

Nov 22

COMPSCI 3331

Fall 2022

What's next?

- ▶ Assignment 3: due today.
- ▶ Assignment 4: now available, gradescope update later.
- ▶ Quiz 7 tomorrow - **Lectures 12 and 13.**
- ▶ Assignment 2: marks now available.
- ▶ Quiz 5, Quiz 6: being marked.

Feedback

- ▶ Feedback now available on `feedback.uwo.ca`
- ▶ Available until Dec 9.
- ▶ “Technology resources used during lectures (e.g. computer, DVD player, web, PowerPoint) contributed to my learning of the course material.” (mentimeter)
- ▶ “The online discussion board contributed to my learning of the course material.”
- ▶ “The blending of online learning and in-class learning in this course enhanced my understanding of the course material. ” (recorded lectures, etc.)

Complement example

$$L = \{a^i b^j c^k : i, j, k \geq 0, i \neq j\}.$$

$$= \underbrace{\{a^i b^j : i, j \geq 0, i \neq j\}}_{\downarrow} \underbrace{c^k}_{\downarrow}$$

context-free w

Regular,

Context-free

$i > j$

$i < j$

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

$$= \{a^i b^j; i, j \geq 0, i \neq j\} + c^* \rightarrow i > j$$

$$i < j$$

\Rightarrow both could be constructed CFG

$$L = \{a^r b^{r^2}; r \geq 0\}.$$

Square example

$$L_7 = \{a^r b^{r^2} : r \geq 0\}$$

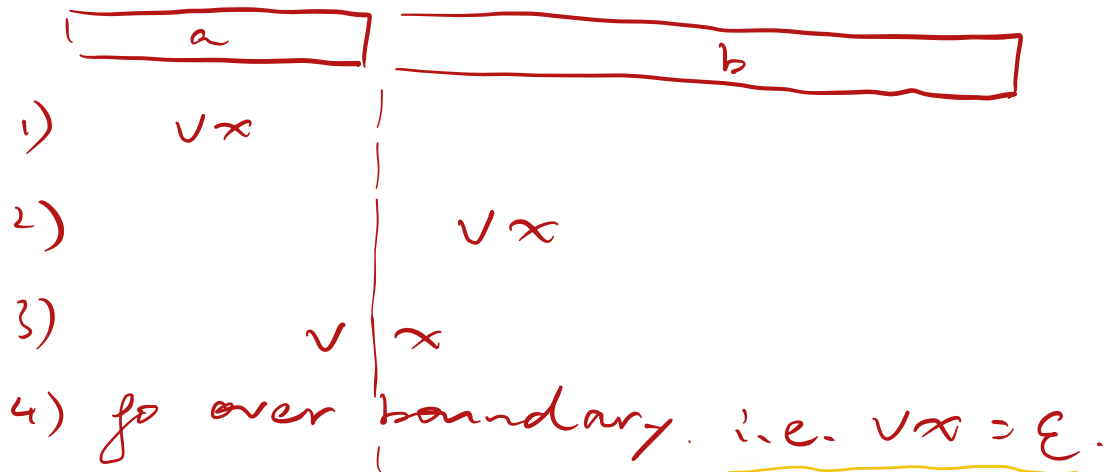
* it is not context-free

pumping lemma:

Let n be the constant from pumping lemma P, L.

$$z = a^n b^{n^2} \in L, |z| = n^2 + n \geq n$$

Decomposition $z = uvwxy$ where $|vwx| \leq n$
 $|vx| > 0$



4) If v or x consist more than one letter than uv^2wx^2y has a b before an a

1) u, x are both in a 's. $u = a^i$ $v = a^j$ $w = a^k$ $x = a^l$ $y = a^{n-i-j-k-l} b^{n^2}$
 $uv^2wx^2y = \underline{a^{n+j+l} b^{n^2}}$

this word is not in grammar

since $(n+j+l)^2 > n^2$.

2) u, x are both in b 's. $u = b^i$ $v = b^j$ $w = b^k$ $x = b^l$ $y = \dots$
 $n^2 \neq (n+i+j)^2$.

3) $u = a^i$ $v = a^j$ $w = a^{n-i-j} b^k$ $x = b^l$ $y = b^{n^2-k-l}$

$uv^2wx^2y = a^{n+j} b^{n^2+l} \Rightarrow$ it is not in the language.

we need to show that $(n+j)^2 \neq n^2 + l$

if $j=0$, then $l \neq 0 \Rightarrow (j+l)^2 > 0$

$(n+j)^2 = n^2 \neq n^2 + l$ since $l \neq 0$.

Assume $j \neq 0$, since $j+l \leq n$ (pumping lemma rules)

$$\Rightarrow l \leq n$$

$$n^2 + l \leq n^2 + n < n^2 + 2n + 1 = (n+1)^2 \leq (n+j)^2$$

$$\Rightarrow n^2 + l \neq (n+j)^2.$$

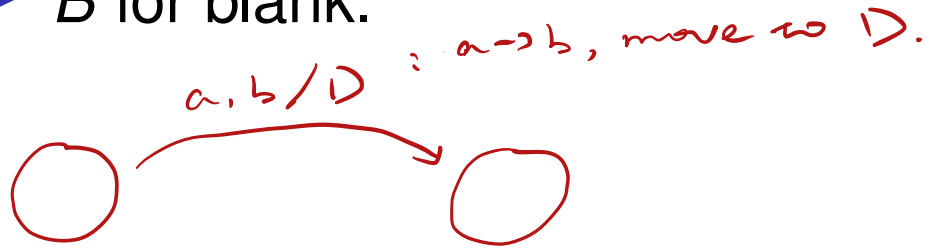
Therefore, -----

Turing Machine basics *to show something is computable.*

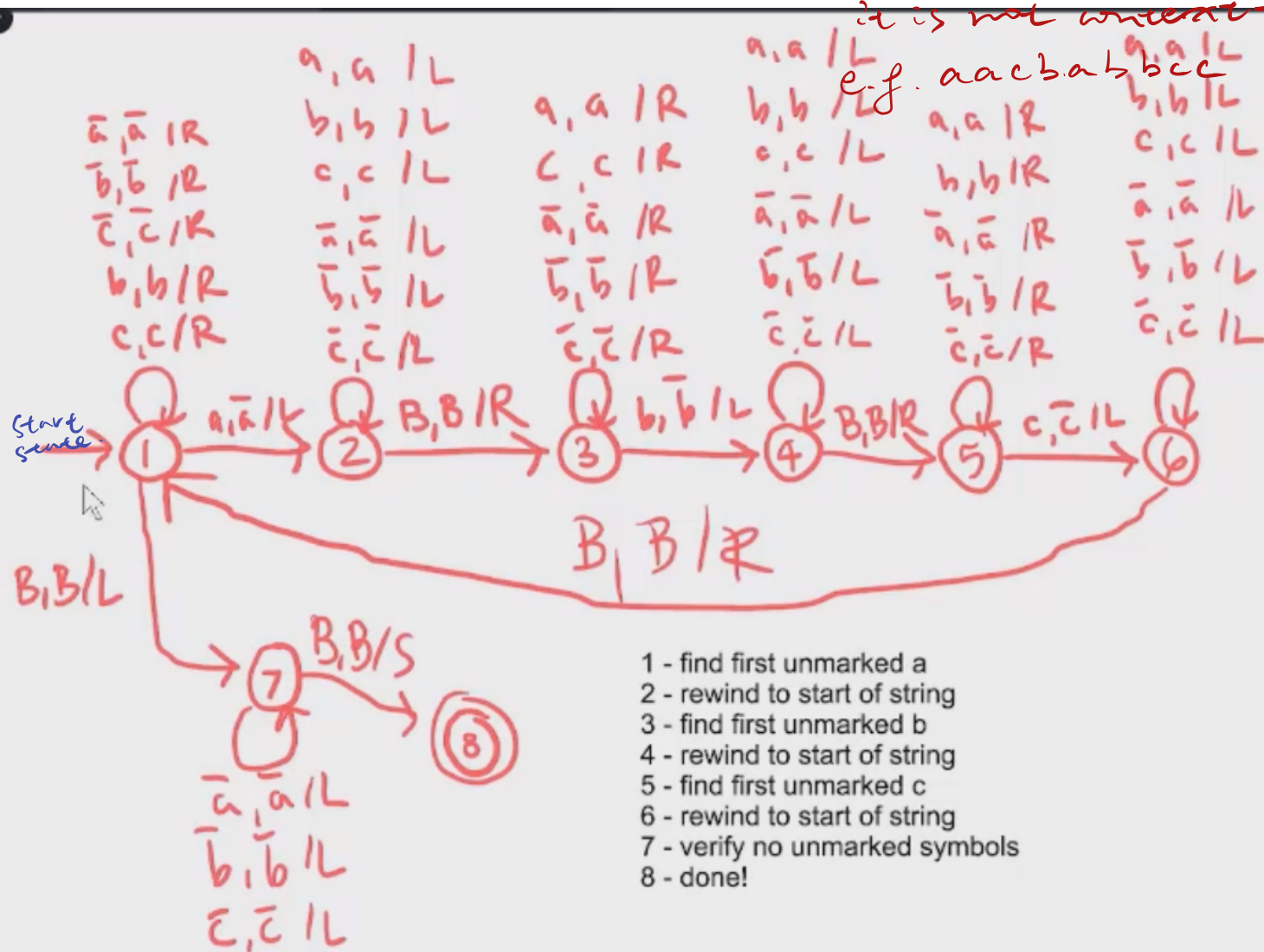
图灵机

▶ TM transitions: $a, b/D$

▶ B for blank.



it is not context-free.
e.g. $a^n b^n c^n$

$$= |w|_c \}$$


Turing Machine example

Multi-tape TM for $L = \{a^n b^m c^n d^m : n, m \geq 0\}$.

In fact, you can have as many tapes as you want.

three-tape TM:

1) input

2) storage for n

3) storage for m

*calculate n on tape 2) to get the number of a's
3) compare c's for tape 2) and same with d's.*

b's.

What constitutes a good TM description?

- ▶ Make sure you completely specify the set-up - how many tapes. / *what do they do?*
- ▶ Make sure you describe how acceptance works.
- ▶ Use basic operations as much as possible: match, count, copy, etc. *easy for TM to achieve*
- ▶ Avoid complex descriptions that may not be obvious how to do. *keep it BASIC*
- ▶ If you use complex operations, describe how they are done with the basic function of a TM.

e.g.

1) input

doable for TM.

2) n

3) m

4) $n \times m$

} in binary.

do multiplication for n and m using grade school algorithm.

Simulate PDA with TM: put stack on tape 2. push up stack

Is English CFL? No