Chomsky Normal Form & CYK Algorithm

Summary of the conversion procedure to Chomsky normal form (CNF):

1) Remove unproductive symbols. (optional)
2) Remove unreachable symbols. (optional)
3) Make terminals occur alone on right-hand side.
4) Reduce arity of every production to 2 or less.
5) Remove epsilons.
6) Remove unit productions.
7) Remove unproductive symbols.
8) Remove unreachable symbols.

Exercise 1

Convert the following grammar to Chomsky normal form.

```
S ::= P
P ::= A | B | if B then P else P | P ; P | ε
A ::= U A | A + A | A * A
U ::= + | -
B ::= true | false | B && B
```

Exercise 2

Convert the following grammar to Chomsky normal form.

```
S ::= a S b | ε
```

Apply the CYK algorithm to parse the following inputs.

```
a a a b b b
```

```
a b a b
```

Exercise 3

Convert the following grammar to Chomsky normal form.

```
S ::= P ;
P ::= I | I ; P
I ::= if E then P R | print E
R ::= else P | ε
W ::= while E do P
E ::= L | E or E | C
C ::= C and E | E and C
L ::= true | false
```

Apply the CYK algorithm to parse the following input. Count the number of possible parse trees.

```
if true then print true ; print false ;
```

Without actually running the CYK algorithm, count the number of parse trees of the following inputs.

```
if true or false or true then print true or false or true ;
```

```
if true then if false then print true else print false ;
```

```
if true then print true ; print false ; print true ;
```