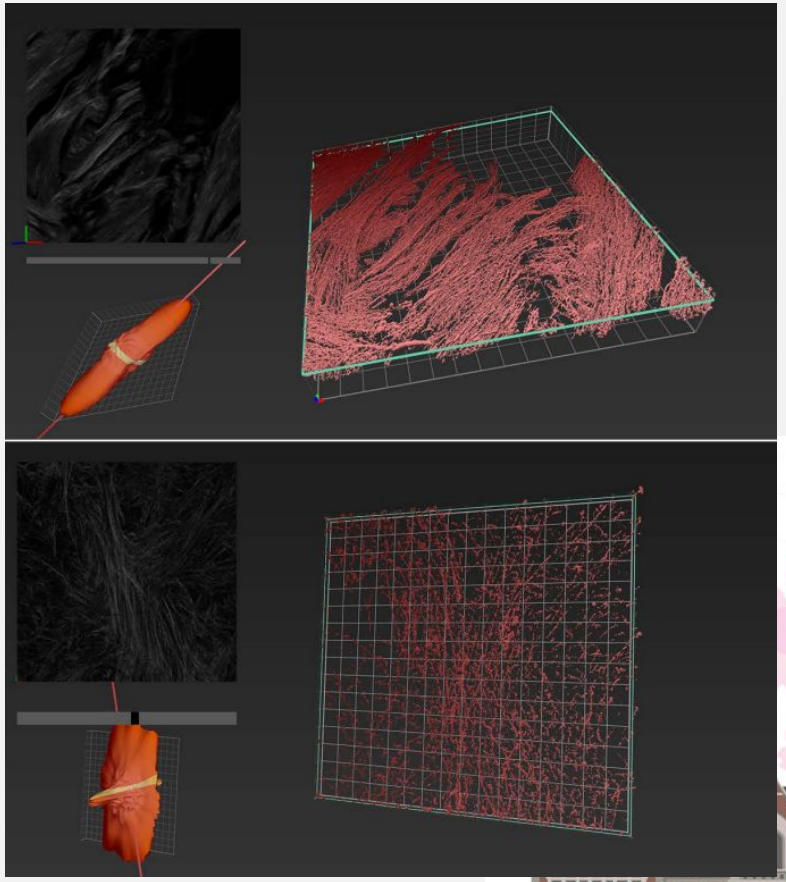
Display Environment

To contain representations

Tangible System

Where physical objects are used to control or form visualizations

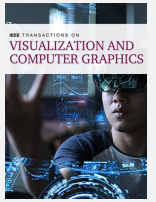




(Jackson et al., 2013)

IEEE VIS

EuroVis



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Motivation

For linking representations

Display Environment

To contain representations

Layout

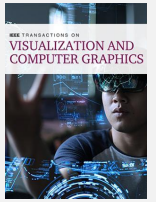
Of representations

Approach

For interacting with the links

IEEE VIS

EuroVis



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Motivation
For linking representations

Display Environment
To contain representations

Layout
Of representations

- Juxtaposed
- Compounded

Approach
For interacting with the links

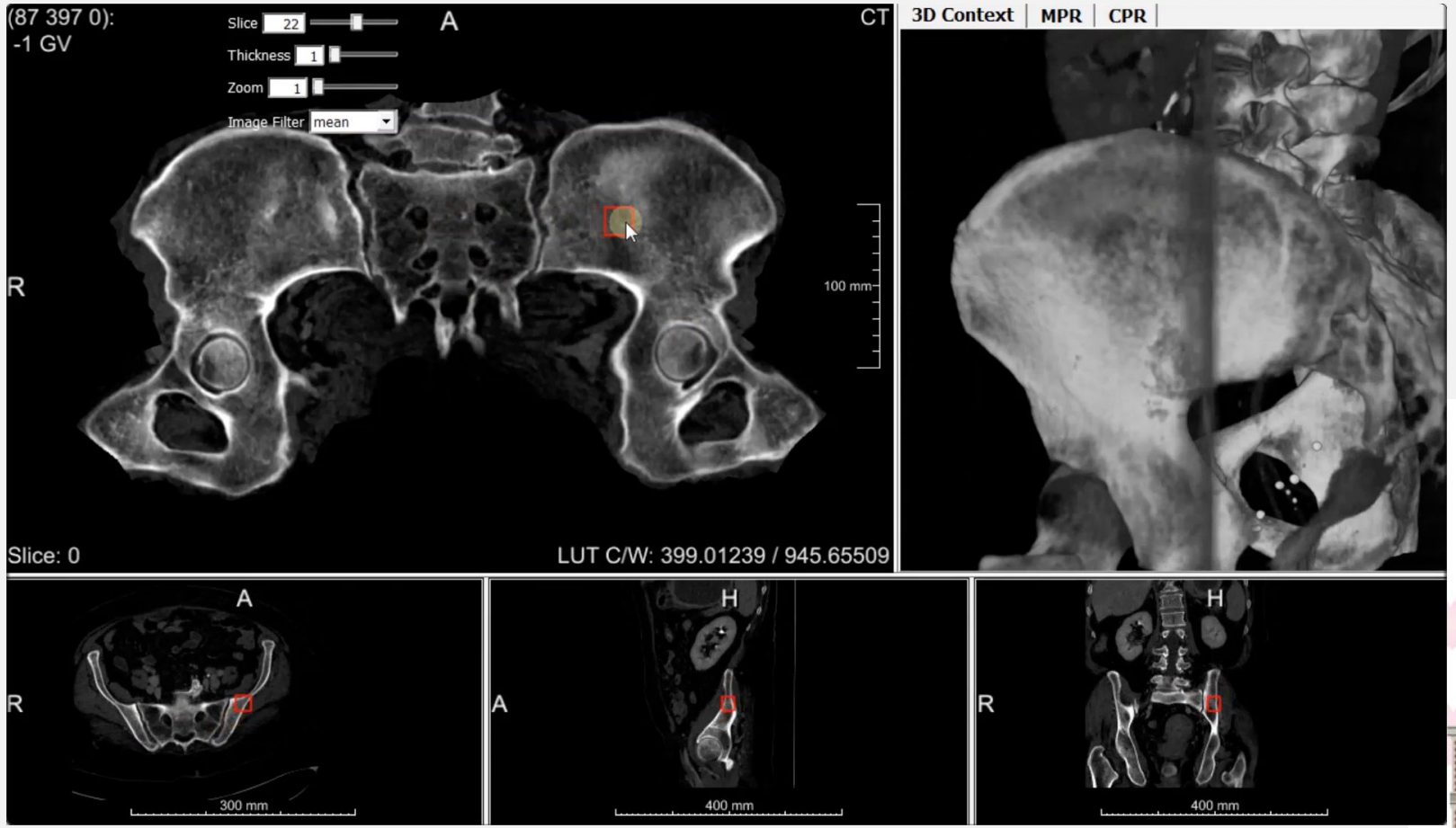
Design Space

Of combining 2D and 3D visualizations

Layout *Of representations*

Juxtaposed

Layouts place representations side-by-side



(Kretschmer et al., 2014)

02

Design Space

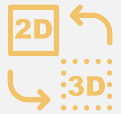
Of combining 2D and 3D visualizations

Layout *Of representations*

2D
3D

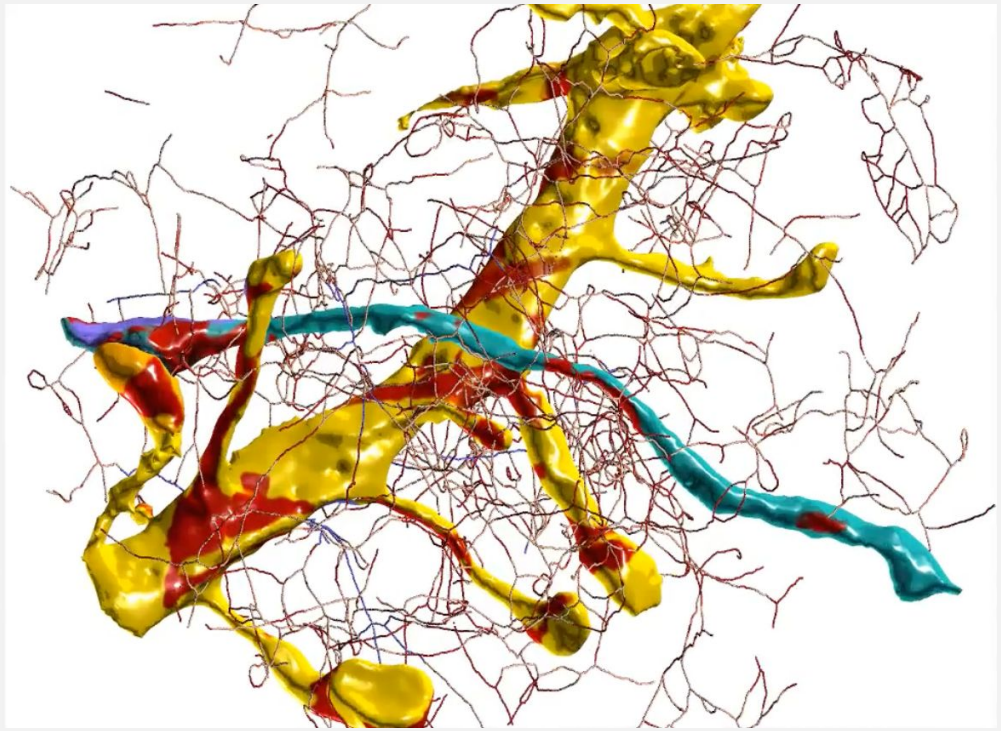
Compounded

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

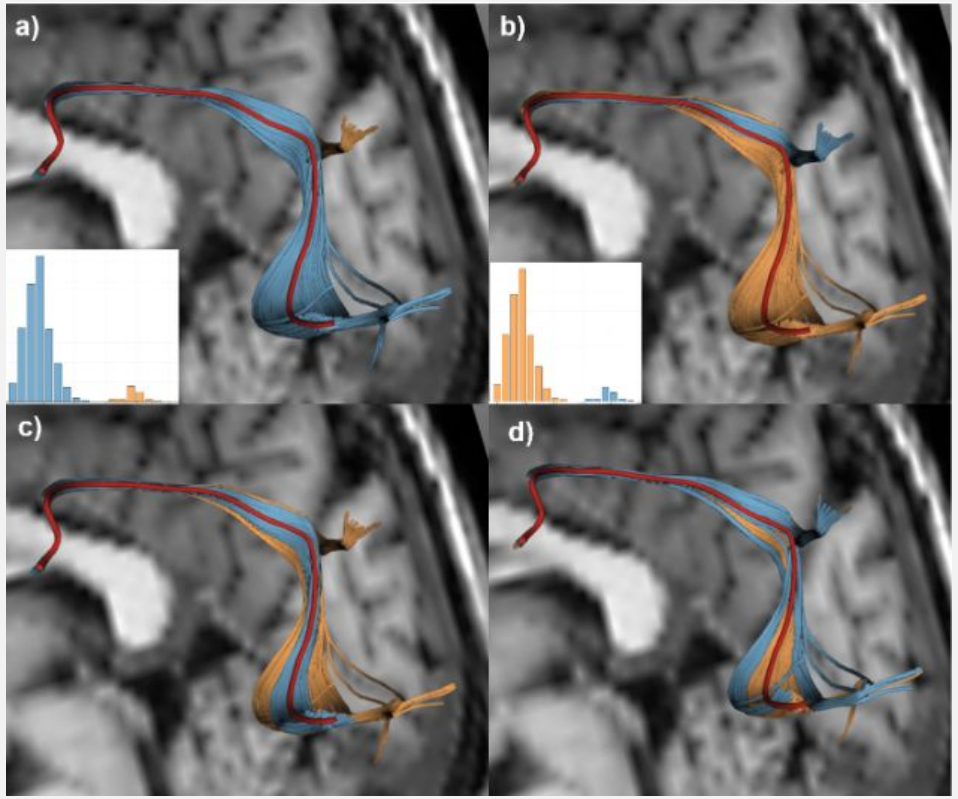
Compounded

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

Layout *Of representations*

2D
3D

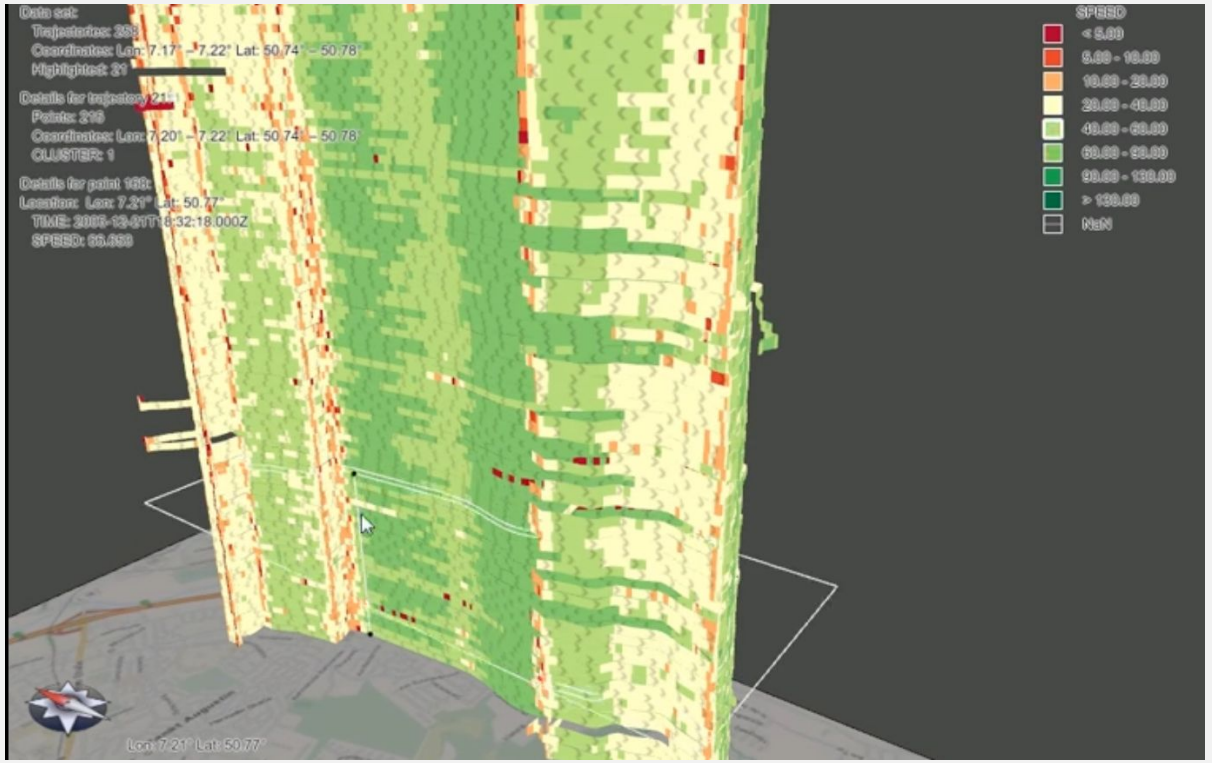
Compounded

Layouts use the same display space

2D
3D

Embedded

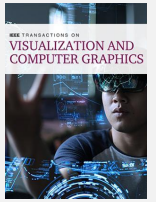
Layouts position two representations in the exact same place



(Tominski et al., 2012)

IEEE VIS

EuroVis



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105 Papers from 2012 to 2022

Motivation

For linking representations

Display Environment

To contain representations

Layout

Of representations

Approach

For interacting with the links

IEEE VIS

EuroVis

TVCG

105 Papers from 2012 to 2022

Motivation
For linking representations

Display Environment
To contain representations

Layout
Of representations

Approach
For designing the links

- Visually Connected
- Interactively Connected
- Animated

02

Design Space

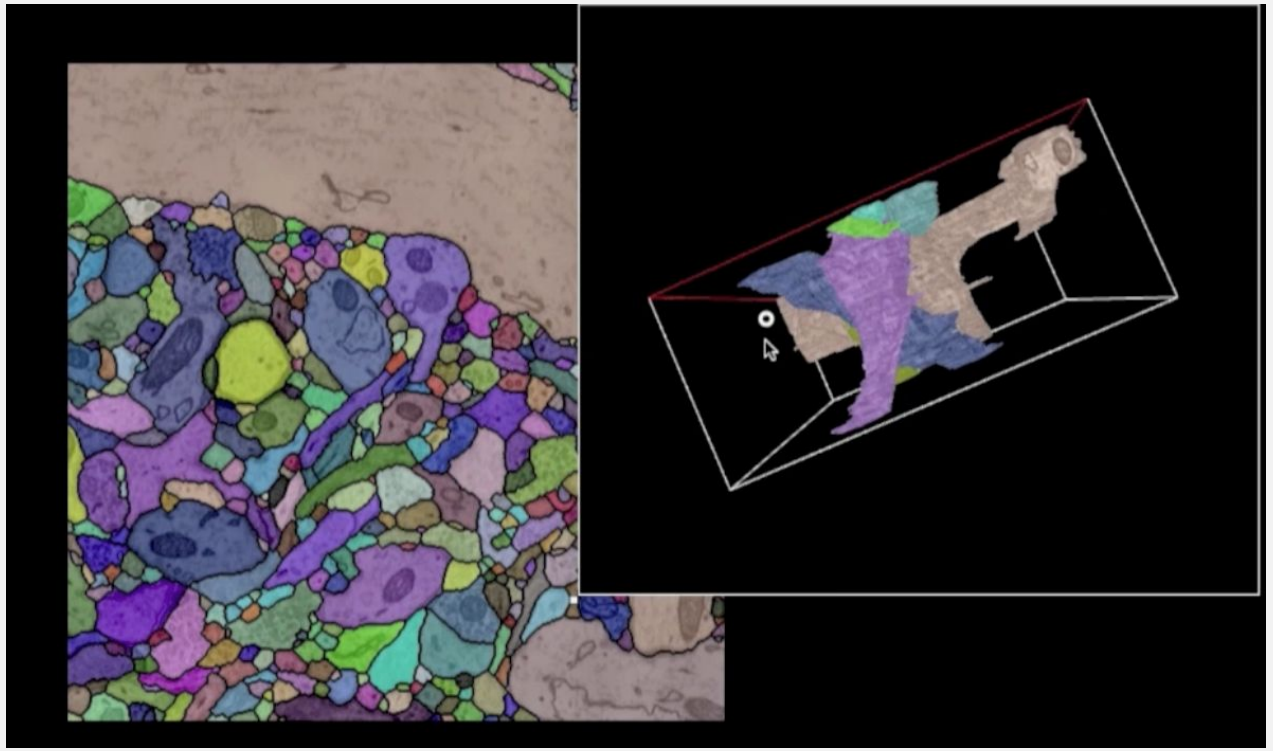
Of combining 2D and 3D visualizations

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

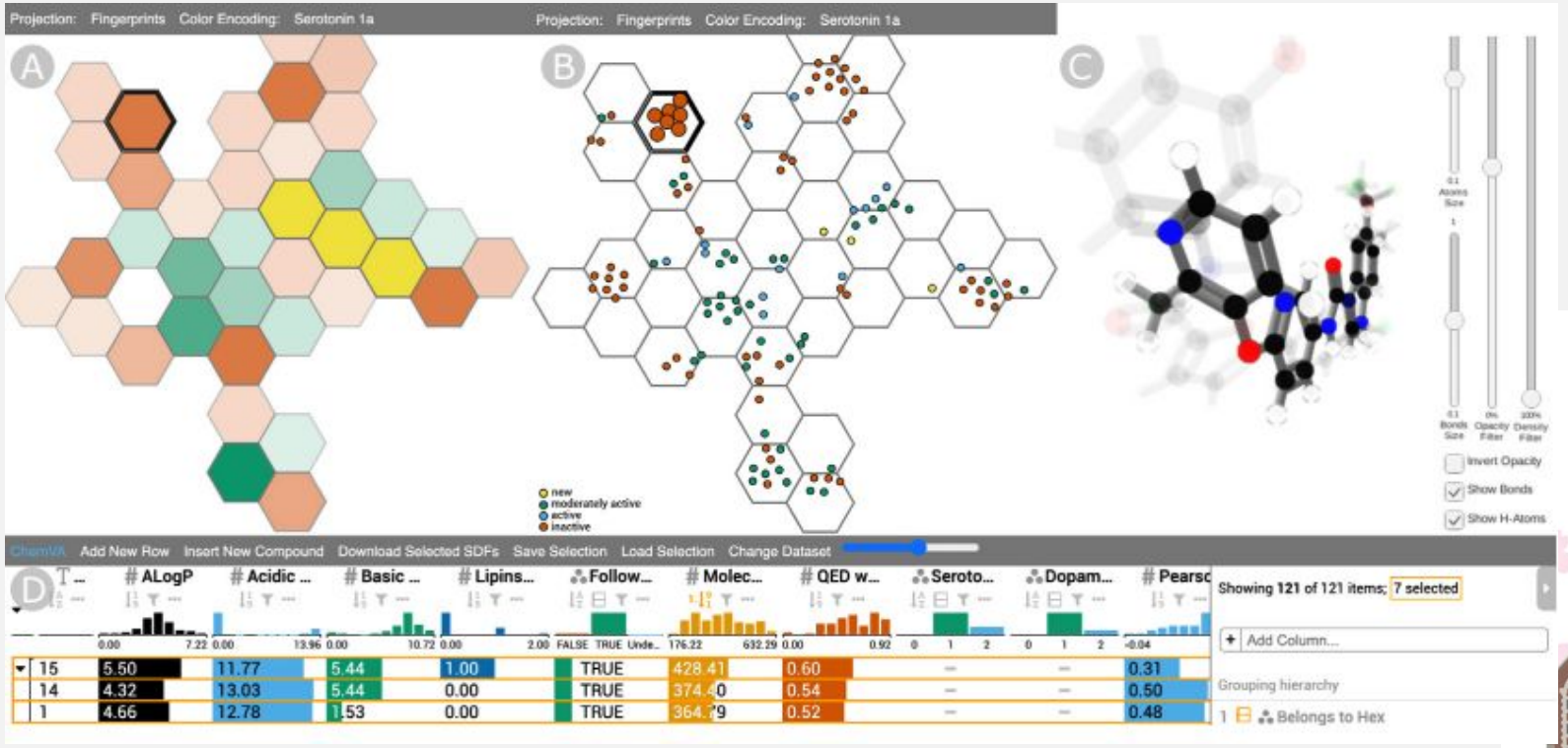
Approach

For designing the links

Visually Connected

Approaches highlight the relationships between representations visually

Position



(Sabando et al., 2021)

02

Design Space

Of combining 2D and 3D visualizations

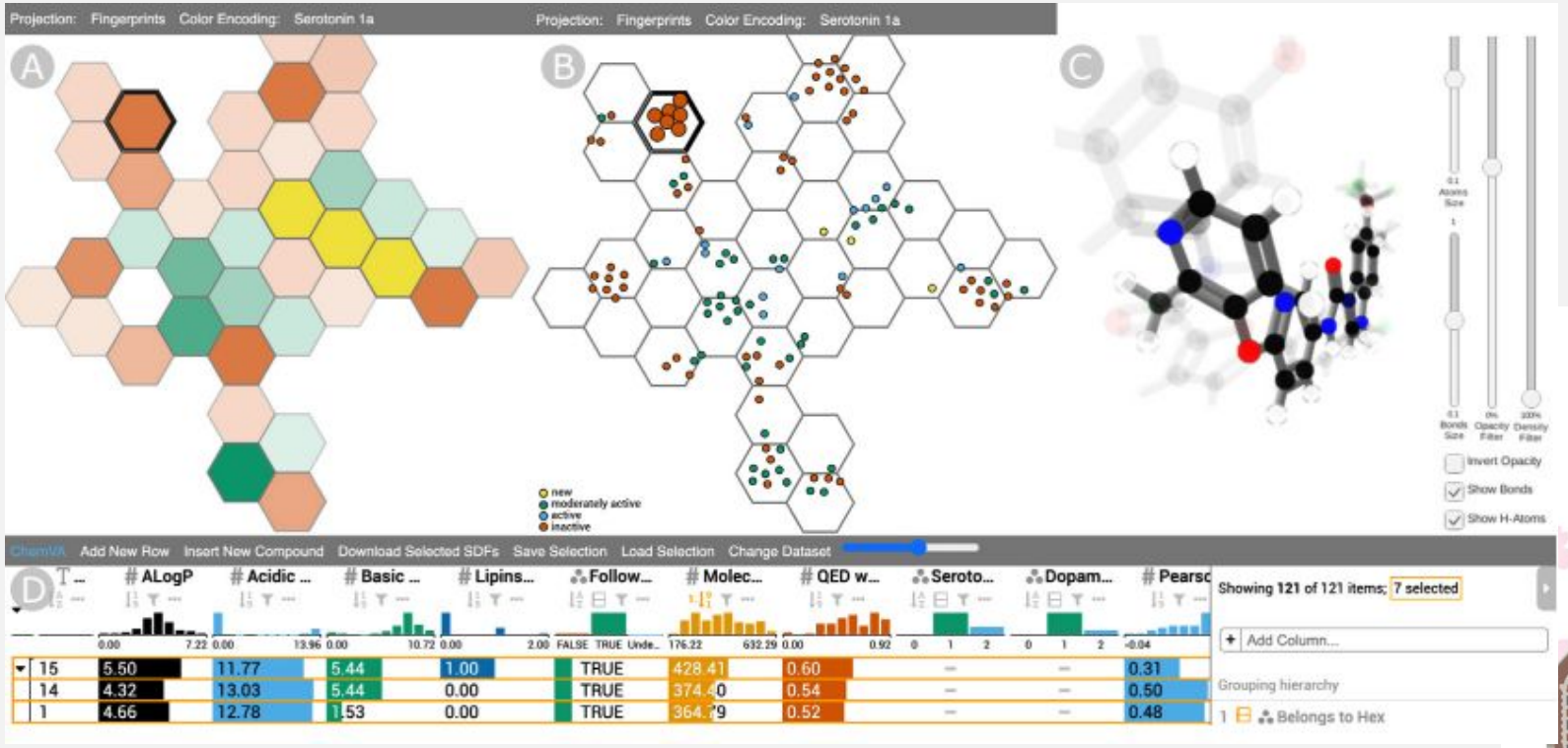
Approach

For designing the links

Visually Connected

Approaches highlight the relationships between representations visually

Shape



(Sabando et al., 2021)

02

Design Space

Of combining 2D and 3D visualizations

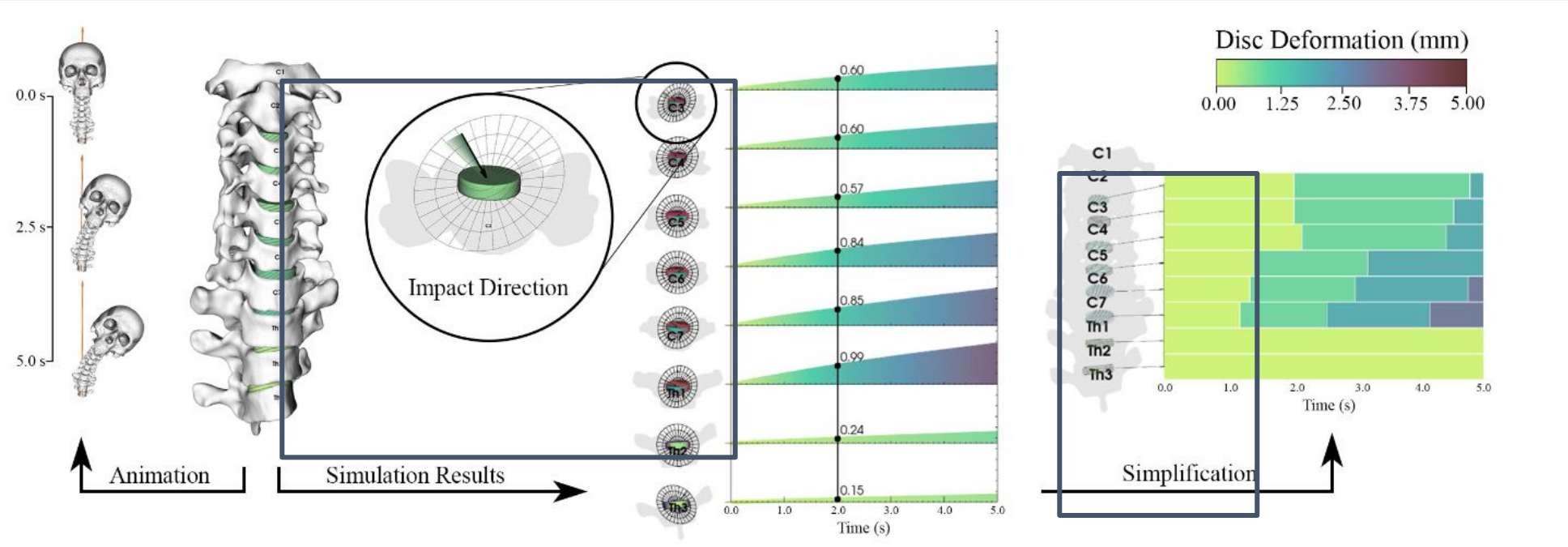
Approach

For designing the links

Visually Connected

Approaches highlight the relationships between representations visually

Guides



(Eulzer et al., 2021)

02

Design Space

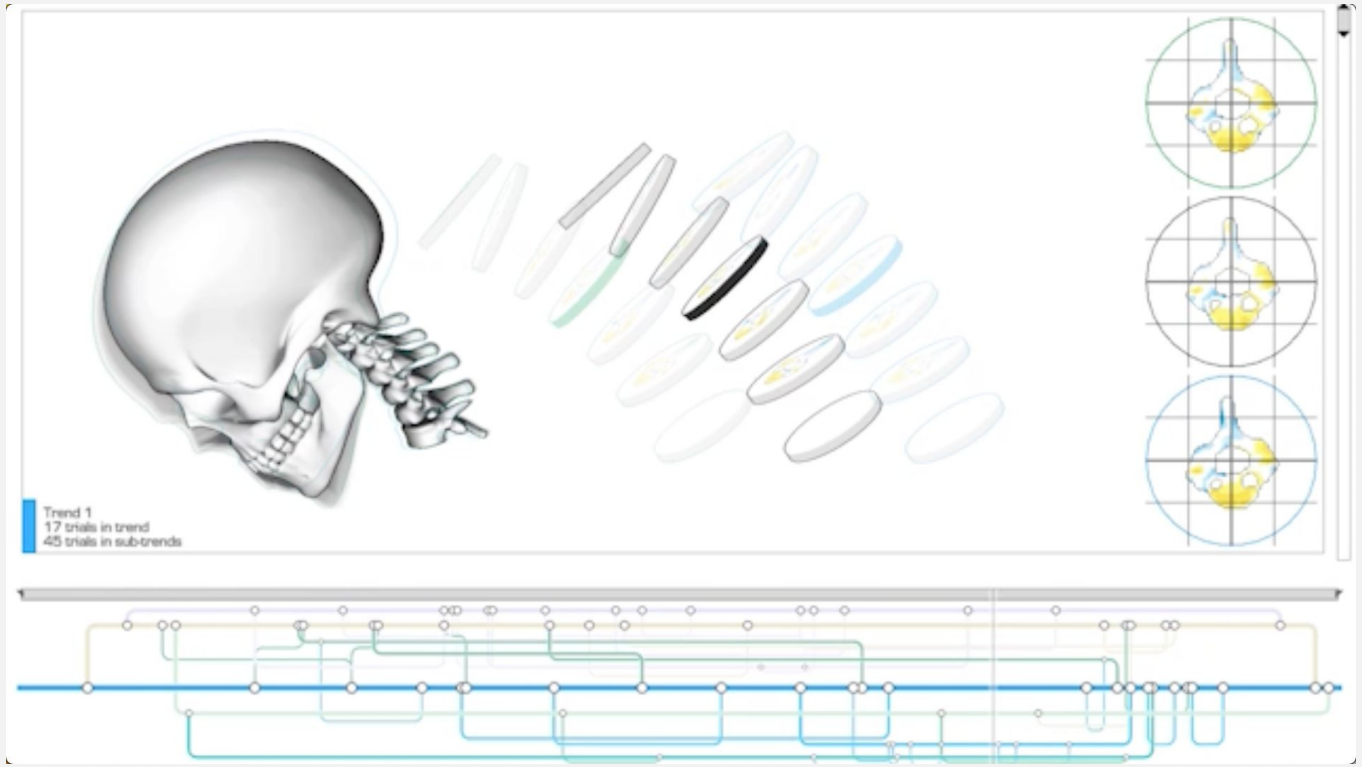
Of combining 2D and 3D visualizations

Approach *For designing the links*

Interactively Connected

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

2D Control 3D



(Schroeder et al., 2014)

02

Design Space

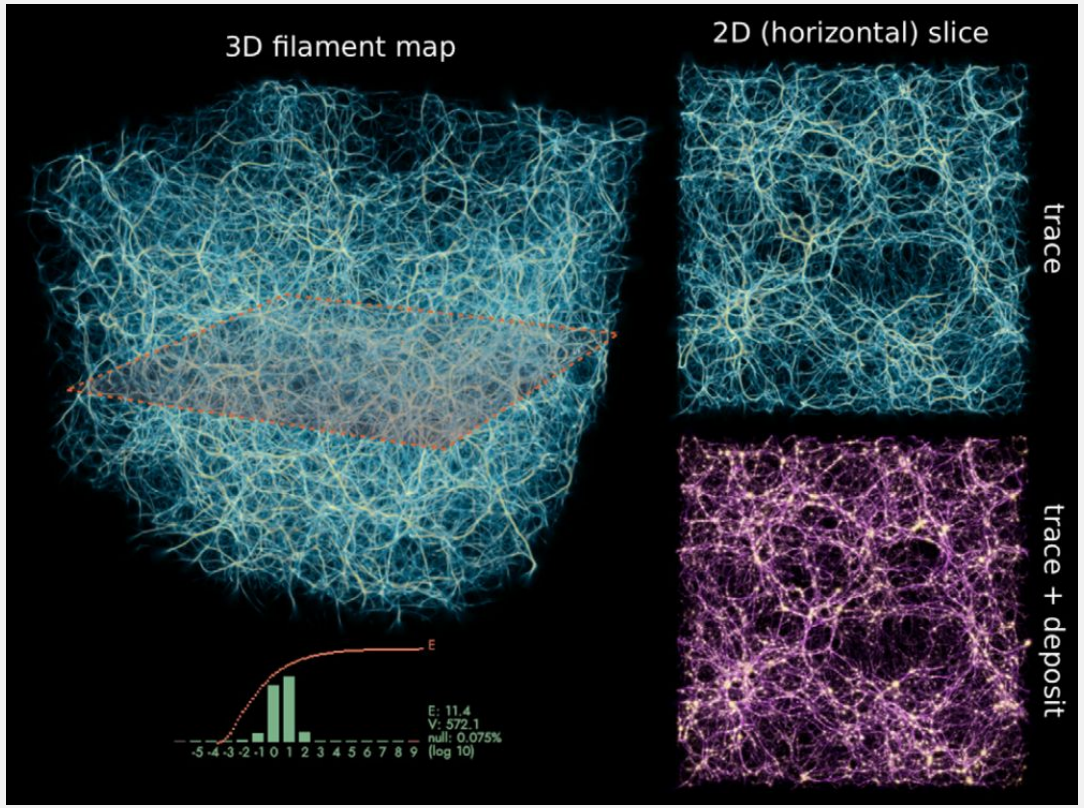
Of combining 2D and 3D visualizations

Approach *For designing the links*

Interactively Connected

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

3D Control 2D



(Elek et al., 2021)

02

Design Space

Of combining 2D and 3D visualizations

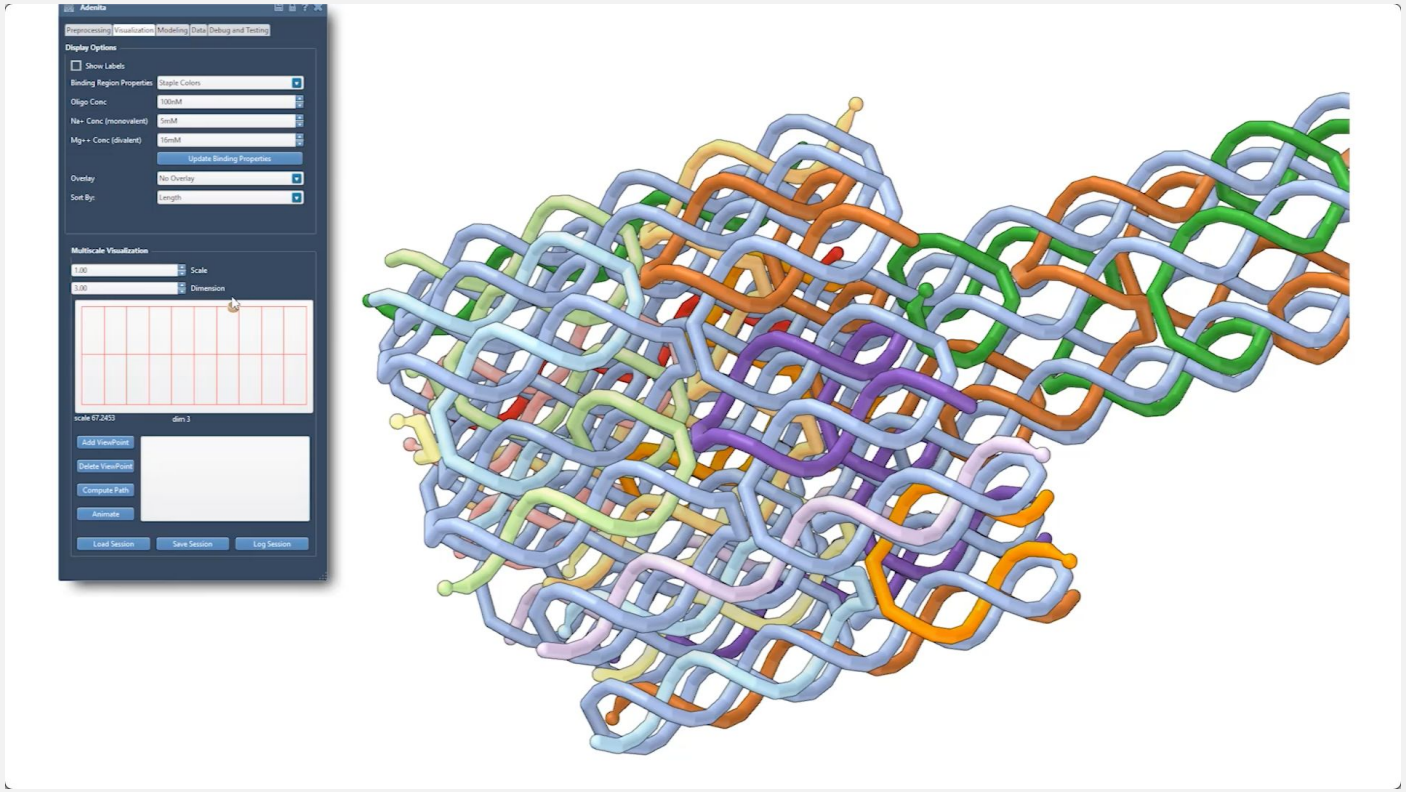
Approach

For designing the links

Interactively Connected

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

Bidirectional



(Miao et al., 2018)

02

Design Space

Of combining 2D and 3D visualizations

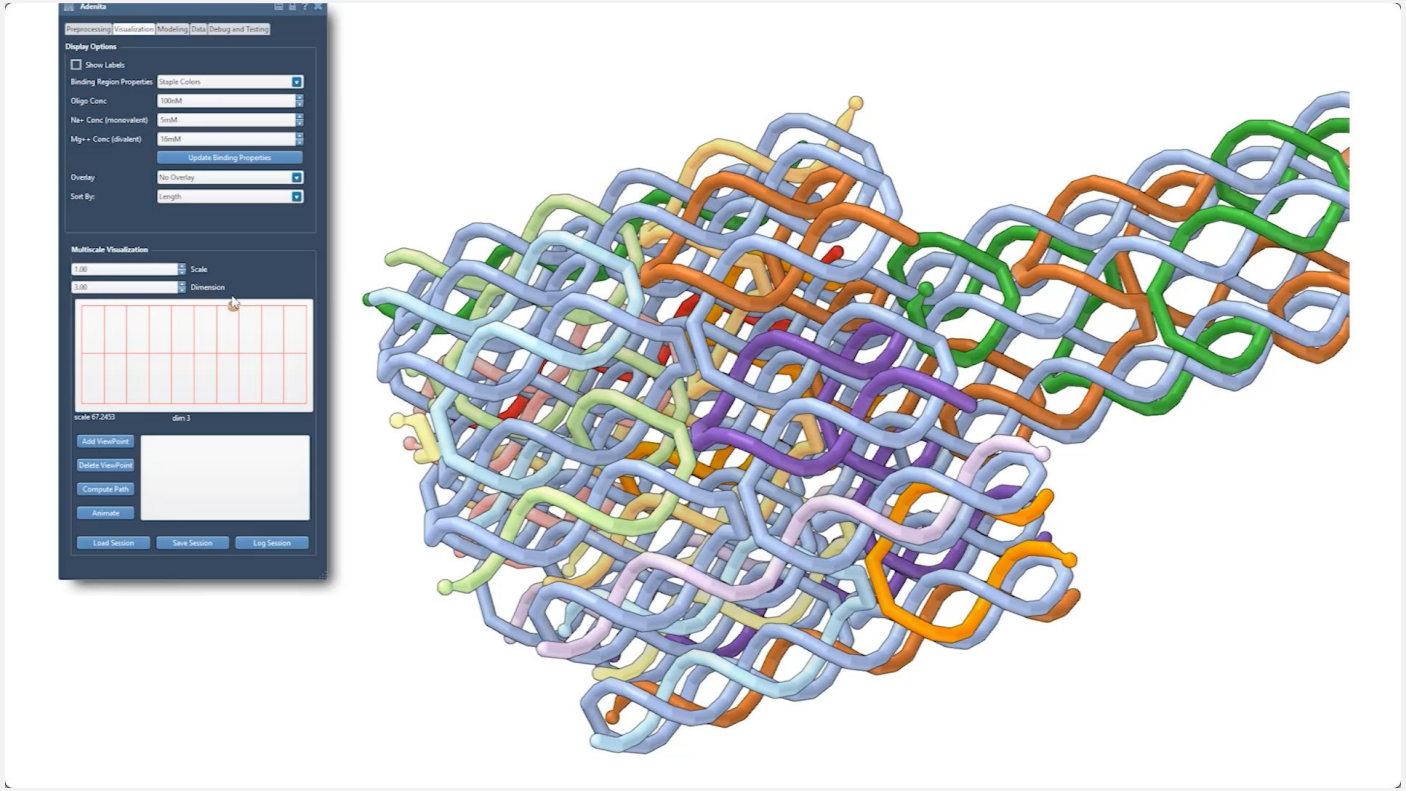
Approach *For designing the links*

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

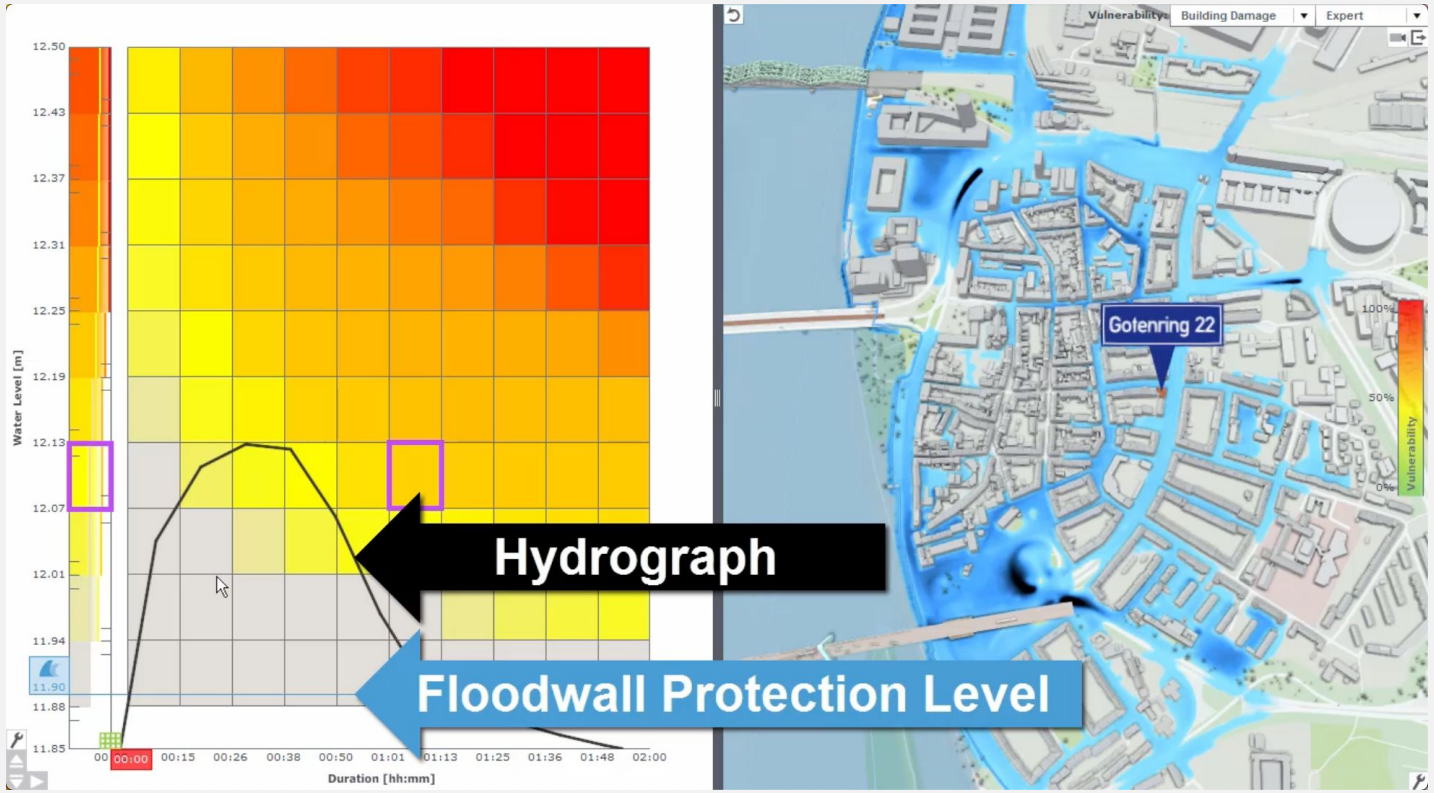
For designing the links

Animated

Linked approaches via animation

Modification

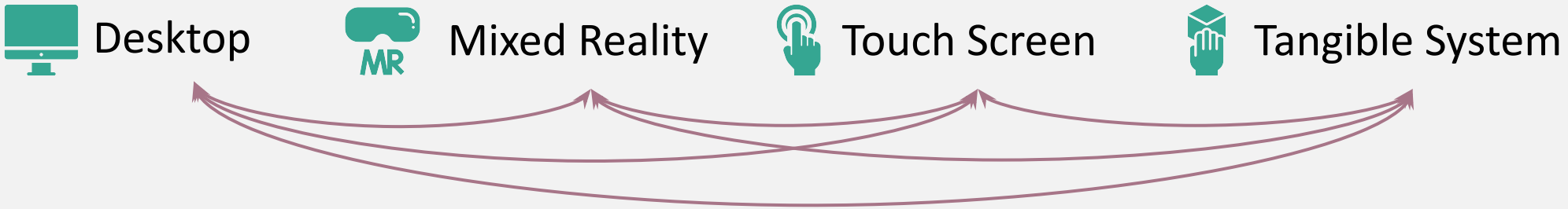
Animated approaches allow viewers to interact with one component



(Cornel et al., 2015)

03 *Takeaways* *From our work*

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



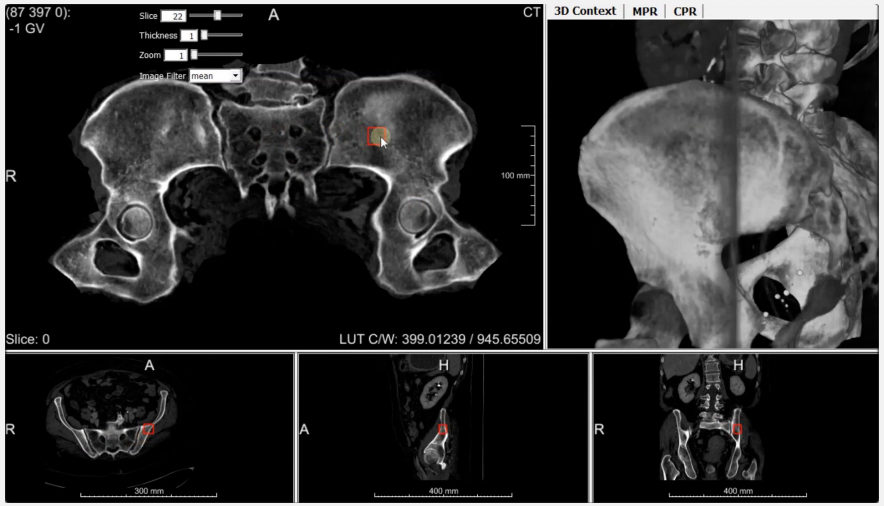
Desktop & Mixed Reality		Large 3D Spatial Datasets
Desktop & Tangible System		Edutainment Purposes
Mixed Reality & Tangible System		Enhance Data Understanding

Design an appropriate Layout.

Both representations are needed for tasks.

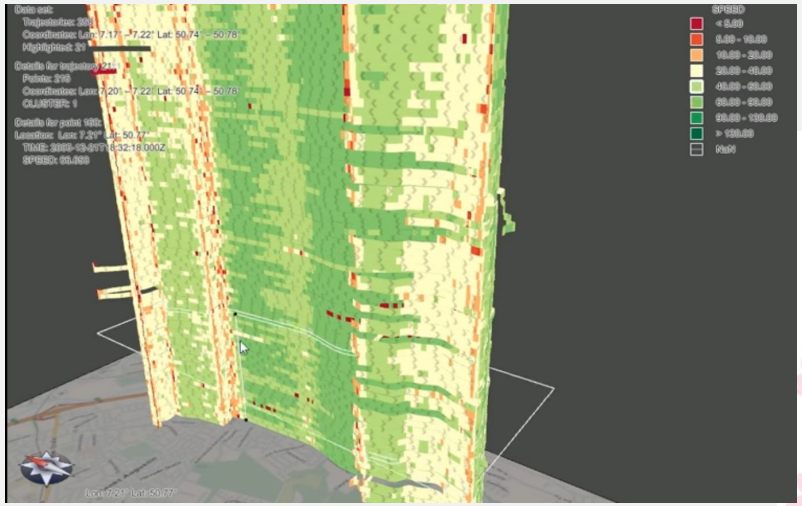
Emphasize the position.

Juxtaposed



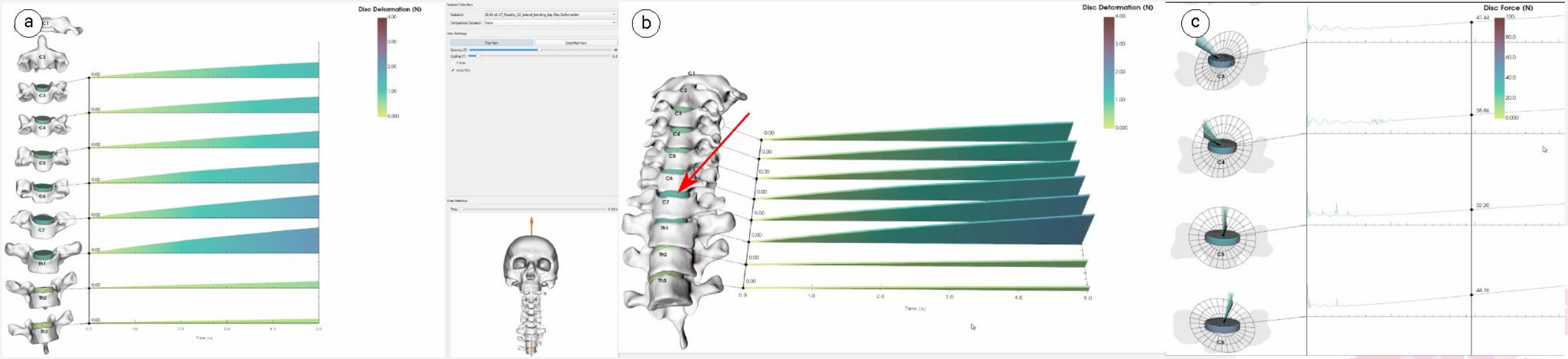
(Kretschmer et al., 2014)

Embedded



(Tominski et al., 2012)

Adding multiple approaches to link 2D and 3D representations



(Eulzer et al., 2021)

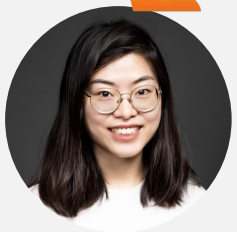
A Survey of Designs for Combined 2D+3D Visual Representations

Website

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.

Hire Me!



I am looking for a faculty position in the upcoming hiring cycles!
Contact me via email: jhong76@asu.edu (https://jiayihong.info/)