

Conceptual Graph

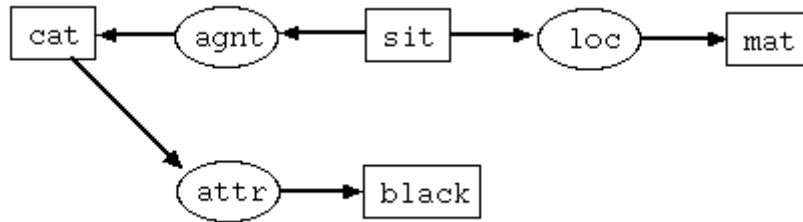
大森健児

特徴

- 一階述語論理を完全にサポートしており、どんな Conceptual Graph も一階述語論理に変換できる。
- 知識表現としての能力は低いですが、自然言語の意味を簡潔に表現するのに適しており、また推論にも適している。
- 計算機で扱うのに効率のよい手法も併せて考案されている。

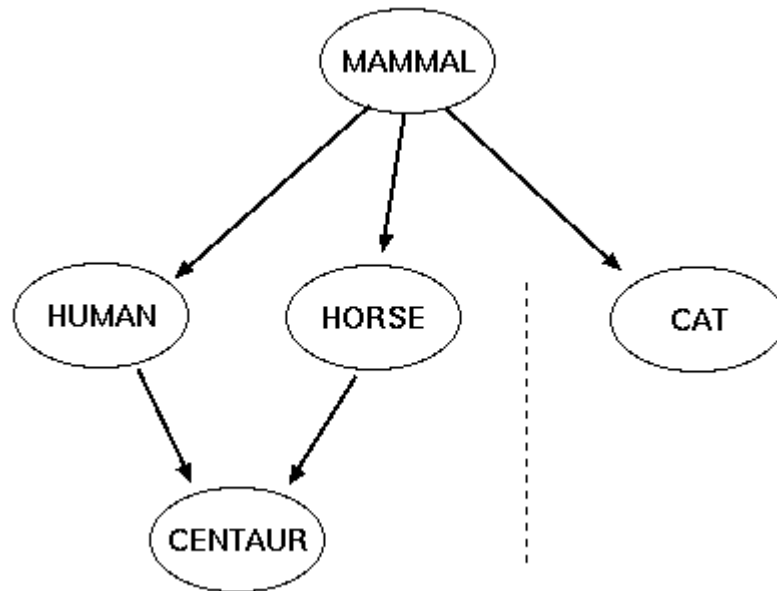
格フレーム

- 格の種類: ATTR, AGNT, OBJ, MANR, LOCなど
- 例: "A black cat sits on a mat."



Type-Hierarchy

- 述語論理の推論のさいに 役立つ



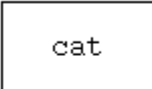
$\forall x \text{ CAT}(x) \rightarrow \text{MAMMAL}(x)$
 $\forall x \text{ CENTAUR}(x) \rightarrow \text{HORSE}(x)$

- 多重継承がされていない *Concept-Type* の場合には、次の規則で推論の効率を上げることができる

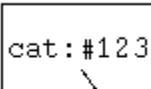
$\forall x \text{ CAT}(x) \rightarrow \neg \text{HORSE}(x)$

インスタンス

- インスタンスの例:

a. 

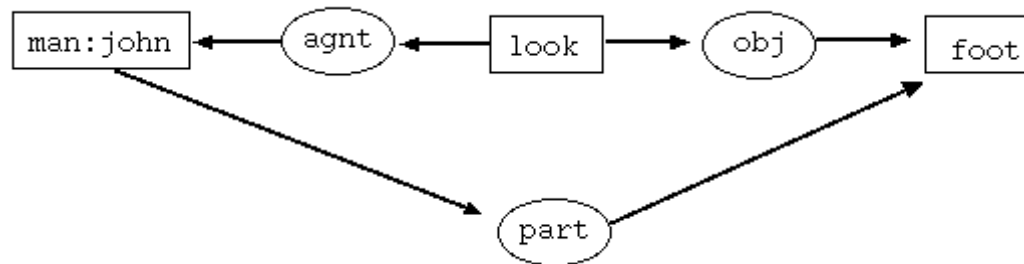
$\exists x \text{ cat}(x)$

b. 
Referent Field

$\text{cat}(\text{'\#123'})$

Concept-Relation

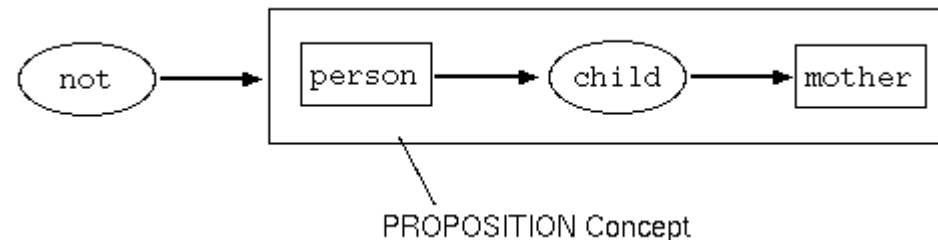
- *Concept-Relation* は 2変数の述語に変換
- “The man ‘John’ looks at his foot.”



$\exists x \exists y \text{ man}('john') \wedge \text{agent}('john', y) \wedge \text{look}(y) \wedge \text{object}(y, x) \wedge \text{foot}(x) \wedge \text{partof}(x, 'john')$

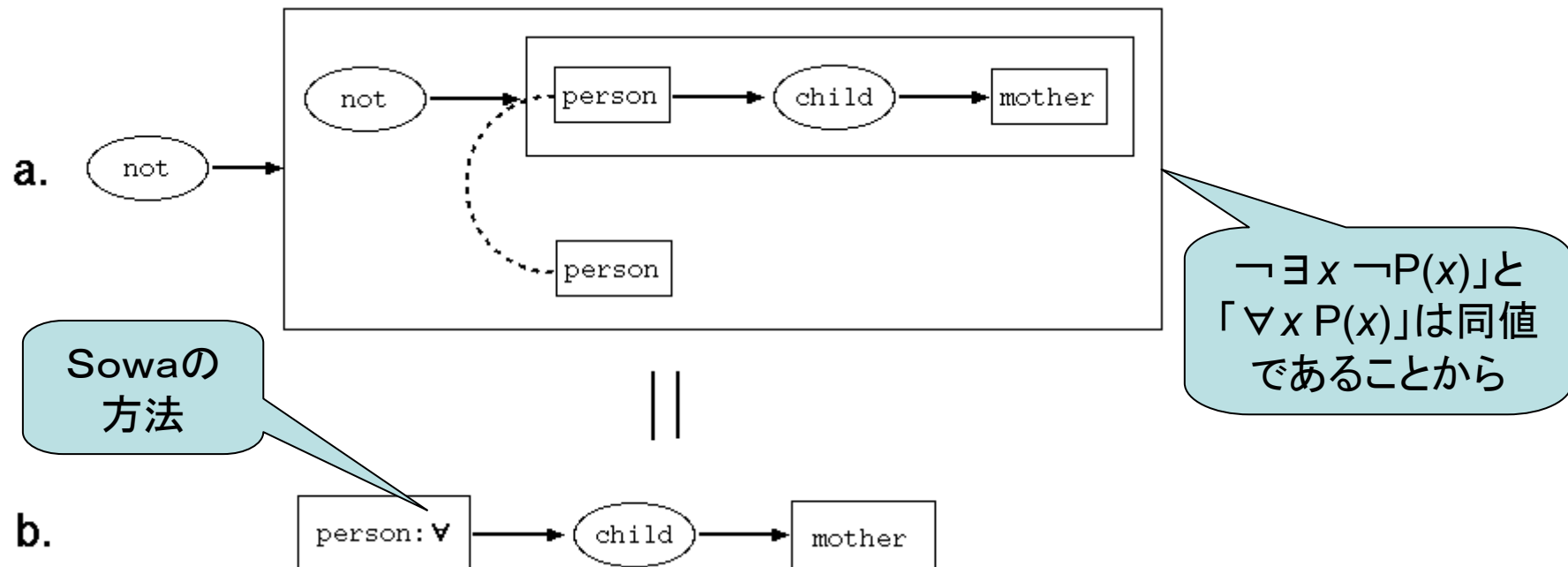
Concept (PROPOSITION)

- 一階述語論理における、いわゆるカッコを使えるようにするため Conceptual Graph を入れ子に (C. S. Peirceが導入)
- “There exists a person with a mother.”という命題の否定



全称限定子

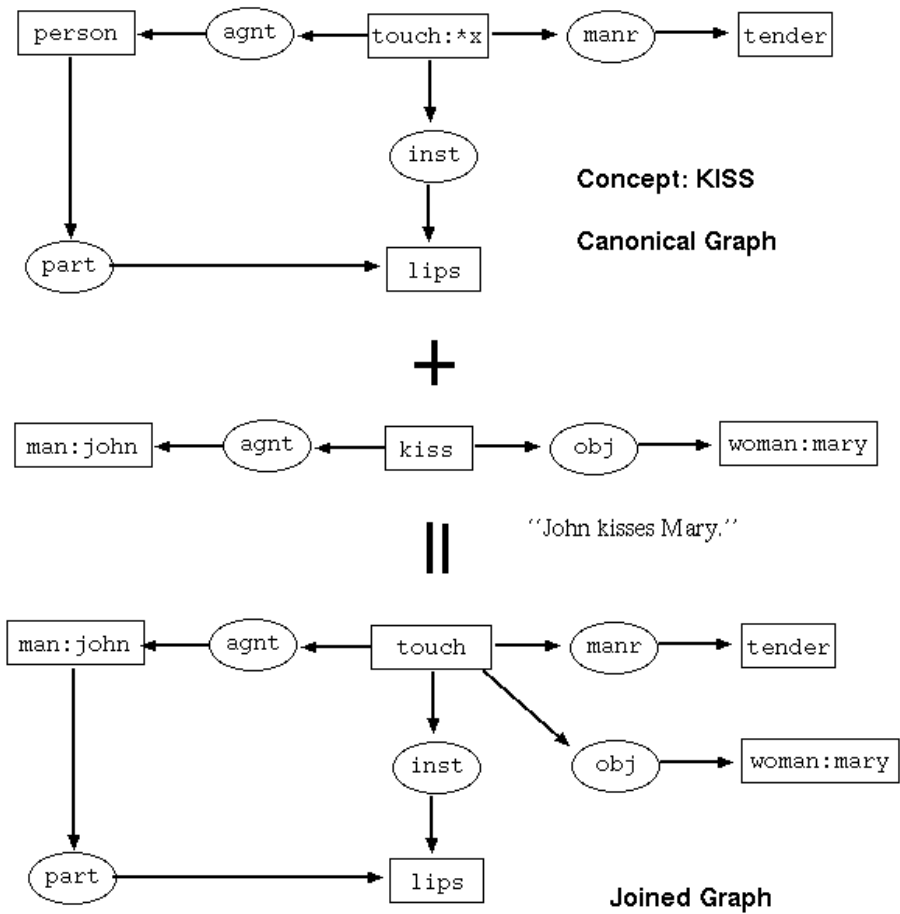
- 存在限定子だけでなく全称限定子も扱うことが可能に
 - 点線: 2つの変数が同じ (co-referent)



概念定義

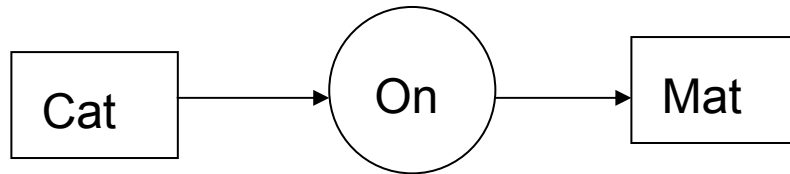
- ある *Concept* を別の *Concept* を使って定義する場合
 - 「*Canonical Graph*」と呼ばれる Conceptual Graph をつくる
 - 定義される *Concept* はその *Canonical Graph* に従って展開される
 - いくつかのデフォルト値やデフォルトの「グラフ」を適切に展開できるような機構を Sowa は考え出した

概念定義(例)



例1

- ***A cat is on a mat.***



Linear form: [Cat]->(On)->[Mat].

Conceptual graph interchange form: [Cat: *x] [Mat: *y] (On ?x ?y)

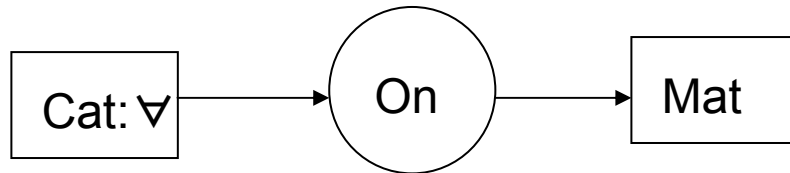
Alternative CGIF: (On [Cat] [Mat])

Knowledge Interchange Format: (exists ((?x Cat) (?y Mat)) (On ?x ?y))

predicate calculus: $(\exists x:\text{Cat})(\exists y:\text{Mat})\text{on}(x,y).$

例2

- ***Every cat is on a mat.***



LF: [Cat: ∇]->(On)->[Mat].

[Cat:@every]->(On)->[Mat].

CGIF: [Cat: @every*x] [Mat: *y] (On ?x ?y)

(On [Cat: @every] [Mat])

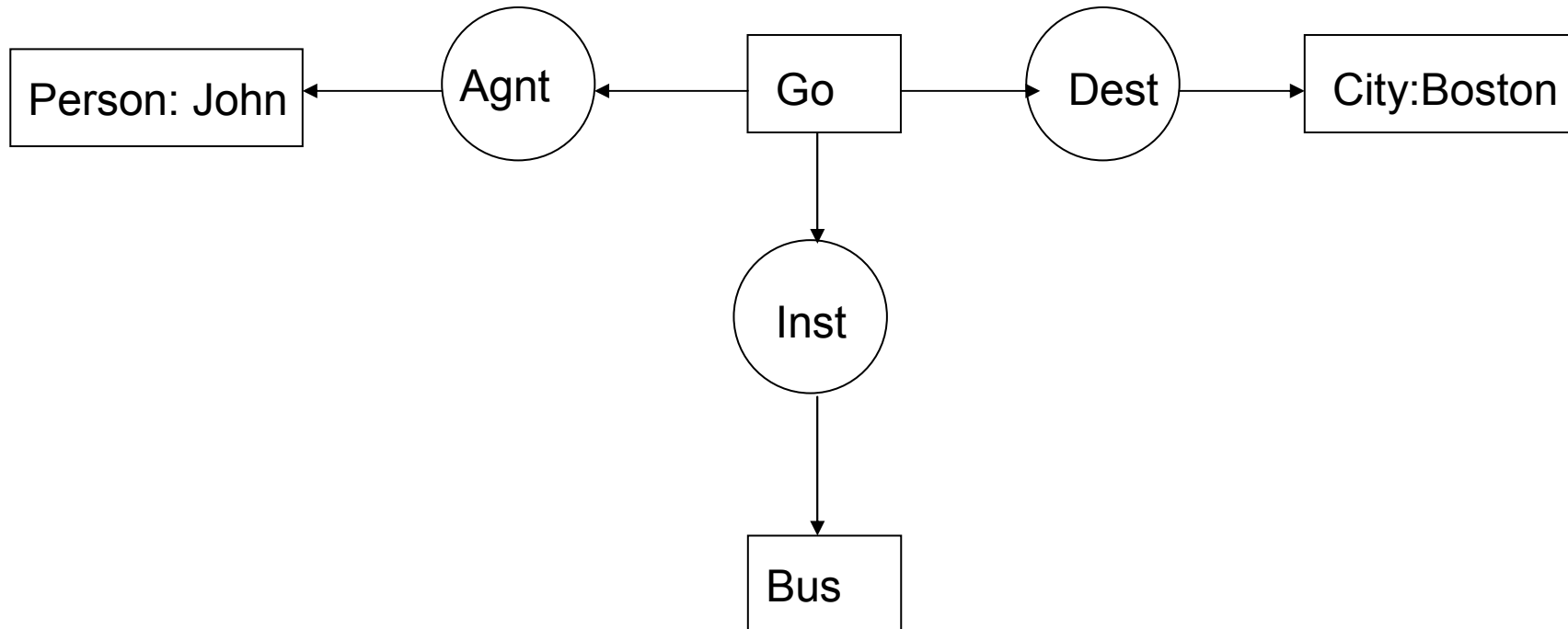
KIF: (forall ((?x Cat)) (exists ((?y Mat)) (On ?x ?y)))

pc: (∇ x:Cat)(∃ y:Mat)on(x,y).

$\neg[[Cat: *x] \neg[[?x]->(On)->[Mat]]]$.

例3

- ***John is going to Boston by bus.***



例3

- ***John is going to Boston by bus.***

LF: [Go]- (Agnt)->[Person: John] (Dest)->[City: Boston] (Inst)->[Bus].

CGIF: [Go: *x] [Person: John *y] [City: Boston *z] [Bus: *w]

(Agnt ?x ?y) (Dest ?x ?z) (Inst ?x ?z)

[Go *x] (Agnt ?x [Person: John]) (Dest ?x [City: Boston]) (Inst ?x [Bus])

KIF: (exists ((?x Go) (?y Person) (?z City) (?w Bus)))

(and (Name ?y John) (Name ?z Boston) (

Agnt ?x ?y) (Dest ?x ?z) (Inst ?x ?w)))

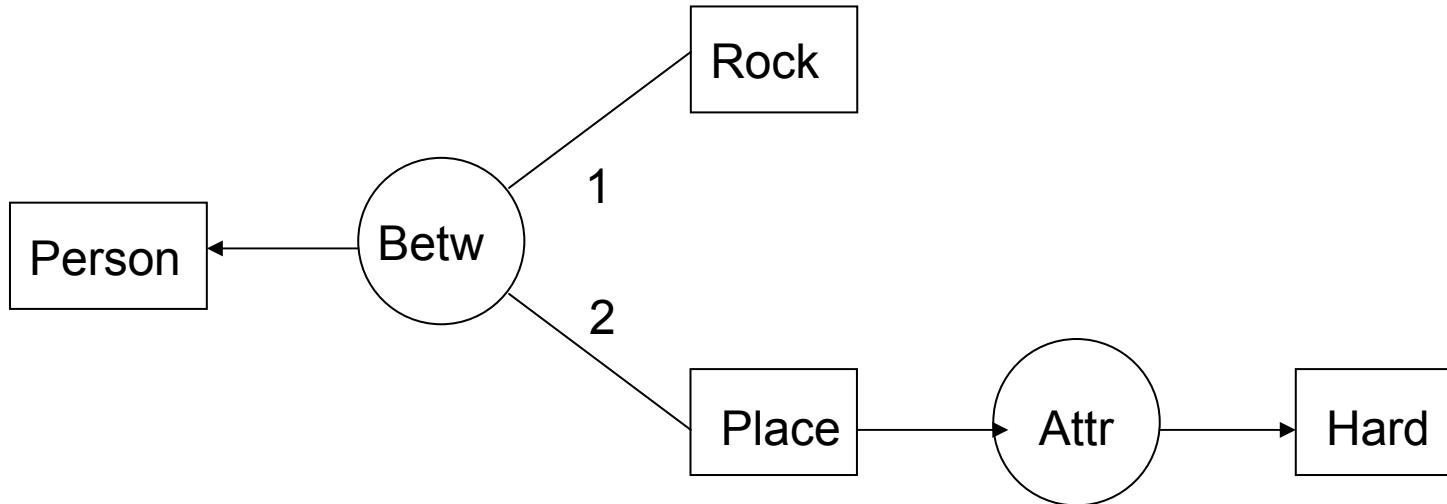
pc: (∃ x:Go)(∃ y:Person)(∃ z:City)(∃ w:Bus)

(name(y,'John') ∧ name(z,'Boston') ∧

agnt(x,y) ∧ dest(x,z) ∧ inst(x,w))

例4

- ***A person is between a rock and a hard place.***



例4

- ***A person is between a rock and a hard place.***

LF: [Person]<-(Betw)- <-1-[Rock] <-2-[Place]->(Attr)->[Hard].

CGIF: (Betw [Rock] [Place *x] [Person]) (Attr ?x [Hard])

[Place: *x]->(Attr)->[Hard] (Betw [Rock] ?x [Person]).

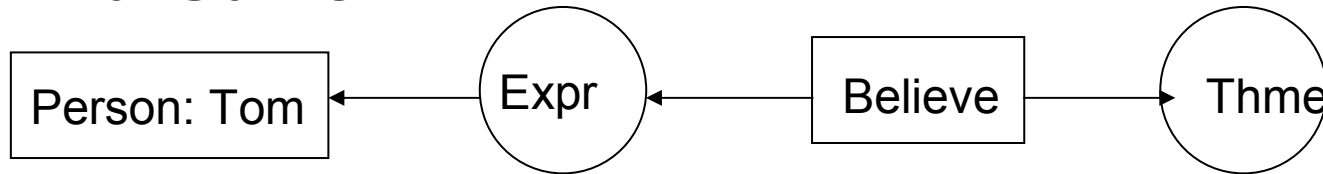
KIF: (exists ((?x person) (?y rock) (?z place) (?w hard)))

(and (betw ?y ?z ?x) (attr ?z ?w)))

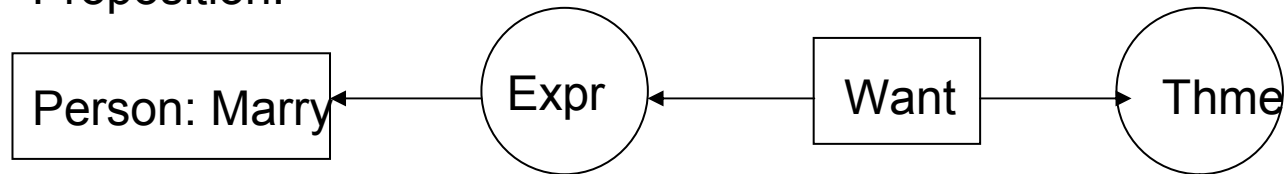
pc: (∃ x:Person)(∃ y:Rock)(∃ z:Place)(∃ w:Hard) (betw(y,z,x) ∧ attr(z,w))

例5

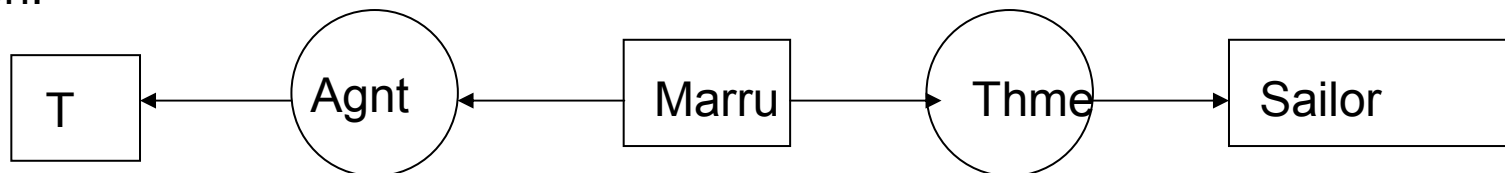
- ***Tom believes that Mary wants to marry a sailor.***



Proposition:



Situation:



例5

- ***Tom believes that Mary wants to marry a sailor.***

LF: [Person: Tom]<-(Expr)<-[Believe]->(Thme)-

[Proposition: [Person: Mary *x]<-(Expr)<-[Want]->(Thme)-

[Situation: [?x]<-(Agnt)<-[Marry]->(Thme)->[Sailor]]].

CGIF: [Person: *x1 'Tom'] [Believe *x2] (Expr ?x2 ?x1)

(Thme ?x2 [Proposition: [Person: *x3 'Mary'] [Want *x4] (Expr ?x4 ?x3)

(Thme ?x4 [Situation: [Marry *x5] (Agnt ?x5 ?x3) (Thme ?x5 [Sailor])]])

例5

- ***Tom believes that Mary wants to marry a sailor.***

KIF: (exists ((?x1 person) (?x2 believe))

(and (expr ?x2 ?x1)

(thme ?x2

(exists ((?x3 person) (?x4 want) (?x8 situation))

(and (name ?x3 'Mary) (expr ?x4 ?x3) (thme ?x4 ?x8)

(dscr ?x8 (exists ((?x5 marry) (?x6 sailor))

(and (Agnt ?x5 ?x3) (Thme ?x5 ?x6))))))))))

例5

- ***Tom believes that Mary wants to marry a sailor.***

pc: (\exists x1:Person)(\exists x2:Believe)(expr(x1,x2) \wedge
thme(x2, (\exists x3:Person)(\exists x4:Want)(\exists x8:Situation)
(name(x3,'Mary') \wedge expr(x4,x3) \wedge thme(x4,x8) \wedge
dscr(x8, (\exists x5:Marry)(\exists x6:Sailor) (agnt(x5,x3) \wedge thme(x5,x6))))))