

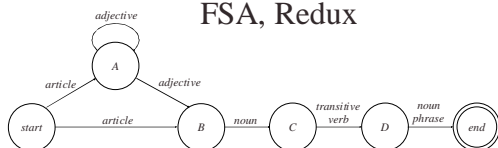
Syntax Done Right: What LING 250 Covers

LING 106
Nov. 16, 2007

Modeling Syntactic Strings: Things That Don't Work

- Storing every string in the language.
- Using very local contexts.
 - Long distance dependencies
 - Can "is" follow "my parents" in a string?
 - No, if it's part of my parents is living in the south.
 - Yes, if it's part of visiting my parents is stressful.
 - Which is to say, we need to know where we are in the structure and what came before.
 - (Which is why FSAs don't work)

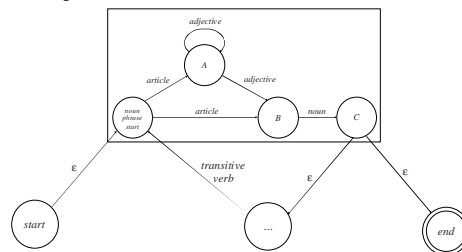
FSA, Redux



- We know, of course, that this doesn't work. Could it be on the right track?
- Consider:
 - the dog saw a cat
 - a cat saw the dog
 - the happy dog saw every sad cat
 - every sad cat saw the happy dog

FSA, Redux

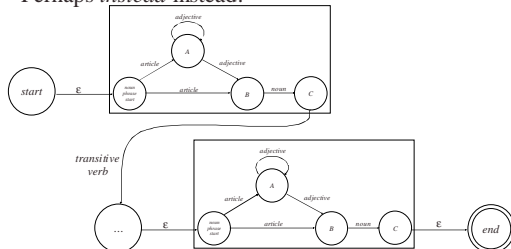
- Perhaps instead:



- ...well, perhaps not.

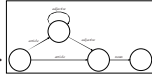
FSA, Redux

- Perhaps *instead* instead:



- This works. Well, except that...

FSA, Redux

- Some more data:
 - the dog {slept/barked/walked/jumped/...}
 - the cat {saw/liked/chased/...} the dog
 - the dog {saw/liked/chased/...} the cat
 - my sweater is {on/under/near/...} the dog
 - etc.
- Our "noun phrase" box has to appear in a lot of different places in the FSA. 
- That's irritating, from the point of view of FSAs.
- ...but not context-free grammars!

Context-Free Grammars: Review

- Context Free Grammars:

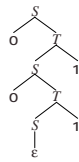
$A \rightarrow Bx$ or $A \rightarrow xB$ or $A \rightarrow x$

- e.g., $0^n 1^n$

- Example:

- $S \rightarrow \epsilon$
- $S \rightarrow OT$
- $T \rightarrow S1$

$S \Rightarrow$
 $OT \Rightarrow$
 $O(S1) \Rightarrow$
 $O((OT)1) \Rightarrow$
 $O((O(S1))1) \Rightarrow$
 $O((O((\epsilon)1))1) =$
 0011



Turning the FSA "Box" into a CFG

- If what we want is "an article, followed by any number of adjectives, followed by a noun":

$noun\text{-}phrase \rightarrow article\ adjective^* noun$
 $NP \rightarrow Art\ Adj^* N$

- ...where *noun-phrase* (NP), *article* (Art), *adjective* (Adj), *noun* (N) are all non-terminals;
- and *adjective** means "zero or more adjectives"

Using CFGs

- So for our data:

- the dog {slept/barked/walked/jumped/...}
- the cat {saw/liked/chased/...} the dog
- the dog {saw/liked/chased/...} the cat
- my sweater is {on/under/near/...} the dog

- We have:

- $S[\text{entence}] \rightarrow NP \{\text{slept/barked/walked/jumped/...}\}$
- $S \rightarrow NP \{\text{saw/liked/chased/...}\} NP$
- $S \rightarrow \text{my sweater is} \{\text{on/under/near/...}\} NP$

- Or, better yet:

- $S \rightarrow NP$ intransitive-verb $S \rightarrow NP IV$
- $S \rightarrow NP$ transitive-verb NP $S \rightarrow NP TV NP$
- $S \rightarrow NP$ is preposition NP $S \rightarrow NP \text{ is Prep NP}$

Using CFGs

- In fact:

- We drew a box for noun phrases, because a variety of things could be interchanged.
- We could do the same thing for other phrases.

- e.g., **john put the book...**

- ...on {the table/a tall shelf/his foot}
- ...near {the table/a tall shelf/his foot}
- ...under {the table/a tall shelf/his foot}
- generally: "P NP".

- From there:

- $S \rightarrow NP$ put NP PP
- $PP \rightarrow P NP$

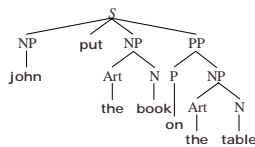
In A Tree

- Rules:

- $S \rightarrow NP$ put NP PP [john] put [Art N] [P NP] \Rightarrow
- $PP \rightarrow P NP$ [john] put [[the] [book]] [[on] [Art N]] \Rightarrow
- $NP \rightarrow Art\ Adj^* N$ [john] put [[the] [book]] [[on] [the] [table]]

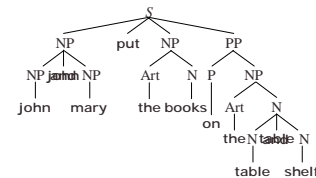
- More rules:

- $NP \rightarrow \text{john}$
- $N \rightarrow \text{table} \mid \text{shelf} \mid \text{foot}$
- $Art \rightarrow \text{the} \mid \text{a} \mid \text{an} \mid \text{his}$
- $Adj \rightarrow \text{tall}$
- $Prep \rightarrow \text{on} \mid \text{near} \mid \text{under}$

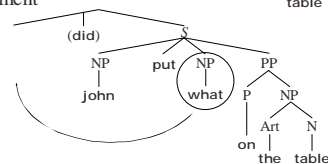


Things We Can Do With Trees

- Conjunction



- Movement



Things We Can Do With Trees

- More generally: we can refer to structure in a way that we couldn't with a Right Linear Grammar (aka a regular language).

