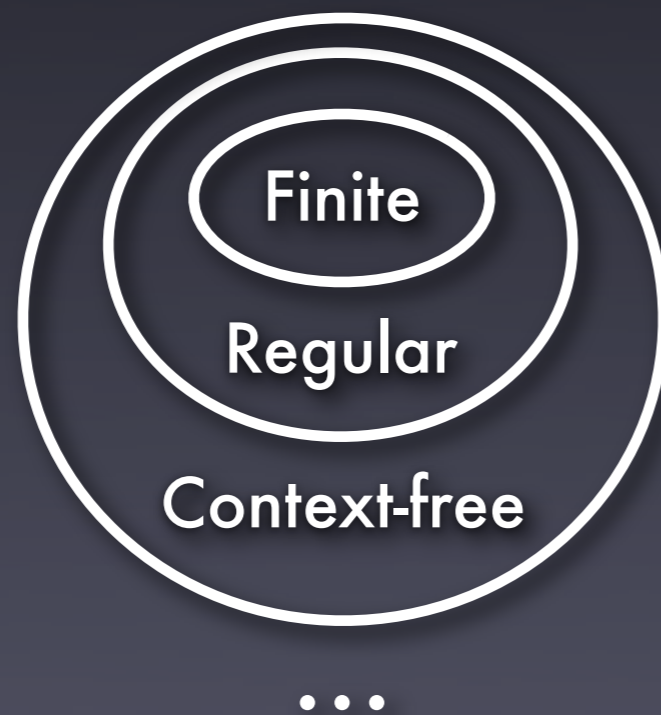


On Context-free Languages

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- CFLs are a generalization of regular languages.
- Give a nondeterministic finite automaton a stack and...
- ...the expanded set of languages you can accept is the context-free languages.



- An example CFL with alphabet a,b,c
 - $S \rightarrow c \mid aSa \mid bSb$
(above: the single *production rule*)
- Applying the rule, we start with S :
 - $S \Rightarrow aSa \Rightarrow aaSaa \Rightarrow aabSbaa \Rightarrow aabacabaa$ (done)
- How would you recognize members of this language?

- We describe a pushdown automaton with a sextuple:

$$M = (\underset{\text{States}}{K}, \underset{\text{Input Symbols}}{\Sigma}, \underset{\text{Stack Symbols}}{\Gamma}, \underset{\text{Transitions}}{\Delta}, \underset{\text{Initial State}}{s}, \underset{\text{Final State}}{F})$$

Where:

- K is a finite set of states,
- $s \in K$,
- $F \subseteq K, \dots$

- We describe a pushdown automaton with a sextuple:

$$M = (\underset{\text{States}}{K}, \underset{\text{Input Symbols}}{\Sigma}, \underset{\text{Stack Symbols}}{\Gamma}, \underset{\text{Transitions}}{\Delta}, \underset{\text{Initial State}}{s}, \underset{\text{Final State}}{F})$$

Where:

- ...the transition relation Δ is made up of things like:

$$((\underset{\text{Current State}}{p}, \underset{\text{Input}}{u}, \underset{\text{Stack Contents}}{\beta}), (\underset{\text{Next State}}{q}, \underset{\text{Stack Modification}}{\gamma})) \in \Delta$$

NB: an example!

- We need to represent the configuration (current state) of a computation—particularly:
 - the current state of the machine
 - all remaining input
 - all the symbols on the stack. We use 3-tuples like this:

$$(p , \underset{\text{Input... } \rightarrow}{uvwx\dots} , \underset{\text{Stack Contents... } \rightarrow}{\beta\sigma\lambda\eta\dots})$$

NB: also an example!

$$M = (K, \Sigma, \Gamma, \Delta, s, F)$$

States
Input Symbols
Stack Symbols
Transitions
Initial State
Final State

$$((p, u, \beta), (q, \gamma)) \in \Delta$$

Current State
Input
Stack Contents
Next State
Stack Modification

$$(p, \text{uvwx}\dots, \text{βουλη}\dots)$$

Input... →
Stack Contents... →