

SEMANTIC GRAPHS DERIVED FROM TRIPLETS WITH APPLICATION IN DOCUMENT SUMMARIZATION

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Department of Knowledge Technologies



October 17, 2008

Data Mining and Data Warehouses (SiKDD)

Overview



- Introduction
- System Pipeline
- System Evaluation
- Conclusions

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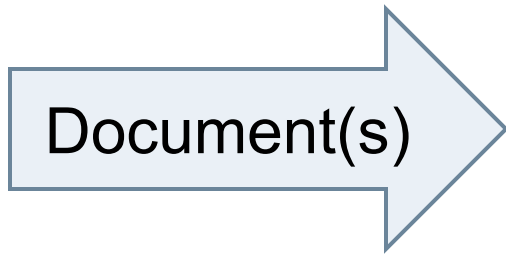
Introduction

- Given a document, perform the following:
 - Annotate it with **named entities** (people, places, organizations)
 - Extract **(subject, verb, object) – triplets**
 - Refine the triplets and obtain a graphical representation of the document – a **semantic graph**
 - **Automatically summarize the document** based on the semantic graph

Overview

- Introduction
- **System Pipeline**
 - **Named Entities and Triplets**
 - **Semantic Graphs**
 - **Document Summarization**
- System Evaluation
- Conclusions

System Pipeline



System Pipeline

Berlin Hotel Unsure How to Deal with Raccoon Guest

A Berlin hotel is trying to figure out how to deal with an unusual guest -- a raccoon who has moved into its garage. According to German law, the hotel does not have the right to evict the furry trespasser.

For North Americans, having a raccoon in your garage is hardly a big deal. In Germany, however -- where the animals are something of a rarity -- the same can't be said.

For the past few weeks, a raccoon has been causing a stir in Germany's capital Berlin after making its home in the garage of one of the city's landmark hotels, the 39-story Park Inn. The furry creature has been spotted scurrying around the hotel's garage and scavenging for food in the trash cans of a near-by Burger King fast food restaurant. Hotel staff have christened the little guest Alex, after the nickname for Alexanderplatz, the square where the hotel is located.

Over the last few weeks, the little animal has become a minor celebrity after Berlin's media got wind of the raccoon's unusual choice of home.

The city's newspapers have been reporting about the latest sightings of Alex and the hotel's failed attempt to find it a new home.

Although welcoming their unusual guest, the hotel's management seems ambivalent about having a raccoon living in its garage. When the news first broke, the hotel's general manager Thomas Hattenberger told reporters they were proud the animal had chosen their hotel as its new home. However, at the same time he announced they were looking for a new home -- one more suitable for a raccoon -- for Alex. The hotel even offered to sponsor the animal, if a zoo or a private individual could be found to take Alex in.

But, after seeking the help of wildlife experts at Berlin's Senate Department for Urban Development, the hotel's management discovered it might not be allowed to evict Alex. According to German hunting law, a wild animal cannot be removed from private property -- even from one's own -- unless it presents a danger.

But the raccoon has not yet caused any trouble. "At the moment we are just waiting to see what will happen," hotel spokeswoman Catherina Cora told SPIEGEL ONLINE Monday. "The raccoon is not a danger to anyone and so far it has created no harm." She added that the hotel's only concern was that, because the animal was quite unusual, it might frighten a driver and cause an accident.

To check up on the raccoon's health, Derk Ehlert, expert for wild animals at Berlin's Senate Department for Urban Development, paid the animal a visit on Sunday night. Ehlert suspects Alex could have grown up at Berlin's most famous tourist attraction. He told newspaper Berliner Morgenpost that a raccoon family living at the Brandenburg Gate had been missing two young raccoons for a while.

Raccoons are native to North America, but have become more widespread in Europe since the beginning of the 20th century after escaping from fur farms. The Berlin raccoon population, which experts estimate to comprise around 100 or 120 family groups, derives from a farm in the town of Strausberg, 30 kilometers east of Berlin. Raccoons are believed to have escaped from the farm at the end of World War II and ended up settling in the German capital.

Although some of them, like Alex, have made their home in buildings -- such as a shopping center in the Berlin district of Spandau -- most have sought to live near rivers, canals and lakes.

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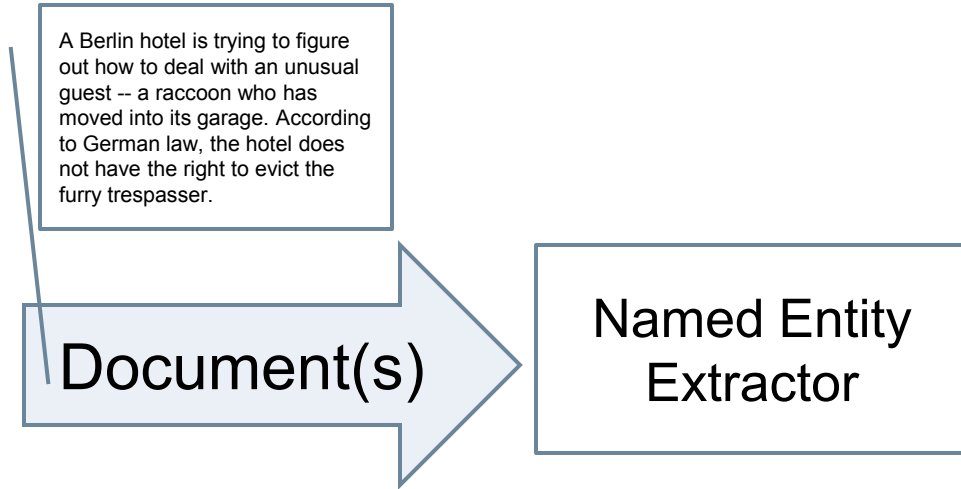
Document(s)

System Pipeline

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Document(s)

Named Entity
Extractor



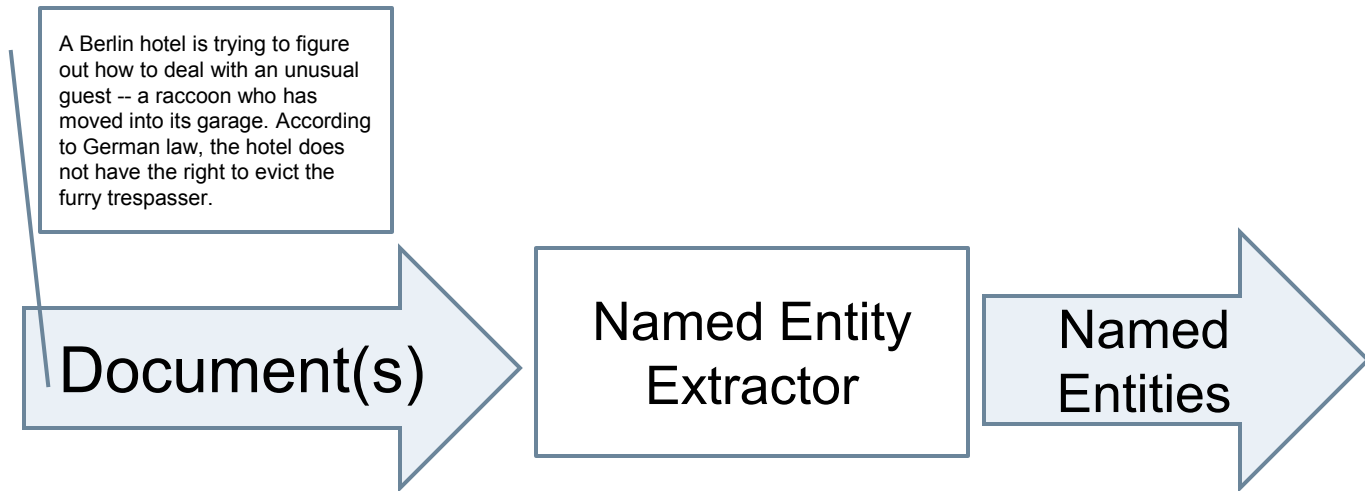
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Named
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System Pipeline

Named Entities

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legend

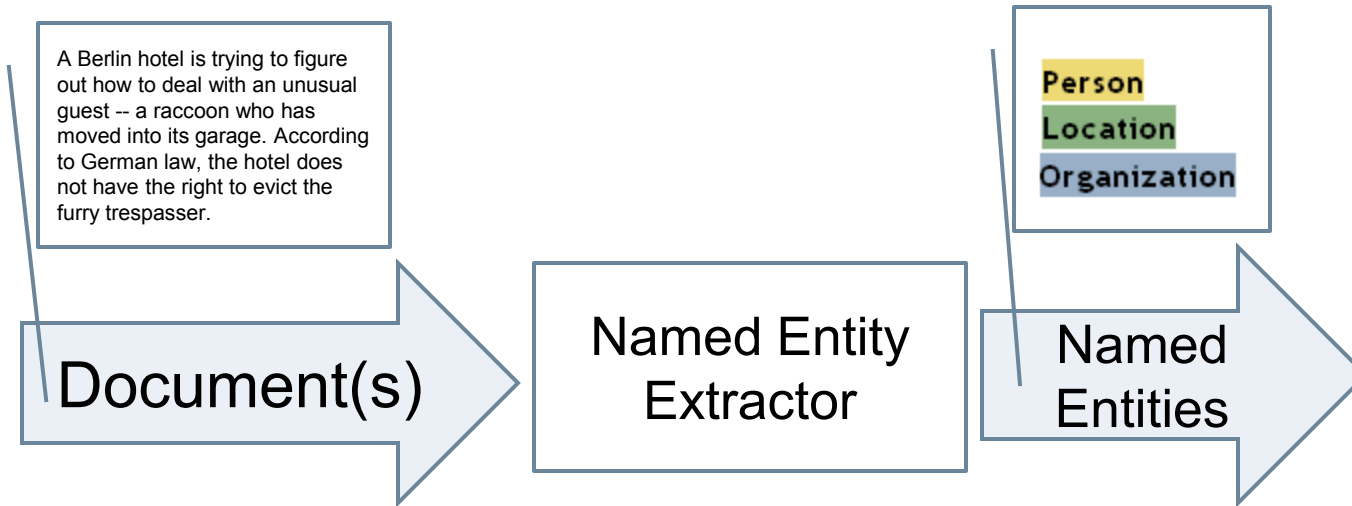
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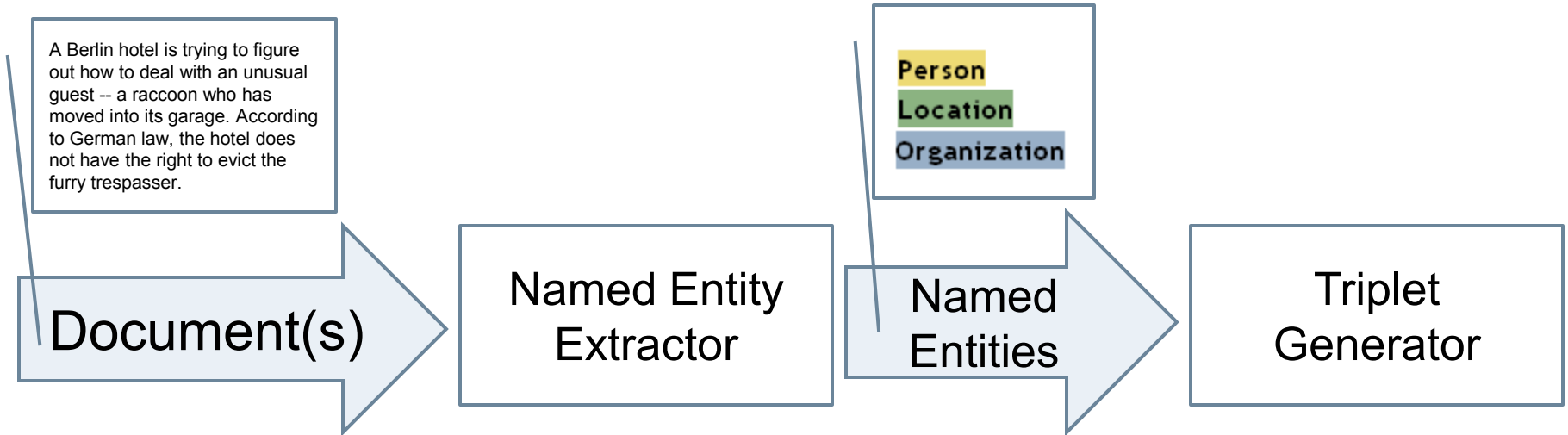
Location, highlighting the location name.

Organization, highlighting the organization name.

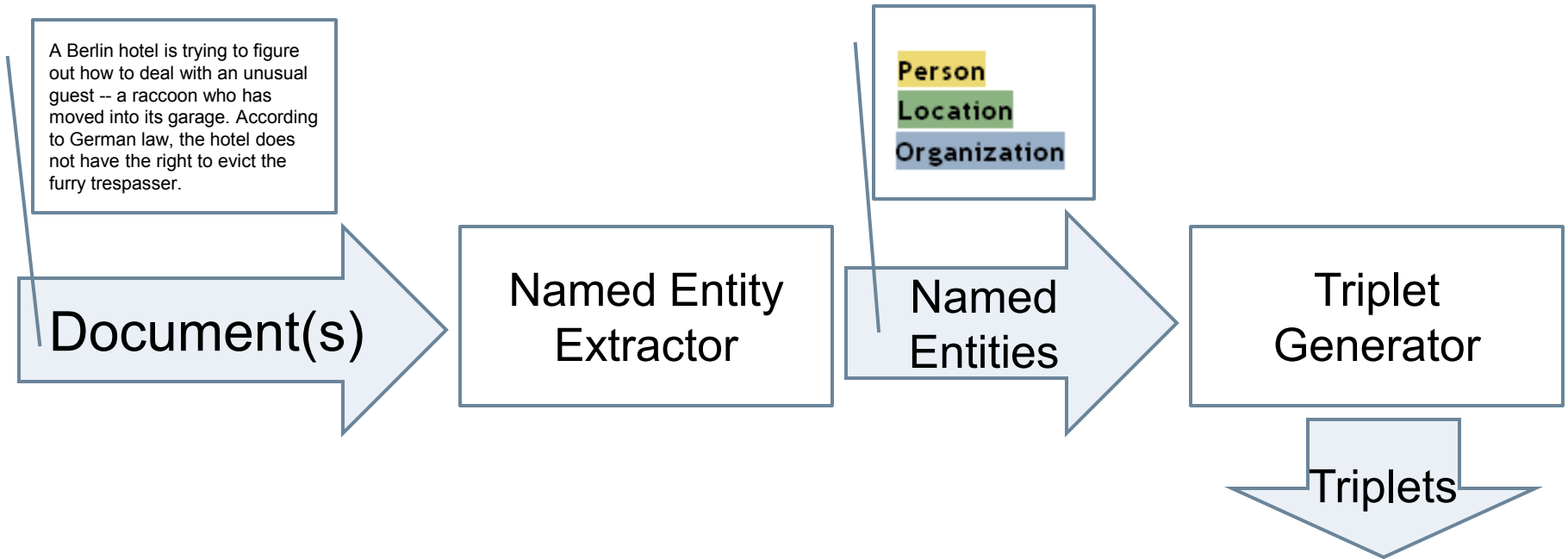
System Pipeline



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System Pipeline

Triplets (subject, verb, object)

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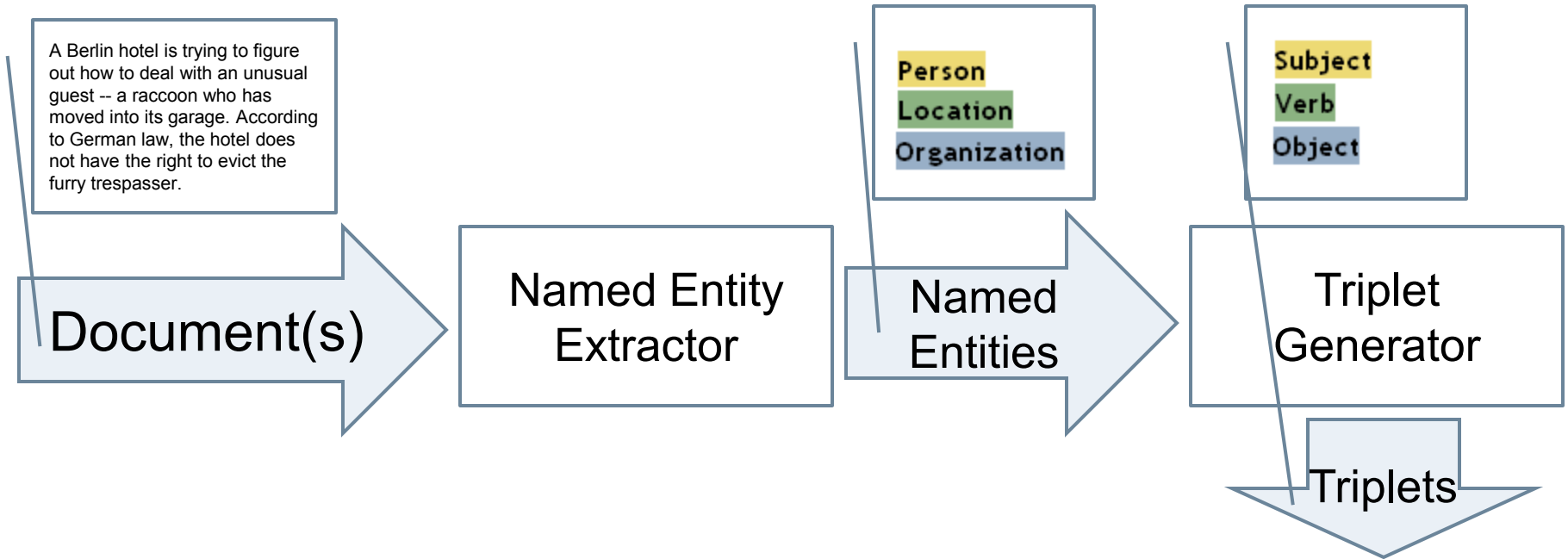
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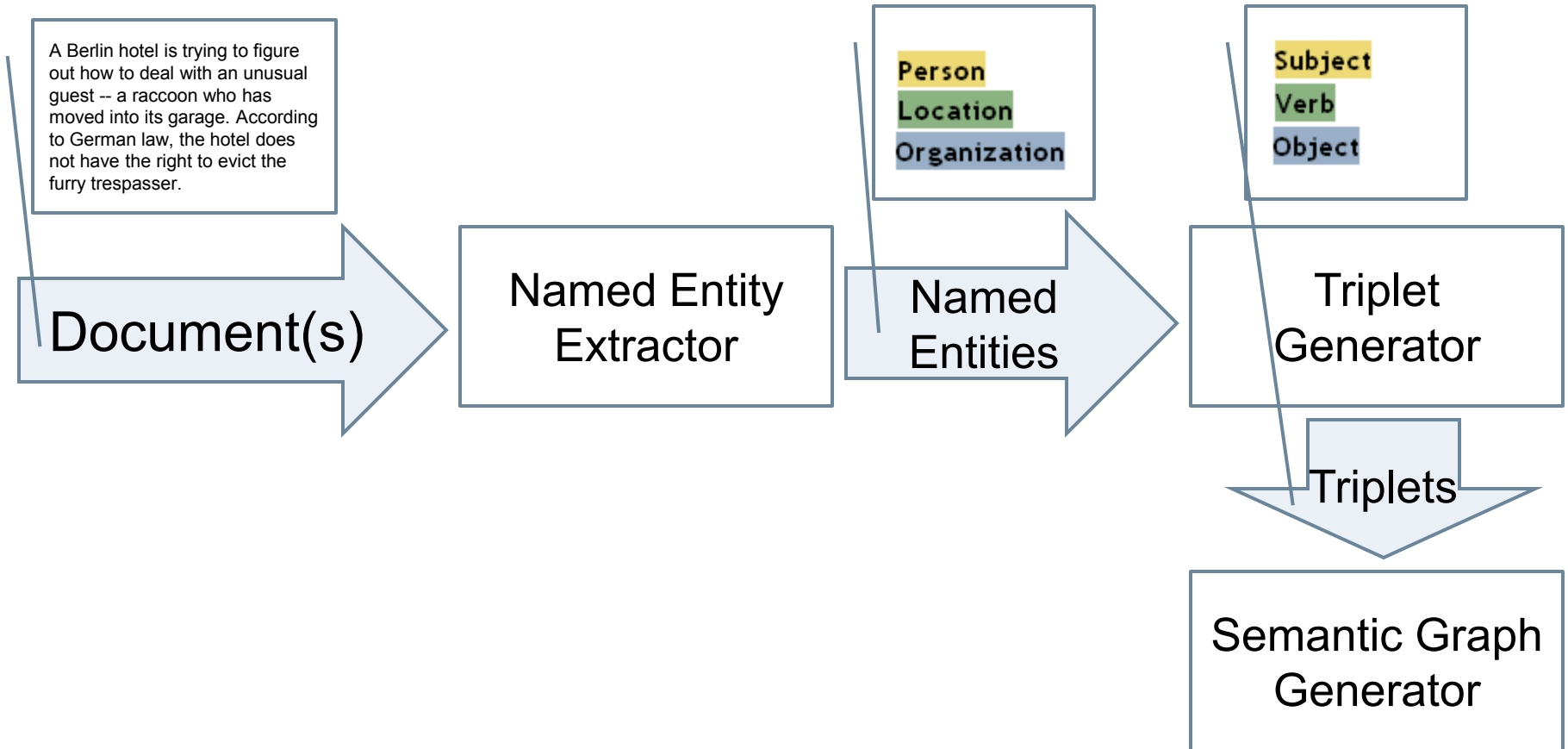
Verb, highlighting the verb triplet element.

Object, highlighting the object triplet element.

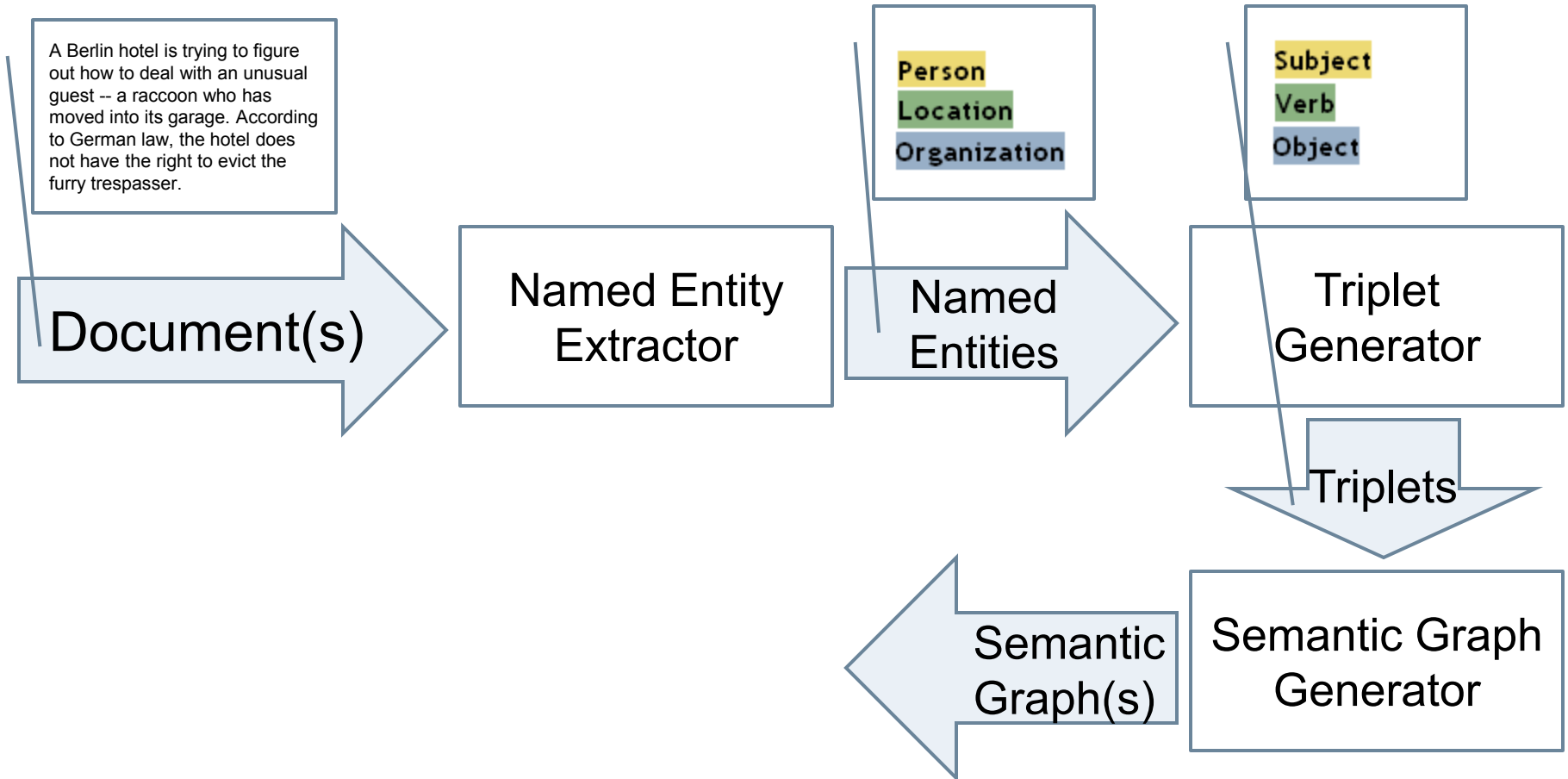
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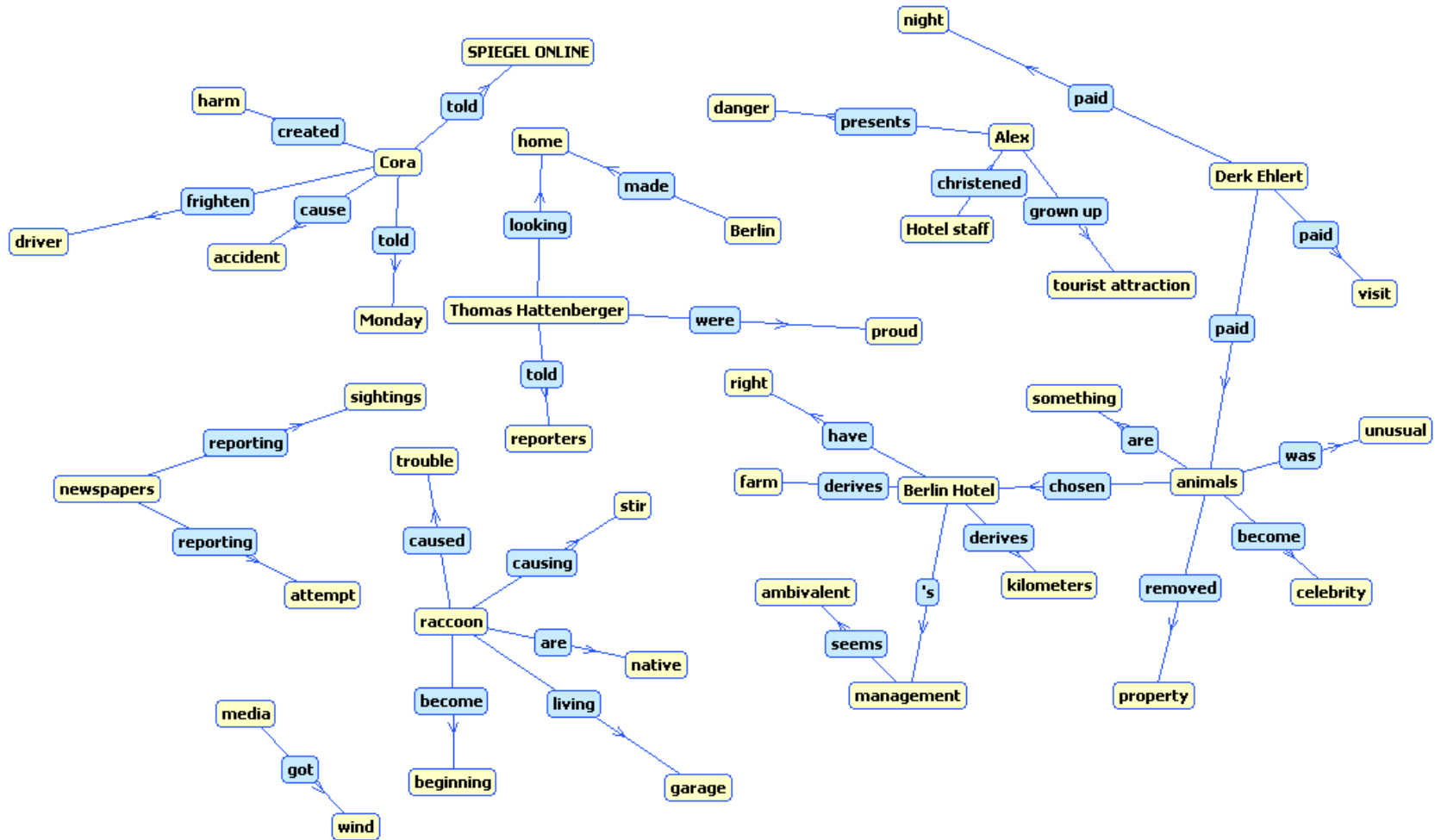
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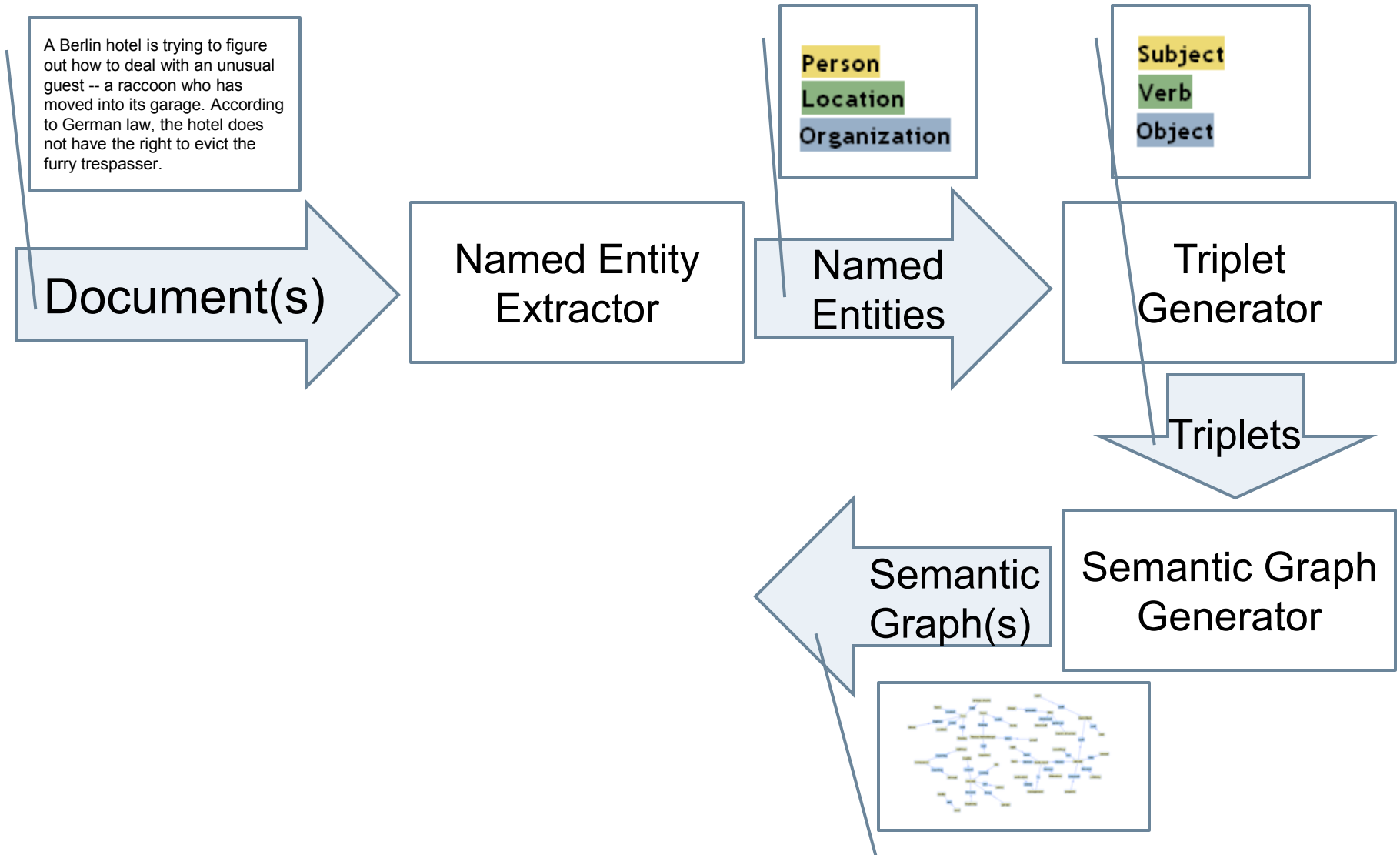
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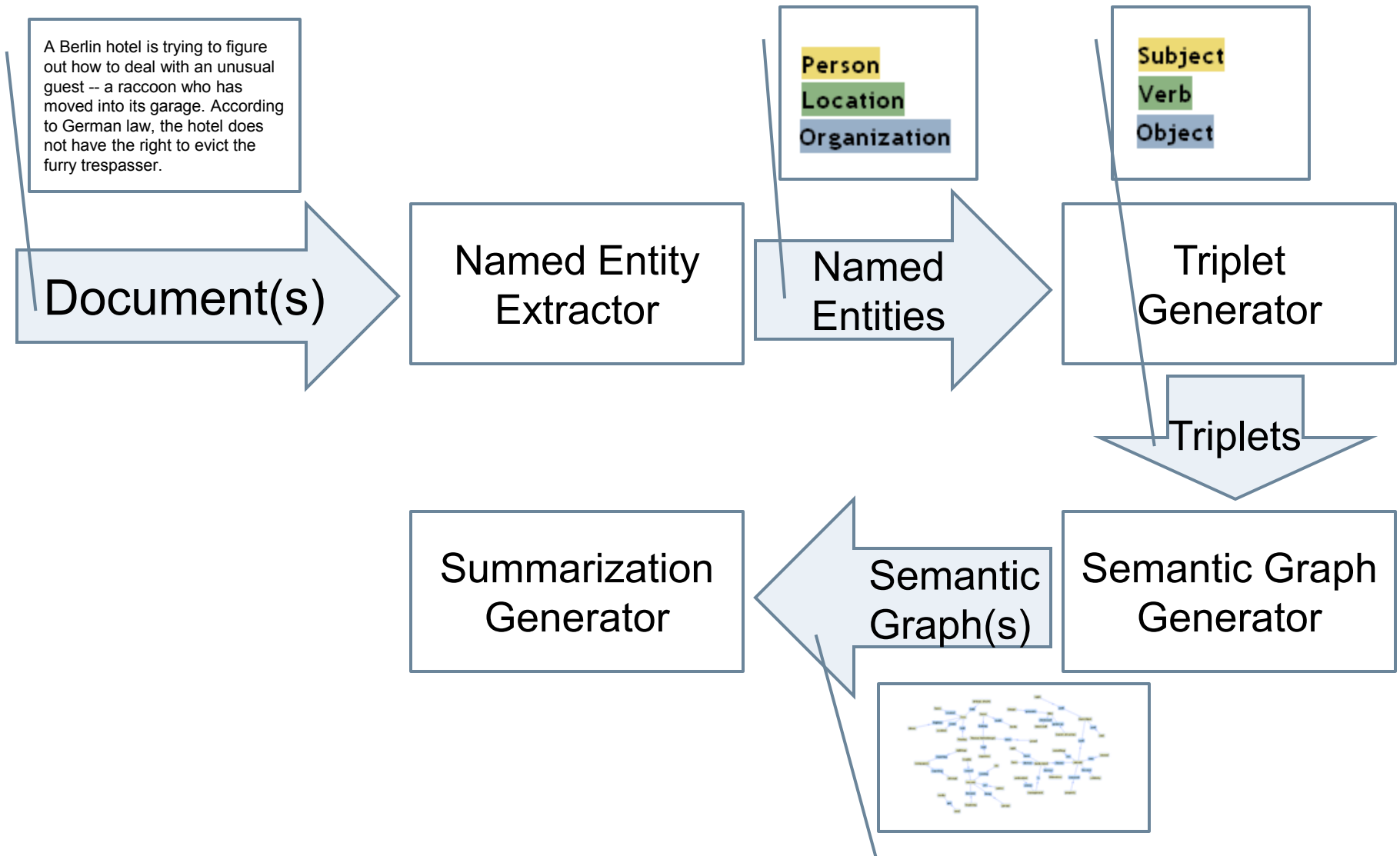
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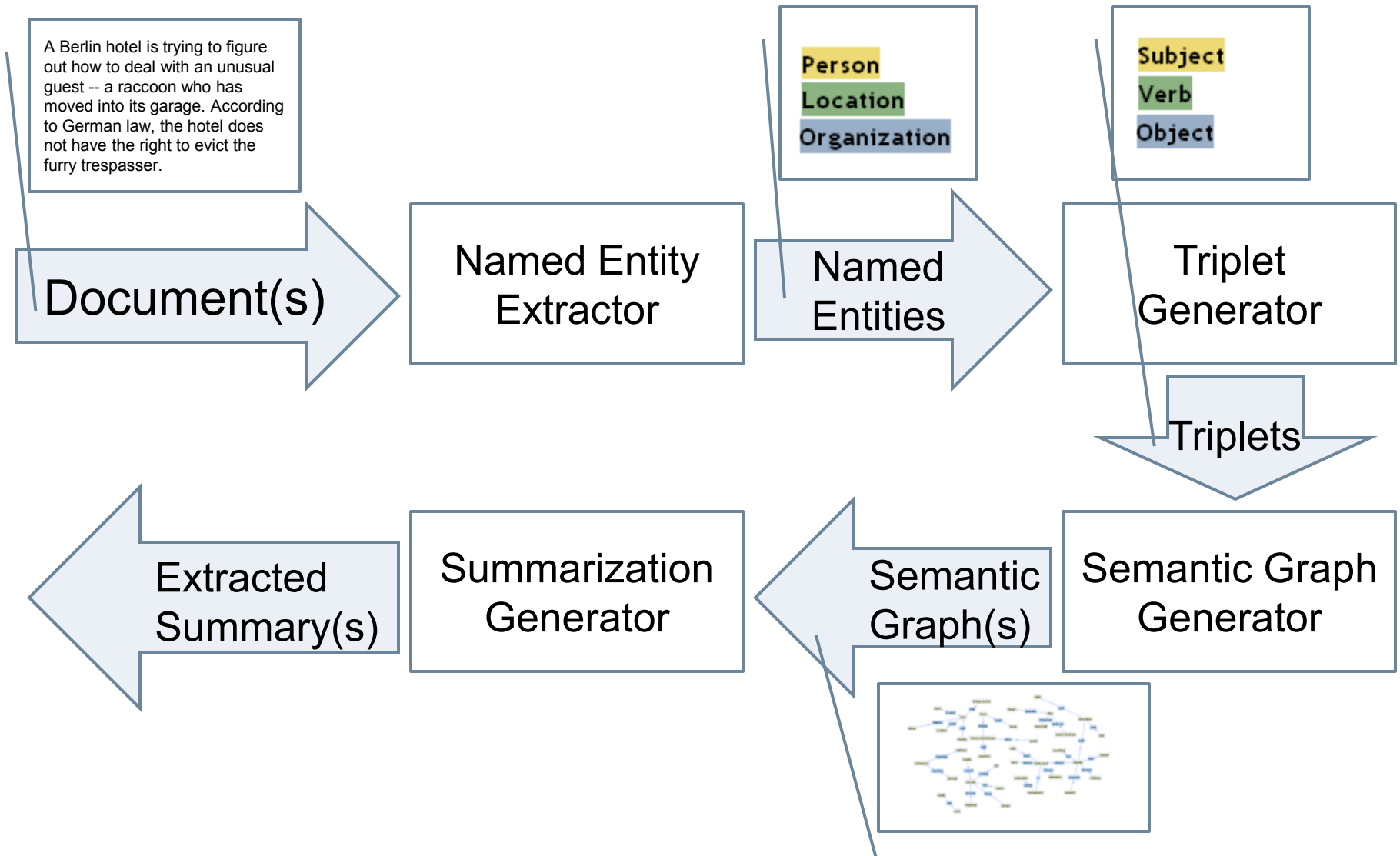
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System Pipeline



System Pipeline

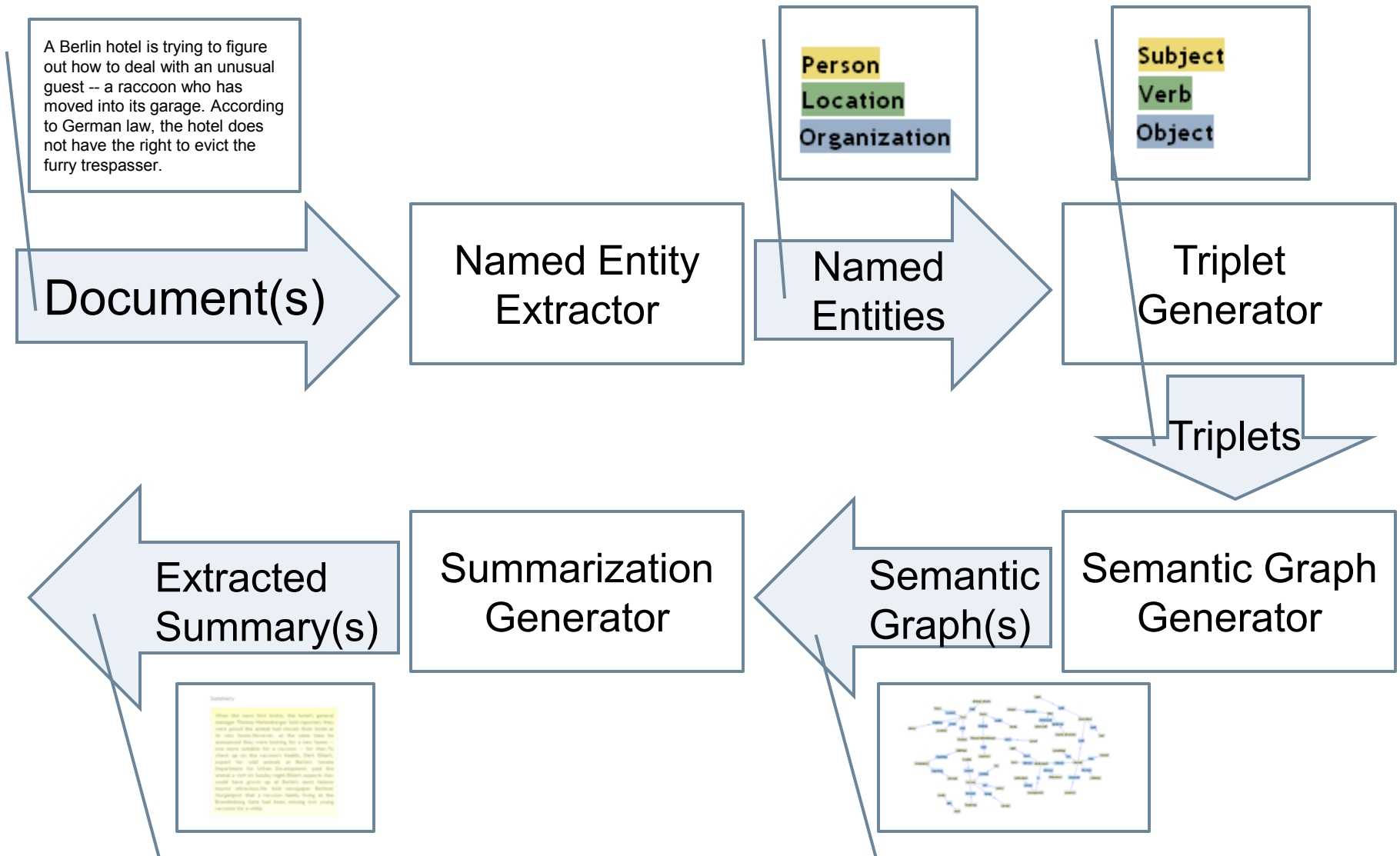


System Pipeline

Summary

When the news first broke, the hotel's general manager Thomas Hattenberger told reporters they were proud the animal had chosen their hotel as its new home. However, at the same time he announced they were looking for a new home -- one more suitable for a raccoon -- for Alex. To check up on the raccoon's health, Derk Ehlert, expert for wild animals at Berlin's Senate Department for Urban Development, paid the animal a visit on Sunday night. Ehlert suspects Alex could have grown up at Berlin's most famous tourist attraction. He told newspaper Berliner Morgenpost that a raccoon family living at the Brandenburg Gate had been missing two young raccoons for a while.

System Pipeline



Named Entities and Triplets

- Named Entities:
 - ▣ Names of people, locations, organizations
 - ▣ Manually annotated (e.g., REUTERS data set) and/or automatically extracted (e.g., using **GATE - General Architecture for Text Engineering** <http://gate.ac.uk/>)
- Triplets:
 - ▣ Extracted with **Stanford Parser** <http://nlp.stanford.edu/software/lex-parser.shtml>

Semantic Graphs



Co-
reference

Semantic Graphs



Co-
reference

Arrigo Sacchi

Sacchi

Mr. Sacchi

=>

Arrigo Sacchi

Semantic Graphs



Co-
reference

Anaphora

Semantic Graphs



Co-
reference

Anaphora

Gilles Garin, chairman of DHL France, said that the express distribution group still hoped to build the hub at Strasbourg. “As long as they have not said clearly 'no', we are still interested,” he told Reuters by telephone.

Semantic Graphs

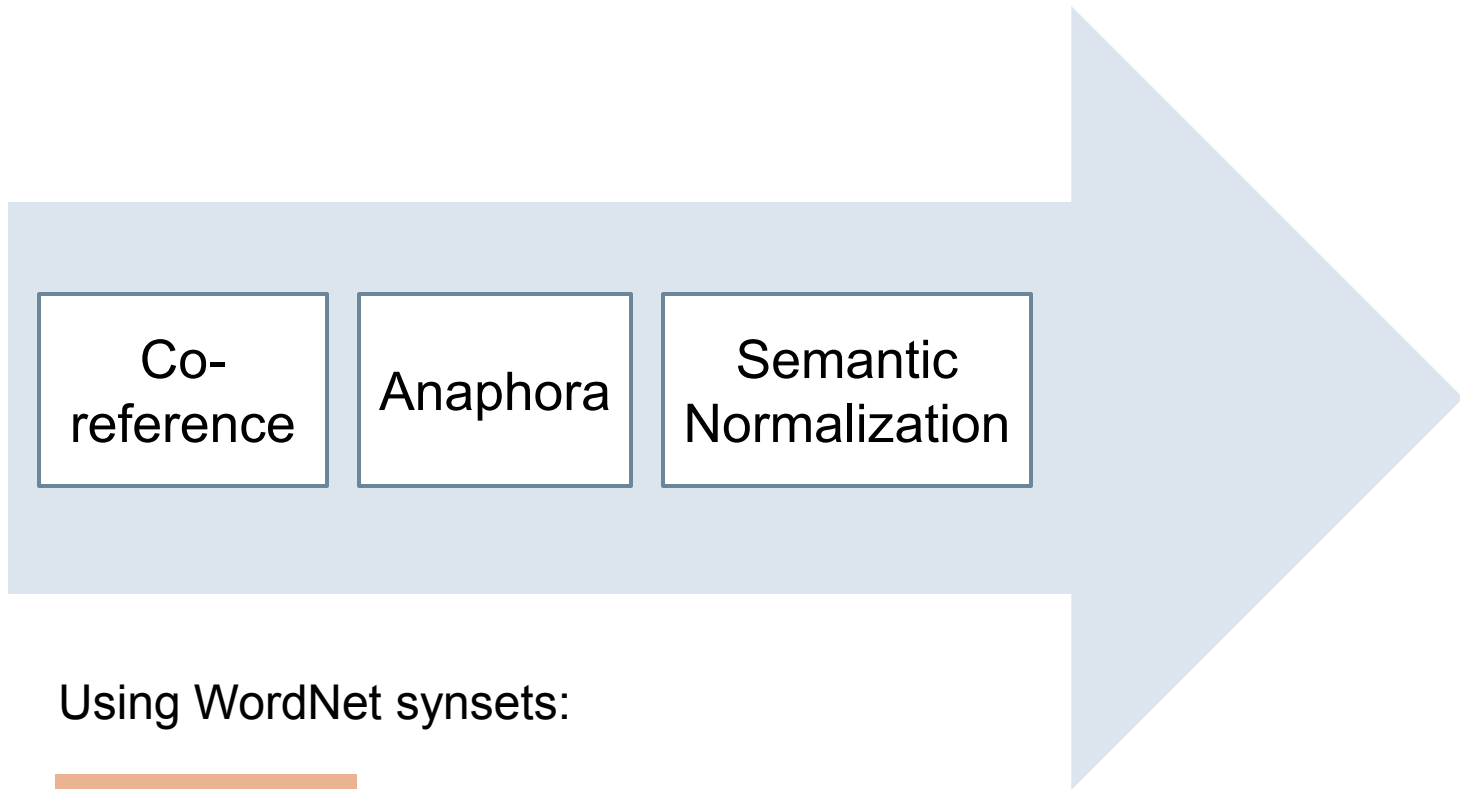


Co-
reference

Anaphora

Semantic
Normalization

Semantic Graphs

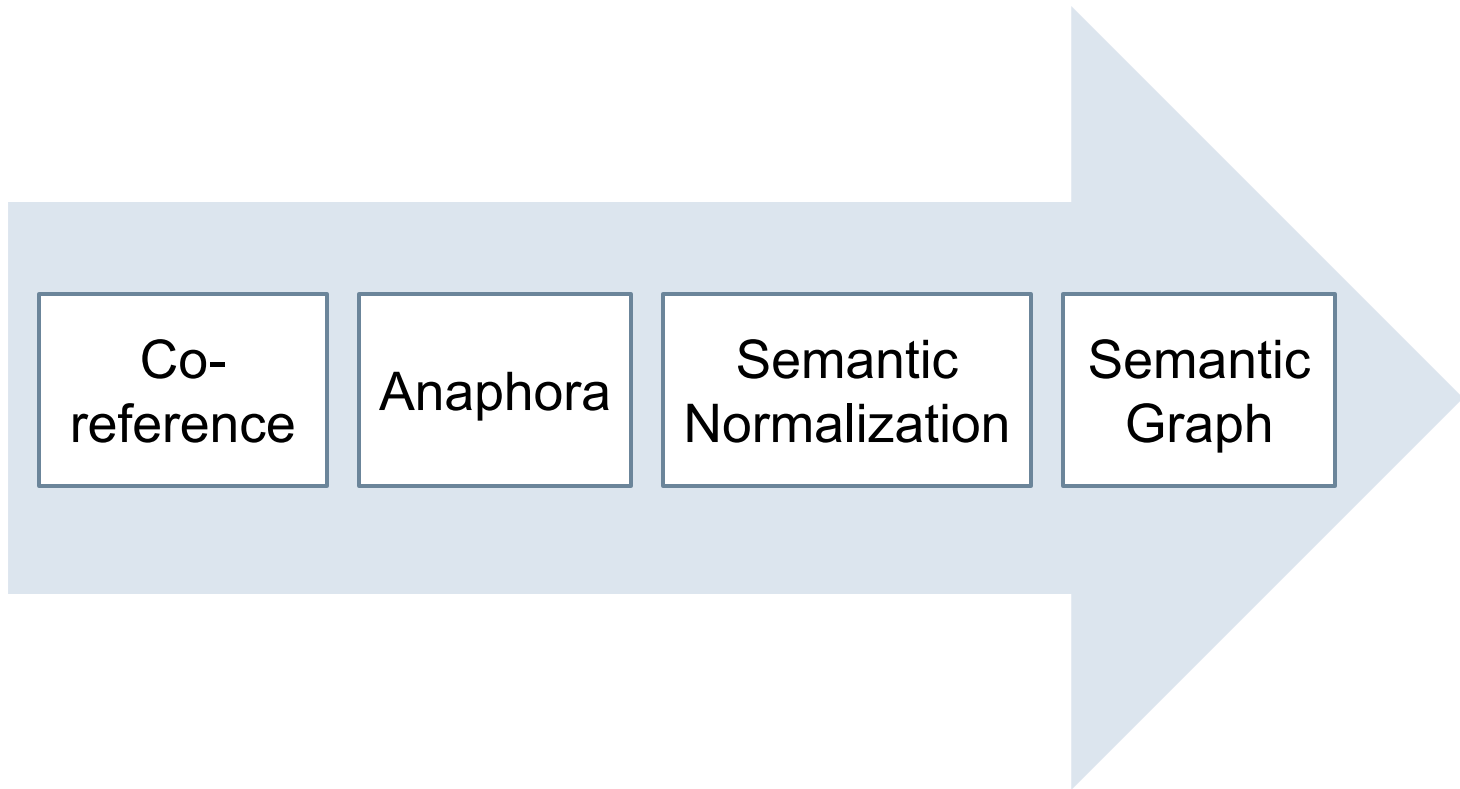


Using WordNet synsets:

sediments – assume – characteristics

Tokyo Bay – built – deposits

Semantic Graphs



Document Summarization

HOLY JETPACKS, FUSION MAN!

Swiss Man Flies With Own Wings

It's a bird, it's a plane ... it's a crazy Swiss guy with four jet engines strapped to his back flying above the Alps! A dedicated inventor has set a new record for powered personal flight.

The name he chose sounds like the title of a summer blockbuster: Fusion Man. But Swiss inventor Yves Rossy is no mutant superhero or Hollywood creation. On Wednesday, he jumped out of a plane above the Swiss town of Bex and took flight using a jetpack he created.

The five-minute flight was the first public demonstration of Rossy's one-of-a-kind device, which took him five years to create. The inventor brings years of more conventional experience to his death-defying feats. He is a former Swiss military pilot and has been a co-pilot and captain for Switzerland's two national airlines, Swissair and Swiss.

Dressed in a white flight suit, wearing a white helmet and strapped to his black device, Rossy was dropped from an airplane 2,348 meters above the Earth. He first unfolded the rigid, eight-foot wings strapped to his back, then fired up four tiny jet engines originally intended to power model aircraft.

A helicopter flew nearby to document his five minutes of glory, and an airplane followed to measure his speed. Rossy reached speeds of 300 kilometers per hour (186 miles per hour).

"The flight was excellent," Rossy told reporters gathered at the airfield where he touched down. Rossy wears a heavy, heat-resistant flying suit, similar to those worn by race car drivers and firefighters, to protect himself from the jet engines' exhaust.

Should anything go wrong, Rossy has a parachute to rely on. "I've had many 'whoops' moments," he said Wednesday. "My safety is altitude."

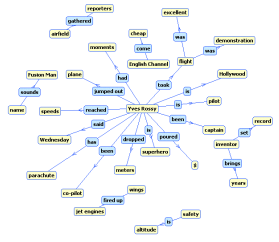
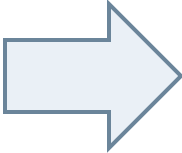
Rossy has more flights planned for the future -- including a 22-mile crossing of the English Channel that may be broadcast live on television. He would also like to fly through the Grand Canyon some day.

Jetpack hopefuls, take heart: Rossy plans to market his invention to the public in the future. It won't come cheap. Rossy and his sponsors say they've poured almost €200,000 (\$300,000) into the project so far.



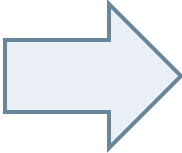
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The inventor brings years of more conventional experience to his death-defying feats. He is a former Swiss military pilot and has been a copilot and captain for Switzerland's national airline, Swire and Swissair.
Dressed in a white flight suit, wearing a white helmet and strapped to his back, Rossy was dropped from an airplane 2,348 meters above Soer. He first controlled the risk, eight-foot wings strapped to his back, then fired out four jet engines originally intended to power a turboprop aircraft.
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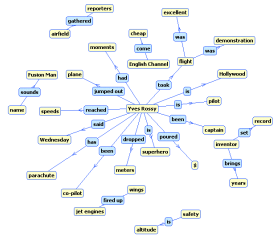


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Jetpacks, like most new inventions, are expensive. Rossy's jetpack cost him about \$300,000. He and his sponsors say they've poured almost \$200,000 (\$300,000) into the project so far.

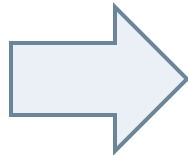
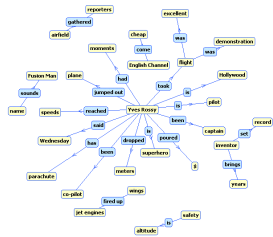


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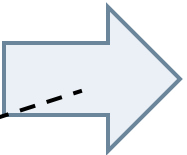


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Dressed in a white flight suit, wearing white helmet and strapped to his back, Rossy was dropped from an airplane 2,348 meters above Soer. He fell onto the right, with four wings strapped to his back, one fitted out four tiny jet engines originally intended to power a B-2 bomber.
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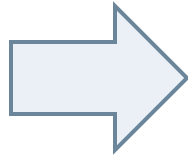
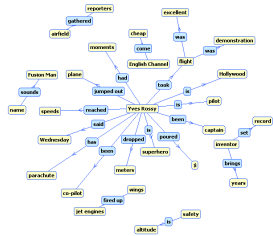
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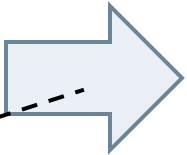
- Linguistic Attributes
- Document Attributes
- Graph Attributes

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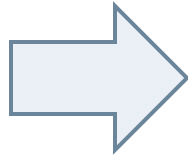
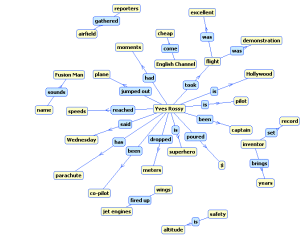


Linear SVM

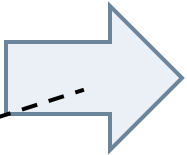
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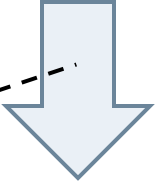
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Feature Extractor



Linear SVM

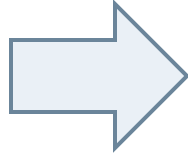
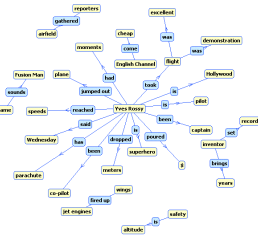


- Linguistic Attributes
- Document Attributes
- Graph Attributes

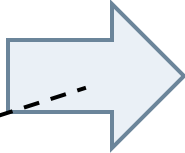
Linear Model

Document Summarization

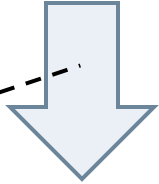
HOLY JEPHACKS, FUSSION MAN!
Swiss Man Fies With Own Wings
It's a bird. It's a plane... It's a crazy Swiss guy with four jet engines strapped to his back flying above the Alps! A dedicated inventor has set a new record for powered human flight.
The name he chose sounds like the title of a summer blockbuster: Fusion Man. But Swiss inventor Yves Rossy is no mutant superhero or Hollywood creation. On Wednesday, he jumped out of a plane above the Swiss town of Soer and took flight using a jetpack he created. The five-minute flight was the first public demonstration of Rossy's one-of-a-kind device, which took him five years to create.
The inventor brings years of more conventional experience to his death-defying feats. He is a former Swiss military pilot and has been a copilot and captain for Swissair and two regional airlines, Swissair and Swiss.
Dressed in a white flight suit, wearing white helmet and strapped to his back device, Rossy was dropped from an airplane 2,340 meters above the Soer. He first cut off the right, left foot wings strapped to his back, then fired out four tiny jet engines originally intended to power a radio aircraft.
A helicopter flew nearby to document his five minutes of glory, and an airplane followed to measure his speed. Rossy reached speeds of 300 kilometers per hour (186 miles per hour).
"The flight was excellent," Rossy told reporters gathered at the airfield where he touched down. Rossy wears a heavy, heat-resistant flying suit, similar to those worn by race car drivers and Formula 1 drivers to protect himself from the jet engine's exhaust.
Should anything go wrong, Rossy has a parachute to rely on. "I've had many 'oh-oh' moments," he said Wednesday. "My safety is absolute."
Rossy has more flights planned for the future -- including a 22-mile crossing of the English Channel that may be broadcast live on television. He would also like to fly through the Grand Canyon some day.
Jetpack hobbyist, like most, Rossy plans to patent his invention to the public in the future. It won't come cheap. Rossy and his sponsors say they've poured almost €200,000 (\$300,000) into the project so far.



Feature Extractor



Linear SVM



Rossy and his sponsors say they poured almost 200,000 (300,000) into the project so far. [12.4989]

Rossy has more flights planned for the future -- including a 22-mile crossing of the English Channel that may be broadcast live on television. [7.50326]

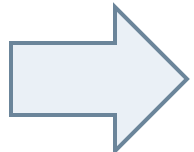
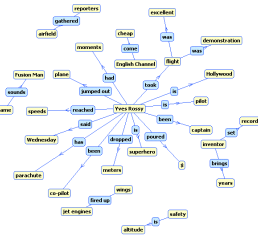
...

- Linguistic Attributes
- Document Attributes
- Graph Attributes

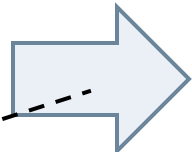
Linear Model

Document Summarization

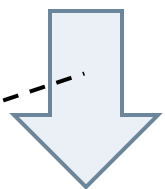
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The name he chose sounds like the title of a summer blockbuster: Fusion Man. But Swiss inventor Yves Rossy is no mutant superhero or Hollywood creation. On Wednesday, he jumped out of a plane above the Swiss town of Soer and took flight using a jetpack he created. The five-minute flight was the first public demonstration of Rossy's one-of-a-kind device, which took him five years to create.
The inventor brings years of more conventional experience to his death-defying feats. He is a former Swiss military pilot and has been a copilot and captain for Swissair and two regional airlines, Swire and Swissair.
Dressed in a white flight suit, wearing a white helmet and strapped to his back, Rossy was dropped from an airplane 2,348 meters above the Soer. He first controlled the eight jet engines strapped to his back, then fired out four tiny jet engines originally intended to power a radio aircraft.
A helicopter flew nearby to document his five minutes of glory, and an airplane followed to measure his speed. Rossy reached speeds of 300 kilometers per hour (186 miles per hour).
"The flight was excellent," Rossy told reporters gathered at the airfield where he touched down. Rossy wears a heavy, heat-resistant flying suit, similar to those worn by race car drivers and Formula 1 drivers, to protect himself from the jet engines' exhaust.
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Feature Extractor



Linear SVM



Ranking

Rossy and his sponsors say they poured almost 200,000 (300,000) into the project so far. **[12.4989]**

Rossy has more flights planned for the future -- including a 22-mile crossing of the English Channel that may be broadcast live on television. **[7.50326]**

...

- Linguistic Attributes
- Document Attributes
- Graph Attributes

Linear Model

Document Summarization

□ EXTRACTED FEATURES

Linguistic Attributes (13)

- Logical form tag
- Treebank tag
- Part of speech tag
- Depth of linguistic node
- 8 semantic tags for named entities

Document Attributes (11)

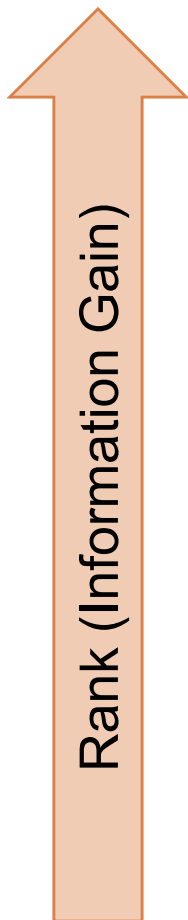
- Sentence related:
e.g. – location of sentence within doc
- Triplet related: e.g.-
frequency of triplet elem in sentence, in doc, ...

Graph Attributes (9)

- Authority and Hub weight, Page Rank
- Node degree
- Size of weakly connected component
- Size of max length chain
- Frequency of verbs among edges

Document Summarization

□ Features Ranking (Weka)



Object - Word
Subject - Word
Verb - Word
Location Of Sentence In Document
Similarity With Centroid
Number Of Locations In Sentence
Number Of Named Entities In Sentence
Authority Weight Object
Hub Weight Subject
Size Weakly Conn Comp Object

Document Summarization

Human Extracted Document Summary

Some of Mr. Thomas's opponents have warned that they intend to make him answer very explicit questions about his personal and philosophical beliefs, in order to avoid repeating the example of David Souter, "the stealth candidate."

But if Mr. Thomas does refuse to answer explicit questions, it will not be merely Mr. Souter's example he will be following -- it will be that of the justice he has been nominated to replace, Thurgood Marshall.

Thurgood Marshall's example makes it plain, though, that Mr. Thomas may refuse to give that categorical answer.

During the Marshall hearings in 1967, the issue of the day was not abortion but crime, and the most controversial case was Miranda v. Arizona.

But such personal experiences are irrelevant to the work of a justice of the Supreme Court, according to Thurgood Marshall.

"A judge is not permitted to use his own personal views under any circumstances," he said, "but if the particular decision-maker, whether he be judge or justice or magistrate, applies the Constitution to the facts and it comes out that way, that is inevitable."

Sen. Kennedy stressed a central point both in the committee room and before the full Senate: The Senate is to assess qualifications; it is not to examine political or judicial philosophy.

Automatic Document Summary

With hearings scheduled to begin today, the nomination of Judge Clarence Thomas to the U.S. Supreme Court has again raised questions concerning the responsibilities of senators and nominees during the confirmation process.

Some of Mr. Thomas's opponents have warned that they intend to make him answer very explicit questions about his personal and philosophical beliefs, in order to avoid repeating the example of David Souter, "the stealth candidate."

But if Mr. Thomas does refuse to answer explicit questions, it will not be merely Mr. Souter's example he will be following -- it will be that of the justice he has been nominated to replace, Thurgood Marshall.

During the Marshall hearings in 1967, the issue of the day was not abortion but crime, and the most controversial case was Miranda v.

But such personal experiences are irrelevant to the work of a justice of the Supreme Court, according to Thurgood Marshall.

Mr. Thomas, too, has been previously approved by the committee.

As the second black American to serve on the Supreme Court, Judge Thomas will shoulder many responsibilities; not because he is black, but because he will hold a lofty office.

Overview

- Introduction
- System Pipeline
- **System Evaluation**
 - **Gender Retrieval**
 - **Co-reference Resolution**
 - **Anaphora Resolution**
 - **Summary Generation**
- Conclusions

Gender Retrieval Evaluation

	Masculine	Feminine	Total
System	170/206 (83%)	7/14 (50%)	177/220 (80%)
Baseline	206/206 (100%)	0/14 (0%)	206/220 (94%)

- 15 random documents taken from Reuters RCV1 data set were manually annotated

System – the system we implemented

Baseline – assigns the most frequent gender (masculine) to all named entities labeled as persons

Co-reference Resolution Evaluation

	Co-References
System	750/783 (96%)
GATE	646/783 (83%)

- 15 random documents taken from Reuters RCV1 data set were manually annotated

System – the system we implemented

GATE – the co-reference resolver implemented within the GATE system

Anaphora Resolution Evaluation

- 77 random documents taken from Reuters RCV1 data set were manually annotated
- **System** – the system we implemented
- **Baseline Gender** – takes the closest named entity as a pronoun replacement, having gender information into account
- **Baseline No Gender** – takes the closest named entity as a pronoun replacement, but no gender information is considered

Anaphora Resolution Evaluation

Pronouns	System	Baseline-gender	Baseline-no gender
He	35/42 (83%)	18/42 (43%)	18/42 (43%)
They	7/20 (35%)	8/20 (40%)	2/20 (10%)
I	4/15 (27%)	0/15 (0%)	2/15 (13%)
She	0/0	0/0	0/0
Who	0/0	0/0	0/0
It	11/35 (31%)	11/35 (31%)	11/35 (31%)
Other	2/4 (50%)	2/6 (33%)	3/6 (50%)
Total	59/116 (51%)	39/118 (33%)	36/118 (31%)

Summary Generation Evaluation

- **Document Understanding Conference (DUC) 2002 and 2007 data sets**
- **DUC 2002 task**
 - ▣ automatic summarization of a single newswire/newspaper article
- **DUC 2007 task**
 - ▣ update task – produce short (~100 words) multi-document update summaries of newswire articles
 - ▣ 10 topics (A-J), each divided in 3 clusters (A-C); each cluster with 7-10 articles
 - ▣ Our aim:
 - **A summary of documents in cluster A**
 - ▣ Training data: DUC 2002 & DUC 2007 main task

Summary Generation Evaluation

DUC 2002 Task

Our System Results

Test Set

Documents	Precision	Recall	F1
100	31,25%	71,49%	43,43%

J. Leskovec et al.'s system results

Test Set

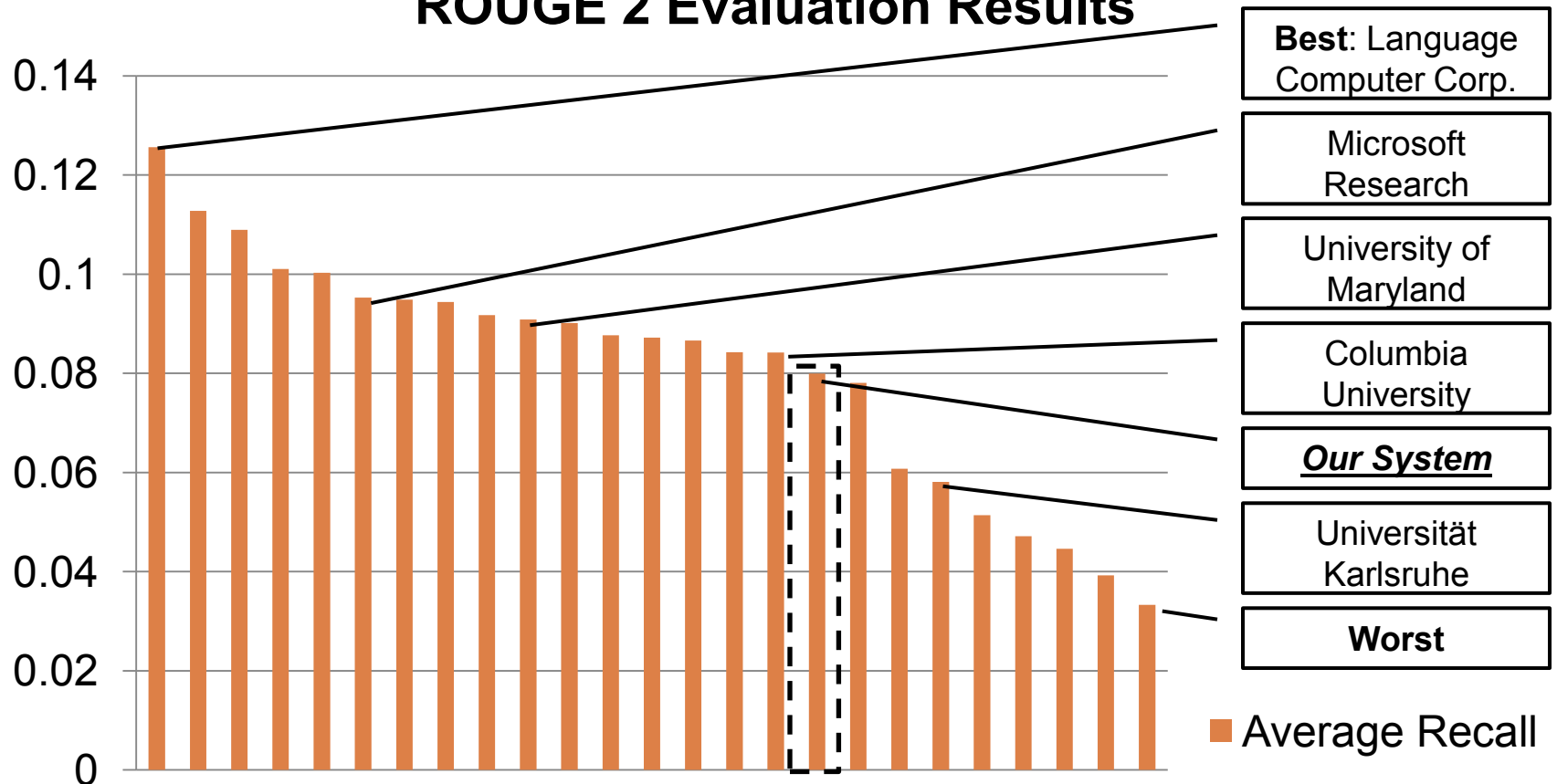
Documents	Precision	Recall	F1
100	26,25%	73,22%	38,64%

- Ten-fold cross validation results comparison between the two systems:
- the system proposed in the paper
 - J. Leskovec et al.'s system presented at LinkKDD 2004 (Workshop on Link Analysis and Group Detection)

Summary Generation Evaluation

DUC 2007 Update Task

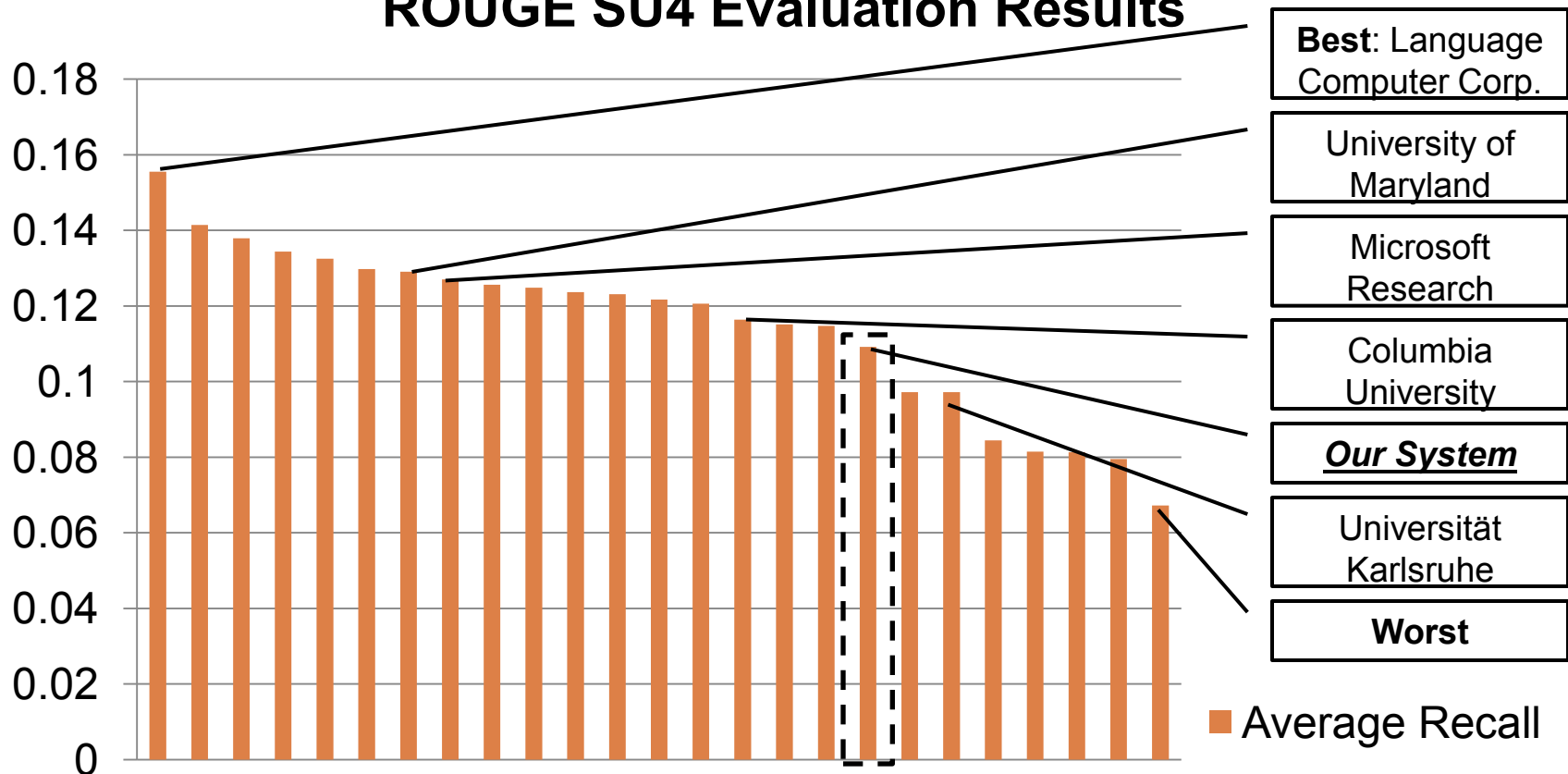
ROUGE 2 Evaluation Results



Summary Generation Evaluation

DUC 2007 Update Task

ROUGE SU4 Evaluation Results

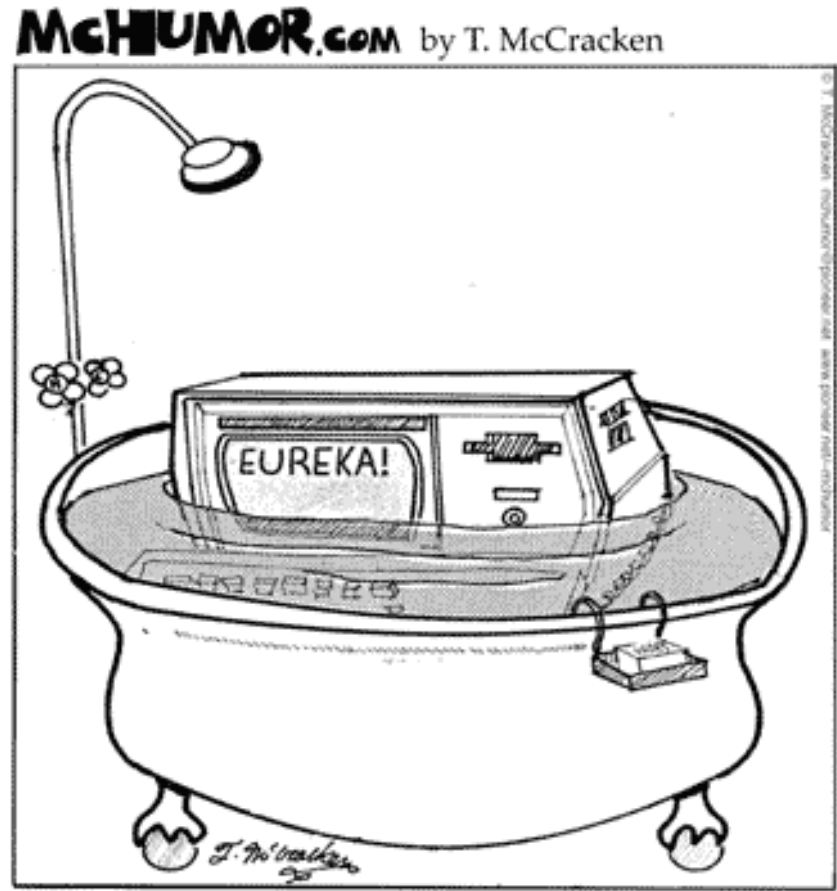


Conclusions

- **Semantic graph** representation of documents
- **Automatic document summary** obtained by sentence extraction
- Future work
 - ▣ system integration
 - online newswire crawler
 - complex ontology

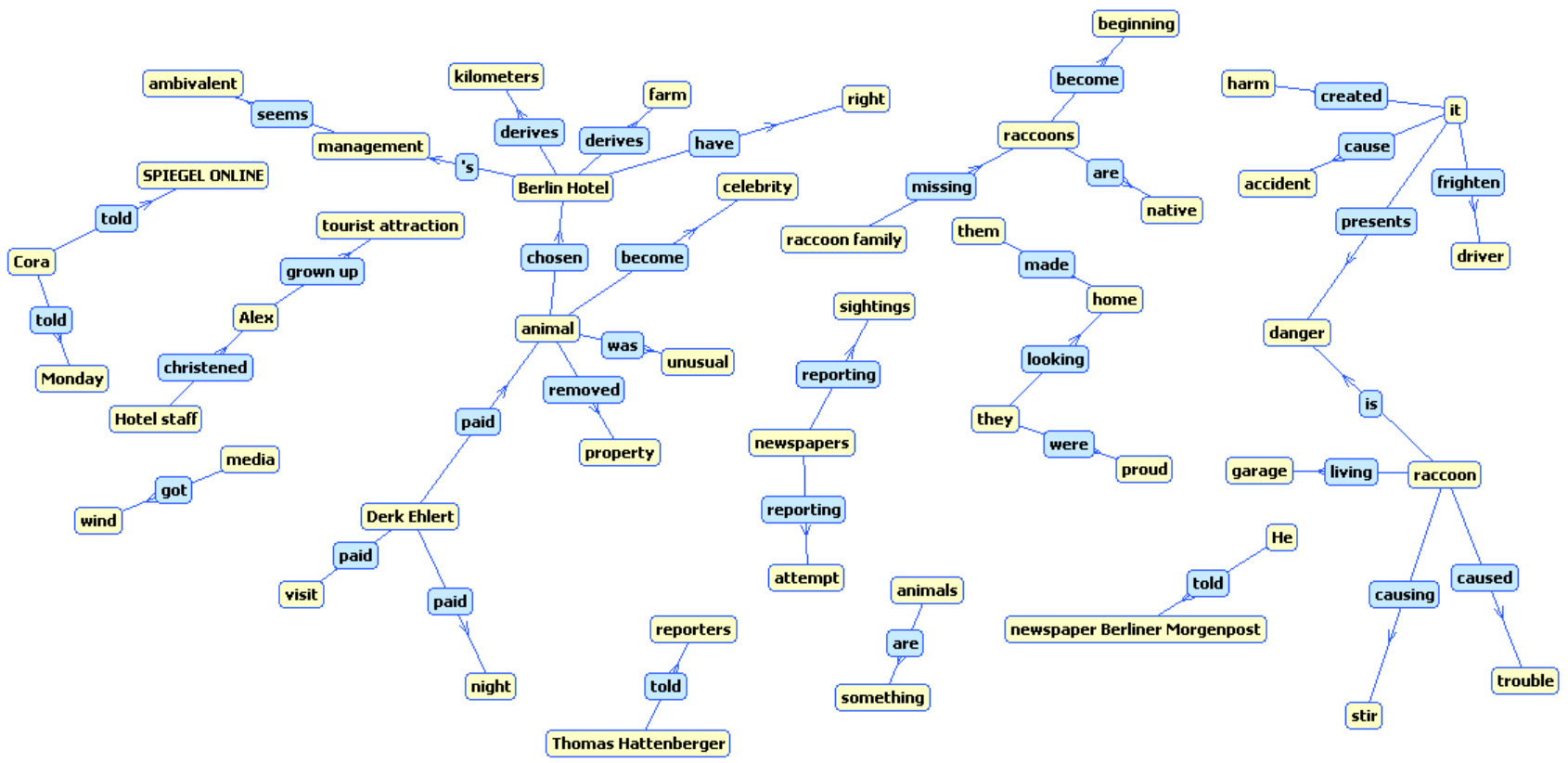
Q & A

Thank you for your attention !



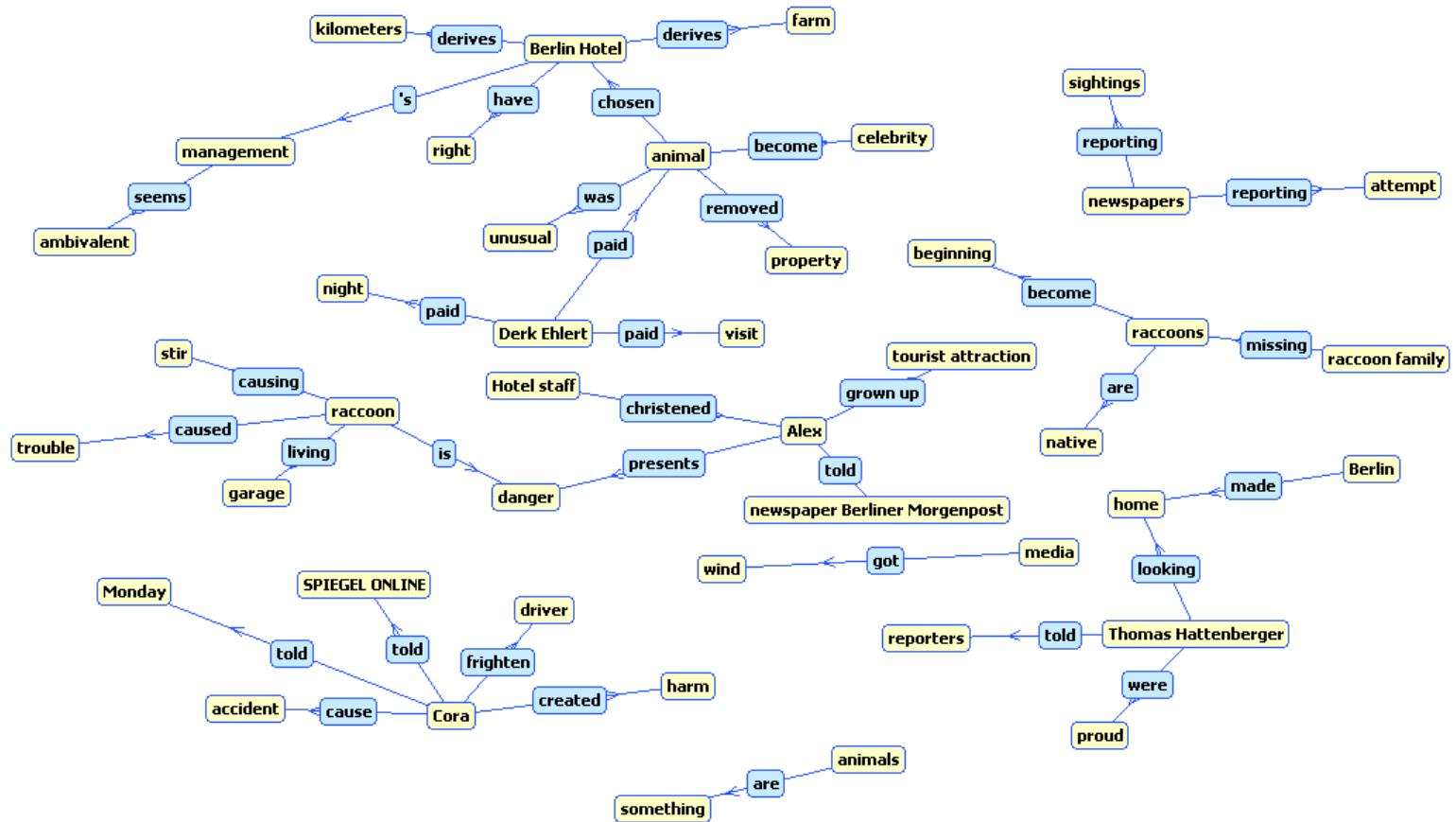
Great Moment #193 in Computer Science.

Applying Co-reference Resolution



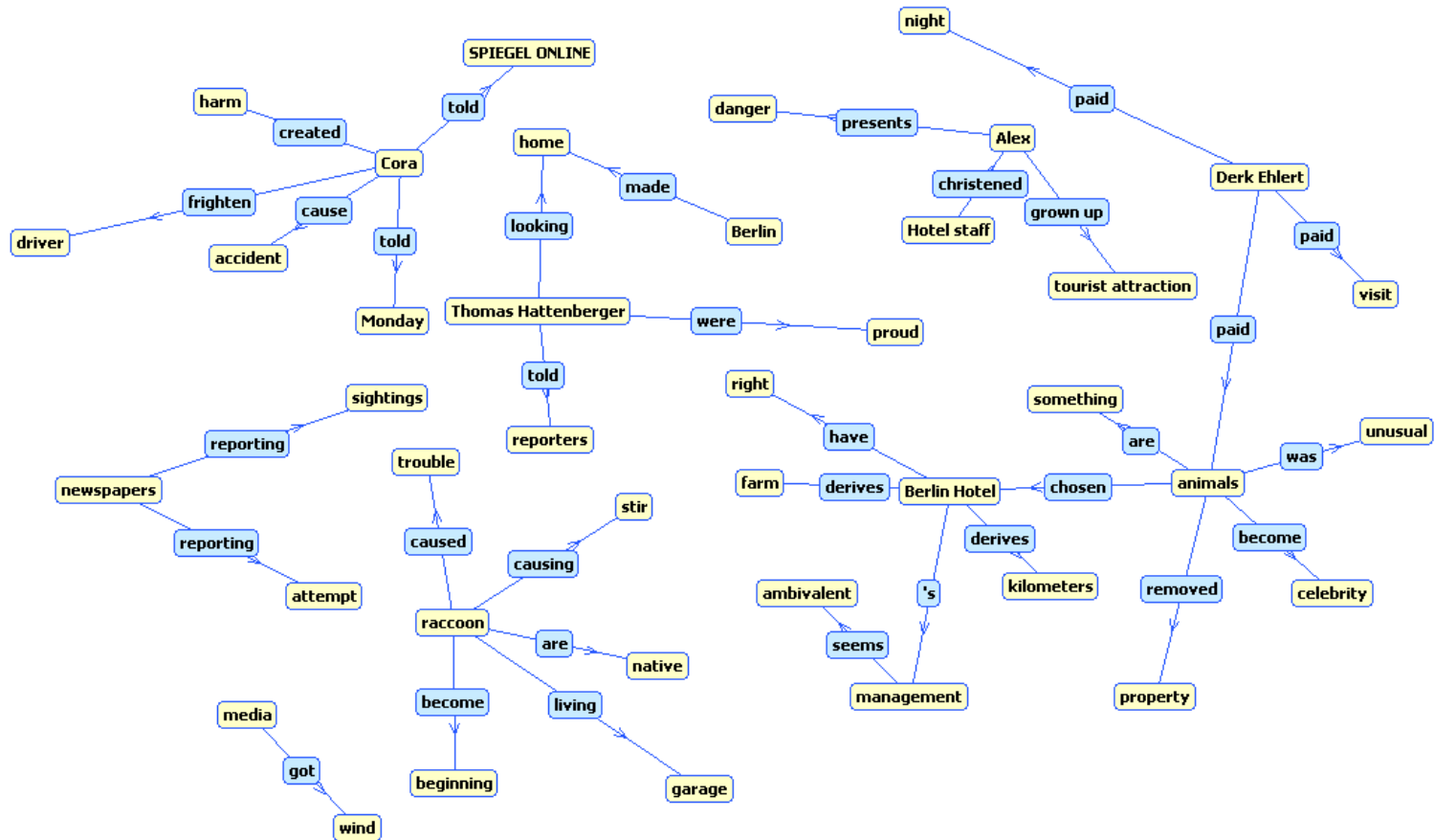
-> Graph with 46 nodes, 35 edges

Applying Anaphora Resolution



-> Graph with 43 nodes, 35 edges

Applying Semantic Normalization



-> Graph with 39 nodes, 33 edges