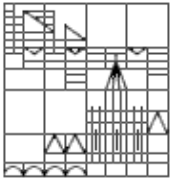




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# Information Networks: State of the Art

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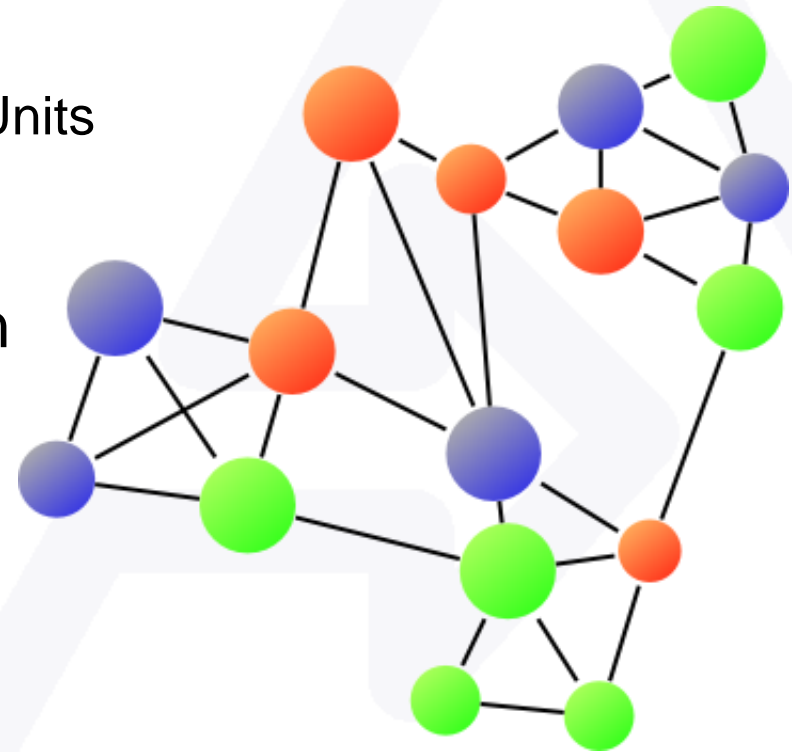
# Outline

- Information Networks
- Properties of Information Networks
  - Information Unit properties
  - Relation properties
- Prominent Types of Information Networks
  - Ontologies
  - Semantic Networks
  - Topic Maps
  - Bayesian Networks
  - Bisociative Information Networks (BisoNets)
- Comparative Matrix



# Information Networks

- Composed of:
  - Information Units
    - Physical items, concepts, ideas, ...
    - Represented by vertices
  - Relations
    - Connections between Information Units
    - Usually represented by edges
- Commonly used for data integration
- Well defined structure allows to
  - discover pattern of interest
  - extract network summarization
  - visually explore underlying relations





# Properties of Information Units

- **Named**
  - the name of the information unit
- **Attributed**
  - E.g. link to original data or translations of the original label
  - Might be considered while reasoning or analyzing the network
  - Do not carry general semantic information
- **Typed**
  - Allows to distinguish between different semantics of information units
  - Can additionally be organized in a hierarchy or ontology
- **Hierarchical**
  - Subgraph
  - Represents more complex concepts



# Properties of Relations

- **Attributed**
  - Can be considered during the reasoning process
  - Do not carry a general semantic information
- **Typed**
  - Distinguishes between different semantics of relations
  - Can be organized in a hierarchy or ontology
- **Weighted**
  - Measure of reliability
  - Allows the integration of facts and pieces of evidence
- **Directed**
  - Explicitly models relationships that are only valid in one direction
- **Multi relation**
  - Multi edges supporting any number of members



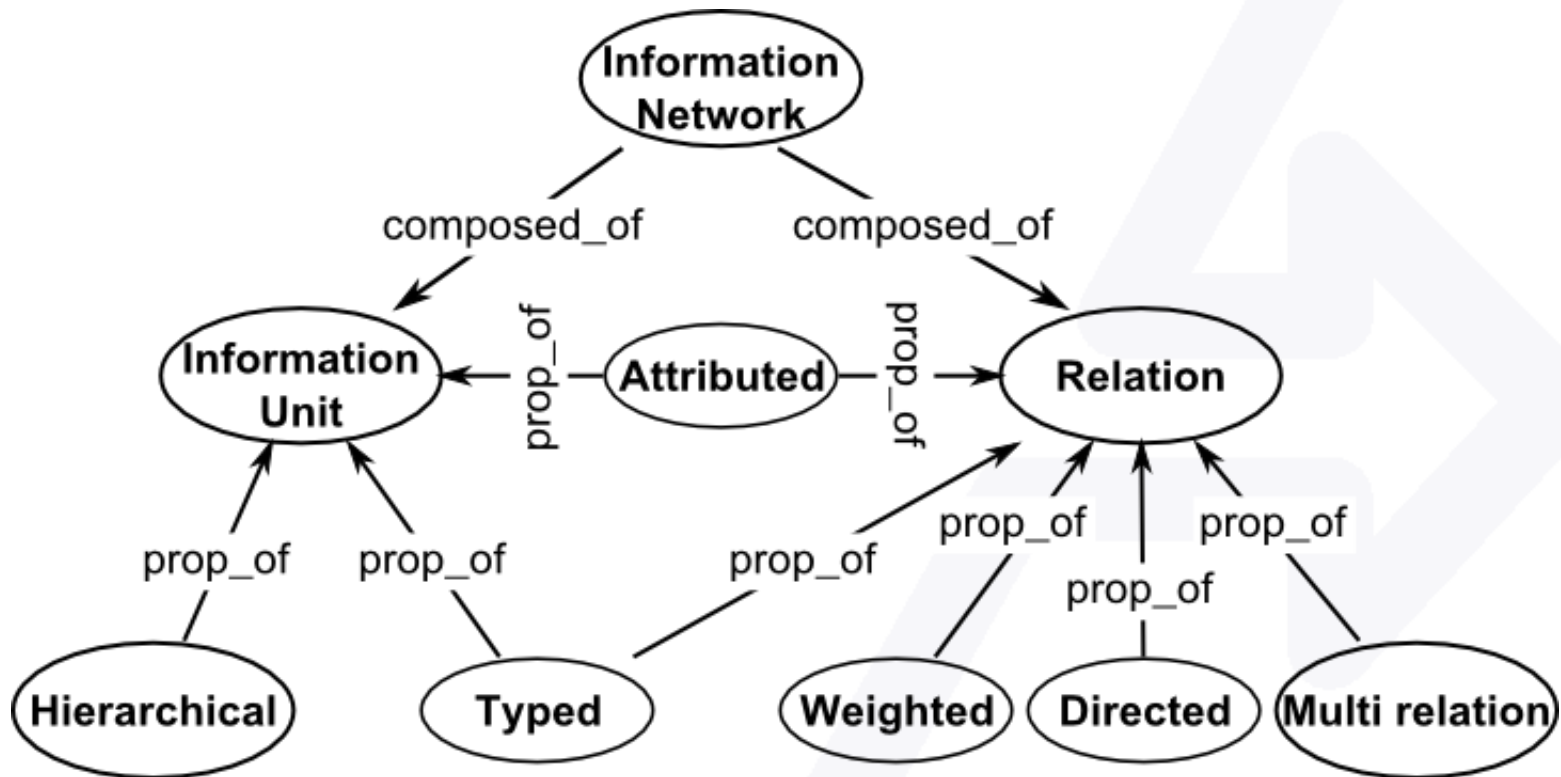
# Properties of Ontologies

		Relations				
		Attributed	Typed	Weighted	Directed	Multi relation
Information Units	Named					
	Attributed					
	Typed					
	Hierarchical					



# Ontology

- Controlled vocabulary for information units and relations
- Requires comprehensive domain knowledge
- Mostly manual or semi-automatic created





# Properties of Semantic Networks

		Relations				
		Attributed	Typed	Weighted	Directed	Multi relation
Information Units	Named	✗	✓	✗	✓	✗
	Attributed	✗	✓	✗	✓	✗
	Typed	✗	✗	✗	✗	✗
	Hierarchical	✗	✗	✗	✗	✗



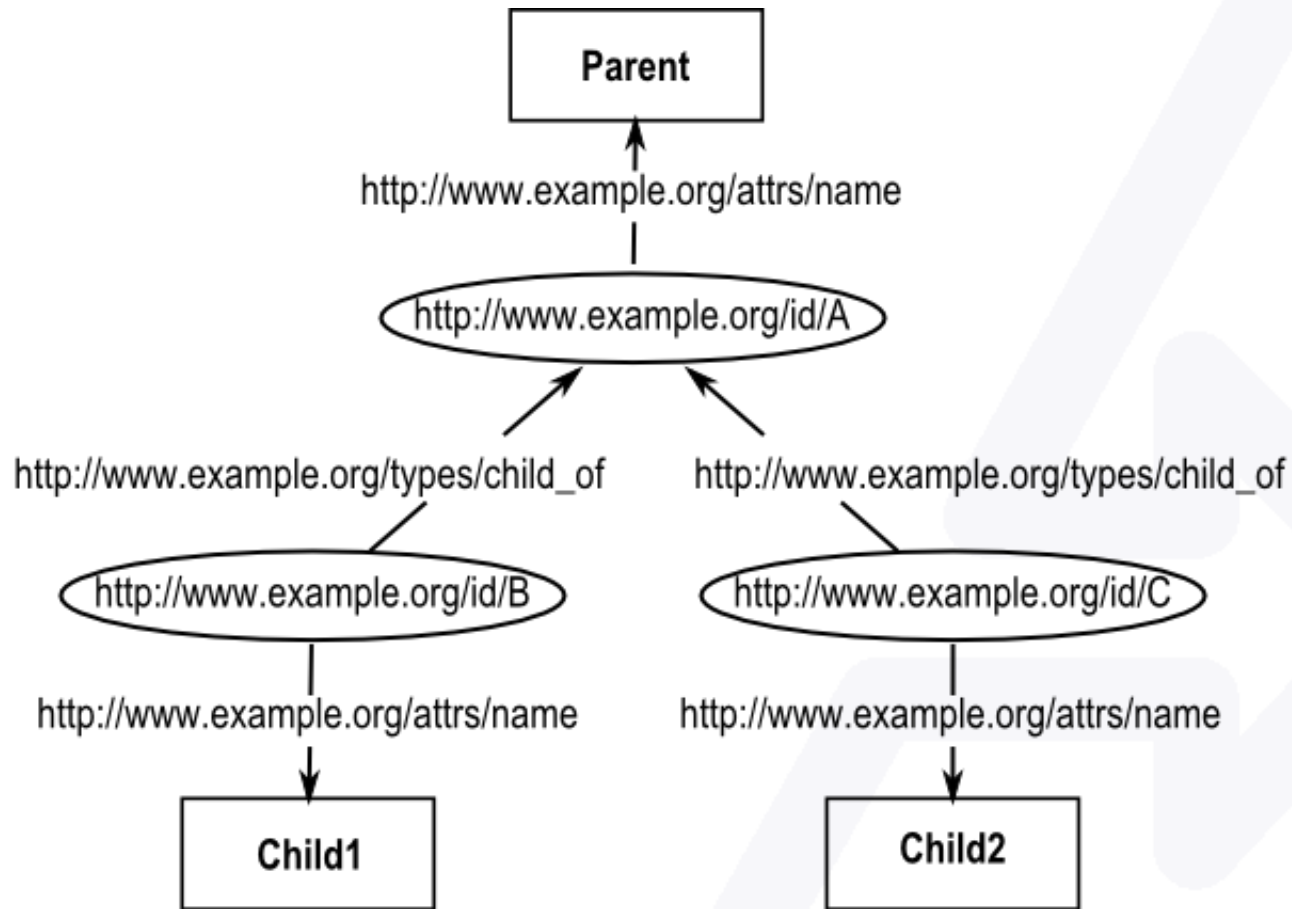


# Semantic Networks

- Types might be organized in an ontology
- URI used to identify information units and relations
- Usually based on Semantic Web technologies
  - Resource Description Framework (RDF)
    - Knowledge representation and storage framework
    - Triples consists of subject, predicate and object
  - RDF Vocabulary Description Language (RDF Schema)
    - Defines a vocabulary to describe properties and classes
    - Used to describe the members of a triple
  - Web Ontology Language (OWL)
    - Extends RDF Schema



# Semantic Network: Example





# Properties of Topic Maps

		Relations				
		Attributed	Typed	Weighted	Directed	Multi relation
Information Units	Named	✗	✓	✗	✗	✓
	Attributed	✗	✓	✗	✗	✓
	Typed	✗	✓	✗	✗	✓
	Hierarchical	✗	✗	✗	✗	✗

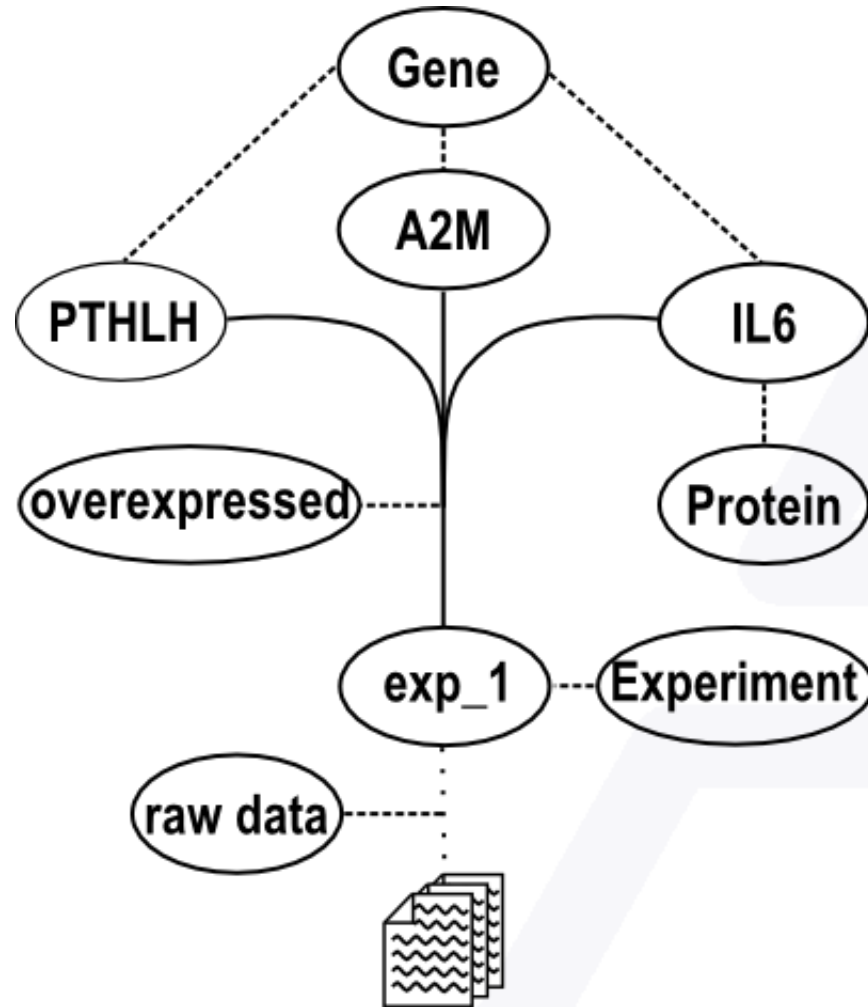


# Topic Map

- Topic represents generally everything, a concept, an idea, ...
  - Topics have zero or more types assigned represented by topics
  - Associations model relations between any number of topics
  - Association have a type assigned represented by topics
  - Association members play a certain role represented as topic
  - Occurrences link topics with resources they stem from
  - Occurrences have any number of types represented by topics
- Virtually everything in topic maps is a topic



# Topic Map: Example





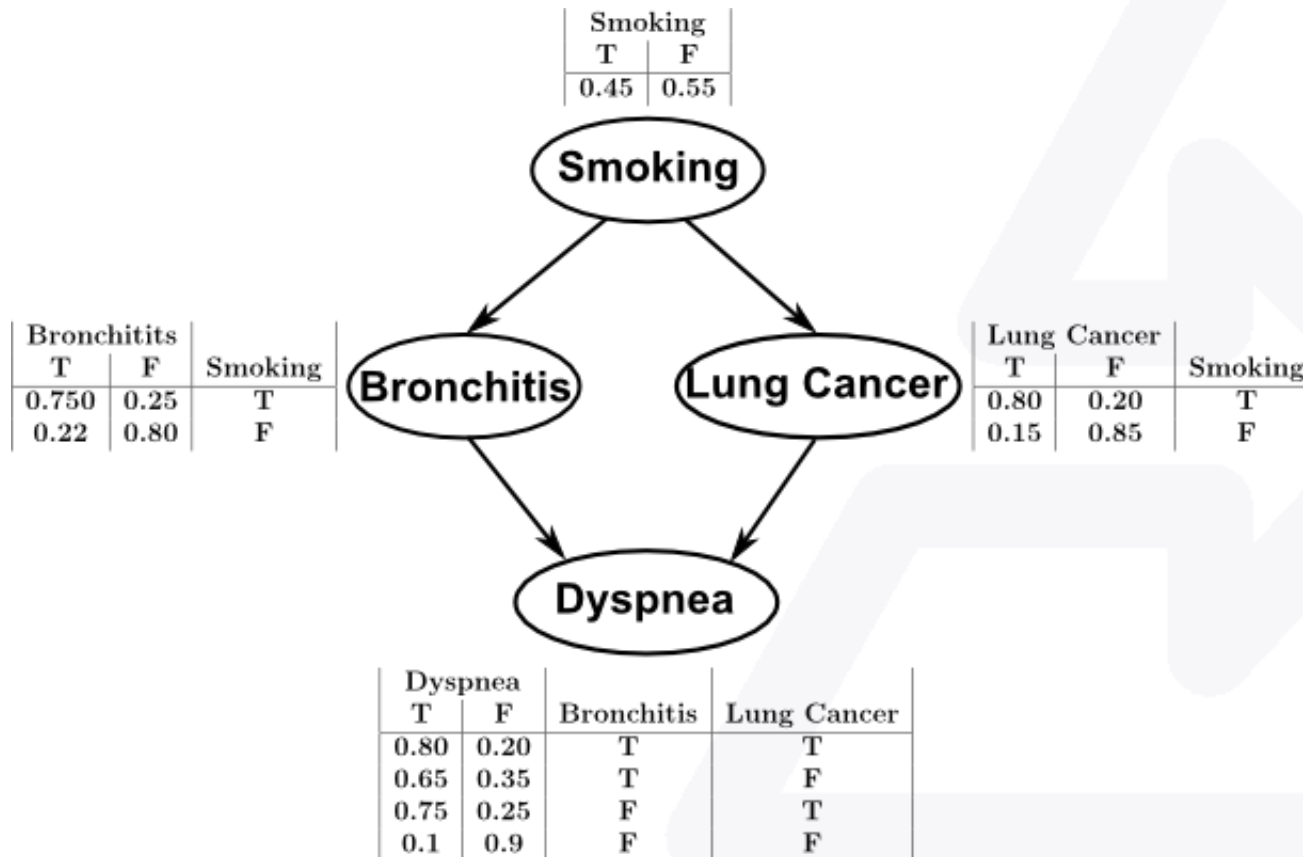
# Properties of Bayesian Networks

		Relations				
		Attributed	Typed	Weighted	Directed	Multi relation
Information Units	Named	✗	✗	✓	✓	✗
	Attributed	✗	✗	✗	✗	✗
	Typed	✗	✗	✗	✗	✗
	Hierarchical	✗	✗	✗	✗	✗



# Bayesian Networks

- Vertices represents variables
- Relations and their direction model dependencies
- Relation weights represent probabilities





# Properties of BisoNets

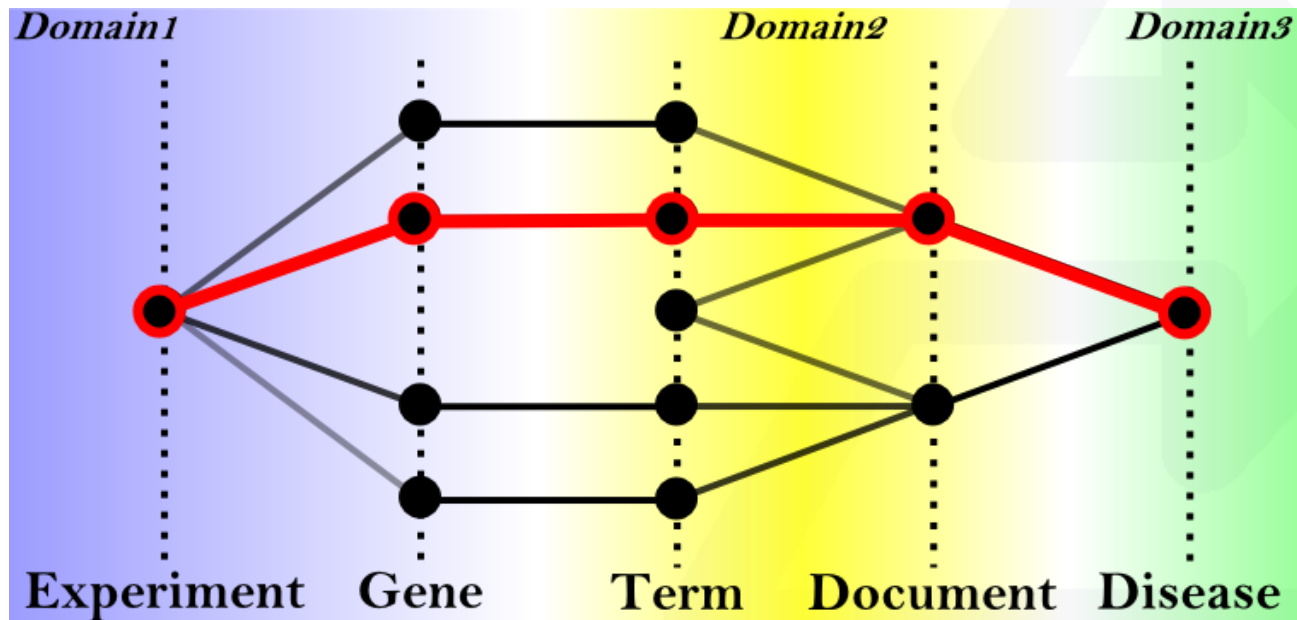
		Relations				
		Attributed	Typed	Weighted	Directed	Multi relation
Information Units	Named	✓	✓	✓	✓	✓
	Attributed	✓	✓	✓	✓	✓
	Typed	✓	✓	✓	✓	✓
	Hierarchical	✓	✓	✓	✓	✓





# BisoNets: Bisociative Information Networks

- k-partite graph
- Partitions represent types e.g. gene, document, ...
- Nodes represent concepts, relations or BisoNets
- Edge weight represents the certainty of a connection
- Nodes might carry any number of attributes





# Comparative Matrix

	Information Units			Relations				
	Attributed	Typed	Hierarchical	Attributed	Typed	Weighted	Directed	Multi relation
Ontology								
Semantic Networks								
Topic Map								
Bayesian Networks								
BisoNets								



Thank you for your attention!

Any questions?