EHIME TEXTUAL ENTAILMENT SYSTEM USING MARKOV LOGIC IN NTCIR-10 RITE2

Yuji Takesue and Takashi Ninomiya
Ehime University

Abstract

- This poster presents our experiments on NTCIR-10 RITE2 using Markov Logic .
- The tasks that we participated in are BC subtask and MC sub task.

Markov Logic

- Statistical learning and inferece for first-order logic.
- Statical model is defined as a Markov Random Field(MRF).
- First-order formulas are used as features in MRF.
- We used ***Alchemy***[1] as a Markov Logic tool.

[1] S. Kok, P. Singla, M. Richardson, P. Domingos,M. Sumner, and H. Poon. *The Alchemy System for Statistical Relational AI: User Manual*, 2007

Operator " * " and " + " in *Alchemy*

- Operator *: **This operator instantiates predicates with positive or negative predicate.**

Formula with *	Meaning	Weight
*P(x) ∧ *Q(x)	P(x) ∧ Q(x)	w_1
	¬P(x) ∧ Q(x)	w_2
	P(x) ∧ ¬Q(x)	w_3
	¬P(x) ∧ ¬Q(x)	w_4

- Operator +: **This operator instantiates the variables with the values in the database. This enables the system to learn per "constant" weights.**

Formula with +	Meaning	Weight
P(+x) ⇒ R(y)	P("A") ⇒ R(y)	w_1
	P("B") ⇒ R(y)	w_2
	P("C") ⇒ R(y)	w_3
	…	…

Markov Logic : Example

Predicate	Meaning
Family(x,y)	x and y are family
Fat(x)	x is fat
Gout(x)	x is gout

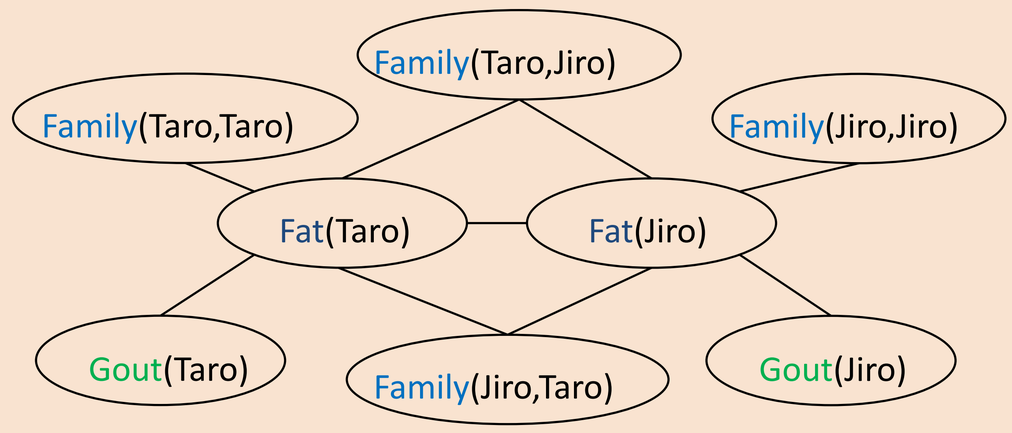
Weight **Formula**

- **Fat men get Gout**

w_1 $\forall x\ Fat(x) \Rightarrow Gout(x)$

- **if some of my family is fat, I'm also fat**

w_2 $\forall x, y\ Family(x, y) \Rightarrow \left(Fat(x) \Leftrightarrow Fat(y)\right)$



$$\mathbf{P}(x) = \frac{1}{\mathbf{Z}} \exp\left(\sum_i w_i n_i(x)\right)$$

$P(x)$:Probability of a world *x*.
w_i: Weight of formula *i*
$n_i(x)$:Number of true groundings of formulas *i* in *x*
Z :Normalized function

Our Proposal & Experiment

We defined first-order logic formulas in Markov Logic for recognizing textual entailment in RITE-2. ※Infer the value of the *label*
※In the BC subtask, *label*={Y,N}
※In the MC subtask, *label*={F,B,C,I}

Predicate	Explanation	Example
Entail(*label*, *id*)	The label of *id* is *label*	Entail("Y", 1)
HasWord(*w, t1ort2, id*)	Text *t1ort2* of *id* has word *w*	HasWord("プロメーテウス", "t1", 1)
Hypo(*hy*, *w*)	Hypernym of a word *w* is *hy*	Hypo("神", "プロメーテウス")

Proposed Formula Features : BC subtask

BC-01 Method
* HasWord(+*w*, "t1", *i*) ∧ * HasWord(+*w*, "t2", *i*) ⇒ Entail(+*lab*, *i*)
HasWord(*w1*, "t1", *i*) ∧ HasWord(*h*, "t2", *i*) ∧Hypo(*h*,*w1*) ⇒ Entail(+*lab*, *i*)
HasWord(*h*, "t1", *i*) ∧ HasWord(*w2*, "t2", *i*) ∧Hypo(*h*,*w2*) ⇒ Entail(+*lab*, *i*)

BC-02 Method
HasWord(+*w*, "t1", *i*) ∧ HasWord(+*w*, "t2", *i*) ⇒ Entail(+*lab*, *i*)
HasWord(*w1*, "t1", *i*) ∧ HasWord(*h*, "t2", *i*) ∧Hypo(*h*,*w1*) ⇒ Entail(+*lab*, *i*)
HasWord(*h*, "t1", *i*) ∧ HasWord(*w2*, "t2", *i*) ∧Hypo(*h*,*w2*) ⇒ Entail(+*lab*, *i*)

BC-03 Method
HasWord(+*w*, "t1", *i*) ∧ HasWord(+*w*, "t2", *i*) ⇒ Entail(+*lab*, *i*)
HasWord(+*w1*, "t1", *i*) ∧ HasWord(*h*, "t2", *i*) ∧Hypo(*h*,+*w1*) ⇒ Entail(+*lab*, *i*)
HasWord(*h*, "t1", *i*) ∧ HasWord(+*w2*, "t2", *i*) ∧Hypo(*h*,+*w2*) ⇒ Entail(+*lab*, *i*)

Features Example : BC-01 Method

<pair label="**Y**" id="**1**">
<t1>プロメーテウスは人類に火を渡し、張り付けにされた。</t1>
<t2>とある神は人類に火を齎して罰を受けた。</t2>
</pair> （※For purposes of explanation, I have changed the original）

Freq.	Formula Feature
1	HasWord("人類","t1",id) ∧ HasWord("人類","t2",id) ⇒Entail("Y",id)
1	HasWord("火","t1",id) ∧ HasWord("火","t2",id) ⇒Entail("Y",id)
1	HasWord("プロメーテウス","t1",id) ∧ ¬HasWord("プロメーテウス","t2",id) ⇒Entail("Y",id)
1	¬HasWord("神","t1",id) ∧ HasWord("神","t2",id) ⇒Entail("Y",id)
…	…
1	HasWord("プロメーテウス", "t1", *i*) ∧ HasWord("神", "t2", *i*) ∧Hypo("神", "プロメーテウス") ⇒ Entail("Y", *i*)
…	…

Proposed Formula Features : MC subtask

MC-01 Method
HasWord(+*w*,"t1", *i*) ∧ HasWord(+*w*,"t2", *i*) ⇒ Entail(+*lab*, *i*)
HasWord(*w1*, "t1", *i*) ∧ HasWord(*h*, "t2", *i*) ∧Hypo(*h*,*w1*) ⇒ Entail(+*lab*, *i*)
HasWord(*h*, "t1", *i*) ∧ HasWord(*w2*, "t2", *i*) ∧Hypo(*h*,*w2*) ⇒ Entail(+*lab*, *i*)

MC-02 Method
* HasWord(+*w*,"t1", *i*) ∧ * HasWord(+*w*,"t2", *i*) ⇒ Entail(+*lab*, *i*)
HasWord(*w1*, "t1", *i*) ∧ HasWord(*h*, "t2", *i*) ∧Hypo(*h*,*w1*) ⇒ Entail(+*lab*, *i*)
HasWord(*h*, "t1", *i*) ∧ HasWord(*w2*, "t2", *i*) ∧Hypo(*h*,*w2*) ⇒ Entail(+*lab*, *i*)

MC-03 Method
* HasWord(+*w*,"t1", *i*) ∧ * HasWord(+*w*,"t2", *i*) ⇒ Entail(+*lab*, *i*)
HasWord(+*w1*, "t1", *i*) ∧ HasWord(*h*, "t2", *i*) ∧Hypo(*h*,+*w1*) ⇒ Entail(+*lab*, *i*)
HasWord(*h*, "t1", *i*) ∧ HasWord(+*w2*, "t2", *i*) ∧Hypo(*h*,+*w2*) ⇒ Entail(+*lab*, *i*)

Result

BC Subtask

	BC-01 Method	BC-02 Method	BC-03 Method
Accuracy	59.34	51.48	48.36
Macro F1	54.34	50.14	48.05

MC Subtask

	MC-01 Method	MC-02 Method	MC-03 Method
Accuracy	28.10	36.31	40.33
Macro F1	24.47	21.99	25.89