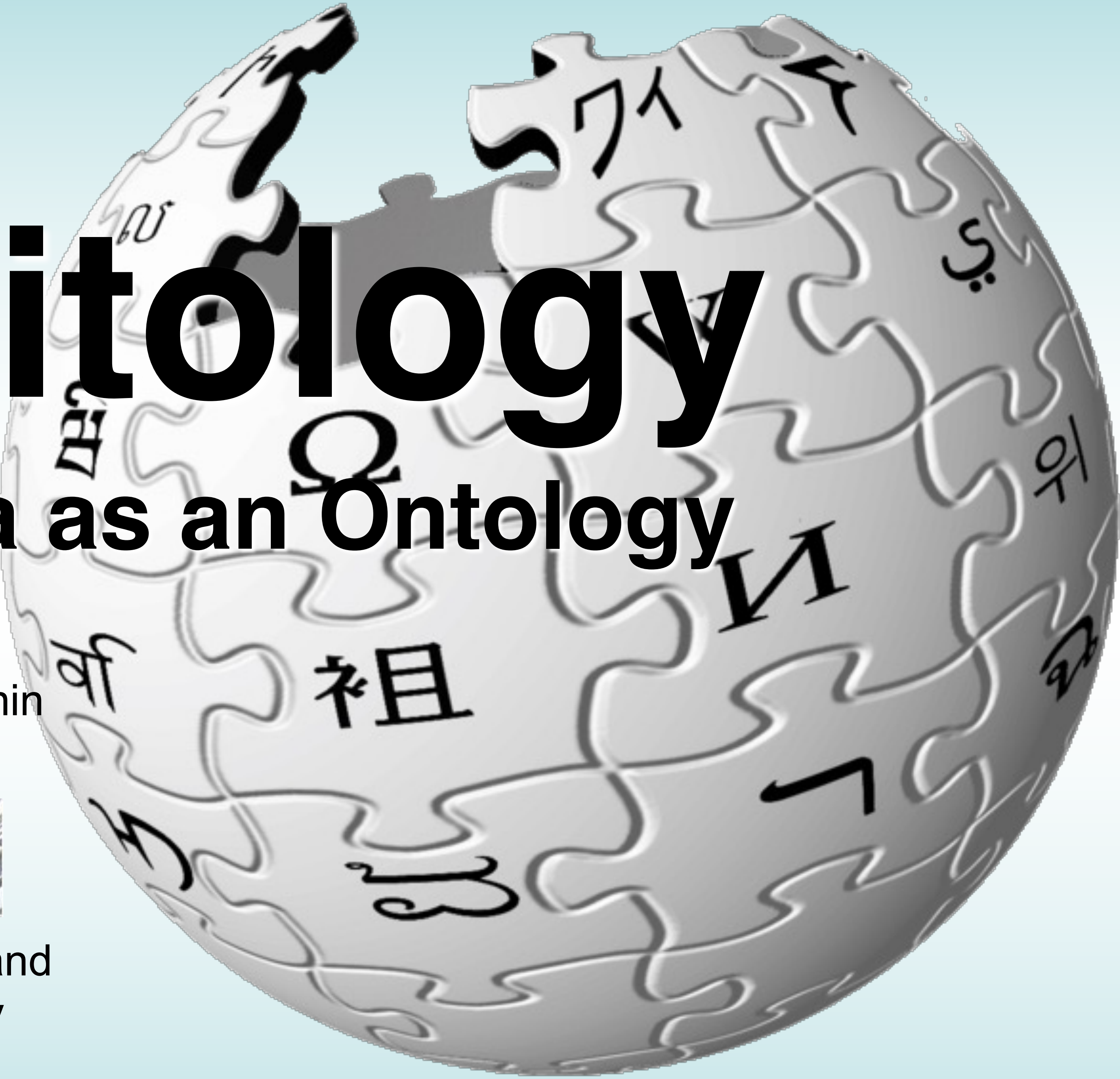
Wikitology

Wikipedia as an Ontology



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Outline

- Introduction and motivation
- Wikipedia
- Methodology and Experiments
- Evaluation
- Future Work Directions
- Conclusion

Introduction

- Identifying the topics and concepts associated with a document or collection of documents is a common task for many applications and can help in:
  - Annotation and categorization of documents in a corpus.
  - Modelling user interests
  - Business intelligence
  - Selecting Advertisements

Motivation

- **Problem:** describe what an analyst has been working on to support collaboration

- **Idea:**
  - track documents she reads
  - map these to terms in an ontology
  - aggregate to produce a short list of topics

Approach

- Use Wikipedia articles and categories as ontology terms
- Categories as Generalized Concepts
- Articles as Specialized Concepts
- How to map the documents she reads to the ontology terms?
  - Use document to Wiki-article similarity for the mapping
- How to aggregate to get a shorter list?
  - Use spreading activation algorithm for aggregation

What’s a document about?

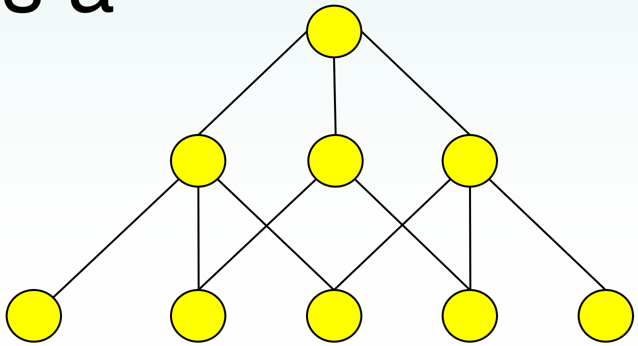
- Two common approaches:
  - (1) Statistical Approach
    Select words and phrases using TF-IDF that characterize the document
  - (2) Controlled Vocabulary or Ontology
    Map document to a list of terms from a controlled vocabulary or ontology
- First approach is flexible and does not require creating and maintaining an ontology
- Second approach can tie documents to a rich knowledge base

Wikitology !

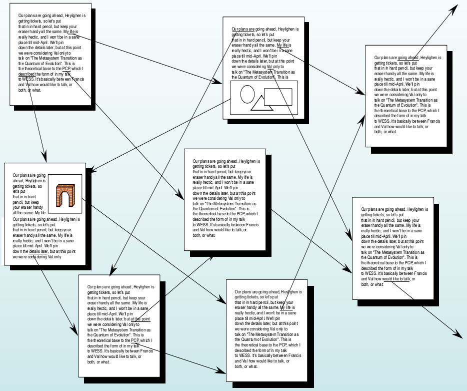
- Using Wikipedia as an ontology offers the best of both approaches
- Each article is a concept in the ontology
- Terms linked via Wikipedia’s category system and inter-article links
- It’s a consensus ontology created, kept current and maintained by a diverse community
- Overall content quality is high
- Terms have unique IDs (URLs) and are “self describing” for people
- Underlying graphs provide structure: categories, article links

Wikipedia Graph Structures

- Wikipedia Category graph is a thesaurus



- Wikipedia Page links graph is similar to WWW Network

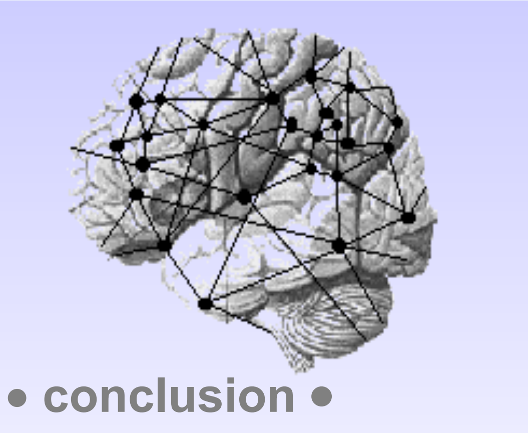


Methods

- Goal: given one or more documents, compute a ranked list of the top N Wikipedia **articles** and/or **categories** that describe it.
- Basic metric: document similarity between Wikipedia article and document(s)
- Variations:
  - role of categories
  - eliminating uninteresting articles
  - use of spreading activation
  - using similarity scores for weighing links
  - number of spreading activation pulses
  - individual or set of query documents, etc, etc.

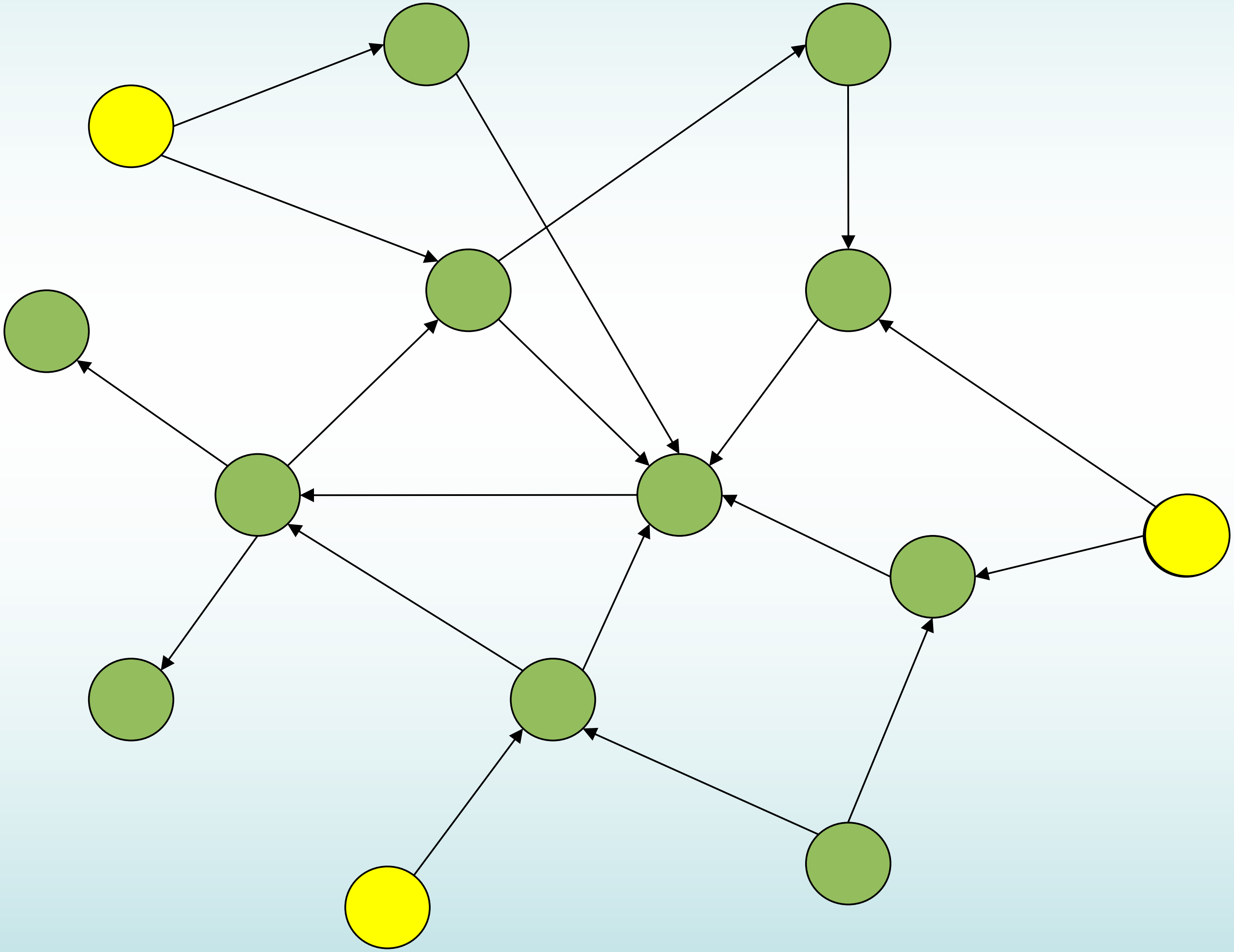
Spreading Activation

- In associative retrieval the idea is that it is possible to retrieve relevant documents if they are associated with other documents that have been considered relevant by the user.
- The documents can be represented as nodes and their associations as links in a network.



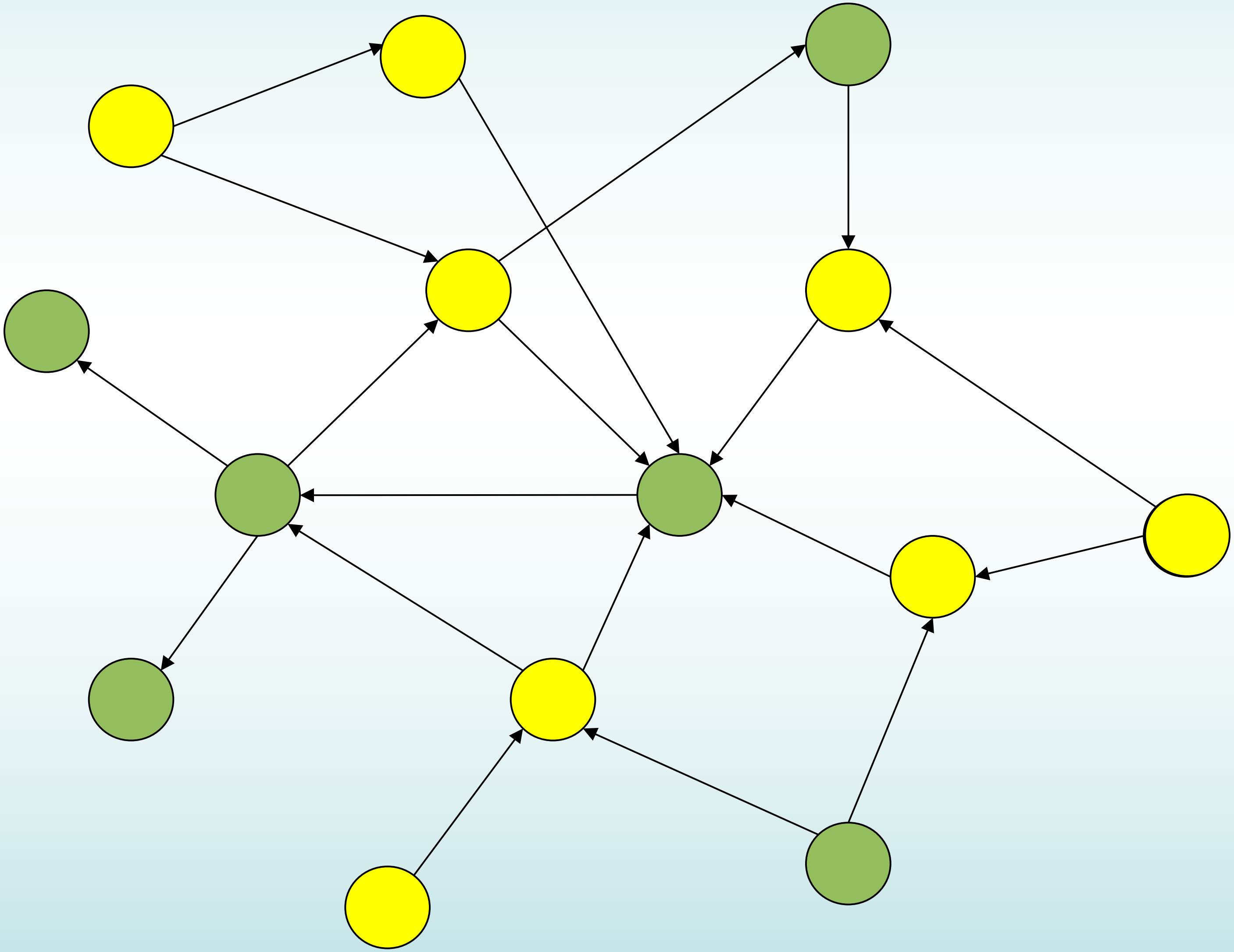
Spreading Activation

Start with an initial set of activated nodes



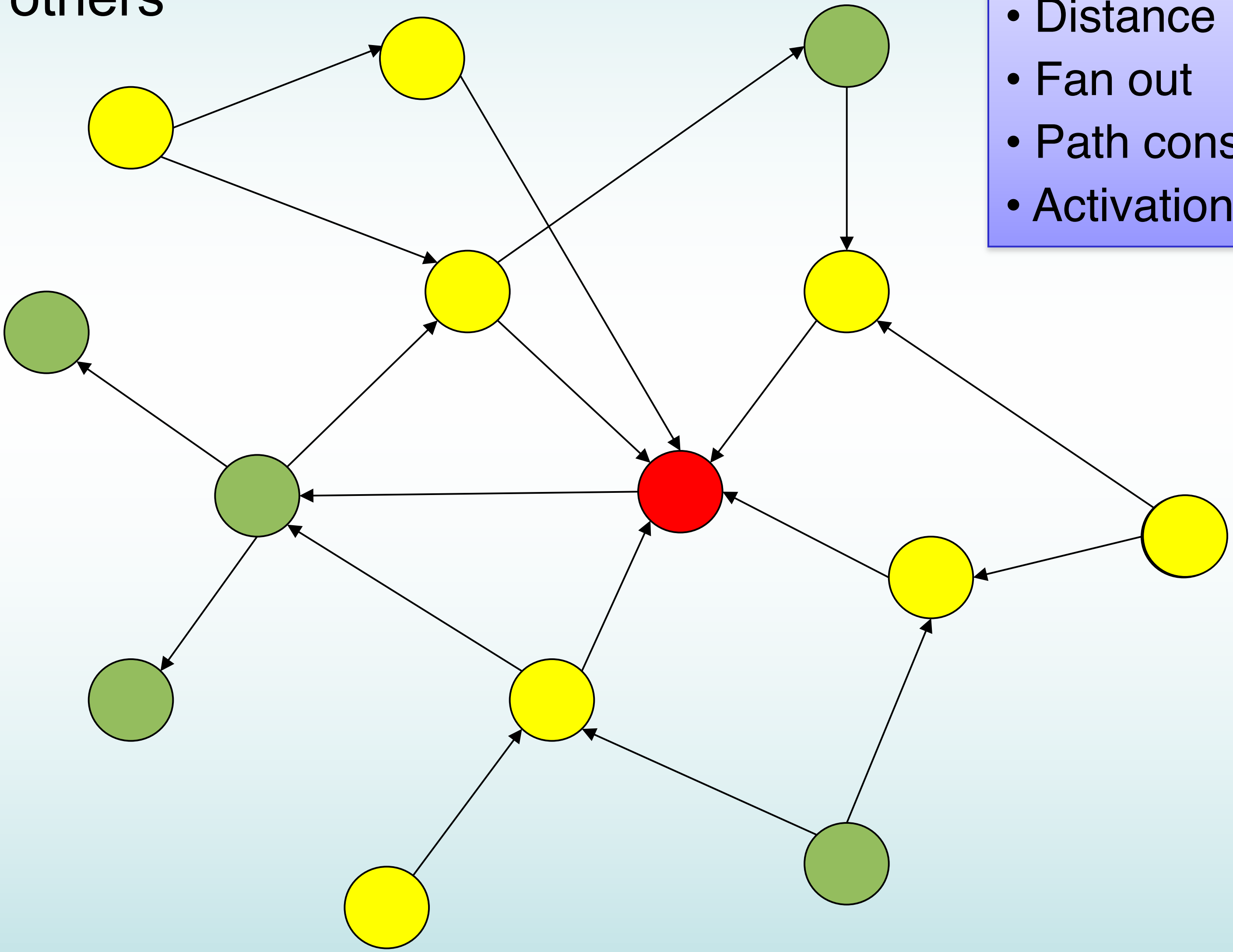
Spreading Activation

At each pulse/iteration, spread activation to adjacent nodes



Spreading Activation

Some nodes will have higher activation than others

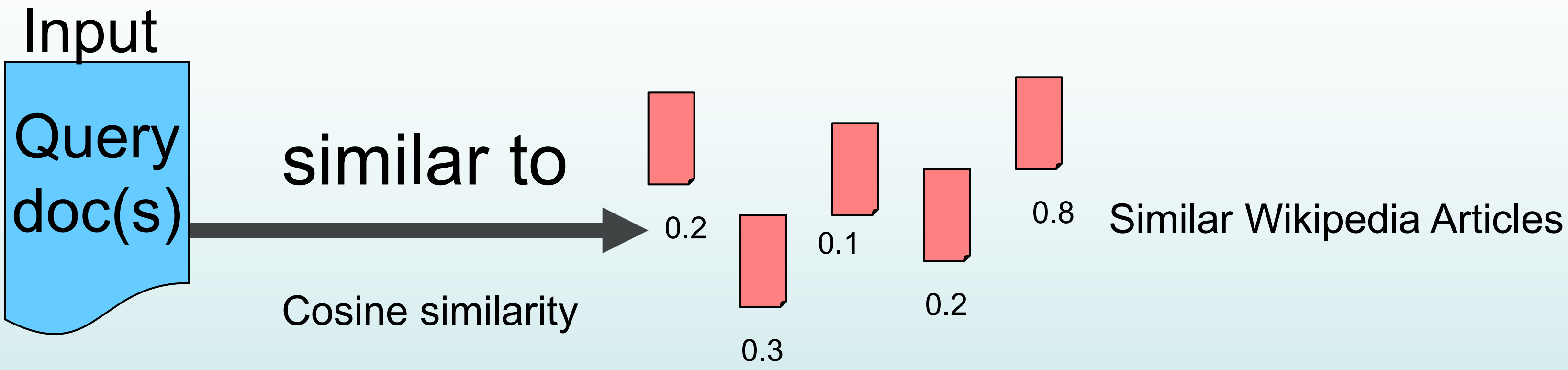


Constraints

- Distance
- Fan out
- Path constraints
- Activation threshold

Method 1

Using Wikipedia Article Text and Categories to Predict Concepts



Input

Query doc(s)

similar to

Cosine similarity

0.2

0.3

0.1

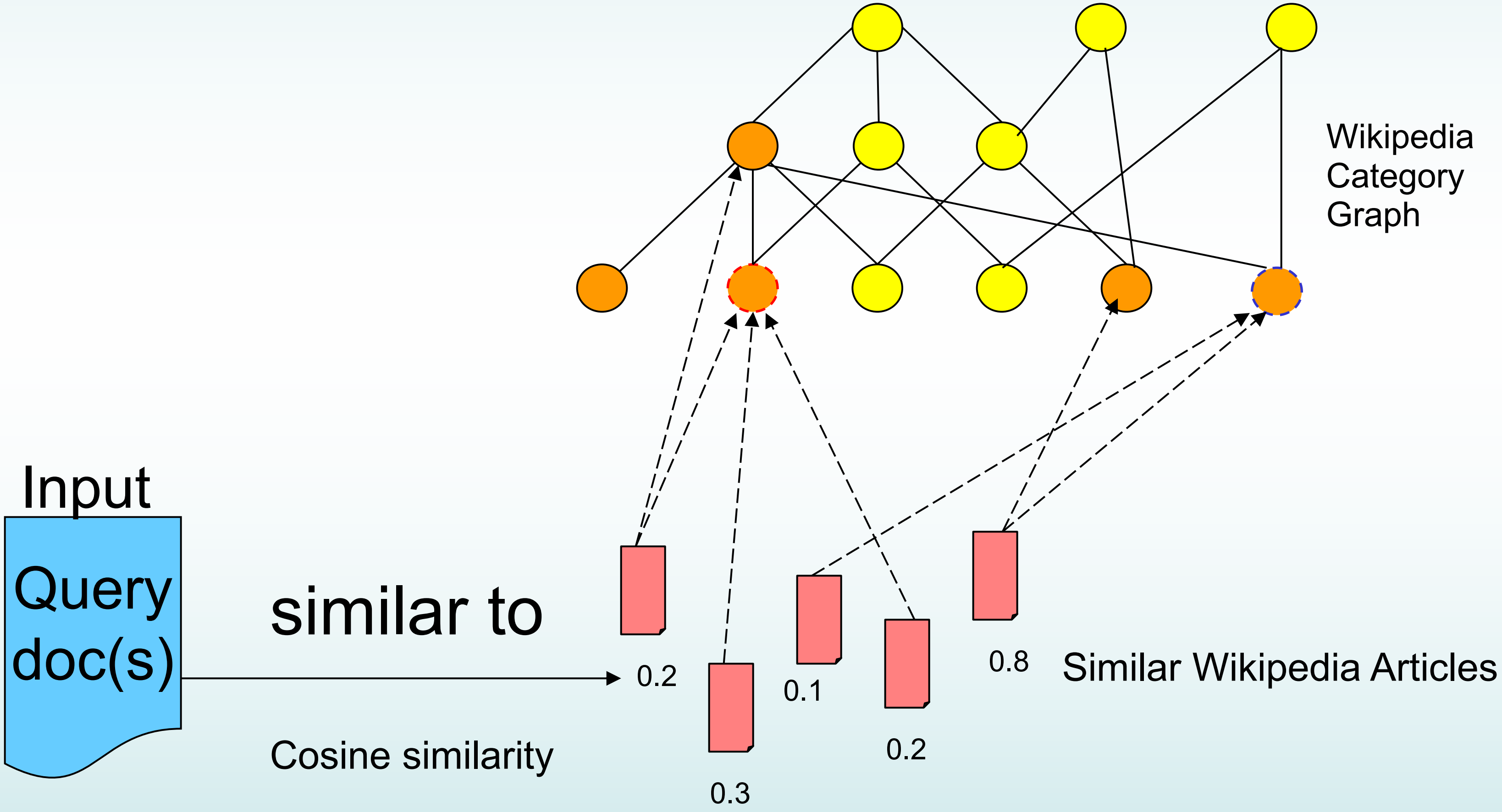
0.2

0.8

Similar Wikipedia Articles

Method 1

Using Wikipedia Article Text and Categories to Predict Concepts



Input

Query doc(s)

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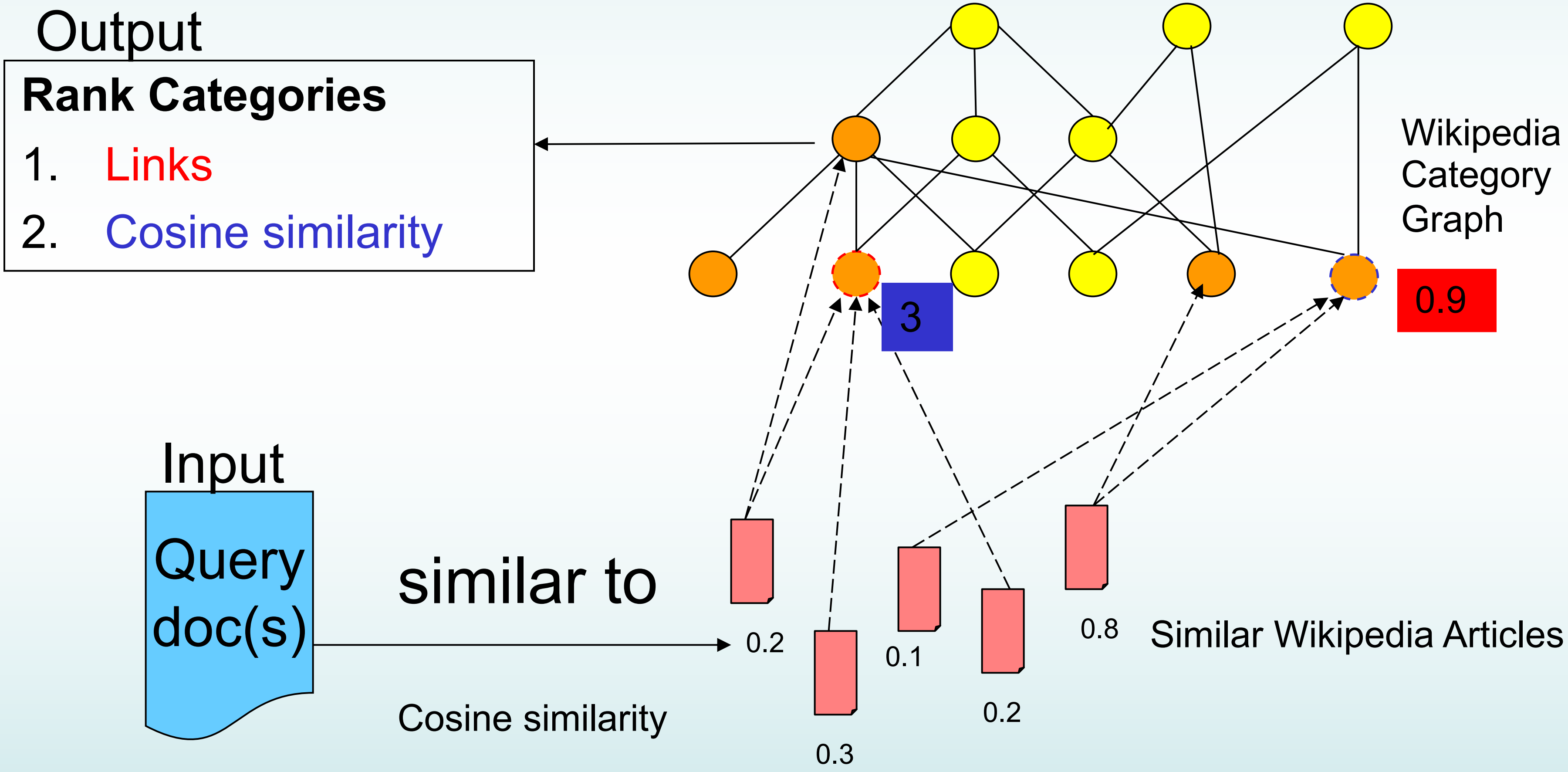
Cosine similarity

Similar Wikipedia Articles

Wikipedia Category Graph

Method 1

Using Wikipedia Article Text and Categories to Predict Concepts



Output

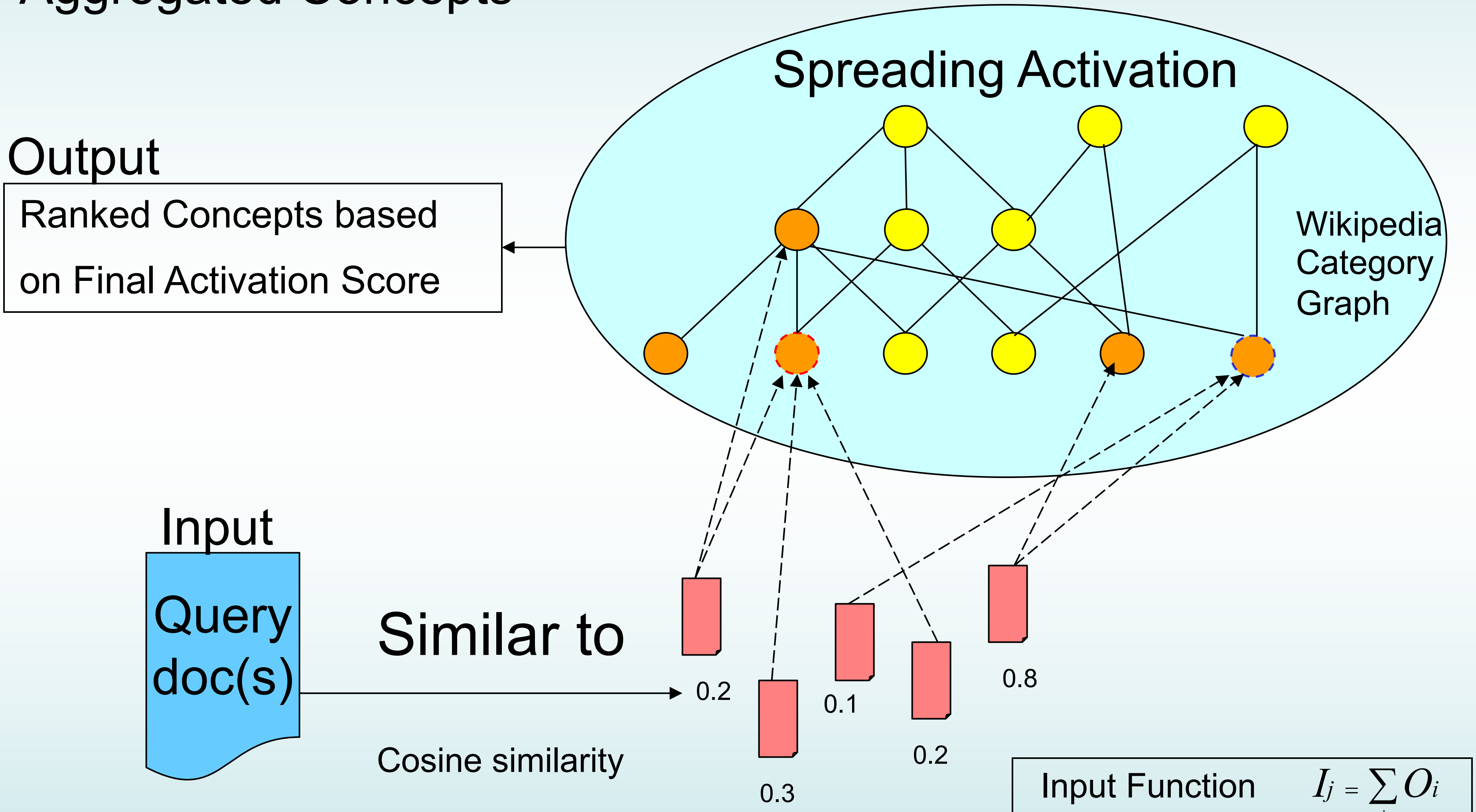
Rank Categories

1. Links
2. Cosine similarity

Input

Method 2

Using Spreading Activation on Category Links Graph to get Aggregated Concepts



Spreading Activation

Wikipedia Category Graph

Output

Ranked Concepts based on Final Activation Score

Input

Query doc(s)

Similar to

Cosine similarity

Input Function $I_j = \sum_i O_i$

Output Function $O_j = \frac{A_j}{D_j * k}$

- Can we predict concepts that are NOT present in the category hierarchy?
- Use the article concepts!
- But How?

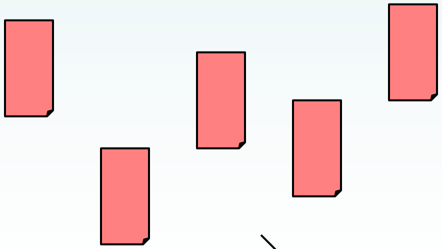
Method 3

Using Spreading Activation on Article Links Graph

Input

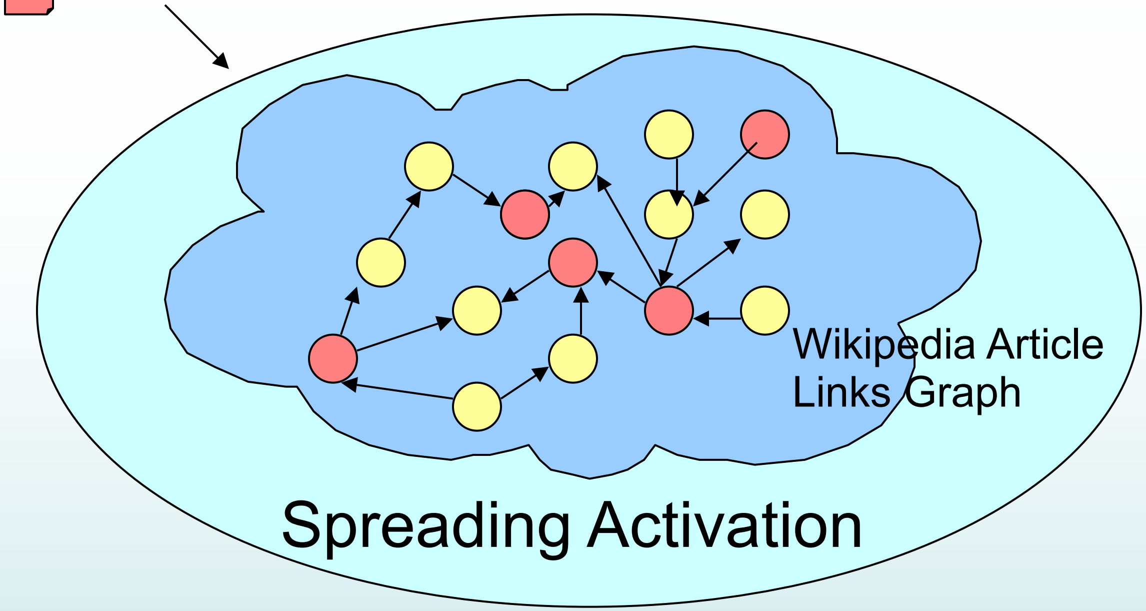
Query doc(s)

Similar To



Threshold: Ignore Spreading Activation to articles with less than 0.4 Cosine similarity score

Edge Weights: Cosine similarity between linked articles



Node Input Function $I_j = \sum_i O_i w_{ij}$

Node Output Function $O_j = \frac{A_j}{k}$

Output

Ranked Concepts based on Final Activation Score

Preliminary Experiments

- An initial informal evaluation compared results against our own judgments
- Downloaded articles from internet and predicted concepts
- Using Single Document and Group of Related Documents

Prediction for Single Test Document

Test Document Title	Method 1 Ranking Categories Directly	Method 2 Spreading Activation Pulses=2	Method 2 Spreading Activation Pulses=3
Weather Prediction of thunder storms (CNN)	“Weather_Hazards”	“Weather_Hazards”	“Meterology”
	“Winds”	“Current_events”	“Nature”
	“Severe_weather_and_convection”	“Types_of_cyclone”	“Weather”

More pulses -> More Generalized Concepts

Preliminary Experiments

Prediction for Set of Test Documents

Test Document Titles in the Set: (Wikipedia Articles)

Crop_rotation
Permaculture
Beneficial_insects
Neem
Lady_Bird
Principles_of_Organic_Agriculture
Rhizobia
Biointensive
Intercropping
Green_manure

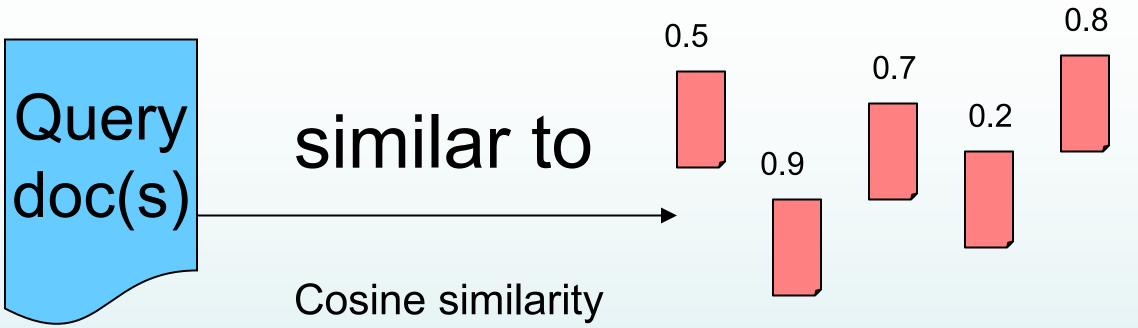
Concept not in the Category Hierarchy

Method 1 **Ranking Categories Directly**	**Method 2 (2 pulses)** **Spreading Activation on Category links Graph**	**Method 3 (2 pulses)** **Spreading Activation on Article Links Graph**
Agriculture	Skills	Organic_farming
Sustainable_technologies	Applied_sciences	Sustainable_agriculture
Crops	Land_management	Organic_gardening
Agronomy	Food_industry	Agriculture
Permaculture	Agriculture	Companion_planting

Evaluation

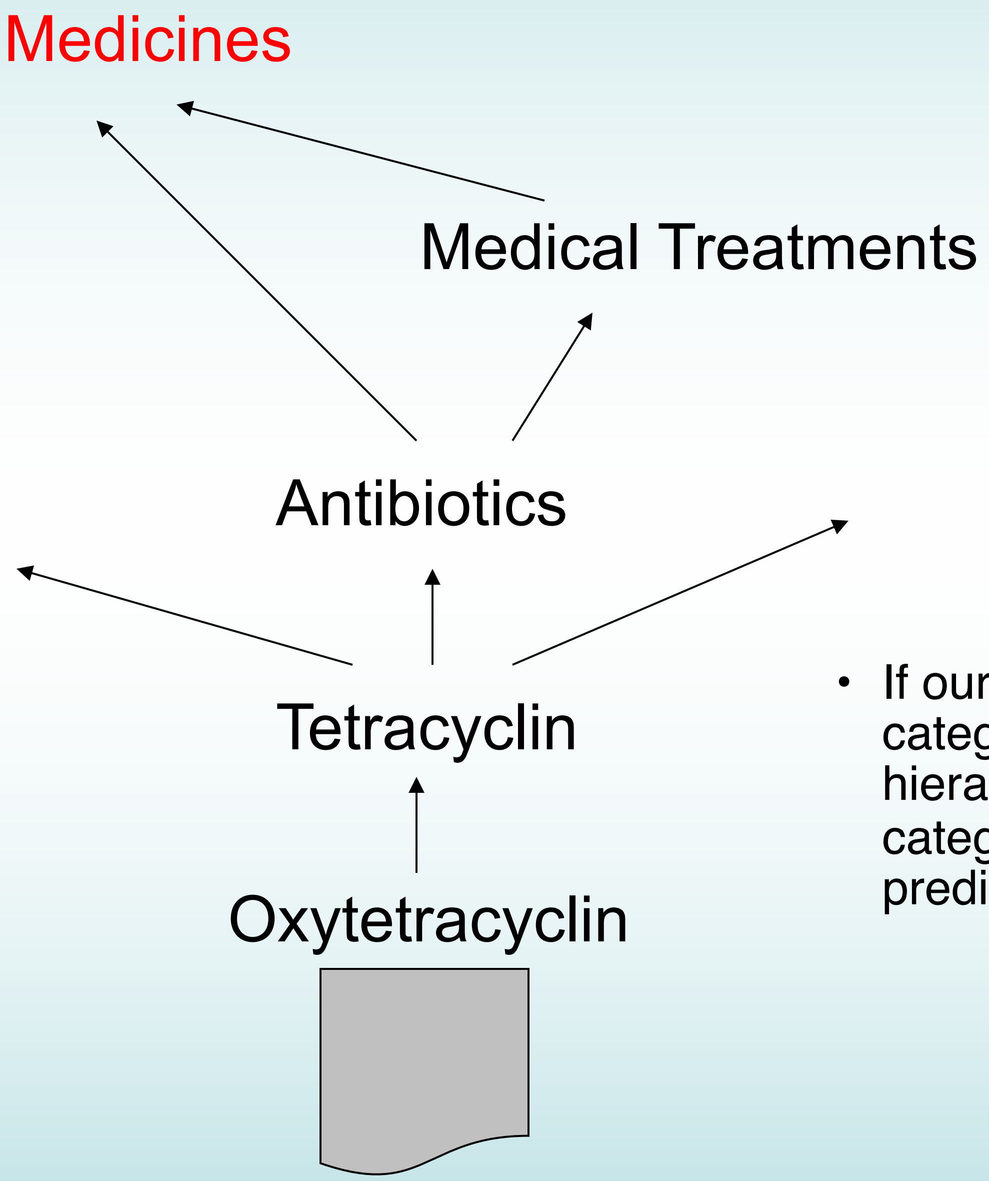
- Select wikipedia articles randomly and predict their categories and links
- Sort the results based on Average Similarity

Average Similarity



$$\frac{0.5 + 0.9 + 0.7 + 0.2 + 0.8}{5}$$

Evaluation



Medicines

Medical Treatments

Antibiotics

Tetracyclin

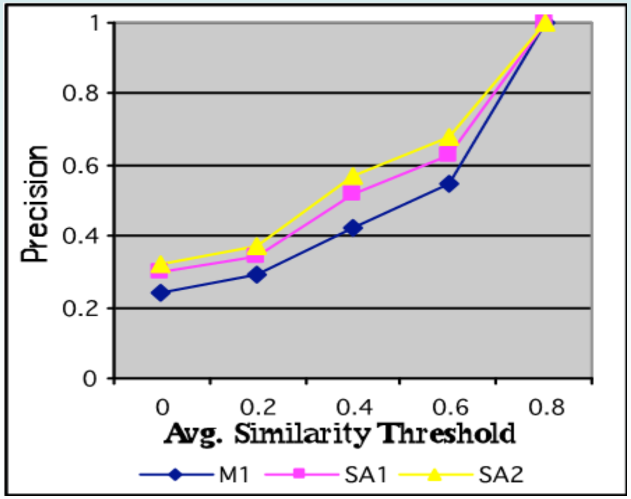
Oxytetracyclin

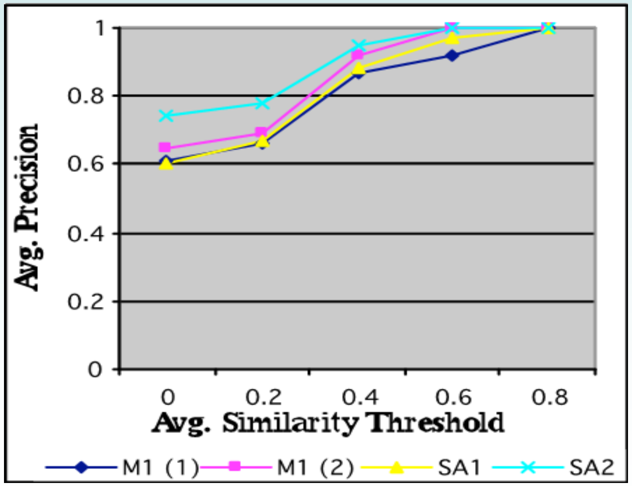
Observation

Articles are linked often with super and sub categories both

- If our system predicts a category three levels higher in hierarchy than the original category we consider our prediction to be correct

Category Prediction Evaluation

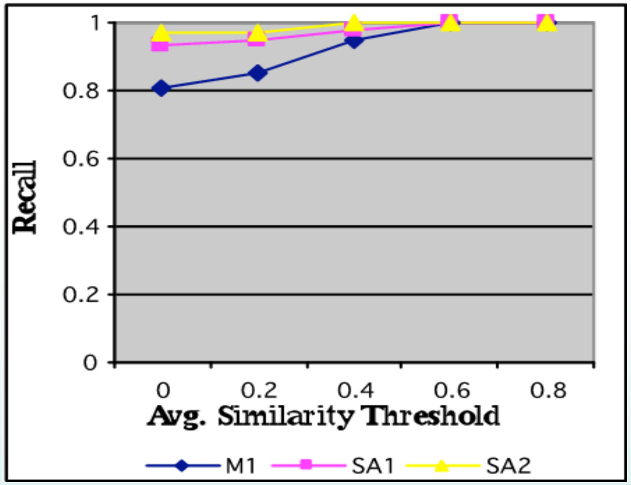


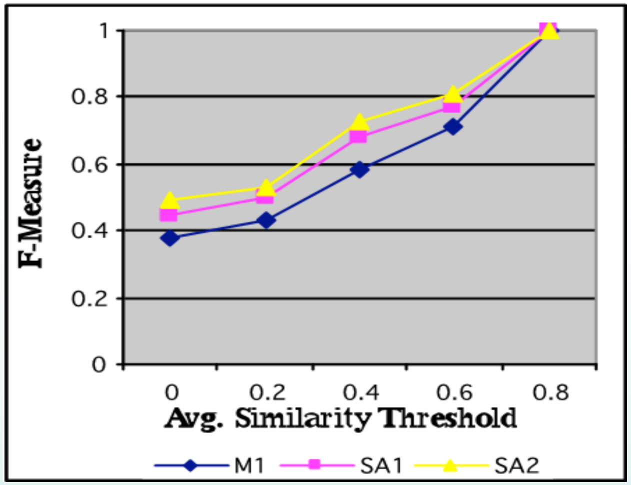


M1 Method 1

SA1 Spreading Activation pulse(s)= 1

SA2 Spreading Activation pulse(s)=2

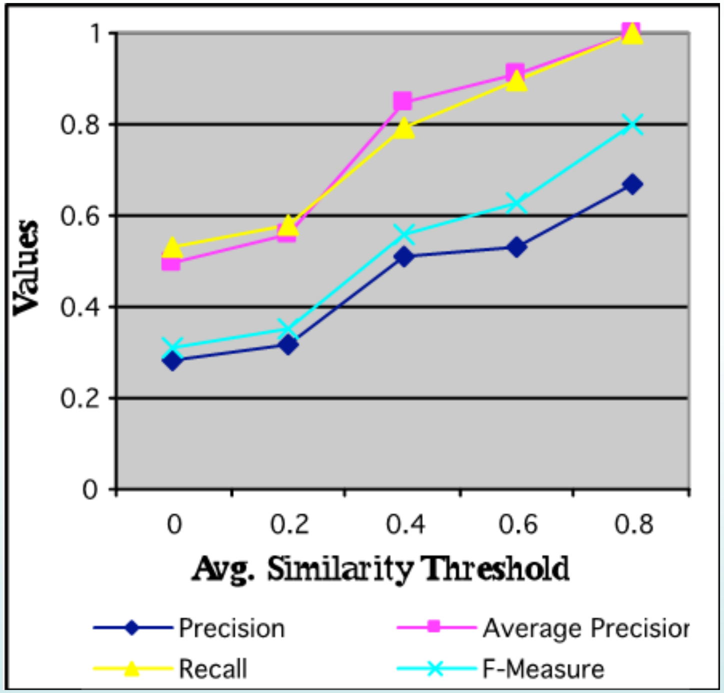




- Spreading activation with two pulses worked best
- Only considering articles with similarity > 0.5 was a good threshold

Article Links Prediction Evaluation

- Spreading activation with one pulse worked best
- Only considering articles with similarity > 0.5 was a good threshold



Similar Documents, N = 5
Spreading Activation pulses=1

Prediction Accuracy

- Issues:
  - To what extent the concept is represented in Wikipedia For eg. we have a category related to the fruit apple but not for mango
  - Presence of links between semantically related concepts
  - Presence of links between irrelevant articles (term definitions, country names)
- Possible Solutions:
  - Use Average Similarity Score to measure the extent of concept representation with in Wikipedia
  - Use existing semantic relatedness measures to handle presence or absence of semantically related links

Potential Applications

- Recommending categories and links for new Wikipedia articles
- Introducing new Wikipedia categories
- Automating the process of building a Wiki from a corpus

Future Work

- Classifying links in Wikipedia using Machine learning techniques
  - To Predict semantic type of article
  - To control flow of spreading activation
- Exploit parallel execution on cluster
- Refining Wikipedia ontology
- Bridging the gap between Wikipedia and formal ontologies

Document Expansion with Wikipedia Derived Ontology Terms [*]

- Expansion of each TREC document using Wikitology terms
- We are still working on refining the methodology

Doc: FT921-4598 (3/9/92)
... Alan Turing, described as a brilliant mathematician and a key figure in the breaking of the Nazis' Enigma codes. Prof IJ Good says it is as well that British security was unaware of Turing's homosexuality, otherwise he might have been fired 'and we might have lost the war'. In 1950 Turing wrote the seminal paper 'Computing Machinery And Intelligence', but in 1954 killed himself ...

Turing_machine, Turing_test, Church_Turing_thesis, Halting_problem, Computable_number, Bombe, Alan_Turing, Recusion_theory, Formal_methods, Computational_models, Theory_of_computation, Theoretical_computer_science, Artificial_Intelligence

[*] In Collaboration with Paul McNamee, John Hopkins University Applied Physics Laboratory

Conclusion

- We tested the idea of using Wikitology for describing documents and proposed different methods using the Wikipedia article text, category links and article links
- Suggested improvements
- Using average similarity to judge the accuracy of prediction
- Easily extendable to other wikis and collaborative KBs, e.g., Intellipedia, Freebase

References

- Crestani, F. 1997. Application of Spreading Activation Techniques in Information Retrieval. Artificial Intelligence Review, 1997, vol 11; No. 6, 453-482.
- Gabrilovich, E., and Markovitch, S. 2006. Overcoming the brittleness bottleneck using Wikipedia: Enhancing text categorization with encyclopedic knowledge. Proceedings of the Twenty-First National Conference on Artificial Intelligence. AAAI'06. Boston, MA.
- Schonhofen, P. 2006. Identifying Document Topics Using the Wikipedia Category Network. Proc. 2006 IEEE/WIC/ACM International Conference on Web Intelligence. 456-462, 2006. IEEE Computer Society, Washington, DC, USA.
- Strube,M., and Ponzetto, S.P. 2006. Exploiting semantic role labeling, WordNet and Wikipedia for coreference resolution. Proceedings of the main conference on Human Language Technology Conference of the North American Chapter of the Association of Computational Linguistics (2006). Asso-ciation for Computational Linguistics Morristown, NJ, USA.

References

- Gabrilovich, E., and Markovitch, S. 2007. Computing Semantic Relatedness using Wikipedia-based Explicit Semantic Analysis, Proc. of the 20th International Joint Con-ference on Artificial Intelligence (IJCAI'07), 6-12.
- Krizhanovsky, A. 2006. Synonym search in Wikipedia: Synarcher.
- URL:http://arxiv.org/abs/cs/0606097v1
- Mihalcea, R. 2007. Using Wikipedia for Automatic Word Sense Disambiguation. Proc NAACL HLT. 196-203.
- Strube,M., and Ponzetto, S.P. 2006. WikiRelate! Computing semantic relatedness using Wikipedia. American Association for Artificial Intelligence, 2006, Boston, MA.
- Voss, J. 2006. Collaborative thesaurus tagging the Wikipedia way. Collaborative Web Tagging Workshop. Arxiv Computer Science e prints . URL http://arxiv.org/abs/cs/0604036
- Milne, D. 2007. Computing Semantic Relatedness using Wikipedia Link Structure. Proceedings of the New Zealand Computer Science Research Student conference (NZCSRSC'07), Hamilton, New Zealand.

Thank you

Questions and Suggestions?