Logical Forms

Prof. Sameer Singh

CS 295: STATISTICAL NLP

WINTER 2017

February 21, 2017

Based on slides from Noah Smith, Dan Klein, Tom Kwiatkowski, and everyone else they copied from.

Outline

Combinatory Categorical Grammar

Learning CCGs

Outline

Combinatory Categorical Grammar

Learning CCGs

CCG Types

Instead of non-terminals, it has infinitely large set of **categories or types**

Primitive

S, NP, VP, ...

Complex

S\NP

S except it lacks an NP on the left

S/NP

right

CCG Combinators

	Forward	Backward
Application	$X/Y \; Y \Rightarrow X$	$Y \; X\backslash Y \Rightarrow X$
Conjunction	$X \text{ and } X \Rightarrow X$	
Composition	$X/Y \; Y/Z \Rightarrow X/Z$	$Y\backslash Z \; X\backslash Y \Rightarrow X\backslash Z$
Type-Raising	$X \Rightarrow Y/(Y\backslash X)$	$X \Rightarrow Y\backslash(Y/X)$

Connection to Semantics?

Application

$$\underset{f}{X/Y} \quad \underset{g}{Y} \Rightarrow \underset{f(g)}{X}$$

Conjunction

$$X_f \text{ and } X_g \Rightarrow X_{(f \wedge g)}$$

Composition

$$X/Y_f \quad Y/Z_g \Rightarrow X/Z_{\lambda x.f(g(x))}$$

Type-raising

$$X_g \Rightarrow Y/(Y\backslash X)_{\lambda f.f(g)}$$

Outline

Combinatory Categorical Grammar

Learning CCGs

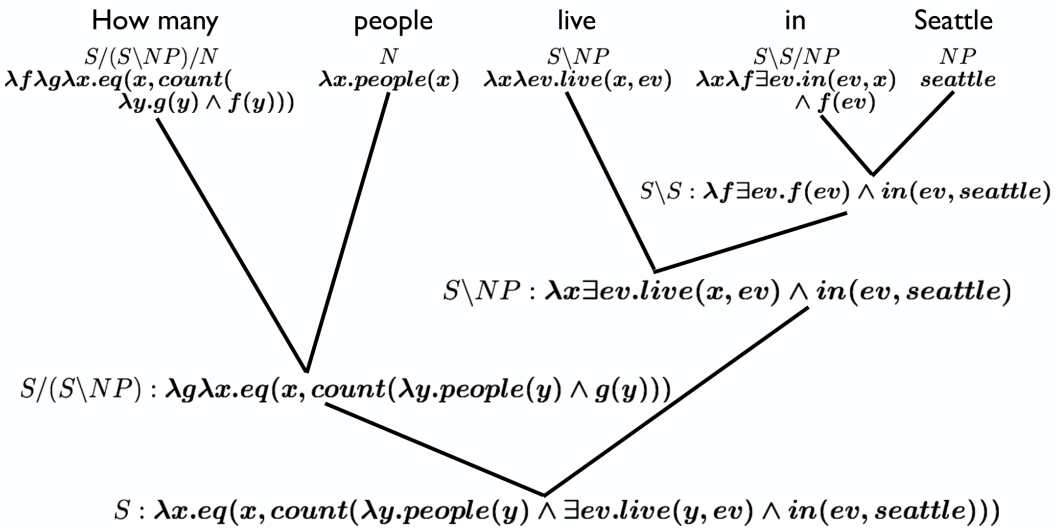
Components: Lexicon and Grammar

How many [people] live in [Seattle] Lexicon

Grammar

Scoring Derivations

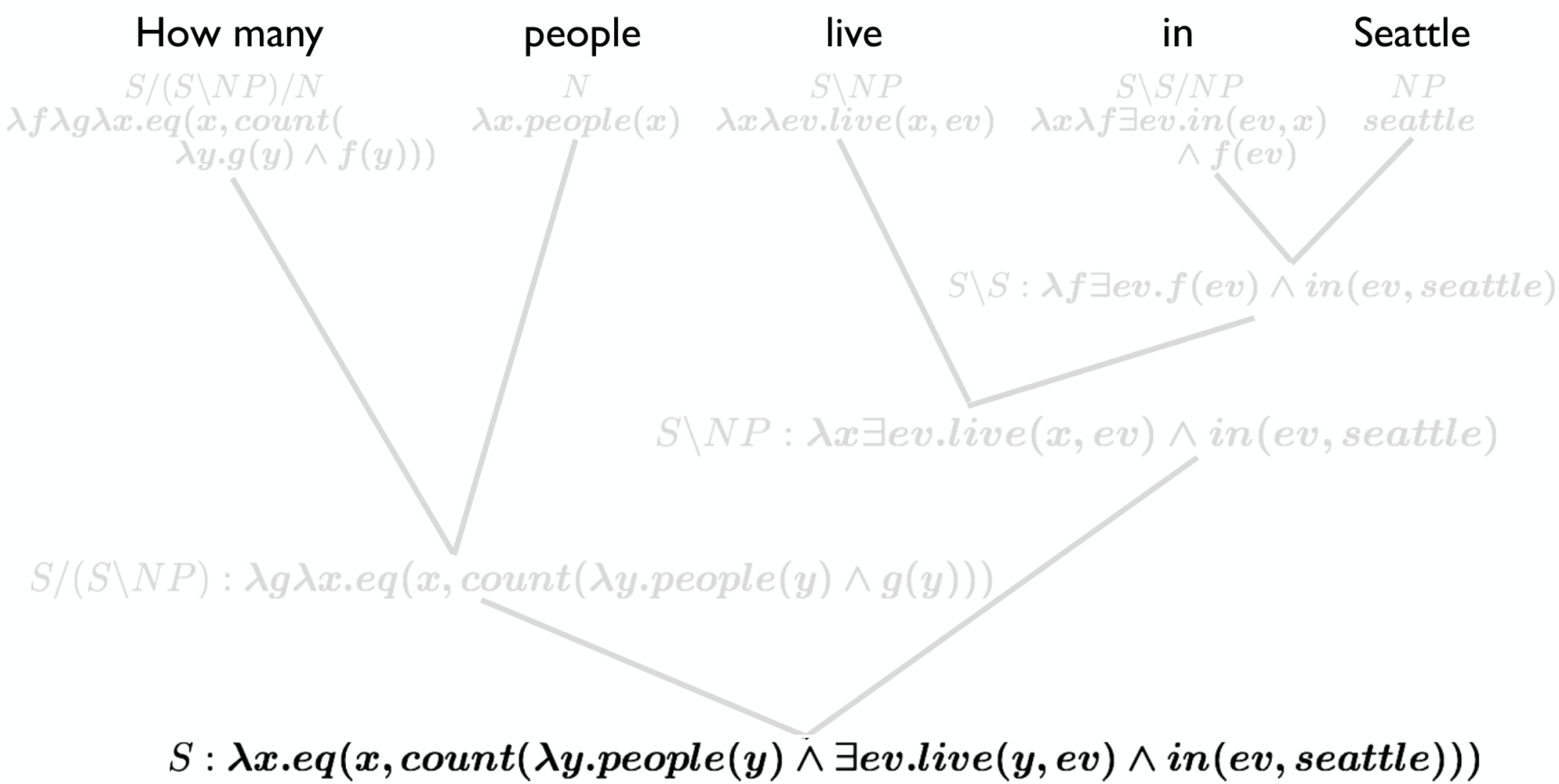
d



$$d^* = \underset{d}{\operatorname{argmax}}\ s(d)$$

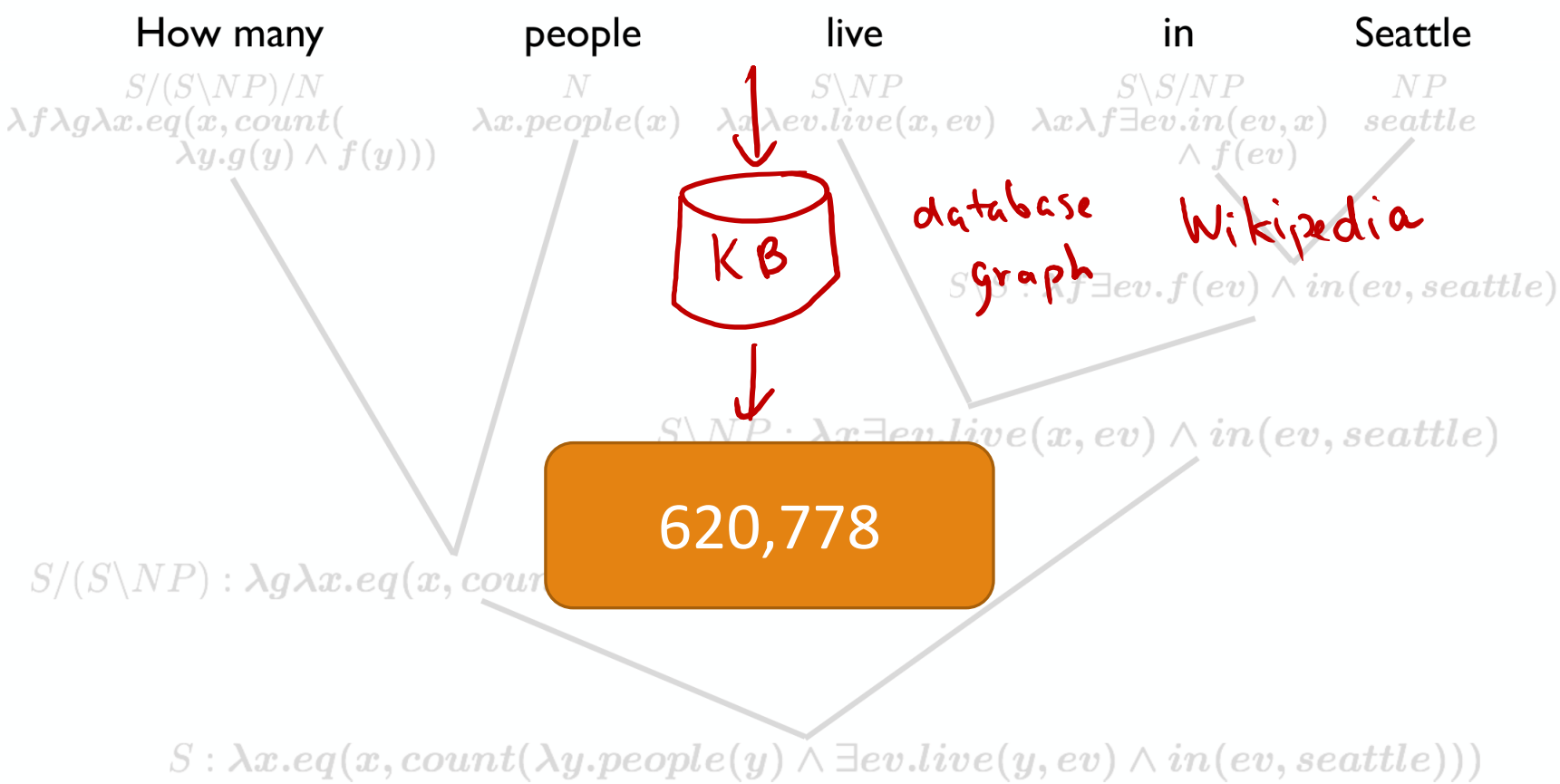
$$s(d) = \theta \cdot \phi(d)$$

We don't have derivations!



Steedman, 2000

Sometimes, we don't have LFs



Steedman, 2000

Learning Algorithm

Structured Perception

Input:

How ...

(20,77)

- Question/Answer pairs $\{(q_i, a_i) : 1, \ldots, N\}$
- Lexicon, Grammar, Knowledge base **K**, initial parameters θ_0

Output

- Parameters $\theta_{T \times N}$

q_1 ⋮ q_k

for $t = 1, \ldots, T$:

  for $i = 1, \ldots, N$:

    $C \leftarrow$ Max scoring correct derivations of q_i

    $W \leftarrow$ Margin violating incorrect derivations of q_i

$$\theta_{i \times t} = \theta_{i \times t-1} + \frac{1}{|C|} \sum_{c \in C} \phi(c) - \frac{1}{|W|} \sum_{w \in W} \phi(w)$$