Left Recursion – Test Yourself

Basic rule:

A → Aa | b

can be replaced by the pair of rules

A → bA' and A' → aA' | ε

If you have something more complicated, e.g.

X → Yx
Y → Zy
  | x
Z → Xy
  | z

you first need to "massage" it so that it matches the above form. Typically this involves re-writing rules. So for the above grammar, we get:

X → Zyx
  | xx
Z → Xy
  | z

which in turn becomes:

X → Xyyx
  | zyx
  | xx

Now, relating that back to the original form A → Aa | b, we have A = X, a = yyx, b = zyx | xx. So the pair of rules A → bA' and A' →aA' | ε become:

X → (zyx | xx)X' and X' → yyxX' | ε

which can also be written as:

X → zyxX' | xxX' and X' → yyxX' | ε

Ok, now that you've learnt the rule, try removing left recursion from these grammars:

1.
   S → Aa
     | b
   A → Ac
     | dS
     | ε

2.
   A → Br
   B → Cs
   C → At

3.
   S → AA
     | 0
   A → SS
     | 1

4. S →R a | A a | a
   R →a b
   A →A R | A T | b
   T →T b | a

5. A→B|a|CBD
   B→C|b
   C→A|c
   D→d

6. Q→QED|q
   E→e
   D→NFA|d
   N→DFA|n
   F→f
   A→a