

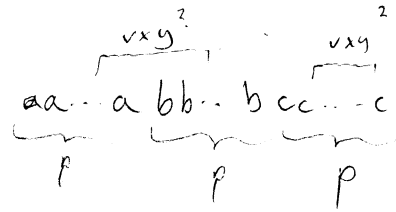
- CFG equivalent to PDAs
- Pumping lemma for CFL's
- Intro to TMs

CFL pumping lemma: For each CFL A , there is a number p , such that every $s \in A$ where $|s| > p$ can be divided into 5 parts $s = wvxyz$ such that

- 1) wv^ixy^iz for all $i \geq 0$
- 2) $|vy| > 0$
- 3) $|vxy| \leq p$

Review: $C = \{a^n b^n c^n \mid n \geq 0\}$ is not CF

why? well $a^p b^p c^p$ can't be pumped



Q) show $L = \{w \mid w \text{ contains equal \# of a's, b's, c's}\}$ is not CF

Proof) $C = \underbrace{L}_{\text{not CF}} \cap \underbrace{a^* b^* c^*}_{\text{regular}}$

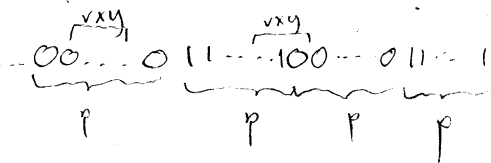
L must not be CF, since intersection of a CFL and regular lang is a CFL (could also use pumping lemma directly)

(note: can't intersect two CFGs to get a CFG)

Q) Show $L = \{ww \mid w \in \{0,1\}^*\}$ is not CF

Proof) Use pumping lemma. Can we use $0^p 1 0^p$? No, doesn't work

But $0^p 1^p 0^p 1^p$ can't be pumped.

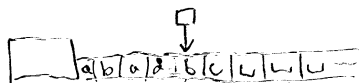


Both of them can reject by looping forever.

For example, a PDA can have ϵ -transitions that also push things on stack before
 If there is a loop of those ϵ -transitions, characters may be pushed on ^{the whole input} the stack indefinitely. This "branch" of computation is infinite, and thus considered to be a rejecting branch.

Q] A left-reset TM is a TM that is not allowed to move left, but is allowed to move its head to the beginning left-hand side of the tape. In other words, its transition function is of the form $\delta: Q \times \Gamma \rightarrow Q \times \Gamma \times \{R, \text{RESET}\}$. Show that left-reset TM recognize the same class of languages as normal TMs.

proof] We must simulate a regular TM with a left-reset TM



But what to do when the regular TM moves left?

What should left-reset machine do then?

- 1) Mark the current cell with an x . Reset, put a \bullet on the first cell
- 2) Move right until you see a \bullet

i) If the next cell has an x mark, erase it, reset, and move right to the cell with a \bullet on it.

ii) If the next cell does not have an x mark, reset, move right until you see the \bullet again, erase it, and put a \bullet on the next cell to the right