18.1

句法驱动的语义分析

▲组合性原则 → 语义附着

e.g.1 Franco likes Frasca.

18.2

e.g.2 Maharani closed.

Closed (Maharani)

ProperNoun → Maharani {Maharani}

↓复制

NP → ProperNoun {ProperNoun.sem}

↓VP怎么办呢？

① 谓词名称

② 论元数量

③ 合并论元

VP → Verb {Verb.sem}

Verb → closed {λx.closed(x)}

一元谓词　未确定的内容

↓ NP作为谓词的第一个论元插入x

↓得到最终的语义附着。

S → NP VP {VP.sem (NP.sem)}

表达式　FOL常量 (constant)

λx.Closed(x)(Maharani)

↓Closed (Maharani)

? 对λ不熟悉了。

Det → every {λP.λQ.∀xP(x) ⇒ Q(x)}

Q(x)(λx.Restaurant(x))

? 为什么λ-reducing可行？背后的原理是什么？

e.g.3

目标：Every restaurant closed.

方法：∀x Restaurant(x) ⇒ ∃e Closed(e) ∧ ClosedThing(e,x)

约束 (restriction)　核心范围 (nuclear scope)

范围 (Q)

∀x Restaurant(x) ⇒ Q(x)

λQ. ∀x Restaurant(x) ⇒ Q(x)

e.g.3

$NP \rightarrow Det\ Nominal \quad \{Det.Sem(Nominal.Sem)\}$

$Det \rightarrow every \quad \{\lambda P.\lambda Q.\forall x P(x) \Rightarrow Q(x)\}$ → 如何推？

$Nominal \rightarrow Noun \quad \{Noun.sem\}$

$Noun \rightarrow restaurant \quad \{\lambda x.Restaurant(x)\}$

The critical step in this sequence involves the λ-reduction in the *NP* rule. This rule applies the λ-expression attached to the *Det* to the semantic attachment of the *Nominal*, which is itself a λ-expression. The following are the intermediate steps in this process.

every·(x)　中间谓词

$\lambda P.\lambda Q.\forall x P(x) \Rightarrow Q(x)(\lambda x.Restaurant(x))$

restaurant → 某个restaurant状态

$\lambda Q.\forall x \lambda x.Restaurant(x)(x) \Rightarrow Q(x)$

多出了λx.(x)

$\lambda Q.\forall x\ Restaurant(x) \Rightarrow Q(x)$

18.2 补充句法规则的语义扩充、

Det → a {λP.λQ.∃x P(x) ∧ Q(x)}
捕获 a

VP → verb NP {Verb.Sem (NP.Sem)}

↓ open 的附着为：

打开之事 施事 -er 受事 -thing

verb → opened {λw.λz.w(λx∃e Opened(e) ∧ Opener(e,z) ∧ OpenThing(e,x))}

等于：

∃x Restaurant(x) ∧ ∃e Opened(e) ∧ Opener(e, Matthew) ∧ OpenedThing(e,x)

以餐馆为事件核心

如何利用语法规则进行语义附着处理？

Grammar Rule	Semantic Attachment
$S \rightarrow NP\ VP$	$\{NP.sem(VP.sem)\}$
1 $NP \rightarrow Det\ Nominal$	$\{Det.sem(Nominal.sem)\}$
2 $NP \rightarrow ProperNoun$	$\{ProperNoun.sem\}$
3 $Nominal \rightarrow Noun$	$\{Noun.sem\}$
$VP \rightarrow Verb$	$\{Verb.sem\}$
$VP \rightarrow Verb\ NP$	$\{Verb.sem(NP.sem)\}$
$Det \rightarrow every$	$\{\lambda P.\lambda Q.\forall x P(x) \Rightarrow Q(x)\}$
$Det \rightarrow a$	$\{\lambda P.\lambda Q.\exists x P(x) \wedge Q(x)\}$
$Noun \rightarrow restaurant$	$\{\lambda r.Restaurant(r)\}$
$ProperNoun \rightarrow Matthew$	$\{\lambda m.m(Matthew)\}$
$ProperNoun \rightarrow Franco$	$\{\lambda f.f(Franco)\}$
$ProperNoun \rightarrow Frasca$	$\{\lambda f.f(Frasca)\}$
$Verb \rightarrow closed$	$\{\lambda x.\exists e Closed(e) \wedge ClosedThing(e,x)\}$
$Verb \rightarrow opened$	$\{\lambda w.\lambda z.w(\lambda x.\exists e Opened(e) \wedge Opener(e,z) \wedge Opened(e,x))\}$

Figure 18.3 Semantic attachments for a fragment of our English grammar and lexicon.

18.3 量词辖域及非确定性.

18.3 Quantifier Scope Ambiguity and Underspecification

量词辖域

The grammar fragment developed in the last section appears to be sufficient to handle examples like the following that contain two or more quantified noun phrases.

(18.6) Every restaurant has a menu.

Systematically applying the rules given in Fig. 18.2 to this example produces the following perfectly reasonable meaning representation.

歧义1：(正确)

$$\forall x\, Restaurant(x) \Rightarrow \exists y\, Menu(y) \wedge \exists e Having(e) \wedge Haver(e,x) \wedge Had(e,y)$$

有外部辖域(更大)

与几表达式位置顺序有关，那么，如何解决？

18.3.1 (非确定性)
18.3.2 (生成|抽取)

This formula more or less corresponds to the common sense notion that all restaurants have menus.

Unfortunately, this isn't the only possible interpretation for this example. The following is also possible.

歧义2：(错误)

$$\exists y\, Menu(y) \wedge \forall x\, Restaurant(x) \Rightarrow \exists e\, Having(e) \wedge Haver(e,x) \wedge Had(e,y)$$

18.3.1 存储与检索方法

库珀存储 (Cooper storage)

—作用：让量词填充特定的角色

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$$\exists y\, Menu(y) \wedge \forall x\, Restaurant(x) \Rightarrow \exists e\, Having(e) \wedge Haver(e,x) \wedge Had(e,y)$$

$$\exists e\ Having(e) \wedge Haver(e, s_1) \wedge Had(e, s_2)$$
$$(\lambda Q.\ \forall x\ Restaurant(x) \Rightarrow Q(x), 1)$$
$$(\lambda Q.\ \exists x\ Menu(x) \wedge Q(x), 2)$$

?

18.3.2 基于约束的方法

孔语义学 (hole)

18.4 基于合一的语义分析方法

$\exists e\, Closing(e) \wedge Closed(e, Rhumba)$

FoL公式：

1、谓词、论元（原子公式）
2、运算逻辑符 $\wedge \vee \Rightarrow$
3、量词、变量、规则和量化公式

e.g.1 一个典型的特征结构（BNF风格）

计量　变量

$$\begin{bmatrix} \text{QUANT} & \exists \\ \text{VAR} & \boxed{1} \\ \text{FORMULA} & \begin{bmatrix} \text{OP} & \text{AND} \\ \text{FORMULA1} & \begin{bmatrix} \text{PRED} & \text{CLOSING} \\ \text{ARG0} & \boxed{1} \end{bmatrix} \\ \text{FORMULA2} & \begin{bmatrix} \text{PRED} & \text{CLOSED} \\ \text{ARG0} & \boxed{1} \\ \text{ARG1} & \text{RHUMBA} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(=∧ 运算)

原子公式

e.g.2 (DAG风格)

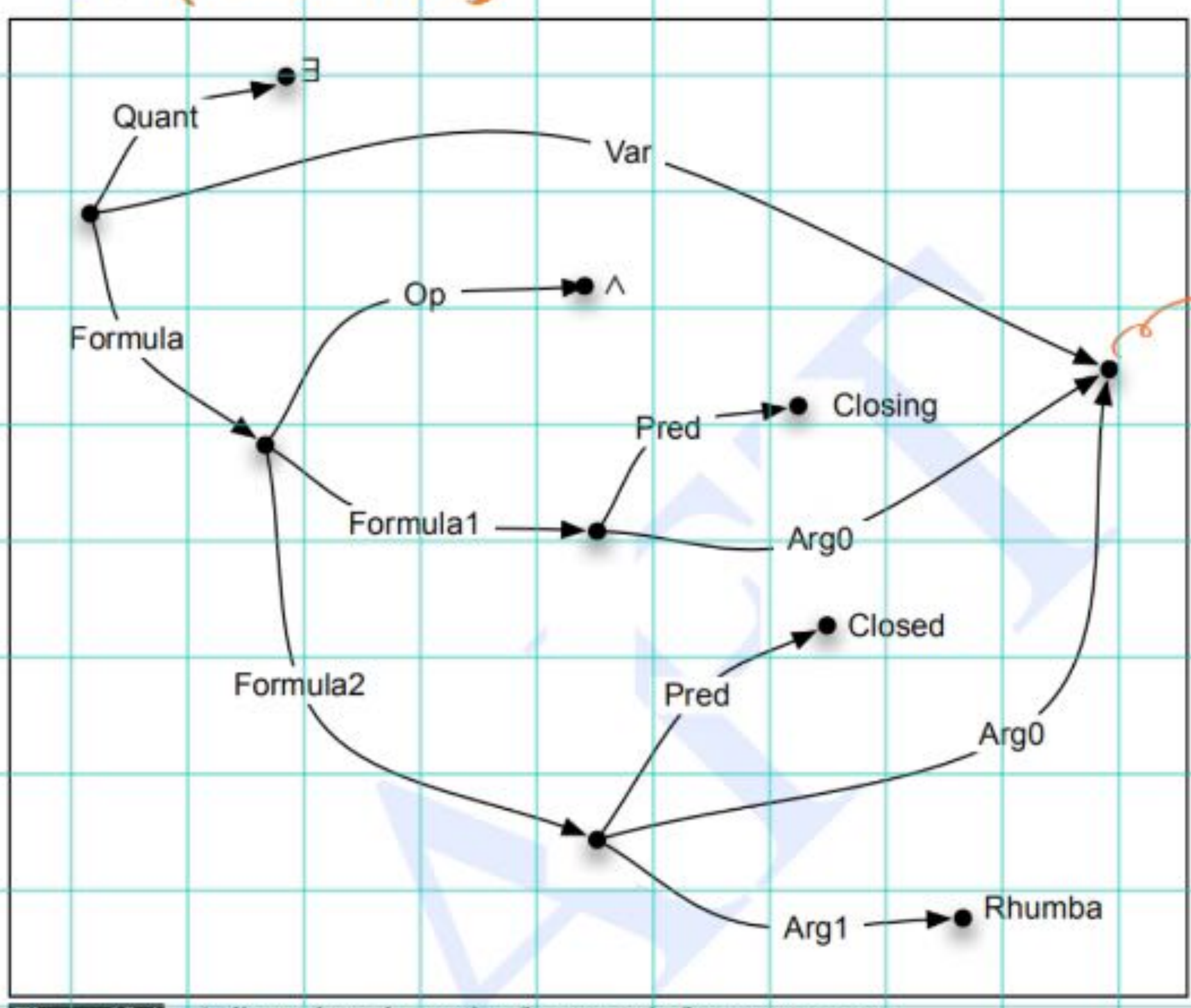

Figure 18.4 A directed graph notation for semantic feature structures.

可能存在的变量，都往这里走。

语义附着的2个不同任务：
1、VP的语义填充 实者NP的 核心范围
2、NP的变量必须指派给事件结构中的正确角色、

closed x

e.g.3 更复杂的例子 →

$\forall x Restaurant(x) \Rightarrow (\exists e Closing(e) \wedge Closed(e,x))$

$$\begin{bmatrix} \text{QUANT} & \forall \\ \text{VAR} & \boxed{1} \\ \text{FORMULA} & \begin{bmatrix} \text{OP} & \Rightarrow \\ \text{FORMULA1} & \begin{bmatrix} \text{PRED} & \text{RESTAURANT} \\ \text{ARG0} & \boxed{1} \end{bmatrix} \\ \text{FORMULA2} & \begin{bmatrix} \text{QUANT} & \text{EXISTS} \\ \text{VAR} & \boxed{2} \\ \text{FORMULA} & \begin{bmatrix} \text{OP} & \wedge \\ \text{FORMULA1} & \begin{bmatrix} \text{PRED} & \text{CLOSING} \\ \text{ARG0} & \boxed{2} \end{bmatrix} \\ \text{FORMULA2} & \begin{bmatrix} \text{PRED} & \text{CLOSED} \\ \text{ARG0} & \boxed{2} \\ \text{ARG1} & \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

∃