

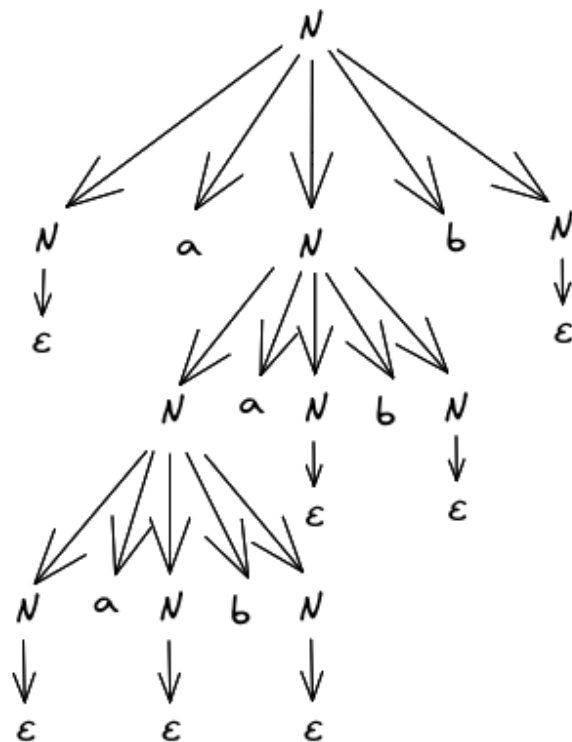
Assignment Five

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1 Question One

```
N -> N a N b N
-> ε a N b N (using N -> ε)
-> ε a N a N b N b N (using N -> N a N b N)
-> ε a N a N b N a N b N b N (using N -> N a N b N)
-> ε a ε a N b N a N b N b N (using N -> ε)
-> ε a ε a ε b N a N b N b N (using N -> ε)
-> ε a ε a ε b ε a N b N b N (using N -> ε)
-> ε a ε a ε b ε a ε b N b N (using N -> ε)
-> ε a ε a ε b ε a ε b ε b N (using N -> ε)
-> ε a ε a ε b ε a ε b ε b ε (using N -> ε)
-> aababb (remove epsilons for clarity)
```



2 Question Two

N $\rightarrow$ N N
 $\rightarrow$ N * N (using N $\rightarrow$ N *)

```

-> (N) * N (using N -> (N))
-> (N + N) * N (using N -> N + N)
-> (a + N) * N (using N -> a)
-> (a + a) * N (using N -> a)
-> (a + a) * a (using N -> a)

```

3 Question Three

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N -> b N a N
-> b ε a N (using N -> ε)
-> b ε a a N b N (using N -> a N b N)
-> b ε a a a N b N b N (using N -> a N b N)
-> b ε a a a ε b N b N (using N -> ε)
-> b ε a a a ε b ε b N (using N -> ε)
-> b ε a a a ε b ε b ε (using N -> ε)

```

4 Question Four

```

N -> aNbN
N -> bNaN
N -> ε

```

5 Question Five

$count(a) \neq count(b) \Rightarrow count(a) > count(b) \vee count(a) < count(b)$

- More A's than B's = G
- Less A's than B's = L

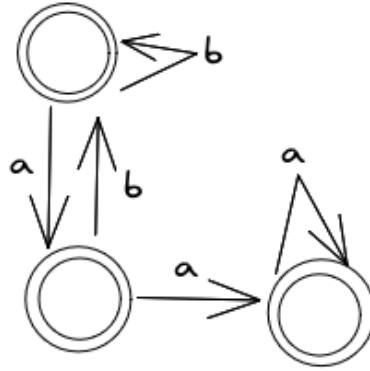
```

S -> G
S -> L
G -> GG
G -> EAE
L -> LL
L -> EBE
E -> aEaE
E -> bEaE
E -> ε
A -> aA
A -> a
B -> bB
B -> b

```

6 Question Six

This one we can actually create from a DFA!



$S \rightarrow aN$
 $N \rightarrow aM$
 $N \rightarrow bS$
 $M \rightarrow MM$
 $M \rightarrow a$

7 Question Seven

A grammar, S , with regular expressions in its production's bodies, after replacing any extensions on regular expressions with their corresponding algebraic equivalents as given in 3.3.5, then, we can transform S into an equivalent grammar by the following rules for nonterminals or terminals:

7.1 Kleene Closure

If we have a match in a production body corresponding to Kleene Closure, then we can transform it into two new productions:

B^*

is mapped to

$A \rightarrow \epsilon$
 $A \rightarrow BA$

7.2 Union

If we have a match in a production body corresponding to the union operator, then we can rewrite it as two new productions:

$B \mid C$

is mapped to

$A \rightarrow B$
 $A \rightarrow C$

7.3 Example

Consider the grammar:

$N \rightarrow (A \mid B)^*$
 $A \rightarrow aA$
 $A \rightarrow \varepsilon$
 $B \rightarrow bB$
 $B \rightarrow \varepsilon$

then we can form our first transformation by replacing N (with no need to rename since it's already the start symbol):

$N \rightarrow \varepsilon$
 $N \rightarrow (A \mid B)N$
 $A \rightarrow aA$
 $A \rightarrow \varepsilon$
 $B \rightarrow bB$
 $B \rightarrow \varepsilon$

which is then further reduced when we transform $(A \mid B)$

$N \rightarrow \varepsilon$
 $N \rightarrow DN$
 $D \rightarrow A$
 $D \rightarrow B$
 $A \rightarrow aA$
 $A \rightarrow \varepsilon$
 $B \rightarrow bB$
 $B \rightarrow \varepsilon$