1 3F-1 Bookkeeping

- 0 pts Correct

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Exercise 3F-2. Regular Expression, Large-Step [10 points].

$$\frac{\vdash \mathsf{e}_1 \text{ matches } s_1 \text{ leaving } s_2 \qquad \vdash \mathsf{e}_2 \text{ matches } s_2 \text{ leaving } s_3}{\vdash \mathsf{e}_1\mathsf{e}_2 \text{ matches } s_1 \text{ leaving } s_3}$$

$$\frac{\vdash \mathsf{e}_1 \text{ matches } s_1 \text{ leaving } s_2}{\vdash \mathsf{e}_1|\mathsf{e}_2 \text{ matches } s_1 \text{ leaving } s_2}$$

$$\frac{\vdash \mathsf{e}_2 \text{ matches } s_1 \text{ leaving } s_2}{\vdash \mathsf{e}_1|\mathsf{e}_2 \text{ matches } s_1 \text{ leaving } s_2}$$

$$\frac{}{\vdash \mathsf{e}* \text{ matches } s_1 \text{ leaving } s_1}$$

$$\frac{\vdash \mathsf{e} \text{ matches } s_1 \text{ leaving } s_2 \qquad \vdash \mathsf{e}* \text{ matches } s_2 \text{ leaving } s_3}{\vdash \mathsf{e}* \text{ matches } s_1 \text{ leaving } s_3}$$

2 3F-2 Regular Expressions, Large Step

- 0 pts Correct

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Exercise 3F-3. Regular Expression and Sets [5 points].

It's impossible to construct such inference rules for $e*$ and e_1e_2, because their inferences rules can't have finite and fixed set of hypothesis.

Consider the inference rule for $e*$

$$\frac{}{\vdash e* \text{ matches } s \text{ leaving } \{s\}}$$

$$\frac{\vdash e \text{ matches } s \text{ leaving } S' \qquad \forall s_i \in S', \vdash e* \text{ matches } s_i \text{ leaving } S_i}{\vdash e* \text{ matches } s \text{ leaving } \bigcup_{i=1}^{|S'|} S_i}$$

Consider the inference rule for e_1e_2

$$\frac{\vdash e_1 \text{ matches } s \text{ leaving } S' \qquad \forall s_i \in S' \vdash e_2 \text{ matches } s_i \text{ leaving } S_i}{\vdash e_1e_2 \text{ matches } s \text{ leaving } \bigcup_{i=1}^{|S'|} S_i}$$

Since we cannot have an inference rule that has a countably or uncountably infinite number of hypotheses and we cannot have hypotheses that change in number or form depending on conditions, these two inference rules is not valid.

3 3F-3 Regular Expressions and Sets

- 0 pts Correct

Exercise 3F-4. Equivalence [7 points].
It is decidable.

Input e_1, e_2

1. Use Thompson's construction algorithm to obtain Nondeterministic finite automaton NFA_1 and NFA_2 from e_1 and e_2
2. Use subset construction algorithm to transform NFA_1 and NFA_2 to Deterministic finite automaton DFA_1 and DFA_2
3. Reduce DFA_1 and DFA_2 to minimal DFA min_1 and min_2
4. (a) If min_1 and min_2 are equivlant, output $e_1 \sim e_2$ is true
   (b) Else, output $e_1 \sim e_2$ is false

4 3F-4 Equivalence

- 0 pts Correct

Exercise 3F-5. SAT Solving [6 points].

The last two test case runs a quite long time is because that it has more arithmetic related clauses, which all requires brutally searching through lower bound and upper bound locates at line `68-72` in `arith.ml`. It will be $O(256^n)$ time complexity if the number of variables is n. In some more efficient DPLL(X) engines, we usually use a simple, minimal interface to solve for arithmetic constraint solver. We can apply linear programming to refine the search space of each variable

5 3F-5 SAT Solving

- 0 pts Correct