

Recognizing paraphrase and entailment relationships between complex sentences based on logical relations

Shuya ABE
Computational Linguistics Lab.
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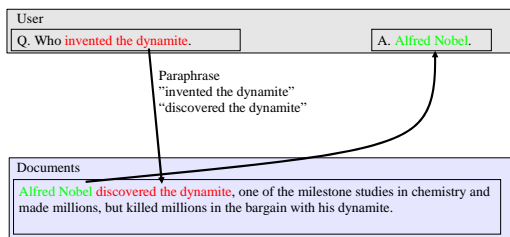
Background

- Needs of accessibility to information
 - Some information was written in natural language.
 - Textbook, novel, chat and mail are written in natural language.
 - Movie, music and game aren't written in natural language.
 - Using natural language to request a system.
 - system: search engine, QA system, machine translation system.

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Appropriate result

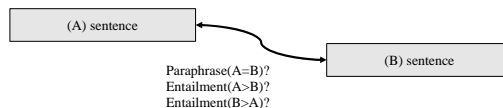
- The system replies appropriate answers
 - The system recognizes a paraphrase relation.



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Objective

- Recognize a paraphrase/entailment relation between sentences.
 - The sentence is a complex sentence included two events and two clauses.
 - Two sentences represent different rhetorical relations.



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Example

- A Paraphrase relation between sentences.
 - Two events
 - "Get a key"
 - "Open a safe"
 - Sentences
 - Get a key, before you open a safe.
 - Temporal location(rhetorical relation)
 - Get a key, so that you open a safe.
 - Purpose(rhetorical relation)

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Example

- An Entailment relation between sentences.
 - Two events
 - "Put a marble away"
 - "A child swallows a marble"
 - Sentences
 - Put a marble away, before a child swallows them.
 - Temporal location(rhetorical relation)
 - If you don't put a marble away, a child will swallow them.
 - Condition(rhetorical relation)

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Complex sentence

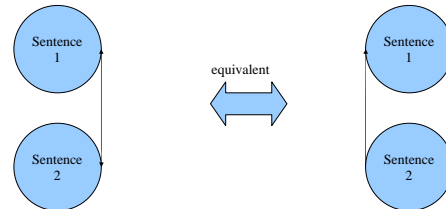
- Sentence
 - Simple sentence
 - It contains only one clause.
 - Ex: My friend invited me to a party.
 - Ex: I do not want to go.
 - Complex sentence
 - It contains more two clauses.
 - Ex: Although my friend invited me to a party, I do not want to go.

Quote from <http://www.arts.uottawa.ca/wricent/hypergrammar/sntstrect.html>

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Paraphrase and Entailment

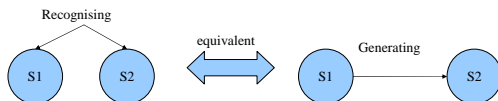
- A paraphrase relation is equivalent to mutually entailment relations.



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Recognise/Generate

- Purpose to recognize a paraphrase between S1 to S2.
- Approach to generate S2 from S1.
 - S2 paraphrases S1.



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Using Patterns

- Generate a paraphrase by a pattern.
 - Pattern: P1 -> P2
 - P1: "A, **before** B."(temporal location)
 - P2: "A, **so that** B1 **not** B2."(purpose)
 - Examples: S1 -> S2
 - S1: Put a marble away, **before** a child swallows them.
 - S2: Put a marble away, **so that** a child does **not** swallow them.

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Using Patterns

- Generate a paraphrase by a pattern.
 - Pattern: P1 -> P2
 - P1: "A, **before** B."(temporal location)
 - P2: "A, **so that** B1 **not** B2."(purpose)
 - Examples: S3 -> S4: Not paraphrase!
 - S3: Get a key, **before** you open a safe.
 - S4: Get a key, **so that** you **don't** open a safe.

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Using Patterns

- Generate a paraphrase by a same pattern.
 - S2 generated from S1 by a pattern(P1->P2)
 - S1 and S2 are a paraphrase relation.
 - S4 generated from S3 by a pattern(P1->P2)
 - S3 and S4 are not a paraphrase relation.
 - S3 and S4 are same rhetorical relations.
 - S3 is not correct sentence.
- Can't Generate a paraphrase by a pattern

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Using logical relations

- Paraphrase sentences own each logical relation.
 - Cause(S1 & S2)
 - Motivation: "A child swallows them"
 - Action: "Put a marble away"
 - Condition(S3 & S4)
 - Condition: "Get a key"
 - Action: "You open a safe"
- S1,2 and S3,4 are different logical relations.

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Using logical relations

- S1,2 and S3,4 are different logical relations.
 - The logical relation between two events
 - S2: Cause
 - S4: Condition
 - Correct or not correct
 - S2: correct sentence
 - S4: no correct sentence

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Proposed model

- Assume two things
 - Using logical relations for generating correct sentences.
 - Using paraphrase/entailment patterns for judging a relation between two sentences.
- Proposed model
 - The model generate paraphrase/entailment sentences by logical relations and paraphrase/entailment patterns.

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Three issues

- 1: Make a corpus(like a training data).
 - Sentences generated by a same logical relation. (logical relation map)
- 2: Develop definition of logical relation.
 - Each logical relation corresponds to correct sentences.
- 3: Create patterns to recognize each paraphrases/entailments on the corpus.

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1: Create a corpus

- Two steps to create a corpus
 - Generate potential sentences by two events and one logical relation.
 - Example
 - Events: "Get a key", "Open a safe"
 - Logical relation: Necessary condition
 - Sentences:
 - S1: Get a key, before you open a safe.
 - S2: Get a key, before you dont' open a safe.
 - S3: Get a key, so that you open a safe.
 - Judge that sentences is correct by hand.
 - S1(OK), S2(NG), S3(OK), ...

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1: Create a corpus

- Our corpus(example in japanese)

前提ノ後件	関係表現	否定	肯定	真偽	同義
「パスポートを取る」 ／「海外へ行く」	ために	海外へ行かぬために「パスポートを取る」。	海外へ行かぬので「パスポートを取る」。	海外へ行かぬので「パスポートを取る」。	海外へ行かぬので「パスポートを取る」。
	ので	海外へ行かぬので「パスポートを取る」。	海外へ行かぬので「パスポートを取る」。	海外へ行かぬので「パスポートを取る」。	海外へ行かぬので「パスポートを取る」。
	れば	「パスポートを取らば、海外へ行く」。	「パスポートを取らば、海外へ行く」。	「パスポートを取らば、海外へ行く」。	「パスポートを取らば、海外へ行く」。
	なら	海外へ行かぬなら「パスポートを取る」。	海外へ行かぬなら「パスポートを取る」。	海外へ行かぬなら「パスポートを取る」。	海外へ行かぬなら「パスポートを取る」。
	ほど	「パスポートを取るほど、海外へ行く」。	「パスポートを取るほど、海外へ行く」。	「パスポートを取るほど、海外へ行く」。	「パスポートを取るほど、海外へ行く」。
	でも	「パスポートを取っても、海外へ行く」。	「パスポートを取っても、海外へ行く」。	「パスポートを取っても、海外へ行く」。	「パスポートを取っても、海外へ行く」。

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2: Definition of logical relation

- Two Event have a action
 - Necessary condition
 - Sufficiently condition
 - Accountability
 - Motivation
- Two Events have only two states
 - Cause
 - Effect

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Experiments: logical relation

- Three steps
 - Pick up 18 event pairs.
 - Label each event "action" or "state" by hand.
 - Generate potential sentences by restricting rule.

	Precision	Recall	F-measure
18 event pairs	0.96	0.88	0.92

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Conclusion

- Verify the performace of logical relation by experiments.
- Even when logical relations are applied, our methods for preprocess of paraphrase recognition have low recall.

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Future work

- Rest works
 - 3: Create patterns to recognize each paraphrases/entailments on the corpus.
- Improve recall
- Make a more large size corpus
 - Pick up more event pairs
 - Cover more sentence patterns

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