CECS 329, Homework Assignment 4, Spring 2025, Dr. Ebert

Directions: Please review the `Homework` section on page 6 of the syllabus including a list of all rules and guidelines for writing and submitting solutions.

Due Date: Tuesday, March 25th as a PDF-file upload to the HW4 Canvas dropbox.

Problems

1. **Recognizing "Classic" SSN's.** Before the Social Security Administration began randomizing social security numbers in 2011, the "classic" social security number took the form

   a-g-s,

   where $a, g, s \in \{0, 1, \ldots, 9\}^*$, a is a three-digit *area* word, g is a two-digit *group* word, and s is a four digit *serial* word. Moreover, $a \neq 000$, $g \neq 00$ and $s \neq 0000$. Finally, when viewed as a number it must be the true that $a \leq 772$ and a cannot lie within the interval $[734, 749]$.

   (a) Provide the state diagram of an NFA N that accepts the language of all classic SSN's. Assume all words are over the alphabet is $\{-, 0, 1, \ldots, 9\}$. Hint: use the notation $a : b$ to denote the range of digits from a to b. For example, an edge labeled with $1 : 6$ is equivalent to an edge labeled as $1, 2, 3, 4, 5, 6$.
   (20 pts)

   (b) Show the computation of N on inputs i) 217-34-9218, ii) 740-49-8734, and iii) 641-00-5923. (10 pts)

   (c) Provide a regular expression whose associated language is the set of all classic SSN's. Again you may use colon notation of the form $[a : b]$ which in this case is equivalent to the set of numbers $\{a, a + 1, \ldots, b\}$. (10 pts)

2. Let A denote the set of binary words that begin with 00 and have an odd number of 1's, while B denotes the set of binary words that have $2n$ 0's, for some $n \geq 1$.

   (a) Provide NFA state diagrams N_A and N_B that accept A and B, respectively. (10 pts)

   (b) Provide the state diagram of an NFA N_1 that accepts the language $A \cup B$ and show the computation of N on input 001011 (5 pts)

   (c) Provide the state diagram of an NFA N_2 that accepts the language $A \circ B$. Show the computation of N_2 on input $w = 0010101001$, and highlight a state from each subset state so that the sequence of highlighted states represents the branch of N_2's computation tree that accepts w in such a way that w is parsed as $0010101 \in A$ and $001 \in B$. (10 pts)

   (d) Provide the state diagram of an NFA N_3 that accepts A^*. (5 pts)