

Image based algorithm to support interactive data exploration

September 2016

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Laboratoire
d'Informatique
Interactive

K H R O N O S
GROUP



Research@ENAC



OPTIM
Optimization
and Control of
Dynamical
Systems

DEVI
Data
Economy
Visualization

II
« Informatique
Interactive »
Interactive
Computing

TELECOM
Signal Processing
Antenna
Networks

A
C
H
I
L

UAS

ATM

AGHOPA

Substainable Development

Safety and Security

Support Team

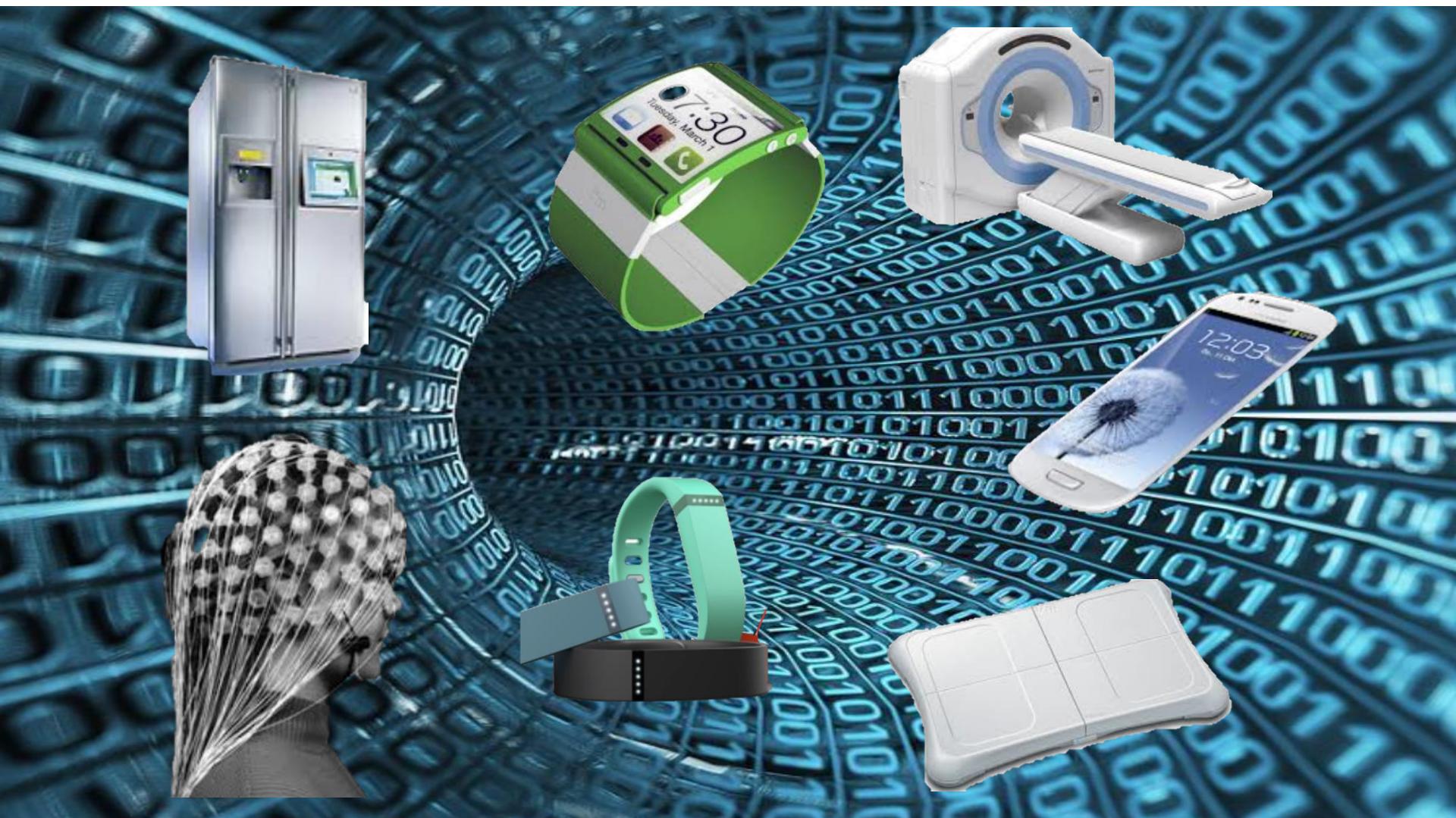
Volière Drone Midi
Pyrénée VDMP
Midi Pyrénées
Flight Arena



DEVI

Data Economy and Visualization

- Scientific and technological commitment to emerging subjects in Air transport systems,
- Data collection, organization, cleaning, qualification, storage and sharing,
- Establishing the economical models allowing the analysis of the behavior of stakeholders,
- Evaluation and test of this models by the means of tools provided by the econometrics and the statistics,
- Statistical and economical data analysis,
- Interactive Visualization of data for knowledge extraction and for decision making.



How to support data exploration?

The key to supporting this task is not only to **visualize data**, but also to allow users to **interact with them**.

I explored new computing techniques called **pixel-based algorithms** so as to support efficient interactive visualizations for the exploration of **large datasets**.

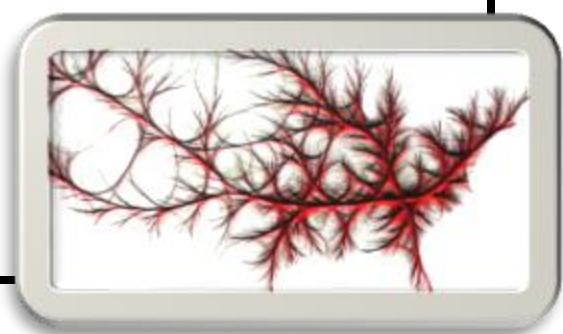
Brushing and linking

FromDady



View simplification

Edge Bundling techniques



View animation

MoleView

ColorTunneling

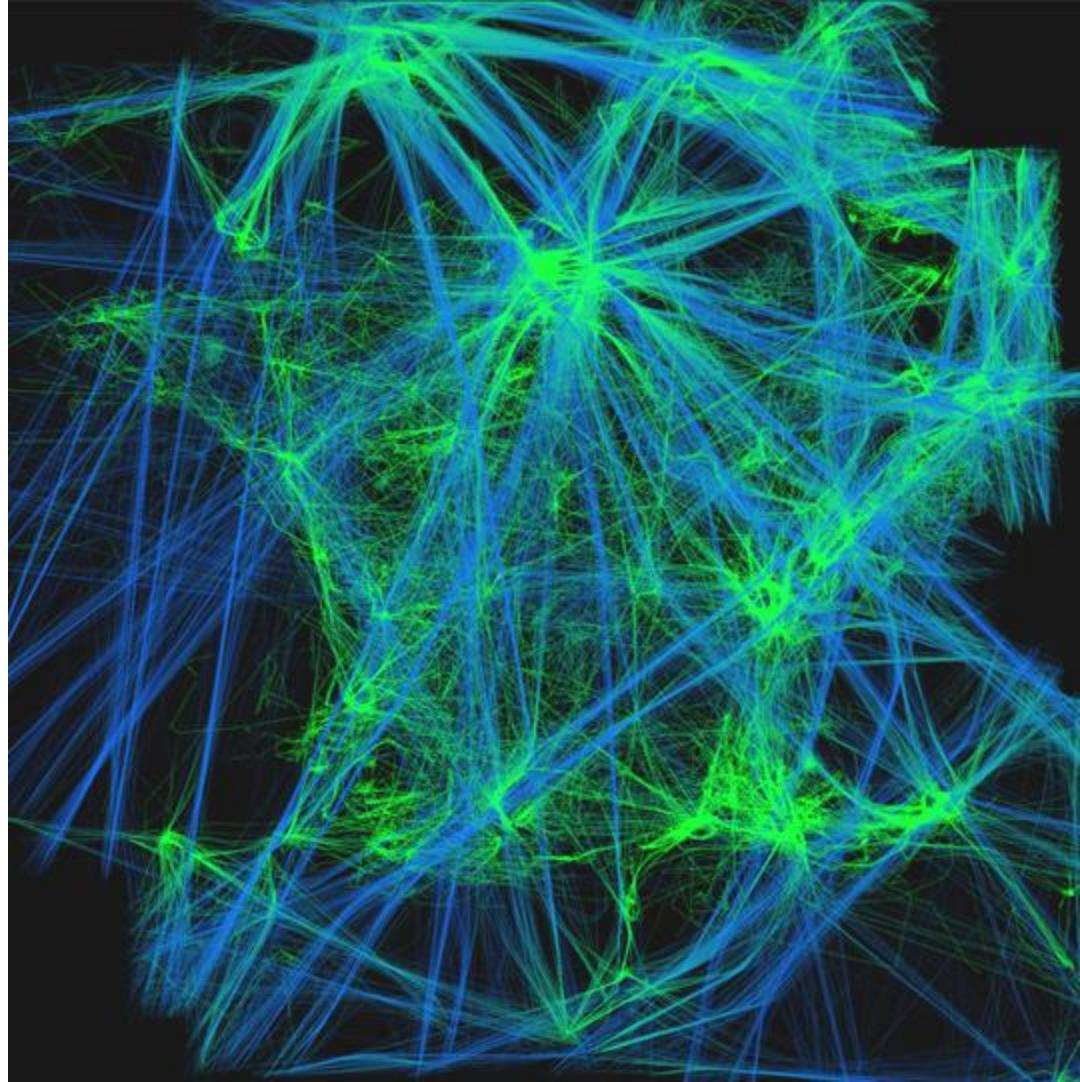


Brushing and linking

FromDady



from Data to Display



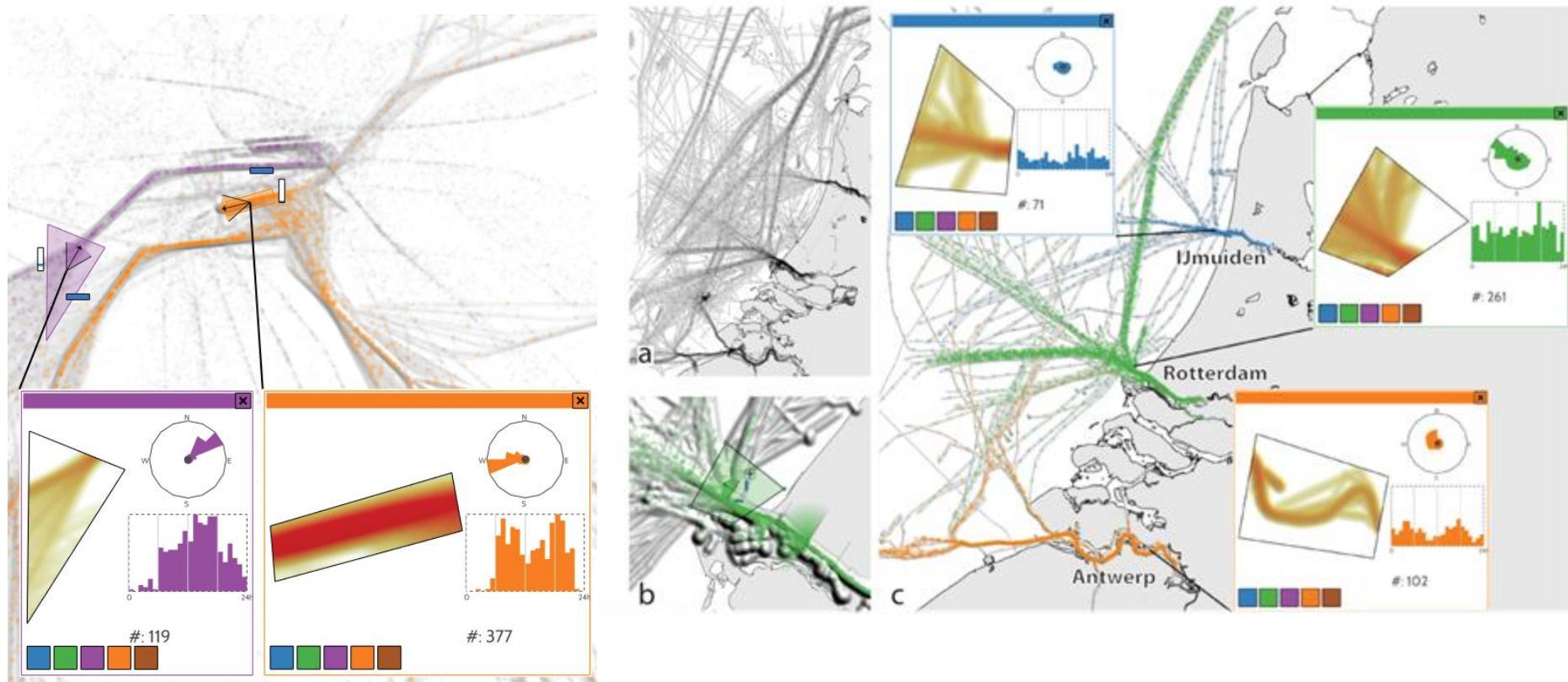
EXE: <http://recherche.enac.fr/~hurter/FromDaDy/FromDaDy.rar>

Hurter, C., Tissoires, B., Conversy, S.

FromDaDy: spreading data across views to support iterative exploration of aircraft trajectories.

In IEEE Transactions on Visualization and Computer Graphics xx(y), (Proceedings of IEEE InfoVis 2009).

*Outgoing investigation: What if system...
How the flows get reallocated when an harbor is closed,,,*

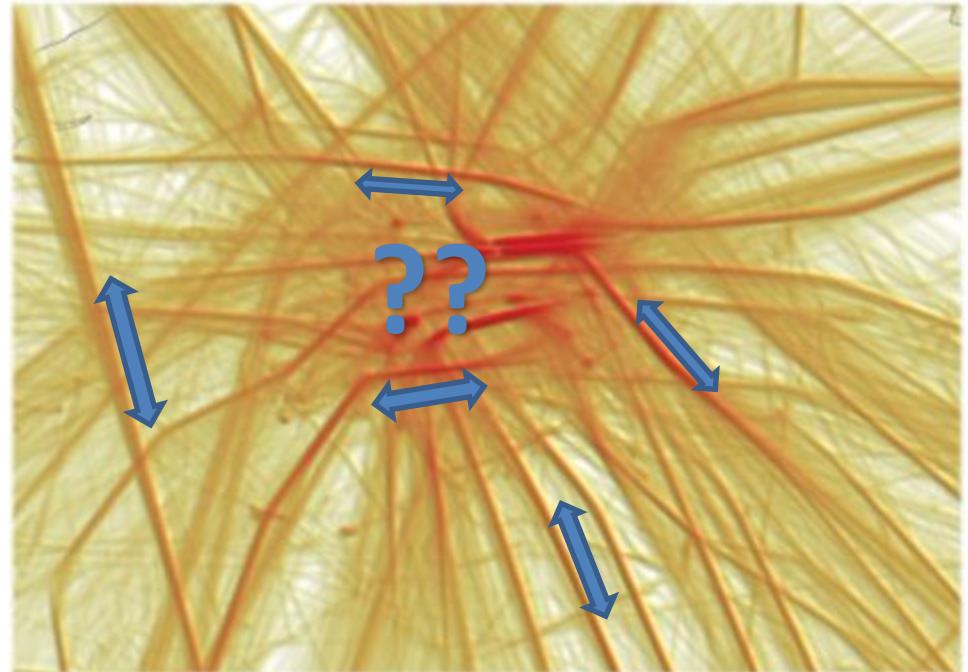


Roeland Scheepens, Christophe Hurter, Huub van de Wetering, Jarke van Wijk
Visualization, Selection, and Analysis of Traffic Flows
*In IEEE Transactions on Visualization and Computer Graphics xx(y),
(Proceedings of IEEE InfoVis 2015).*

<http://recherche.enac.fr/~hurter/AnimatedParticles/AnimatedParticles.html>

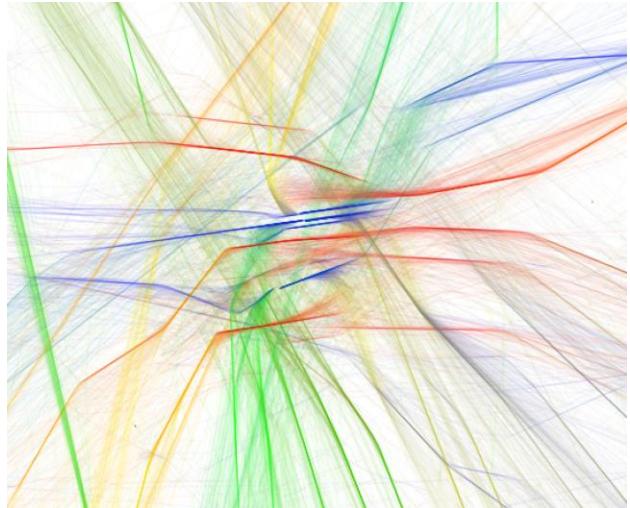
Context

- Moving objects with **functional relationship**.
- Users
- Traffic Flows



Visualization

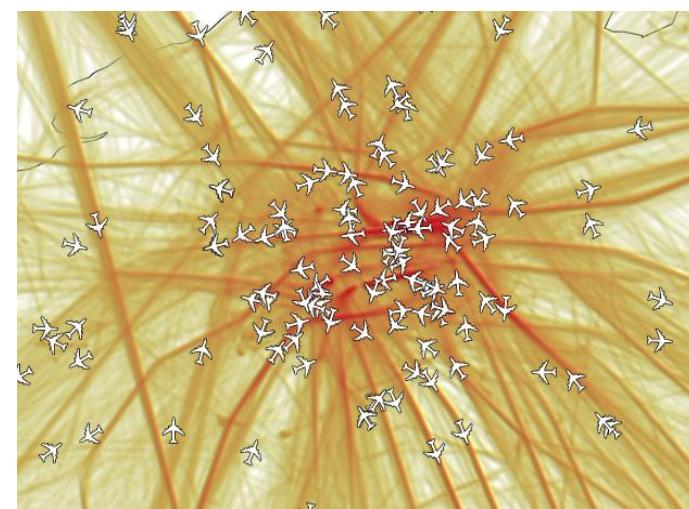
- Direction of flows



Colors?



Animated Particles!

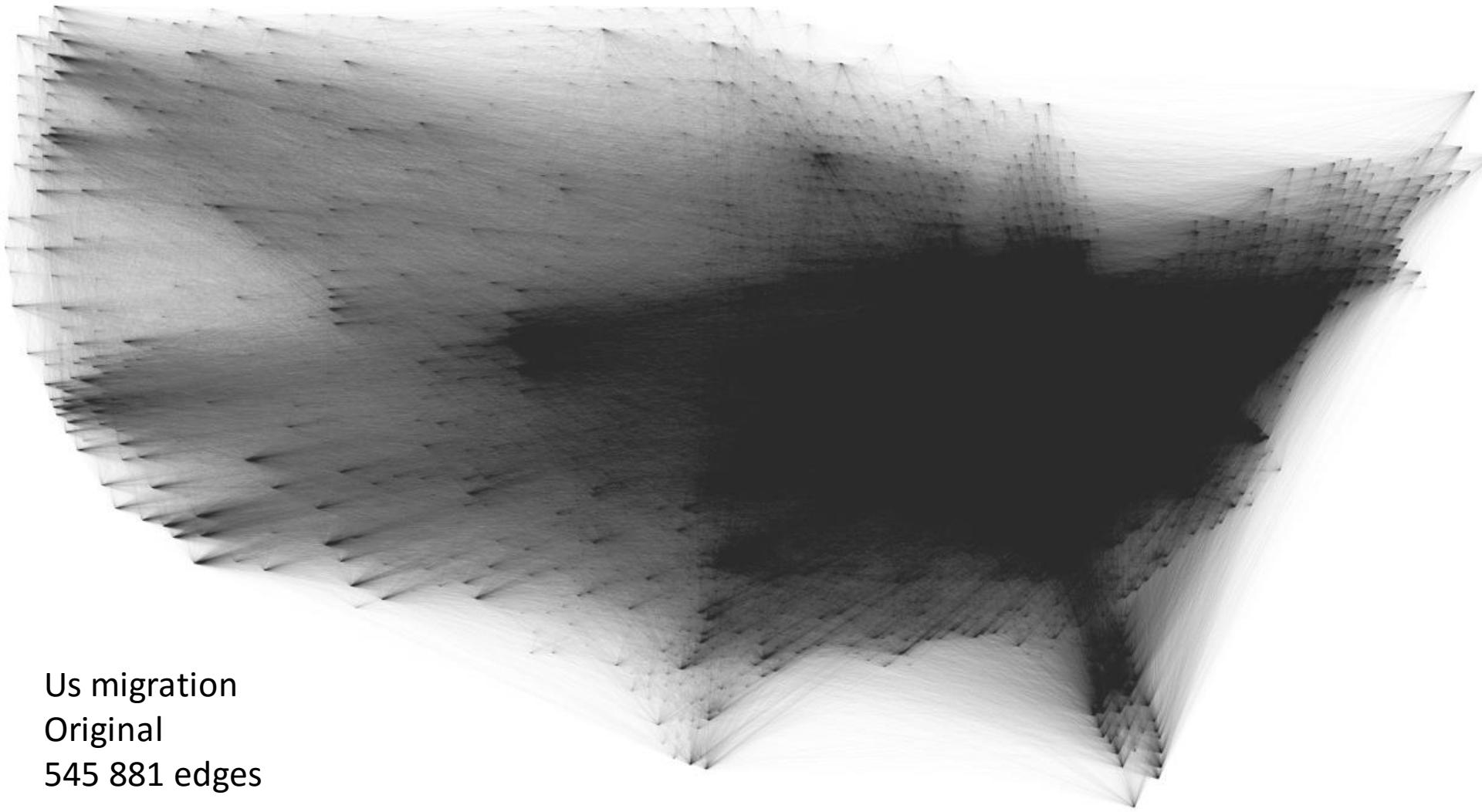


Glyphs?

View simplification
Edge Bundling techniques

County-to-county migration flow files

(<http://www.census.gov/population/www/cen2000/ctytoctyflow/>). These data come from the Census 2000 long-form question on residence 5 years ago and contain the number of people who moved between counties.

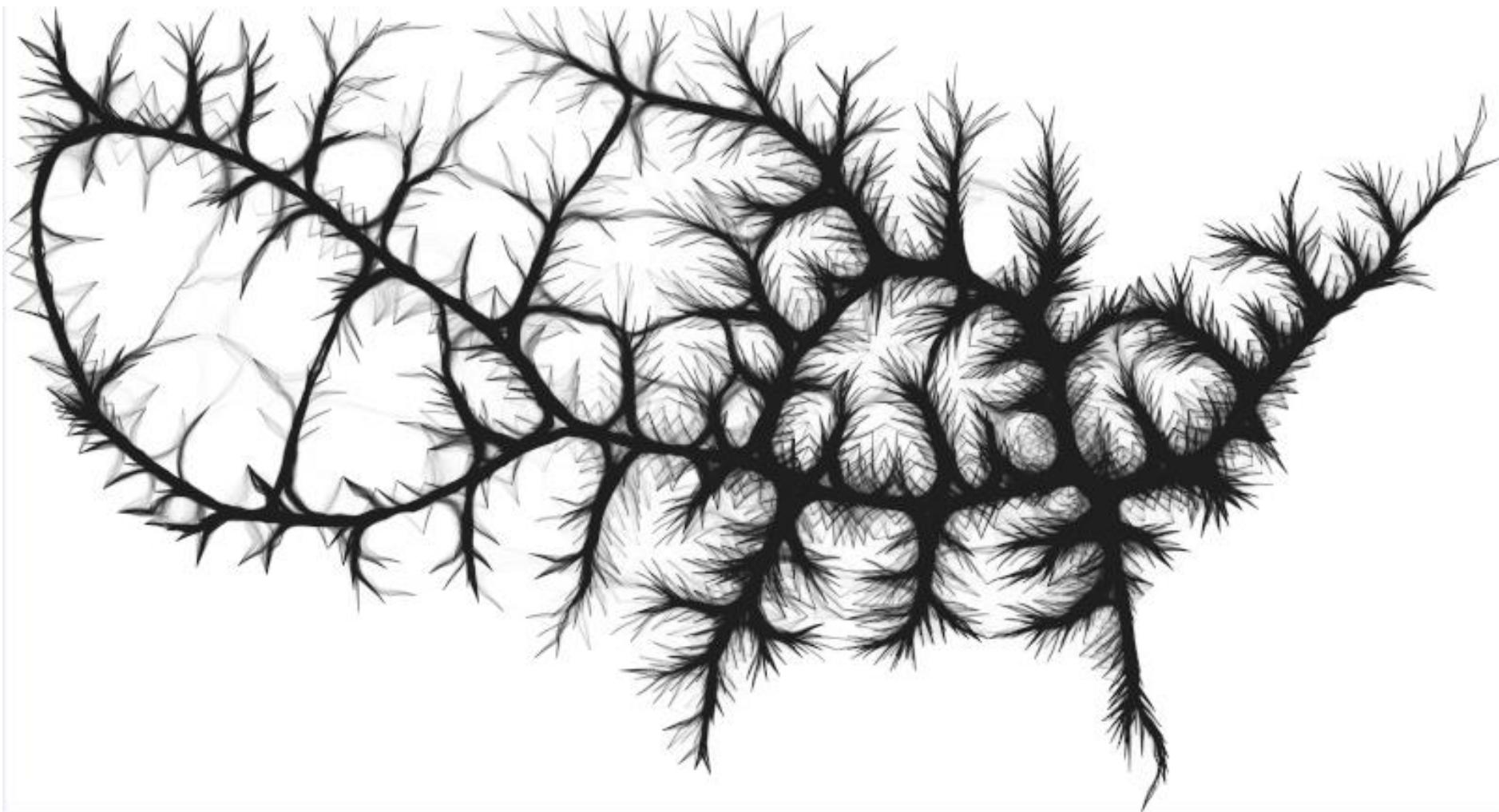


Us migration

Original

545 881 edges

Bundled

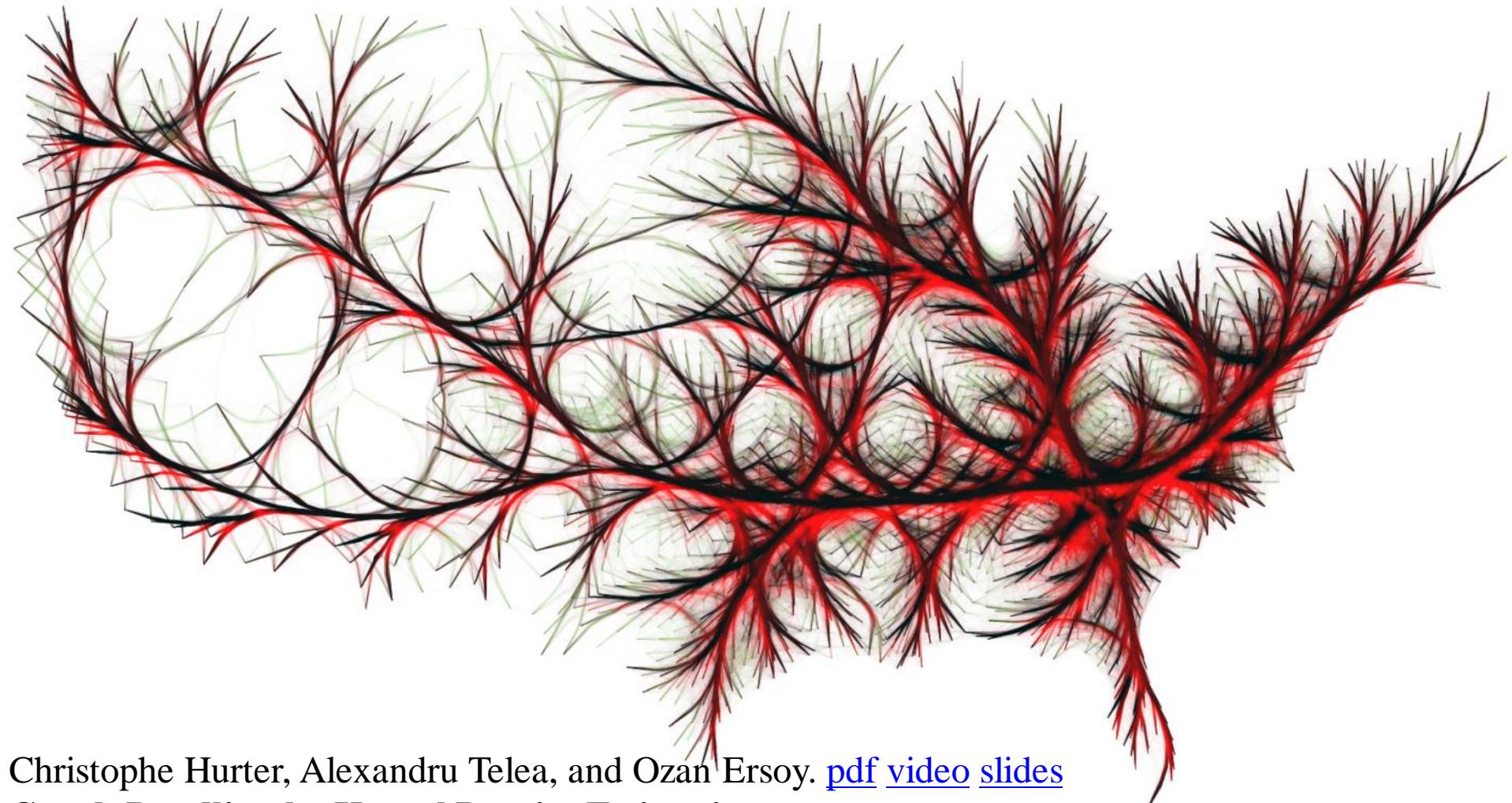


Us migration

Kernel Density Based Edge Bundling

22 million vertexes

Shading



Christophe Hurter, Alexandru Telea, and Ozan Ersoy. [pdf](#) [video](#) [slides](#)

Graph Bundling by Kernel Density Estimation.

EuroVis 2012. Computer Graphics Forum journal.



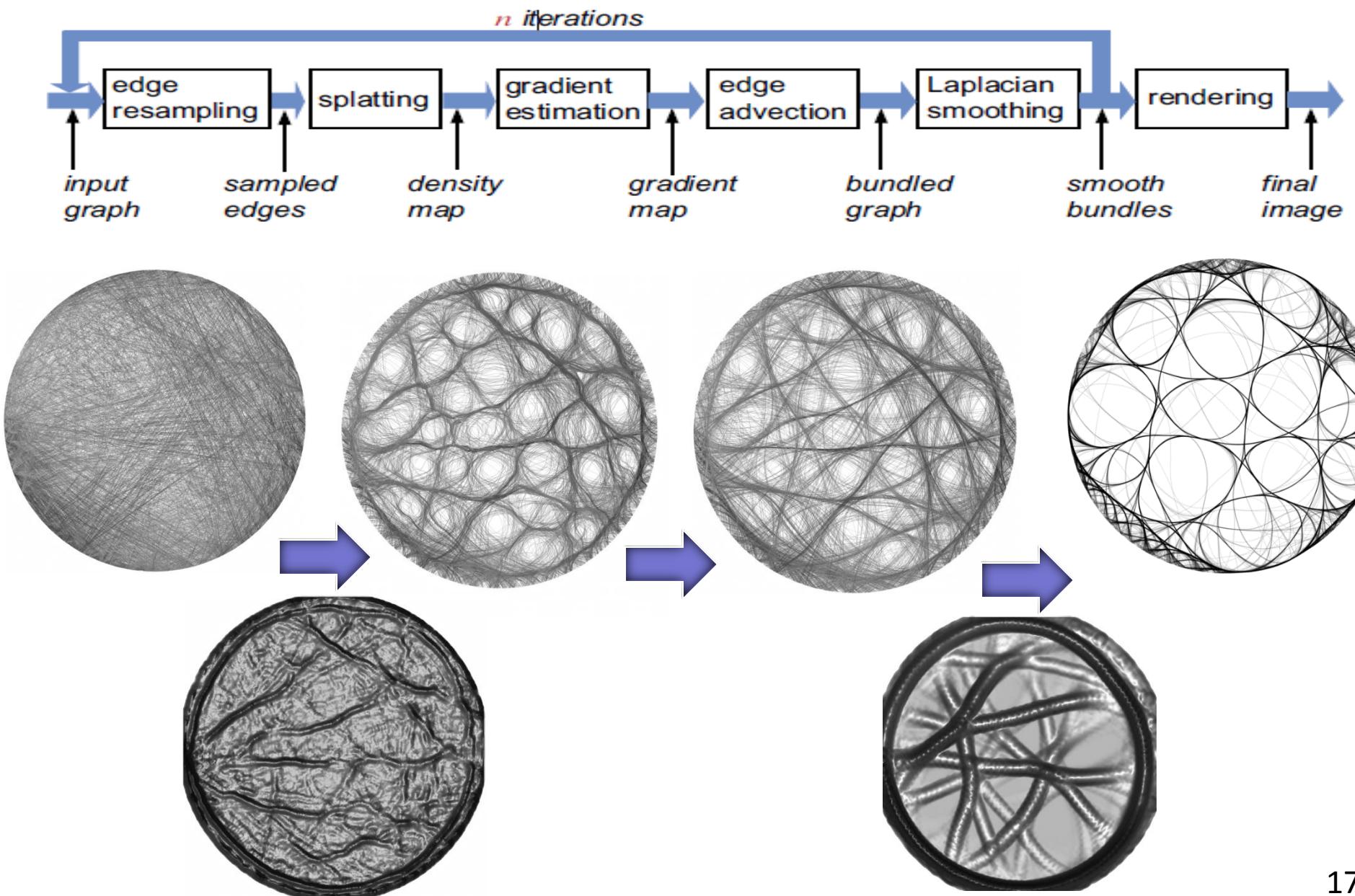
US migration

dataset

realtime bundling

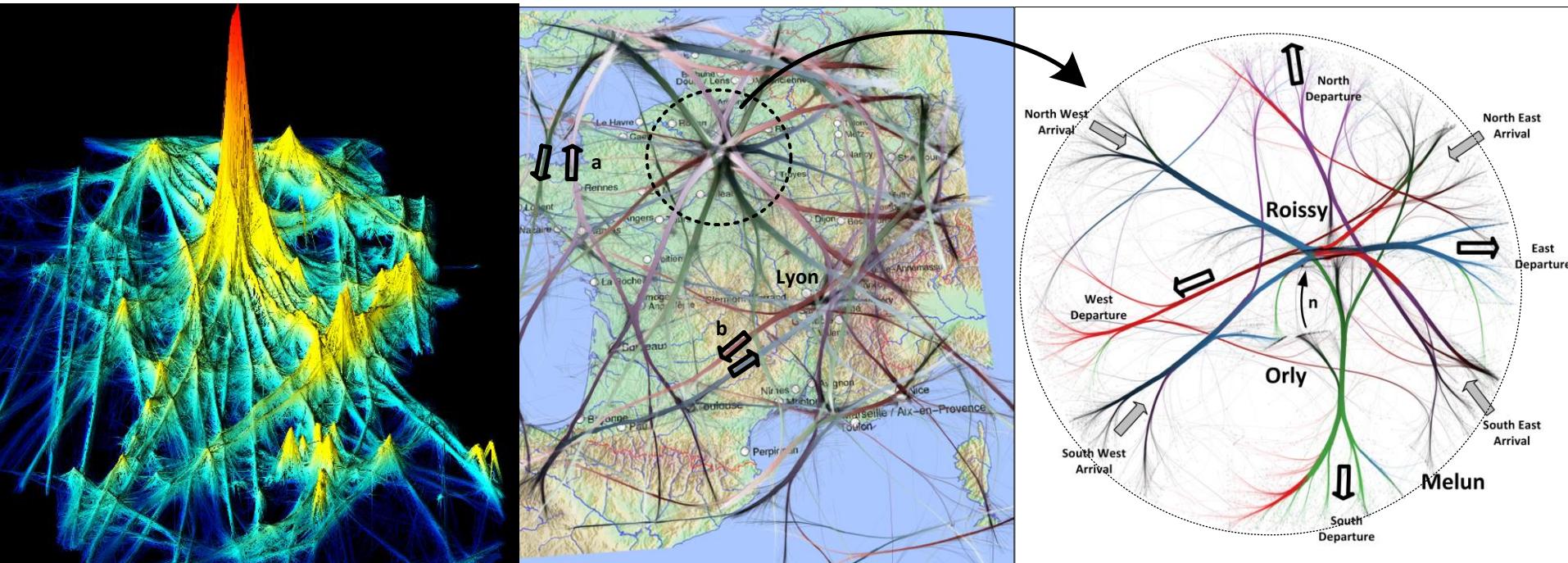
[Visual Studio C# code instance](#) (GPU version)
[Visual Studio C# code instance](#) (CPU version),

KDEEB pipeline





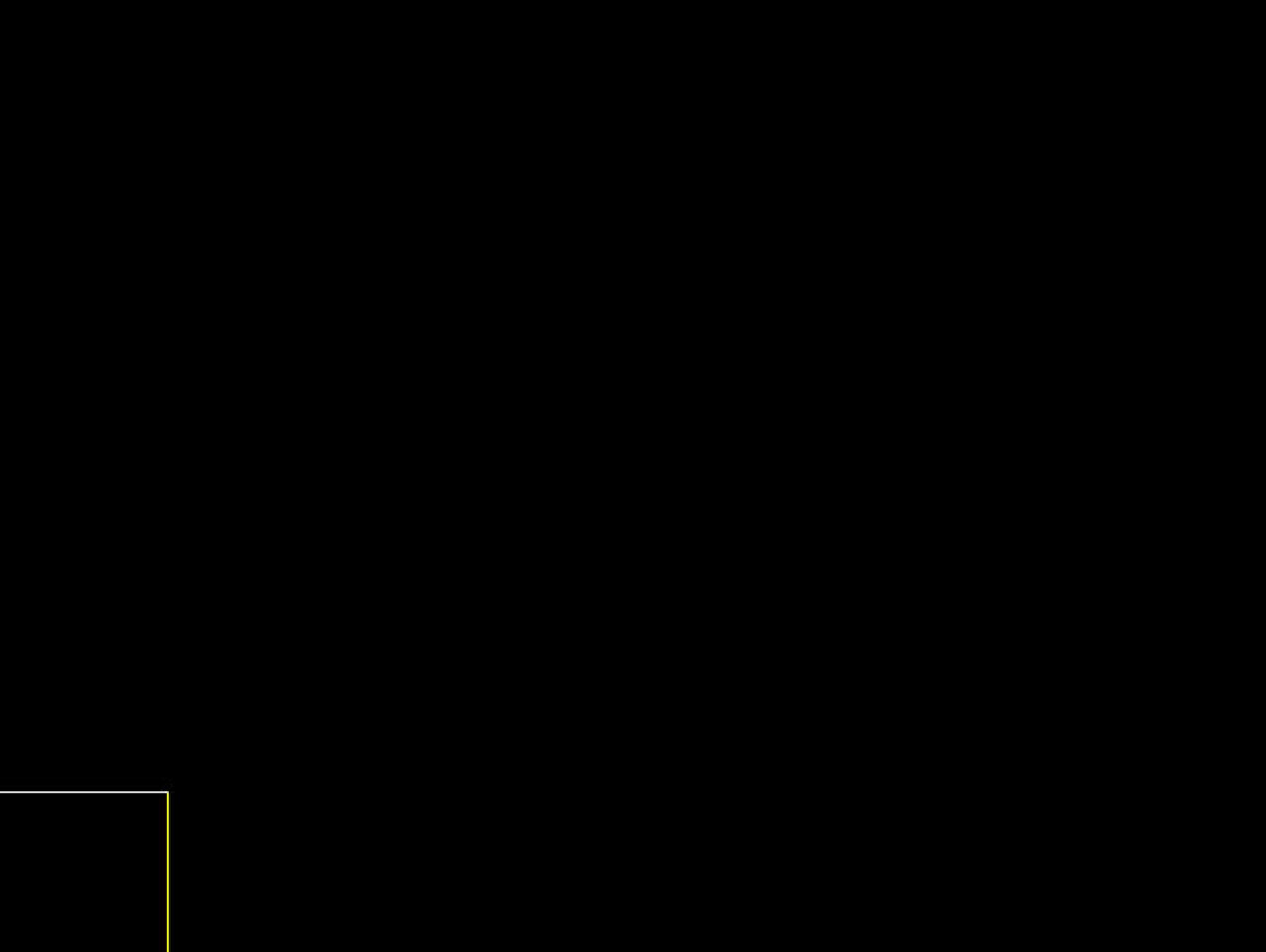
Visual Aggregation of trajectories (edge bundling)

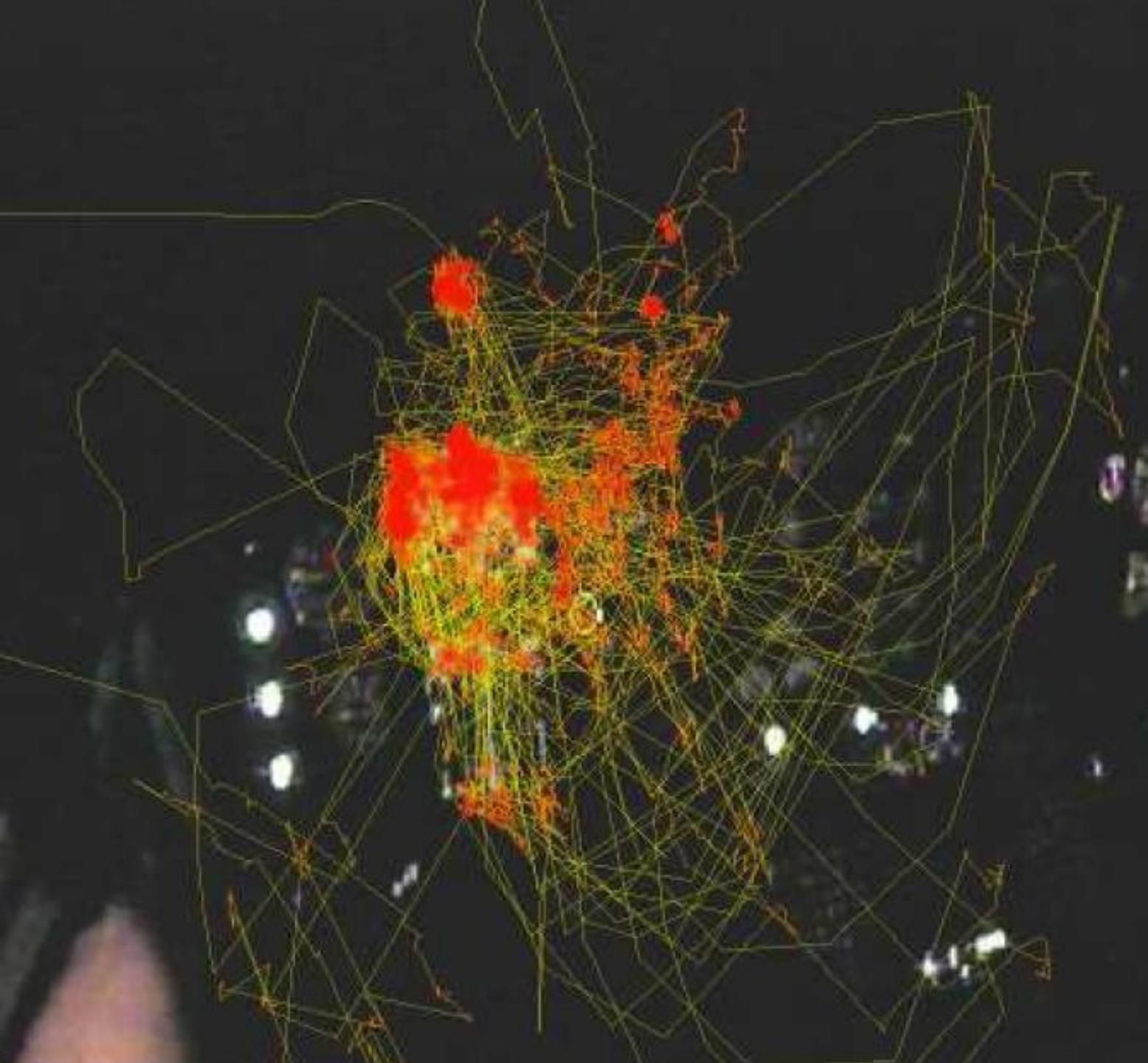


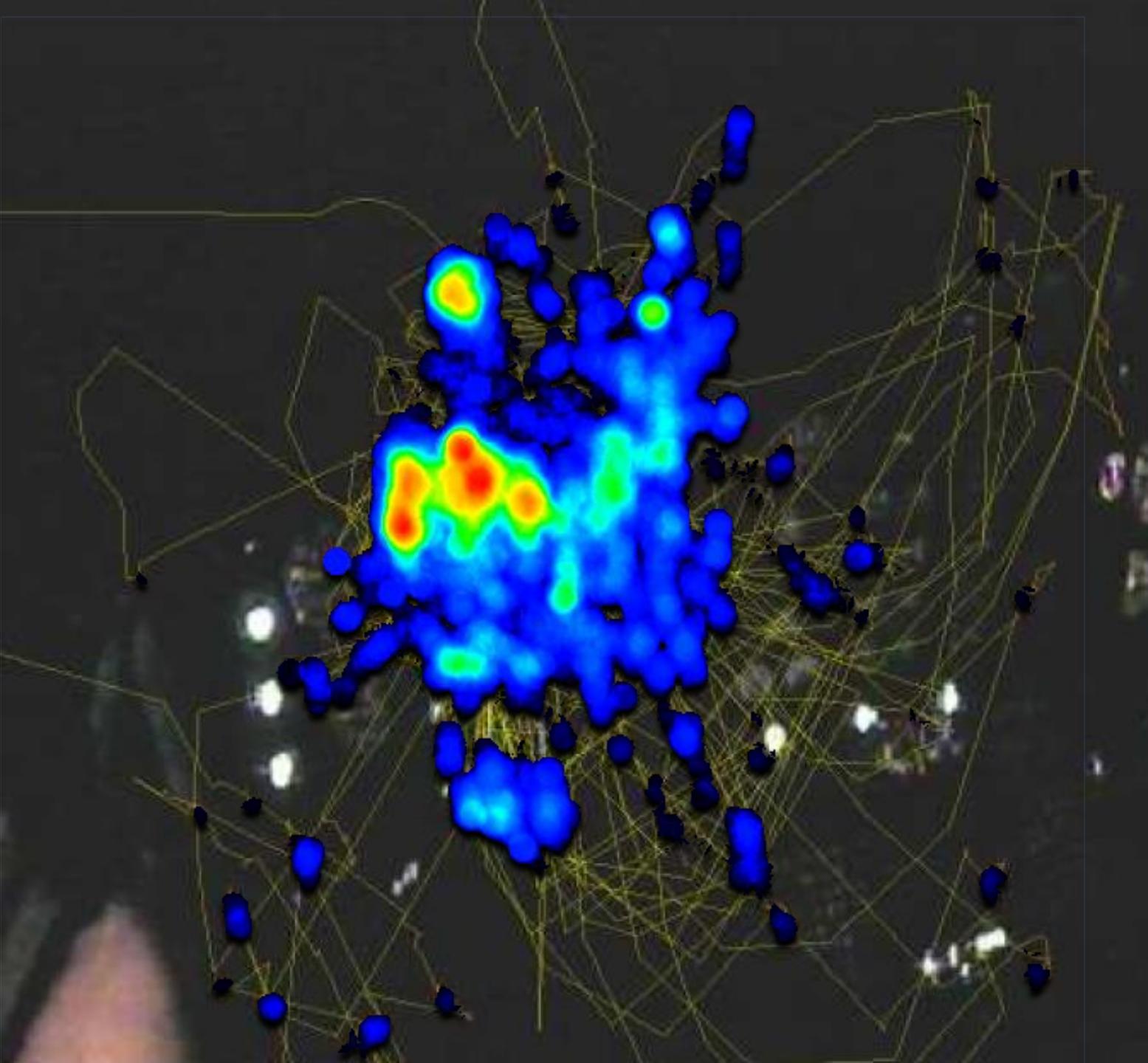
V. Peysakhovich, C. Hurter, A. Telea [pdf](#)

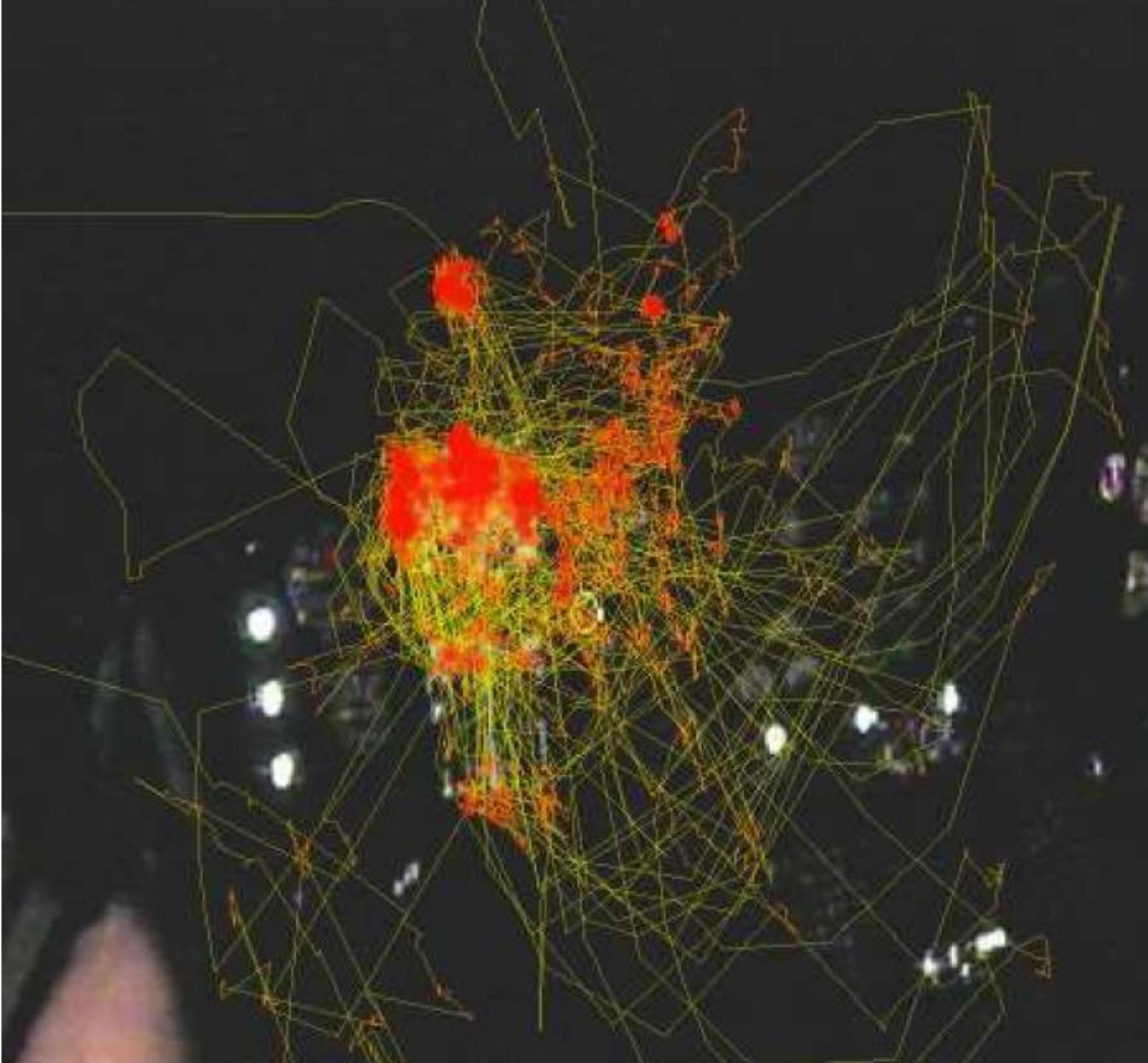
Attribute-Driven Edge Bundling for General Graphs with Applications in Trail Analysis

Proc. IEEE PacificVis, 2015





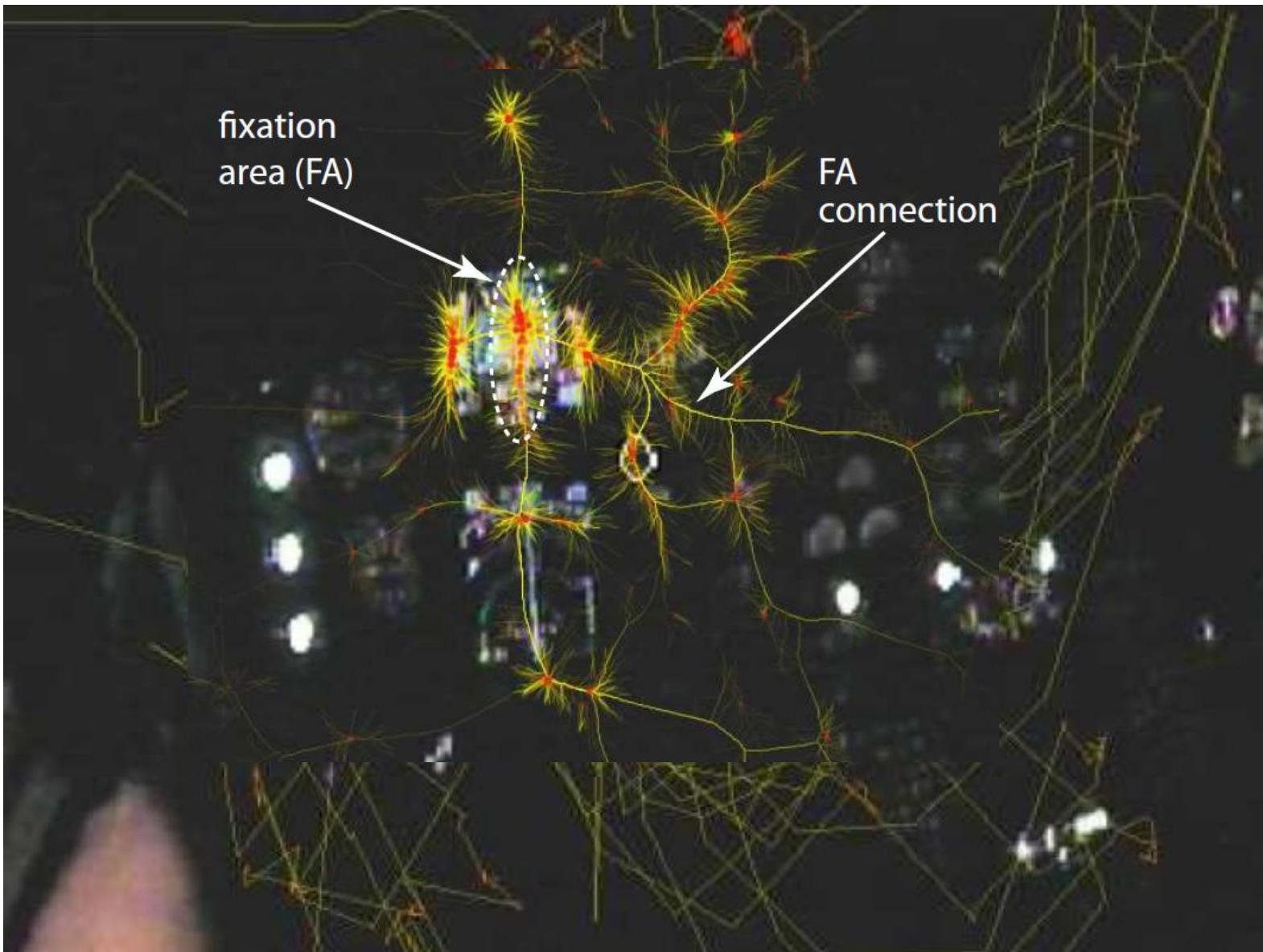




Hurter, C.; Ersoy, O.; Fabrikant, S.; Klein, T.; Telea, A.,

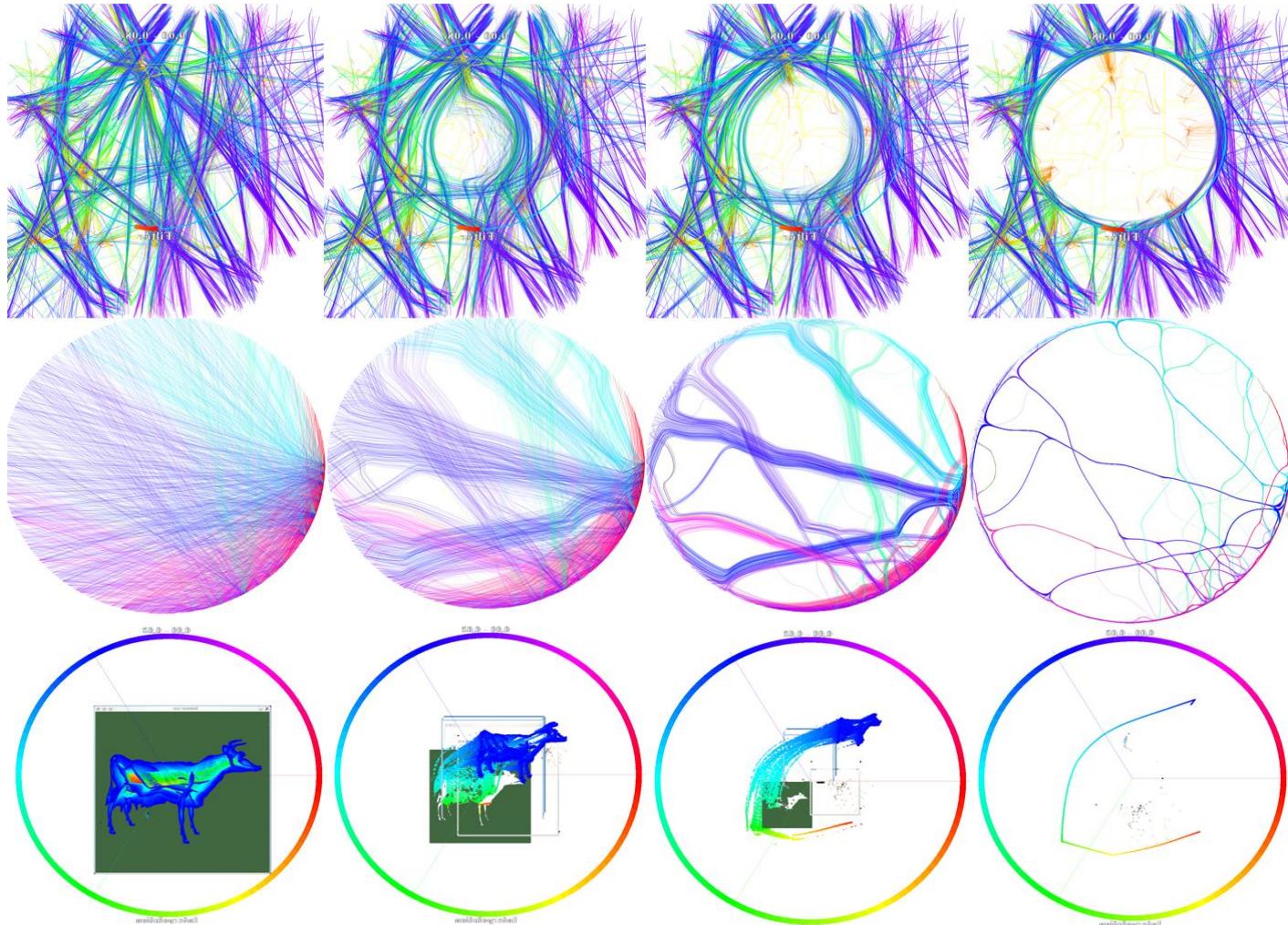
Bundled Visualization of Dynamic Graph and Trail Data.

(TVCG) *Visualization and Computer Graphics, IEEE Transactions on*, vol.PP, no.99, pp.1,1
doi= 10.1109/TVCG.2013.246



View animation
MoleView
ColorTunneling

The MoleView

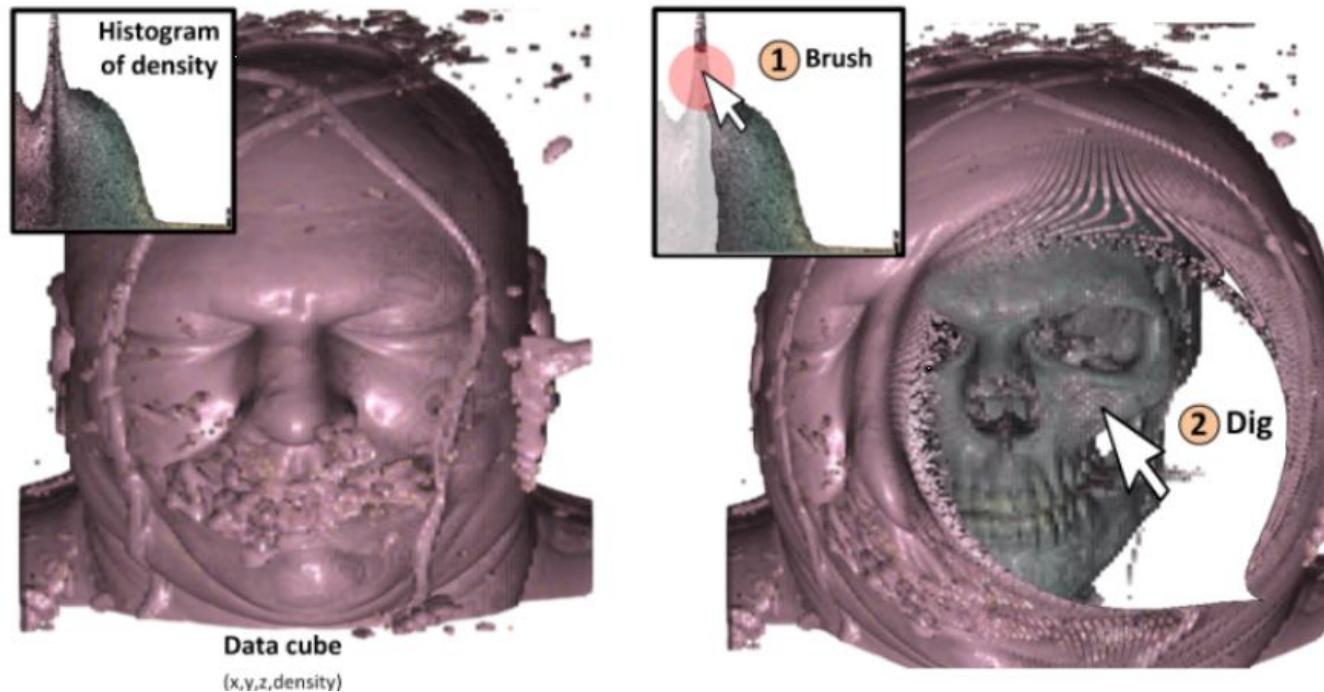


Christophe Hurter, Ozan Ersoy and Alexandru Telea. 2011. [pdf](#) [video](#) [exe](#)

MoleView: An Attribute and Structure-Based Semantic Lens for Large Element-Based Plots. *IEEE Transactions on Visualization and Computer Graphics* 17, 12 (December 2011), 2600-2609.

Color Tunneling

Pixel based visualization technique



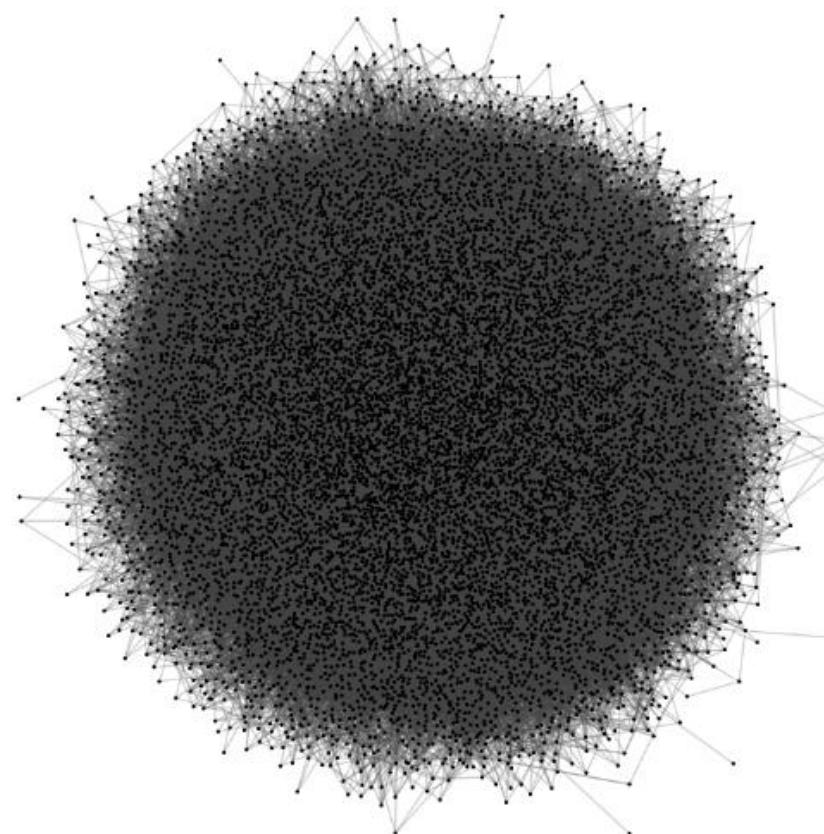
C. Hurter, A. R. Taylor, S. Carpendale and A. Telea

Color Tunneling : Interactive Exploration and Selection in Volumetric Datasets

PacificVis 2014

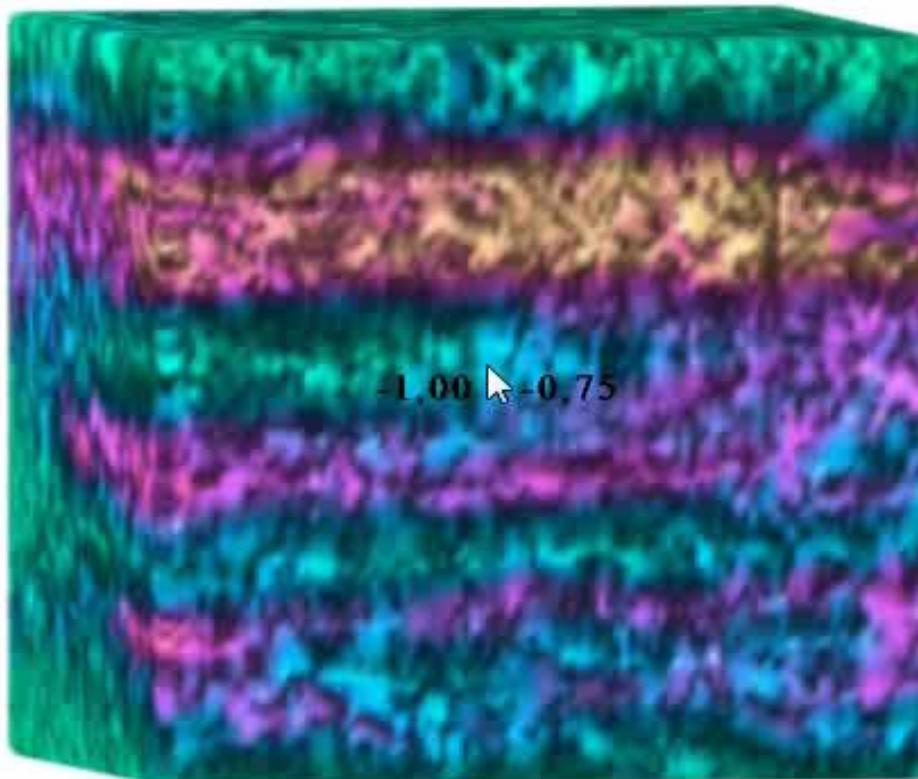
Research question

How to deal with large data set visualization
and data occlusion ?



Method

We provide a set of **real-time** multi-dimensional data deformation techniques that aim to help users to easily **select, analyze, and eliminate spatial-and-data patterns.**



Contributions

Animation as an efficient exploration tool

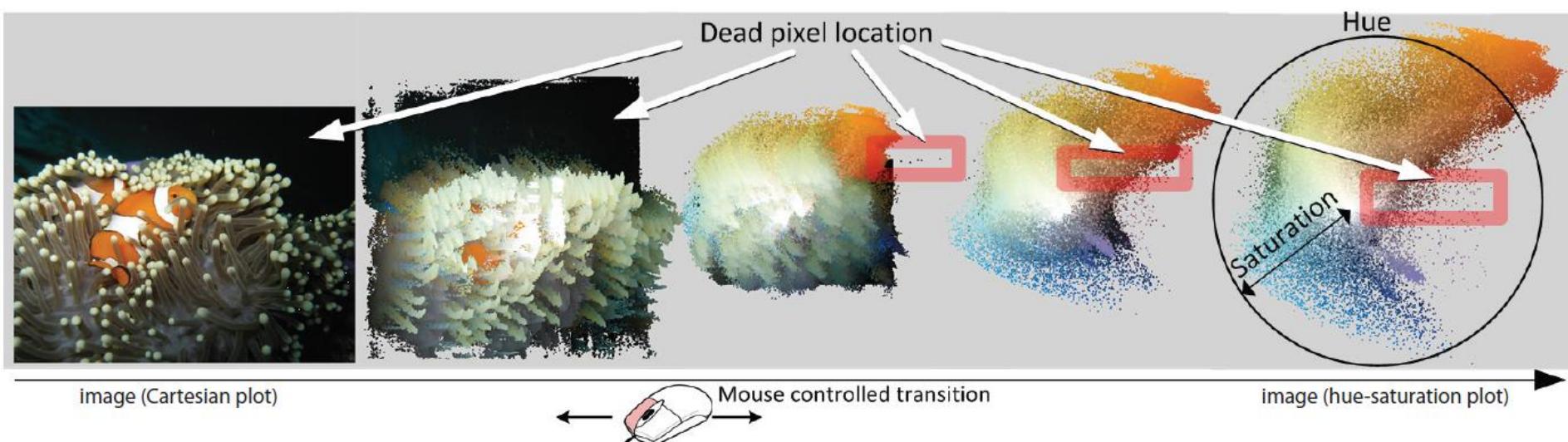
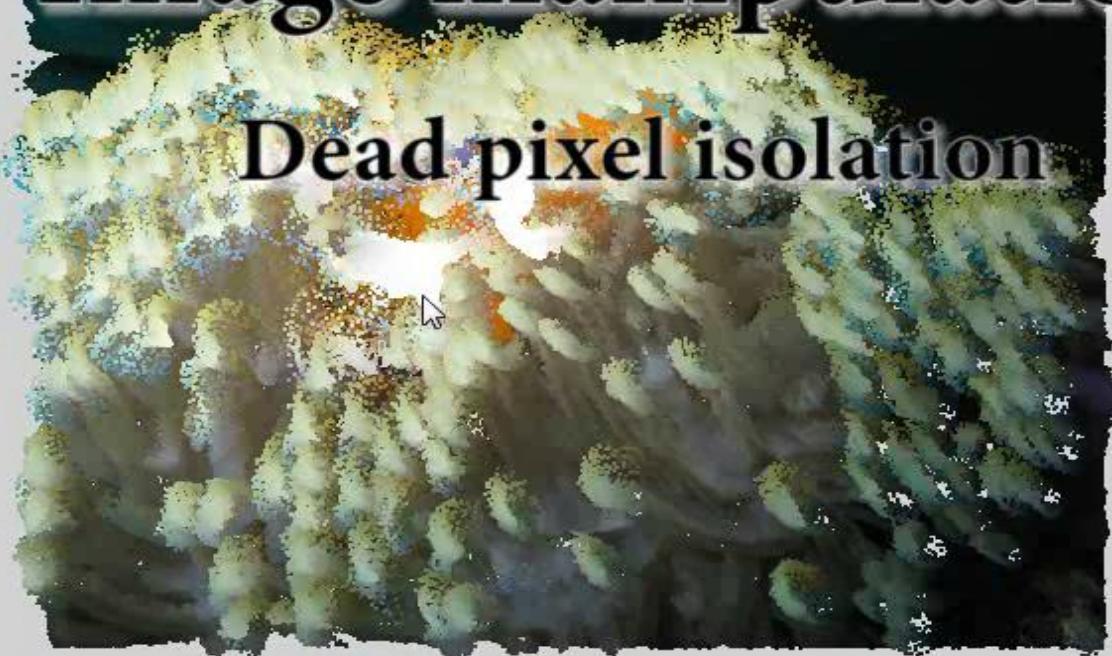


Image manipulation

Dead pixel isolation

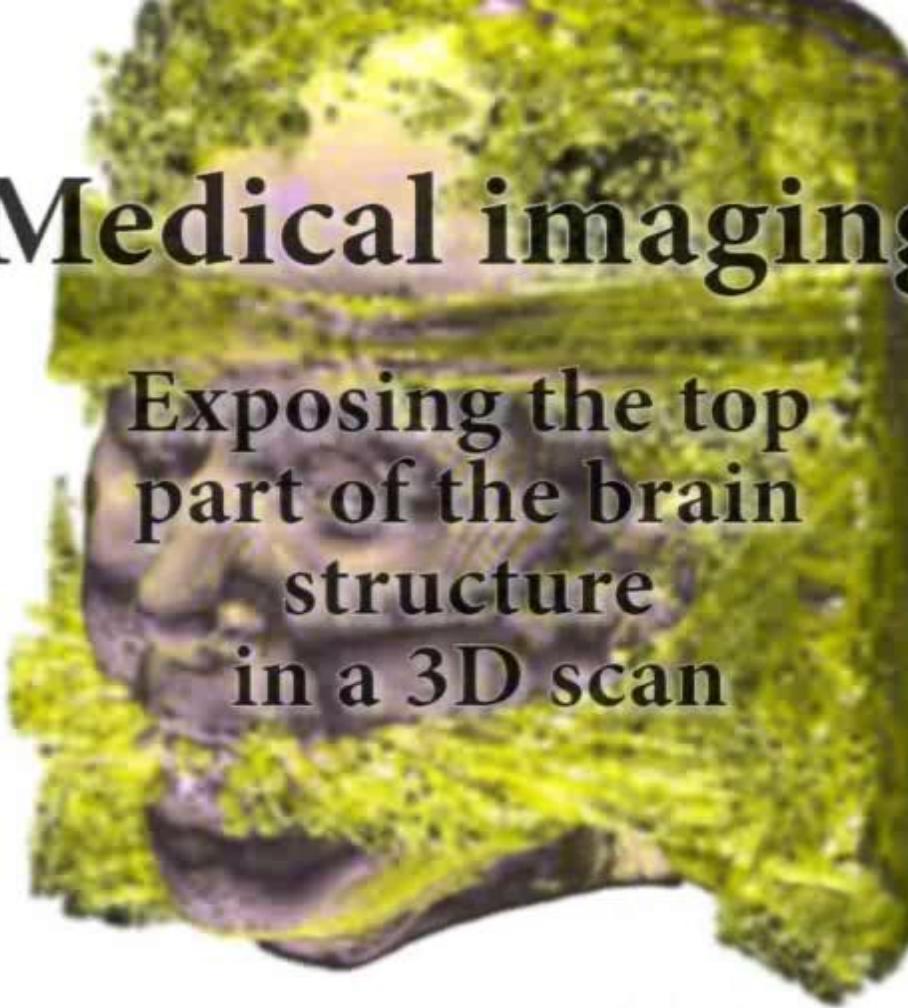


Medical imaging

Exposing the top
part of the brain
structure
in a 3D scan

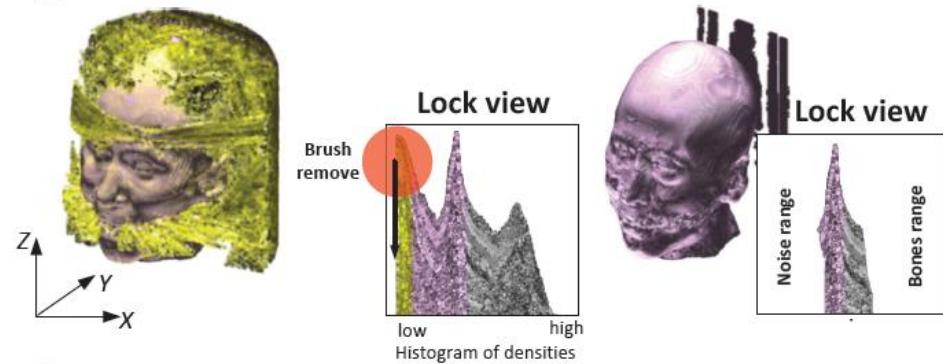
y

z

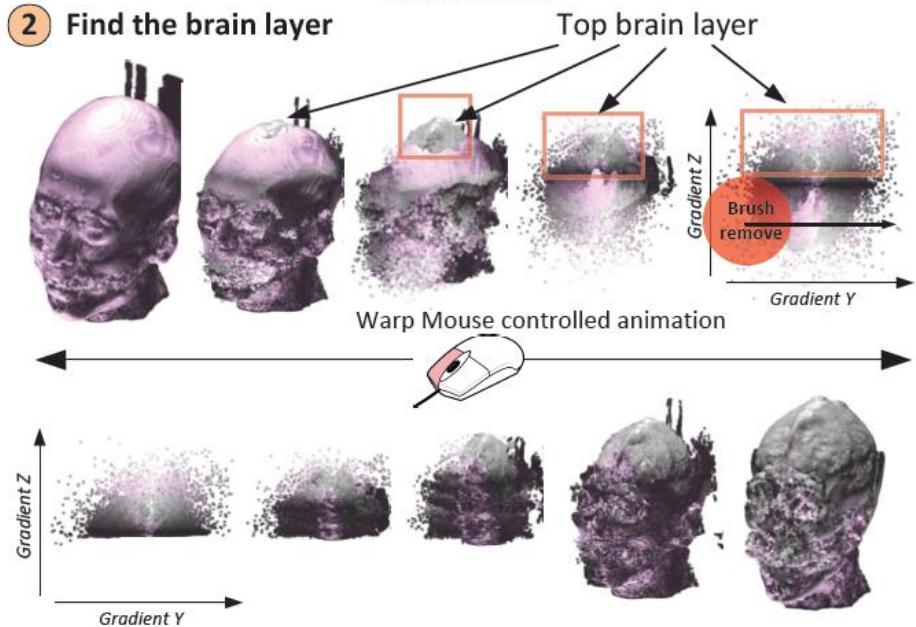


Use case 2: CT scan exploration

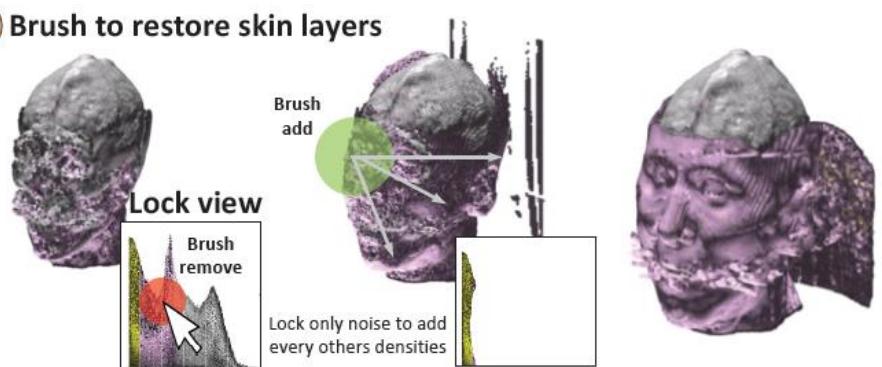
1 Brush to remove noise and bones



2 Find the brain layer



3 Brush to restore skin layers



Use case 3: image segmentation

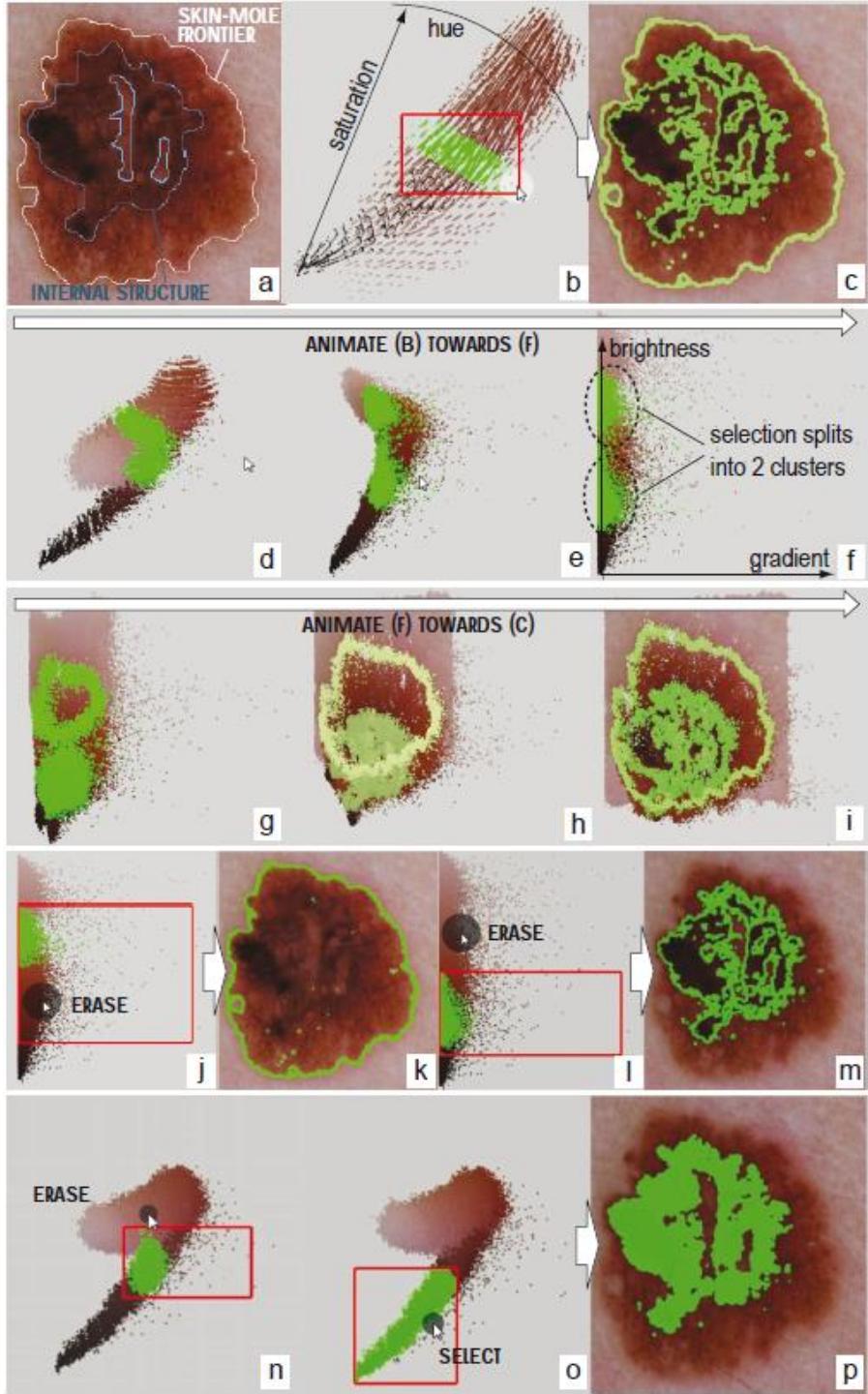
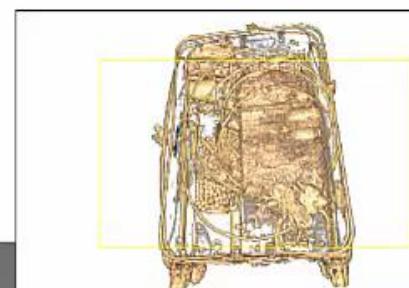
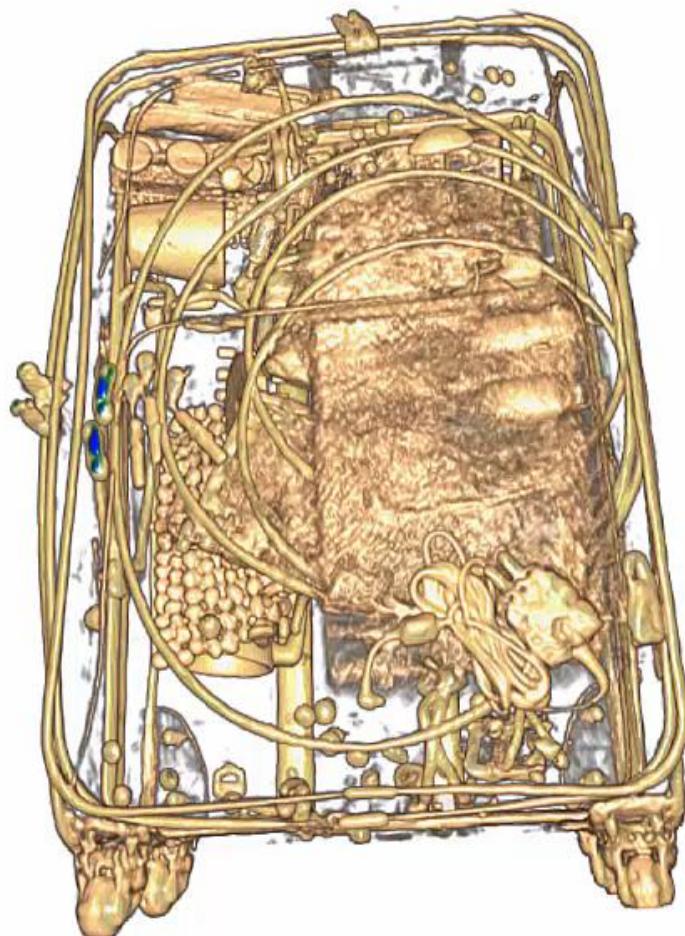


Image segmentation

Skin tumor segmentation



Open 1 view 2 views Overview Snapshots Shading Tmp



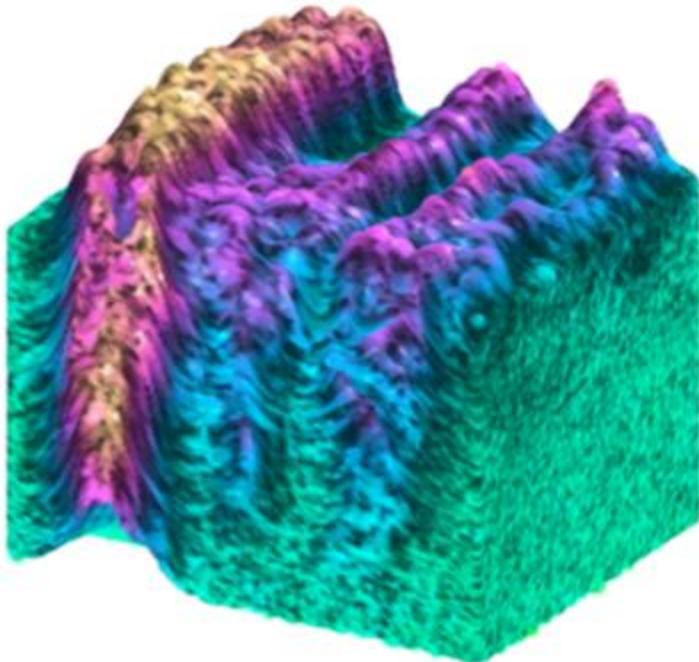
Lv1 1 Lv1 2 Lv1 3 Lv1 4 Lv1 5 Lv1 6 0,00

Contributions

GPGPU technique

Transform feedback :

GPU implementation able to handle over 10M displayed data points at a frame rate of 20 images per second on a modern graphic card.



Take away message

- Design for interaction
- Design of the visualization
- Design of the pixel-based algorithm

It takes times to leverage the user capability and expression power



MORGAN & CLAYPOOL PUBLISHERS

Image-Based Visualization

*Interactive Multidimensional
Data Exploration*

Christophe Hurter

Christophe Hurter

**Image-Based Visualization: Interactive
Multidimensional Data Exploration.**

Synthesis Lectures on Visualization, Morgan
& Claypool Publishers 2015

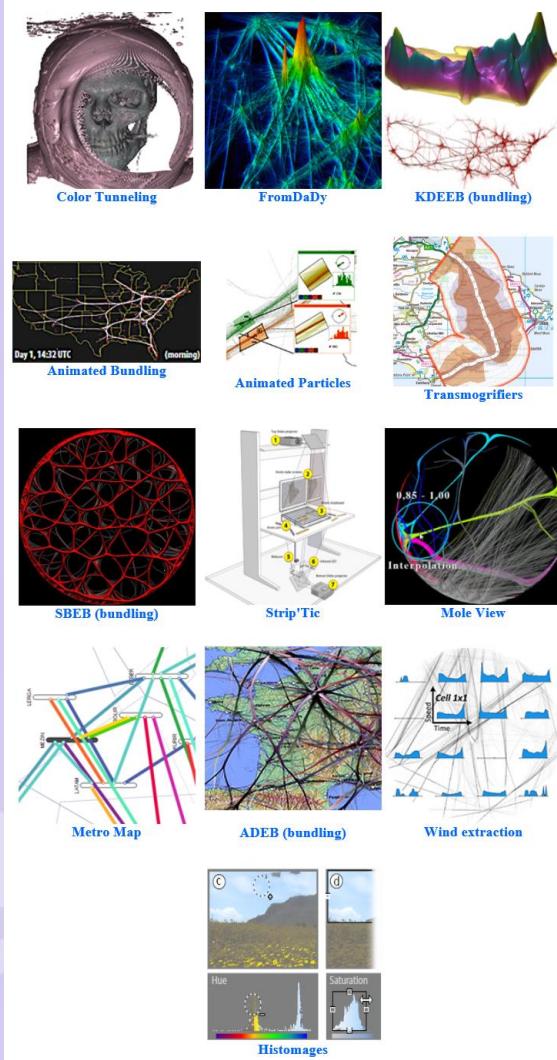
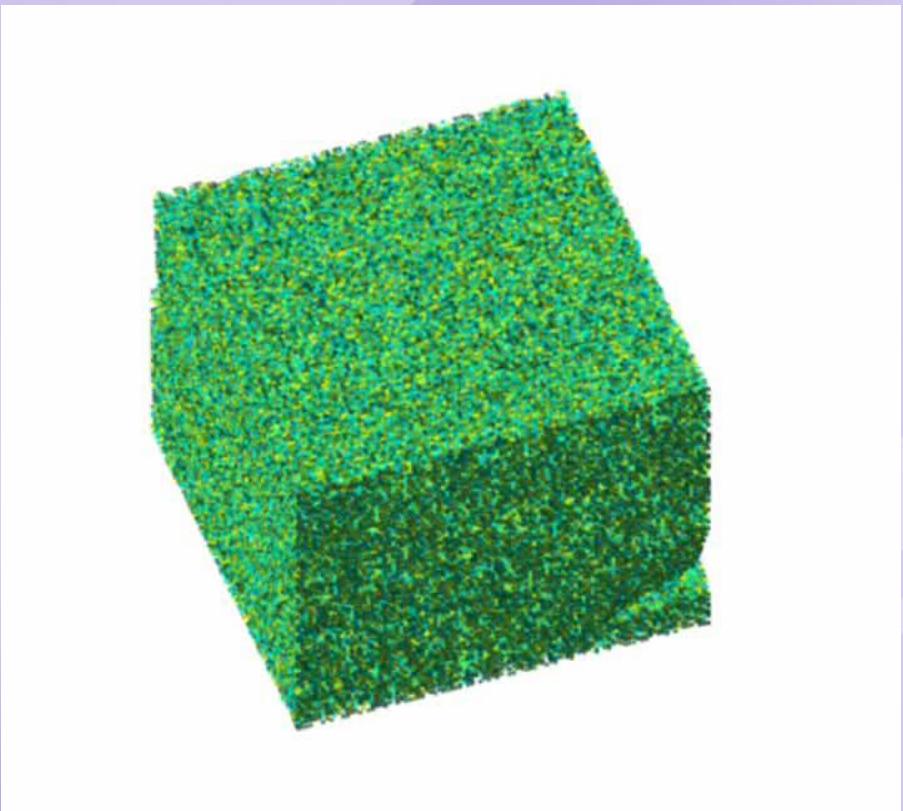
SYNTHESIS LECTURES ON VISUALIZATION

Niklas Elmqvist & David Ebert, Series Editors



Christophe Hurter

<http://www.recherche.enac.fr/~hurter/>



Direction générale de l'Aviation civile