Natural Language Processing

Class 7: Classification Tasks

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1. Information Extraction
2. Relation Extraction
3. Coreference Resolution
4. Semantic Role Labeling
5. Logical Entailment
6. Argumentation Mining

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Information Extraction

- Information extraction (IE) turns the unstructured information embedded in texts into structured data,
- You're given the task of determining the relationship (if any) between airline announcements of fare increases and the behavior of their stocks the next day. How can we extract the relevant data from the following article?

> Citing high fuel prices, United Airlines said Friday it has increased fares by $6 per round trip on flights to some cities also served by lower-cost carriers. American Airlines, a unit of AMR Corp., immediately matched the move, spokesman Tim Wagner said. United, a unit of UAL Corp., said the increase took effect Thursday and applies to most routes where it competes against discount carriers, such as Chicago to Dallas and Denver to San Francisco.

Information Extraction

- **Relation extraction**: finding and classifying semantic relation extraction relations among entities mentioned in a text, like child-of (X is the child-of Y), or part-whole or geospatial relations.
- **Event extraction**: the task of finding events in which these event extraction entities participate; for example, in our sample text, the fare increases by United and American and the reporting events *said* and *cite*.
- **Template filling**: find recurring stereotypical events or situations in documents and fill in the template slots. These slot-fillers may consist of text segments extracted directly from the text, or concepts like times, amounts, or ontology entities that have been inferred through additional processing.

Information Extraction

FARE-RAISE ATTEMPT:	LEAD AIRLINE:	UNITED AIRLINES
	AMOUNT:	$6
	EFFECTIVE DATE:	2006-10-26
	FOLLOWER:	AMERICAN AIRLINES

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Relation Extraction

- **Relation extraction**: Finding and classifying semantic relation extraction relations among entities mentioned in a text, like child-of (X is the child-of Y), or part-whole or geospatial relations.
- Lets assume that we have detected the named entities in our sample text and would like to discern the relationships that exist among the detected entities:

> Citing high fuel prices, [ORG **United Airlines**] said [TIME **Friday**] it has increased fares by [MONEY **$6**] per round trip on flights to some cities also served by lower-cost carriers. [ORG **American Airlines**], a unit of [ORG **AMR Corp.**], immediately matched the move, spokesman [PER **Tim Wagner**] said. [ORG **United**], a unit of [ORG **UAL Corp.**], said the increase took effect [TIME **Thursday**] and applies to most routes where it competes against discount carriers, such as [LOC **Chicago**] to [LOC **Dallas**] and [LOC **Denver**] to [LOC **San Francisco**].

Relation Extraction

- The text tells us, for example, that *Tim Wagner* is a spokesman for *American Airlines*, that *United* is a unit of *UAL Corp.*, and that *American* is a unit of *AMR*. These binary relations are instances of more generic relations such as part-of or employs that are fairly frequent in news-style texts.
- **Ontologies** are databases that encode these relations relations

Relations	Types	Examples
Physical-Located	PER-GPE	**He** was in **Tennessee**
Part-Whole-Subsidiary	ORG-ORG	**XYZ**, the parent company of **ABC**
Person-Social-Family	PER-PER	**Yoko**'s husband **John**
Org-AFF-Founder	PER-ORG	**Steve Jobs**, co-founder of **Apple**...

Relation Extraction

- The UMLS (Unified Medical Language System) is one of the more famous ontologies.
- 134 broad subject categories, entity types, and 54 relations between the entities

Entity	Relation	Entity
Injury	disrupts	Physiological Function
Bodily Location	location-of	Biologic Function
Anatomical Structure	part-of	Organism
Pharmacologic Substance	causes	Pathological Function
Pharmacologic Substance	treats	Pathologic Function

- Given a medical sentence like this one:

  Doppler echocardiography can be used to diagnose left anterior descending artery stenosis in patients with type 2 diabetes

  we could thus extract the UMLS relation: **Echocardiography, Doppler** Diagnoses **Acquired stenosis**

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Coreference Resolution

important component of language processing is knowing who is being talked about in a text. Consider the following passage:

> Victoria Chen, CFO of Megabucks Banking, saw her pay jump to $2.3 million, as the 38-year-old became the company's president. It is widely known that she came to Megabucks from rival Lotsabucks.

- Each of the underlined phrases in this passage is used by the writer to refer to a person named *Victoria Chen*. We call linguistic expressions like *her* or *Victoria Chen* **mentions** or referring expressions, and the discourse entity that is referred referent to (Victoria Chen) the **referent**.
- Two or more referring expressions that are used to refer to the same discourse entity are said to **corefer**; thus, *Victoria Chen* and *she* corefer

Coreference Resolution

A dialogue system that has just told the user “There is a 2pm flight on United and a 4pm one on Cathay Pacific” must know which flight the user means by Ill take the **second one**.

- A question answering system that uses Wikipedia to answer a question about Marie Curie must know who **she** was in the sentence “She was born in Warsaw.”

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Semantic Role Labeling

- Consider the meanings of the arguments *Sasha, Pat, the window,* and *the door* in these two sentences.
  - Sasha broke the window.
  - Pat opened the door.

  The subjects *Sasha* and *Pat*, what we might call the breaker of the window-breaking event and the opener of the door-opening event, have something in common. They are both volitional actors, often animate, and they have direct causal responsibility for their events.

Semantic Role Labeling

- **Thematic roles** are a way to capture this semantic commonality between breakers and openers. We say that the subjects of both these verbs are **agents**. Thus, **AGENT** is the thematic role that represents an abstract idea such as volitional causation.
- Similarly, the direct objects of both these verbs, the **BrokenThing** and **OpenedThing**, are both prototypically inanimate objects that are affected in some way by the action. The semantic role for these participants is theme.

Thematic Role	Definition
AGENT	The volitional causer of an event
EXPERIENCER	The experiencer of an event
FORCE	The non-volitional causer of the event
THEME	The participant most directly affected by an event
RESULT	The end product of an event
CONTENT	The proposition or content of a propositional event
INSTRUMENT	An instrument used in an event
BENEFICIARY	The beneficiary of an event
SOURCE	The origin of the object of a transfer event
GOAL	The destination of an object of a transfer event

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Logical Entailment

- Also known as **Natural Language Inference (NLI)** or **Recognizing Textual Entailment (RTE)**.
- It is the task of determining the semantic relationship between two text segments: a **Premise (P)** and a **Hypothesis (H)**.
- The goal is to classify the relationship into one of three categories:
  1. **Entailment** ($\mathbf{P} \Rightarrow \mathbf{H}$): If the premise is true, the hypothesis must also be true.
  2. **Contradiction** ($\mathbf{P} \Rightarrow \neg\mathbf{H}$): If the premise is true, the hypothesis must be false.
  3. **Neutral**: The premise neither guarantees the truth nor the falsehood of the hypothesis.

Logical Entailment

Definition: Entailment

The truth of the Premise **P guarantees** the truth of the Hypothesis **H**.

Example 1: Lexical Hypernymy

P: A Labrador is fetching a ball.
H: A **dog** is fetching a ball.
Relationship:

Example 2: Syntactic Variation

P: The company was acquired by a rival firm last month.
H: A rival firm acquired the company last month.
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Example 2: Syntactic Variation

P: The company was acquired by a rival firm last month.
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Relationship: Entailment (Same meaning via **Active/Passive** transformation).

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Example 1: Explicit Negation

P: All students passed the final exam.
H: **No** students passed the final exam.
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Example 2: World Knowledge/Semantic Conflict

P: A person is swimming in the ocean.
H: The person is **completely dry**.
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Relationship: Contradiction (Swimming implies getting wet; this is **common sense reasoning**).

Logical Entailment

Definition: Neutral

The Premise **P neither confirms nor refutes** the Hypothesis **H**.

Example 1: Additional Information/Unrelated

P: The concert was well attended.
H: The lead singer wore a blue shirt.
Relationship:

Example 2: Possibility vs. Necessity

P: John saw a dog.
H: John saw a Golden Retriever.
Relationship:

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P: John saw a dog.
H: John saw a Golden Retriever.
Relationship: Neutral (It could be a Golden Retriever, but P doesn't guarantee it; it could be any dog).

Logical Entailment

- **Fundamental Task**: Serves as a benchmark for general **Natural Language Understanding (NLU)**.
- **Question Answering (QA)**:
  - Used to verify if a candidate answer entails the question (when rephrased as a declarative statement).
- **Summarization**:
  - Used to ensure that sentences in the summary are entailed by the source document (i.e., maintaining factual consistency).
- **Fact Checking/Verification**:
  - Check if a claim (Hypothesis) is entailed or contradicted by a piece of evidence (Premise).

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6 Argumentation Mining

What is Argumentation Mining (AM)?

- **Definition**: An NLP subfield focused on the automatic identification and extraction of argumentative structures from natural language text.
- **Goal**: To transform unstructured text (e.g., essays, debates, reviews) into a structured, machine-readable argument graph.
- It goes beyond simple sentiment analysis to understand **why** a person holds a certain opinion.

The Importance of AM

- **NLU Benchmark**: A major step towards true Natural Language Understanding (NLU), as human communication is often argumentative.
- **Decision Making**: Provides structured input for systems that aggregate and compare arguments (e.g., policy support).
- **Critical Thinking**: Used in educational settings to assess and provide feedback on students' argumentation skills.

The Argumentation Mining Pipeline (Subtasks)

Argumentation Mining is typically broken down into four sequential subtasks:

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   - Determining which components are linked (e.g., P and C).
4. **Argumentative Relation Classification (ARC)**
   - Classifying the type of relationship (Support or Attack/Rebuttal).

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Warrant (Toulmin Model) The (often implicit) general rule or principle that connects the Premise to the Claim.

- *Example*: *(Implicit)* "We should ban activities that cause serious health risks to the public."

A Complete Argument Example

Text Snippet

The voting age should be lowered to 16.

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The voting age should be lowered to 16. Teenagers can legally work and pay taxes, so they are active participants in the economy. Furthermore, many 16-year-olds are already educated in civics, making them informed voters.

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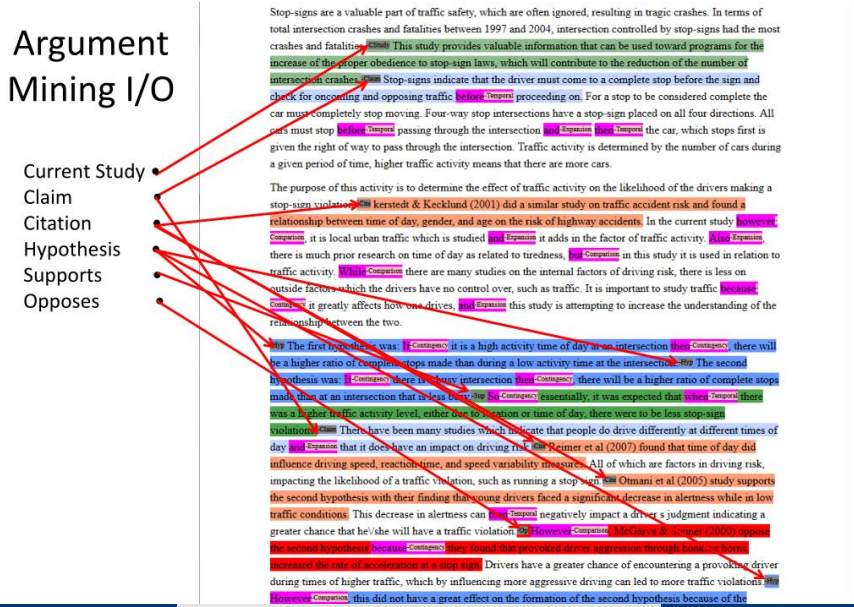
The voting age should be lowered to 16. Teenagers can legally work and pay taxes, so they are active participants in the economy. Furthermore, many 16-year-olds are already educated in civics, making them informed voters. However, some argue that **lowering the age would increase voter volatility** because **young people lack life experience**.

- **Main Claim (C)**: The voting age should be lowered to 16.
- **Premise 1 (P_1)**: Teenagers can legally work and pay taxes...
- **Premise 2 (P_2)**: Many 16-year-olds are already educated in civics...
- **Counter-Claim (C')**: lowering the age would increase voter volatility.
- **Counter-Premise (P')**: young people lack life experience.

Argument Mining I/O

- Current Study
- Claim
- Citation
- Hypothesis
- Supports
- Opposes



Stop-signs are a valuable part of traffic safety, which are often ignored, resulting in tragic crashes. In terms of total intersection crashes and fatalities between 1997 and 2004, intersection controlled by stop-signs had the most crashes and fatalities. Result This study provides valuable information that can be used toward programs for the increase of the proper obedience to stop-sign laws, which will contribute to the reduction of the number of intersection crashes. Claim Stop-signs indicate that the driver must come to a complete stop before the sign and check for oncoming and opposing traffic before Temporal proceeding on. For a stop to be considered complete the car must completely stop moving. Four-way stop intersections have a stop-sign placed on all four directions. All cars must stop before Temporal passing through the intersection and Expansion then Temporal the car, which stops first is given the right of way to pass through the intersection. Traffic activity is determined by the number of cars during a given period of time, higher traffic activity means that there are more cars.

The purpose of this activity is to determine the effect of traffic activity on the likelihood of the drivers making a stop-sign violation. Cite kerstedt & Kecklund (2001) did a similar study on traffic accident risk and found a relationship between time of day, gender, and age on the risk of highway accidents. In the current study however Comparison, it is local urban traffic which is studied and Expansion it adds in the factor of traffic activity. Also Expansion, there is much prior research on time of day as related to tiredness, but Comparison in this study it is used in relation to traffic activity. While Comparison there are many studies on the internal factors of driving risk, there is less on outside factors which the drivers have no control over, such as traffic. It is important to study traffic because Contingency it greatly affects how one drives, and Expansion this study is attempting to increase the understanding of the relationship between the two.

Hyp The first hypothesis was: H-Contingency if it is a high activity time of day at an intersection then Contingency, there will be a higher ratio of complete stops made than during a low activity time at the intersection. Hyp The second hypothesis was: H-Contingency there is a busy intersection then Contingency, there will be a higher ratio of complete stops made, than at an intersection that is less busy. Hyp So Contingency essentially, it was expected that when Temporal there was a higher traffic activity level, either due to location or time of day, there were to be less stop-sign violations. Claim There have been many studies which indicate that people do drive differently at different times of day and Expansion that it does have an impact on driving risk. Cite Reimer et al (2007) found that time of day did influence driving speed, reaction time, and speed variability measures. All of which are factors in driving risk, impacting the likelihood of a traffic violation, such as running a stop sign. Cite Otmani et al (2005) study supports the second hypothesis with their finding that young drivers faced a significant decrease in alertness while in low traffic conditions. This decrease in alertness can then Temporal negatively impact a driver's judgment indicating a greater chance that he\/she will have a traffic violation. Hyp However Comparison, McGarva & Steiner (2000) oppose the second hypothesis because Contingency they found that provoked driver aggression through honking, brake increased the rate of acceleration at a stop sign. Drivers have a greater chance of encountering a provoking driver during times of higher traffic, which by influencing more aggressive driving can led to more traffic violations. Hyp However Comparison, this did not have a great effect on the formation of the second hypothesis because of the

Next class: October 28

Sequence Modeling Tasks

Reading

- Jurafsky & Martin Chapter 18:Context-Free Grammars and Constituency Parsing
- Jurafsky & Martin Chapter 24: Discourse Coherence
- Jurafsky & Martin Chapter 21: Semantic Role Labeling