GALEX:

Exploring the evolution and intersection of disciplines

Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

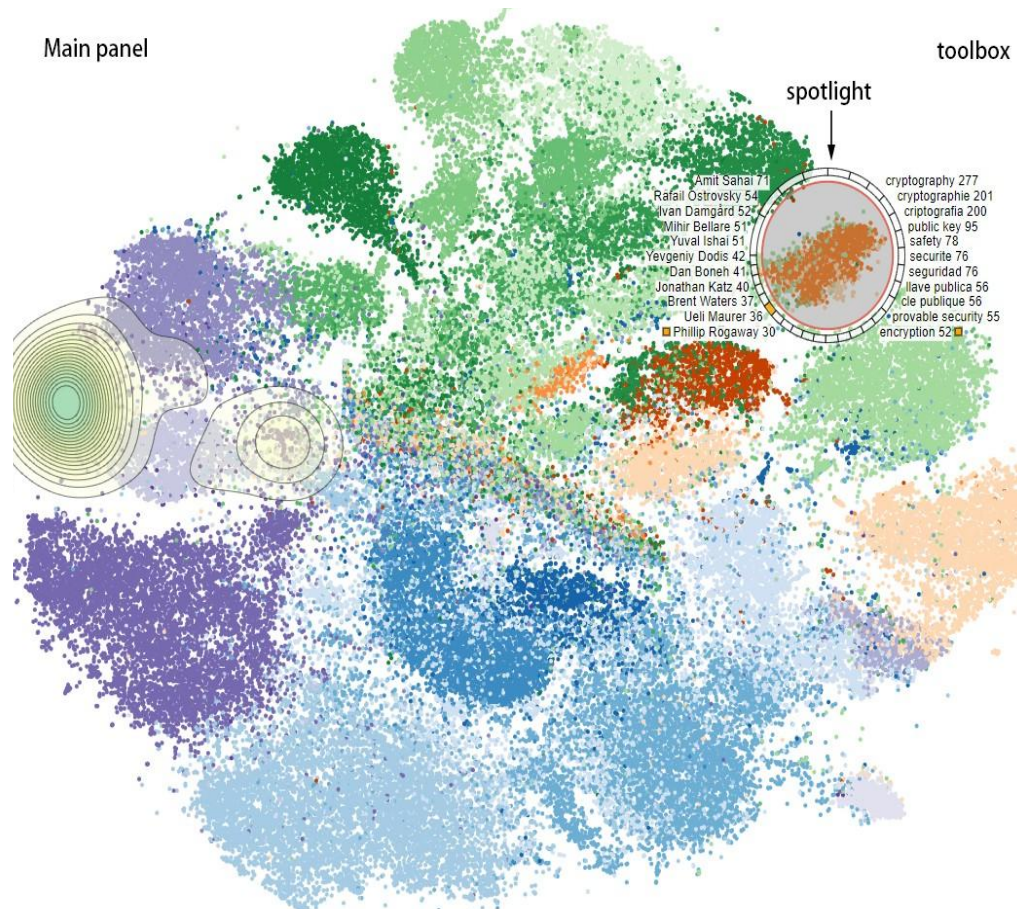Presented by :
Koosha Mirassadollahi

Main panel

toolbox

spotlight

Amit Sahai 71
Rafail Ostrovsky 54
Ivan Damgård 52
Mihir Bellare 51
Yuval Ishai 51
Yevgeniy Dodis 42
Dan Boneh 41
Jonathan Katz 40
Brent Waters 37
Ueli Maurer 36
Phillip Rogaway 30

cryptography 277
cryptographie 201
criptografia 200
public key 95
safety 78
securite 76
seguridad 76
llave publica 56
cle publique 56
provable security 55
encryption 52

Institution | paper

institution picker

University of Utah | Stony Brook University | University of California - Davis | University College London

Galaxy | Topic trees
Select All | Unselect All

time brush

1970 1975 1980 1985 1990 1995 2000 2005 2010 2015

Network panel

phrase network 1990 - 2018   10

visualization

Main panel

toolbox

Artificial intelligence Area picker panel
Computer vision
Machine learning & data mining
Natural language processing
The Web & information retrieval
Computer architecture
Computer networks
Computer security
Databases
Design automation
Embedded & real-time systems
High-performance computing
Mobile computing
Measurement & perf. analysis
Operating systems
Programming languages
Software engineering
Algorithms & complexity
Cryptography
Logic & verification
Comp. bio & bioinformatics
Computer graphics
Economics & computation
Human-computer interaction
Robotics
Visualization

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author network 1990 - 2018   3

Arie E. Kaufman

institution network 1990 - 2018   4

University of Utah

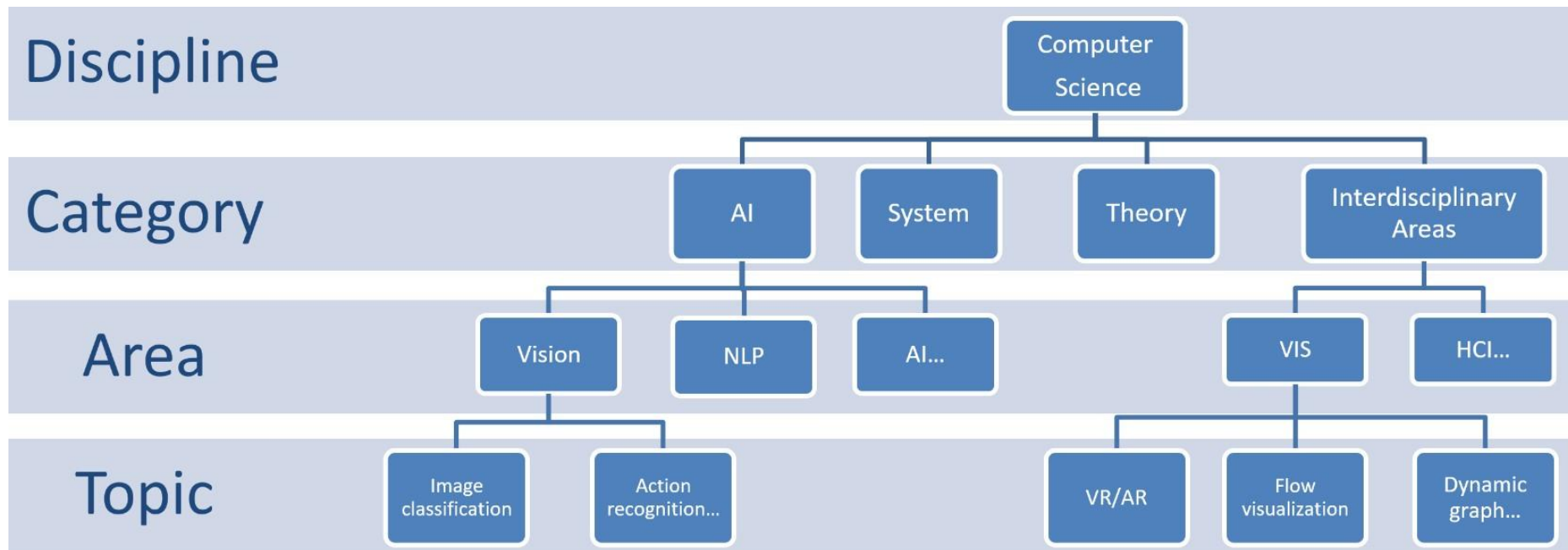Source From Fig.1 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

Source From Fig.3 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

What,How,Why

- **Marks**: Predefined Points, lines
- **Channels**: Color hue and saturation, location

- **ROI:** domains, fields,subfields
- **Task Abstractions:** analyzing, comparing, zooming and filtering,...

Previous tools:

Lacks interactivity

Evolution of topics

Semantic relevance among topics

Showing the structure of science

Related Work:Science mapping

The paper claims that the main difference between them and the precedent work is being

Algorithm-based

Mapping topics into a 2D plane

(compared to representing topics in only one dimension :rivers)

2D space is more intuitive and effective in capturing topic relationships.

The new tool:

Advantages:

- Evolution of hotspots from the viewpoints of an investor(To find the potential fields).
- Inspecting the relationship to others fields from the perspective of relevance.
- Phd candidates who want to have a macro background.
- For Students want to choose supervisors

Representation

	topic1	topic2	topic3	...	topicn
Doc1	0.03	0.02	0.002	...	0.005
Doc2	0.06	0.02	0.001	...	0.008
Doc3	0.08	0.05	0.002	...	0.015
Doc4	0.09	0.02	0.013	...	0.009

	topic1	topic2	topic3	...	topicn
Doc1	0.09	0.02	0.02	...	0.05
Doc2	0.06	0.02	0.21	...	0.08
Doc3	0.08	0.05	0.02	...	0.15
Doc4	0.09	0.02	0.13	...	0.09

Doc2Vec   **LDA**

Text preprocessing

stop words removal
lemmatization
key phrases extraction

Datasets

CSRankings

Category

Area1   Area2

Scopus
keywords
abstract

title +

Co-occurrence Matrix

	entity 1	entity 2	entity 3	entity 4	entity n
entity 1		10	7	30	...
entity 2	10		20	8	...
entity 3	7	20		12	...
entity 4	30	8	12		...
entity n	...	...	...	...	

t-SNE   t-SNE   Force-directed

Visual exploration

Dig into an area →
← Check context

Discipline layer

Split into institutions →
← Merge back

Area layer

Structural information ←

Institution layer

Entity networks

phrase network 2010 - 2018

Knowledge discovery

Evolution   **Intersection**   **Institution comparison**   **Community discovery**

time-varying data visualization

information visualization

phrase network 1995 - 2018

Source From Fig.2 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

Data hierarchy

- **Discipline level**
- **Area level:** origin, growth, fusion, seperation, decline
- **Institution level:** academics Popularity of topics and phrases that are involved in Galex, including phrases, institutions, and authors.

Who could use it?

- Students
- Decision-makers
- Professors
- Analysts
- Investors

The video

https://vimeo.com/360154945

Effectiveness

• Design and implementation of a hierarchical and integrated visual analysis framework that allows analysts to understand a scientific field from macro- to micro-perspective;

• Design of a flexible time brush and a context-aware spotlight, they empower analysts to quickly grasp the semantics of region of interest in any time slice. We also design a synchronous spotlight which enables the comparison of sets of document collections;

• Design of a topic tree metaphor which enables analysts to review topic evolution intuitively and to find representative papers of each topic and potential inter-topical papers expediently;

• Provision of a set of networks revealing the backbone of a field, as a complementary to the structure captured by text data.

Visual Exploration of the Intersections among Scientific Fields

Examples: co -occurrence topical words, Showing citation

Chunag->mapped the topic similarity between areas

Pivot slice

CiteVis2, CiteMatrix

Literature Visualization Software

Cite space->literature review, scientific paradigms identification, topic evolution detection.

VOS viewer-> focuses on creating bibliometric networks . journals , papers, authors and phrases(heatmaps)

CitNet Explorer-> aims the development of research topics

Action science explorer->integrates reference management and network analysis

GALEX: illustrates a hierarchical understanding of on discipline from macro to micro.

Requirements analysis

Use Cases:
1. Disciplinary planning
2. Daily research
3. Career planning

R1 - Comprehension of the overview of one field, inspection of the relationship between its sub-fields, and rapid determination of key entities, such as phrases, institutions, and authors, of any part of the field;

R2 - Perception of hotspots and their evolution, detection of the emergence, rise, decline, fusion, and separation of a field, and inspection of changes in key entities across time;

R3 - Checking the influence scope of a field and exploration of its intersection with other fields;

R4 - Comparison of the academic performances and topic distributions among institutions;

R5 - Detection of top scholars and institutions in a field and assessment of the cooperation among them.

Design, details, interface considerations
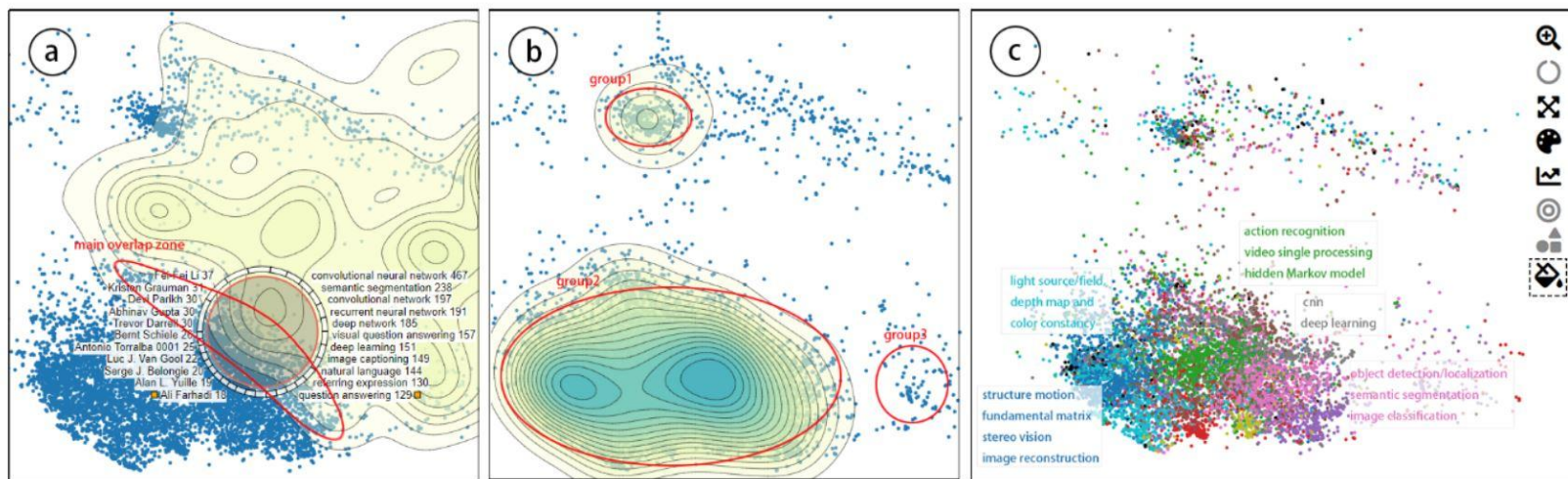
Fig. 4: The main overlap zone between the AI (contour line) and CV area (points) located at the upper right side of the latter. Spotlight indicates the top scholars, institutions (arcs), and phrases inside the covered region ⓐ. Contour line of CV indicates that most papers are distributed across three groups and Group 2 owns most of the papers, forming two cores ⓑ. Paper will be re-colored by its predominant topic after clicking 🪣 ⓒ.

Source From Fig 4 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE
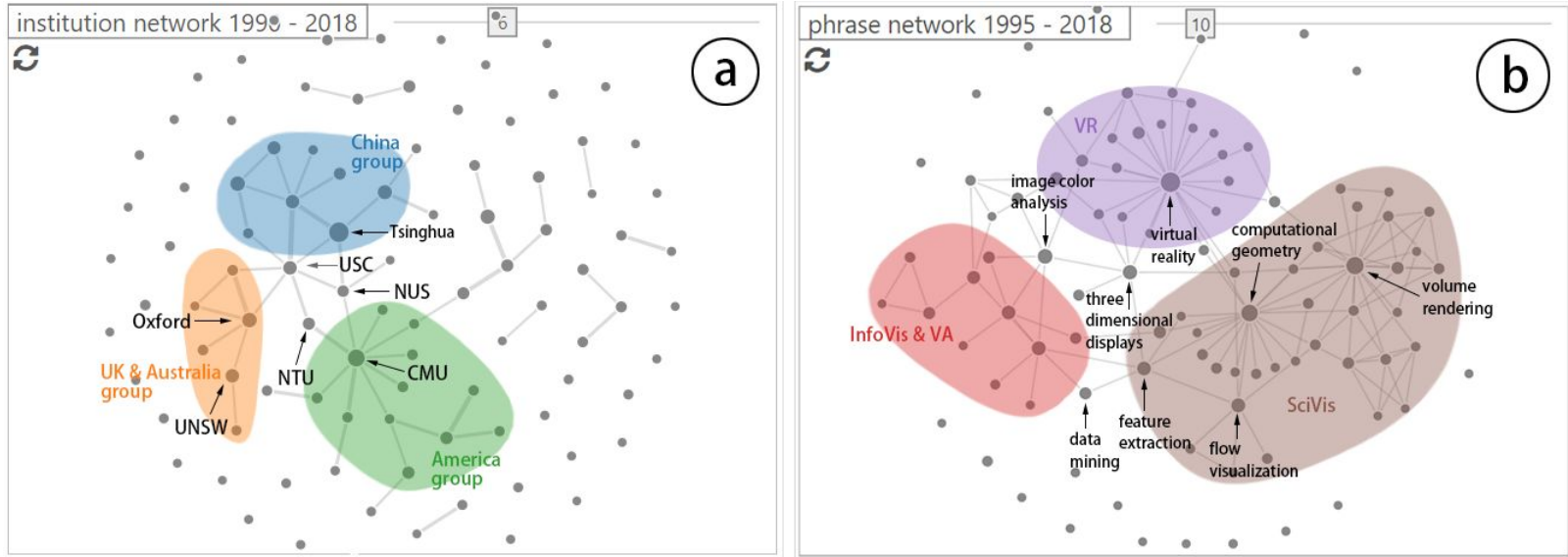
Time Slices Creator

Source From Fig.5 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE
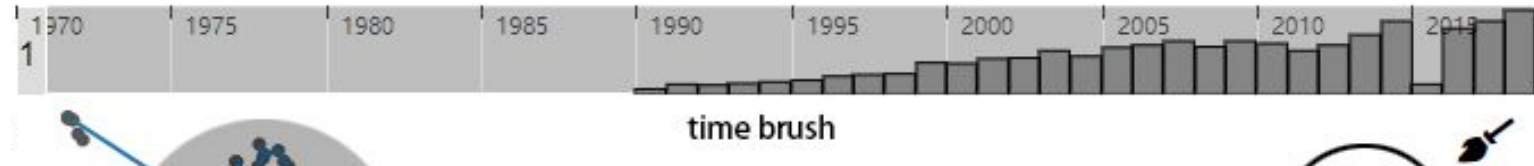
Small snapshots and entity lists

Source From Fig. 6 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE
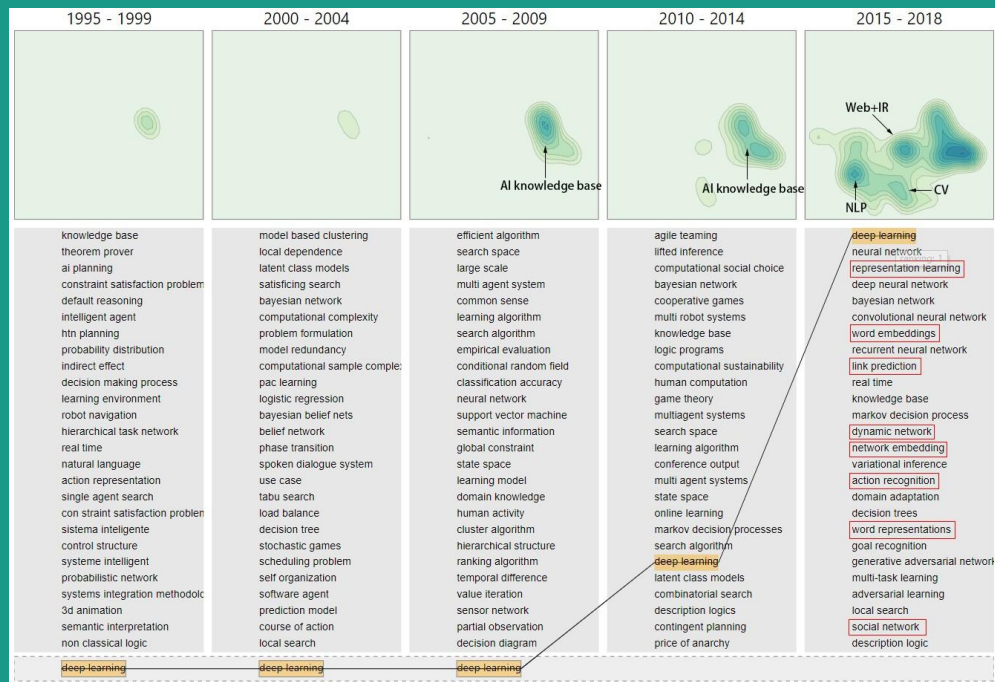
Cumulative time Slice

Area layer.
tSNE+LDA
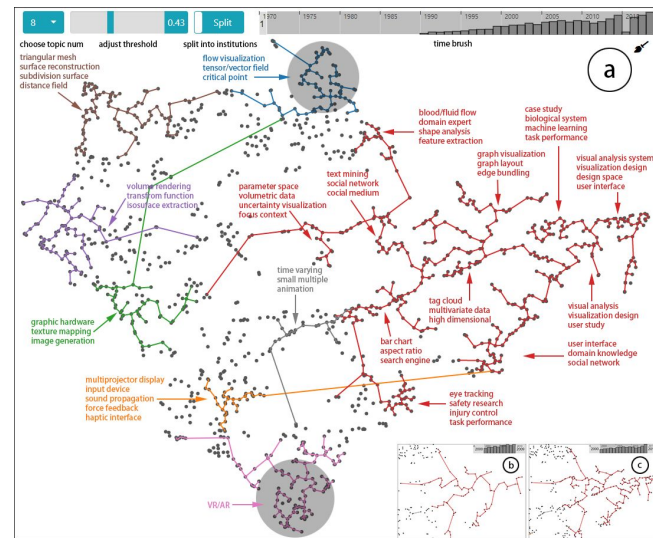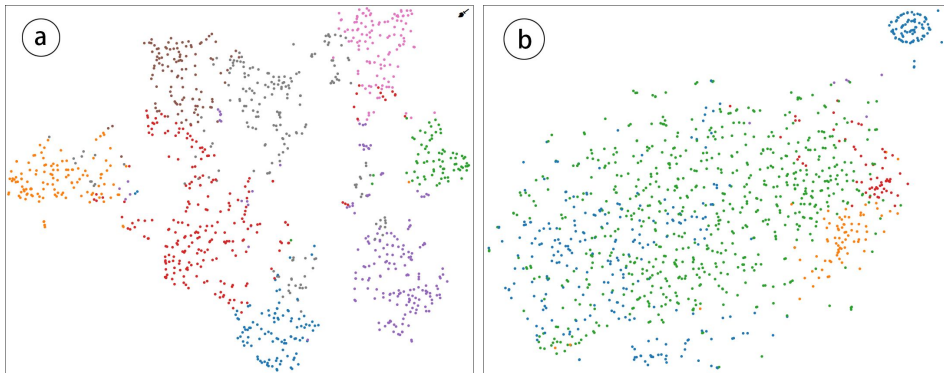
Source From Fig.7,8 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

Institution Level Multiple Spotlights

Synchronous interactions

Line Charts

Comparing between two institutions

Time brush: differences in different disciplines
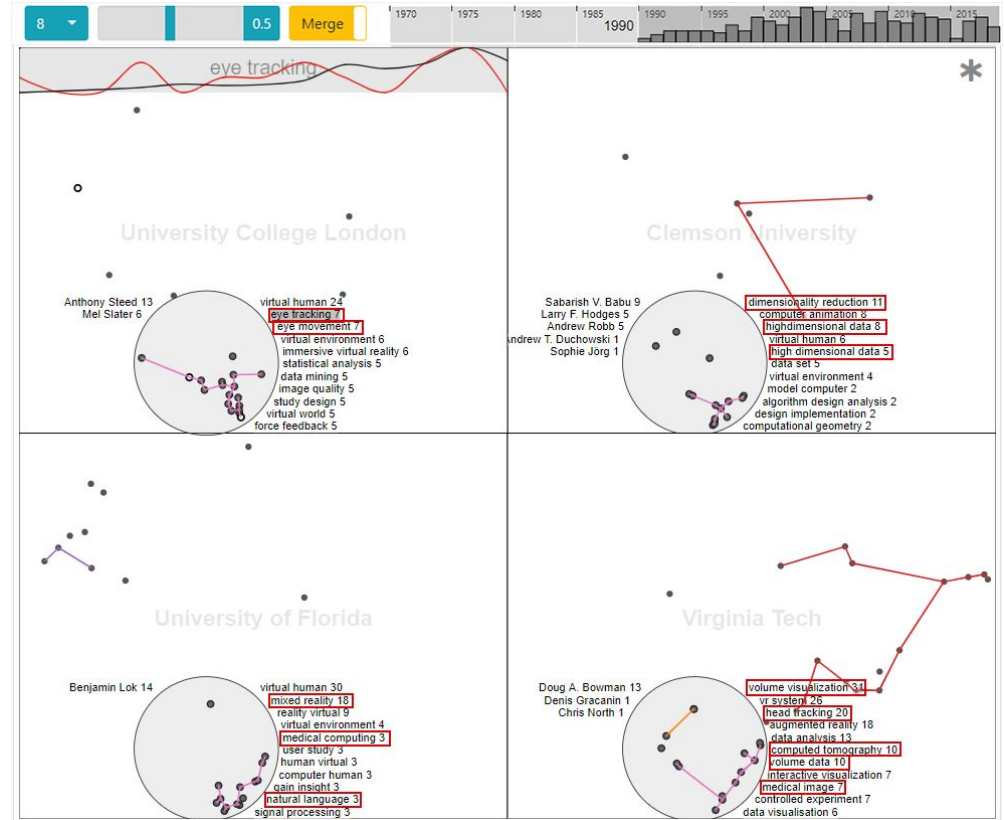
Source From Fig.10 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

Source From Fig.11 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

Network Panel:

Three entity networks provided in the network panel:

- Phrase co-occurrence,
- author cooperation,
- institution cooperation networks

The networks help analysts to deepen the understanding of the structure of research areas from different perspectives,

Case 1: focus on the Computer Vision.
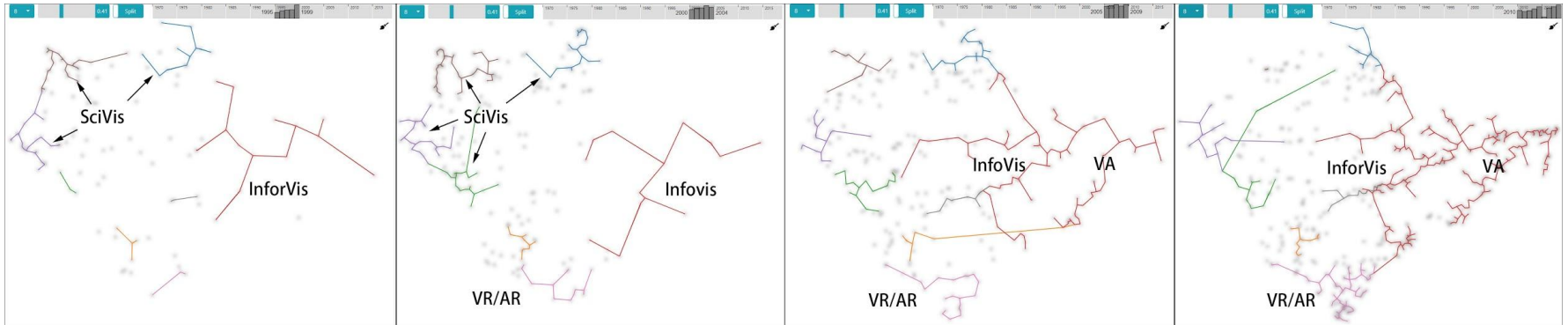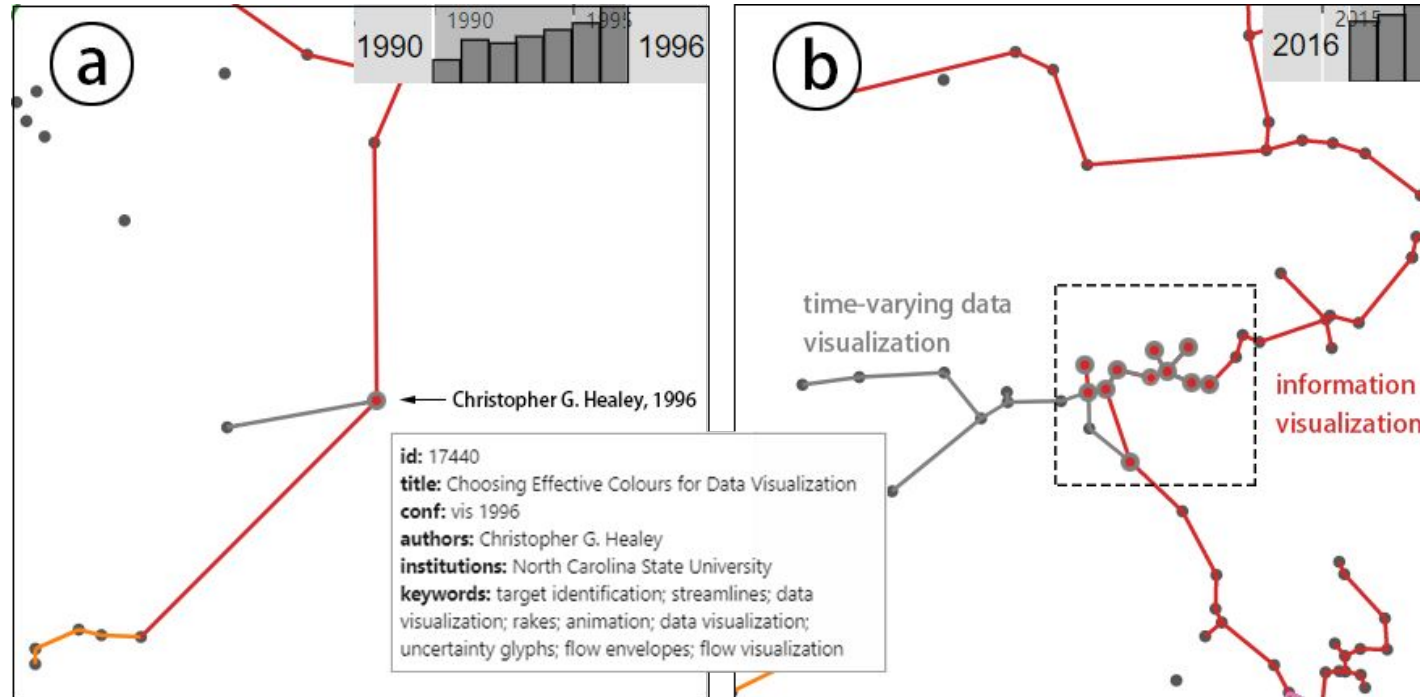
Topic-driven shift and Technique-driven shift

Source From Fig.14 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE
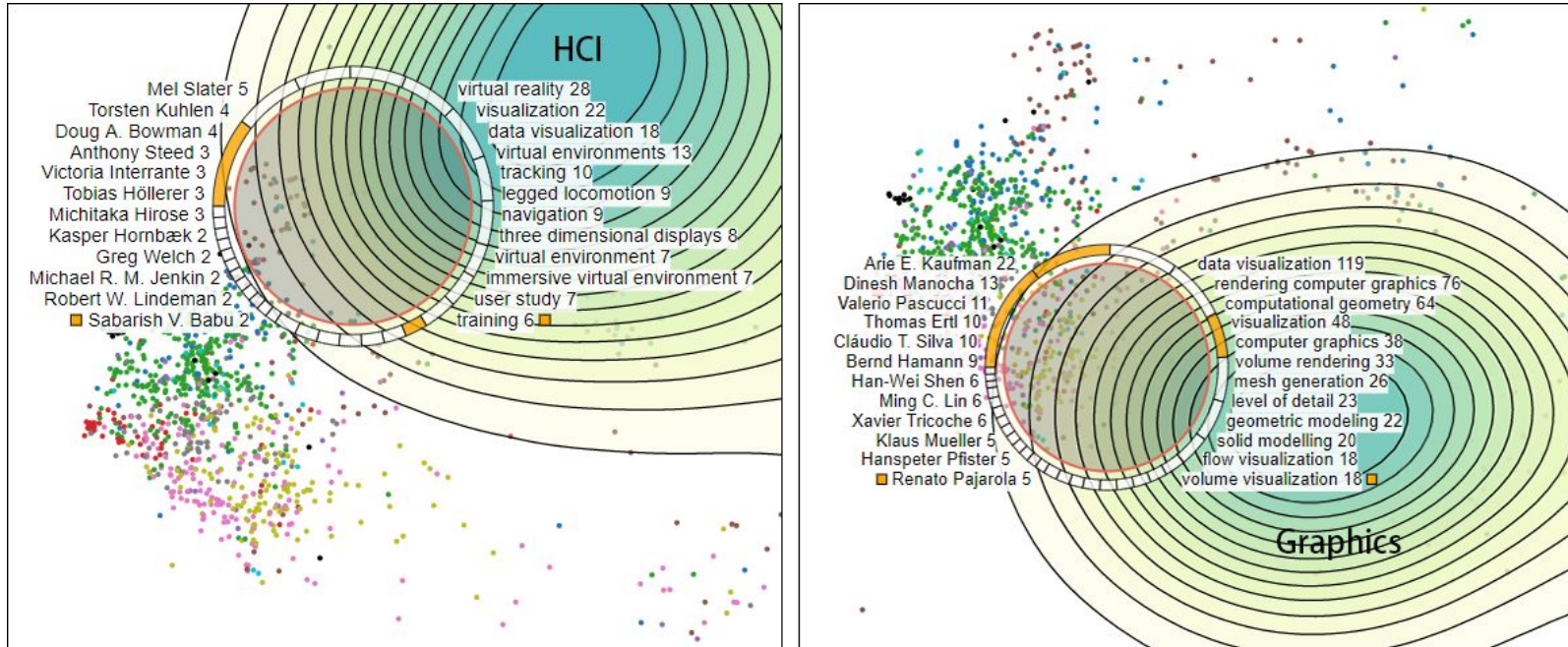
Case 1: focus on the Computer Vision.
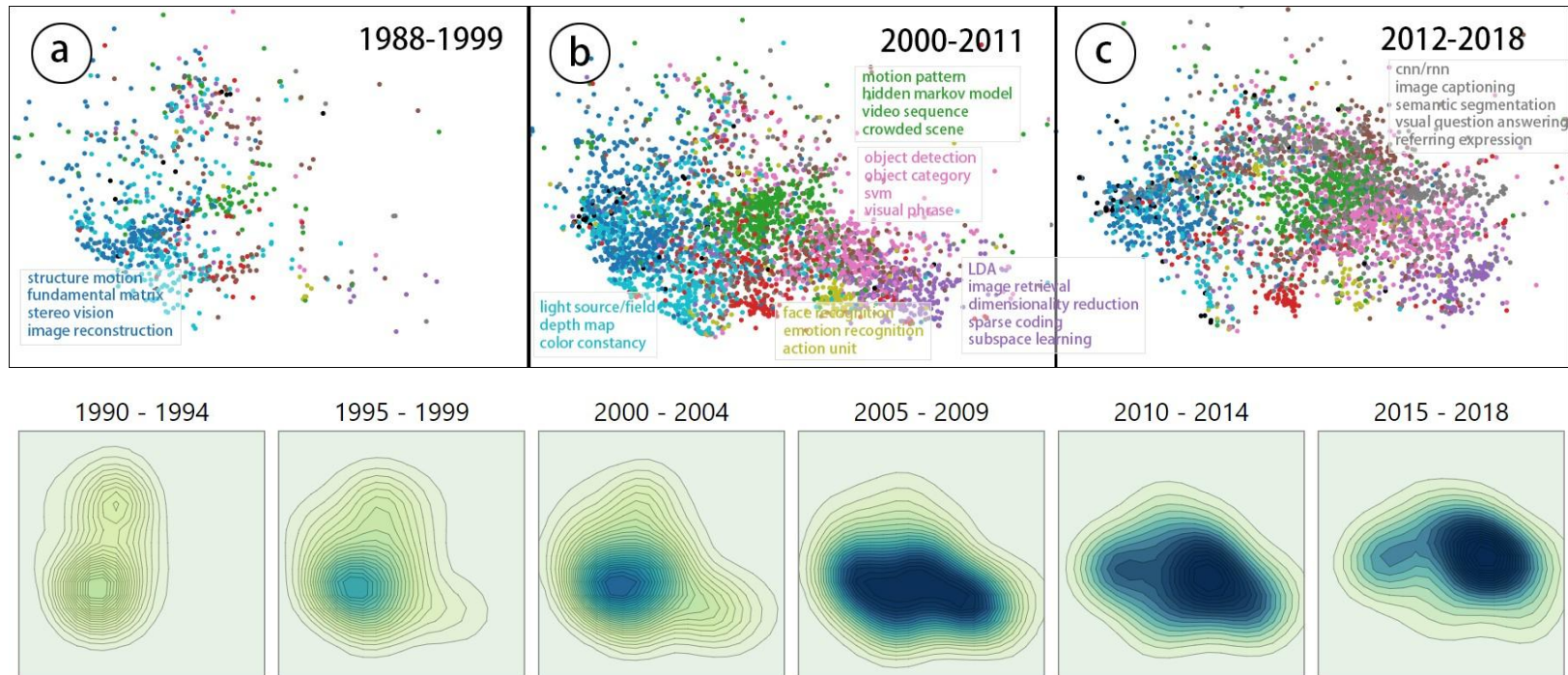
Source From Fig.12,13 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

Case2: Focus on Visualization

Source From Fig.15 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

Case2: Focus on the entire Computer Science

Source From Fig.16 of "Galex: Exploring the Evolution and Intersection of Disciplines", Zeyu Li, Changhong Zhang, Shichao Jia, and Jiawan Zhang, Senior Member, IEEE

Discussion:User Feedback

Finally, we collected their feedback informally. They all agreed that Galex is comprehensive and well-designed, enabling them to gain new insights into a discipline from multiple perspectives quickly and effectively. They favored the interaction components for their natural, flexible, and easy-to-use characteristics.They also pointed out some weaknesses, such as the weak

logical association of the last layer with the first two, and the newly

added papers in topic trees are not explicitly highlighted. They also put forward several suggestions, such as implementing panning and zooming in the area layer and replacing the uncommon interaction: triggering an action by hovering over the element for 1 s. Finally, all the professors are willing to use our system in their daily research.

Scalability

Limitations

Generalizability

Data Quality

Strengths

- Showing a comprehensive overview with different scales
- Interactivity and User friendly
- Basic Design!
- Comparison between areas, institution, phrases, ...

Weaknesses

- Vague labels and details
- Not really explaining the algorithm
- Marks, Basic Design
- Overlap in Clustering

Q & A

Thank You