

Homework 4: Regular Operators and Regular Expressions  
Theory of Computation (CSCI 3500)  
Total Points: 10

Write the solution to each question on its own page.

All questions must be in order.

Your name must be on each page.

Then email me a single PDF file of your solution set.

All assignments not adhering to this will not be graded.

0. Character ranges are extremely useful when defining regular expressions. Example character ranges are:

- (a)  $[A-Z]$
- (b)  $[a-z]$
- (c)  $[a-d]$
- (d)  $[0-9]$
- (e)  $[A, B, C]$
- (f)  $[B, W, Z]$
- (g)  $[42, 13, 24]$
- (h)  $[\$, \%, *]$

Notice that in the first four examples the alphabet must have an order  $x \leq y$  for  $x, y \in \Sigma$ .

Using this intuition extend the definition of regular expressions to support symbol ranges. Then extend the interpretation to regular languages to interpret symbol ranges.

1. Using your solution to the previous problems define a regular expression that matches the language:

$$\text{Triples} = \{(w_1, w_2, w_3) \mid w_1 \in \mathbb{N}, w_2, w_3 \in \{a, b, c, d, e, f\}, |w_2| = 2, \text{ and } |w_3| = 3\}$$

Use the interpretation into regular languages to define the language **Triples** using regular operators. Then using the regular operators define its NFA.

Hint: Make sure to say which ordering you are using if you are using a range that requires one. Also, do not confuse the parens in the definition of words in **Triples** and grouping parens used in regular expressions; you will need to escape the former.

2. Repeating a pattern some fixed number of times is also a very useful feature of regular expressions. Examples are:

(a)  $\{2, (a + b)\} = (a + b)(a + b)$

(b)  $\{3, (a + b)^*\} = (a + b)^*(a + b)^*$

(c)  $\{4, [0-9]\} = [0-9][0-9][0-9][0-9]$

Using this intuition extend the definition of regular expressions to support this feature. Then extend the interpretation to regular languages to interpret this feature.