Graph-based Concept Weighting for Medical Information Retrieval

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Document Representation for IR

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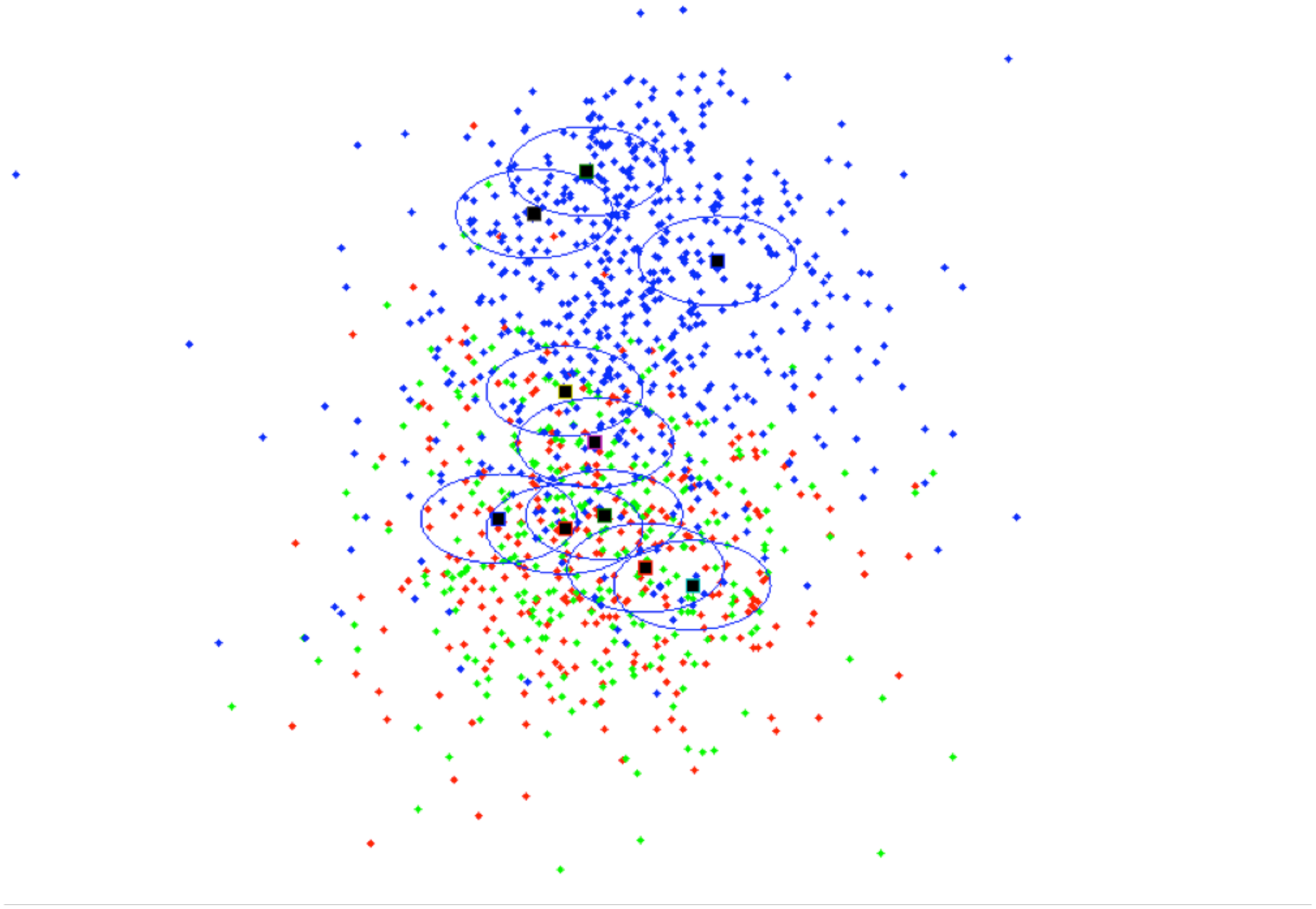

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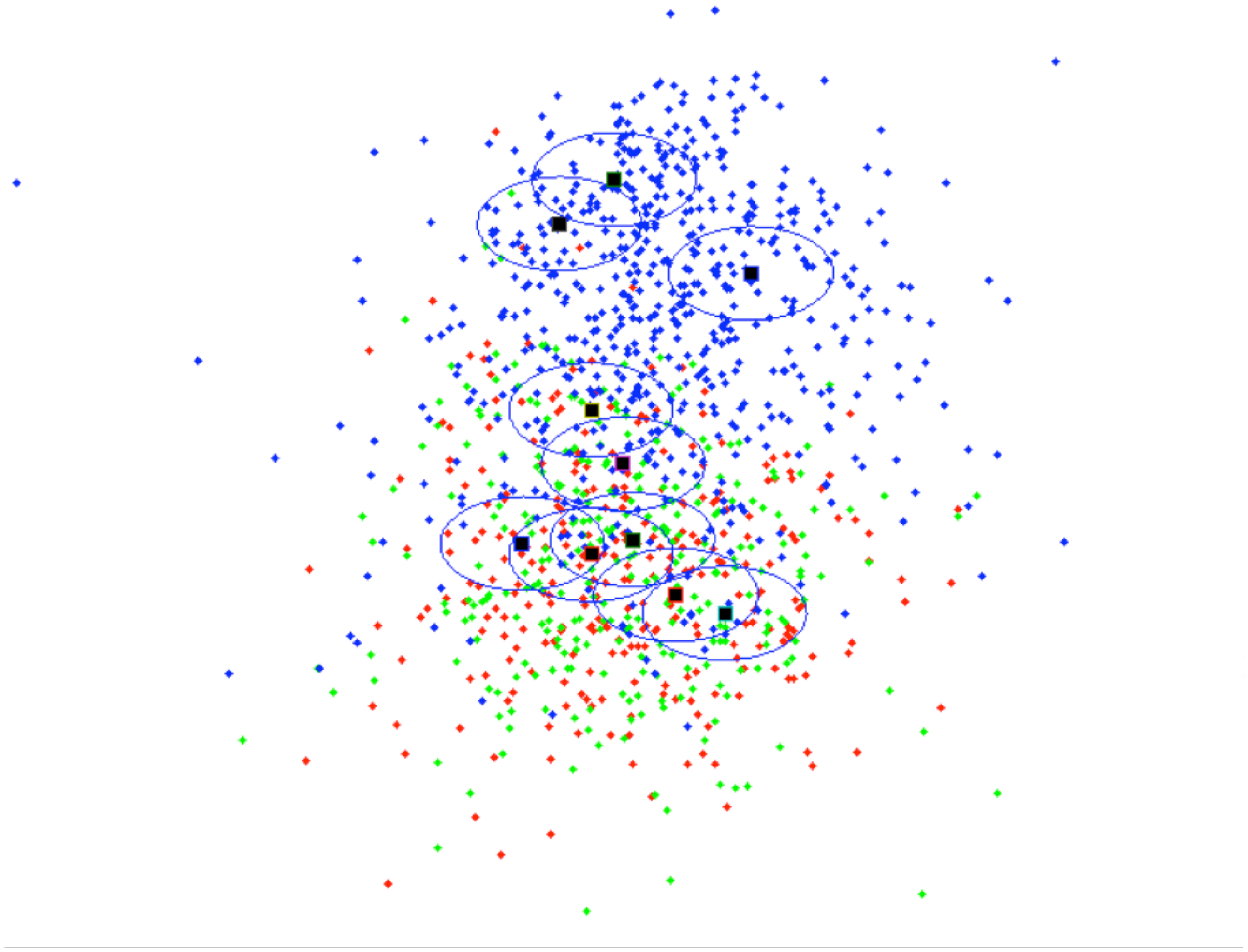
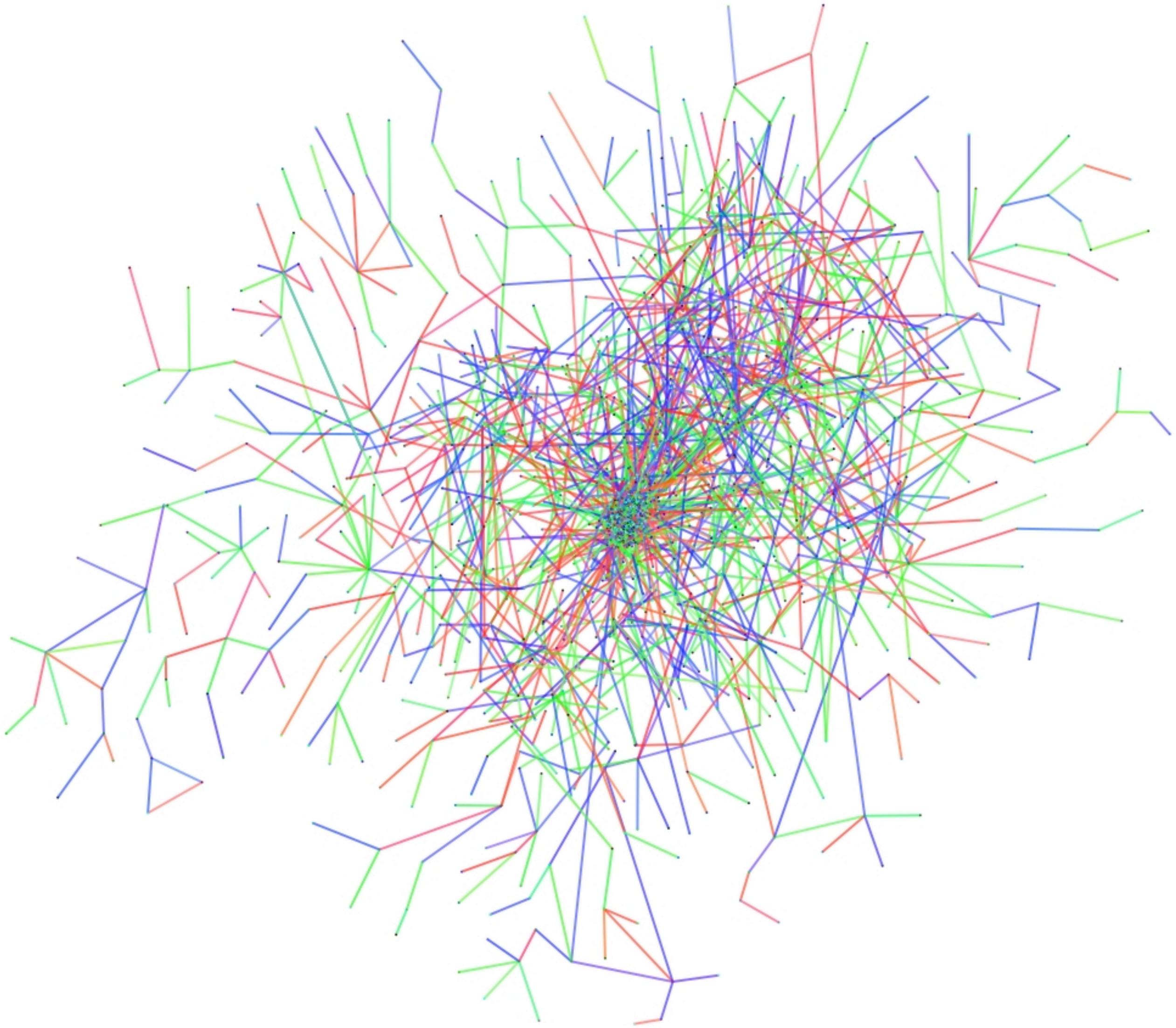
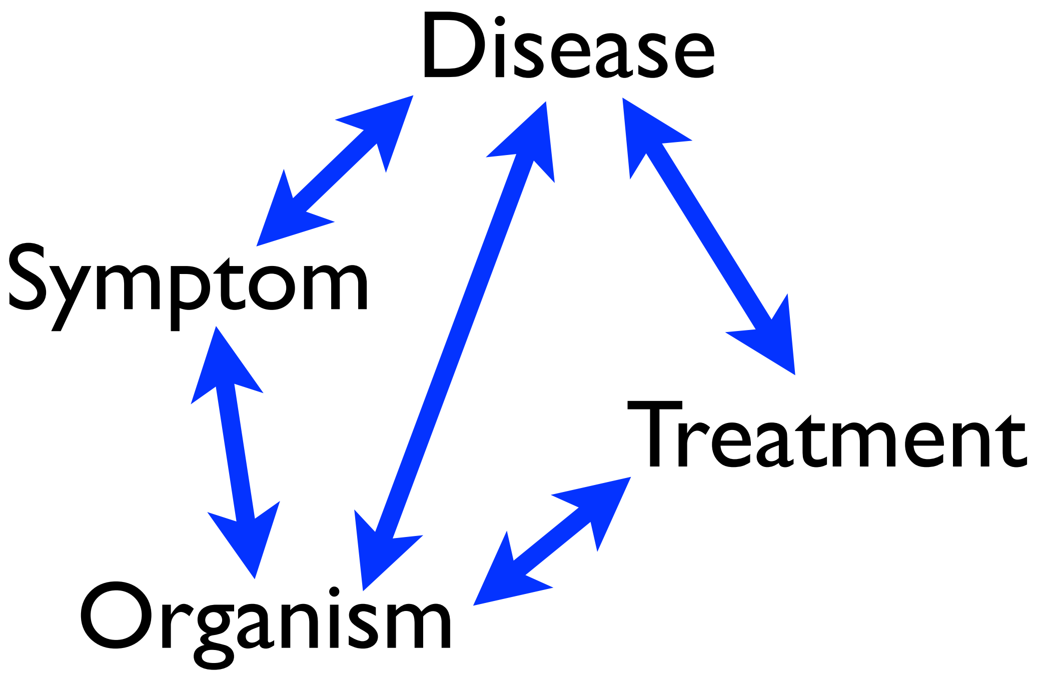




Why Medical IR?

- Vocabulary mismatch
  - hypertension ≈ high blood pressure
- Interdependence between terms



Disease

Symptom

Treatment

Organism

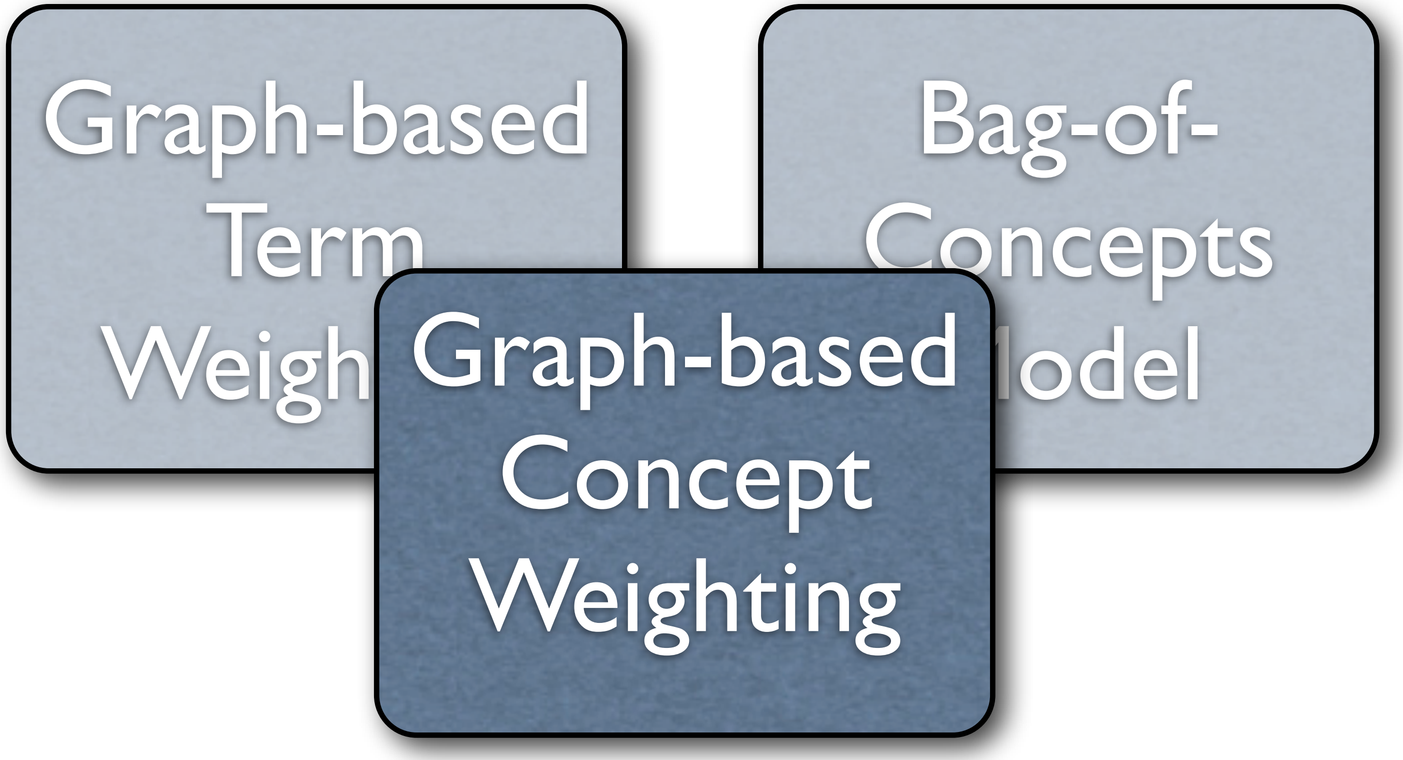
(Patel et al, 2007)

Overview

Graph-based Term Weighting

Bag-of-Concepts Model

Overview



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Graph-based Concept Weighting

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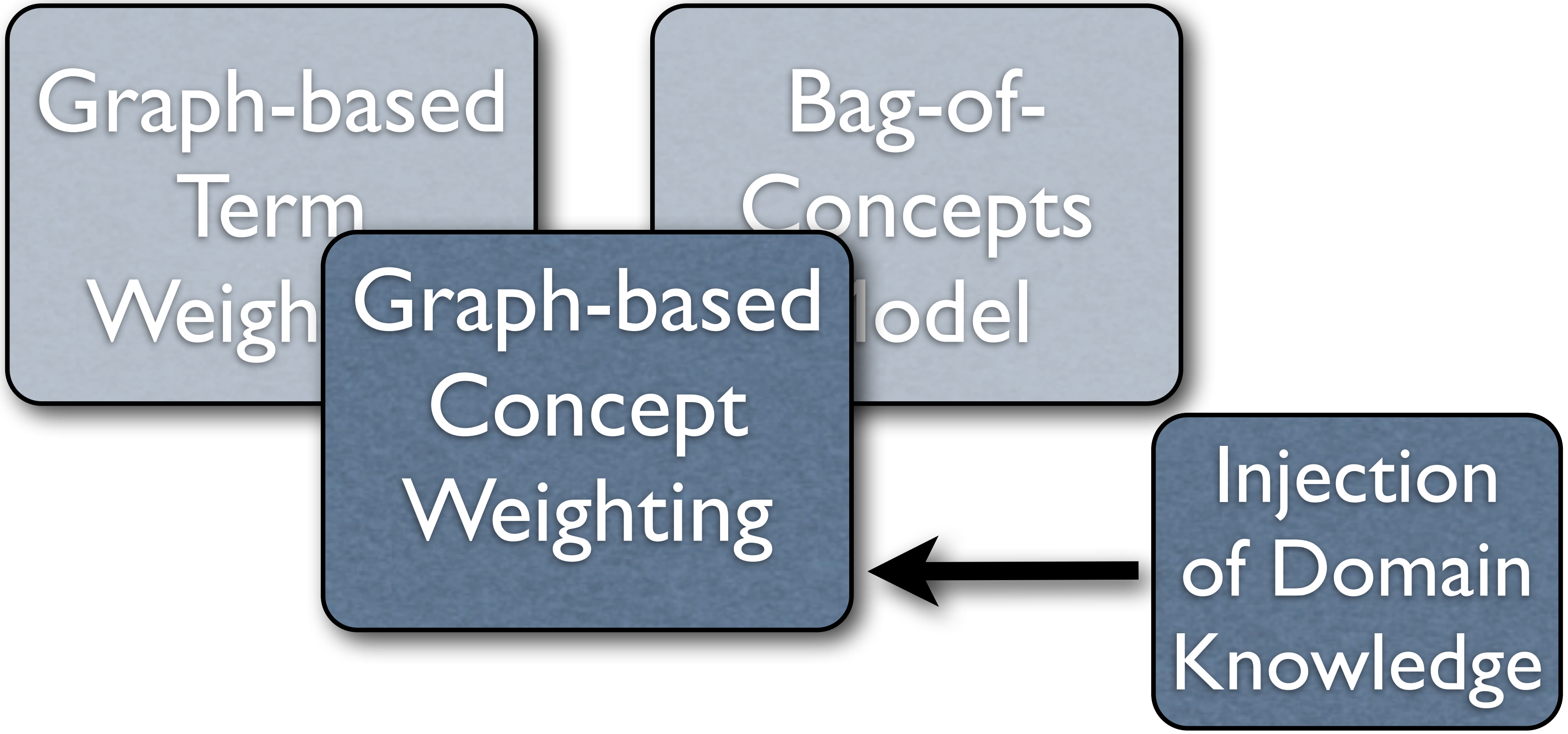
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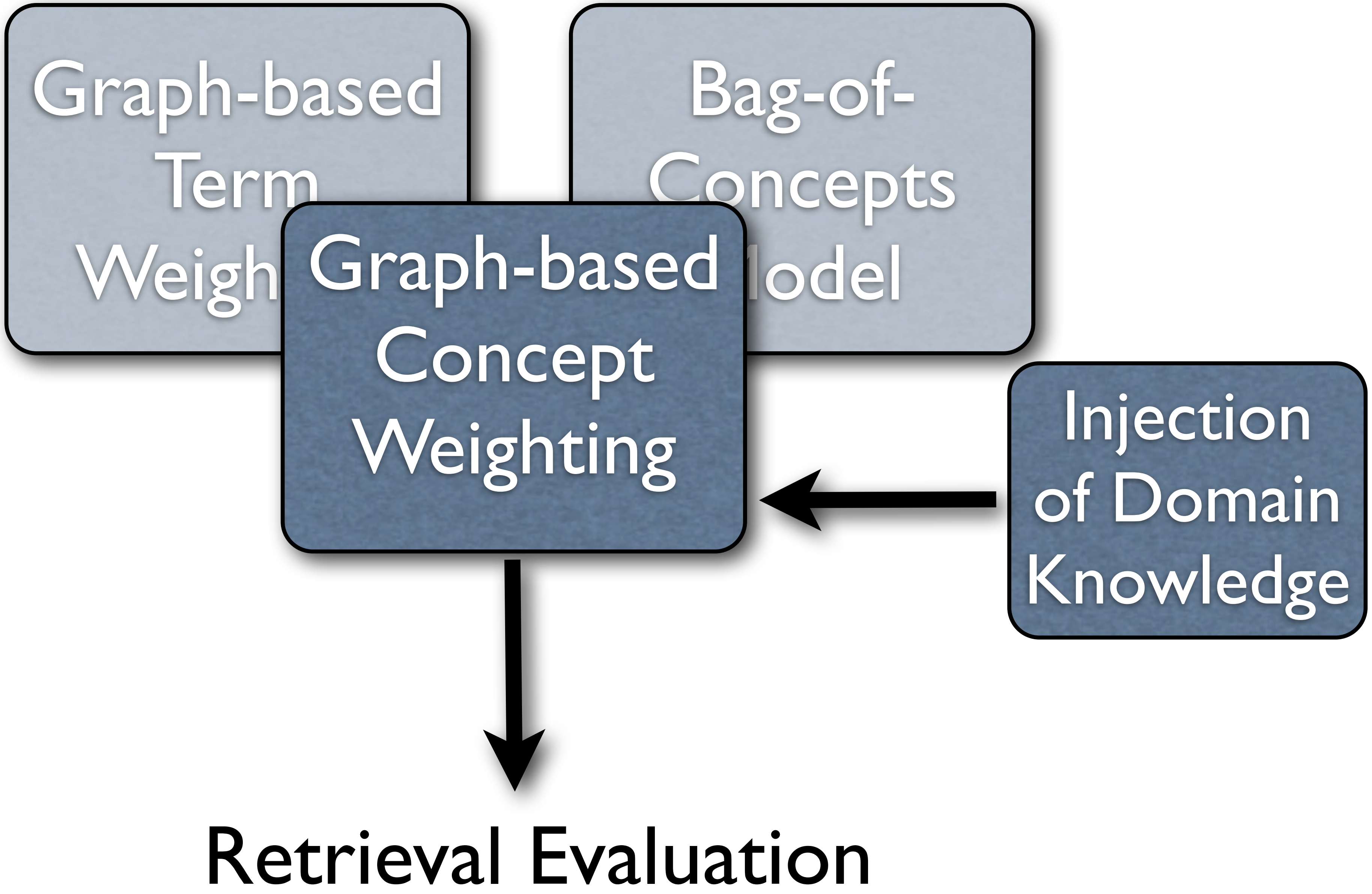
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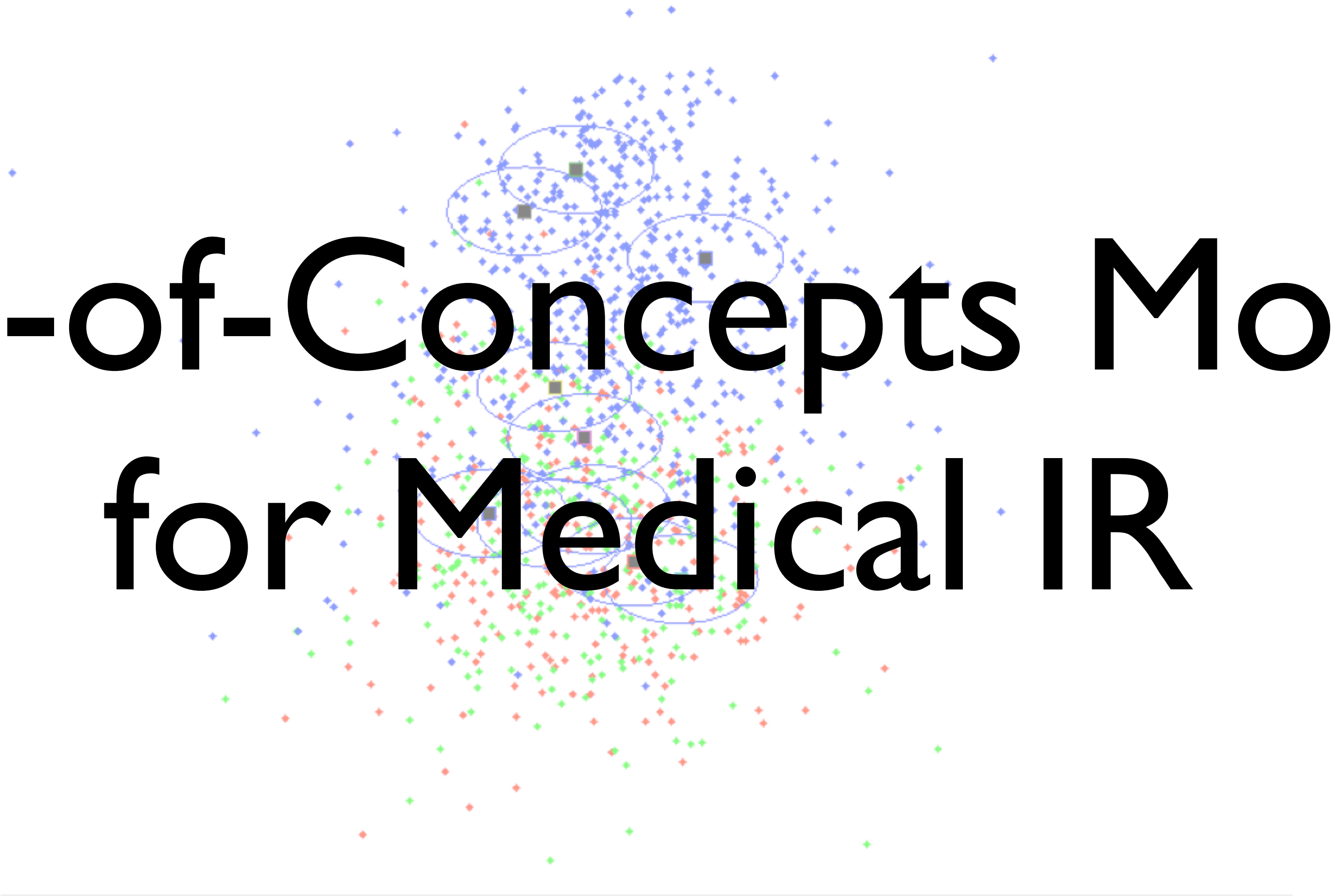
Retrieval Evaluation

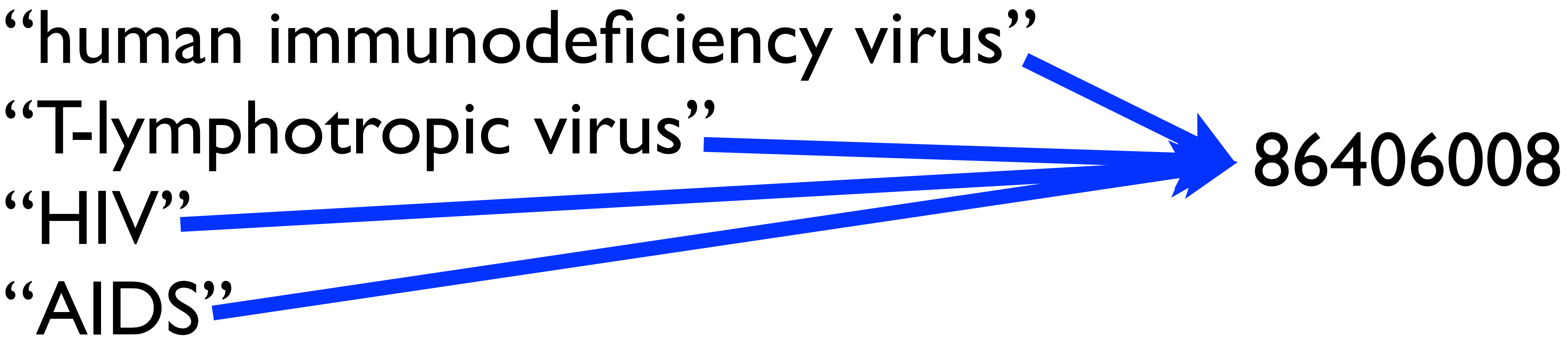


Bag-of-Concepts Model for Medical IR

Convert Terms to Concepts

“human immunodeficiency virus”
“T-lymphotropic virus”
“HIV”
“AIDS”

Convert Terms to Concepts



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86406008

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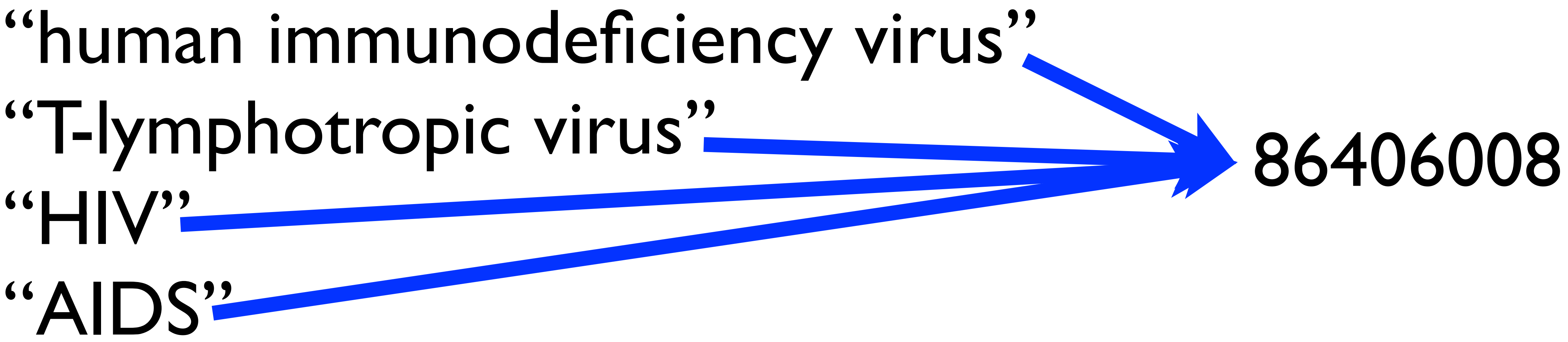

"human immunodeficiency virus"

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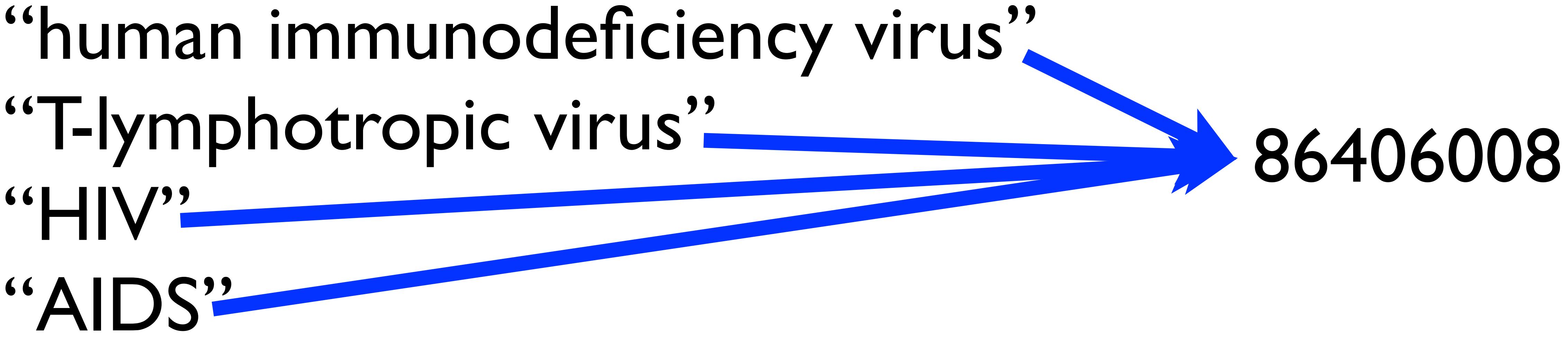
"esophageal reflux"

Convert Terms to Concepts



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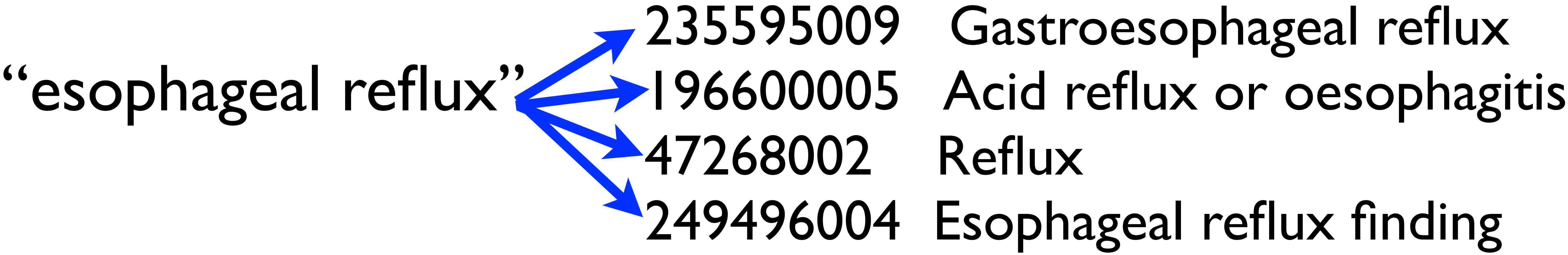
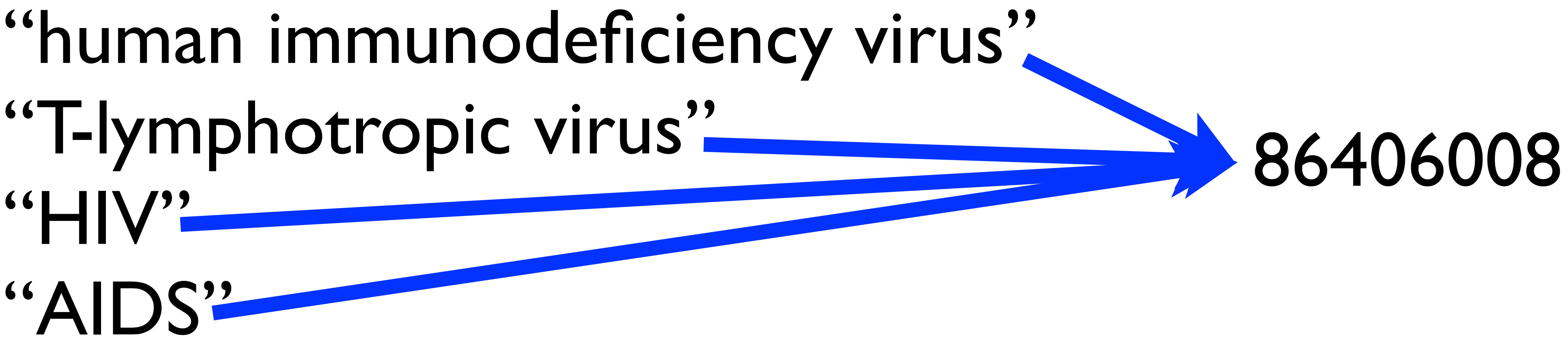


“esophageal reflux”

235595009	Gastroesophageal reflux
196600005	Acid reflux or oesophagitis
47268002	Reflux
249496004	Esophageal reflux finding

Convert Terms to Concepts



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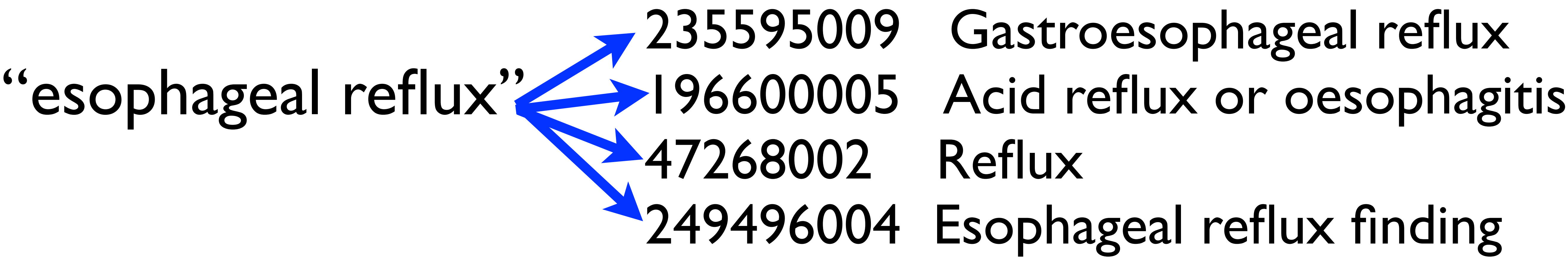

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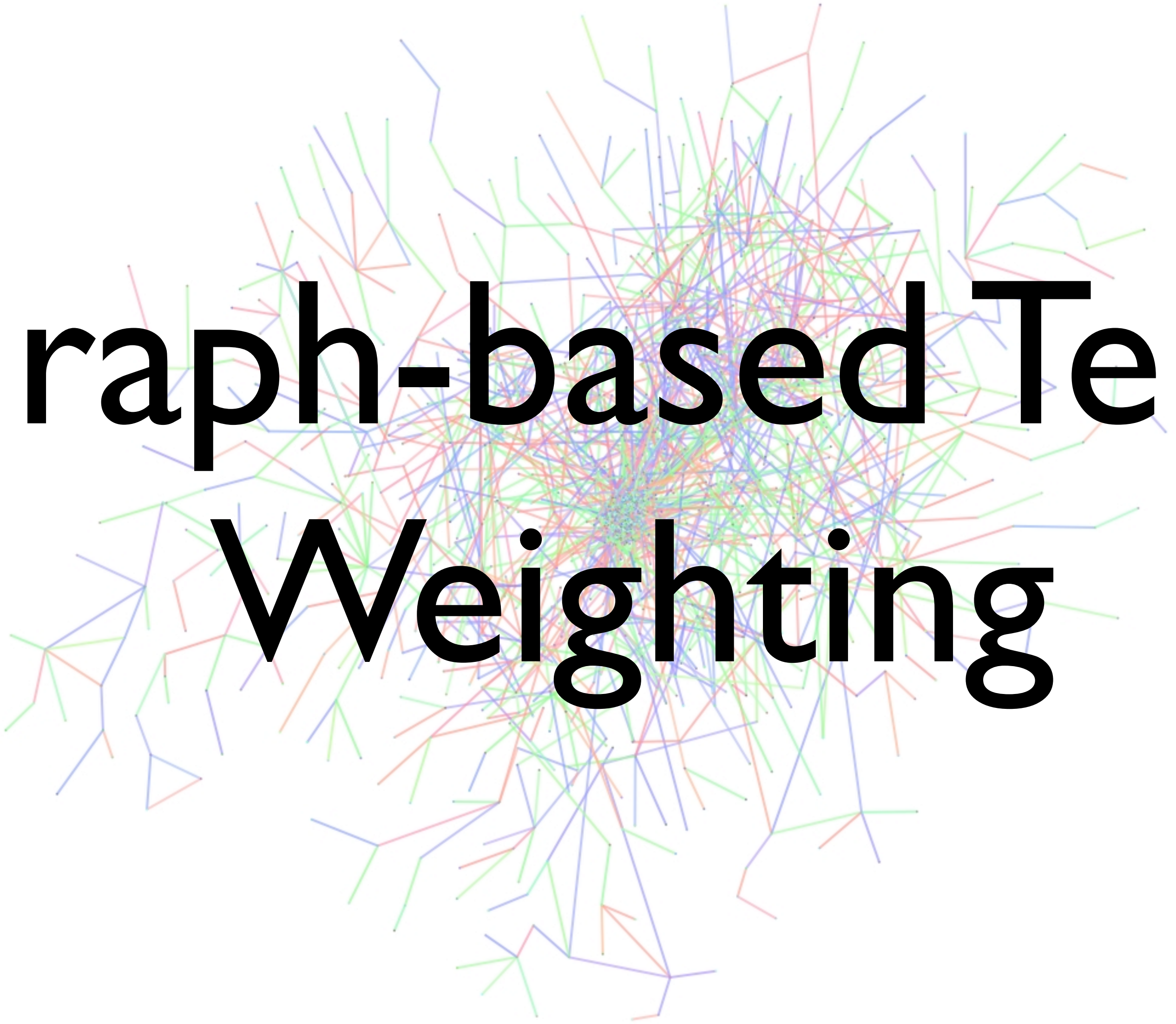
Index & retrieval on "bag-of-concepts" (Koopman et al, 2012)

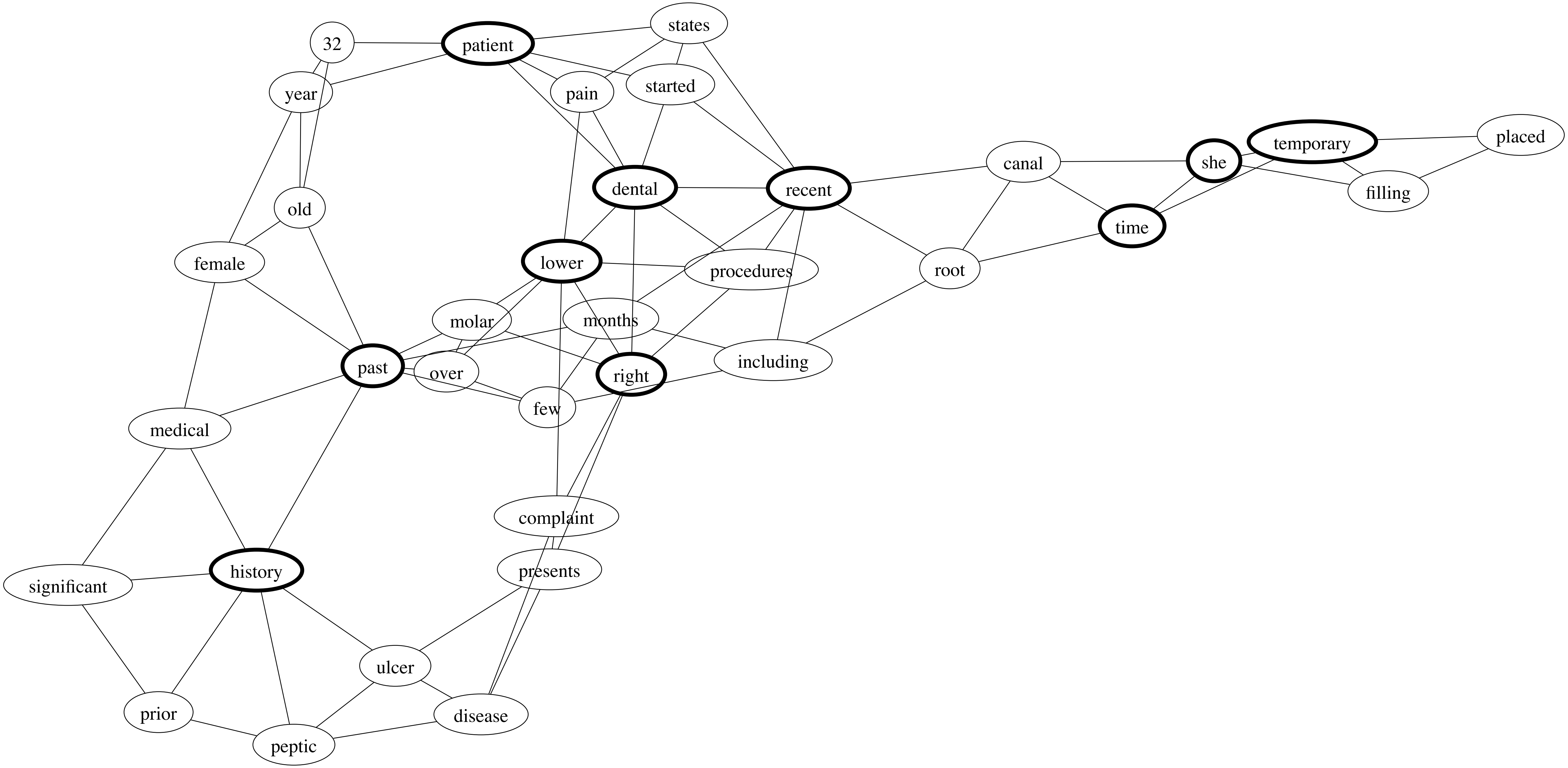
Graph-based Term Weighting



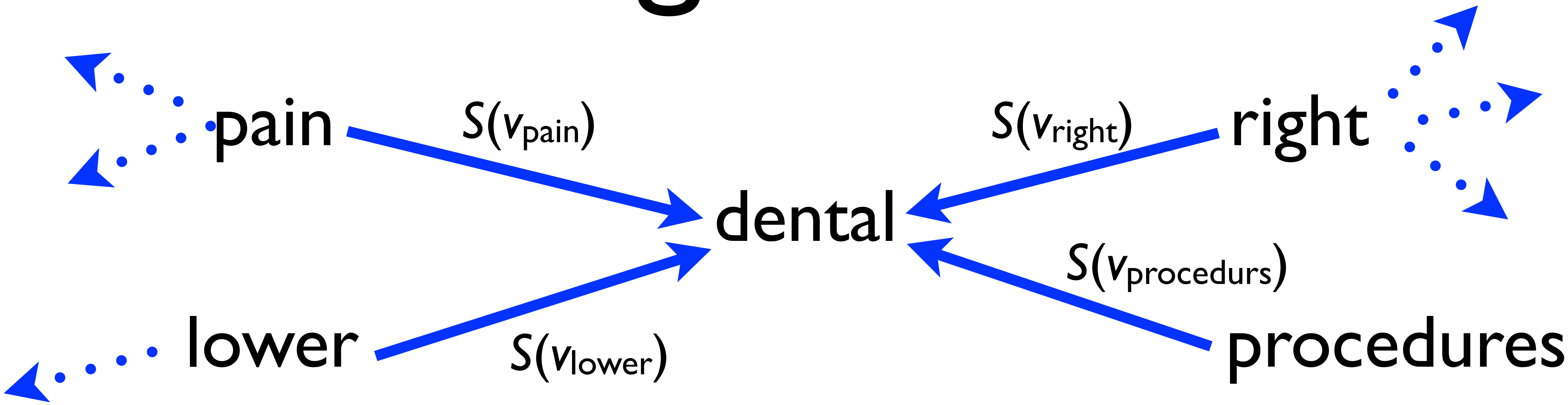
Example Medical Doc

"The patient is a 32-year-old female with a past medical history significant for a prior history of peptic ulcer disease who presents with a complaint of right lower dental pain. The patient states that she was started on recent dental procedures, on a right lower molar, over the past few months, including a recent root canal, at which time she had a temporary filling placed."

Document Term Graph



Term Weighting using PageRank



(Blanco & Lioma, 2012)

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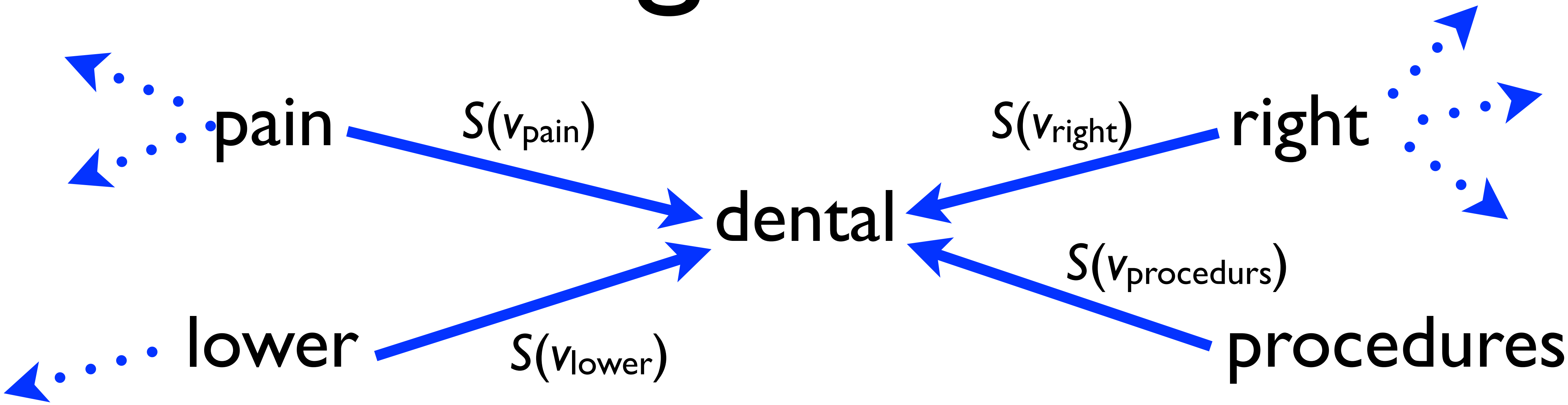

$$S(v_t) = \sum_{v_j \in \mathcal{V}(v_t)} \frac{S(v_j)}{|\mathcal{V}(v_j)|}$$

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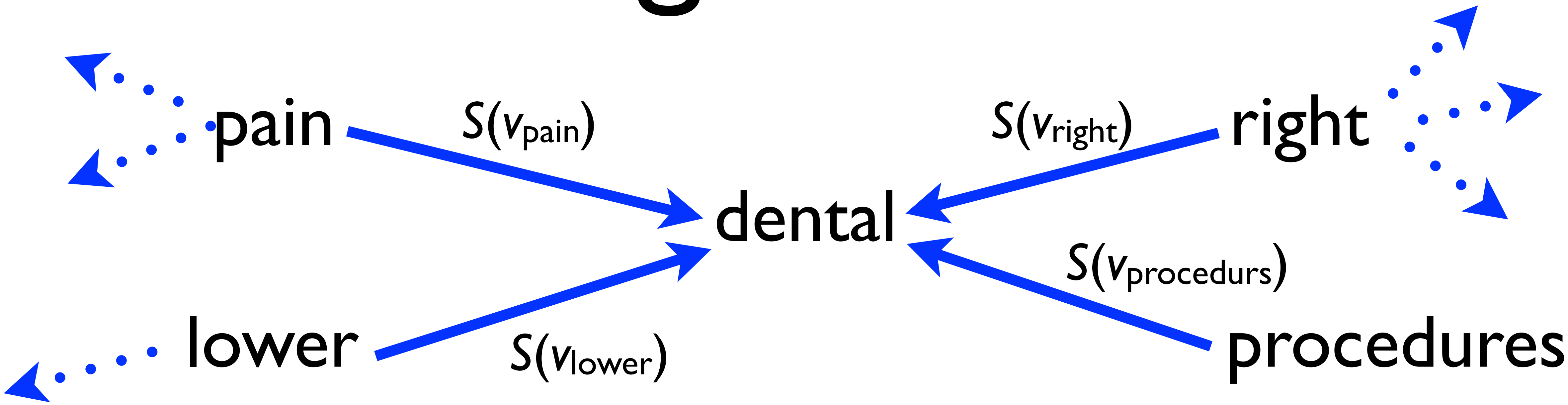

$$S(v_t) = (1 - \phi) + \phi * \sum_{v_j \in \mathcal{V}(v_t)} \frac{S(v_j)}{|\mathcal{V}(v_j)|}$$

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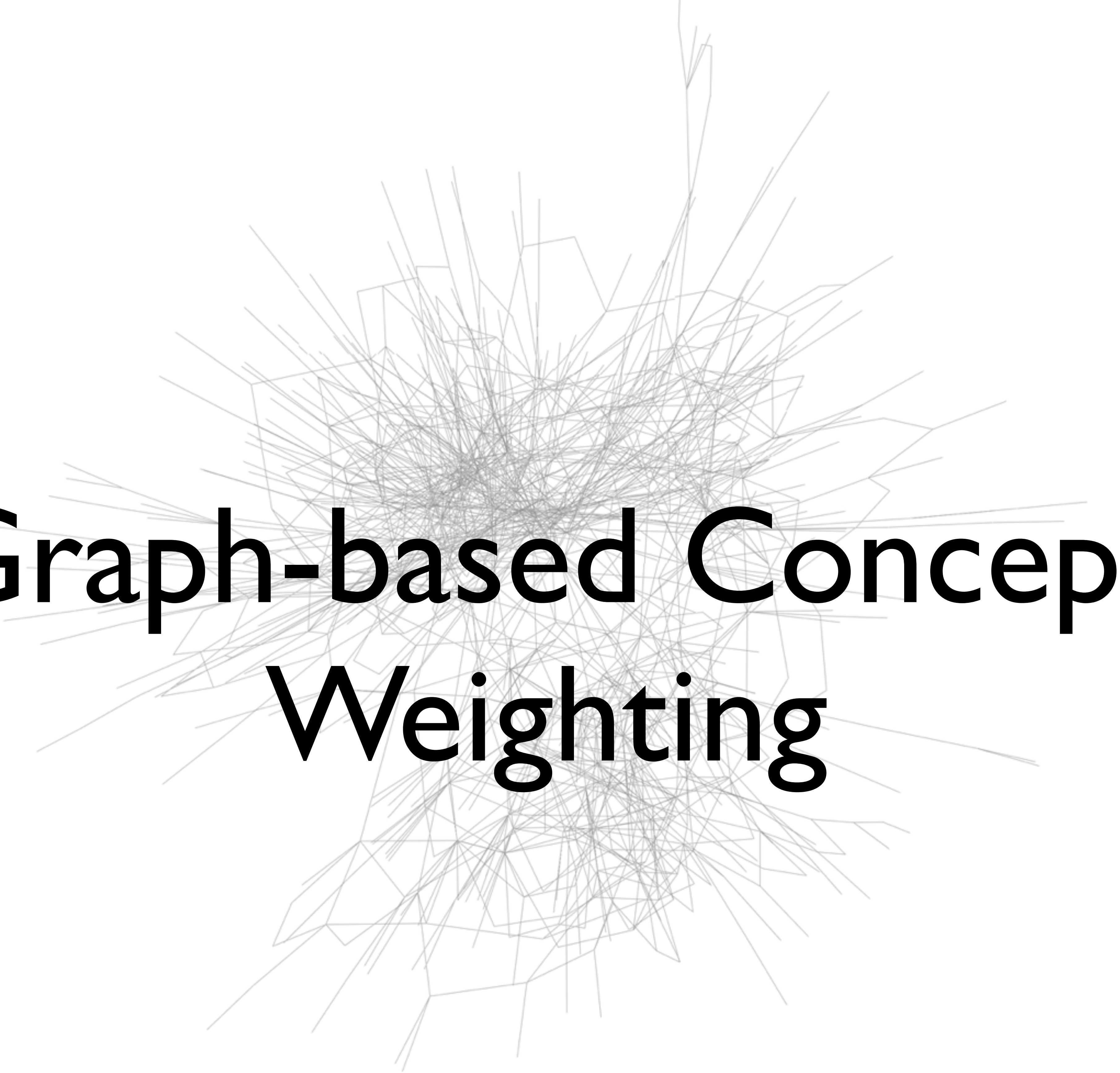
Graph-based Concept Weighting



Concept-based Retrieval Function

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Concept-based Retrieval Function

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Document (concepts) d_c

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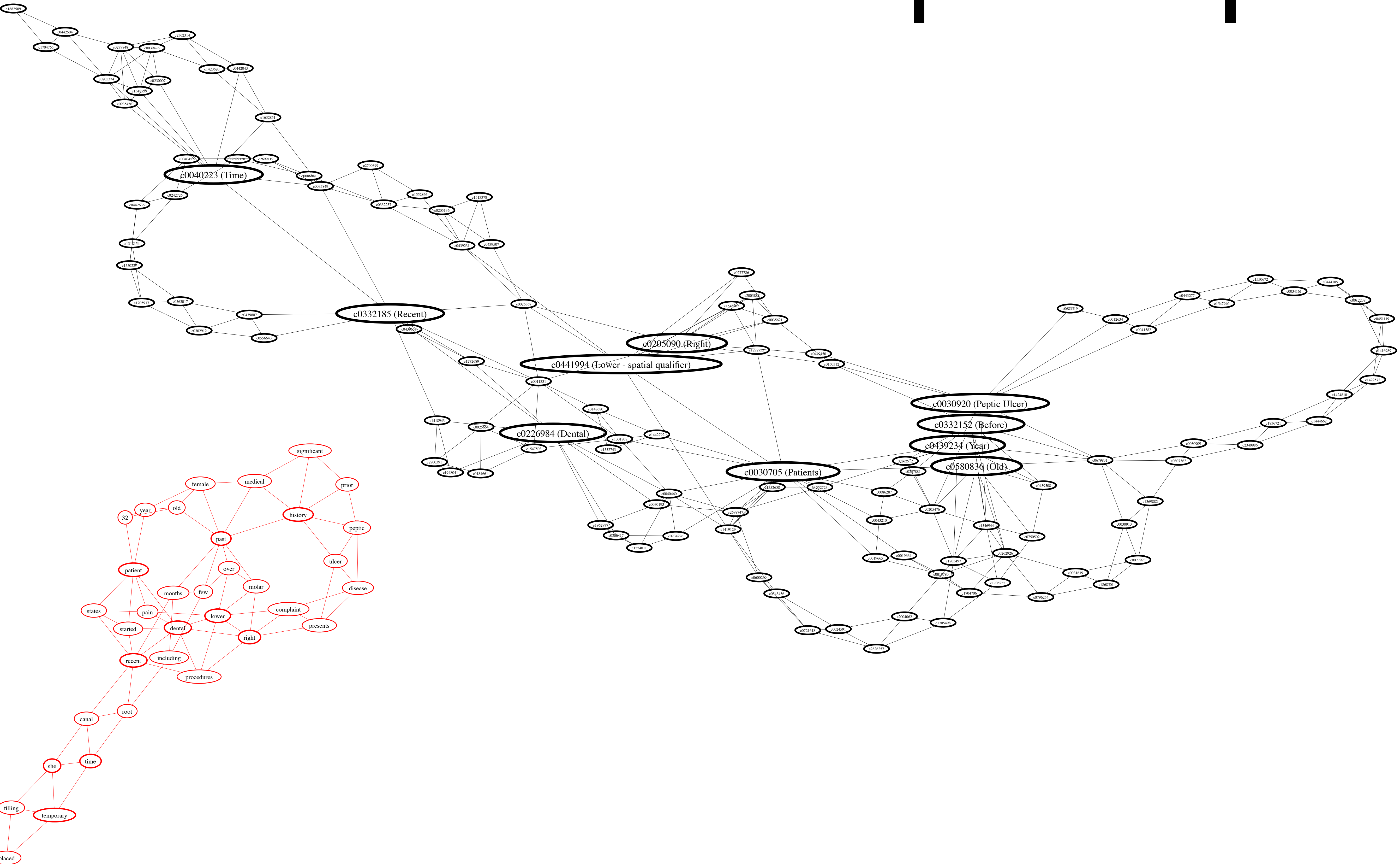
Query (concepts) q_c

Document Concept Graph



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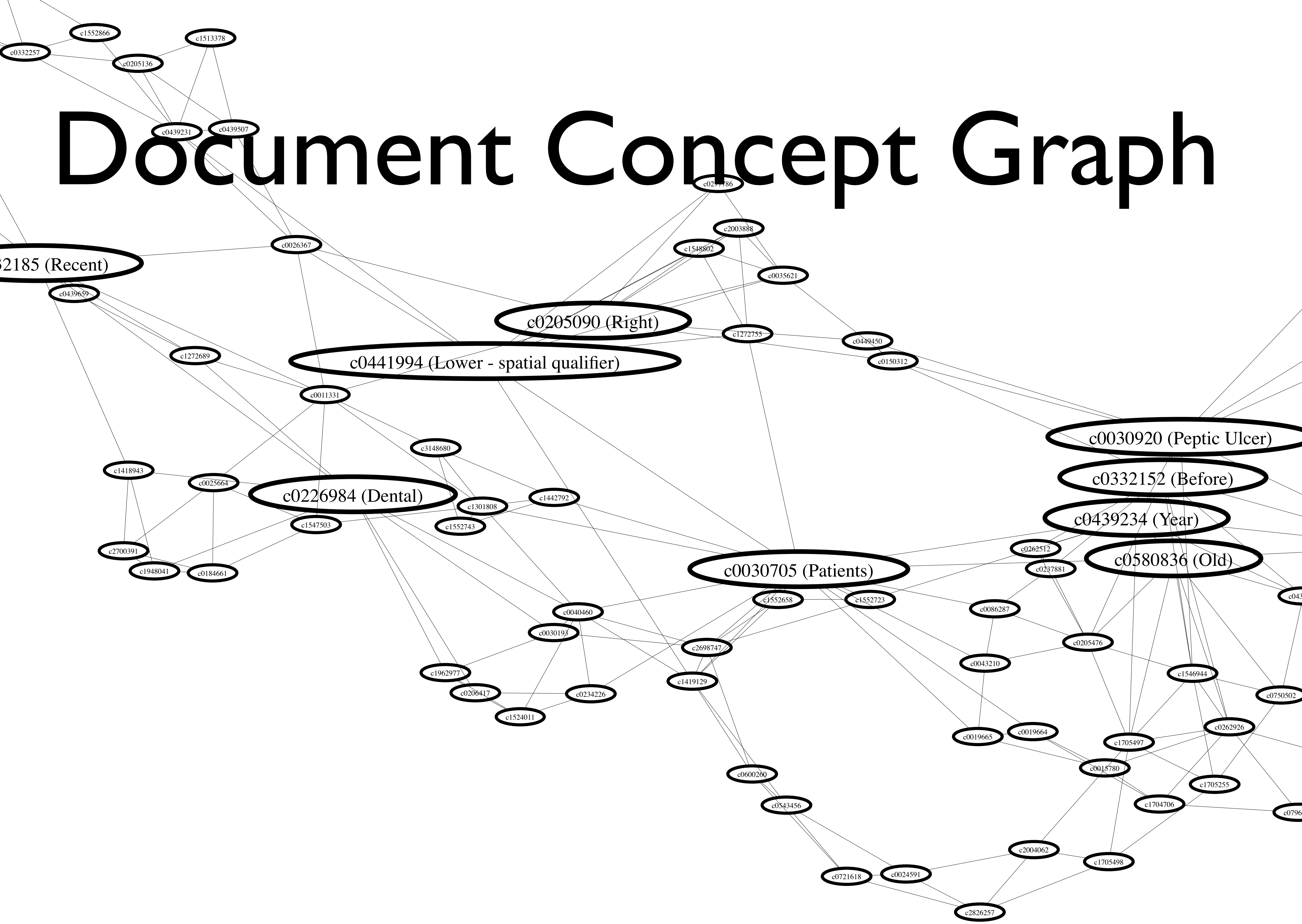

Injection of Domain Knowledge

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- Document is a graph of SNOMED CT concepts

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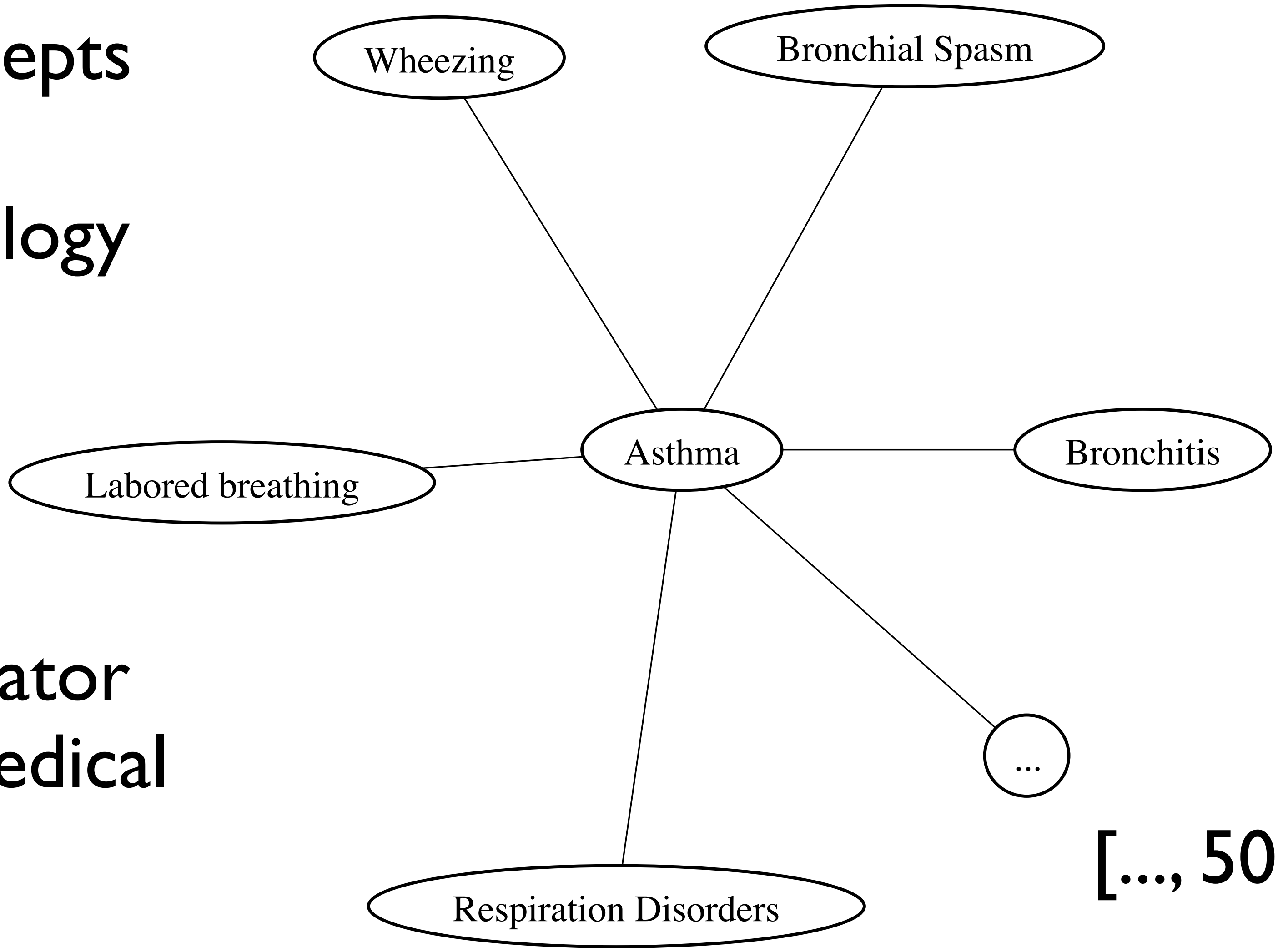

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Domain Importance Concept Weighting

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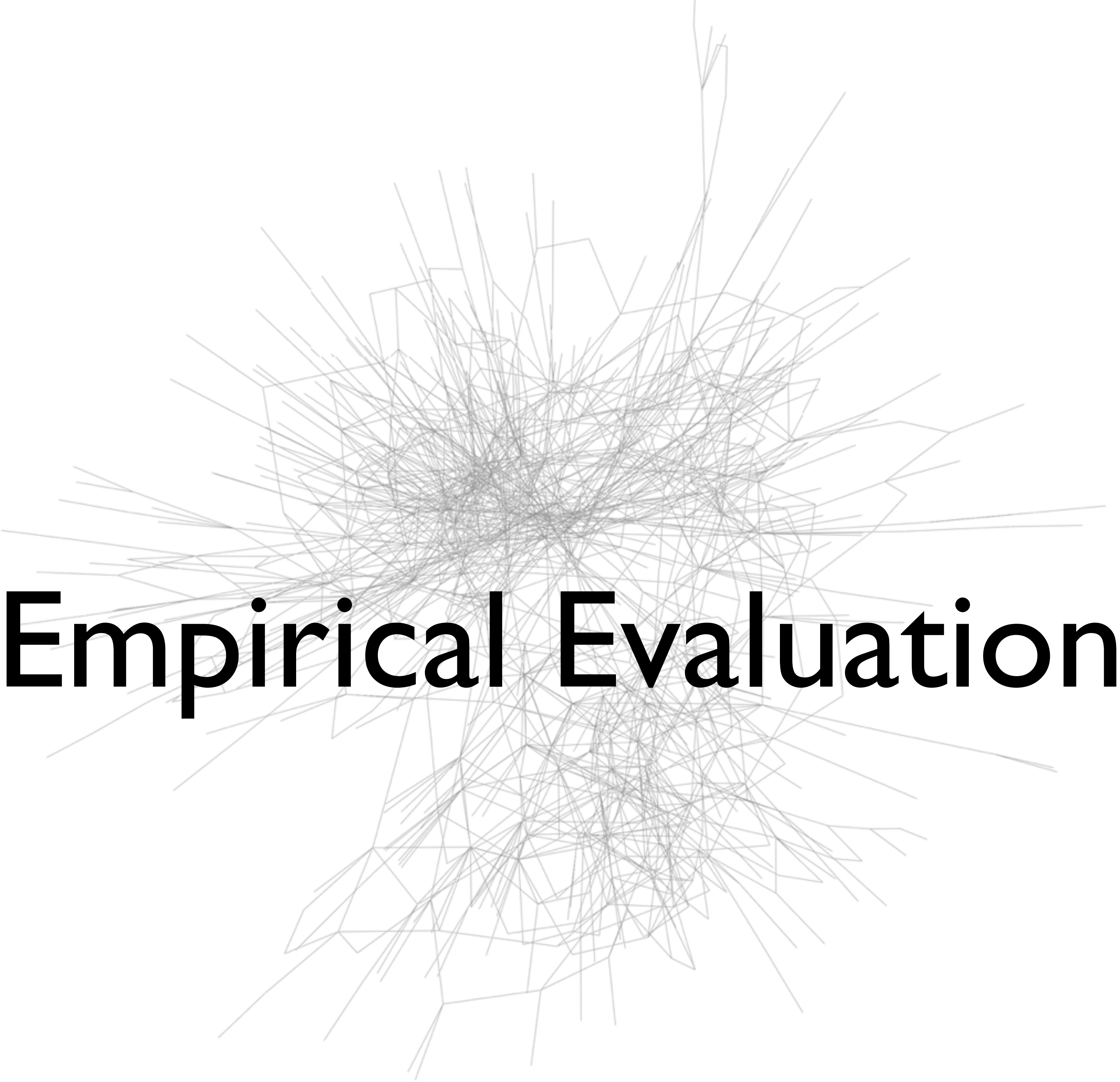
corpus

document

domain

Empirical Evaluation



Test Collection

- TREC 2011 Medical Records Track
  - 100,866 clinical records
  - 34 clinical queries + qrels
- Entire collection converted to SNOMED-CT concepts using MetaMap

Baselines + Models

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- terms-tfidf

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- terms-tfidf
- concepts-tfidf

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- terms-tfidf
- concepts-tfidf
- terms-graph

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- concepts-graph-snomed

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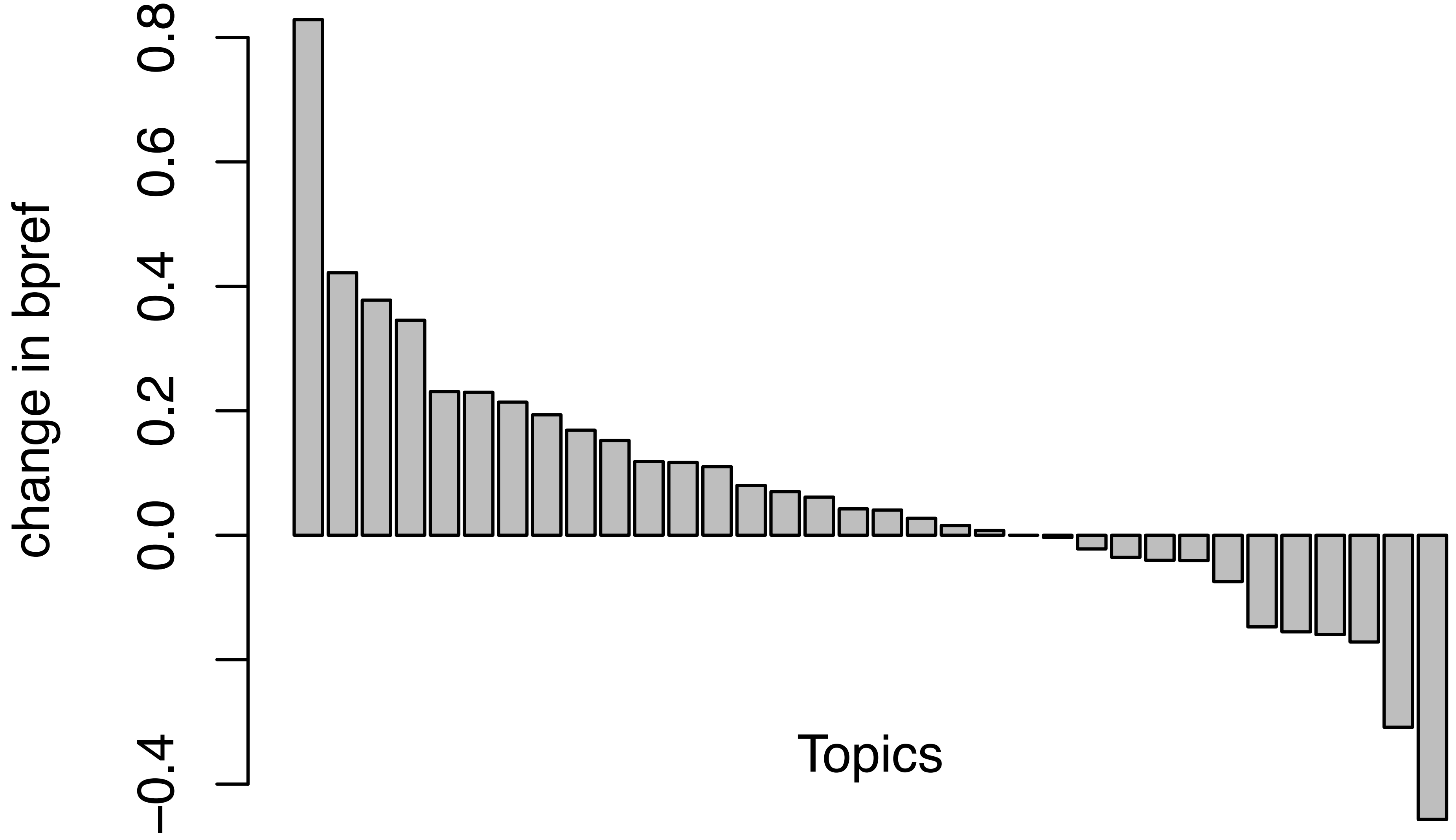
Bpref, Precision@10

Retrieval Results

Run	**Bpref**	**Prec@10**
terms-tfidf	0.4722	0.4882
concepts-tfidf	0.4993	0.5176
terms-graph	0.4393	0.4882
concepts-graph	0.5050 (+15%)	0.5441 (+11%)
concepts-graph-snomed	**0.5245** (+19%)	**0.5559** (+14%)

Per-query



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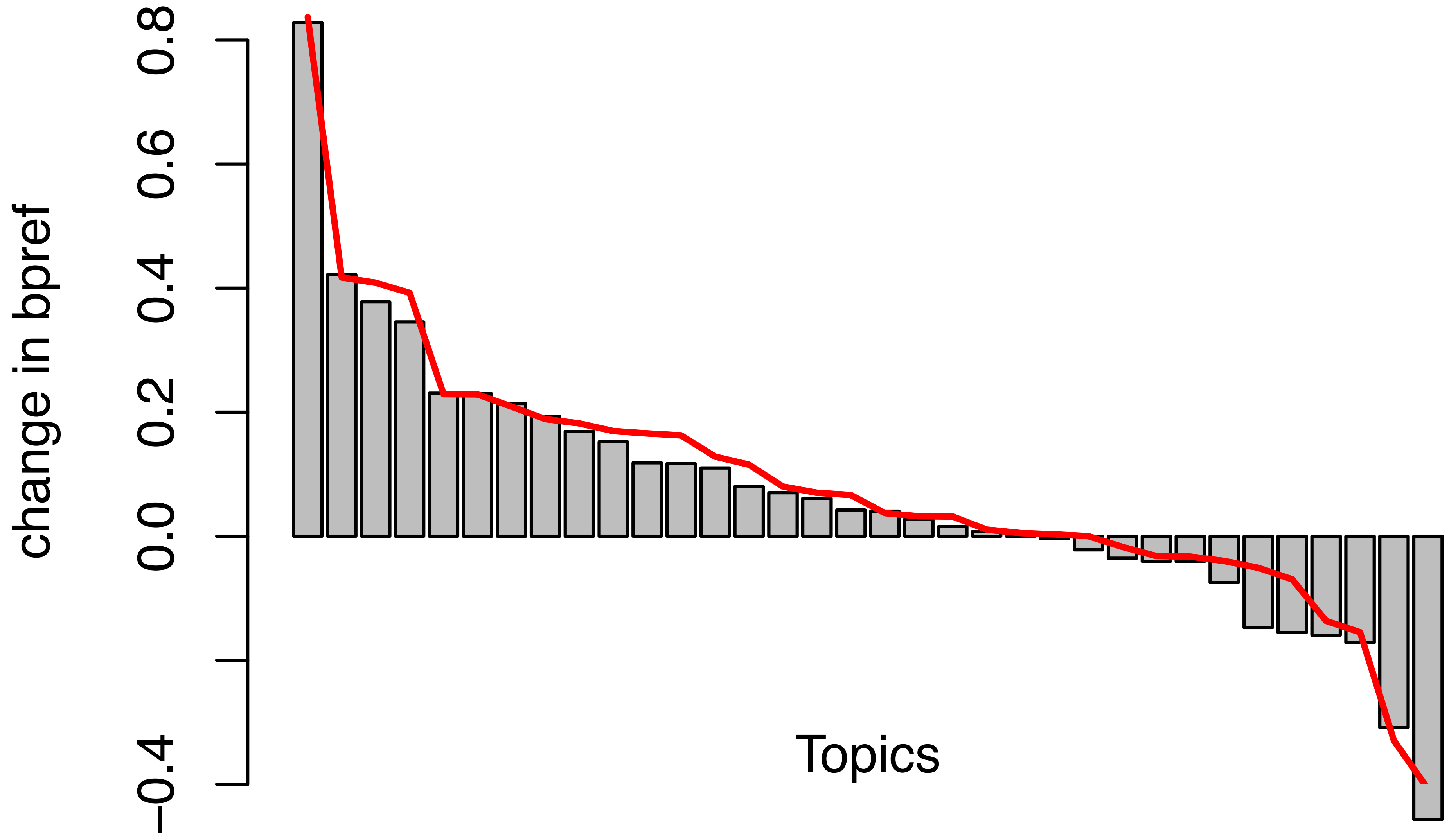

Query reduction..?

$$w(c, d_c) = idf(c) * S(v_c) * \underline{\log(|\mathcal{V}_s(c)|)}$$

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- 34 queries, 448 query concepts

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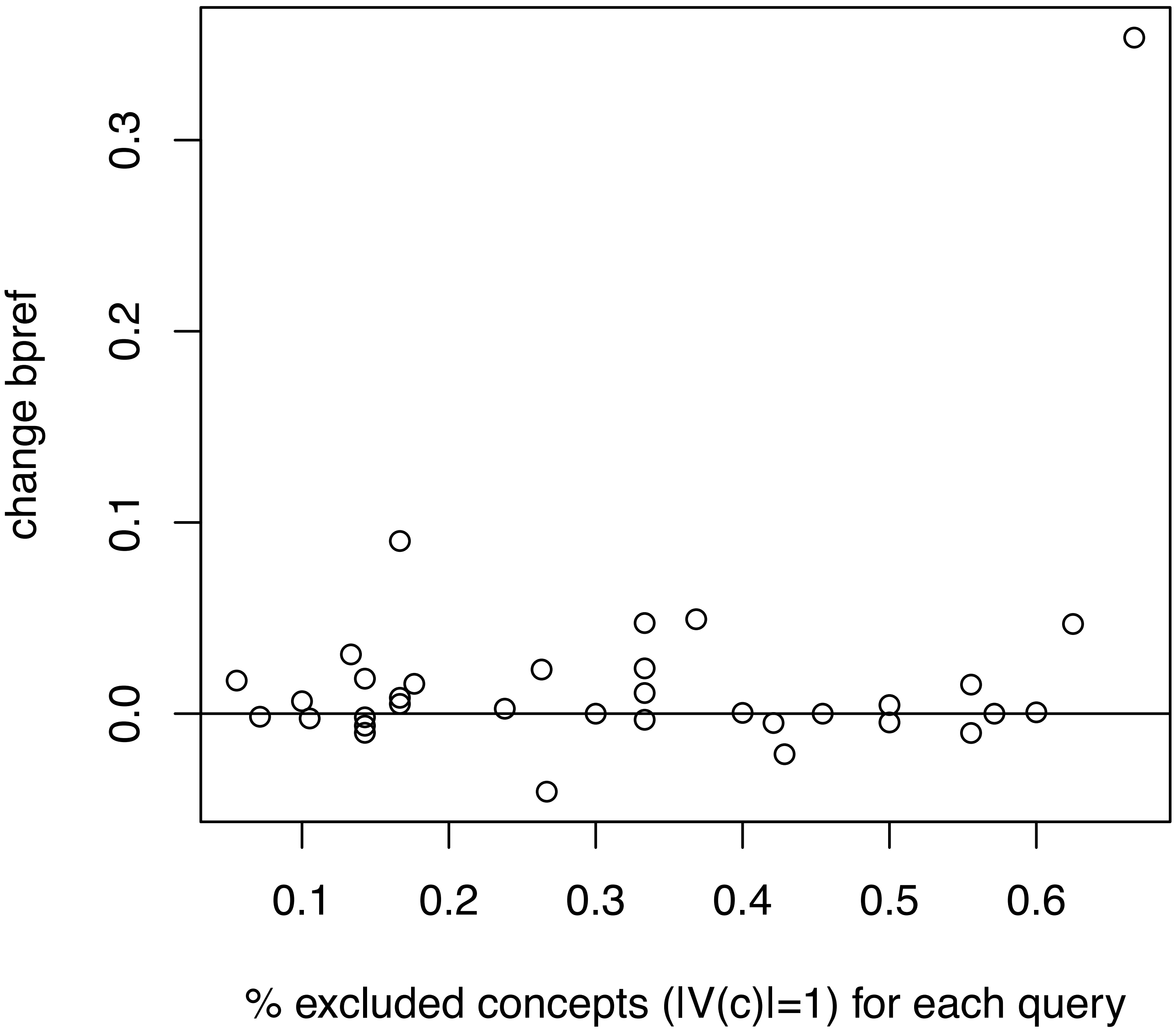
- 127 (28%) excluded

Effect of Reduction



Conclusions

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- Integrating formal background knowledge into data-driven approaches to IR

TREC Medtrack'12

Run	infAP
terms-tfidf	0.1685
concepts-tfidf	0.2027
terms-graph	0.1394
concepts-graph	0.2072
concepts-graph-snomed	0.2123