A Cascade Model for Proposition Extraction in Argumentation

Yohan Jo[1], Jacky Visser[2], Chris Reed[2], Eduard Hovy[1]

[1]Language Technologies Institute, Carnegie Mellon University
[2]Centre for Argument Technology, University of Dundee

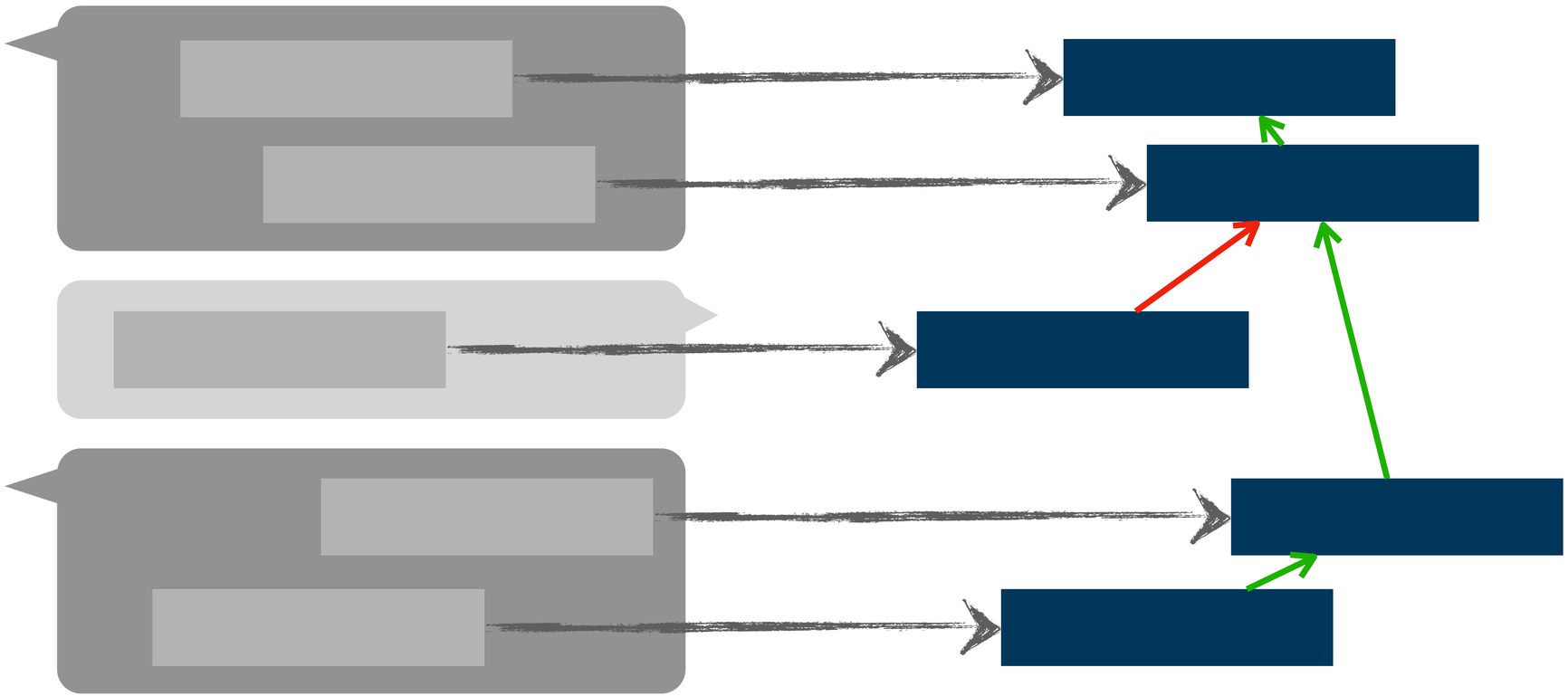
6th Workshop on Argument Mining
August 1, 2019

Argumentation Mining

Argumentative Dialogue/Monologue

Proposition Extraction

Argument Structure Identification



~~Proposition Extraction~~
Argumentative Discourse Unit (ADU) Segmentation

- Original text is **segmented** into ADUs
- Argumentative structure as relations between the ADUs

Prior Work

- Definitions of ADU boundaries
  Stab and Gurevych, 2014; Stede et al., 2016; Peldszus and Stede, 2015; Al-Khatib et al., 2016
- Methods for auto-segmentation
  Eger et al., 2017; Ajjour et al., 2017; Persing and Ng, 2016

Limitations of Segmentation-based ADUs

- ADUs may lack important semantic information
  - Referents of anaphors

(A) ***She** (Alice) complained to **me** (Bob).*

(B) ***Bob** is upset.*

  - Subject of a phrase

(A) ***Alice knows Bob well*** *but* **(B)** ***kept** the secret.*

(C) ***Bob should appreciate that.***

Limitations of Segmentation-based ADUs

- ADUs may completely miss implicit propositions
  - Reported speech

(A) ***The doctor said we need more magnesium.***

  - Questions

(A) ***Why would you spend your valuable money on tax?***

(B) ***Tax is a waste for nothing.***

  - Imperatives

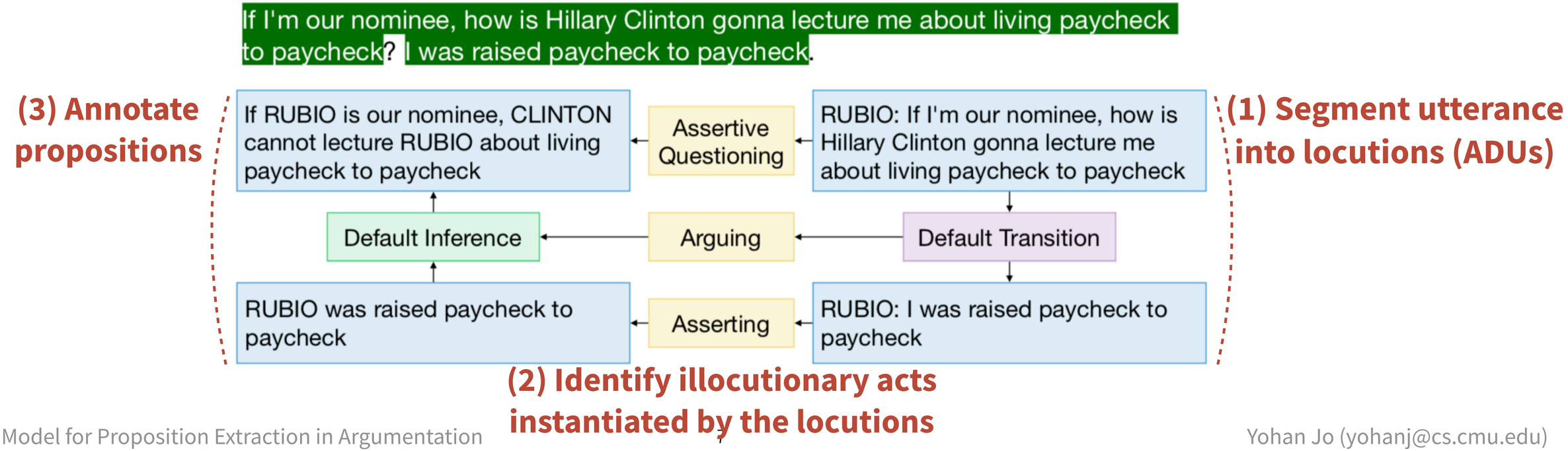
(A) ***Don't spend your valuable money on tax.***

(B) ***Tax is a waste for nothing.***

- What **NLP challenges** are there to obtain **complete propositions**?
- Can we get **semantically improved propositions** using standard NLP techniques?

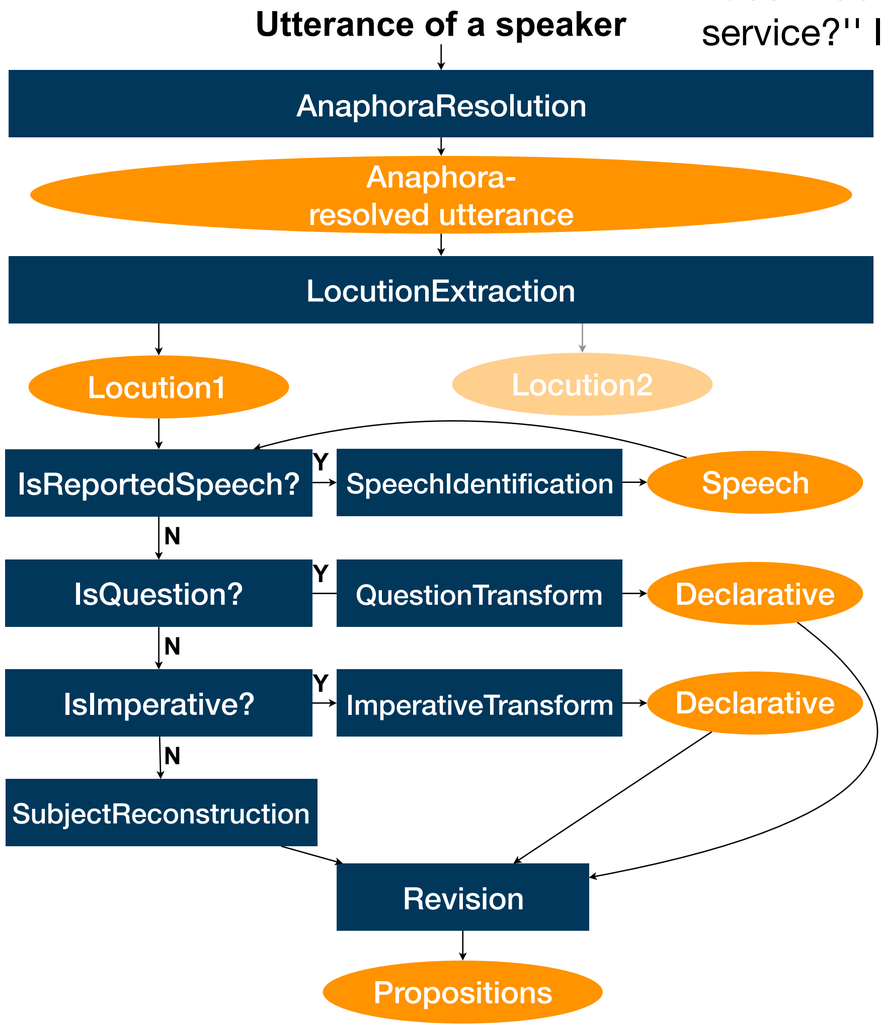
Data

- 2016 U.S. presidential debates (Visser et al., 2019)
  - Inference Anchoring Theory (Reed and Budzynska, 2011)
  - 8,008 locutions (278 reported speech, 565 questions)
  - Cohen's kappa: 0.610

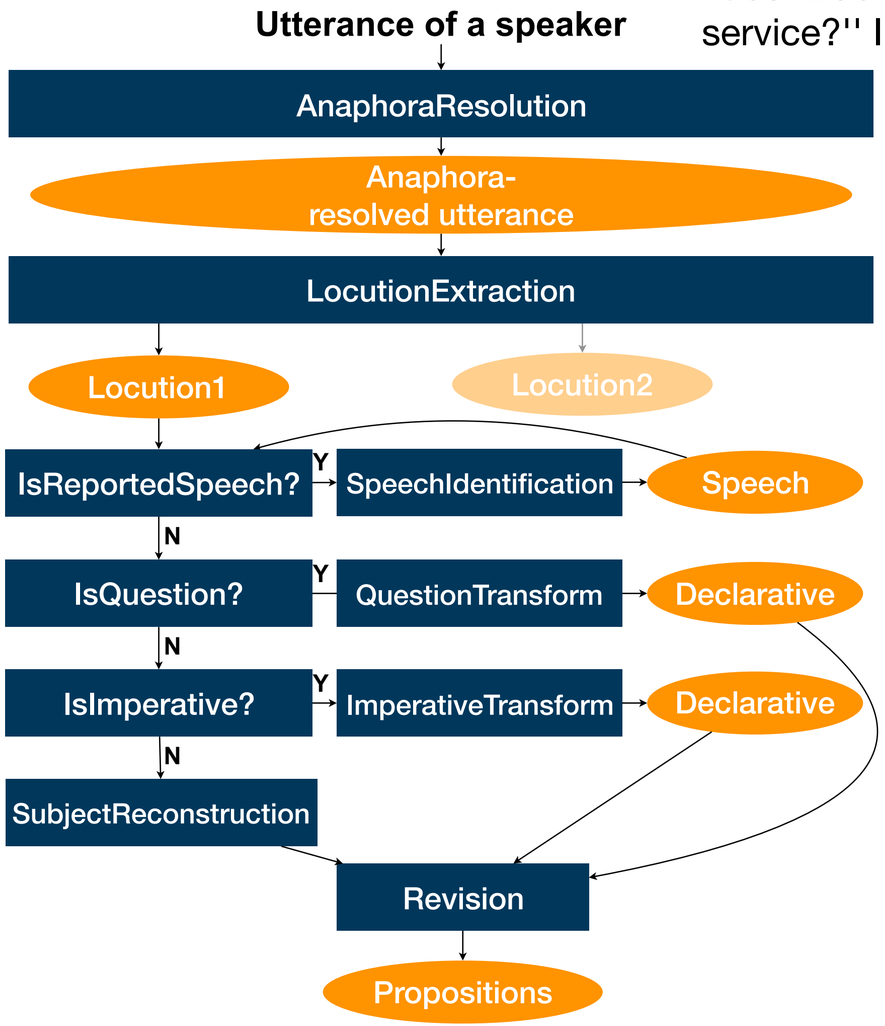


A Cascade Model for Proposition Extraction

Alice: Bob stopped by my office and complained, ``Why is the company not launching the new service?'' I think I have explained to him already.



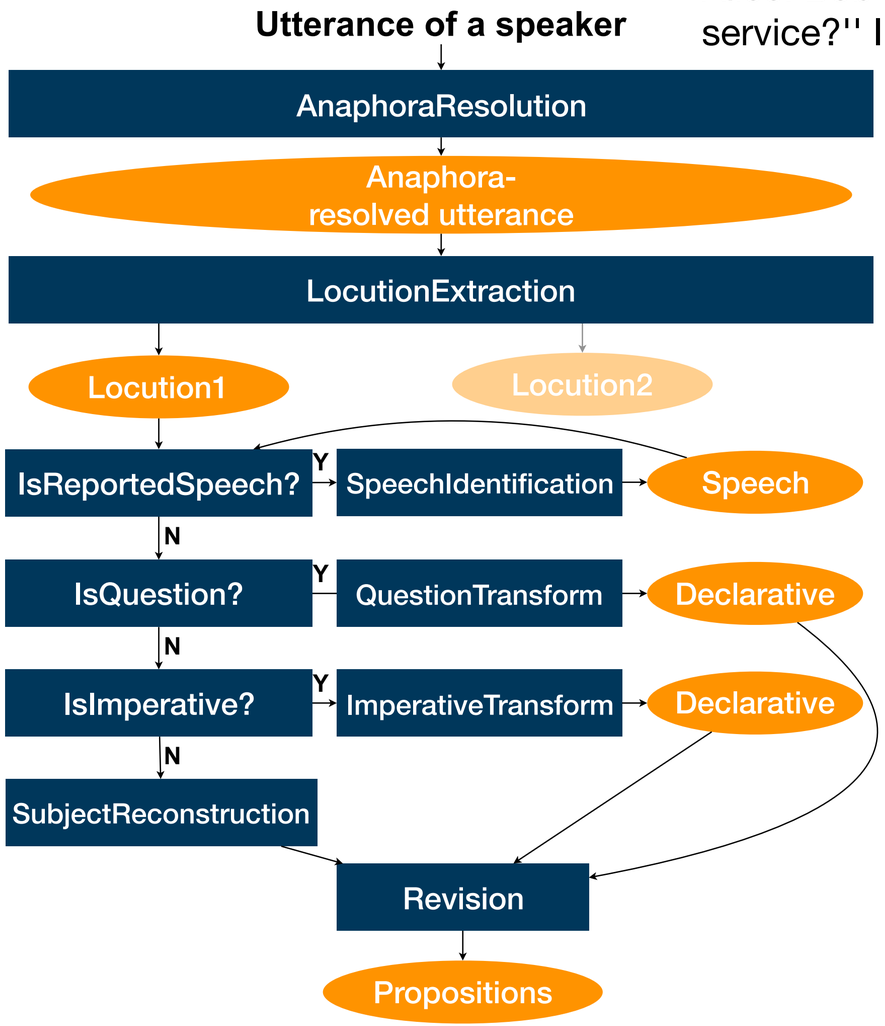
A Cascade Model for Proposition Extraction



Alice: Bob stopped by my office and complained, ``Why is the company not launching the new service?'' I think I have explained to him already.

Bob stopped by **Alice's** office and complained, ``Why is the company not launching the new service?'' **Alice** think **Alice** have explained to **Bob** already.

A Cascade Model for Proposition Extraction

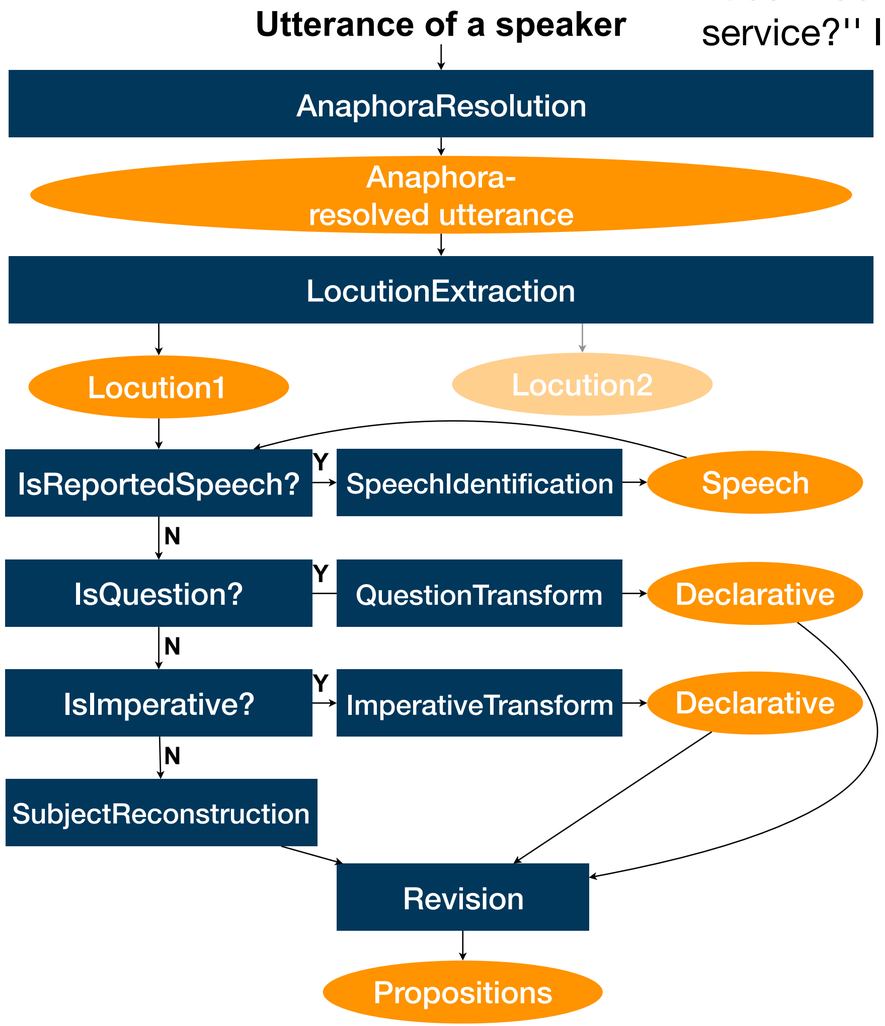


Alice: Bob stopped by my office and complained, ``Why is the company not launching the new service?'' I think I have explained to him already.

Bob stopped by **Alice's** office and complained, ``Why is the company not launching the new service?'' **Alice** think **Alice** have explained to **Bob** already.

[L1] Bob stopped by Alice's office and **[L2] complained, ``Why is the company not launching the new service?''** Alice think **[L3] Alice have explained to Bob already.**

A Cascade Model for Proposition Extraction



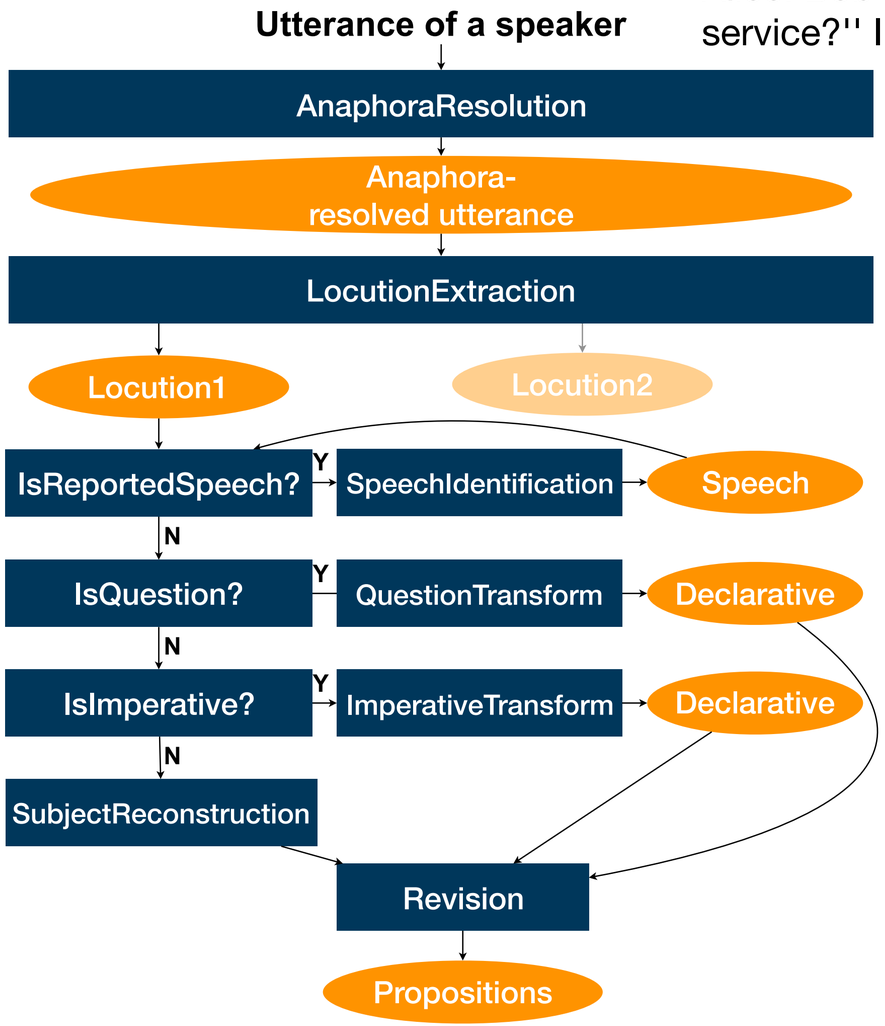
Alice: Bob stopped by my office and complained, ``Why is the company not launching the new service?'' I think I have explained to him already.

Bob stopped by **Alice's** office and complained, ``Why is the company not launching the new service?'' **Alice** think **Alice** have explained to **Bob** already.

[L1] Bob stopped by Alice's office and **[L2] complained, ``Why is the company not launching the new service?''** Alice think **[L3] Alice have explained to Bob already.**

[L2] complained, ``**[L2'] Why is the company not launching the new service?**''

A Cascade Model for Proposition Extraction



Alice: Bob stopped by my office and complained, ``Why is the company not launching the new service?'' I think I have explained to him already.

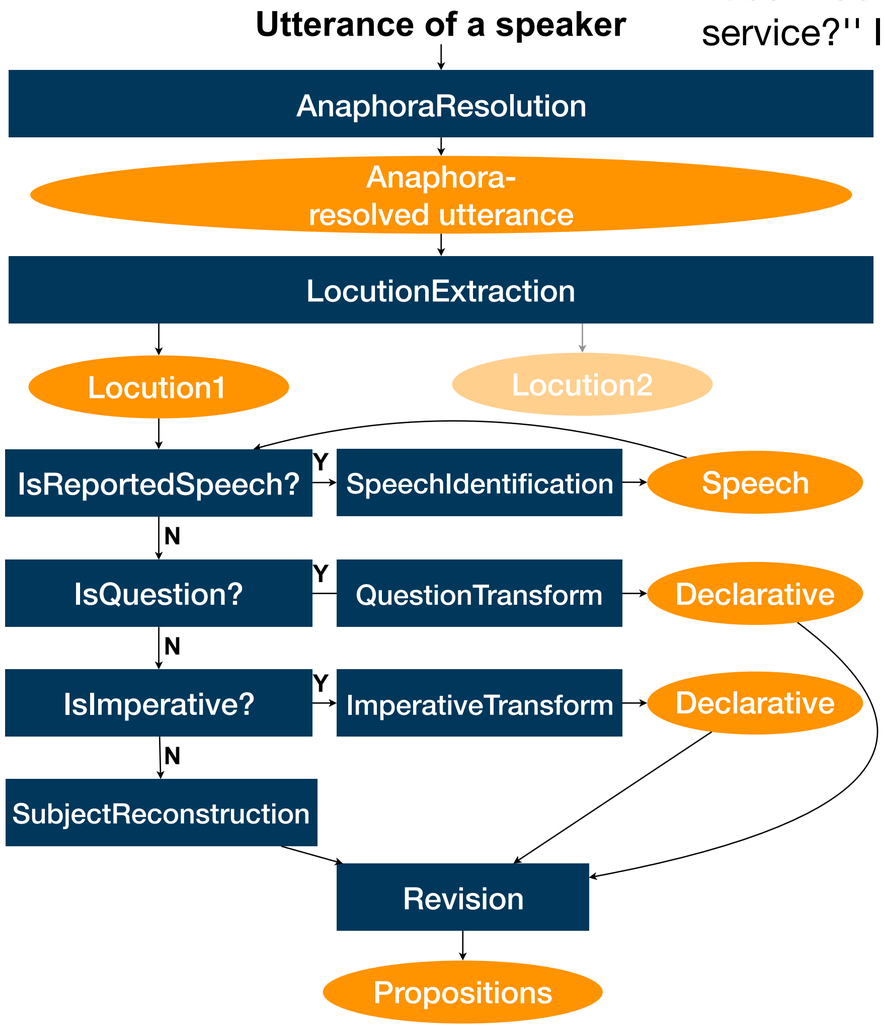
Bob stopped by **Alice's** office and complained, ``Why is the company not launching the new service?'' **Alice** think **Alice** have explained to **Bob** already.

[L1] Bob stopped by Alice's office and **[L2] complained, ``Why is the company not launching the new service?''** Alice think **[L3] Alice have explained to Bob already.**

[L2] complained, ``**[L2'] Why is the company not launching the new service?**''

[L2'] The company should launch the new service

A Cascade Model for Proposition Extraction



Alice: Bob stopped by my office and complained, ``Why is the company not launching the new service?'' I think I have explained to him already.

Bob stopped by **Alice's** office and complained, ``Why is the company not launching the new service?'' **Alice** think **Alice** have explained to **Bob** already.

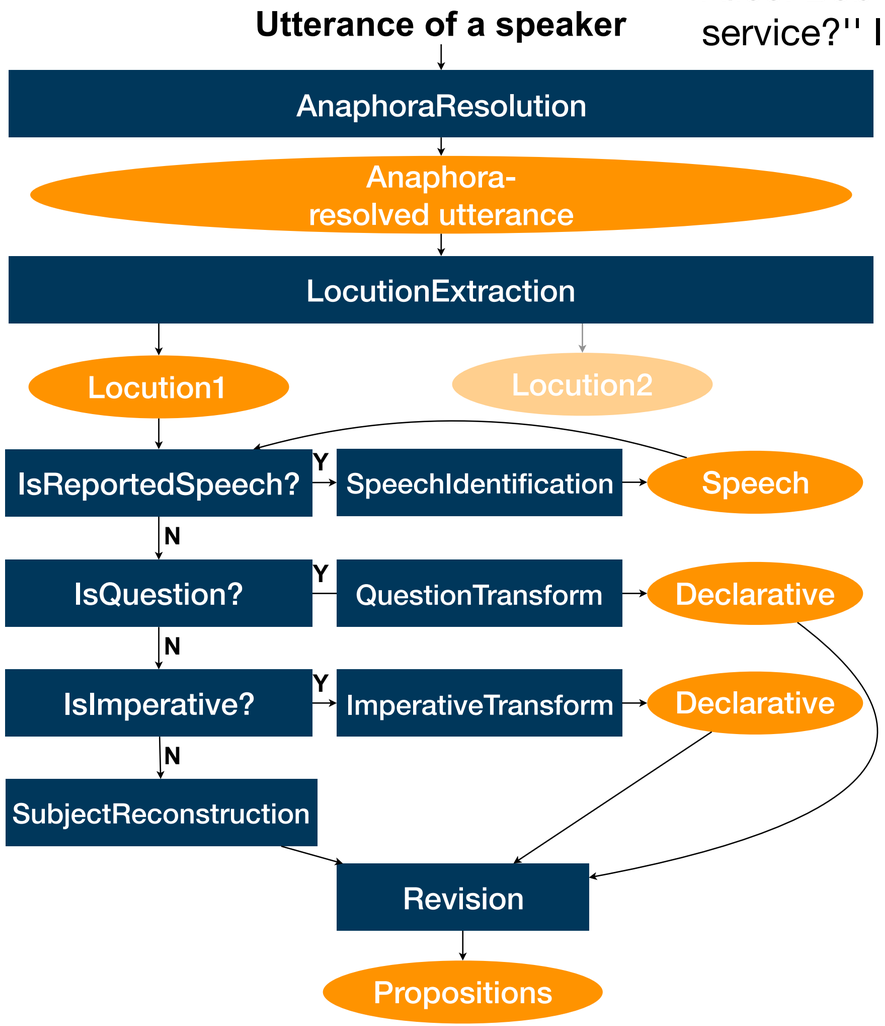
[L1] Bob stopped by Alice's office and **[L2] complained, ``Why is the company not launching the new service?''** Alice think **[L3] Alice have explained to Bob already.**

[L2] complained, ``**[L2'] Why is the company not launching the new service?**''

[L2'] The company should launch the new service

[L2] Bob complained, ``Why is the company not launching the new service?''

A Cascade Model for Proposition Extraction



Alice: Bob stopped by my office and complained, ``Why is the company not launching the new service?'' I think I have explained to him already.

Bob stopped by **Alice's** office and complained, ``Why is the company not launching the new service?'' **Alice** think **Alice** have explained to **Bob** already.

[L1] Bob stopped by Alice's office and **[L2] complained, ``Why is the company not launching the new service?''** Alice think **[L3] Alice have explained to Bob already.**

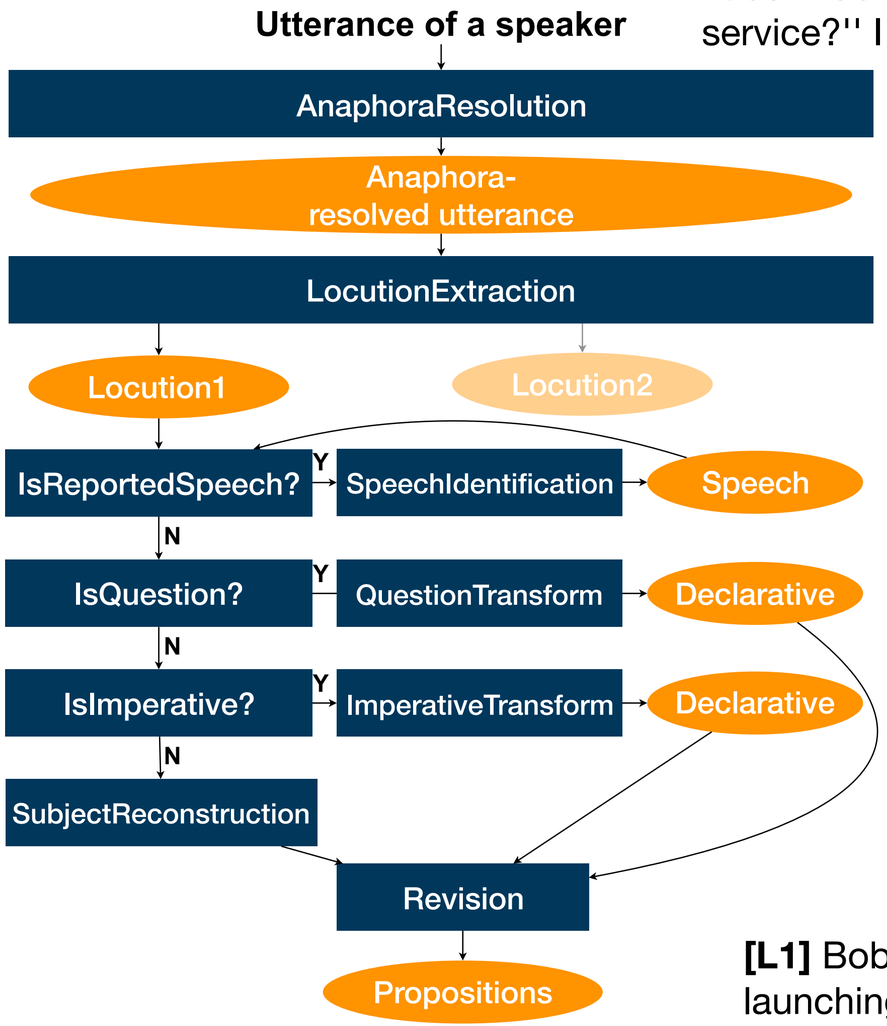
[L2] complained, ``**[L2'] Why is the company not launching the new service?**''

[L2'] The company should launch the new service

[L2] Bob complained, ``Why is the company not launching the new service?''

[L3] Alice **has** explained to Bob already

A Cascade Model for Proposition Extraction



Alice: Bob stopped by my office and complained, ``Why is the company not launching the new service?'' I think I have explained to him already.

Bob stopped by **Alice's** office and complained, ``Why is the company not launching the new service?'' **Alice** think **Alice** have explained to **Bob** already.

[L1] Bob stopped by Alice's office and **[L2] complained, ``Why is the company not launching the new service?''** Alice think **[L3] Alice have explained to Bob already.**

[L2] complained, ``**[L2'] Why is the company not launching the new service?**''

[L2'] The company should launch the new service

[L2] Bob complained, ``Why is the company not launching the new service?''

[L3] Alice **has** explained to Bob already

[L1] Bob stopped by Alice's office **[L2]** Bob complained, ``Why is the company not launching the new service?'' **[L2']** The company should launch the new service **[L3]** Alice has explained to Bob already

Anaphora Resolution

- Subtasks
  - **1p Sing:** {*I, my, me, mine*} → speaker's name
  - **2p:** {*you, your, yours*} → previous speaker's name
  - **3p Sing Gender:** {*he, his, him, she, her, hers*} → CoreNLP
  - **3p Sing Gender-Neutral:** {*it, that*} → CoreNLP
- Similarity-based Metrics
  - **BLEU**
  - **Dep:** F1-score of dependency tuples
  - **Dep-SO:** Dep for subj/obj
  - **Noun:** F1-score of nouns

	BLEU	Dep	Dep-SO	Noun
Locution (no resol)	69.3	.651	.558	.714
CoreNLP	62.8	.617	.538	.704
1S	**70.1**	**.657**	.589	.748
1S+2S	69.7	.655	.583	.746
1S+3SG	69.3	.654	**.601**	**.757**
1S+3SG+3SN	68.5	.649	.592	.756

- Challenges: "You" / "it, that"

Anaphora Resolution

- Subtasks
  - **1p Sing:** {*I, my, me, mine*} → speaker's name
  - **2p:** {*you, your, yours*} → previous speaker's name
  - **3p Sing Gender:** {*he, his, him, she, her, hers*} → CoreNLP
  - **3p Sing Gender-Neutral:** {*it, that*} → CoreNLP
- Similarity-based Metrics
  - **BLEU**
  - **Dep:** F1-score of dependency tuples
  - **Dep-SO:** Dep for subj/obj
  - **Noun:** F1-score of nouns

	BLEU	Dep	Dep-SO	Noun
Locution (no resol)	69.3	.651	.558	.714
CoreNLP	62.8	.617	.538	.704
1S	**70.1**	**.657**	.589	.748
1S+2S	69.7	.655	.583	.746
1S+3SG	69.3	.654	**.601**	**.757**
1S+3SG+3SN	68.5	.649	.592	.756

- Challenges: "You" / "it, that"

Anaphora Resolution

- Subtasks
  - **1p Sing:** {*I, my, me, mine*} → speaker's name
  - **2p:** {*you, your, yours*} → previous speaker's name
  - **3p Sing Gender:** {*he, his, him, she, her, hers*} → CoreNLP
  - **3p Sing Gender-Neutral:** {*it, that*} → CoreNLP
- Similarity-based Metrics
  - **BLEU**
  - **Dep:** F1-score of dependency tuples
  - **Dep-SO:** Dep for subj/obj
  - **Noun:** F1-score of nouns

	BLEU	Dep	Dep-SO	Noun
Locution (no resol)	69.3	.651	.558	.714
CoreNLP	62.8	.617	.538	.704
1S	**70.1**	**.657**	.589	.748
1S+2S	69.7	.655	.583	.746
1S+3SG	69.3	.654	**.601**	**.757**
1S+3SG+3SN	68.5	.649	.592	.756

- Challenges: "You" / "it, that"

Anaphora Resolution

- Subtasks
  - **1p Sing:** {*I, my, me, mine*} → speaker's name
  - **2p:** {*you, your, yours*} → previous speaker's name
  - **3p Sing Gender:** {*he, his, him, she, her, hers*} → CoreNLP
  - **3p Sing Gender-Neutral:** {*it, that*} → CoreNLP
- Similarity-based Metrics
  - **BLEU**
  - **Dep:** F1-score of dependency tuples
  - **Dep-SO:** Dep for subj/obj
  - **Noun:** F1-score of nouns

	BLEU	Dep	Dep-SO	Noun
Locution (no resol)	69.3	.651	.558	.714
CoreNLP	62.8	.617	.538	.704
1S	**70.1**	**.657**	.589	.748
1S+2S	69.7	.655	.583	.746
1S+3SG	69.3	.654	**.601**	**.757**
1S+3SG+3SN	68.5	.649	.592	.756

- Challenges: "You" / "it, that"

Anaphora Resolution

- Subtasks
  - **1p Sing:** {*I, my, me, mine*} → speaker's name
  - **2p:** {*you, your, yours*} → previous speaker's name
  - **3p Sing Gender:** {*he, his, him, she, her, hers*} → CoreNLP
  - **3p Sing Gender-Neutral:** {*it, that*} → CoreNLP

- Similarity-based Metrics
  - **BLEU**
  - **Dep:** F1-score of dependency tuples
  - **Dep-SO:** Dep for subj/obj
  - **Noun:** F1-score of nouns

	BLEU	Dep	Dep-SO	Noun
Locution (no resol)	69.3	.651	.558	.714
CoreNLP	62.8	.617	.538	.704
1S	**70.1**	**.657**	.589	.748
1S+2S	69.7	.655	.583	.746
1S+3SG	69.3	.654	**.601**	**.757**
1S+3SG+3SN	68.5	.649	.592	.756

- Challenges: "You" / "it, that"

Locution Extraction
(ADU segmentation)

- Challenges
  - Whether to separate clauses/phrases that are back-to-back or split by a comma, *and*, *but*.

Reported Speech Detection

- 278 / 8,008 locutions

		Prec	Recl	F1
Regex	*say, said*	0.40	0.36	0.38
	“, :	0.58	0.26	0.36
	called, blamed, argued, insisted	0.58	0.04	0.07
	All regex	0.44	**0.59**	0.51
BERT		**0.63**	0.52	**0.57**

- Challenges
  - **Factuality:** *I **thought** reddit said that Paul was supposed to be the rational one here*
  - **Existence of speech content:** *He said **that** the second time anyway*

Question Detection

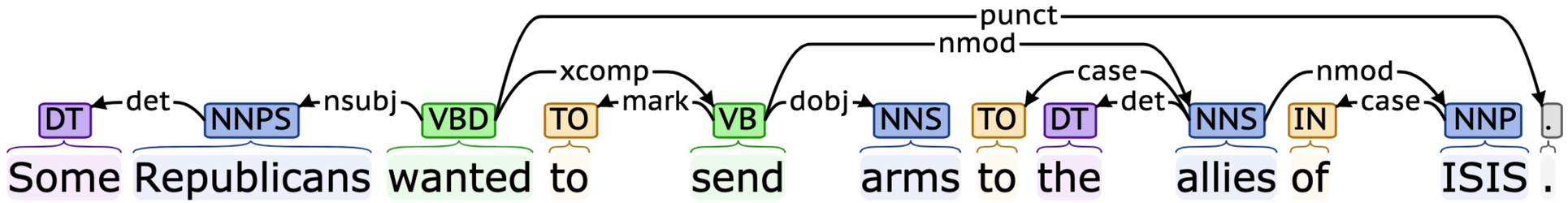
- 565 / 8,008 locutions

		Prec	Recl	F1
Regex	*?*	0.75	0.94	0.83
	what, why, how, can, do, ...	0.51	0.50	0.51
	All regex	0.59	**0.97**	0.73
BERT		**0.81**	0.92	**0.86**

- Challenges
  - **Questions for emphasis:** *It also could just be somebody sitting there,* ***ok?***
  - **Quoted question:** *You* ***say to yourself****, why didn't they make the right deal?*
  - **Questions expressing confusion:** ***Bernie?... Come again?***

Subject Reconstruction

- Identify a subject of each verb before locution extraction
  - Dependency relations: conjunct, auxiliary, copula, open clausal complement



Subject Reconstruction

- 70 locutions (subject missing ∩ annotated)

Prec	BLEU-Reconst	BLEU-Locution
.714	62.6	59.1

(a) Performance of subject reconstruction.

Problem of sentences

Reason	%
Ill-formed sentence	25%
No subject in the sentence	25%
Trace mistake	20%
Phrasal/clausal subject	10%
Complex sentence	10%
Wrong antecedents of relative pronouns	10%

(b) Reasons for subject identification errors.

Subject Reconstruction

- 70 locutions (subject missing ∩ annotated)

Prec	BLEU-Reconst	BLEU-Locution
.714	62.6	59.1

(a) Performance of subject reconstruction.

Problem of tracing method

Reason	%
Ill-formed sentence	25%
No subject in the sentence	25%
Trace mistake	20%
Phrasal/clausal subject	10%
Complex sentence	10%
Wrong antecedents of relative pronouns	10%

(b) Reasons for subject identification errors.

Subject Reconstruction

- 70 locutions (subject missing ∩ annotated)

Prec	BLEU-Reconst	BLEU-Locution
.714	62.6	59.1

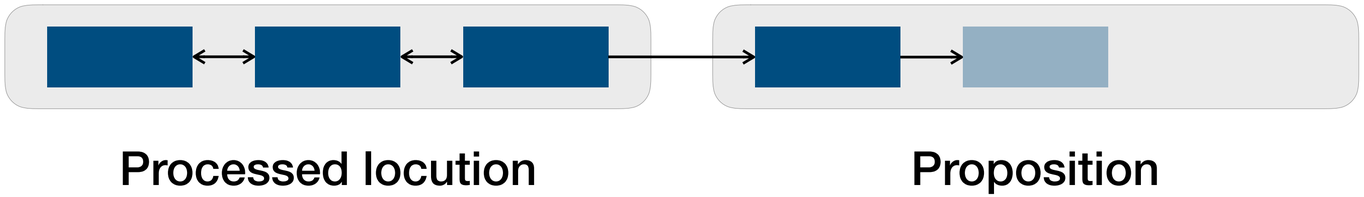
(a) Performance of subject reconstruction.

Reason	%
Ill-formed sentence	25%
No subject in the sentence	25%
Trace mistake	20%
Phrasal/clausal subject	10%
Complex sentence	10%
Wrong antecedents of relative pronouns	10%

Problem of CoreNLP

(b) Reasons for subject identification errors.

Revision



- Standard attention model
  - Requires **much data**
- Copy model
  - Computes the probability of an output word being **copied from input**

Revision

	BLEU
Locution	75.5
Attention	47.2
Copy	76.2
Copy (short)	**76.6**

- Corrects verb cases
  - *Cooper **want** to → Cooper **wants** to*
- Removes non-propositional content
- Changes first name to full name
- **Fails to do semantic** changes (esp. resolving non-personal anaphors)

Revision

	BLEU
Locution	75.5
Attention	47.2
Copy	76.2
Copy (short)	**76.6**

- Corrects verb cases
  - *Cooper **want** to → Cooper **wants** to*
- Removes non-propositional content
- Changes first name to full name
- **Fails to do semantic** changes (esp. resolving non-personal anaphors)

Revision

	BLEU
Locution	75.5
Attention	47.2
Copy	76.2
Copy (short)	**76.6**

- Corrects verb cases
  - *Cooper **want** to → Cooper **wants** to*
- Removes non-propositional content
- Changes first name to full name
- **Fails to do semantic** changes (esp. resolving non-personal anaphors)

Conclusion

- Introduced the problem of **extracting complete propositions**
- Formulated the problem as **7 main tasks** (modules)
- Demonstrated that our models obtain **semantically improved propositions**, compared to original locutions
- Identified several **NLP challenges** in this problem (summarized in the paper)

- Working on systemic extraction of propositional contents from **questions and imperatives**
- Using propositions for identifying **nuanced types of propositional relations**

Thank you

Yohan Jo
yohanj@cs.cmu.edu