

Knowledge Graph Construction from Text

AAAI 2017

JAY PUJARA, SAMEER SINGH, BHAVANA DALVI

Introducing Presenters



Jay Pujara: Postdoc at UC Santa Cruz



Sameer Singh: Assistant Professor at UCI

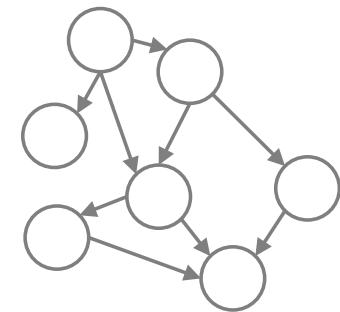


Bhavana Dalvi: Research Scientist at AI2

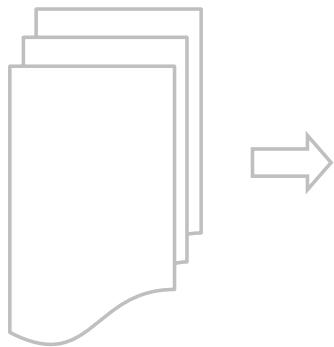
Tutorial Overview

Tutorial Overview

Part 1: Knowledge Graphs

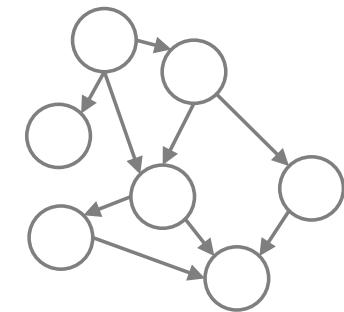


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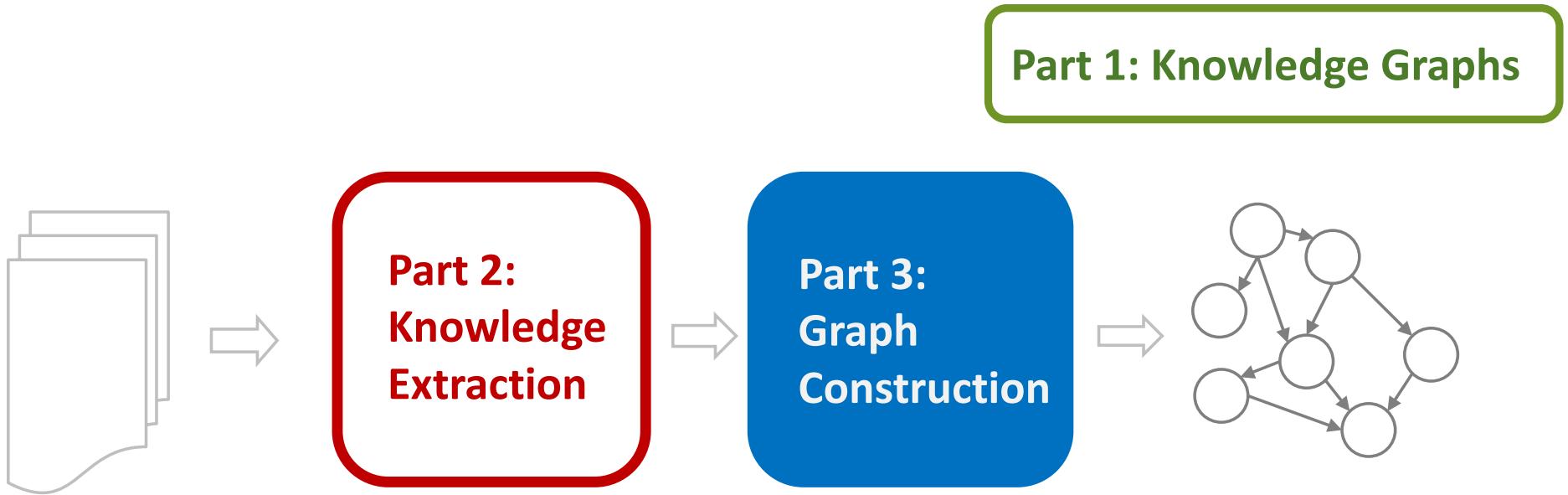


**Part 2:
Knowledge
Extraction**

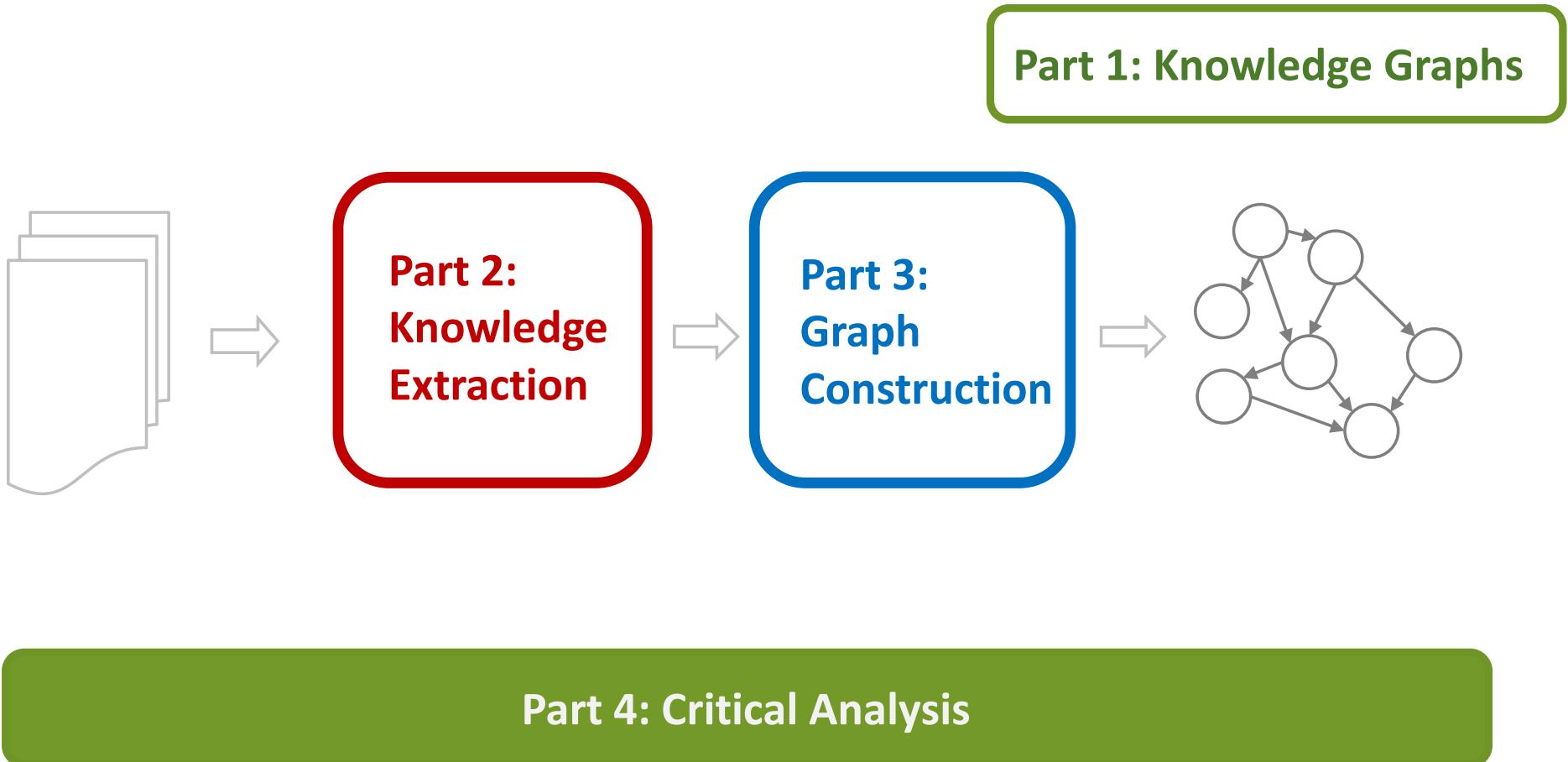
Part 1: Knowledge Graphs



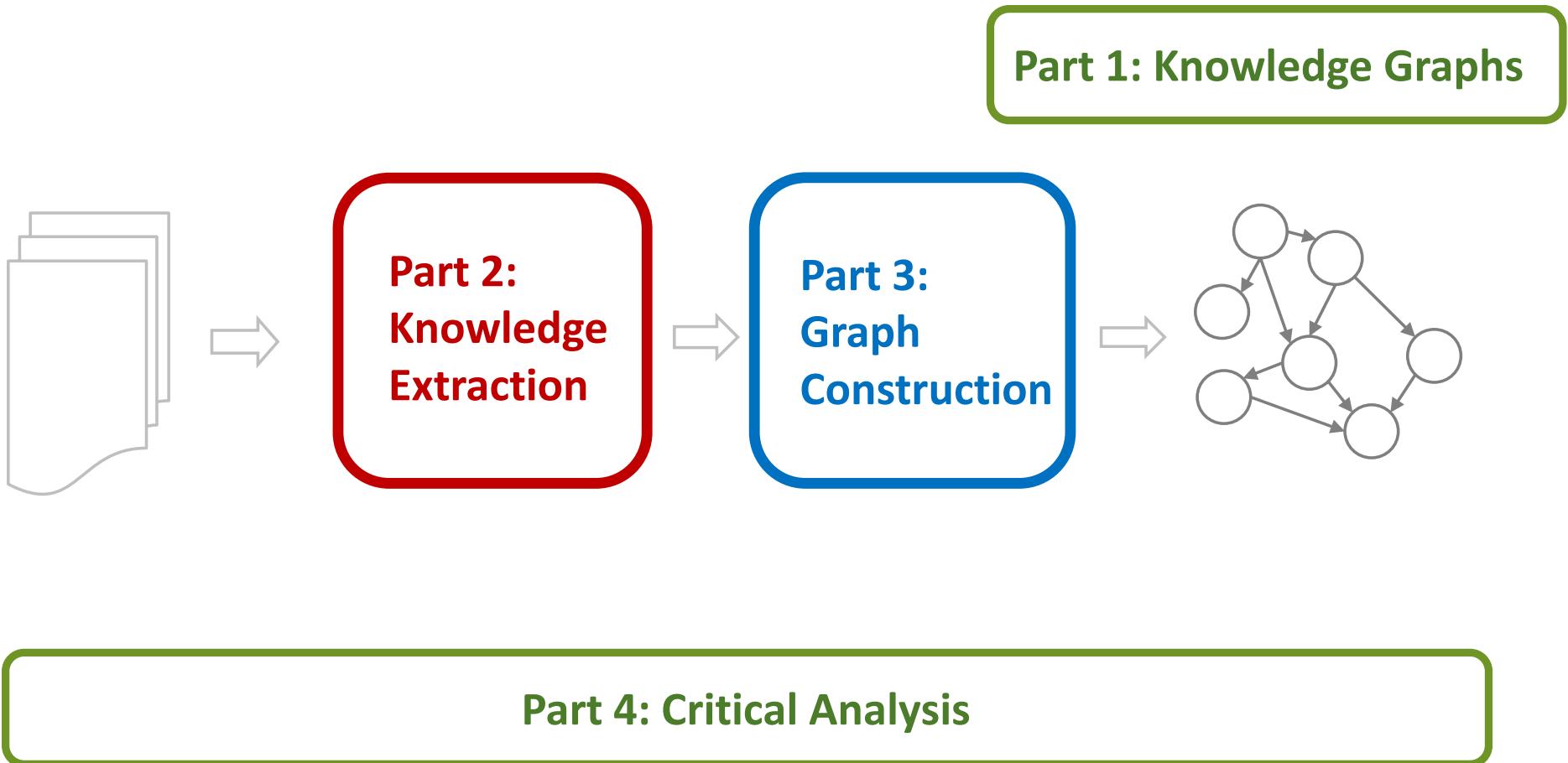
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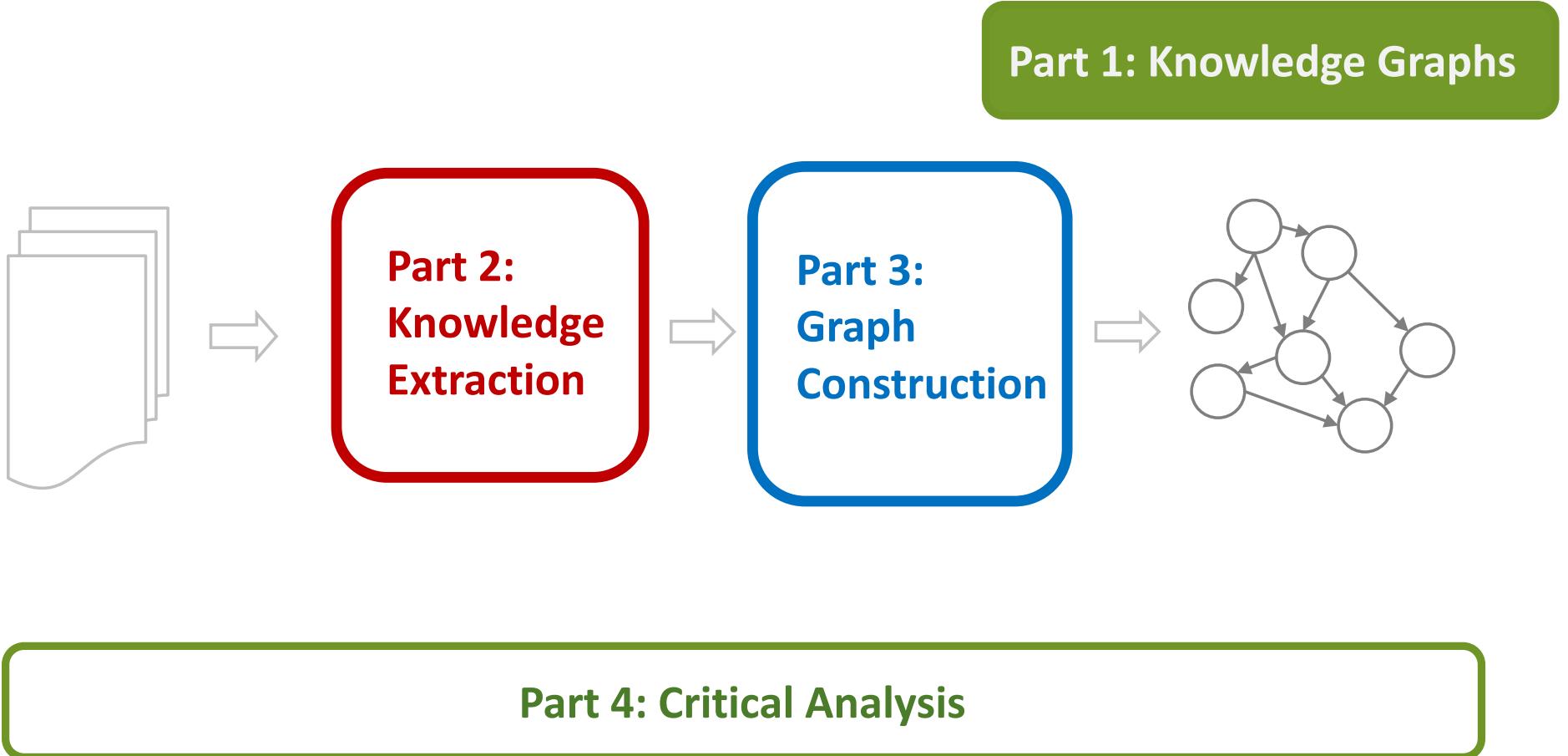
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Tutorial Outline

1. Knowledge Graph Primer [Jay] 
2. Knowledge Extraction from Text
 - a. NLP Fundamentals [Sameer] 
 - b. Information Extraction [Bhavana] 
- Coffee Break 
3. Knowledge Graph Construction
 - a. Probabilistic Models [Jay] 
 - b. Embedding Techniques [Sameer] 
4. Critical Overview and Conclusion [Bhavana] 

Tutorial Overview



Knowledge Graph Primer

TOPICS:

WHAT IS A KNOWLEDGE GRAPH?

WHY ARE KNOWLEDGE GRAPHS IMPORTANT?

WHERE DO KNOWLEDGE GRAPHS COME FROM?

KNOWLEDGE REPRESENTATION CHOICES

PROBLEM OVERVIEW

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What is a knowledge graph?

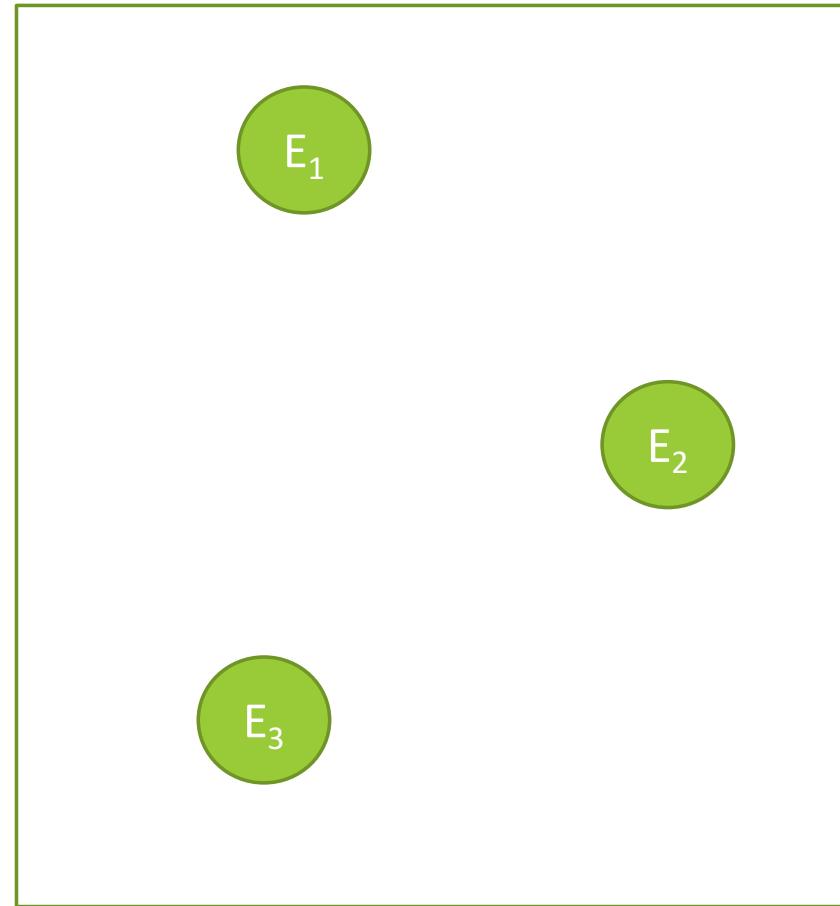
- Knowledge in graph form!

What is a knowledge graph?

- Knowledge in graph form!
- Captures entities, attributes, and relationships

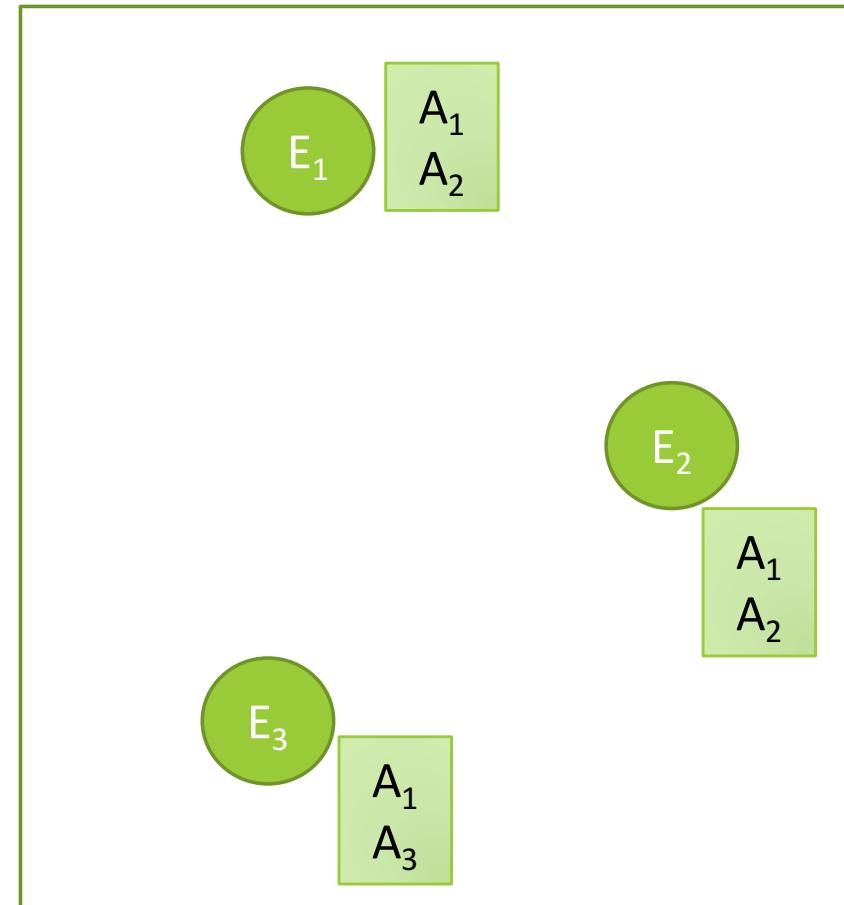
What is a knowledge graph?

- Knowledge in graph form!
- Captures entities, attributes, and relationships
- Nodes are entities



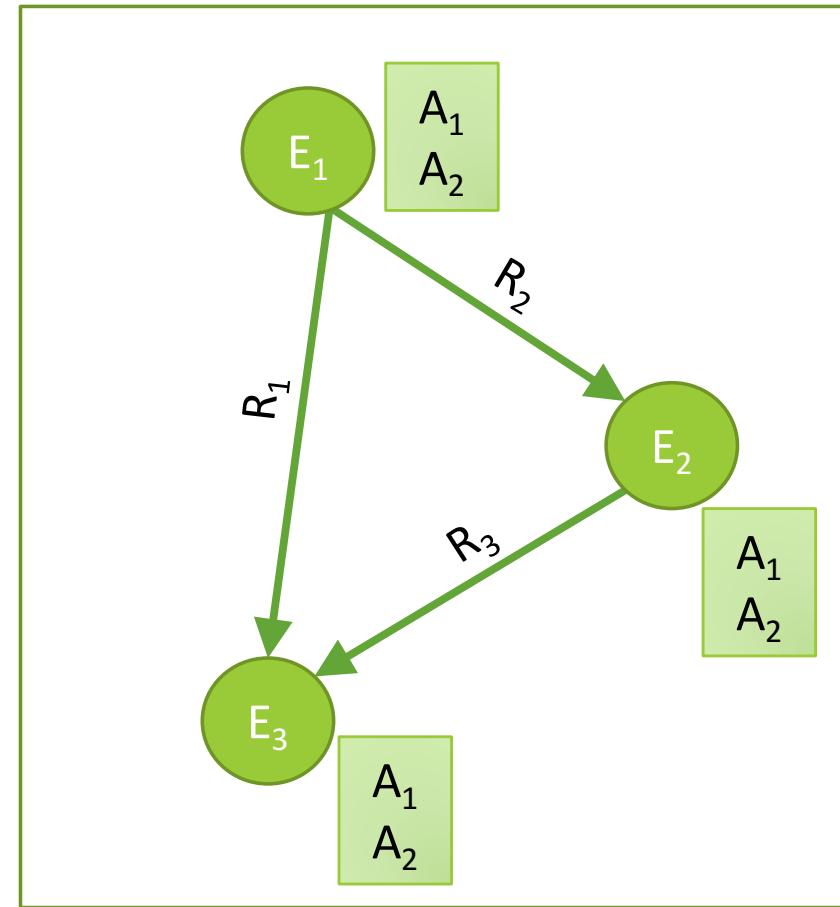
What is a knowledge graph?

- Knowledge in graph form!
- Captures entities, attributes, and relationships
- Nodes are entities
- Nodes are labeled with attributes (e.g., types)



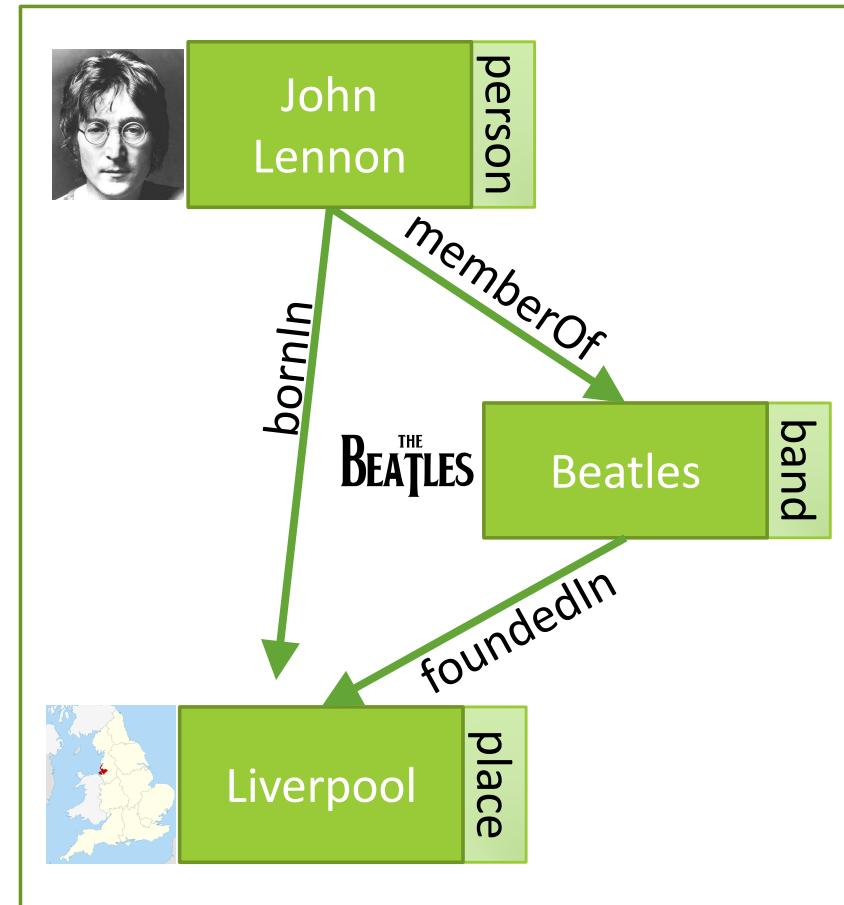
What is a knowledge graph?

- Knowledge in graph form!
- Captures entities, attributes, and relationships
- Nodes are entities
- Nodes are labeled with attributes (e.g., types)
- Typed edges between two nodes capture a relationship between entities



Example knowledge graph

- Knowledge in graph form!
- Captures entities, attributes, and relationships
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Why knowledge graphs?

- Humans:
 - Combat information overload
 - Explore via intuitive structure
 - Tool for supporting knowledge-driven tasks
- AIs:
 - Key ingredient for many AI tasks
 - Bridge from data to human semantics
 - Use decades of work on graph analysis

Applications 1: QA/Agents



The screenshot shows a search results page from a search engine. The search query is "who is playing in this year's super bowl". The results are categorized under "All" (News, Shopping, Videos, Maps, More) and show approximately 15,300,000 results found in 0.66 seconds. The top result is about "Super Bowl LI", which includes information about the game ("Super Bowl Sunday, February 5, 6:30 PM on FOX NRG Stadium, Houston, Texas"), logos for the "New England Patriots" and "Atlanta Falcons", and a link to "Tickets - Preview". To the right of this information is a large image of two football players in action, one from each team, with the NFL logo and a play button icon. At the bottom of the result card, it says "All times are in Eastern Time".

Applications 2: Decision Support

IBM Watson Knowledge Studio

View Details Attribute View View Guidelines Completed Close Alpha... 14pt 1 Entity Mention

A Mention Relation Coreference

2004-49-168A.txt

1 V1, a 1999 Toyota Camry, was traveling southbound in the second lane of a four-lane divided (seven lanes overall, divided by raised median), concrete roadway, approaching an intersection.

2 V2, a 2004 Mercedes S430, was northbound in the fourth lane of a four-lane, divided (seven lanes overall, divided by raised median), concrete roadway, about to turn left into westbound traffic at the same intersection.

3 As both vehicles entered the intersection, the front of V1 impacted the front of V2.

4 V1 rotated clockwise as V2 rotated counter-clockwise, and the left side of V1 impacted the right side of V2 in a sideslap configuration.

5 Both vehicles moved southwest to final rest.

6 Both vehicles were towed due to damage.

7 The unrestrained driver of V1 was hospitalized with foot and rib fractures as well as a liver laceration.

8 The restrained driver of V2 was treated and released with minor abrasion and contusion as well as a finger fracture.

9 The restrained front right passenger in V2 was pronounced brain dead two days later from multiple brain injuries.

10 V1 was equipped with redesigned dual frontal airbags, which deployed.

Type	Subtype	Role
a	ACCIDENT_CAUSE	
o	ACCIDENT_OUTCOME	
-	CONDITION	
i	IMPACT	
f	MANUFACTURER	
m	MODEL	
y	MODEL_YEAR	
j	PART_OF_CAR	
p	PERSON	
s	STRUCTURE	
H	VEHICLE	

Applications 3: Fueling Discovery

beatles (musicartist)

literal strings: [BEATLES](#), [Beatles](#), [beatles](#)

Help NELL Learn!

NELL wants to know if these be
If they are or ever were, click thumbs-up. O

- [beatles](#) is a musical artist  
- [beatles](#) is a musician in the [genre classic pop](#) (musicgenre)  
- [beatles](#) is a musician in the [genre pop](#) (musicgenre)  
- [beatles](#) is a musician in the [genre rock](#) (musicgenre)  
- [beatles](#) is a musician in the [genre classic rock](#) (musicgenre)  

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Where do knowledge graphs come from?

- Structured Text
 - Wikipedia Infoboxes, tables, databases, social nets

The Beatles				
© National Oceanography Centre, Liverpool				
Mon 30th	00:18	07:06	12:36	19:32
Jan 2017	9.15m H	1.34m L	9.50m H	1.20m L
Tue 31st	00:55	07:43	13:14	20:10
	9.18m H	1.36m L	9.49m H	1.25m L
Wed 1st	01:33	08:21	13:53	20:47
Feb 2017	9.10m H	1.51m L	9.37m H	1.42m L
Thu 2nd	02:14	08:59	14:36	21:27
	8.91m H	1.76m L	9.15m H	1.70m L
Fri 3rd	03:00	09:42	15:24	22:12
	8.63m H	2.08m L	8.84m H	2.04m L
Sat 4th	03:52	10:34	16:21	23:09
	8.27m H	2.43m L	8.45m H	2.39m L
Sun 5th	04:59	11:42	17:34	
	7.95m H	2.71m L	8.13m H	
Mon 6th	00:24	06:20	13:09	18:57
	2.63m L	7.82m H	2.73m L	8.06m H
Tue 7th	01:49	07:39	14:31	20:13
	2.56m L	8.03m H	2.42m L	8.29m H
Wed 8th	03:03	08:49	15:43	21:18
	2.23m L	8.46m H	1.93m L	8.69m H
Thu 9th	04:08	09:47	16:45	22:14
	1.82m L	8.94m H	1.41m L	9.07m H
Fri 10th	05:03	10:36	17:38	23:01
	1.44m L	9.34m H	0.99m L	9.35m H
Sat 11th	05:51	11:21	18:24	23:44
	1.17m L	9.61m H	0.75m L	9.47m H
Data				
The Beatles Total Album Sales Statistics				
Total number of Beatles albums sold				
2,303,500,000				
Total Albums Sold on iTunes				
785,000				
Total Singles Sold on iTunes				
3,800,000				
Sales By Available Markets				
United States				
209.1 Million				
Preston • P				
Canada				
13.6 Million				
United Kingdom				
7.5 Million				
Germany				
7.3 Million				
France				
3.1 Million				
Australia				
2.8 Million				
Japan				
1.9 Million				
Argentina				
1.6 Million				
Brazil				
600,000				
Sweden				
584,000				
Austria				
570,000				
Switzerland				
450,000				
ADVERTISEMENT				
Beatles Billboard Chart Statistics				
Total weeks on chart				
1,278 weeks				
Total number ones				
15				
Total weeks at number one				
175 weeks				
Album with longest time spent at number one ("Please Please Me")				
30 weeks				
PREV DATA SET				
NEXT DATA SET				

Where do knowledge graphs come from?

- Structured Text
 - Wikipedia Infoboxes, tables, databases, social nets
- Unstructured Text
 - WWW, news, social media, reference articles

Beatles last live performance

Published: Thursday, January 26th 2017, 5:24 am PST

Updated: Monday, January 30th 2017, 4:06 am PST

Written by Jim Eftink, Producer [CONNECT](#)



(KFVS) - How about a little Beatles history.

It was on this date in 1969, the band performed their last live public performance.

Allan Williams, First Manager of the Beatles, Dies at 86

(Source: Stock image By ALLAN KOZINN DEC. 31, 2016)

 The Beatles January 17 at 10:00am · 4

The Harrison family is proud to announce the release of George Harrison – The Vinyl Collection box set featuring all of George Harrison's solo studio albums in one collection for the first time.

WO GEORGE HARRISON - THE VINYL COLLECTION

Released on 24th February, 2017, the vinyl box set includes all twelve of George's studio albums with exact replicas of the original release track listing and artwork. Also included in the box set are George's classic live album Live In Japan (2L). ... See More



George Harrison - The Vinyl Collection - Released February 24th 2017

George Harrison - The Vinyl Collection, available to pre-order now with an exclusive & limited edition...

YOUTUBE.COM

Like Comment Share

like love wow 9.3K

Top Comments

908 shares

Write a comment...

Jeffrey Smith What I would really be interested in is an "All Things Must Pass... Stripped Down" with just the basic tracks without Phil Spector's Wall of Sound. I'll bet it would sound really good and I would buy it in a heartbeat.

Like · Reply · like 31 · January 17 at 10:20am

17 Replies

Dave Standing

I can just see the greedy Harrison family and the greedy music industry millionaire big wigs rubbing their hands with glee once more whilst discussing various methods to make people buy their already bought and paid for record collections all over... See More

Like · Reply · like 26 · January 17 at 10:19am · Edited

30 Replies

View more comments



imager of the Beatles in 1960, he sent them on a stint in Germany tagcraft. Press Association, via Associated Press

 The Beatles January 17 at 6:58am · 4

"Of very few individual songs can it be said, 'This changed the course of popular music.'" "A Day In The Life" is one such song." - Richard Havers



The Beatles - A Day In The Life

A Day In The Life The Beatles 1 Video Collection is Out Now. Get your copy here!

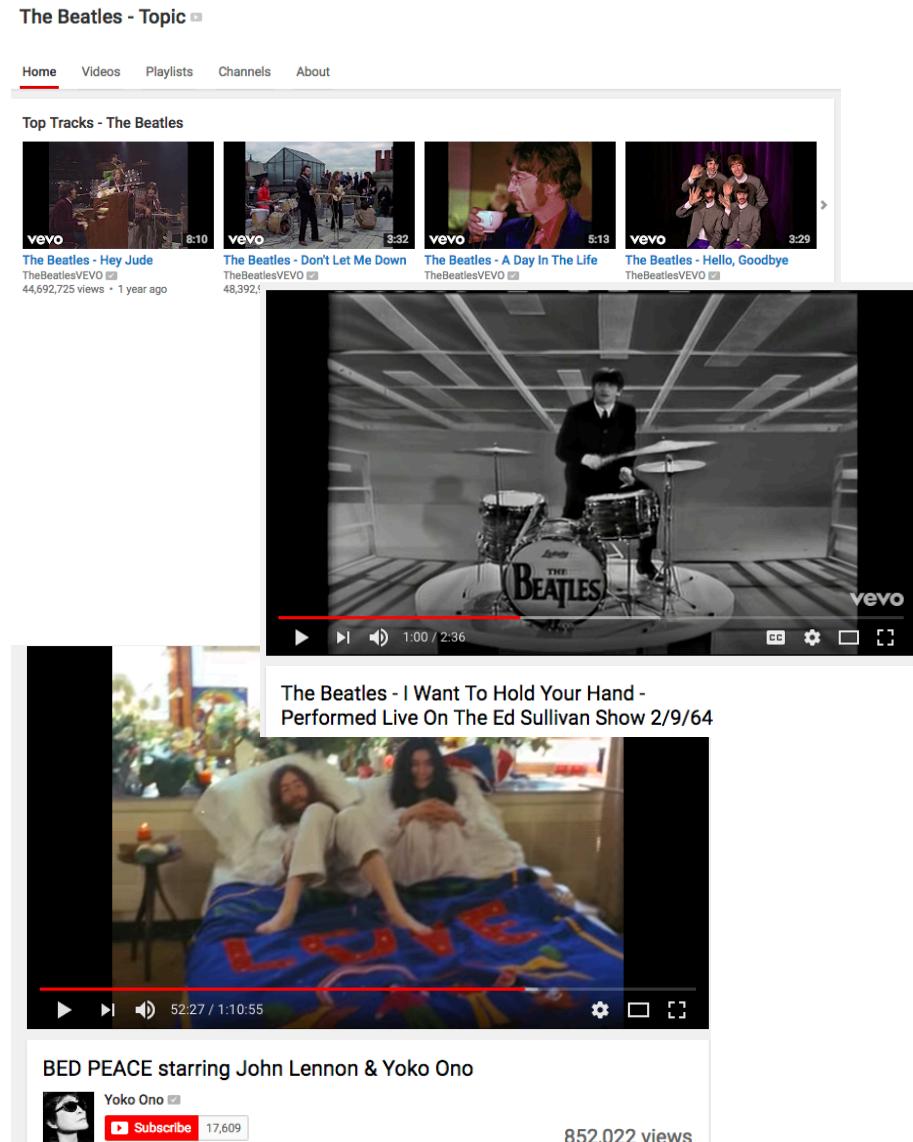
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- Images



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- Images
- Video
 - YouTube, video feeds



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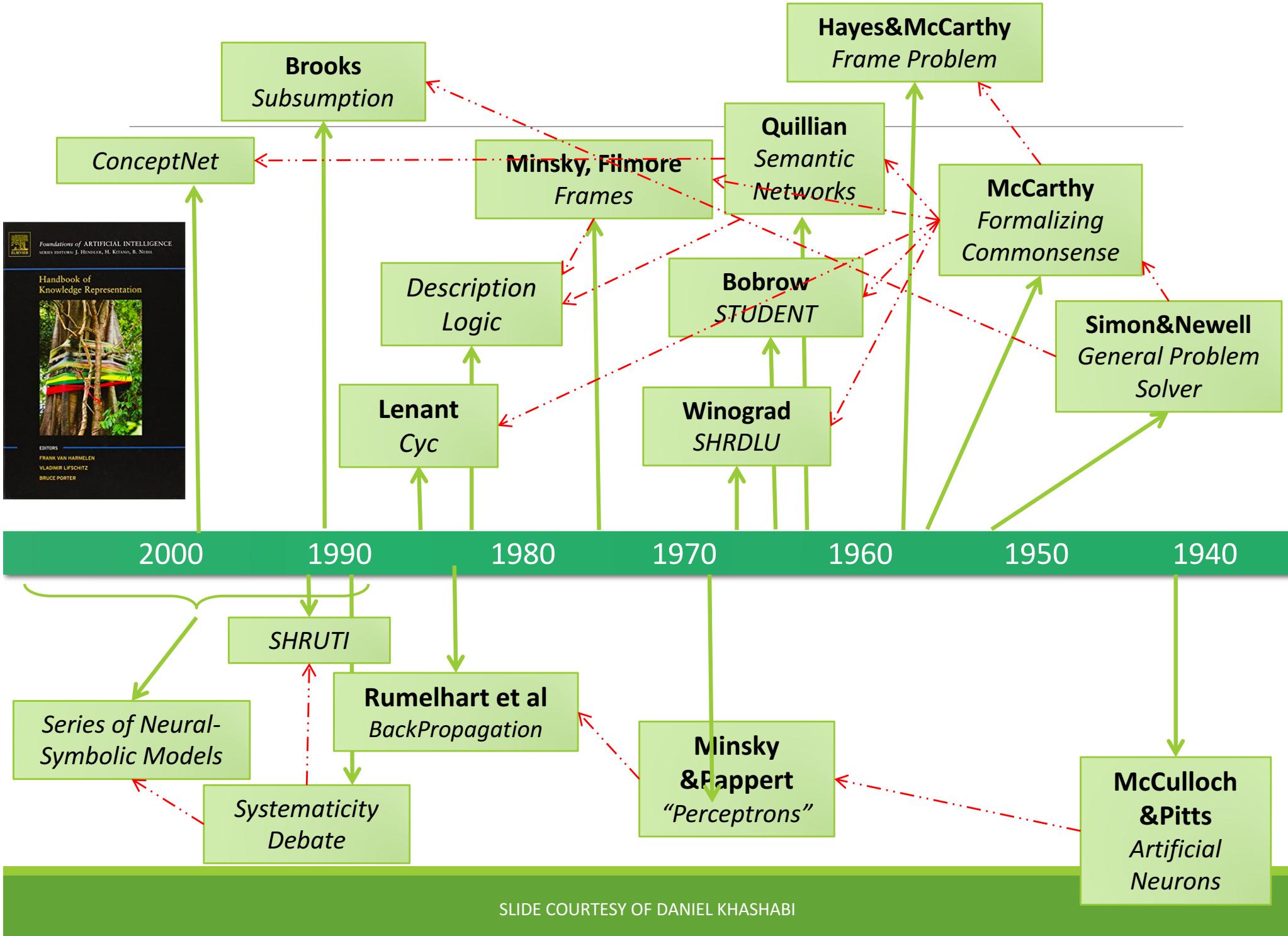
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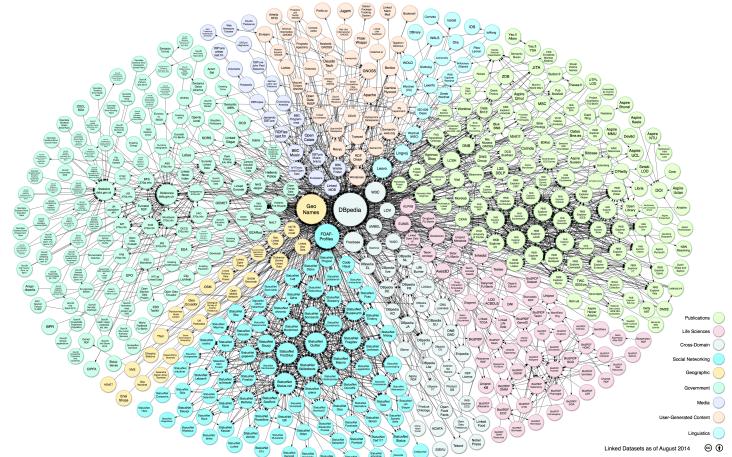


Knowledge Representation

- Decades of research into knowledge representation
- Most knowledge graph implementations use RDF triples
 - $\langle \text{rdf:subject}, \text{rdf:predicate}, \text{rdf:object} \rangle : r(s,p,o)$
 - Temporal scoping, reification, and skolemization...
- ABox (assertions) versus TBox (terminology)
- Common ontological primitives
 - rdfs:domain, rdfs:range, rdf:type, rdfs:subClassOf, rdfs:subPropertyOf, ...
 - owl:inverseOf, owl:TransitiveProperty, owl:FunctionalProperty, ...

Semantic Web

- Standards for defining and exchanging knowledge
 - RDF, RDFa, JSON-LD, schema.org
 - RDFS, OWL, SKOS, FOAF
- Annotated data provide critical resource for automation
- Major weakness: annotate everything?



Information Extraction from Text

- Focus of this tutorial!
- Answer to the knowledge acquisition bottleneck
- Many challenges:
 - chunking
 - polysemy/word sense disambiguation
 - entity coreference
 - relational extraction

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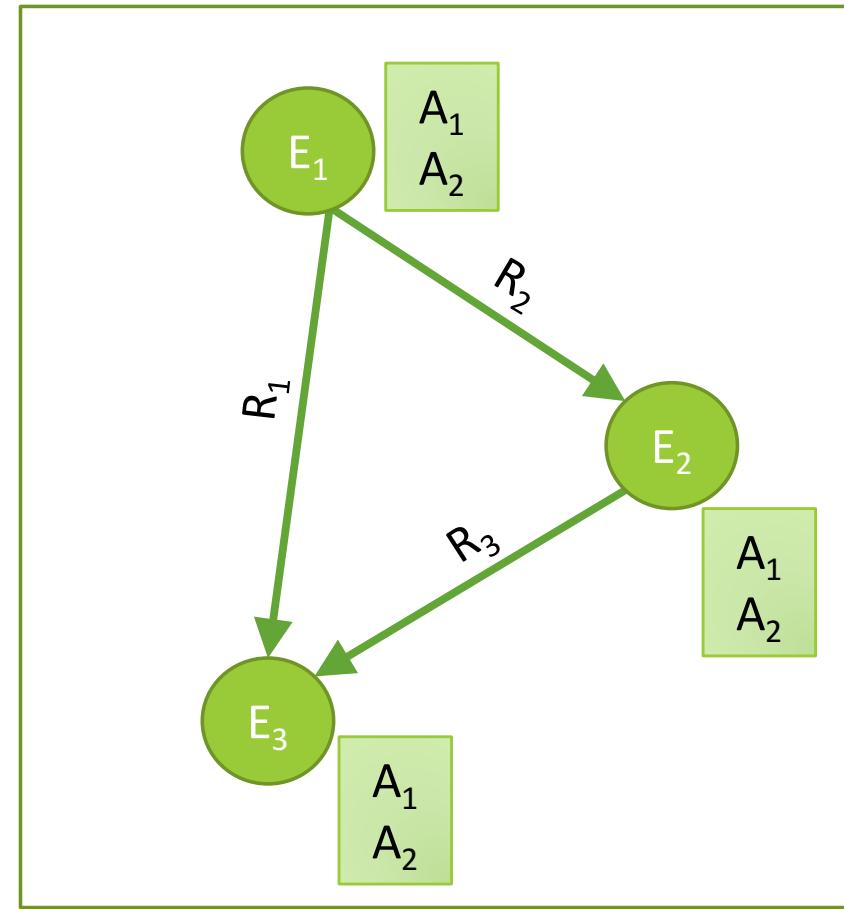
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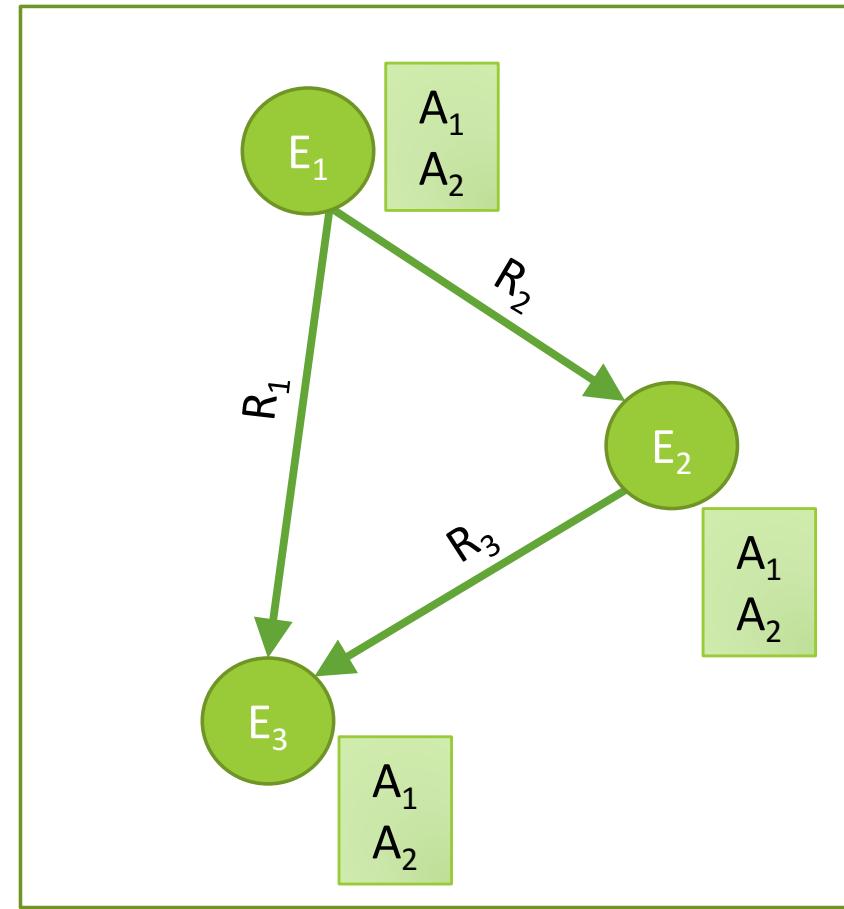
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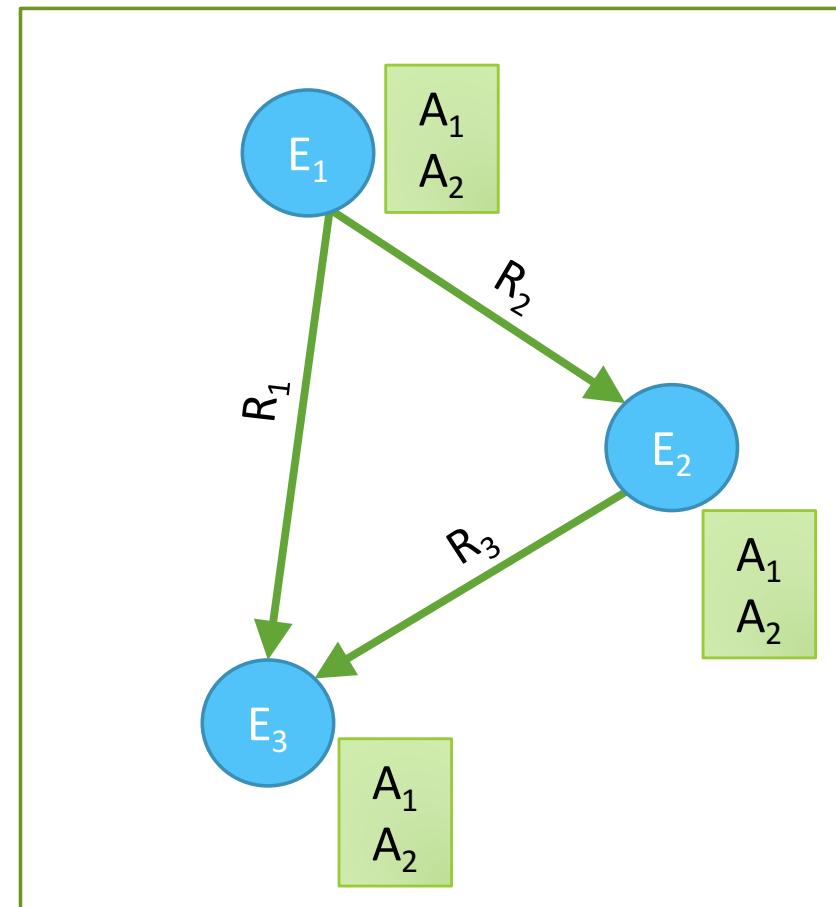


Basic problems



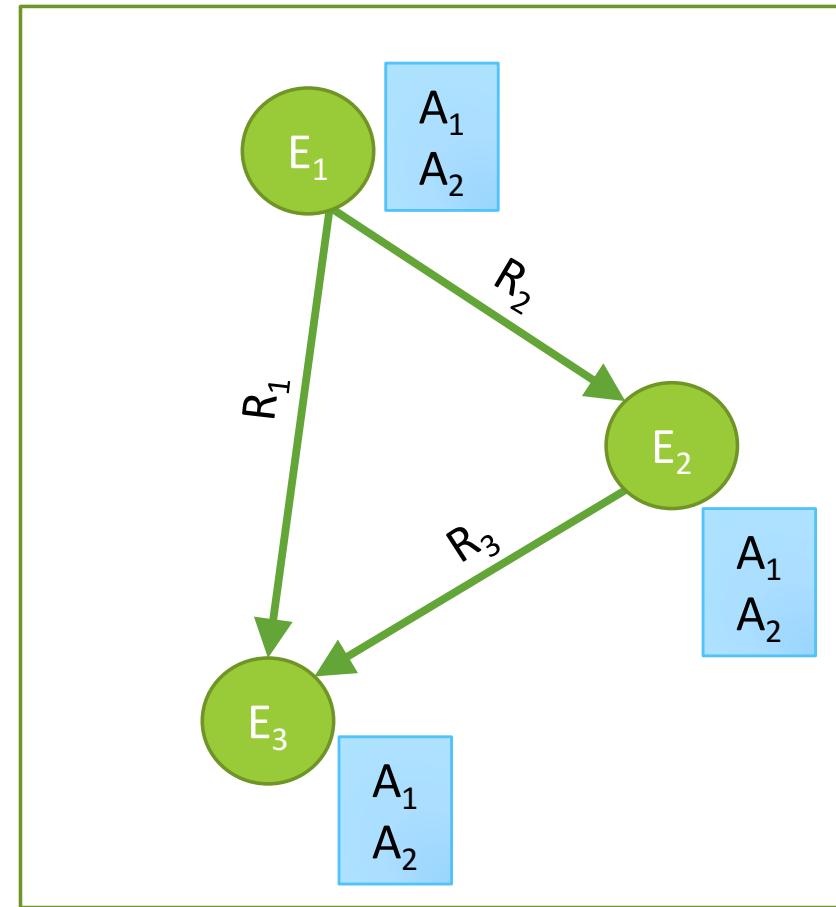
Basic problems

- **Who** are the entities (nodes) in the graph?



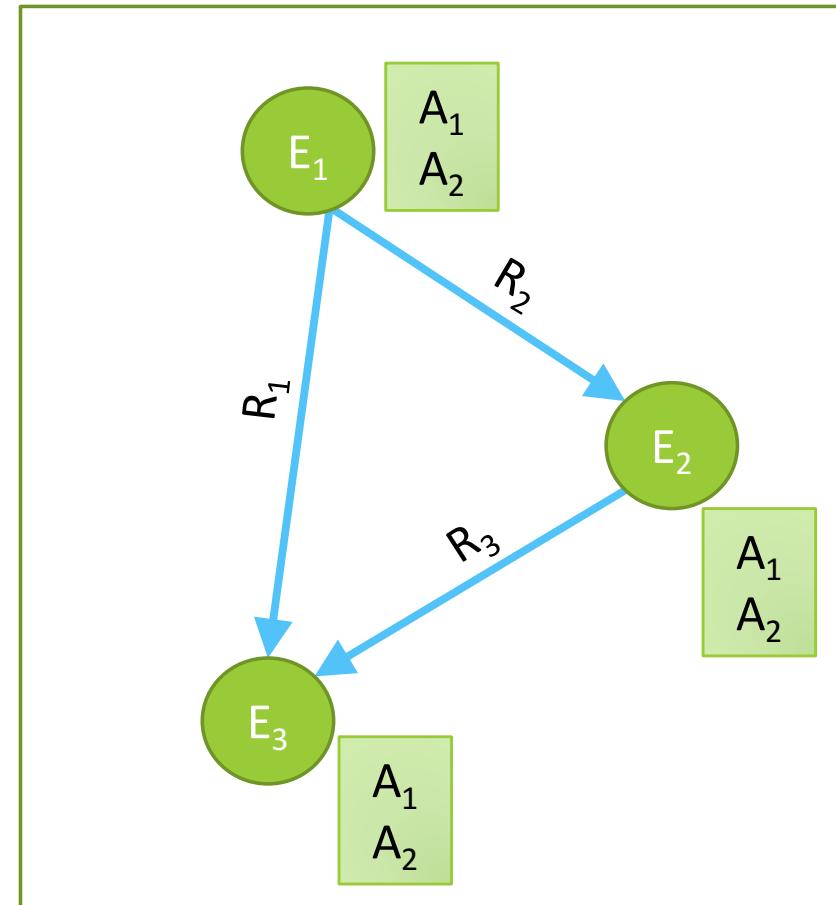
Basic problems

- **Who** are the entities (nodes) in the graph?
- **What** are their attributes and types (labels)?



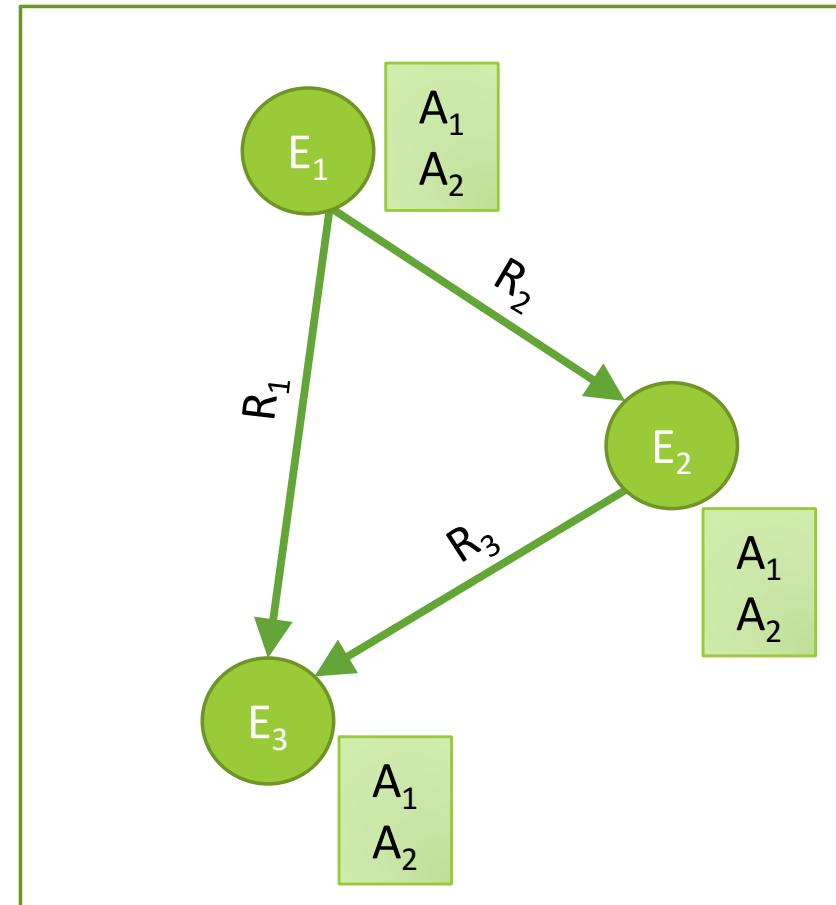
Basic problems

- **Who** are the entities (nodes) in the graph?
- **What** are their attributes and types (labels)?
- **How** are they related (edges)?

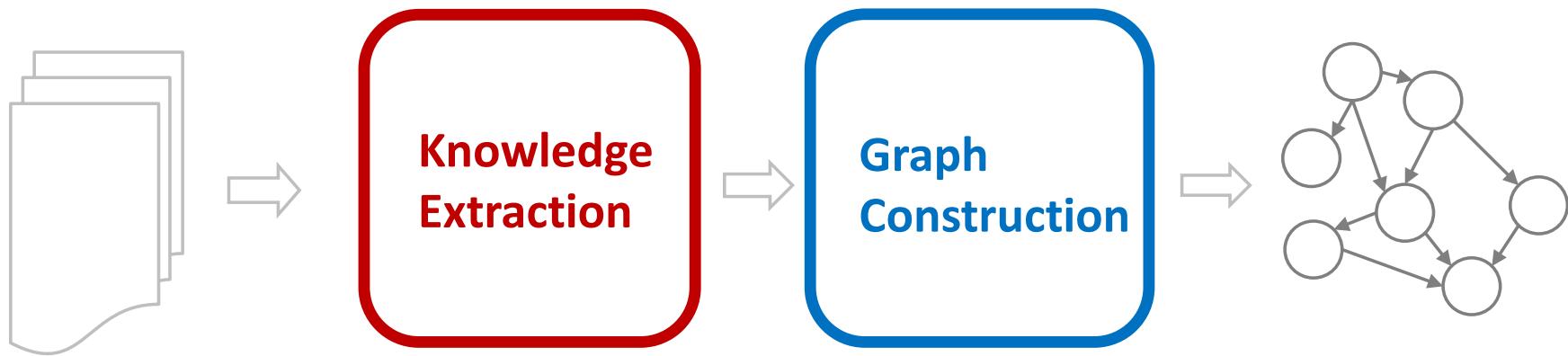


Basic problems

- **Who** are the entities (nodes) in the graph?
- **What** are their attributes and types (labels)?
- **How** are they related (edges)?



Knowledge Graph Construction



Two perspectives

Knowledge Extraction

- **Who** are the entities (nodes) in the graph?
 - Named Entity Recognition
 - Entity Coreference
- **What** are their attributes and types (labels)?
 - Named Entity Recognition
- **How** are they related (edges)?
 - Relation Extraction
 - Semantic Role Labeling

Graph Construction

- **Who** are the entities (nodes) in the graph?
 - Entity Linking
 - Entity Resolution
- **What** are their attributes and types (labels)?
 - Collective Classification
- **How** are they related (edges)?
 - Link Prediction

Tutorial Outline

1. Knowledge Graph Primer [Jay]



2. Knowledge Extraction from Text

a. NLP Fundamentals [Sameer]



b. Information Extraction [Bhavana]



Coffee Break



3. Knowledge Graph Construction



a. Probabilistic Models [Jay]



b. Embedding Techniques [Sameer]

4. Critical Overview and Conclusion [Bhavana]

