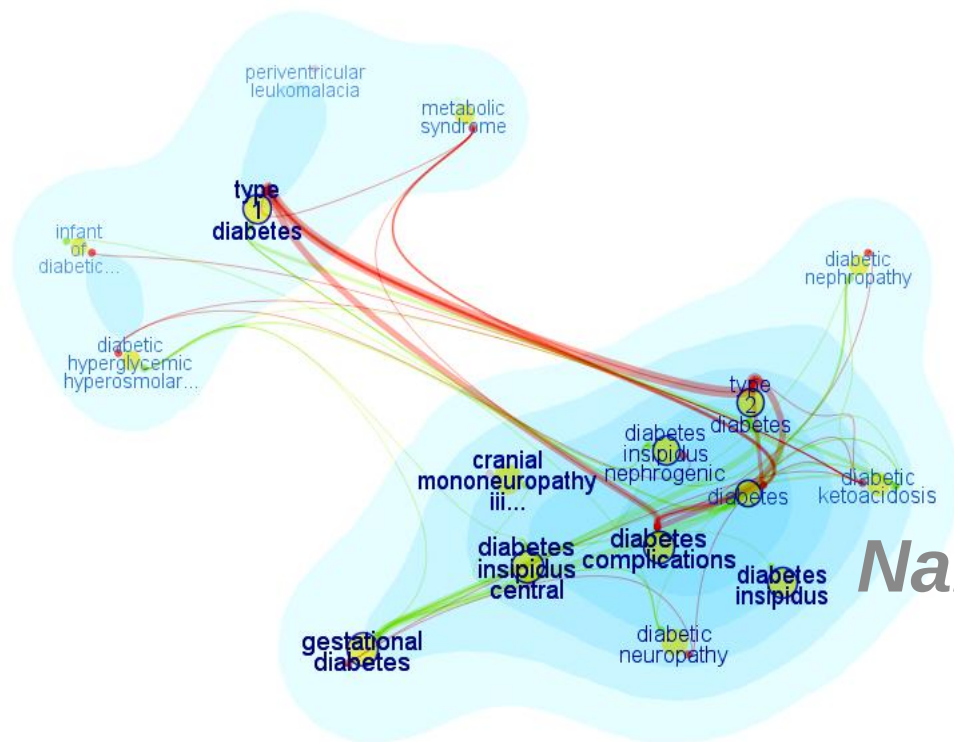


FacetAtlas: Multifaceted Visualization for Rich Text Corpora

*Nan Cao, Jimeng Sun, Yu-Ru Lin, David Gotz
Shixia Liu, Huamin Qu
InfoVis 2010*



Introduction

Google Health - Congenital ... x

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Congenital heart disease

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multiple facets
of Medicine

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Overview

Congenital heart disease refers to a problem with the heart's structure and function due to abnormal heart development before birth. Congenital means present at birth.

Symptoms

Symptoms depend on the specific condition.

Treatment

Treatment depends on the specific condition. Most congenital heart diseases require medications and surgery to repair the defect.

Causes

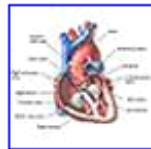
Congenital heart disease (CHD) can describe a number of different problems affecting the heart. According to the American Heart Association, about 35,000 babies are born each year with some type of congenital heart defect. Congenital heart disease is responsible for more deaths in the first year of life than any other birth defects. Many of these defects need to be followed carefully. Some heal over time, others will require treatment.

While congenital heart disease is present at birth, the symptoms may not be immediately obvious. Defects such as [coarctation of the aorta](#) may not cause problems for many years. Other problems, such as a small [ventricular septal defect](#) (VSD), may never cause any problems, and some people with a VSD have normal physical activity and a normal life span.

Some congenital heart diseases can be treated with medication alone, while others require one or more surgeries. The risk of death from congenital heart disease surgery has dropped from about 30% in the 1970s to less than 5% in most cases today.

Congenital heart disease is often divided into two types: cyanotic (blue discoloration caused by a relative lack of oxygen) and non-cyanotic. The following lists cover the most

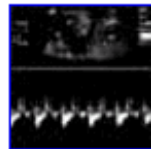
Illustrations



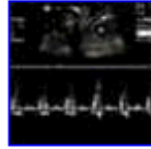
[Heart, section through the middle](#)



[Heart, front view](#)



[Ultrasound, normal fetus - heartbeat](#)



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[PPP suggested for addressing increasing cases of congenital heart diseases of poor](#)
 pharmabiz.com - 5 days ago
 Approximately five per cent of the babies born with **congenital heart disease** have defects disrupting the blood flow from the right ventricle to the ...

[CUHK's Latest Update on Minimally-Invasive Treatment of Atrial Septal Defect](#)
 HealthCanal.com - 1 week ago
Congenital heart disease occurs in 1% of newborn infants and 85% of them survive into adulthood due to improved medical care. Atrial septal defect (ASD, ...

[walk-a-thon to fill hearts born with rare defect](#)
 New Haven Register (subscription) - 3 weeks ago
"Congenital heart disease is the No. 1 birth defect in infants, affecting more than 40000 children each year," she said. "Not enough people know that! ...

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Congenital heart disease

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Symptoms depend on the

Treatment

Treatment depends on the medications and surgery

Causes

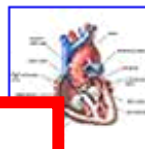
Congenital heart disease the heart. According to the each year with some type responsible for more deaths these defects need to be treatment.

While congenital heart disease immediately obvious. Defects for many years. Other people never cause any problems, and some people with a VSD have normal physical activity and a normal life span.

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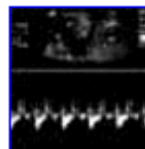
Illustrations



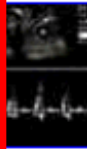
[Heart section the middle](#)



[Heart, front view](#)



[Ultrasound, normal fetus - heartbeat](#)



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biz.com - 5 days ago
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[Latest Update on Minimally-Invasive Treatment Septal Defect](#)
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New Haven Register (subscription) - 3 weeks ago
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Diabetes

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Overview

Diabetes is a chronic (lifelong) disease marked by high levels of sugar in the blood.

See also:

- [Gestational diabetes](#)
- [Type 1 diabetes](#)
- [Type 2 diabetes](#)
- [Metabolic syndrome](#)

Symptoms

High blood levels of glucose can cause several problems, including:

- Blurry vision
- Excessive thirst
- Fatigue
- Frequent urination
- Hunger
- Weight loss

However, because type 2 diabetes develops slowly, some people with high blood sugar experience no symptoms at all.

Symptoms of type 1 diabetes:

- Fatigue
- Increased thirst
- Increased urination
- Nausea
- Vomiting
- Weight loss in spite of increased appetite

Patients with type 1 diabetes usually develop symptoms over a short period of time. The condition is often diagnosed in an emergency setting.

Symptoms of type 2 diabetes:

- Blurred vision
- Fatigue
- Increased appetite
- Increased thirst
- Increased urination

Treatment

The immediate goals are to treat [diabetic ketoacidosis](#) and high blood glucose levels. Because type 1 diabetes can start suddenly and have severe symptoms, people who are newly diagnosed may need to go to the hospital.

The long-term goals of treatment are to:

- Prolong life
- Reduce symptoms
- Prevent diabetes-related complications such as blindness, heart disease, kidney failure, and amputation of limbs

These goals are accomplished through:

- Blood pressure and cholesterol control
- Careful self-testing of blood glucose levels
- Education
- Exercise
- Foot care
- Weight planning and weight control
- Medication or insulin use

There is no cure for diabetes. Treatment involves medicines, diet, and exercise to control blood sugar and prevent symptoms.

Illustrations

[Diabetic ketoacidosis](#) [Diabetic neuropathy](#) [Edema of the legs](#)
[Foot ulcers](#) [Hypertension](#) [Insulin pump](#)
[Insulin injection](#) [Retinopathy](#) [Type 2 diabetes](#)
[Diabetic neuropathy](#) [Foot and heel ulcers](#) [Insulin injection and device](#)

News

[Scientists reveal new clues to origin of diabetes](#)
10/11 - 14 hours ago
Scientists have identified events inside insulin-producing pancreatic cells that set the stage for a neonatal form of non-autoimmune type 1 diabetes.

[Kurdish Doctor: Diabetes Institute signs agreement with the Forsyth Institute](#)
Burien/Vietnam press release - 1 day ago
CAUBERIDGE, Mass., October 12 -- In the face of a dramatic worldwide increase in adolescent obesity and Type 2 diabetes, The Forsyth Institute today...

[Are diabetes and risk of heart attack, stroke](#)
10/11/2010 - 2 days ago
A set of conditions known to accompany or portend type 2 diabetes, including obesity and high blood sugar, could more than double a person's risk of...

Google Scholar

[Role of insulin stress in development of complications in diabetes](#)
[J Baynes - Diabetes, 1991 - diabetes.diabetesjournals.org](#)

[Prevention of type 2 diabetes with losartane in the Diabetes Prevention Program](#)
[W Kivimäki, R Hämäläinen, S Ekelund, B Borch-Johnsen, D ... - Diabetes, 2005 - www.ncbi.nlm.nih.gov](#)

[Prevalence of diabetes and impaired glucose tolerance and plasma glucose levels in the population aged 60-74 in Helsinki VI region W Kivimäki, P Borch-Johnsen, 1997 - diabetes.diabetesjournals.org](#)

Search Trends

People who searched for Diabetes also searched for:

Conditions

Type2

Metabolic Syndrome

Type1

Diabetes

A screenshot of a medical website, likely a search engine or database, showing search results for "diagnosis, prognosis, complications". The text is overlaid diagonally across the image. The background shows a search bar, a list of results, and a sidebar with navigation links. The text is written in a large, bold, black font.

connections on cause
symptom, diagnosis,
prognosis, complications

Gestational Diabetes

Type2

Metabolic Syndrome

Type1

CD

connected symptoms prognosis

How to visualize the **relations** of multifaceted document contents?

Type2

Metabolic Syndrome

Type1

Gestational Diabetes

Diabetes

connections on cause, symptom, diagnosis, prognosis, complications

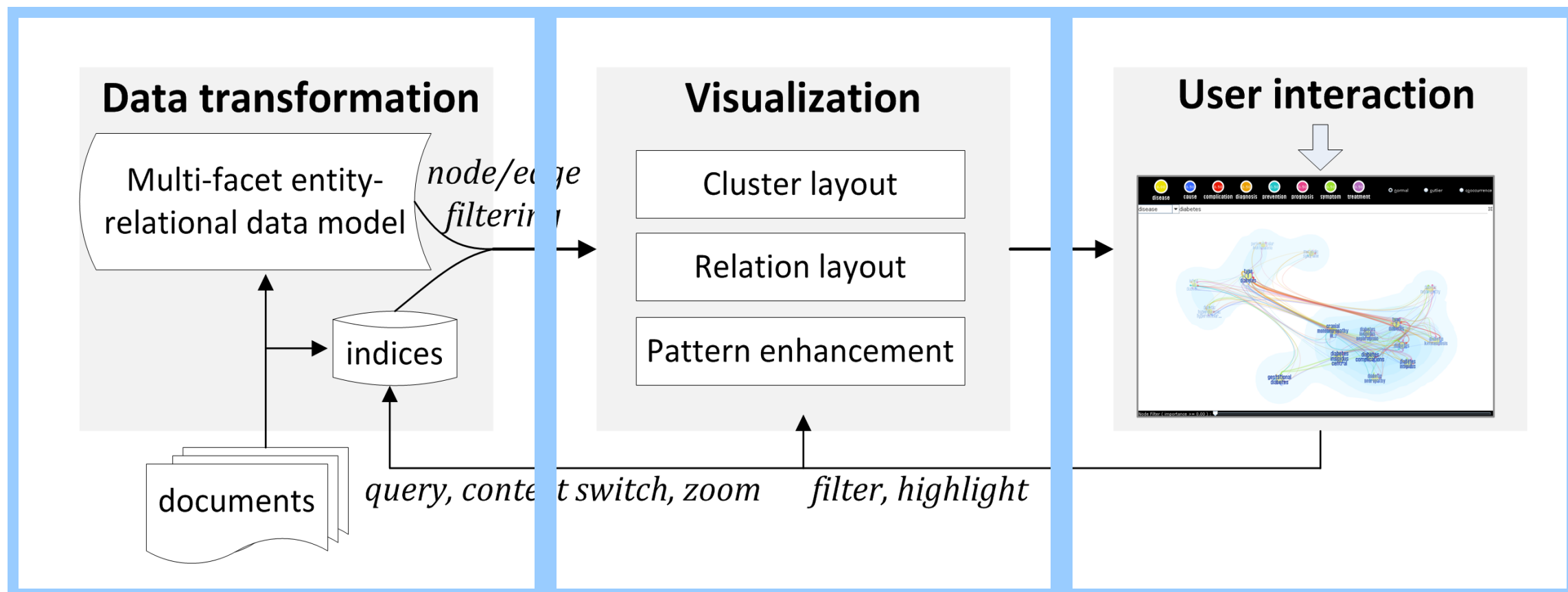
(Q1) How to model the document contents into multifaceted relation data?

(Q2) How to intuitively visualize multifaceted document contents and their relations?

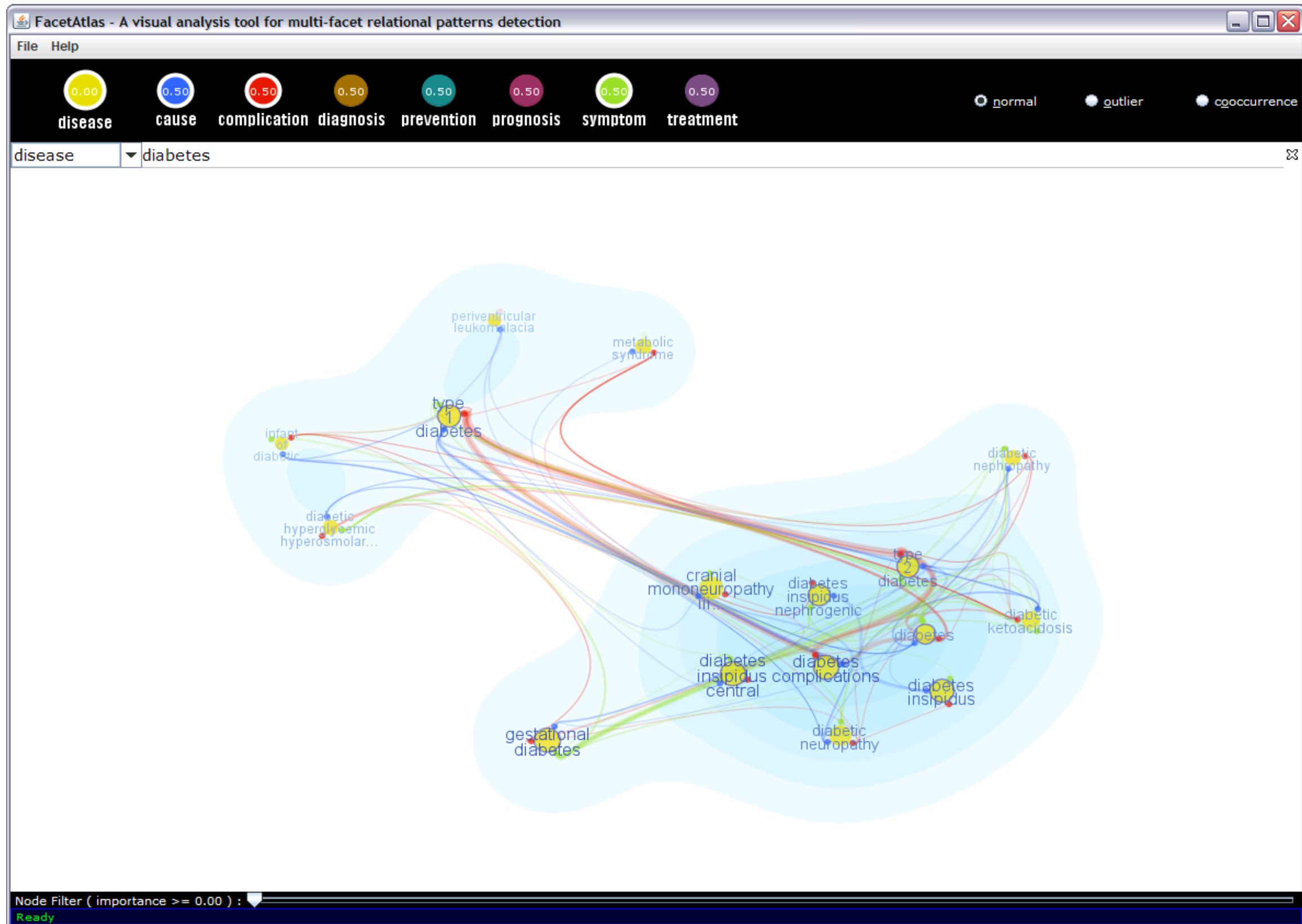
(Q3) How to find the insight patterns visually driven by users' interests?

Solution

- Goal :
 - Visualize both the **global (clusters)** and **local (relations) patterns** in rich text corpora with **multiple facets**.
- Approach :
 - Multifaceted entity-relational data model
 - Intuitive visual encoding and automatic layout
 - Users' interests driven interaction for pattern detection



Demo



Key Challenges

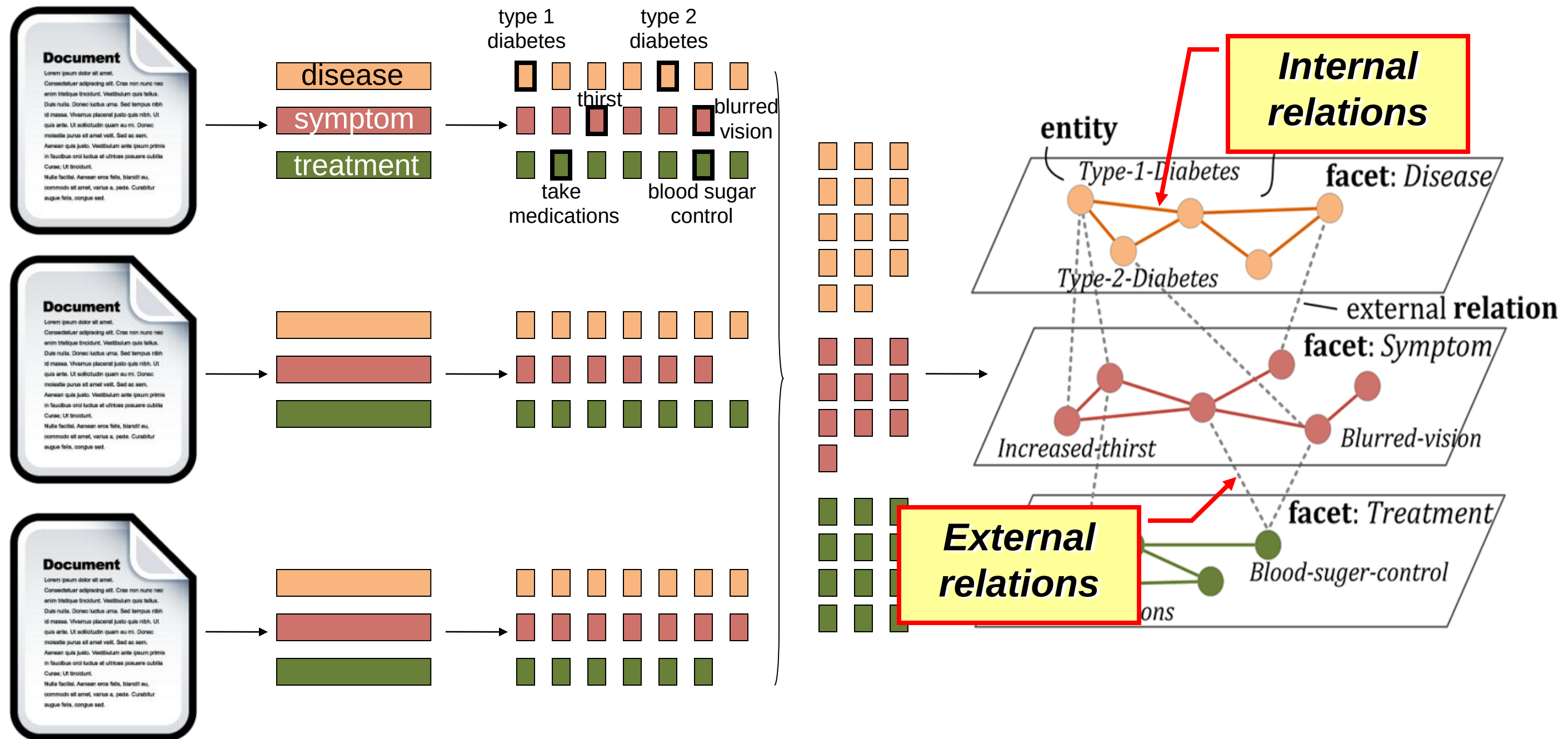
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(Q1) How to model the document contents into multifaceted relational data ?

document set facet segmentation entity extraction entity set multifaceted entity relational data model



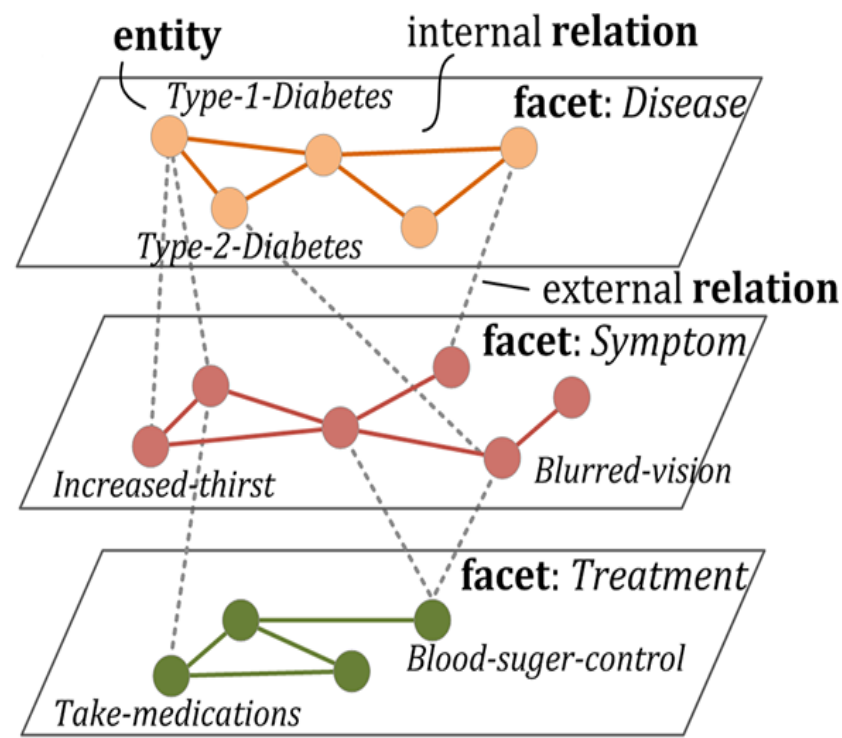
Key Challenges

(Q1) How to model the document contents into multifaceted relation data?

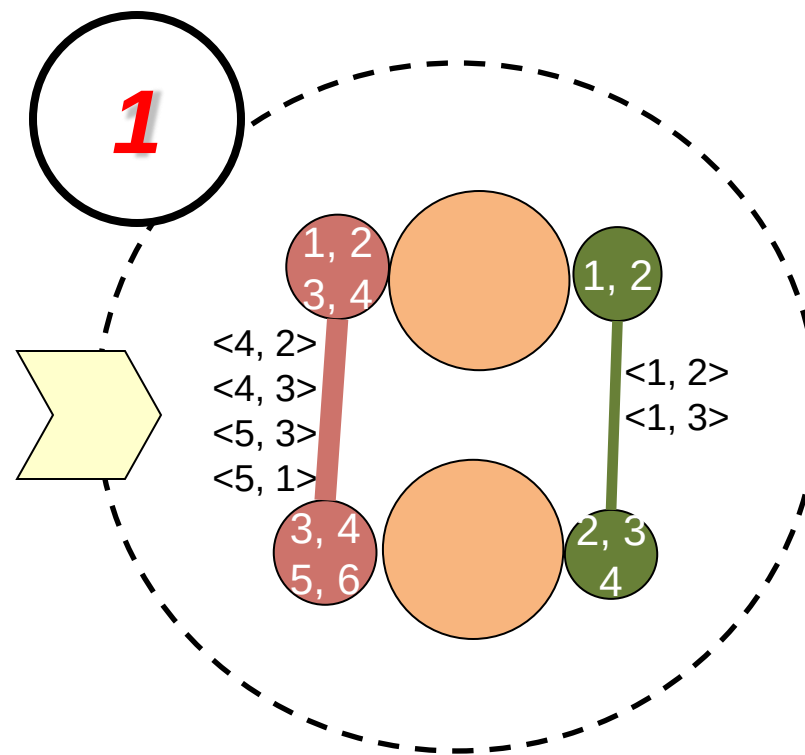
(Q2) *How to intuitively visualize multifaceted document contents and their relations?*

(Q3) How to find the insight patterns visually driven by users' interests?

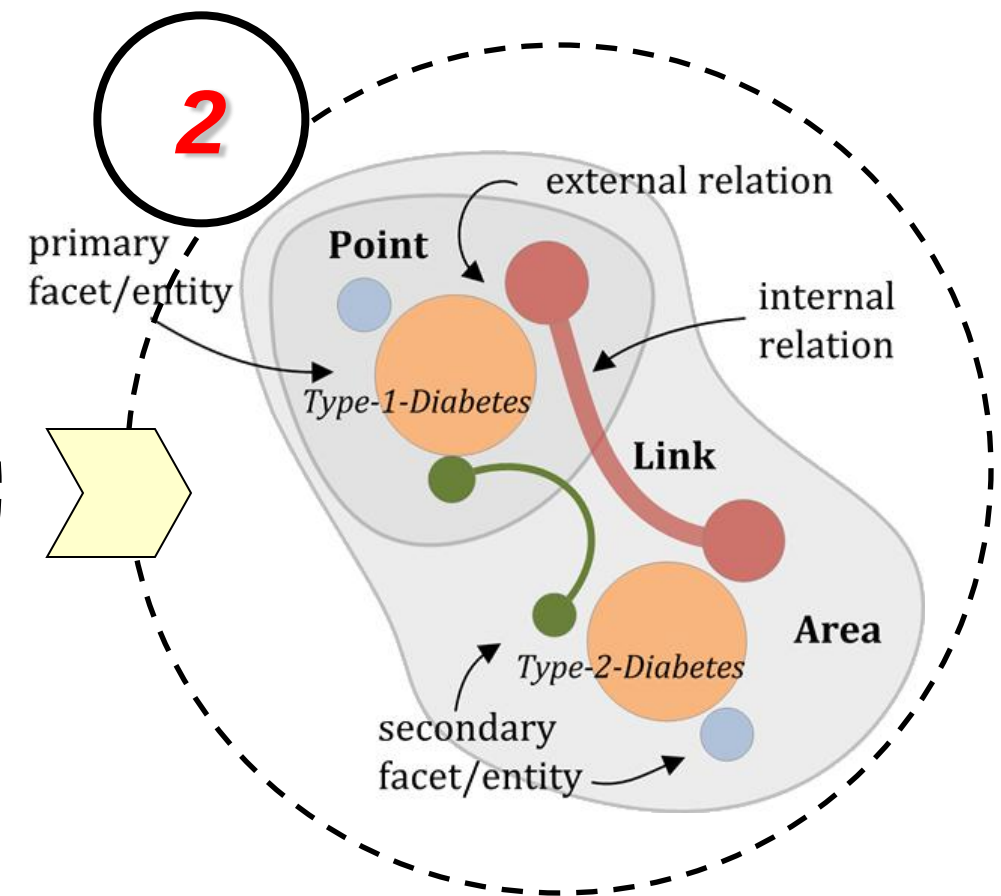
(Q2) How to visualize multifaceted document contents and their relations?



data model

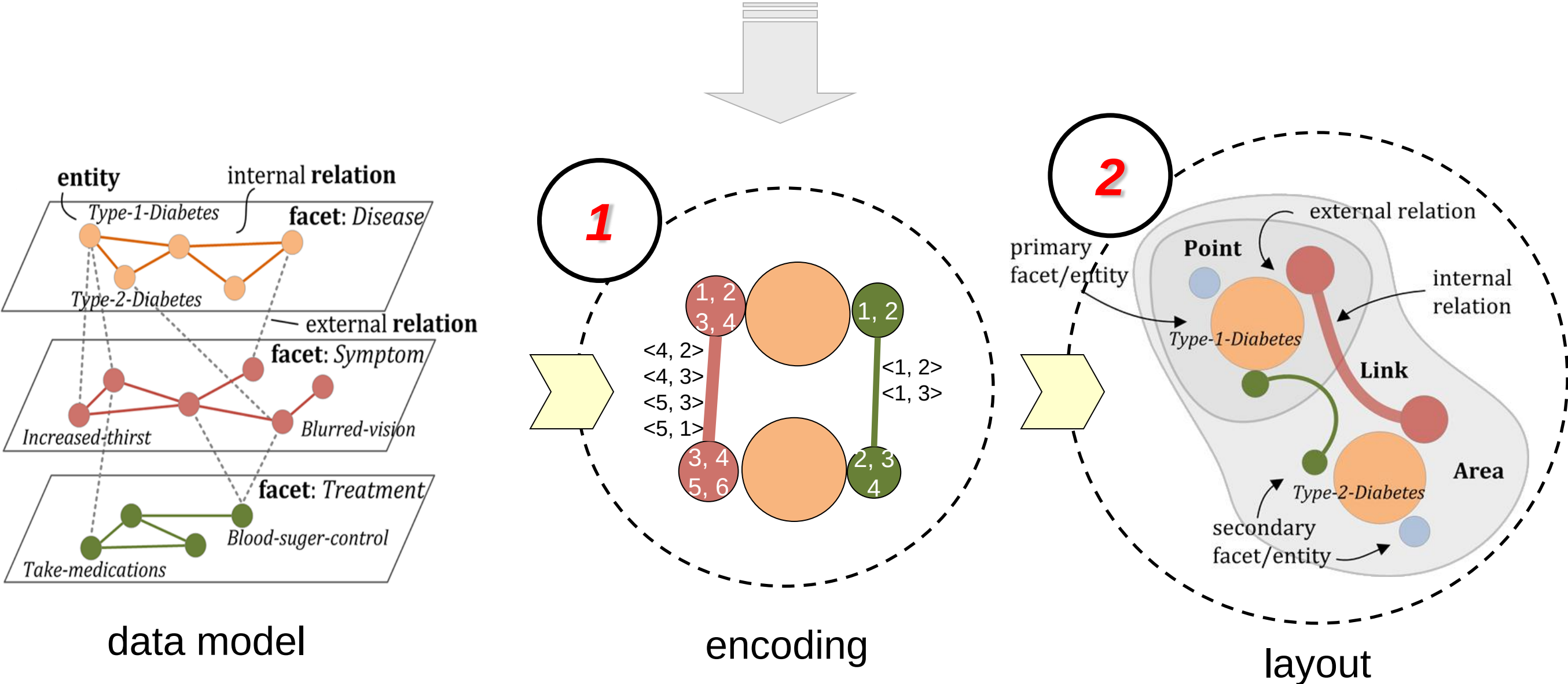


encoding

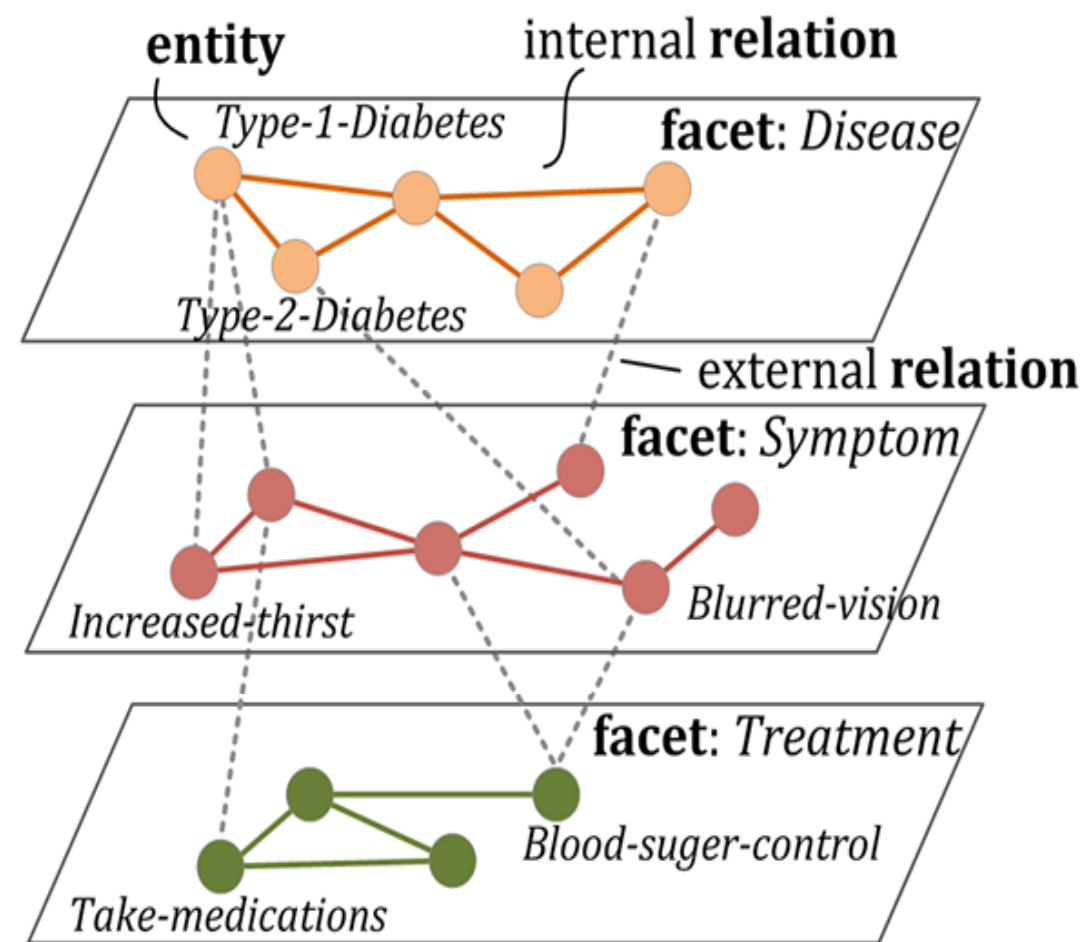


layout

(Q2) How to visualize multifaceted document contents and their relations?

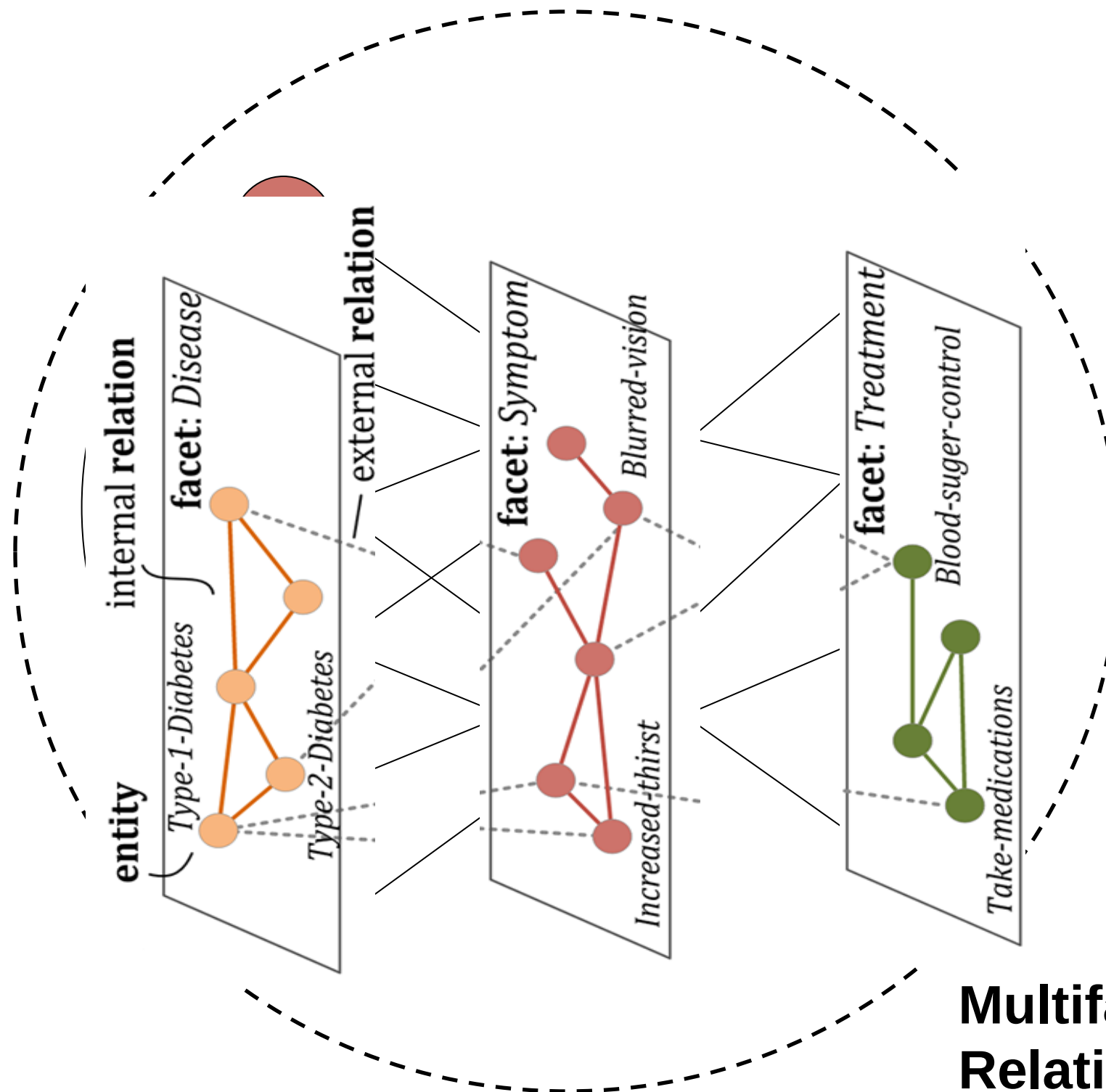


Encoding



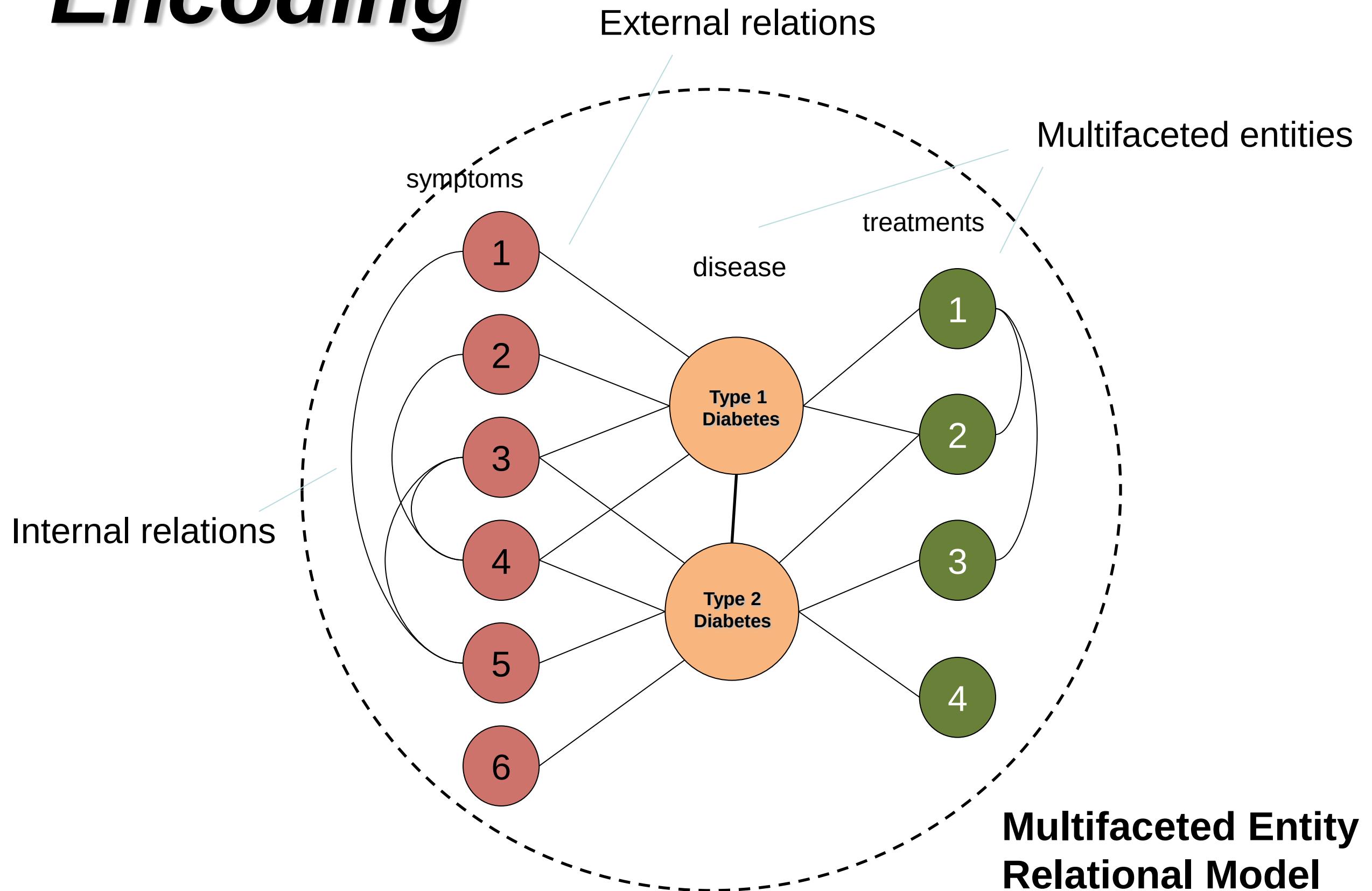
**Multifaceted Entity
Relational Model**

Encoding

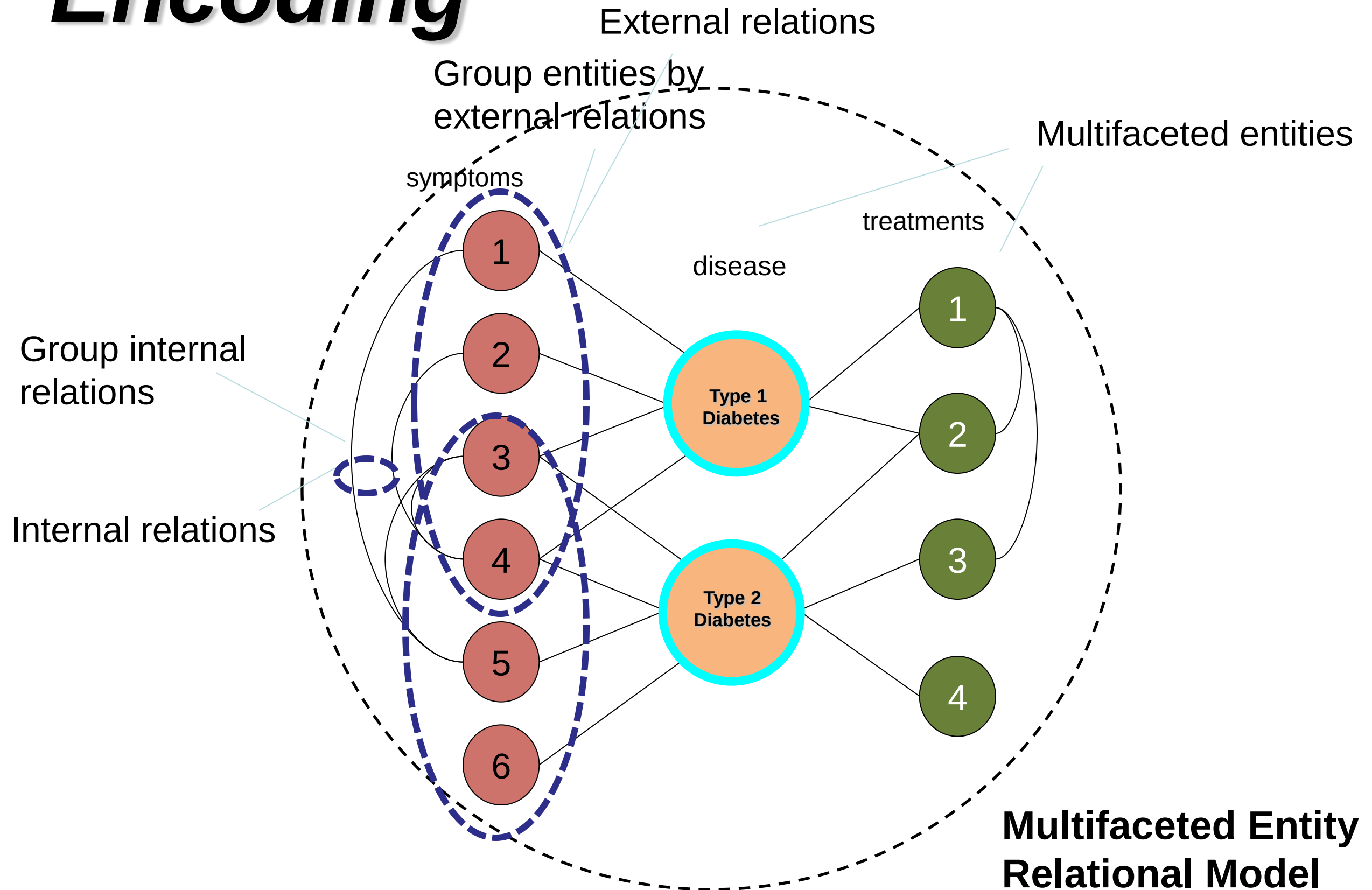


Multifaceted Entity Relational Model

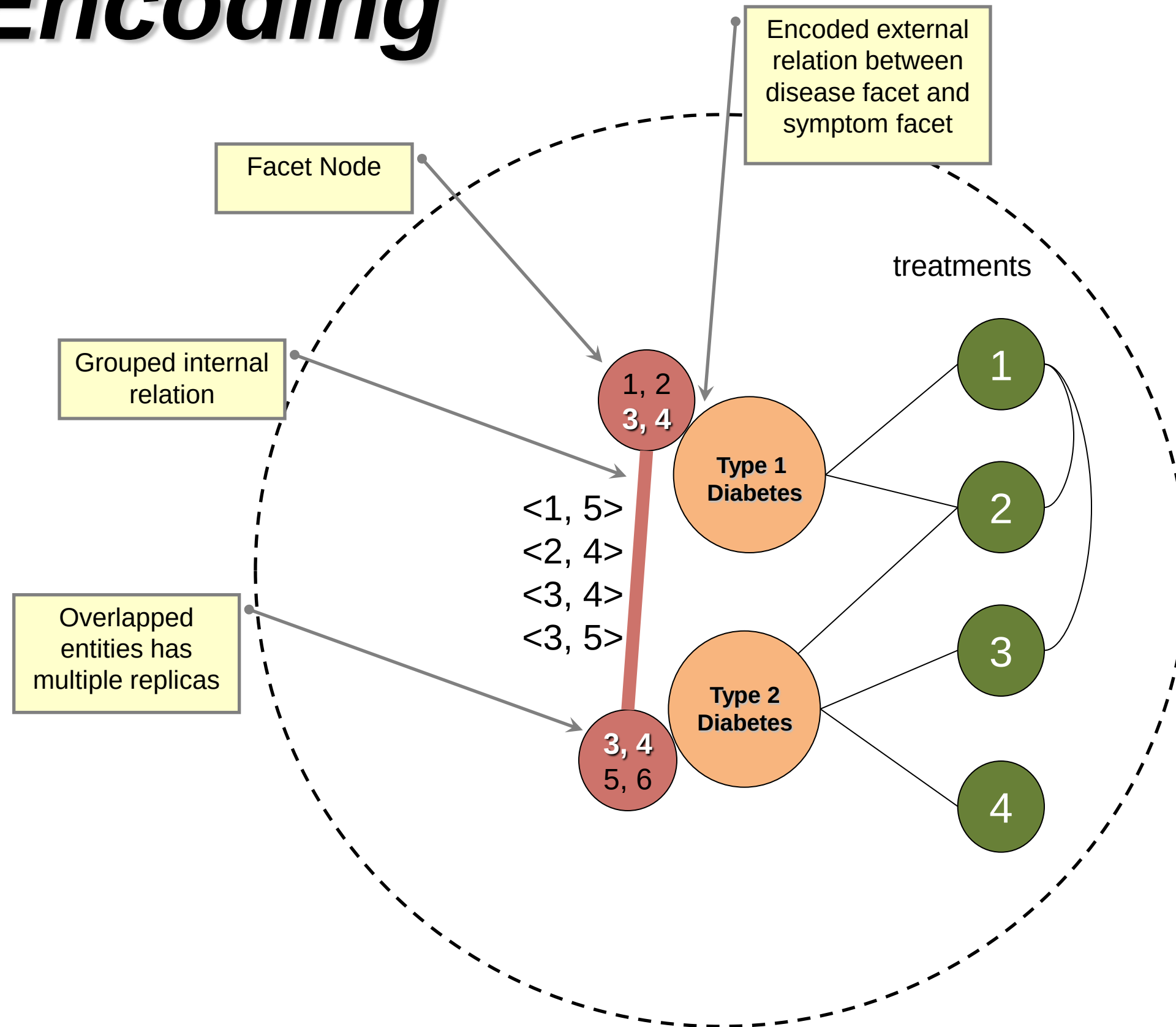
Encoding



Encoding

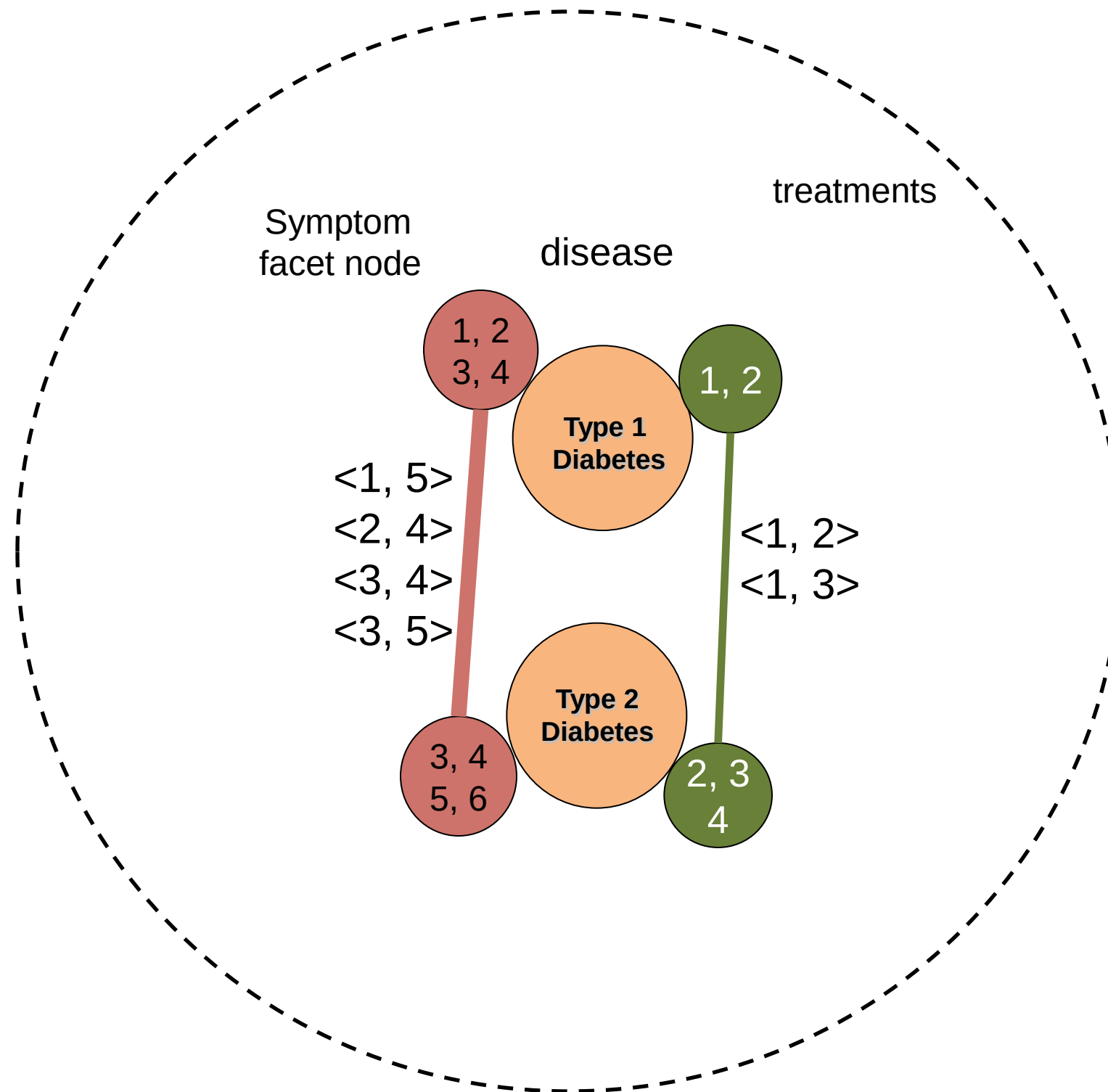


Encoding



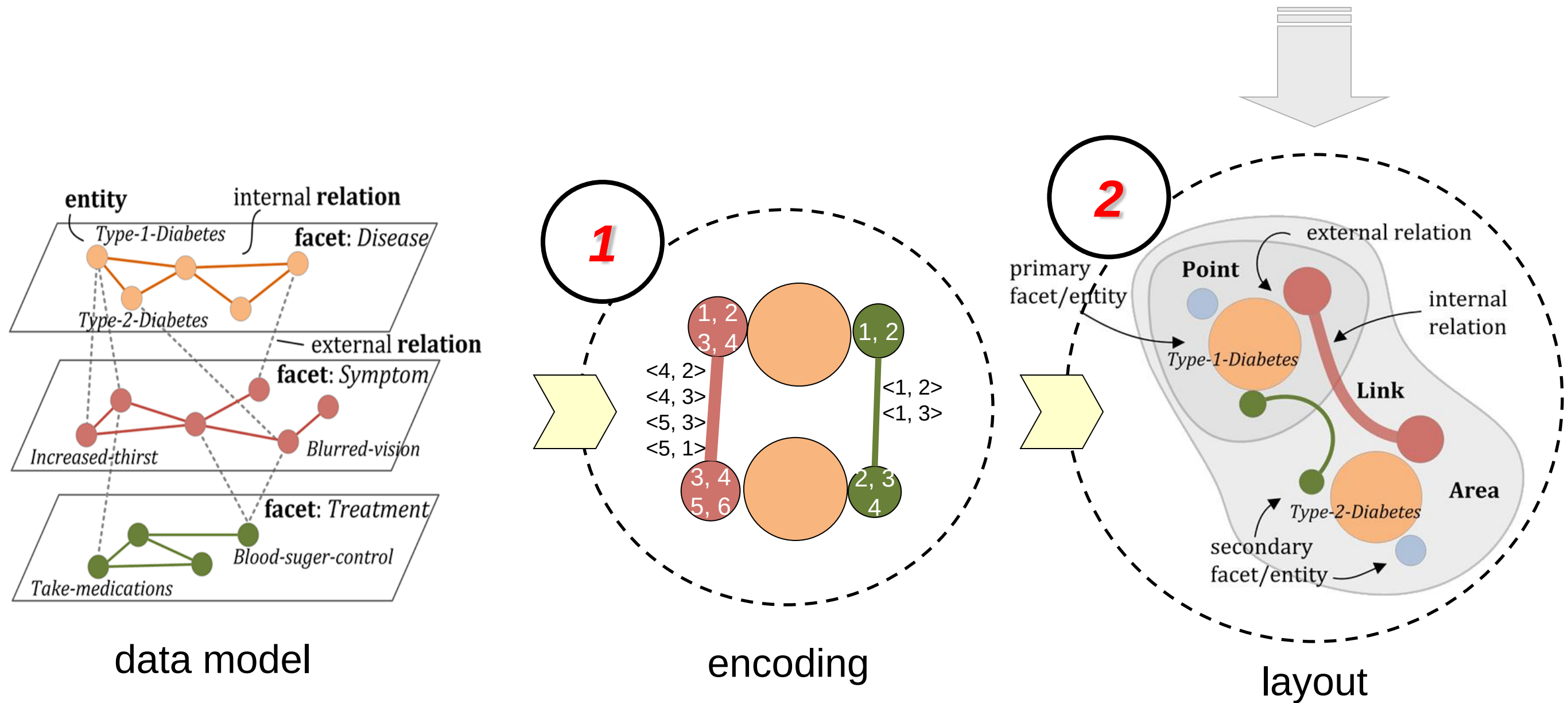
1. Encode external relations by neighborhood
2. Split overlap entities into multiple replicas
3. Group related entities and their replicas in into the facet node
4. Grouping the related internal linkages in the symptom facet

Encoding

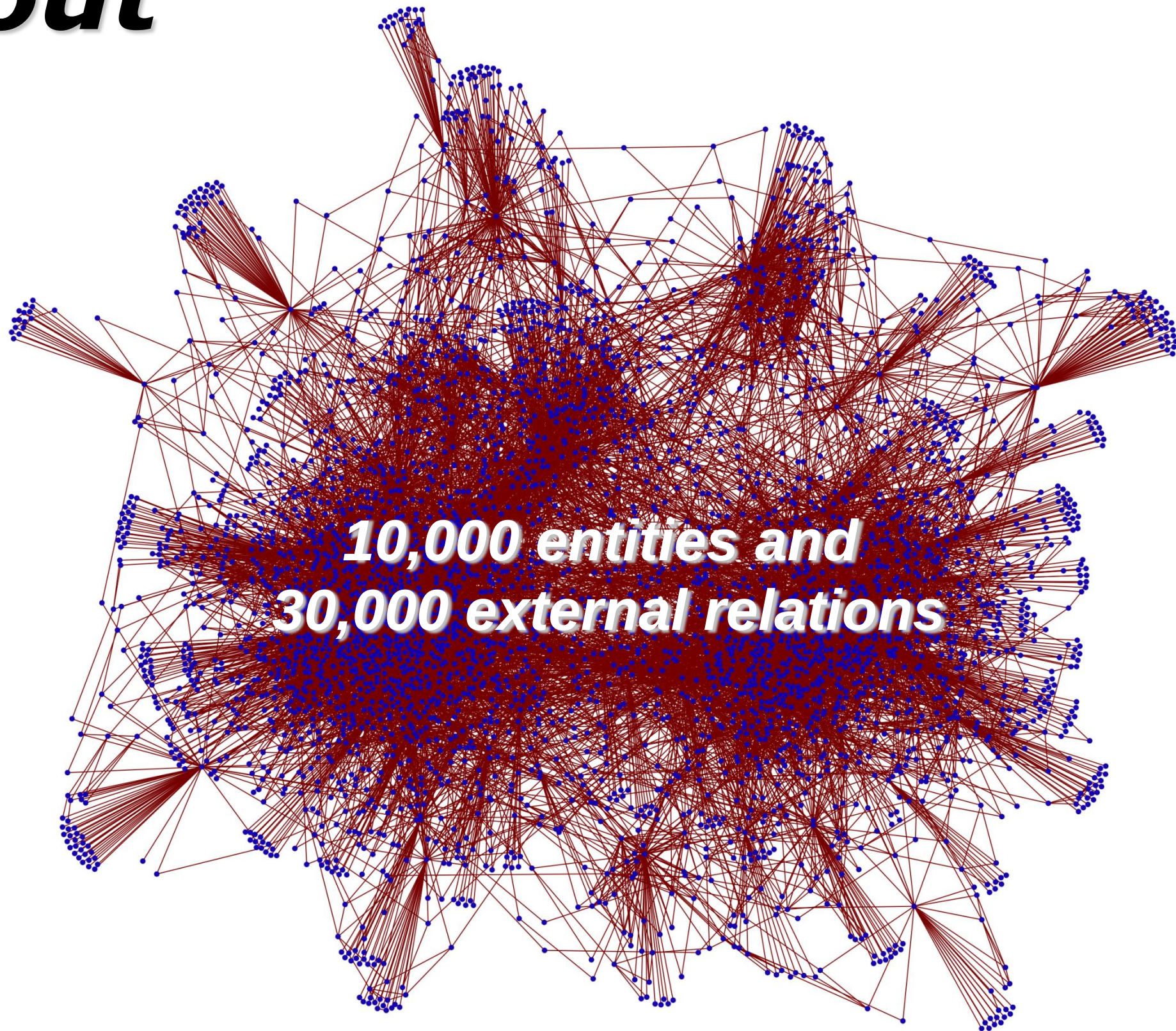


1. Similarly groups the treatments entities into the treatment facet node
2. Then we encoded the data model into visual form

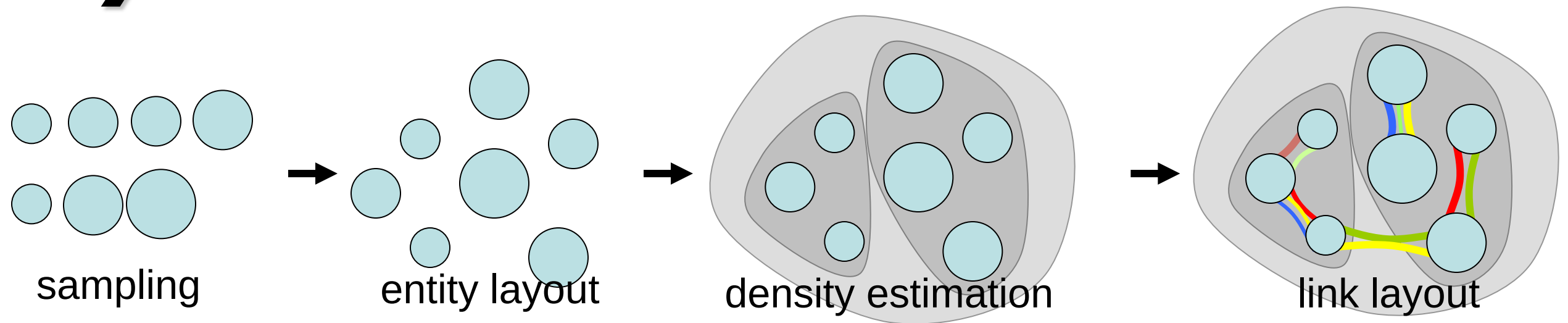
(Q2) How to visualize multifaceted document contents and their relations?



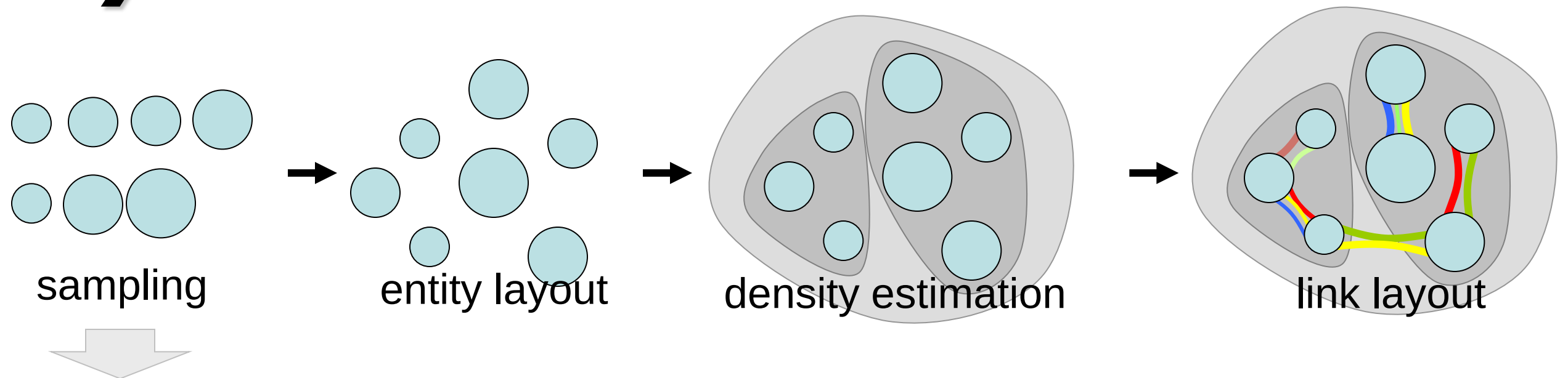
Layout



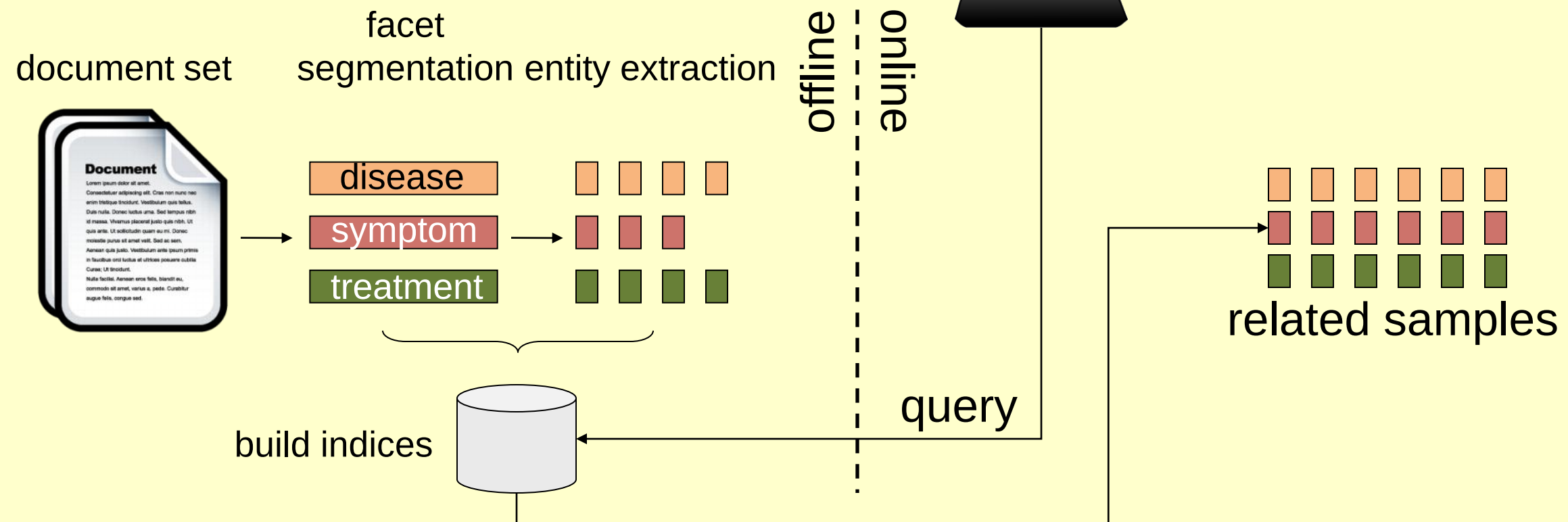
Layout



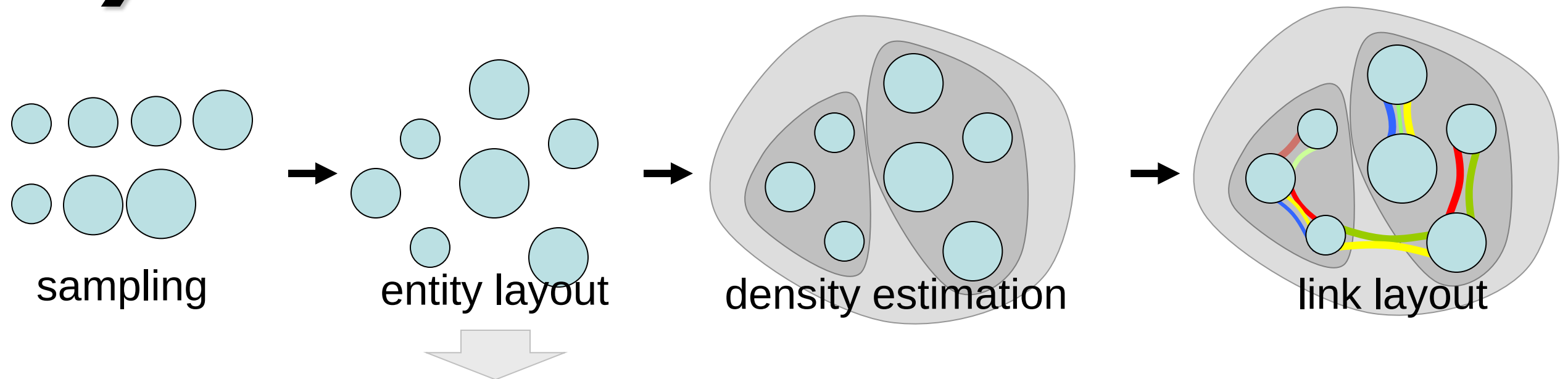
Layout



Sampling by DOI



Layout

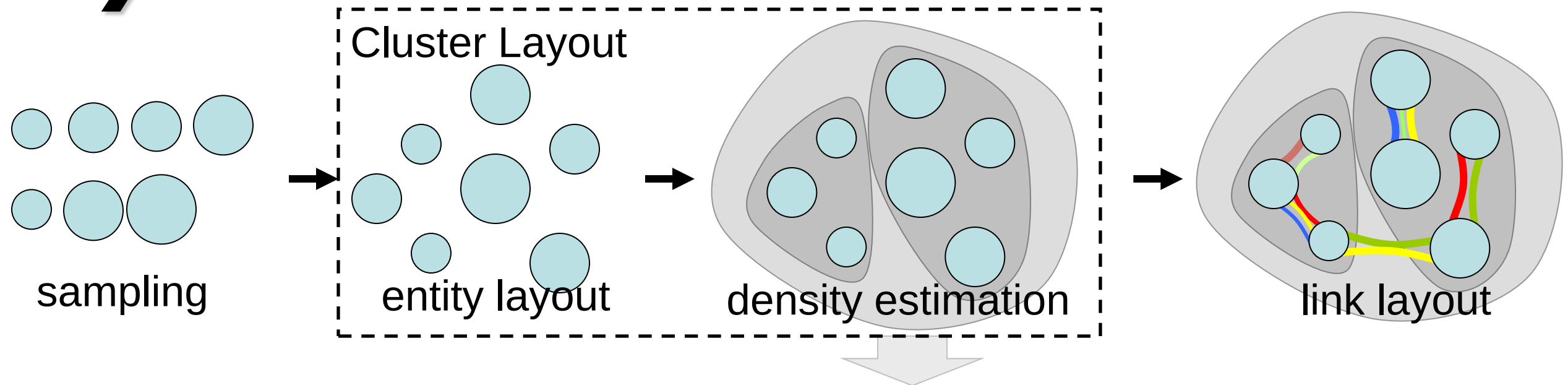


Stabilized Layout

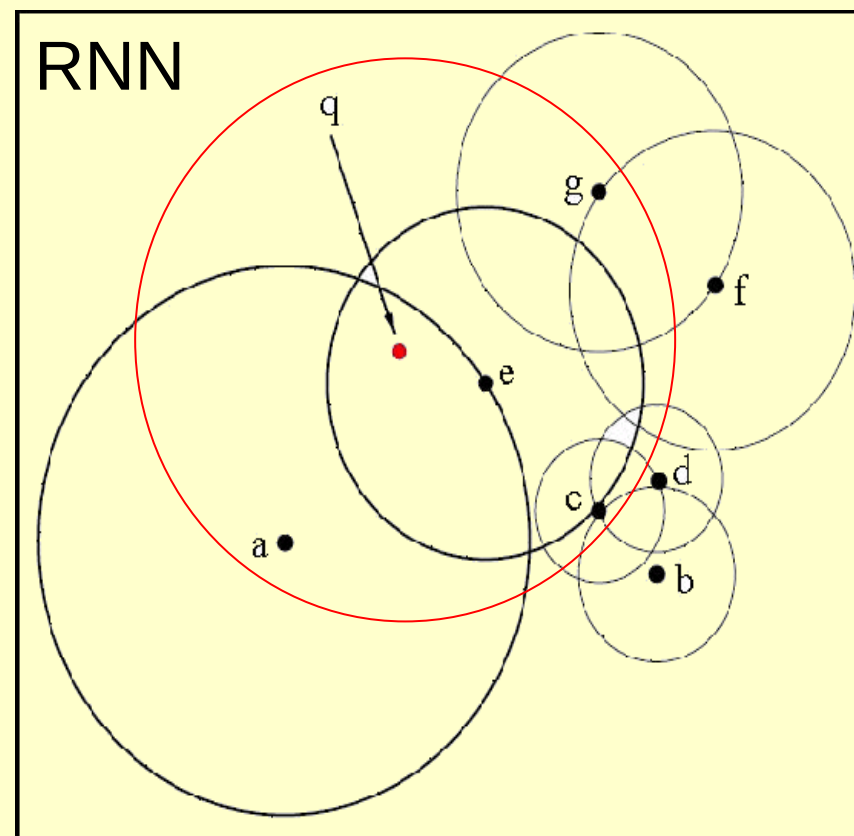
Based on the hidden internal relations of primary facet
Keep users' mental map while data changed

$$\min \left(\underbrace{\sum_{i < j} \frac{1}{d_{ij}^2} \left(\|X_i - X_j\| - d_{ij} \right)^2}_{\text{Cluster Together}} + \underbrace{\sum_{i < j} \|X_i - pre(X_i)\|^2}_{\text{More smoothly}} \right)$$

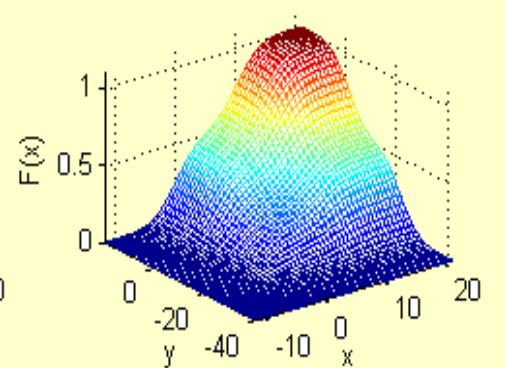
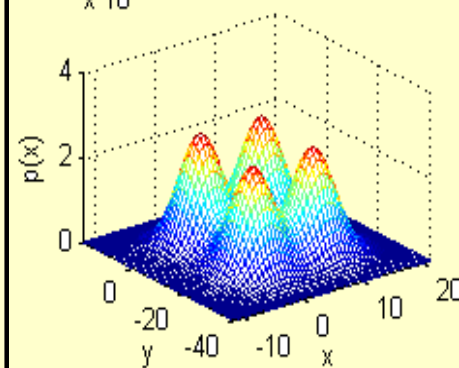
Layout



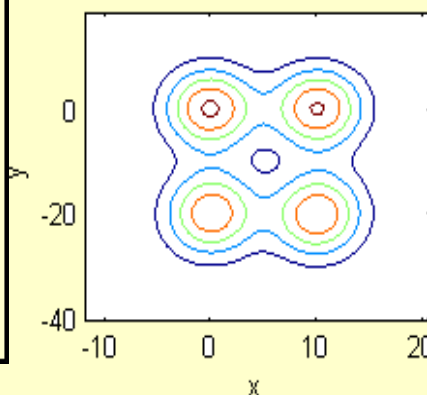
Kernel Density Estimation



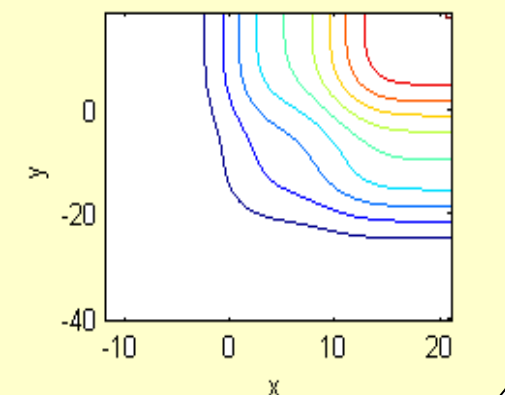
Estimated Probability Density Function Estimated Cumulative Distribution Function



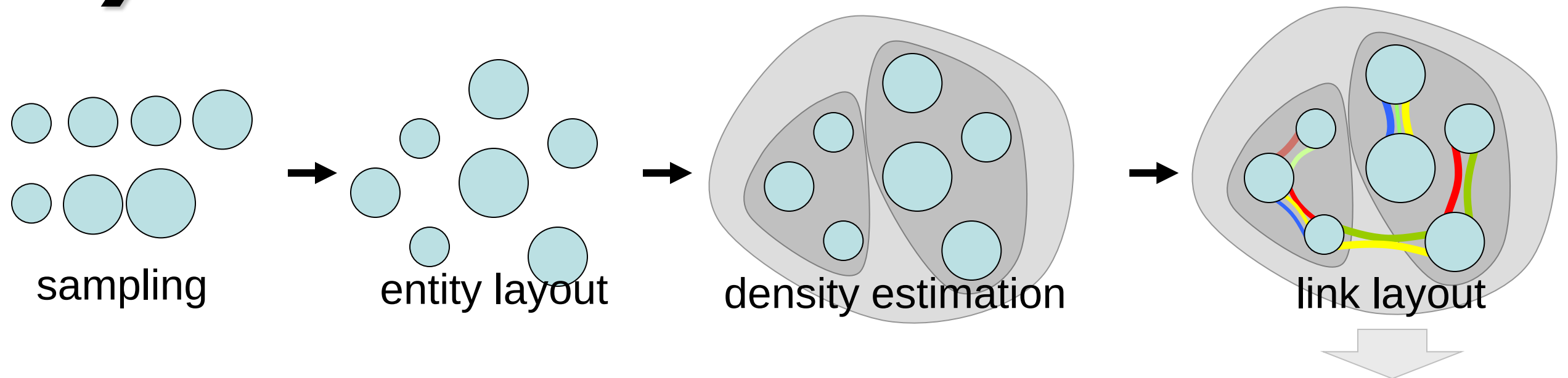
Contour of Probability Density Function



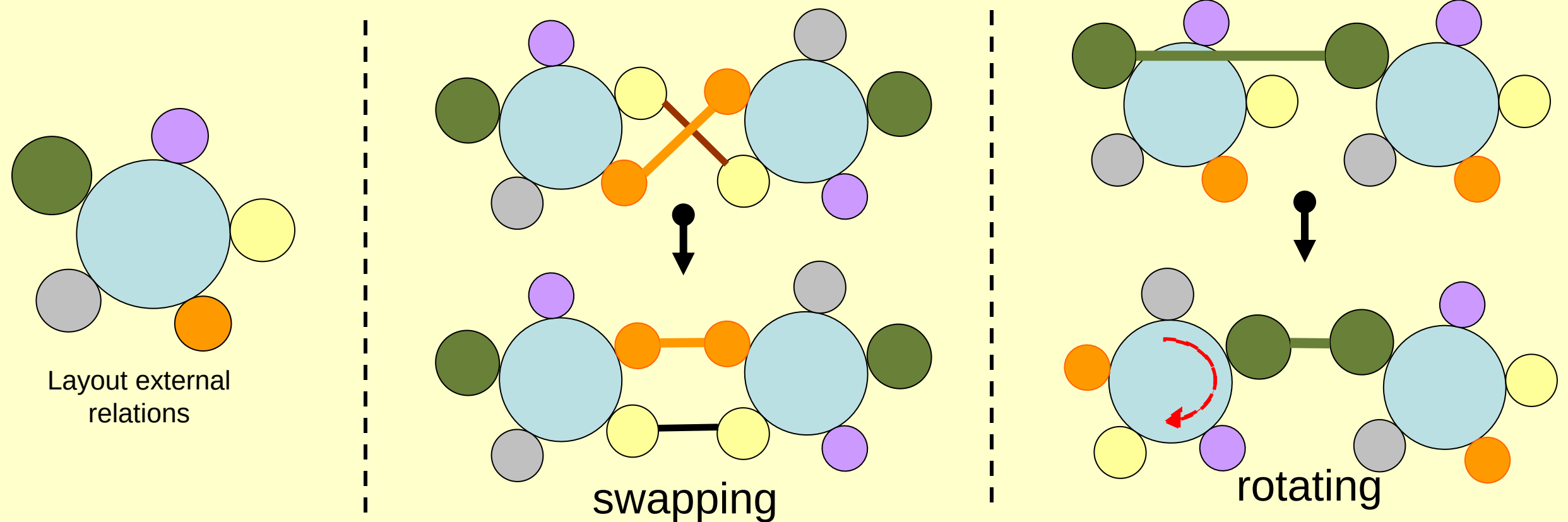
Contour of Cumulative Distribution Function



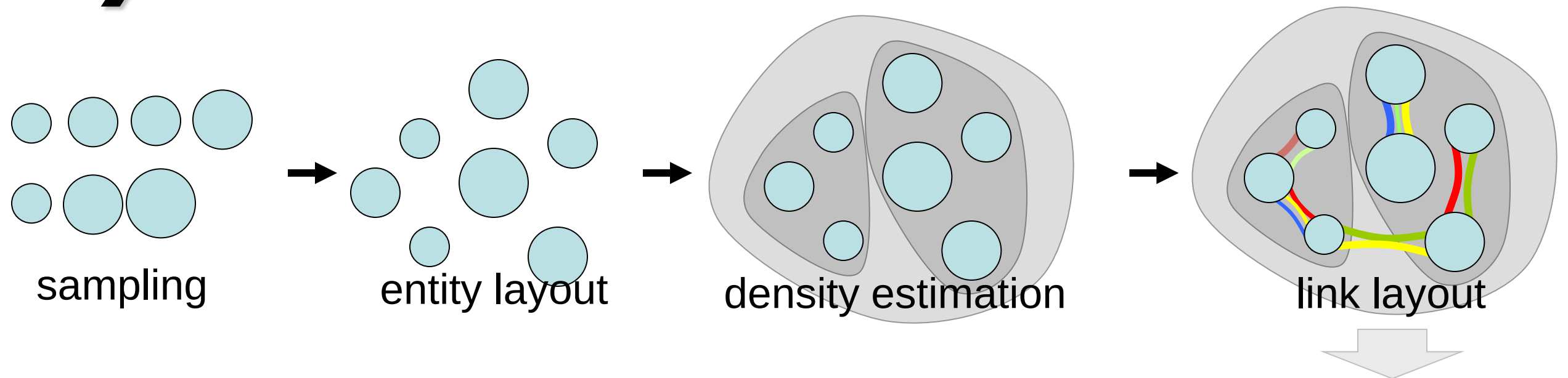
Layout



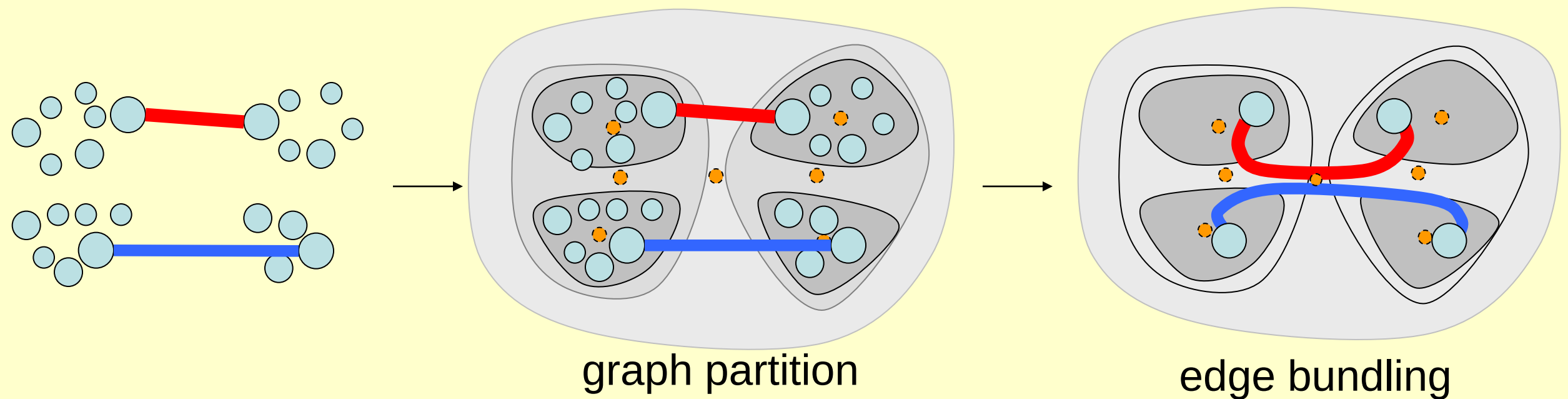
Link Layout (1)

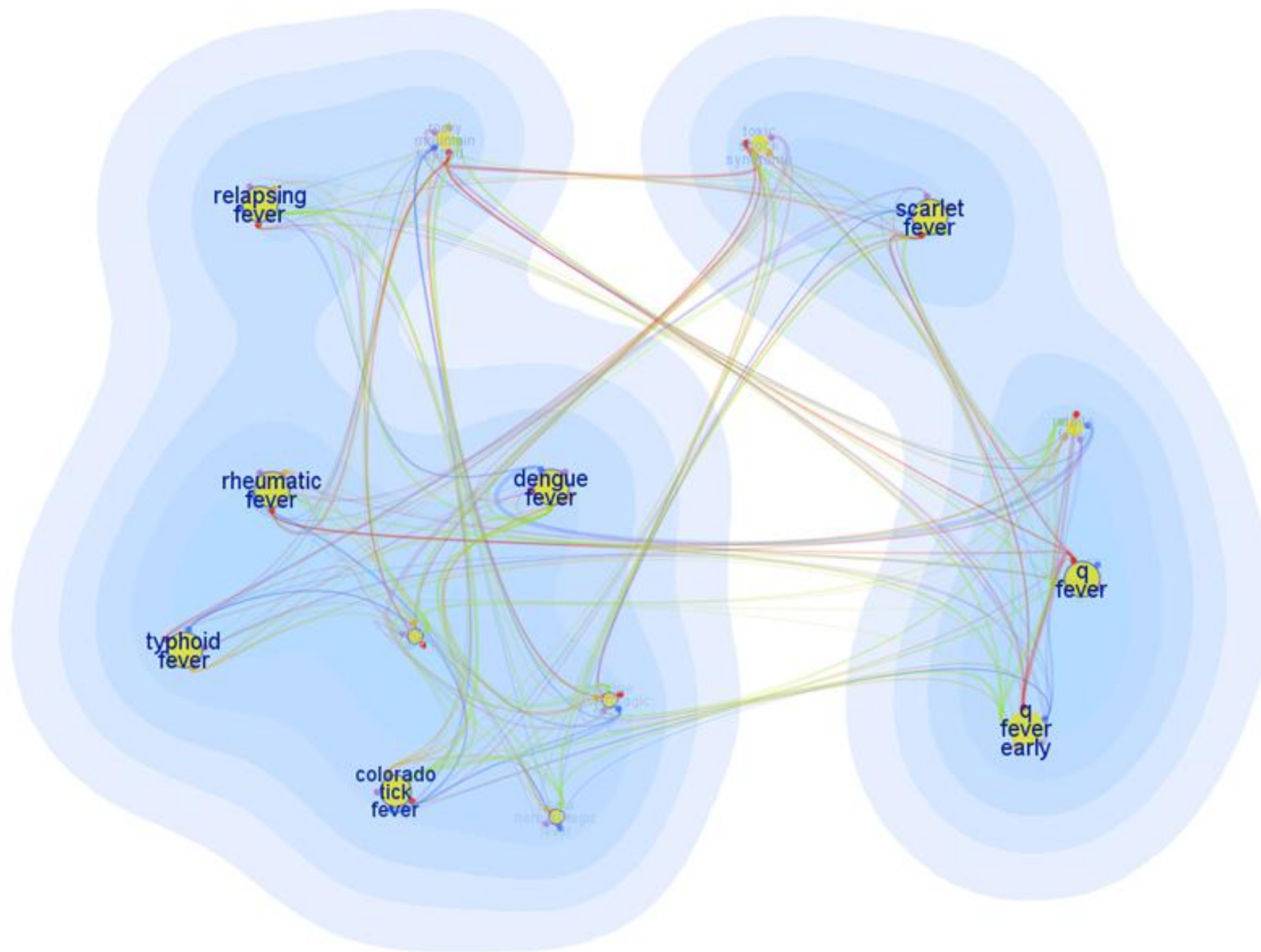


Layout

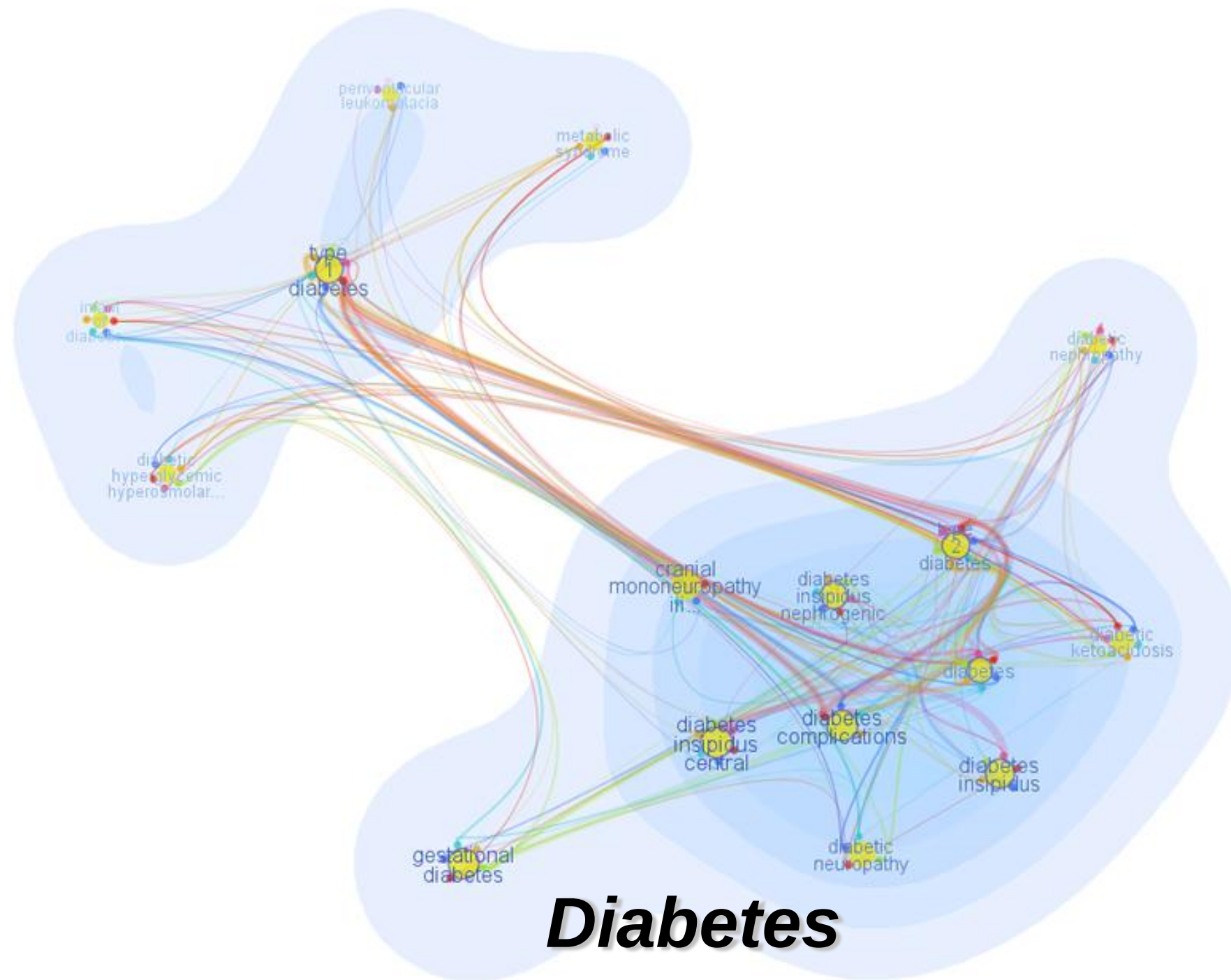


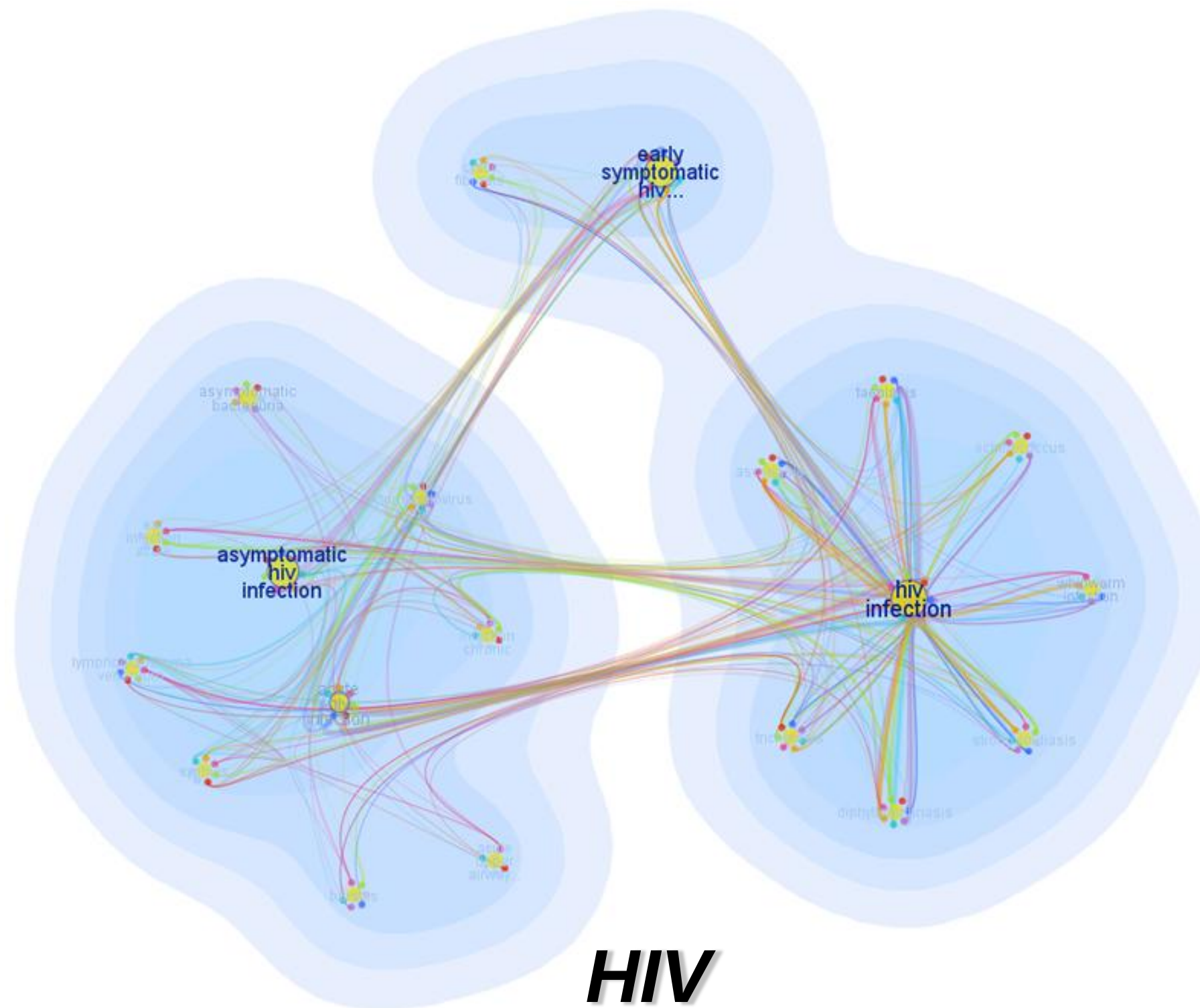
Link Layout (2)

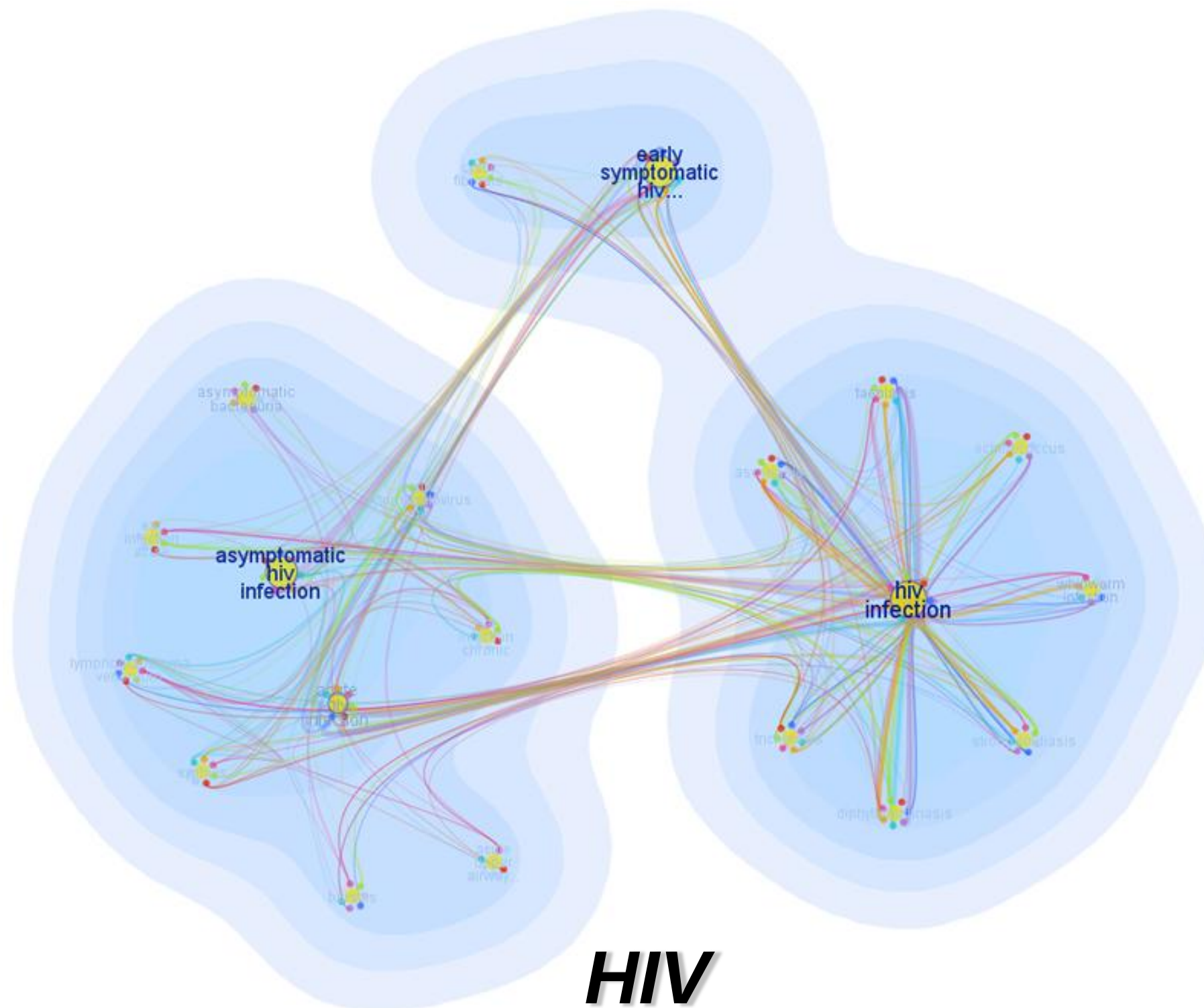




Fever







HIV

***Where are our patterns?
What can we find ?***

Key Challenges

(Q1) How to model the document contents into multifaceted relation data?

(Q2) How to visualize multifaceted information to reveal both global and local patterns?

(Q3) How to find the insight patterns visually driven by users' interests?

(Q3) How to find insights via user interactions?

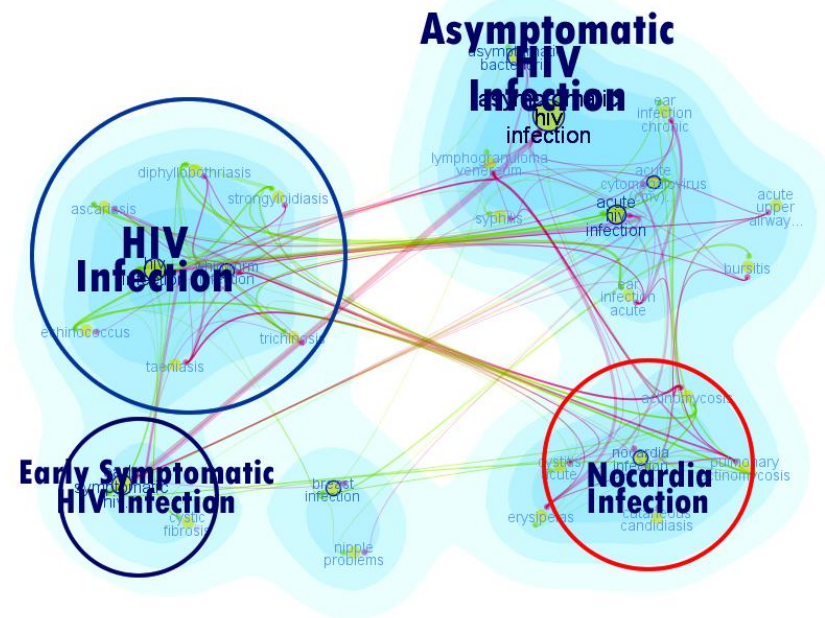
Disease view

Symptom view

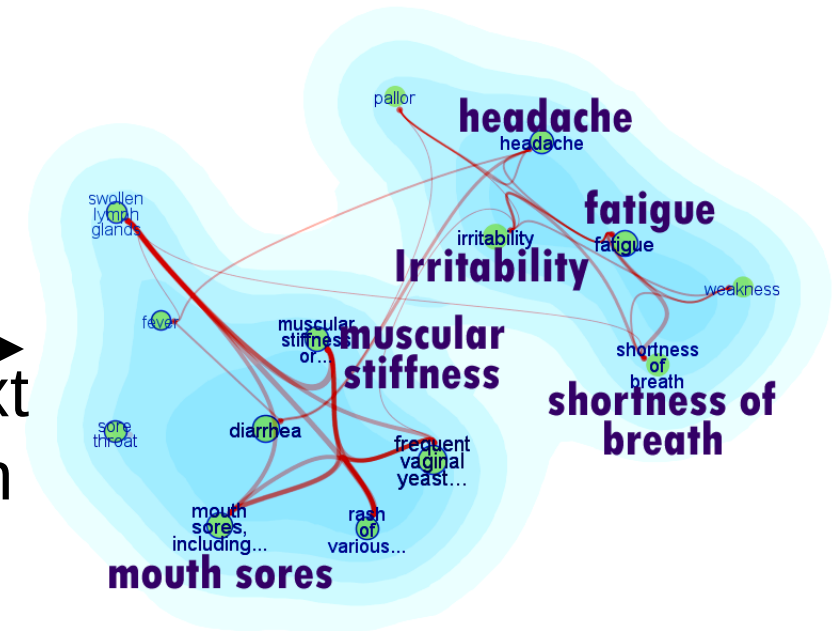


Keyword Query
Context Switch
Filtering
Highlighting

A set of interactions are designed to address users' interests



context switch



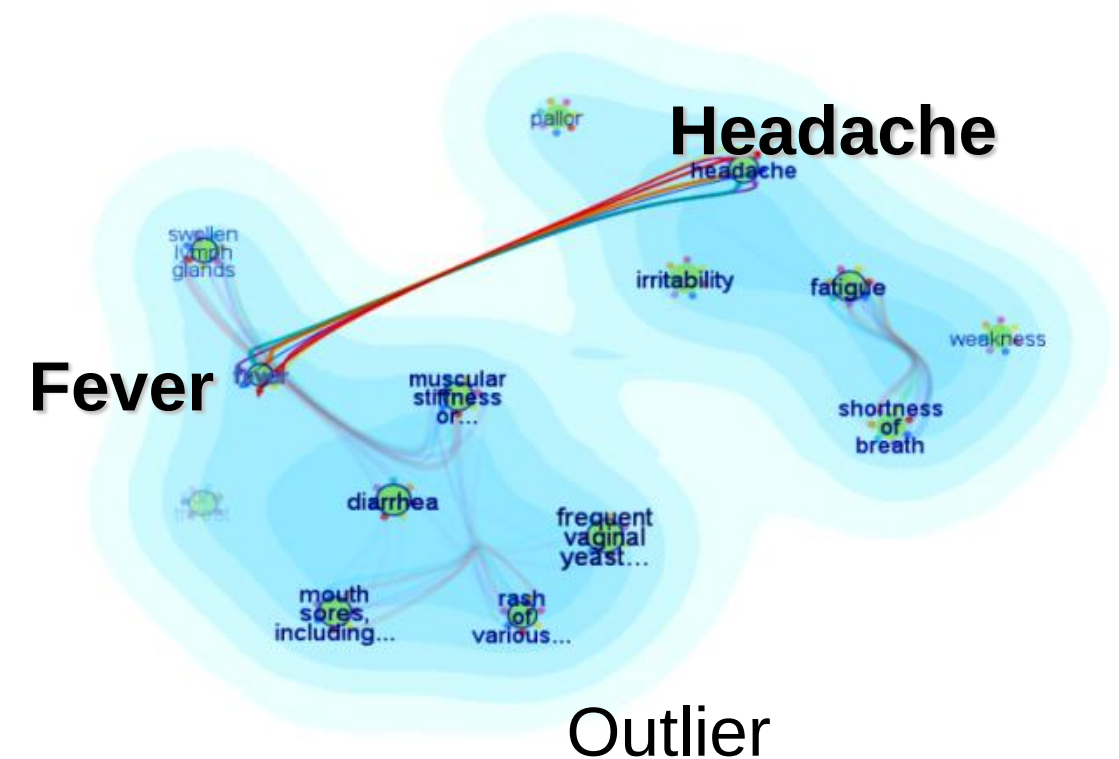
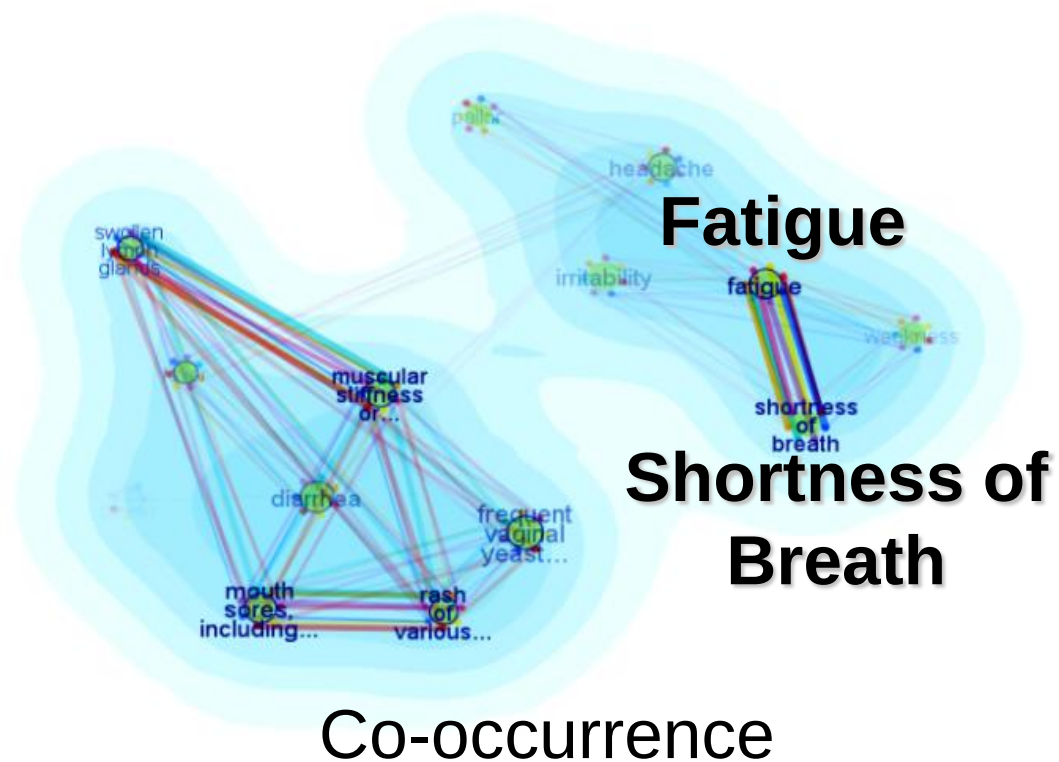
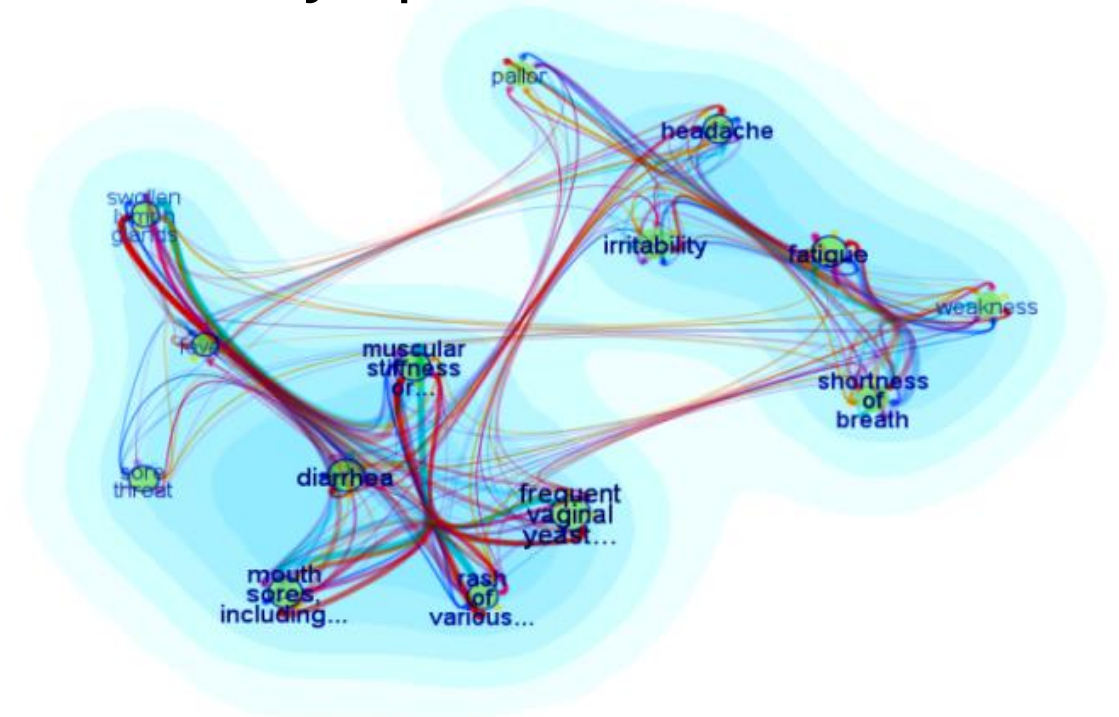
filtering



Visual Patterns

- Global **cluster** patterns
- Local multifaceted relational pattern
 - Co-occurrences pattern
 - Outlier pattern

Symptoms of HIV



(Q3) Interview of domain experts

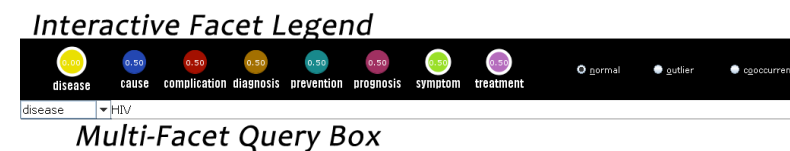
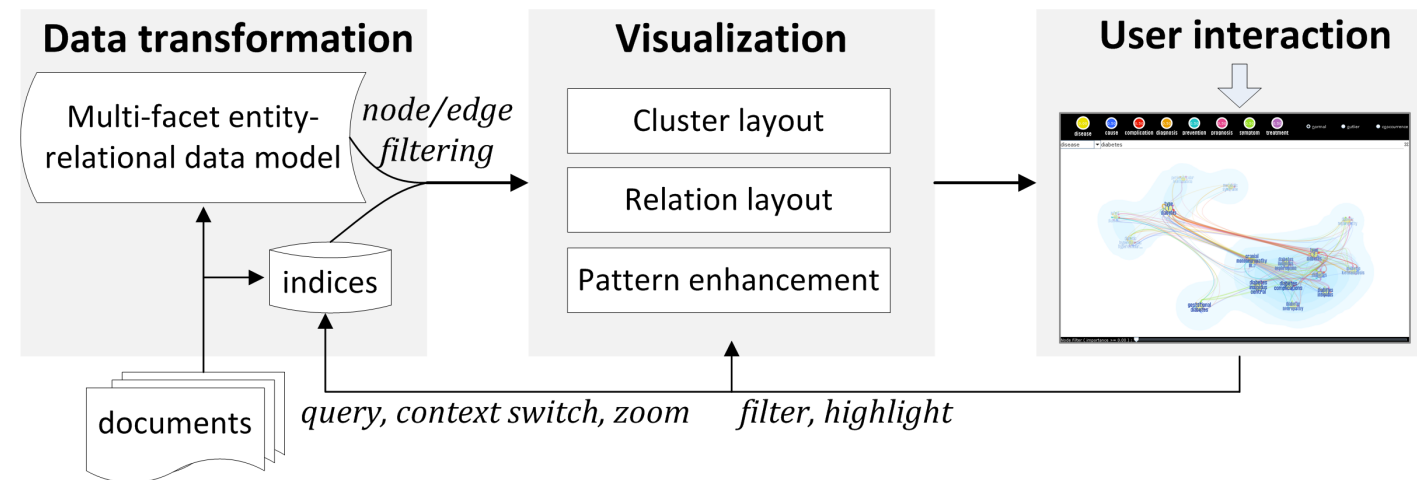
What did domain experts (3 physicians) say?

- “enhance the current thought process of physicians, and help create the **subtle associations between different concepts.**”
- “this will be very helpful for **nurses** who run the **self-care education** activities to **better engage patients.**”
- “this tool has great potential as an **education tool** for interns and residents who have just started their medical career”
- “extremely creative and has great potential for **clinical therapeutic usage** and **diagnosis decision support**”

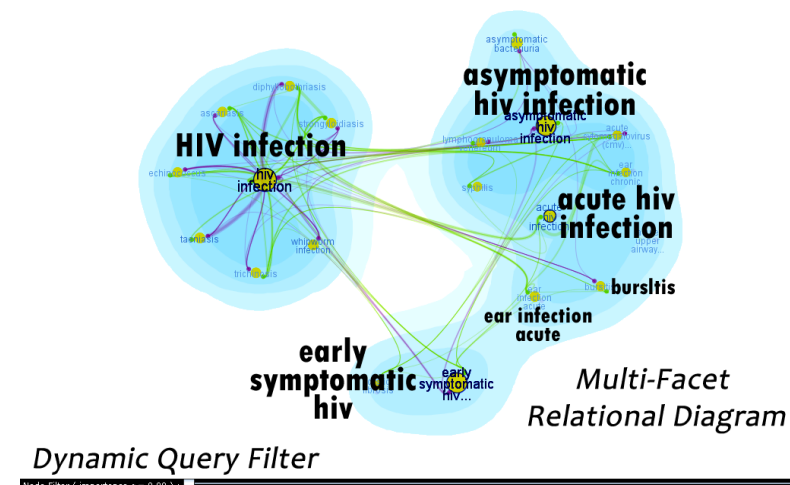
Summary

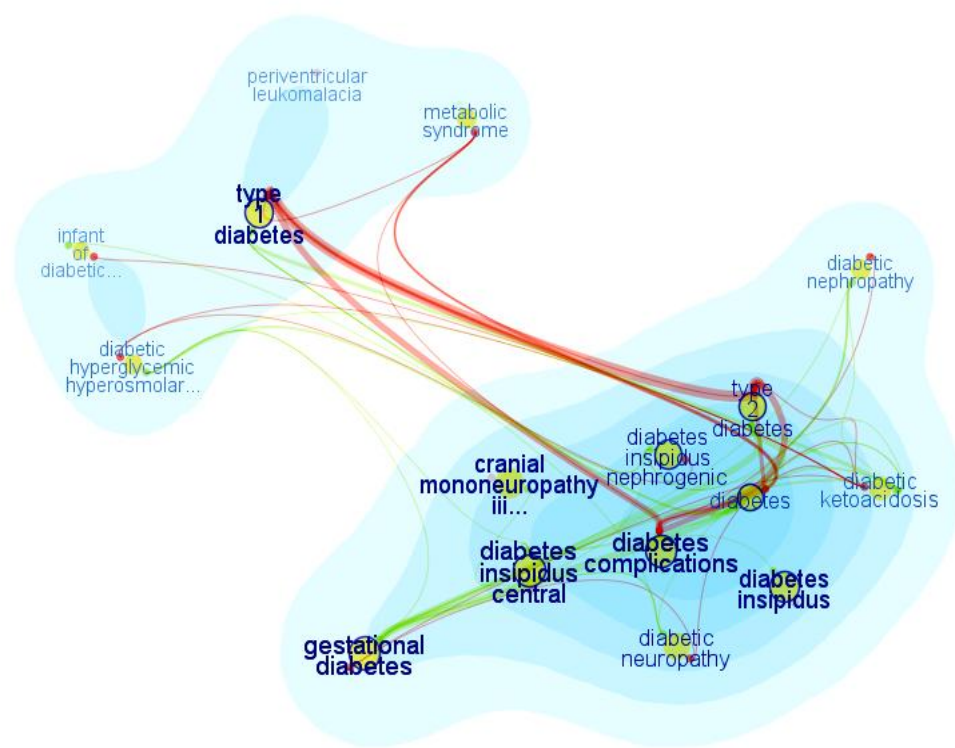
- **Problem :** How to visualize relations of multifaceted document contents ? Global / Local patterns

- **Approach :**



- **Result :**



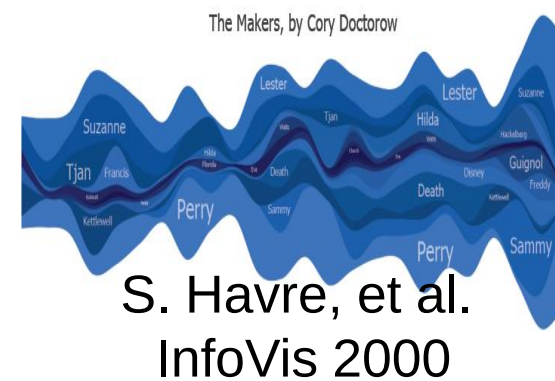


FacetAtlas: Multifaceted Visualization for Rich Text Corpora

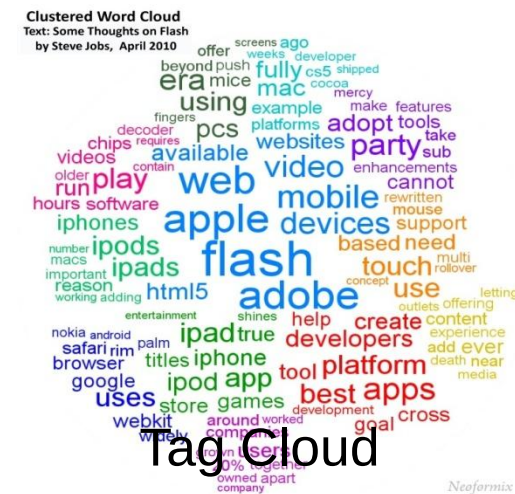
*Nan Cao, Jimeng Sun, Yu-Ru Lin, David Gotz,
Shixia Liu, Huamin Qu
InfoVis 2010*

Related Work

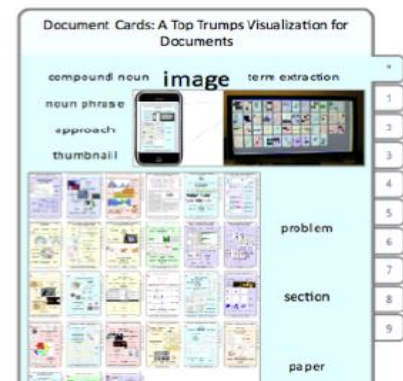
Visualizing Global Content Patterns



S. Havre, et al.
InfoVis 2000

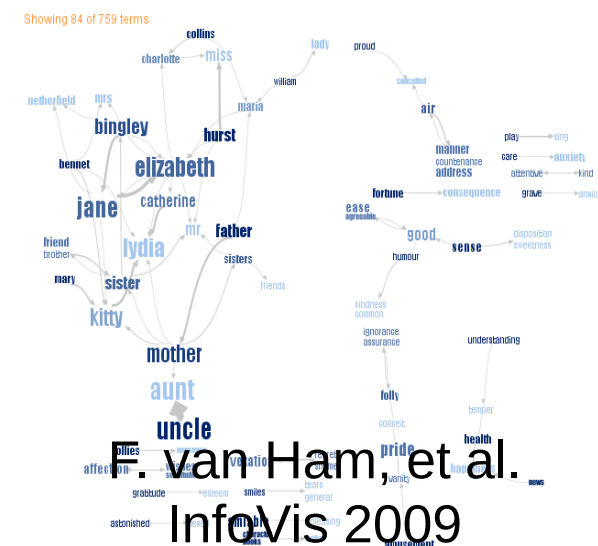


Tag Cloud

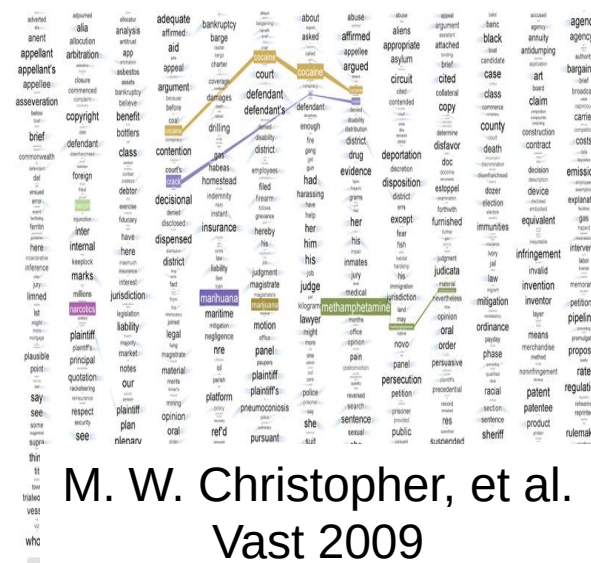


H. Strobel, et al.
InfoVis 09

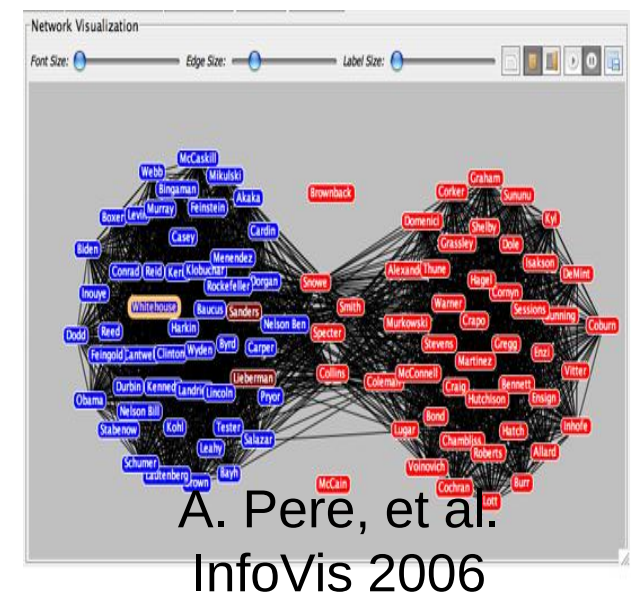
Visualizing Local Relational Patterns



F. van Ham, et al.
InfoVis 2009

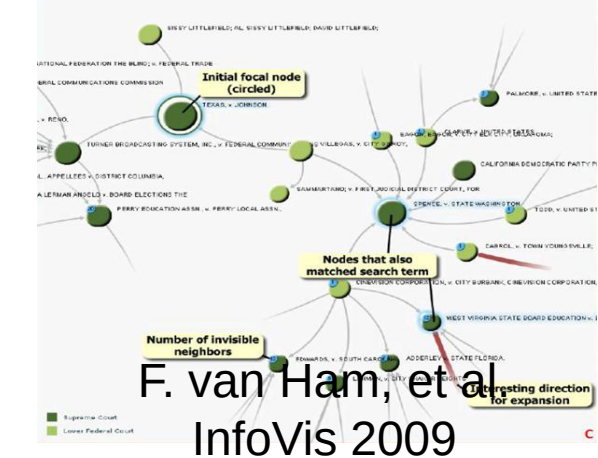


M. W. Christopher, et al.
Vast 2009

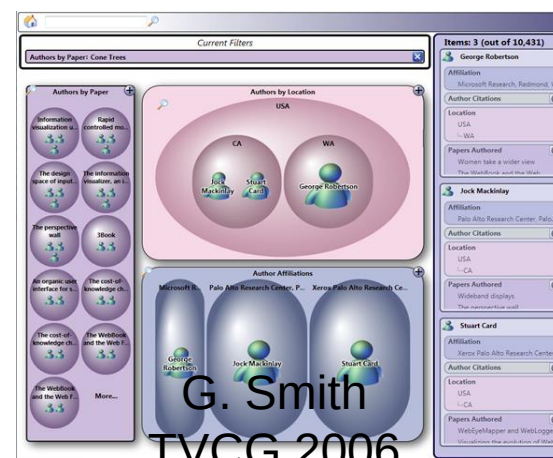


A. Pere, et al.
InfoVis 2006

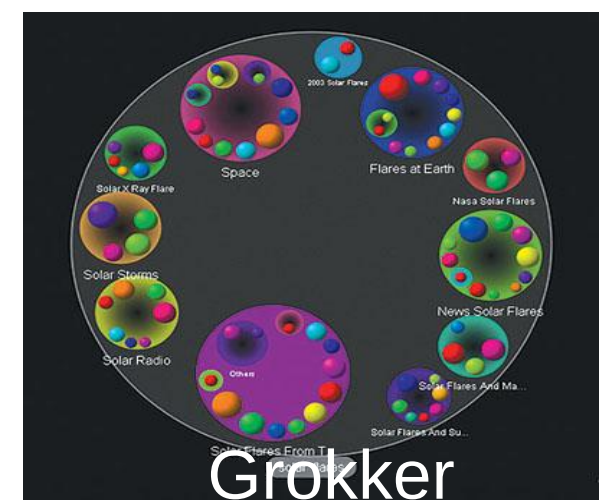
Search Interface



F. van Ham, et al.
InfoVis 2009

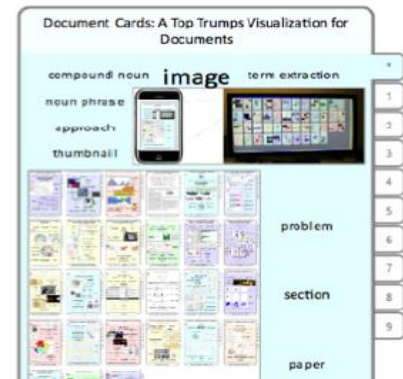
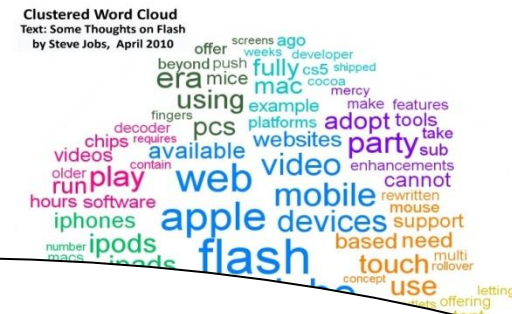
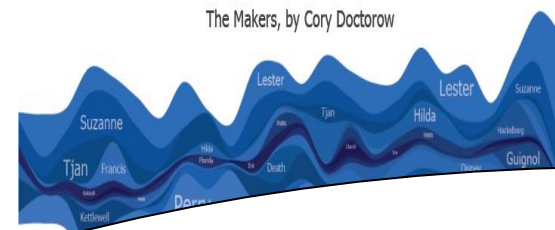


G. Smith
TVCG 2006



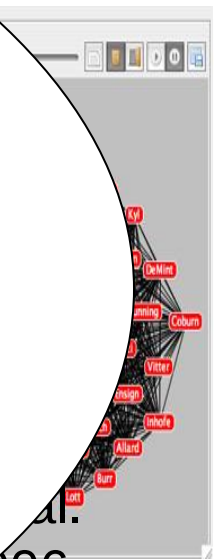
Grokker

Visualizing Global Content Patterns

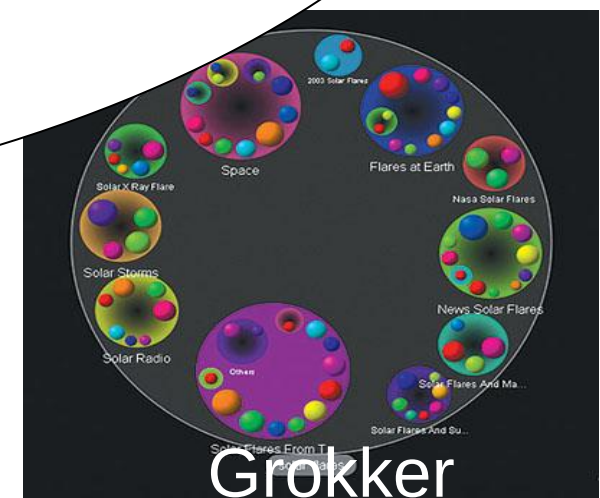
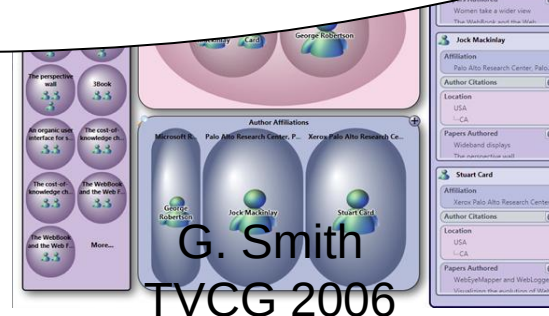
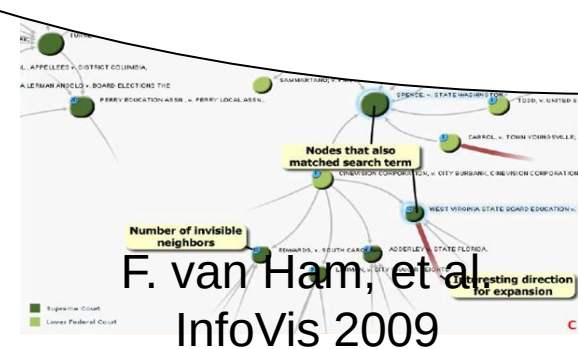


Strobelt, et al.
vis 09

Our Focus :
Extract complex relations
from document contents
by considering
different aspects



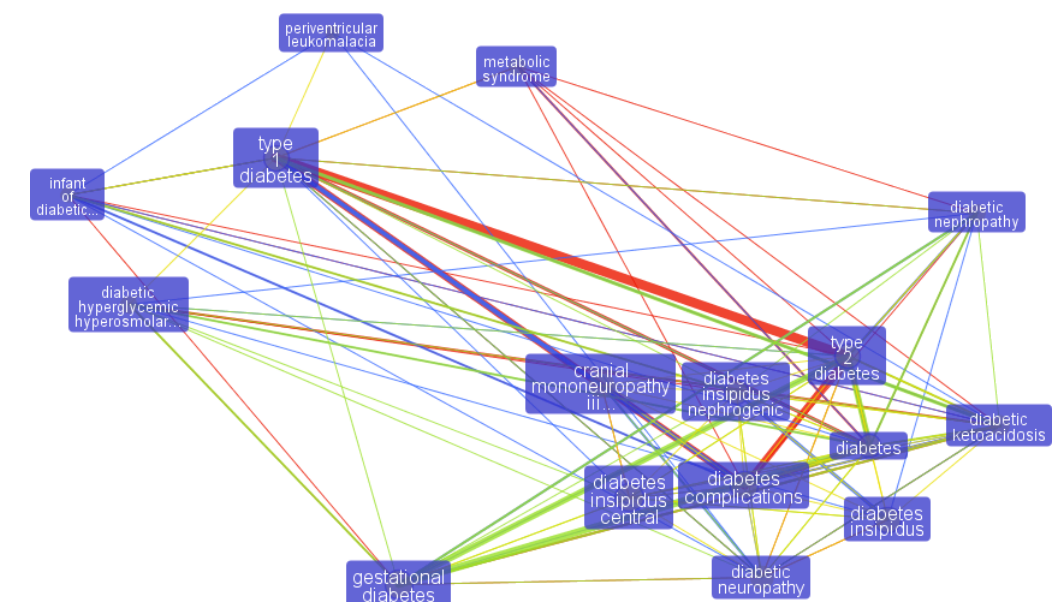
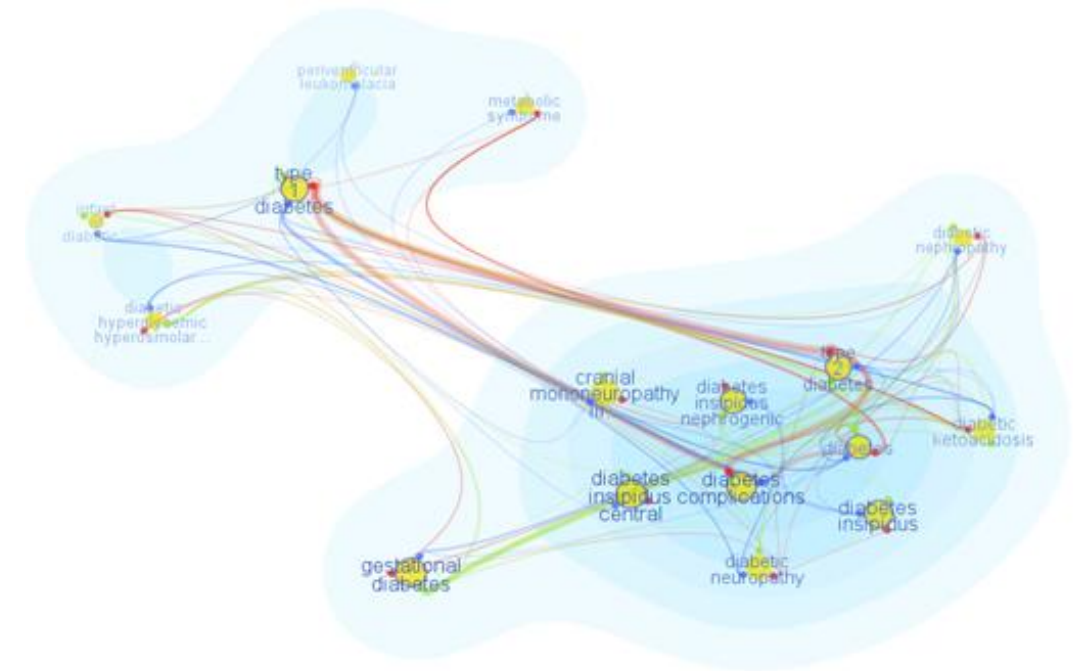
Search Interface



Evaluations

User study

- Participants
 - 3 domain experts (2 physicians with 30 years experience in the healthcare domain, and 1 young medical professional)
 - 20 common users without medical background (2 groups and 10 for each)
- 6 study tasks based on the **Google Health** online documents
 - T4 : identify the facet with the most cross-cluster connections.
 - T6 : identify the facet with the most overall connection across entities.
- Baseline
 - Enhanced Traditional Graph Visualization
 - Based on the same framework with similarly interactions on the same dataset



Evaluation Results from non-experts

Task Com Complete Time

	TASK1		TASK2		TASK3	
	M	SD	M	SD	M	SD
FacetAtlas	4.5	0.92	15.6	1.97	65.5	6.84
Baseline	10.7	1.79	37.6	5.68	70	10.9

	TASK4		TASK5		TASK6	
	M	SD	M	SD	M	SD
FacetAtlas	31	5.26	36.6	4	83.9	6.54
Baseline	127.1	2				

Task Success Rate

	TASK1		TASK2		TASK3	
	M	SD	M	SD	M	SD
FacetAtlas	1	0	1	0	0.89	0.11
Baseline	1	0	1	0	0.77	0.14

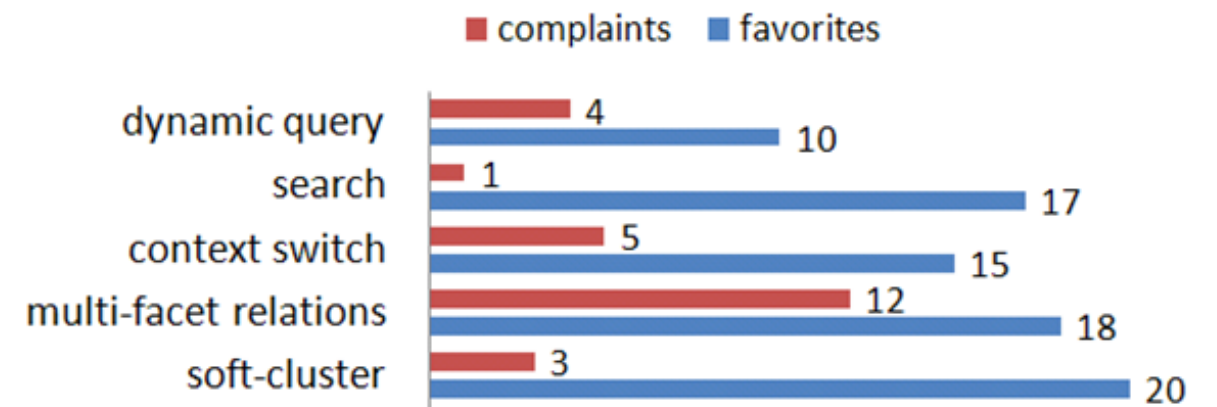
	TASK4		TASK5		TASK6	
	M	SD	M	SD	M	SD
FacetAtlas	0.78	0.14	0.89	0.32	0.76	0.04
Baseline	0.67	0.16	1	0	0.78	0.05

Result (based on two tail t-test)

- Significant efficiency improvement in
 - Visualizing the clusters
 - Showing an overview of multiple connections across clusters
 - Representing the details of multifaceted connection between entities
- Slight improvement in
 - Finding the most connective facet within a cluster

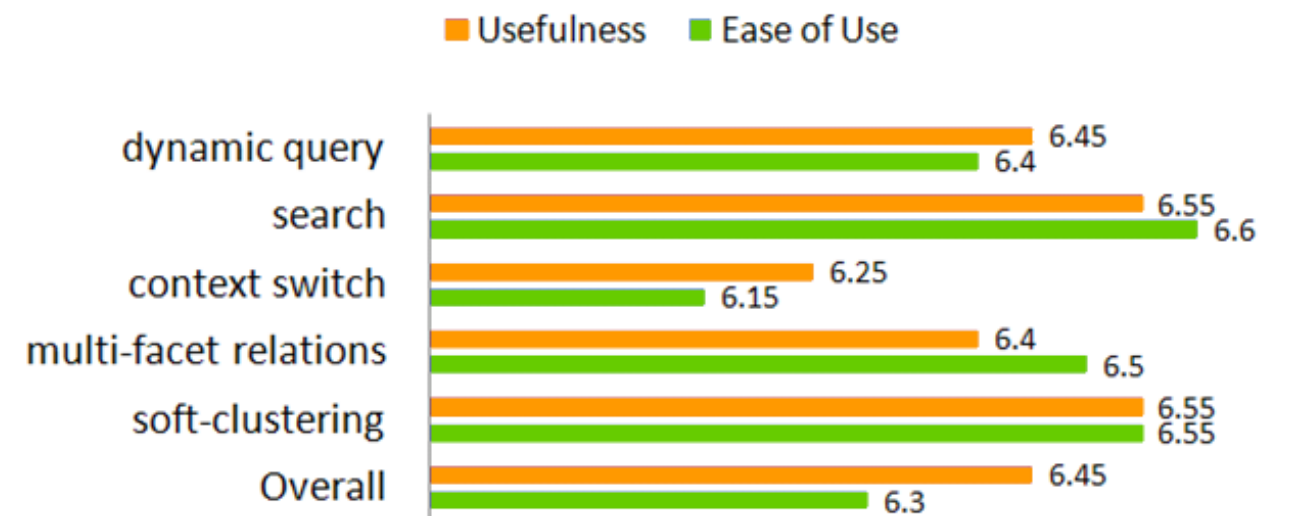
surveys

Users' Feedback Summary on Features of FacetAtlas



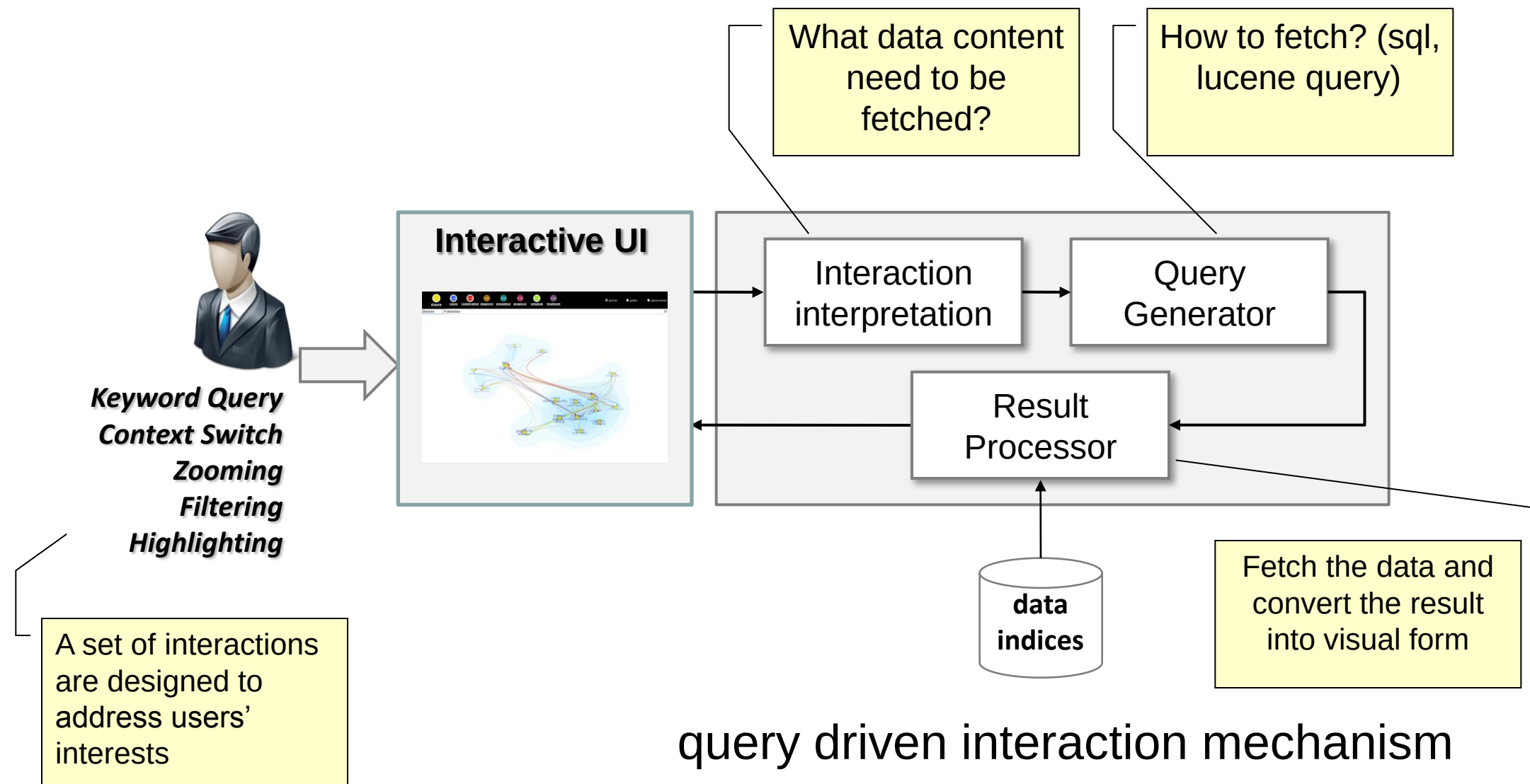
(a)

Usability of FacetAtlas

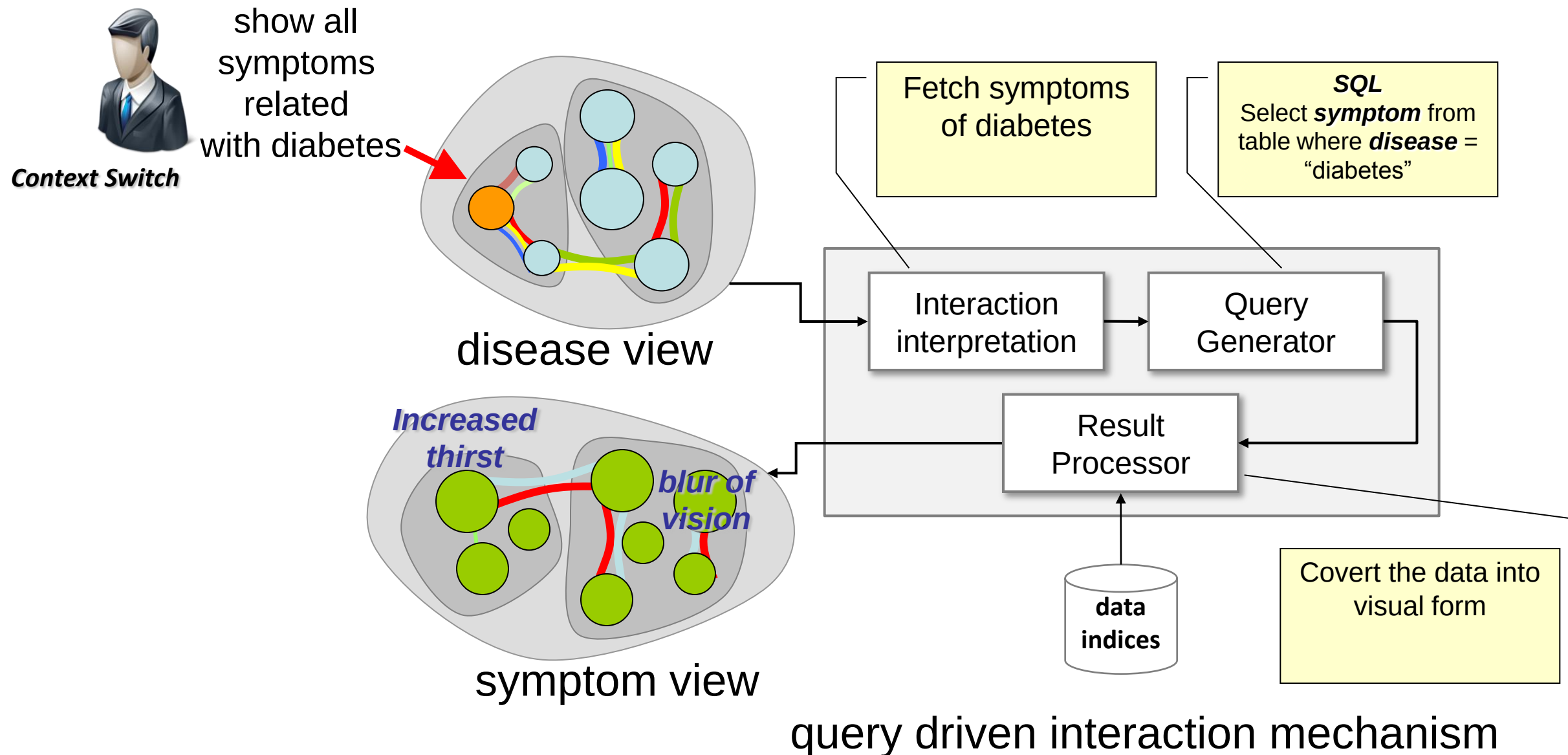


(b)

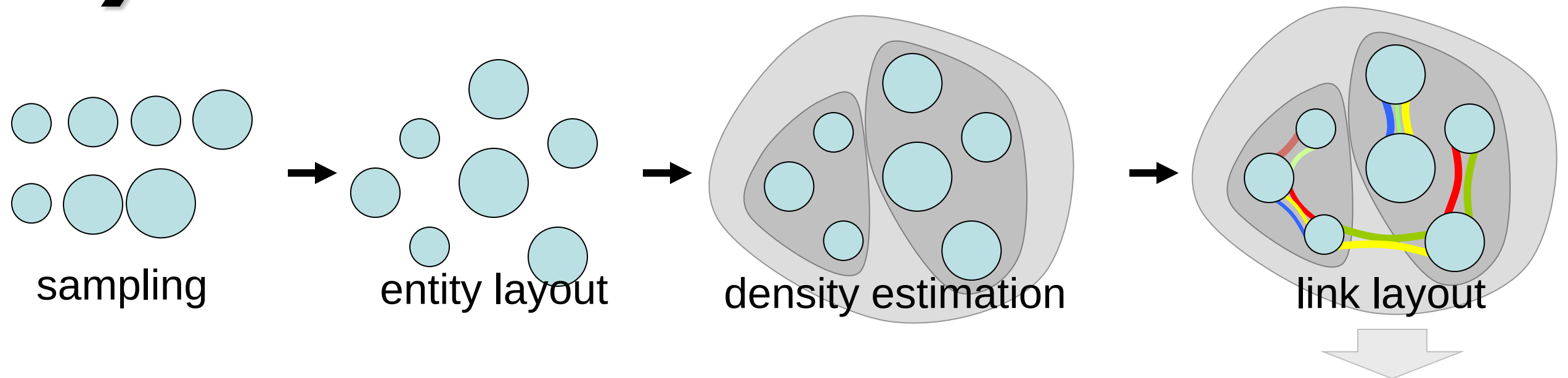
(Q3) How to find insights via user interactions?



(Q3) How to find visual patterns driven by user interests



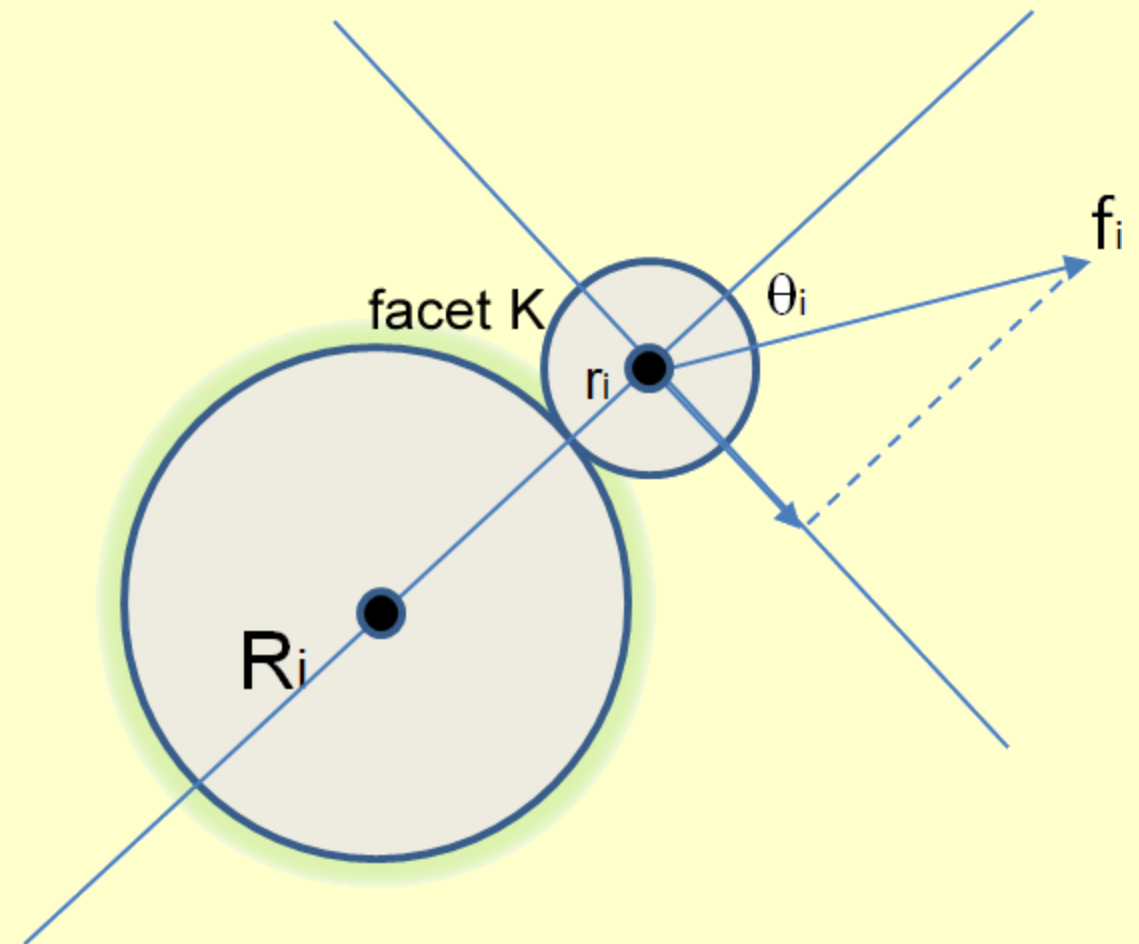
Layout



Link Layout (2)

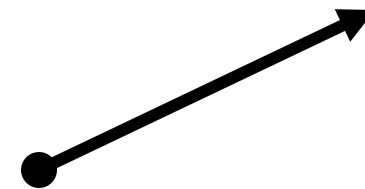
Rotating step tunes node and linkage orientations by minimize the global tension based on a force model

$$\min \sum_k \sum_i \omega_k f_i^k \sin(\theta_i^k) (r_i^k + R_i)$$



Local Patterns

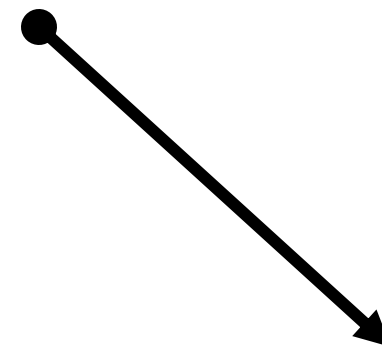
- Co-occurrence
 - Entities have **strong** connections over multiple entities
 - Semantic similarity metric defines what is “**strong**”
- Outlier
 - Entities have “**strong**” connections however “**far away**” from each other
 - Layout closeness defines what is “**far away**”
 - “**strong**” and “**far away**”
- Enhancement by colors
 - Automatic adjust the saturation of node color by pattern metrics



$$sim_{ij} = \sum_{k=1}^M sim_k(i, j)$$



d_{ij} the shortest path in the graph



$$c_{ij} = \sqrt{d_{ij} \cdot sim_{ij}}$$