hw8

Graded

Student

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Total Points

35.5 / 40 pts

Question 1

Chomsky Normal Form

9 / 9 pts

- **– 0 pts** Correct

Question 2

Algorithm About DFAs

6 / 10 pts

- **– 2 pts** decider behavior incorrect; didnt construct DFA that accepts all strings with a single B char (from hw1)
- **– 2 pts** decider behavior incorrect; should compare input DFA to DFA that accepts all strings with a single B char (from hw1) using EQ_DFA decider

Question 3

Algorithm About PDAs

10 / 10 pts

- **– 0 pts** Correct

Question 4

Regular and Decidable?

9.5 / 10 pts

- **– 0.5 pts** Incomplete termination argument

Did not state that decider halts

Question 5

readme

1 / 1 pt

- **– 0 pts** Correct

Question assigned to the following page: 1

1) Chomsky Normal Form

Given CFG:

- $E \to T \mid E-T \mid -T$
- $T \to T \times F \mid F$
- $F \to L \mid F \wedge L$
- $L \to x \mid 1 \mid (E)$

Step 1: new start var

- $S_0 \to E$
- $E \to T \mid E-T \mid -T$
- $T \to T \times F \mid F$
- $F \to L \mid F \wedge L$
- $L \to x \mid 1 \mid (E)$

Step 2: remove ε

- $S_0 \to E$
- $E \to T \mid E-T \mid -T$
- $T \to T \times F \mid F$
- $F \to L \mid F \wedge L$
- $L \to x \mid 1 \mid (E)$

Step 3: remove $A \to B$

- $S_0 \to E$
- $E \to T \mid E-T \mid -T$
- $T \to T \times F \mid F$
- $F \to L \mid F \wedge L$
- $L \to x \mid 1 \mid (E)$

$\longrightarrow$

- $S_0 \to T \times F \mid x \mid 1 \mid (E) \mid F \wedge L \mid E-T \mid -T$
- $E \to T \times F \mid x \mid 1 \mid (E) \mid F \wedge L \mid E-T \mid -T$
- $T \to T \times F \mid x \mid 1 \mid (E) \mid F \wedge L$
- $F \to x \mid 1 \mid (E) \mid F \wedge L$
- $L \to x \mid 1 \mid (E)$

Step 4: split up RHS > 2

- $S_0 \to T \times F \mid x \mid 1 \mid (E) \mid F \wedge L \mid E-T \mid -T$
- $E \to T \times F \mid x \mid 1 \mid (E) \mid F \wedge L \mid E-T \mid -T$
- $T \to T \times F \mid x \mid 1 \mid (E) \mid F \wedge L$
- $F \to x \mid 1 \mid (E) \mid F \wedge L$
- $L \to x \mid 1 \mid (E)$

$\longrightarrow$

- $A \to \times F$
- $B \to E)$
- $C \to \wedge L$
- $D \to E-$
- $S_0 \to TA \mid x \mid 1 \mid (B) \mid FC \mid DT \mid -T$
- $E \to TA \mid x \mid 1 \mid (B \mid FC \mid DT \mid -T$
- $T \to TA \mid x \mid 1 \mid (B \mid FC$
- $F \to x \mid 1 \mid (B \mid FC$
- $L \to x \mid 1 \mid (B$

Question assigned to the following page: 1

Step 5: Replace all terminals

- A → xF
- B → E)
- C → ^L
- D → E-
- S_0 → TA | x | 1 | (B | FC | DT | -T
- E → TA | x | 1 | (B | FC | DT | -T
- T → TA | x | 1 | (B | FC
- F → x | 1 | (B | FC
- L → x | 1 | (B

→

- J → (
- K → -
- G → x
- H →)
- I → ^

- A → GF
- B → EH
- C → IL
- D → EK

- S_0 → TA | x | 1 | JB | FC | DT | KT
- E → TA | x | 1 | JB | FC | DT | KT
- T → TA | x | 1 | JB | FC
- F → x | 1 | JB | FC
- L → x | 1 | JB

Chomsky Normal Form:

- J → (
- K → -
- G → x
- H →)
- I → ^
- A → GF
- B → EH
- C → IL
- D → EK

- S_0 → TA | x | 1 | JB | FC | DT | KT
- E → TA | x | 1 | JB | FC | DT | KT
- T → TA | x | 1 | JB | FC
- F → x | 1 | JB | FC
- L → x | 1 | JB

Question assigned to the following page: 2

2) An algorithm about DFA's?

Prove that the following language is decidable:

$B_{DFA} = \{< M > \mid M \textit{ is a DFA that accepts all strings containing a single B character}\}$

step	statement	justification
1	A language is decidable if there is a decider that recognizes it.	definition of a decidable language
2	Let w be a string with a single B character in it.	given
3	A decider for B_{DFA}: X = "On input <M>, where M is DFA: 1. Simulate M on input string w. 2. If the simulation ends in an accept state, accept. If it ends in a nonaccepting state, reject."	Creating a decider for B_{DFA} and (1)
4	Where "simulate" = ● Define "current" state $q_{current} = start\ state\ q_0$ ● For each input char x in w… ○ Define $q_{next} = \delta(q_{current}, x)$ ○ Set $q_{current} = q_{next}$	A detailed explanation of what is meant by "simulate" in step 3
5	Termination argument: X from step 3 is a decider because the input w is a finite string, so the loop in the simulation has a finite amount of iterations and will always halt.	termination argument and (1)
6	B_{DFA} has a decider X that recognizes it, which means that it is a decidable language.	(1) and (3)

Question assigned to the following page: 3

3) An algorithm about PDA's?
Prove the following language is decidable:
PW = {<P, w> | P is a PDA where w ∈ Lang(P)}

step	statement	justification
1	A language is decidable if there is a decider that recognizes it.	definition of a decidable language
2	A_{CFG} is a decidable language, where S represents its decider.	theorem from class
3	Decider for A_{CFG}: X = "On input <P, w>, where P is a PDA and w is a string in the language of P: 1. Convert PDA P to an equivalent CFG C, using the procedure CFG → PDA from the theorem CFG ↔ PDA. 2. Run the turing machine S on input <C, w> 3. If M accepts, accept; otherwise, reject."	creating a decider for A_{CFG} , CFG ↔ PDA theorem, (1) and (2)
4	Termination argument: X from step 3 is a decider because: ● It's step one (converting) always halts because there's a finite number of states in a PDA. ● It's step two always halts because the turing machine S is a decider.	termination argument and (1)
5	A_{CFG} has a decider X that recognizes it, which means that it is a decidable language.	(1) and (3)

Question assigned to the following page: 4

4) Regular and Decidable?

If a language L is a regular language, then L is decidable.

DFA

step	statement	justification
1	A language is regular if there is a DFA that recognizes it.	definition of a regular language from class
2	A language is decidable if there is a decider that recognizes it.	definition of a decidable language from class
3	Let X be a DFA, (Q, Σ, δ, q_0, F) that recognizes the language L	(1) and given
4	A_{DFA} is a decidable language, where M represents a decider that recognizes it.	theorem from class
5	A decider for L: Y = "On input <X, w>, where X is a DFA and w is a string from the language L: 1. Run the turing machine M on input <X, w>. 2. If M accepts, accept; otherwise reject."	creating a decider
6	termination argument: Y from step 5 is a decider because: ● it's step one is finite because M is a decider	termination argument
7	There is a DFA X and a decider Y that recognize the language L. Therefore, L is a regular language and it is decidable.	(1), (2) and (5)

Question assigned to the following page: 4

NFA

step	statement	justification
1	A language is regular if there is a NFA that recognizes it.	definition of a regular language from class
2	A language is decidable if there is a decider that recognizes it.	definition of a decidable language from class
3	Let X be an NFA, (Q, Σ, δ, q_0, F) that recognizes the language L	(1) and given
4	A_{NFA} is a decidable language, where N represents a decider that recognizes it.	theorem from class
5	A decider for L: Y = “On input <X, w>, where X is an NFA and w is a string from the language L: 1. Run the turing machine N on input <X, w>. 2. If N accepts, accept; otherwise reject.”	creating a decider
6	termination argument: Y from step 5 is a decider because: ● it’s step one is finite because N is a decider	termination argument
7	There is a NFA X and a decider Y that recognize the language L. Therefore, L is a regular language and it is decidable.	(1), (2) and (5)

Question assigned to the following page: 4

Regex

step	statement	justification
1	A language is regular if there is a regular expression that recognizes it.	definition of a regular language from class
2	A language is decidable if there is a decider that recognizes it.	definition of a decidable language from class
3	Let X be regular expression that recognizes L	(1) and given
4	A_{REX} is a decidable language, where P represents a decider that recognizes it.	theorem from class
5	A decider for L: Y = “On input <X, w>, where X is a regular expression and w is a string from the language L: 1. Run the turing machine P on input <X, w>. 2. If P accepts, accept; otherwise reject.”	creating a decider
6	termination argument: Y from step 5 is a decider because: ● it’s step one is finite because P is a decider	termination argument
7	There is a regular expression X and a decider Y that recognize the language L. Therefore, L is a regular language and it is decidable.	(1), (2) and (5)

Question assigned to the following page: 5

README
name of other students: none
books or websites used: class slides and lecture
time spent: 3 hours