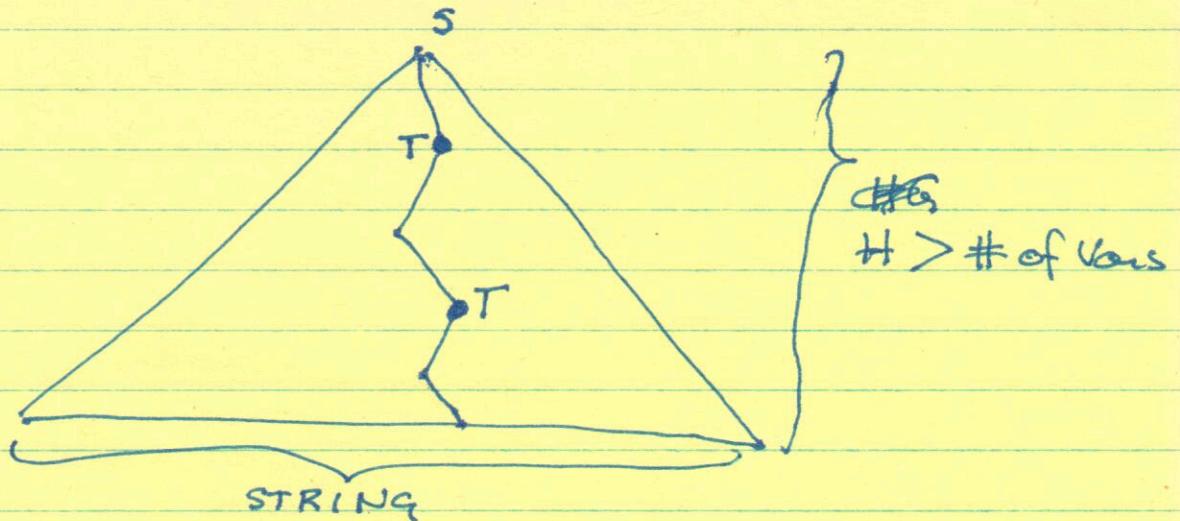


PUMPING LEMMA

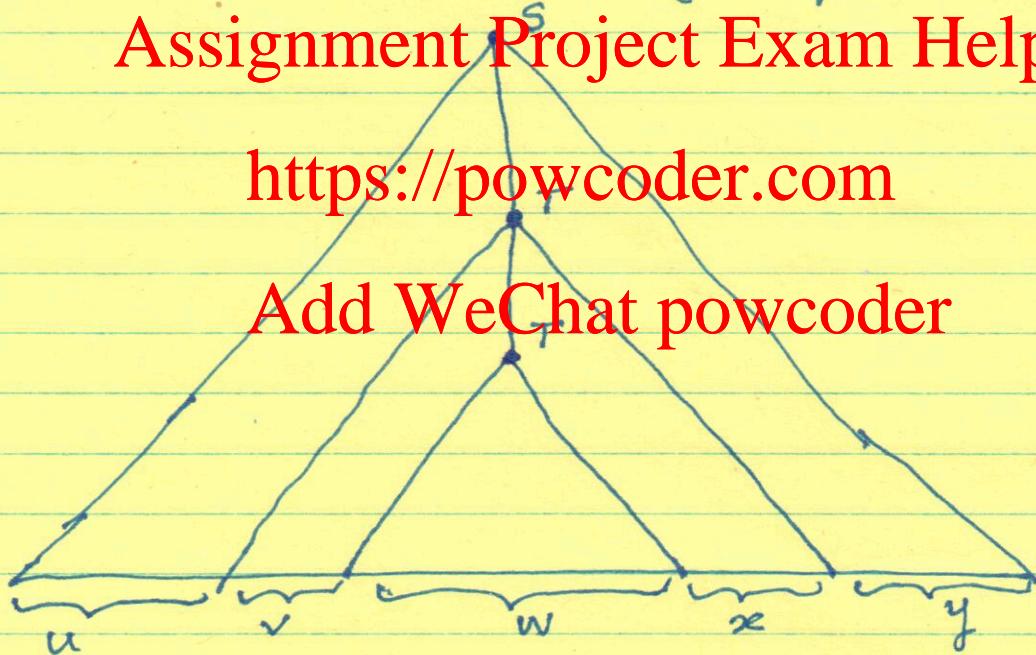


There must be a variable repeated somewhere along the path.

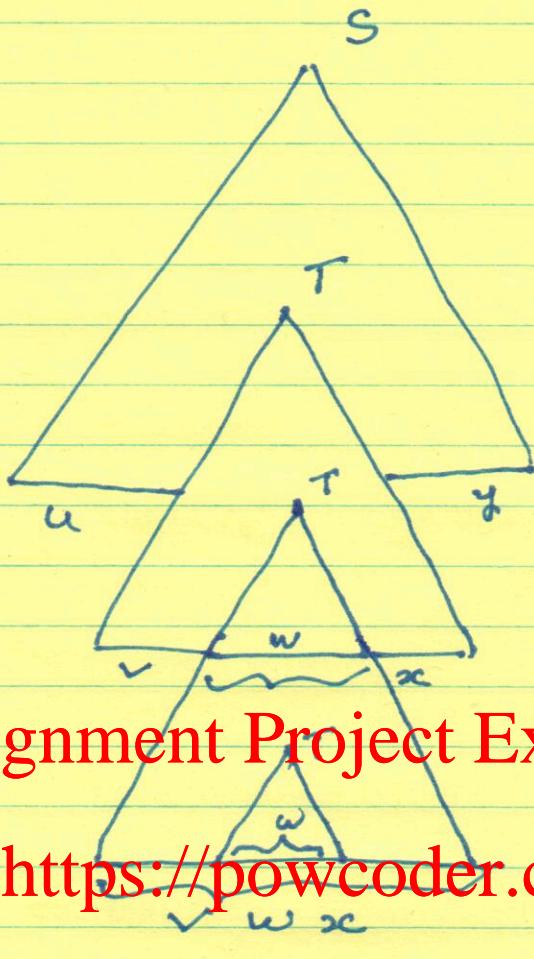
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$$\begin{array}{l} T \xrightarrow{*} vwx \\ T \xrightarrow{*} w \end{array}$$



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Vizo

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\forall CFLs $L \exists p \geq 0$
 $\forall s \in L |s| \geq p$
 $\exists u, v, w, x, y \in \Sigma^*$ s.t
 • $s = uvwxy$
 • $|vx| \neq 0$
 • $|vwx| \leq p$
 $\forall i \geq 0 uv^i w x^i y \in L$

Fix L some language

$\forall p > 0$
 $\exists s \in L |s| \geq p$
 $\forall u, v, w, x, y \in \Sigma^*$

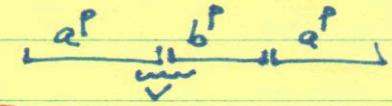
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$\exists i \geq 0 uv^i w x^i y \notin L$

Then Add WeChat powcoder.

$$L = \{a^n b^n a^n \mid n \geq 0\}$$

Demon chooses $b^p > 0$
I choose $a^p b^p a^p$



Possible choices for v, w, x, y

- v (or x) straddles a block boundary.
Demon loses because
pumping gets a 's & b 's
out of order.
- v, x contain only a 's then
they must be in the same block.
so pumping with $i=2$ will put
the string out of L .
- ~~same argument if v, x contain
only b 's.~~

- v ~~contains only a 's~~
 x contains only b 's
so Add WeChat **powcoder**
~~unstretched~~ by the pumping
 $\& i=2$ will put the string
out of L .

$$\Sigma = \{a, b, c\}$$

$$L = \{a^{i+j} b^{j+k} c^{i+k} \mid i, j, k \geq 0\}$$

Σ : arbitrary $|\Sigma| \geq 2$

$$L = \{ww \mid w \in \Sigma^*\} \quad L' = \{ww^{REV} \mid w \in \Sigma^*\}$$

FACT: If L is a CFL, R regular then
 $L \cap R$ is a CFL.

so if R is regular & $L \cap R$ is not a
CFL then L cannot be a CFL.

$$\overset{\Delta}{L} \stackrel{\text{def}}{=} L \cap a^* b^* a^* b^* \quad [\Sigma = \{a, b\}]$$

Demon picks $p > 0$

I pick $a^p b^p a^p b^p$

\downarrow BLOCKS

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- If v, x straddle a block boundary
then - - -
- If v, x are in the same block
demon has no hope - - - [please
write more on your HW]
- If v 's are in the first block &
 x 's are in the second block
choose $i = 2$

The first ~~word~~ w starts with "a"
so the second copy cannot
start with "b".

with $i = 2$ the first "word"
is longer than the second.

$\Sigma = \{a, b\}$ $L = \{\omega\omega \mid \omega \in \Sigma^*\}$ is not a CFL
 but L is a CFL.

$$\begin{array}{l}
 S \rightarrow AB \mid BA \mid A \mid B \\
 A \rightarrow CAC \mid a \quad B \rightarrow CBC \mid b \\
 C \rightarrow a \mid b
 \end{array}$$

A generates strings of the form

$$B \quad " \quad x \text{ by } y \quad - - - -$$

$S \rightarrow AB$ or BA will generate $x^a y^u z^b v$ where

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ASSUME $n > m$

$$L_1 = \{a^n b^n c^m \mid n, m \geq 0\} \quad L_2 = \{a^m b^n c^n \mid n, m \geq 0\}$$

$L_1 \cap L_2 = \{a^n b^n c^n \mid n \geq 0\}$ not a CFL.