CPSC 421/501

Last 2 weeks of class:

Nov	24	26	We'll have presentations
Dec	1	3	for CPSC 501 students

1. Topics suggested on new webpage

very short

2. Presentation: 10 - 15 minutes, material & questions
3. Topics: – Some topics in [Sip] or suggested there.
4. 10-15 very short! You'll probably only have time to (1) summarize (2) present one or two technical need (3) bibliography (4) ready to answer questions
5. groups OK up to 4 people
6. Let me know: the topic(s) you want, preferences for presentation days 24, 26, 1, 3
7. Many other topics possible — should be related to present CPSC 421/501 course, or fundamental part of CS theory
   email me for topics not on webpage
8. Make sure presentation is understandable to CPSC 421/501

students: carefully explain any new terminology, new motivation

9. Try out your presentation on someone else beforehand, for timing, understability, and technological problems.

10. Send me slides, etc. after the presentation, within 2 days

---

Midterm on Nov 5:

1. Probably 1-hour exam
2. Open book exam
3. Probably we will ask ~~you~~ you to leave Zoom cameras on during midterm
4. Cover up to end Chapter 3 (i.e. what we finished 1st part of class on Thursday)
5. Midterm start 9:30 am; make sure that your Canvas time zone is set appropriately
6. Format: midterm will be usual format! some T/F, some short answer, some long answers.

You'll have to submit PDF to gradescope.

Cell phone OK to take pic + upload

Ch 3! deciding vs recognizing

language recognized by TM, M, is

$\{w \mid M(w) = \text{accept}\} = \{w \mid M \text{ accepts } w\}$

This week I'll give a chance to test you uploading system (~~probably~~ via gradescope)

Ch 4: Accept_{TM} i.e. A_{TM} is undecidable

NOT ON EXAM.

Ch 3 includes $\langle \text{graph} \rangle$, $\langle T.M \rangle$, ...

Midterm Nov 3 Nov 5

Tu Th

spend 40 minutes ~~to~~ review answers to questions you may have on midterm material

Back to Ch 4!

— Last time:

$$\text{Accept}_{TM} = A_{TM} = \{ \langle M, w \rangle \mid M \text{ accepts } w \}$$

is ① undecidable ← (proof by contradiction, with <u>negation</u> + "almost self-reference" Closely related to paradoxes.)

② recognizable by a universal Turing machine U

—

[Sip]: U, on input $\langle M, w \rangle$, "simulates" what M would do on input w.

input $\underbrace{20\#2\#7\#\_\_\ldots}_{\text{describe } M}\ \#\#\underbrace{1211211112}_{\text{describe } w}\sqcup\sqcup\ldots$

give algorithm, can use any finite number of tapes

Now! ① We'll show that other languages are undecidable

② We'll show that some languages are not recognizable

Idea ②: If L is undecidable but recognizable, then $L^{comp} = \Sigma^* \setminus L$

$= \{ w \in \Sigma^* \mid w \notin L \}$

is unrecognizable.

If so, A_{TM}^{comp} is unrecognizable

$\left.\begin{array}{l}\text{If } L \text{ is recognizable} \\ \text{and } L^{comp} \text{ is recognizable}\end{array}\right\} \Rightarrow L \text{ is decidable}$

Recognizable = there is a T.M., M s.t. $L = \{ w \mid M \text{ accepts } w \}$

Decidable = ... - - - - - - - - -

and M always halts

L is recognizable by M_1

L^{comp} " " " M_2

If $w \in L$, run M_1 on w eventually reach q_{acc}

" $w \in L^{comp}$, " M_2 - - - - - - q_{acc}

Now run M_1 and M_2 simulteously on input w, then after finite time (= # of steps) we halt and know if $w \in L$ or $w \notin L$

$w \in L^{comp}$.

If M is Turing M., $M(w)$ = run M on w

$$M(w) = \begin{cases} \text{accept} \\ \text{reject} \\ \text{doesn't halt} \end{cases}$$

$\leftarrow$ halt after some finite # steps

M_1 that halts + accepts if $w \in L$

M_2 " " " -- if $w \notin L$, i.e. $w \in L^{comp}$

$w \to$ run one step of M_2 $\to$ run 2^{nd} step of M_2 | ...

$w \to$ run one step of M_1 $\to$ run 2^{nd} step of M_1 | - -

at some finite steps of steps, either M_1 or M_2 halt.

Now 5-min break 10:37 → 10:42

Could $(A_{TM})^{comp}$ be recognizable?

No, since otherwise

$$\left.\begin{array}{l} \underbrace{A_{TM} \text{ is recognizable}}_{\text{by universal TM}} \\ A_{TM}^{comp} \text{ '' \quad ''} \end{array}\right\} \Rightarrow \underbrace{A_{TM} \text{ is decidable}}_{\text{contradiction}}$$

Similarly

L is recognizable but not decidable

$\Rightarrow L^{comp}$ is not recognizable.

Similarly $HALT_{TM}$ is undecidable

① mimmick the proof that that A_{TM} is ~~decidable~~ undecidable

② OR if $\left.\begin{array}{l} HALT_{TM} \text{ is decidable} \\ \Rightarrow A_{TM} \text{ '' \quad ''} \end{array}\right]$ then $HALT_{TM}$ undecidable

(

If you could decide $HALT_{TM}$

and given $\langle M, w \rangle$ and you want

to know if $M(w) =$ accepts

then

$$M(w) = \begin{cases} \text{accepts} \\ \text{rejects} \\ \text{doesn't halt} \end{cases}$$

Create $\hat{M}$

$$\hat{M}(w) = \begin{cases} \text{accepts when } M(w) = \text{accepts} \\ \text{doesn't halt} \quad M(w) = \text{rejects} \\ \text{" } \quad \text{" } \quad M(w) = \text{doesn't halt} \end{cases}$$

then

$M(w)$ accepts $\Rightarrow$ $\hat{M}(w)$ halts

" doesn't accepts $\Rightarrow$ $\hat{M}(w)$ doesn't halt

If $HALT_{TM}$ is decidable, run $HALT_{TM}$ alg

on $\langle \hat{M}, w \rangle$

Class steps

=

Really 3.11 [Sip]

Any algorithm that works

$\ldots | \sqcup | a | b | a | b | \sqcup | \sqcup |$

convert to a TM algorithm

1-tape, could be 2-tape