



#### A Neural Approach to Discourse Relation Signaling



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#### Questions

- What are discourse relations?
- Which ones exist? (Knott 1996, Knott & Sanders 1998)
- Distribution in genres? (Taboada & Lavid 2003)
- How are they marked? (Taboada & Das 2013)
  - Example: contrast
    - Explicit signals: *"on the other hand"* or *"although"*
    - Implicit signals: antonyms, coreferent mentions ...
  - Easiest/hardest relations to identify?
  - Most/least reliable signals in context?

## To answer these questions we need to annotate relations in corpora

#### DRs in Rhetorical Structure Theory (Mann & Thompson 1988)



- See RST Website: <u>http://www.sfu.ca/rst/</u>
- Other frameworks: PDTB (Prasad et al. 2008), SDRT (Asher & Lascarides 2003)

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#### Georgetown University Multilayer corpus (Zeldes 2017) <u>http://corpling.uis.georgetown.edu/gum/</u>

- POS tagging (PTB, CLAWS, TT, UPOS)
- Sentence type (SPAAC++)
- Document structure (TEI)
- Syntax trees (PTB + Stanford + UD)
- Information status (SFB632)
- (Non-) named entity types
- Coreference + bridging
- 20 DRs in Rhetorical Structure Theory
- Speaker information, ISO time...



text type	source	texts	tokens
Academic	Various	6	5,210
Biographies	Wikipedia	6	5,049
Fiction	Small Beer Press	7	5,912
Interviews	Wikinews	19	18,037
News	Wikinews	21	14,093
Travel guides	Wikivoyage	17	14,955
Forum discussions	reddit	6	5,174
How-to guides	wikiHow	19	16,920
Total mir Zeides / A Neural App	roach to Discourse Relat	101	85,350



#### Frequentist approaches to DR markers

Studies often cross-tabulate: words ~ relations

#### Problems:

- Frequency thresholds
- Ambiguity
  - "and" appears in all relations not a Discourse Marker?
  - Context sensitivity some words are cues in specific environments

Relation type	Freq	marker	translation			
Elaboration	150	kotoryj	"which, that"			
Joint	119	i, takzhe	and, as well			
		zajavil,	report, an-			
Attribution	118	soobschil	nounce etc.			
		Odnako, a,	However,			
Contrast	62	no	but			
			so, accord-			
		Poetomu,	ingly,			
Cause-Effect	47	V+prichina	V+cause			
		Chtoby,	In order that,			
Purpose	39	dlya	for			
		Nouns and				
		verbs ex-				
Interpretation-		pressing				
Evaluation	34	opinion				
		No domi-				
		nant mark-				
Background	31	er				
Condition	27	esli	if			
Table 1. Relations with their most frequent markers						

Toldova et al. 2017

#### Relation classification with RNNs

Recurrent Neural Networks can identify relations (e.g. Braud et al. 2017)

- Words vectors are fed to an encoder
- Multiclass classification



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condition 0.6

Relation classification with RNNs

The RNN probably already had it at *If...*We can listen to output at every token



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#### Bi-LSTM CRF (Huang et al. 2015, Ma & Hovy 2016)



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## Visualizing RNN predictions

# Basic idea – find the most 'convincing' tokens: Use tokens' probability of correct relation Shade by:

How good am I in sent? How good am I in doc?

More formally:

- p/max(softmax(sent))
- p/max(softmax(document))

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## Visualizing RNN predictions

[This occurs for two reasons :]<sub>preparation</sub> [As it moves over land,]<sub>circumstance</sub> [it is cut off from the source of energy driving the storm ...]<sub>cause</sub> [Combine 50 milliliters of hydrogen peroxide and a liter of distilled water in a **mixing** bowl .]<sub>sequence</sub> [A ceramic bowl will work best,]<sub>elaboration</sub> [but Do humans agree? plastic works too . ] concession Data: GUM

#### Does the RNN find signals like a human?

Evaluate on sample from RST Signalling Corpus (Taboada & Das 2013)

- 210 relations
- 153 signals
  - Only 83 attributable to words! (not: genre, zero relative, graphical layout...)

In a remark [someone should remember this time next year,]

 Only 47 are lexical items! (not: lexical chain, syntactic parallelism)
 Congress gave Senator Byrd's state ... [Senator Byrd is chairman..]

#### Does the RNN find signals like a human?

#### Use recall rate @k to evaluate



#### Lexical items only

Data: Signaling Corpus

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#### Suppose the RNN really flags signals...

#### Can we:

- Get 'signal strength' for words?
- Ambiguity scores?
- Most 'signally' relations?
- Variation across genres?

#### Assessing ambiguity

#### We can get ambiguity scores based on the range of probabilities each word gets



## Assessing ambiguity

#### Irrelevant 'and's: (Wall Street Journal)

- [but will continue as a director and chairman of the executive committee .]<sub>elaboration</sub>
- [and one began trading on the Nasdaq/National Market System last week .]<sub>inverted</sub>

#### Important 'and's: (Wall Street Journal)

- [and is involved in claims adjustments for insurance companies .]<sub>List</sub>
- [-- and from state and local taxes too , for in-state investors .]<sub>elaboration</sub>



## Giving the network more than words



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Data:

GUM

#### Relations across genres

## DR probabilities vary by genre, sentence type... Even for the same 'sentence' – think of "Yes."



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#### Examples - learning from more than text



- 1 teaspoon baking powder
- Pinch of salt
- 450ml (1-3/4 cup) unsweetened soy milk

#### <u>Plain:</u>

[1 teaspoon baking powder]<sub>joint</sub>

+Genre or Layout: (whow) [1 teaspoon baking powder]<sub>joint</sub>

wikiHow: How to Make Vegan Cupcakes

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## Which genres signal most strongly?



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#### Which relations are hardest?



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#### Top signals - overall



How stable are these markers across genres?

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## Top signals - different genres

	overall	wikihow	fiction	bios
condition	• If • you • if	• lf • you • if	• If • when • if	<n a=""></n>
sequence	<ul><li>minutes</li><li>then</li><li>add</li></ul>	<ul><li> Pour</li><li> add</li><li> minutes</li></ul>	• woke • jumped • fell	<ul><li>became</li><li>died</li><li>August</li></ul>
solutionhood	• ? • you • Do	• ? • Impact • failure	• want • ? • Do	<n a=""></n>
circumstance	• NUM • month • before	<ul><li> After</li><li> When</li><li> Once</li></ul>	<ul><li>when</li><li>outside</li><li>morning</li></ul>	• when • After • war

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## Conclusion

- Relation signaling is complex, genre specific
  - Many signals are lexical, not function words
  - New models go substantially beyond frequentist approaches

Computational models of discourse signals can:

- Inform relation inventory development and corpus annotation schemes
- Improve automatic discourse parsing
- Help develop new theories about DR processing



## Thanks!

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