

Oct 18

COMPSCI 3331

Fall 2022

What's next?

- ▶ Assignment 1: solutions available tomorrow. Marks available before A2 deadline.
- ▶ Assignment 2: due Oct 26.
- ▶ Quiz 2 marks available now.
- ▶ Quiz 4: up to end of Lecture 8.
- ▶ Midterm: October 25. Includes **at least** all of Lecture 8.

Assignment

A2 Q2

should not show a particular example.

- ▶ What does $p_a(L)$ do? *show closure property*
- ▶ What do we do for this question?

A2 Q3b

- ▶ Instead of using pumping lemma, use other facts you know.
- ▶ In particular, can use part (a).

$$p_a(L) = \{ w \in \Sigma^* \mid \exists n \geq 0. w a^n \in L \}.$$

Showing languages aren't regular

- ▶ $L_5 = \{w \in \{a, b, c, d\}^* : \forall x \in \{a, b, c, d\}, |w|_x = 0 \text{ or } |w|_x \geq 5\}$ 5^4 states. $(a=0111w_a \geq 5) + (b=0111w_b \geq 5) + \dots$ calculatable.
- ▶ $L_6 = L^*$ where $L = \{a^n b^n : n \geq 0\}$ L is not regular. $\Rightarrow L^*$ is not reg
- ▶ $L_7 = \{w \in \{a, b\}^* : |w|_a \equiv |w|_b \pmod{10}\}$
- ▶ $L_8 = \{w \in \{a, b\}^* : \exists u \in \{a, b\}^*, w = uu^R\}$ \nwarrow in formula.
 \uparrow
requires too much memory.

L_6 : pumping lemma: $a^n b^n$.

CFGs

Grammar 1

$$V = \{S\}$$

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

S is the start symbol

$$S \rightarrow aSb$$

$$S \rightarrow aSbb$$

$$S \rightarrow \#$$

rules
that apply

update this
statement with
 S itself until
 S is replaced.

S could be replaced
with any other symbol.

start
state

Grammar 2

$$V = \{S\}$$

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

S is the start symbol

$$S \rightarrow aSa$$

$$S \rightarrow bSb$$

$$S \rightarrow SS$$

$$S \rightarrow \varepsilon$$

How do we prove that $L = L(G)$?

$$\{a^i \# b^j : 0 \leq i \leq j \leq 2i\}.$$

$$S \rightarrow aSb$$

$$S \rightarrow aSbb$$

$$S \rightarrow \#$$

1) $L \subseteq L(G)$

prove by showing the derivation.

\Rightarrow steps of rules showing

2) $L(G) \subseteq L$: induction.

Writing Grammars *kelwin*

- ▶ Nested dependencies are ok. $L = \{a^n b^m c^m d^n : n, m \geq 0\}$.
- ▶ “Serial dependencies are not. $L = \{a^n b^m c^n d^m : n, m \geq 0\}$.

S

$\{a, b, c, d\}$

$S \rightarrow a S d$

$S \rightarrow T$ *~ this step*

$T \rightarrow b T c$ *is essential!*

$T \rightarrow \epsilon$.

More examples

- ▶ $L_1 = \{a^i b^j c^i : i, j \geq 0\}$.
- ▶ $L_2 = \{a^n b^m : n > m\}$
- ▶ $L_3 = \{a^n b^m : n \neq m\}$ $L_2 + \{a^n b^m : n < m\} \Rightarrow$
- ▶ $L_4 = L_1^*$.
- ▶ $L_5 = \{a^i b^j c^k : i = j \text{ or } j = k\}$.

$S \rightarrow a s c$
 $S \rightarrow T$
 $T \rightarrow b T$
 $T \rightarrow \epsilon$

$S_1 \rightarrow a S_1$ $S_1 \rightarrow a T_1$ $T_1 \rightarrow a T_1 b$ $T_1 \rightarrow \epsilon$ $S_2 \rightarrow S_2 b \Rightarrow$ $S_2 \rightarrow T_2 b$ $T_2 \rightarrow a T_2 b$ $T_2 \rightarrow \epsilon$	$S \rightarrow S_1$ $S \rightarrow S_2$ $S_1 \rightarrow a T$ $S_2 \rightarrow T b$ $S_1 \rightarrow a S_1$ $S_2 \rightarrow S_2 b$ $T \rightarrow a T b$ $T \rightarrow \epsilon$
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$S \rightarrow a T$
 $T \rightarrow a T b$
 $T \rightarrow \epsilon$
 $S \rightarrow a S$

$X = L_1$
 $X \rightarrow \epsilon$
 $X \rightarrow X X$

Midterm prep.

- ▶ Your group is now available.
- ▶ To find it go to Dropbox (left hand side) and open the file in your dropbox.
- ▶ On the website there's an image of the lecture theatre.
- ▶ Shows your suggested meeting point for your group.

Midterm Format

- ▶ You must write both parts of the midterm.
- ▶ Individual Portion: 90 % of your grade.
- ▶ Group Portion: 10 % of your grade.
- ▶ But your mark will never go down because of the group portion (if you write it). ($\max(.9S_1 + .1S_2, S_1)$)
- ▶ Time: 80 minutes for individual stage, 5 minutes to find groups, 20 minutes for group stage.