





n = 1  
n = 2  
n = 3  
n = 4

That's great, it starts with an earthquake, birds and snakes, an aeroplane - Lenny **Bruce** is not afraid. Eye of a hurricane, to yourself churn - world serves its own needs, regardless of your own needs. Feed it up a knock, speed, grunt no, strength no. **Ladder structure** clatter with fear of height, down height. Wire in a fire, represent the seven games in a government for hire and a combat site. Left her, wasn't coming in a hurry with the furies breathing down your neck. Team by team reporters baffled, trump, tethered crop. **Look at that** low plane! Fine then. Uh oh, overflow, population, common group, but it'll do. Save yourself, serve yourself. World serves its own needs, listen to your heart bleed. Tell me with the rapture and the reverent in the right - right. **You vitriolic, patriotic, slam**, fight, bright light, feeling pretty psyched.

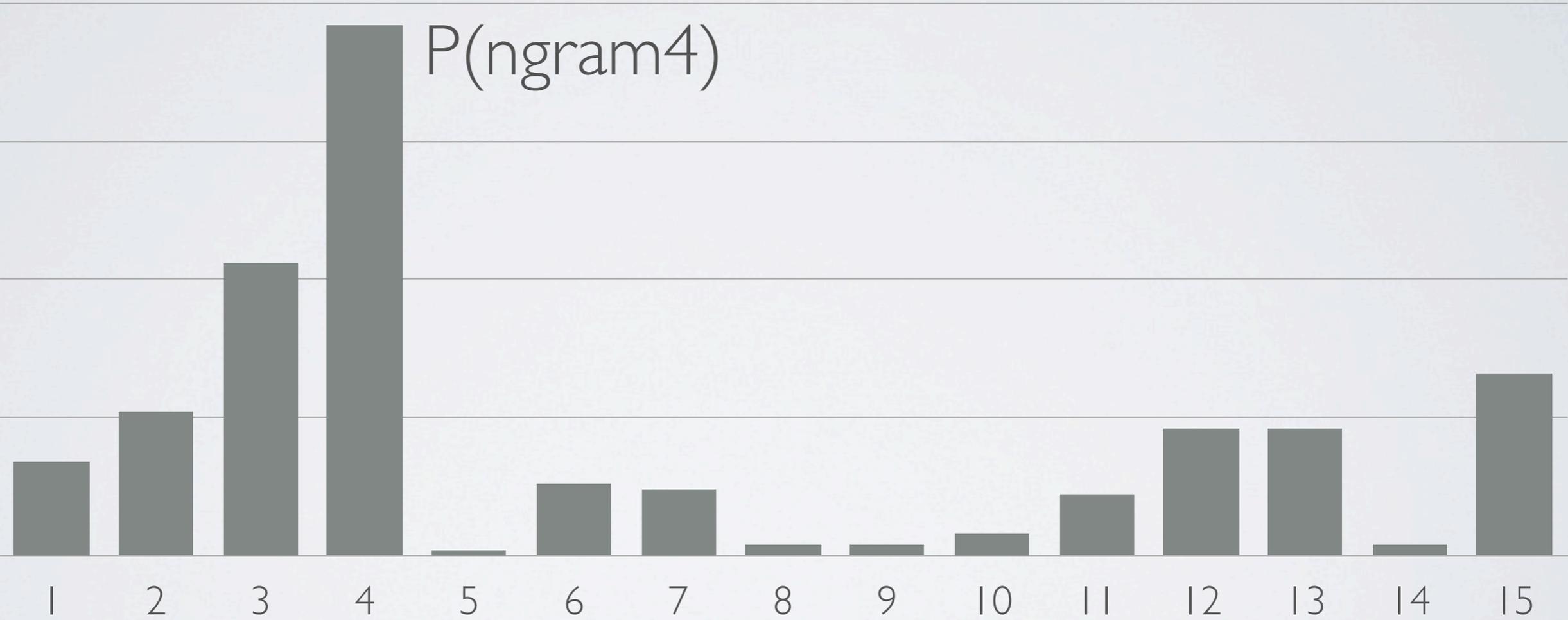
It's the end of the world as we know it.  
It's the end of the world as we know it.  
It's the end of the world as we know it and I feel fine.

# NGRAM MODELS

■ Region I

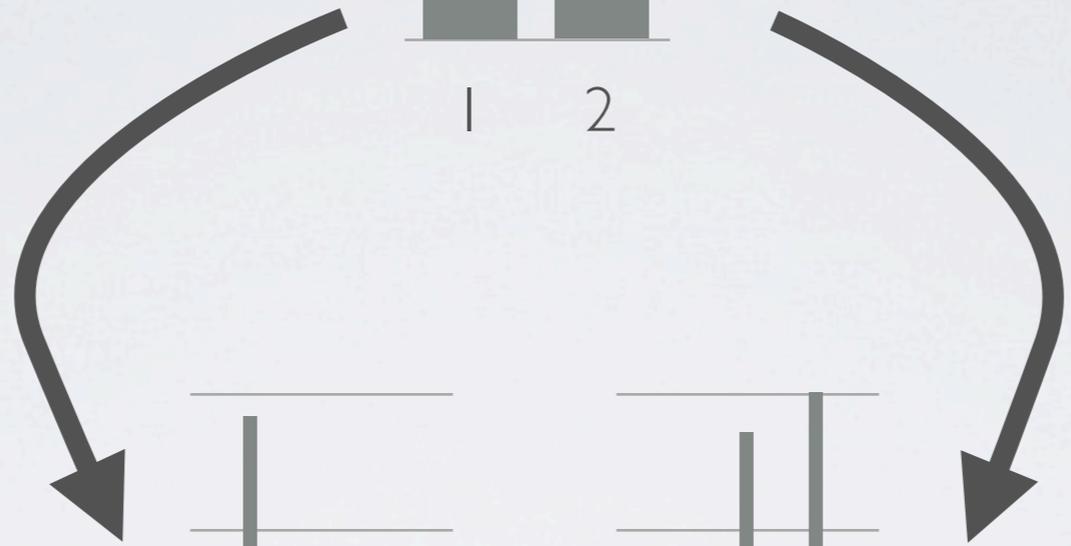
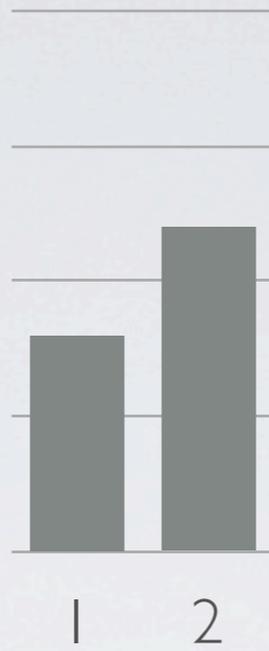
Corpus: latin Body

$P(\text{ngram4})$

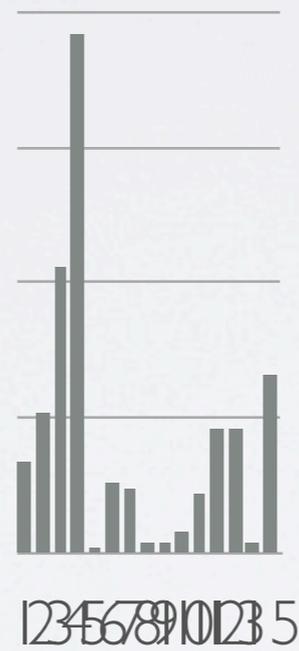


# COUNTING NGRAMS

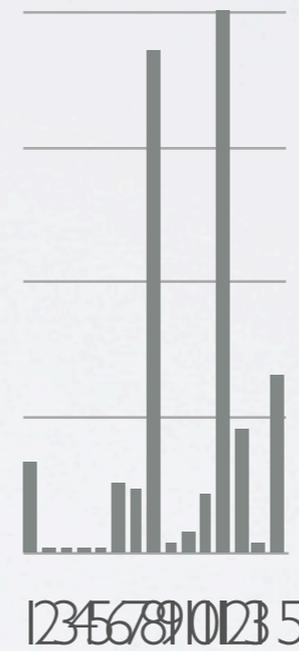
$P(\text{Spam})$



$P(\text{EMAIL}|\text{SPAM})$



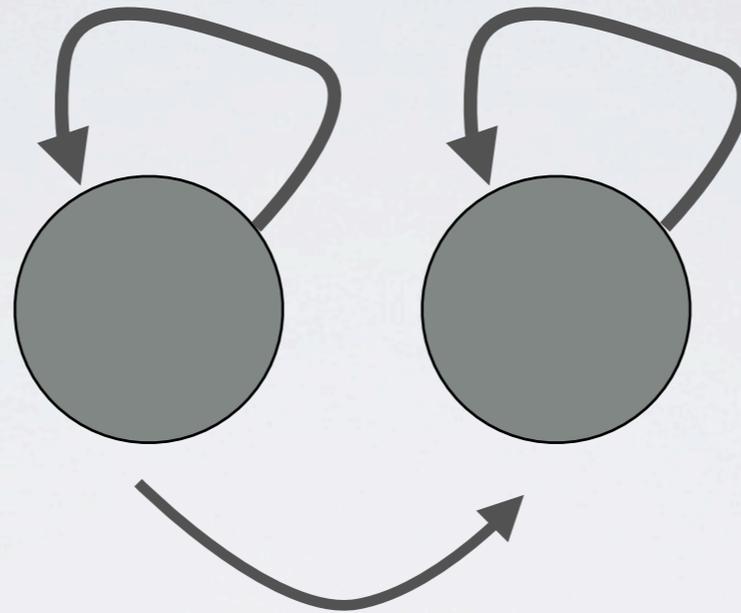
$P(\text{EMAIL}|\overline{\text{SPAM}})$



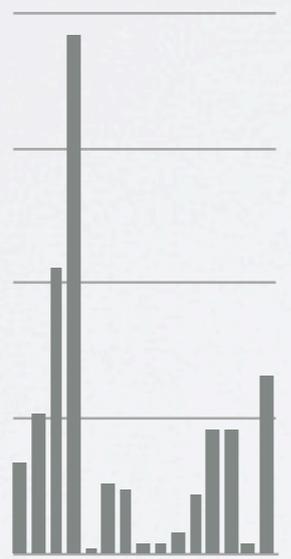
# CLASSIFICATION



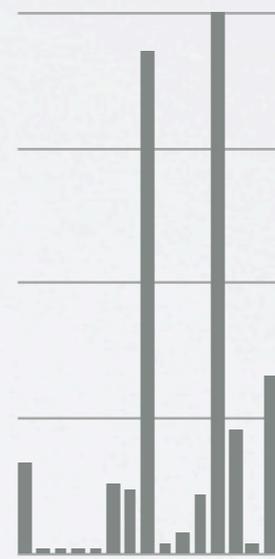
# MIXTURES OF MULTINOMIALS



Transitions



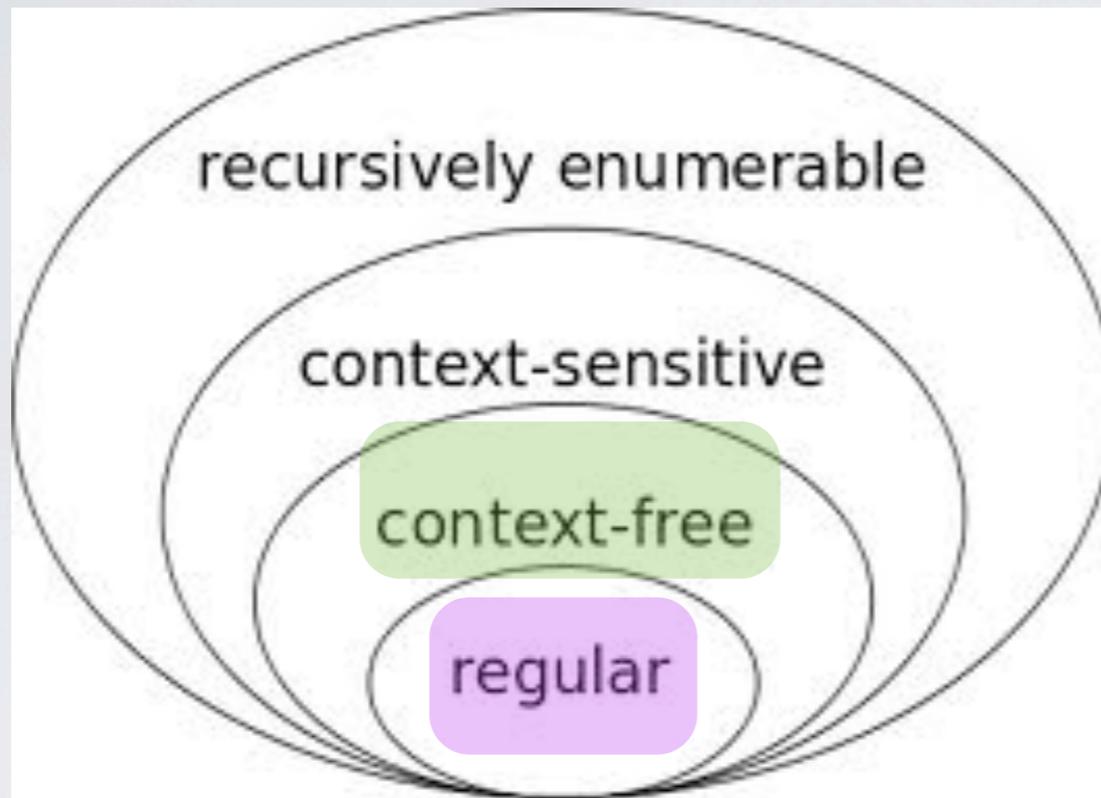
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15



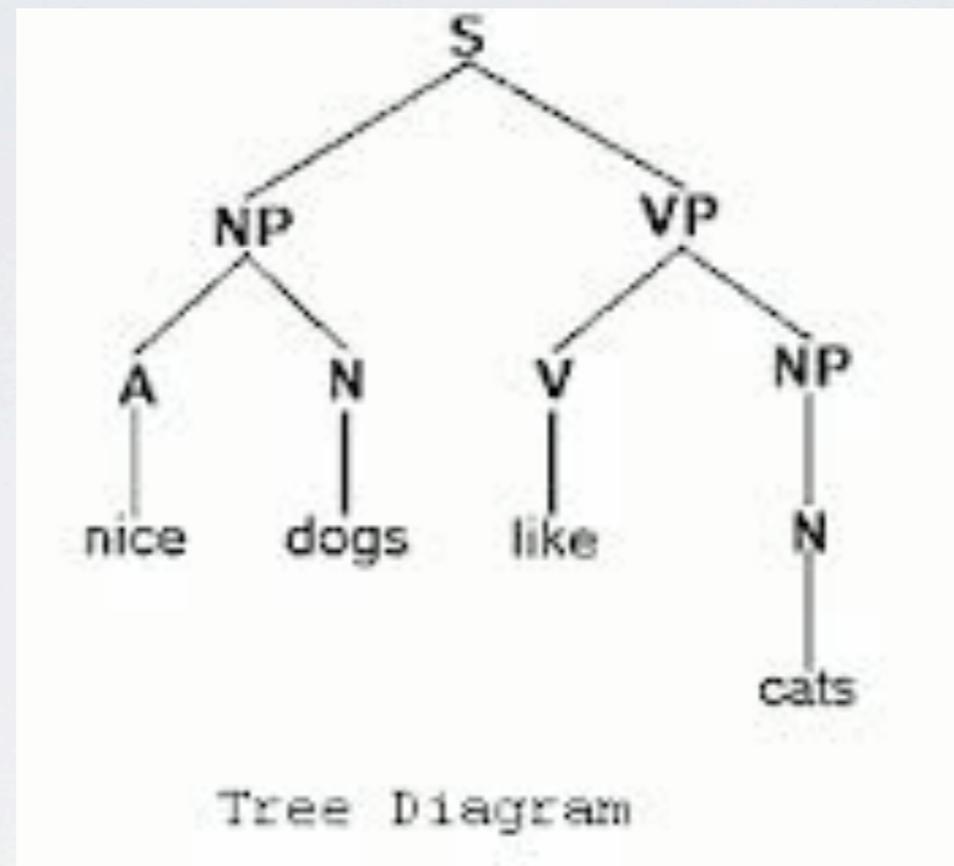
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Observations

# DISCRETE HIDDEN MARKOV MOEDL



# GRAMMARS



# CONTEXT FREE GRAMMAR

**function** CYK-PARSE(*words*, *grammar*) **returns** *P*, a table of probabilities

$N \leftarrow \text{LENGTH}(\textit{words})$

$M \leftarrow$  the number of nonterminal symbols in *grammar*

$P \leftarrow$  an array of size  $[M, N, N]$ , initially all 0

*/\* Insert lexical rules for each word \*/*

**for**  $i = 1$  **to**  $N$  **do**

**for each** rule of form  $(X \rightarrow \textit{words}_i [p])$  **do**

$P[X, i, 1] \leftarrow p$

*/\* Combine first and second parts of right-hand sides of rules, from short to long \*/*

**for**  $\textit{length} = 2$  **to**  $N$  **do**

**for**  $\textit{start} = 1$  **to**  $N - \textit{length} + 1$  **do**

**for**  $\textit{len1} = 1$  **to**  $N - 1$  **do**

$\textit{len2} \leftarrow \textit{length} - \textit{len1}$

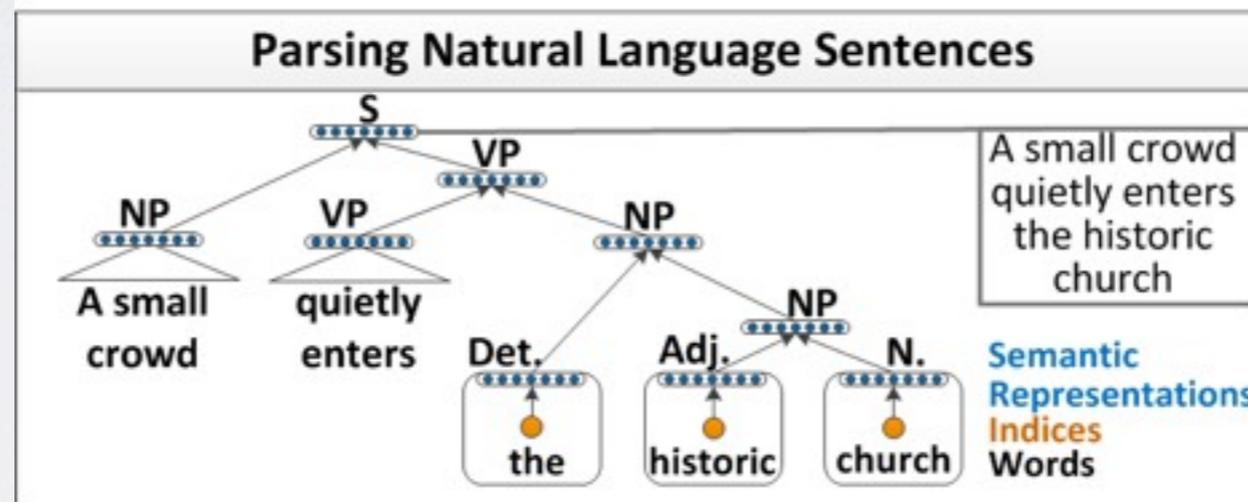
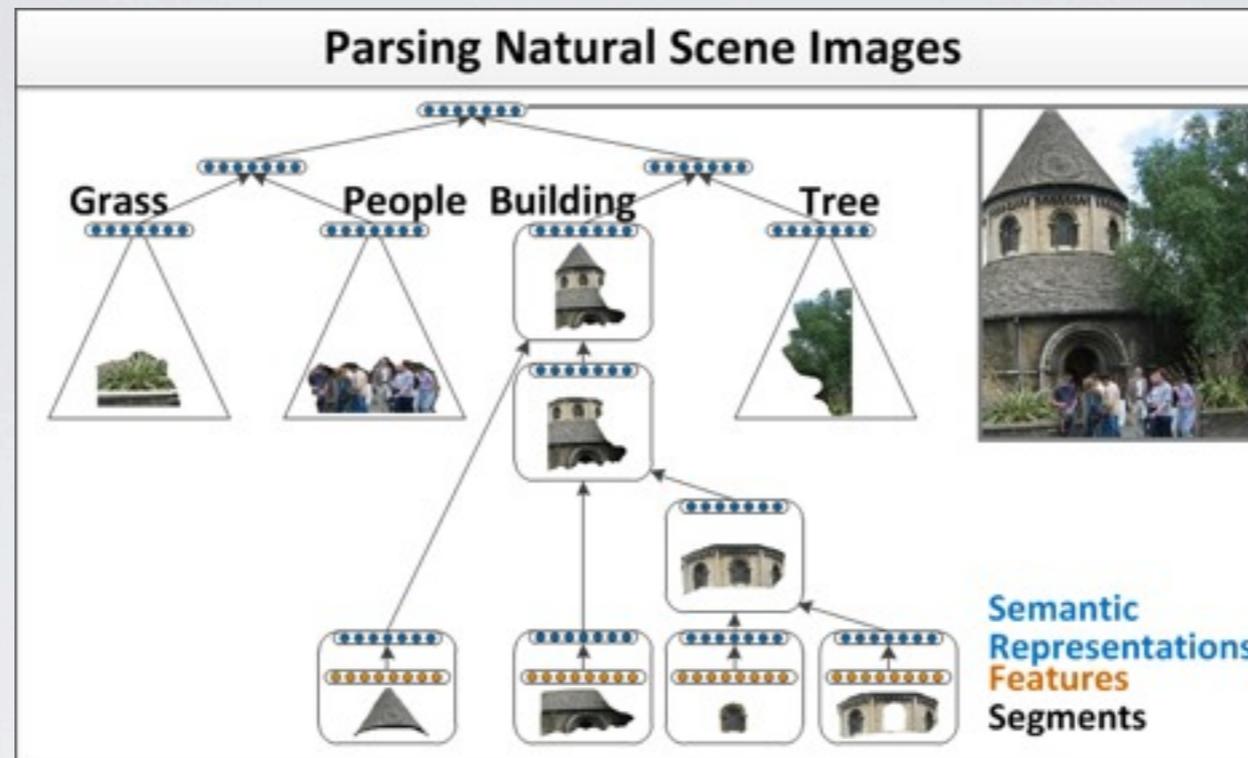
**for each** rule of the form  $(X \rightarrow Y Z [p])$  **do**

$P[X, \textit{start}, \textit{length}] \leftarrow \text{MAX}(P[X, \textit{start}, \textit{length}],$

$P[Y, \textit{start}, \textit{len1}] \times P[Z, \textit{start} + \textit{len1}, \textit{len2}] \times p)$

**return**  $P$

# CYK - ALGORITHM / PARSING



# IMAGE COMPOSITION



Figure 7: *Experiment II: All of the discs have the same size and shape. Also, note that the dark shadow under the hand is labelled as noise*



Figure 9: *Experiment IV: In this frame, the book fully occludes the third peg. The system must infer the interactions that are hidden.*



Figure 8: *Experiment III: The small foreground block is a distracter object in this scene. The system must determine from behavior that it is irrelevant to the activity even when*

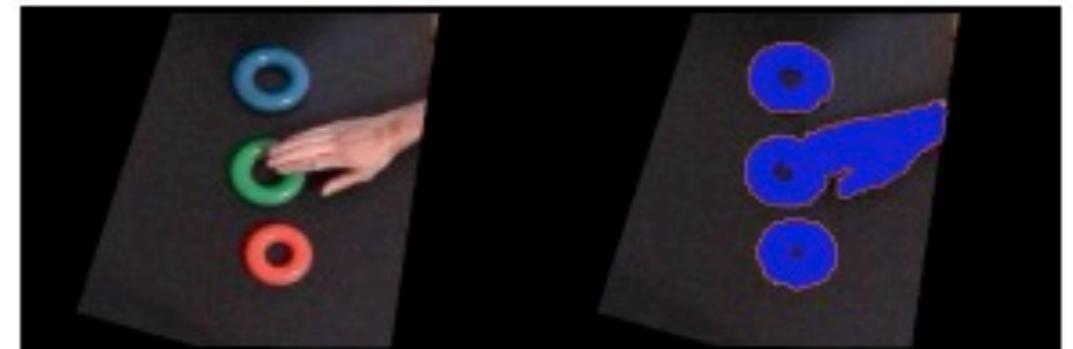


Figure 10: *Screenshot from the Simon game demonstrating analysis of another domain.*

# EXPECTATION GRAMMARS