Predicate-argument Structure based Textual Entailment Recognition System of KYOTO Team for NTCIR9 RITE

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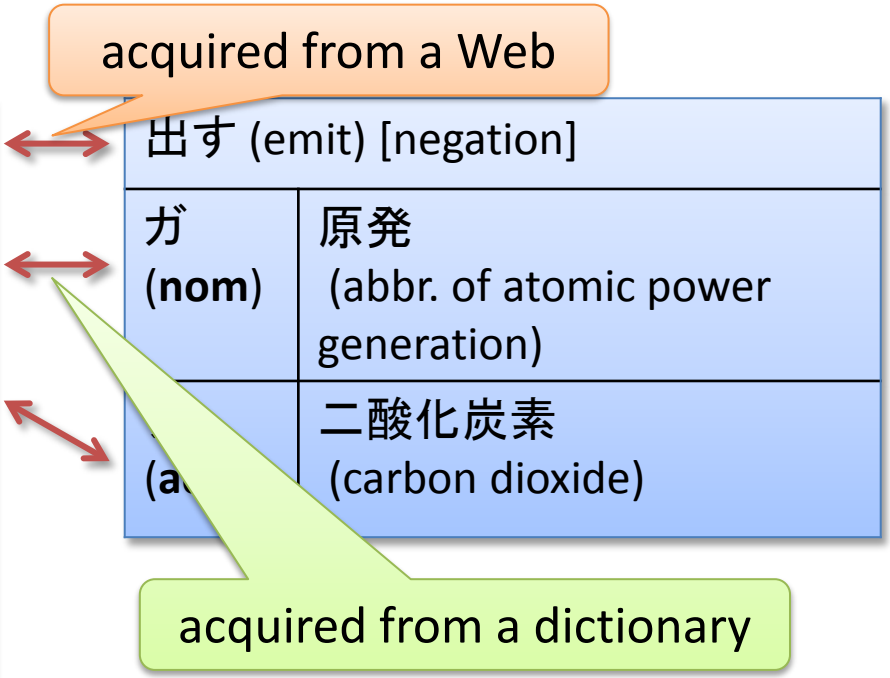
Characteristic of Our System

- Regard predicate-argument (PA) structure as a basic unit of handling the meaning
  - c.f.) bag-of-words approach
- Utilize wide coverage relations between words/phrases, which are automatically acquired from a dictionary, Wikipedia, and a Web corpus

T: 原子力発電は、発電段階で二酸化炭素を排出せず、環境面でも優れている。
(Atomic power generation is excellent in environment aspect as it does not emit carbon dioxide.)

H: 原発は、二酸化炭素を出さない。
(Atomic power generation does not emit carbon dioxide.)



排出 (emit) [negation]	
ガ (**nom**)	原子力発電 (atomic power generation)
ヲ (**acc**)	二酸化炭素 (carbon dioxide)
デ (**loc**)	発電段階 (electric power generation phase)

出す (emit) [negation]	
ガ (**nom**)	原発 (abbr. of atomic power generation)
(**a**	二酸化炭素 (carbon dioxide)

優れる (excellent)	
ガ (**nom**)	原子力発電 (atomic power generation)
デ (**loc**)	環境面 (environment aspect)

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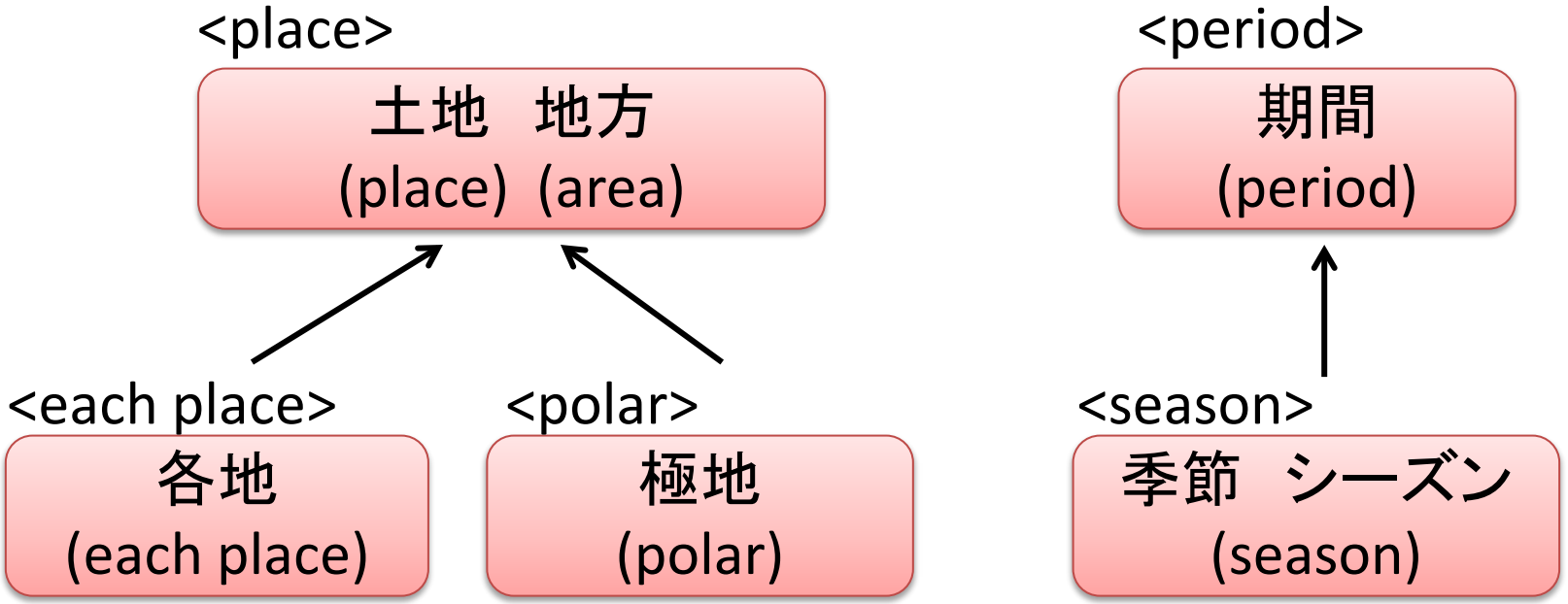
Relations between Words/phrases

- Extract synonym, is-a, and antonym relations automatically from definitions of a dictionary and Wikipedia
- Synonym
  - 季節(season): シーズン (season)
- Is-a
  - 各地 (each place): それぞれの (each) 土地 (place)
  - ジェネシス (Genesis): … 探査機 (probe vehicle)
- Antonym
  - 暑い (hot): [antonym] 寒い (cold)

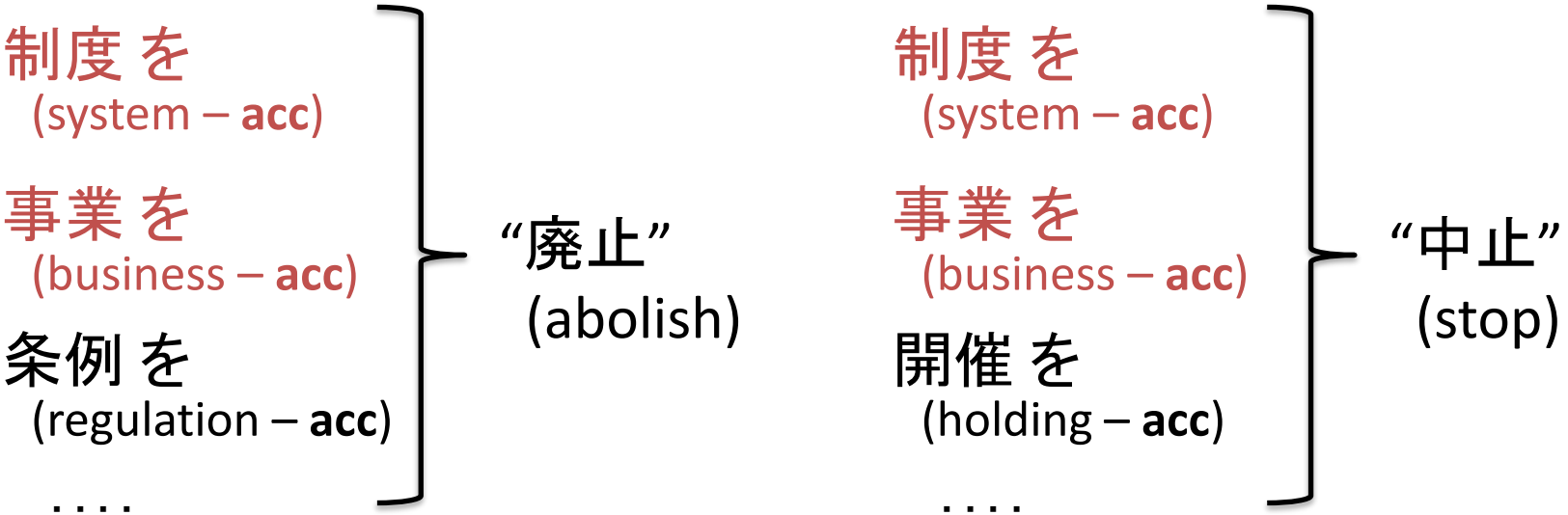
Synonymy Database [Shibata et al. 08]

- With the extracted binomial relations, we compile a synonymy database
- Assign synonymous groups to IDs (SYNID)



Distributional Similarity

- "Words that occur in similar contexts tend to be semantically similar" [Firth57]
- Distributional similarity between verbs is calculated using a large Web corpus
- Calculate similarity between two vectors



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Predicate-argument Structure Analysis

東京都西多摩地区では、各地で季節を楽しむイベントが開かれる。

(In Tokyo West Tama area, the event, where people enjoy the season in each place, is hold.)

Predicate-argument Structure Analysis

東京都西多摩地区では、各地で季節を楽しむイベントが開かれる。

(In Tokyo West Tama area, the event, where people enjoy the season in each place, is hold.)

楽しむ (enjoy) [syn] <enjoy>	
ヲ (**acc**)	季節 (season) [syn] <season>
デ (**loc**)	各地 (each place) [is-a] <place>

開かれる (be held)	
ガ (**nom**)	イベント (event) [syn] <event>
デ (**loc**)	地区 (area) [syn] <area> [mod] 東京都西多摩 (Tokyo West Tama)

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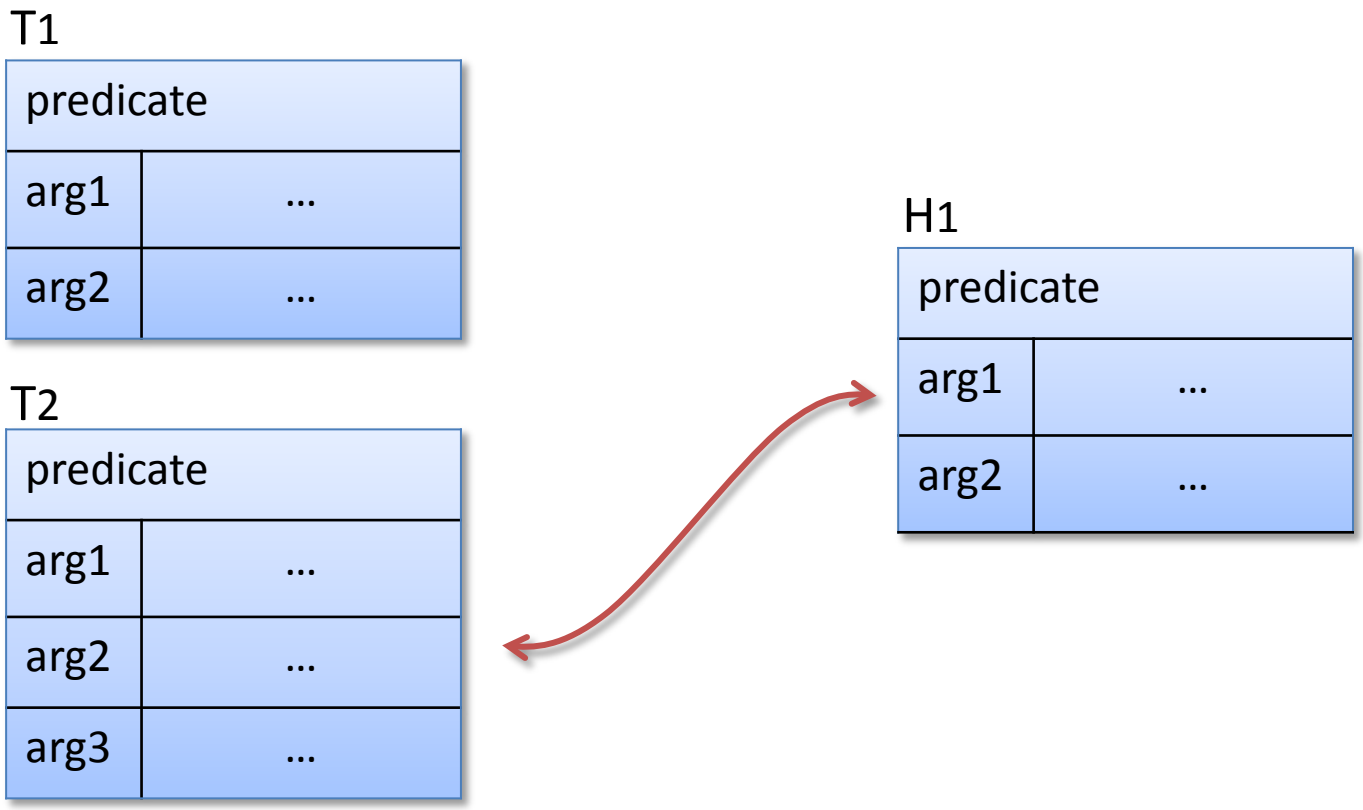
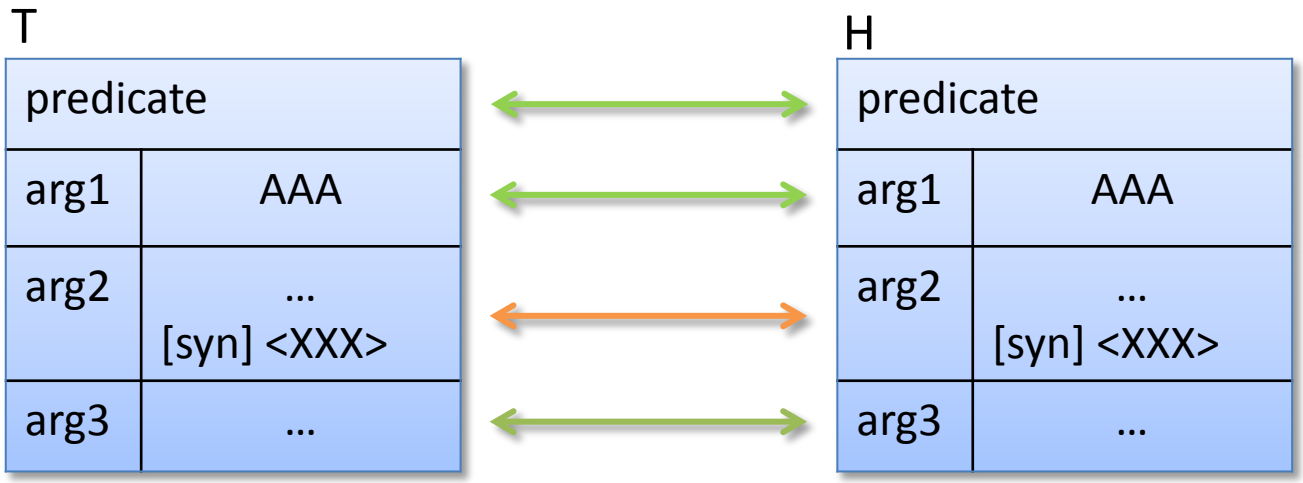
PA-matching Method (1/2)

- If all the PAs in **H** are matched to a PA in **T**, the system judges that **T** entails **H**



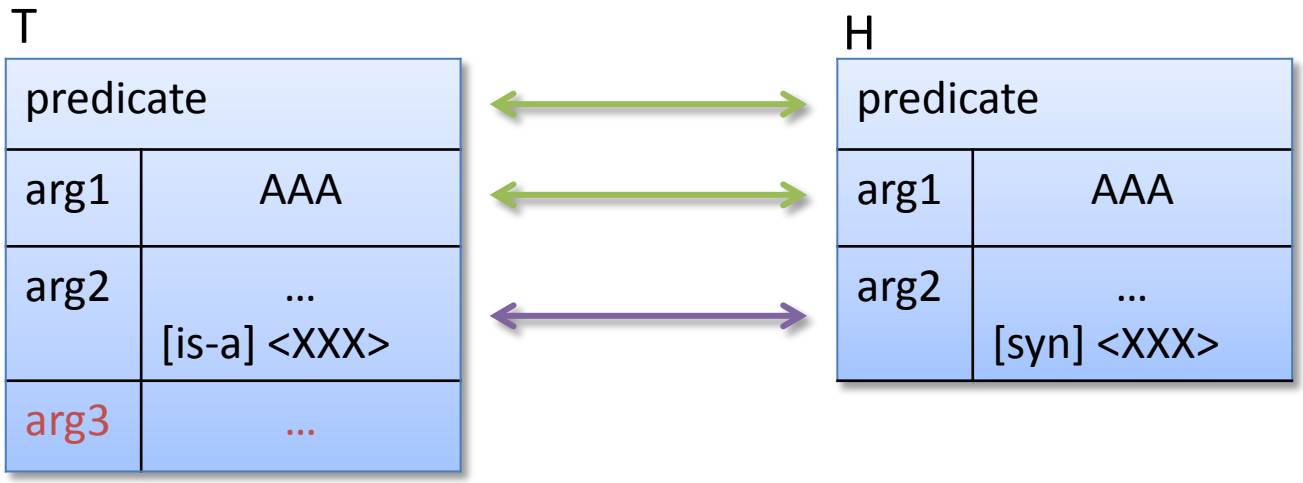
PA-matching Method (2/2)

- Matching between PAs:
  1. The predicate and all the arguments in **H** are matched to those in **T**
     - Correspondence of surface form / SYNID
     - Distributional similarity between predicates > threshold



PA-matching Method (2/2)

- Matching between PAs:
  2. Arguments or predicate in **H** is more "general" compared to those in **T**
     - is-a relation in an argument
     - lack of argument



SVM-Based Method

- PA-matching method often fails due to the shortage of lexical knowledge and world knowledge, …
- Take a machine learning approach (SVM) to consider relatively shallow clues
- Features
  - Overlap ratio of morphemes
  - Overlap ratio of characters (1-gram, 2-gram, 3-gram, 4gram)
  - Result of PA-matching method (Y/N)
  - Correspondence of predicate (1/0)
  - …

Experiments

- We participated in Japanese BC, MC, EXAM, RITE4QA subtasks
- Tools/resources
  - Morphological analyzer: JUMAN, parser: KNP
  - *Reikai-shogaku* dictionary (30,000 entries)
  - Japanese Wikipedia
  - Japanese Web page (100 million pages)

Experimental Result (Accuracy)

	BC dev	BC test	MC dev	MC test
1. PA-matching method	0.550	0.492	0.216	0.214
2. SVM-based method	0.536	0.516	0.498	0.480
3. Two-stage method	0.536	0.516	0.495	0.484

	EXAM dev	EXAM test	RITE4QA
1. PA-matching method	0.593	0.593	0.889
2. SVM-based method	0.655	0.656	0.684
3. Two-stage method	0.655	0.656	0.684

Two-stage method first applies PA-matching method, and if "Y" is obtained, the result is adopted; otherwise the SVM-based method is applied.

Confusion Matrix

PA-matching Method

BC dev (Acc: 0.550)

		correct		
		Y	N	all
system	Y	36	11	47
	N	214	239	453
	all	250	250	500

BC test (Acc: 0.492)

		correct		
		Y	N	all
system	Y	13	17	30
	N	237	233	470
	all	250	250	500

SVM-based Method

(Acc: 0.536)

		correct		
		Y	N	all
system	Y	101	83	184
	N	149	167	316
	all	250	250	500

(Acc: 0.516)

		correct		
		Y	N	all
system	Y	52	44	96
	N	198	206	404
	all	250	250	500

One-leave Out Experiments

	BC dev	BC test	MC dev	MC test
1. PA-matching method	0.550	0.492	0.216	0.214
w/o SynID	0.542	0.496	0.214	0.216
w/o distributional similarity	0.532	0.494	0.205	0.207
2. SVM-based method	0.536	0.516	0.498	0.480
w/o PA-matching method result	0.512	0.570	0.493	0.482

	EXAM dev	EXAM test	RITE4QA
1. PA-matching method	0.593	0.593	0.889
w/o SynID	0.589	0.593	0.890
w/o distributional similarity	0.593	0.588	0.889
2. SVM-based method	0.655	0.656	0.684
w/o PA-matching method result	0.651	0.665	0.362

Correct Examples (Label: Y, System: Y)

- Synonymous expression

  T: 中学生の学力に大きな開きがある。

  H: 中学生の学力に大きな差がある。
  (There is a great difference in the achievement of junior high school students.)

- Distributional similarity

  T: 金沢市の観光名所、兼六園に近い市中心部に金沢21世紀美術館が開館した。
  (Kanazawa 21st century museum was open in the center of the city, near Kenroku-en, which is a tourist spot in Kanazawa City.)

  H: 金沢21世紀美術館が市中心部にオープンした。
  (Kanazawa 21st century museum was open.)

Future Direction (Label: Y, System: N)

- Synonymous expression recognition

T: 歌舞伎は大衆の心をとらえてきた。
(Kabuki has captured the heart of the crowd.)

H: 歌舞伎は大衆を魅了してきた。
(Kabuki has attracted the crowd.)

Distributional similarity between PA and predicate

T: PET検査は、がんの診療に有効とされている。
(PET exam is regarded as effective against the diagnosis of cancer.)

H: PETはがんの診断に役立っている。
(PET is helpful for the diagnosis of cancer.)

Redundant expression

Conclusion

- Predicate-argument structure based RTE system
- Utilize wide coverage relations between words/phrases
- Future work
  - Acquire further synonymous expressions
  - Perform flexible matching between structures of text and hypothesis