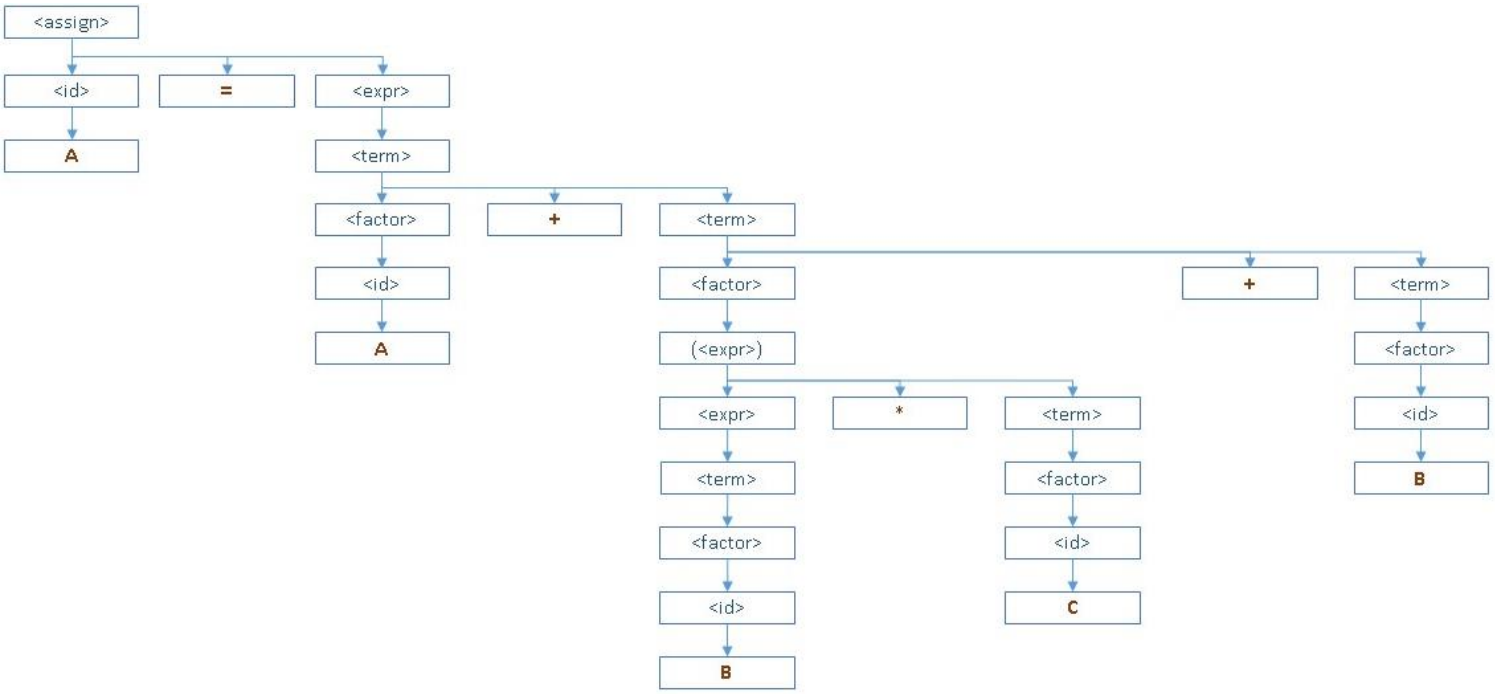
Maciej Medyk – COT5930 – Homework 1

Problem 1

Given the following grammar, rewrite the BNF to give + precedence over * and force + to be right associative. Show parse tree to demonstrate that your answer is correct.

A = A + (B * C) + B

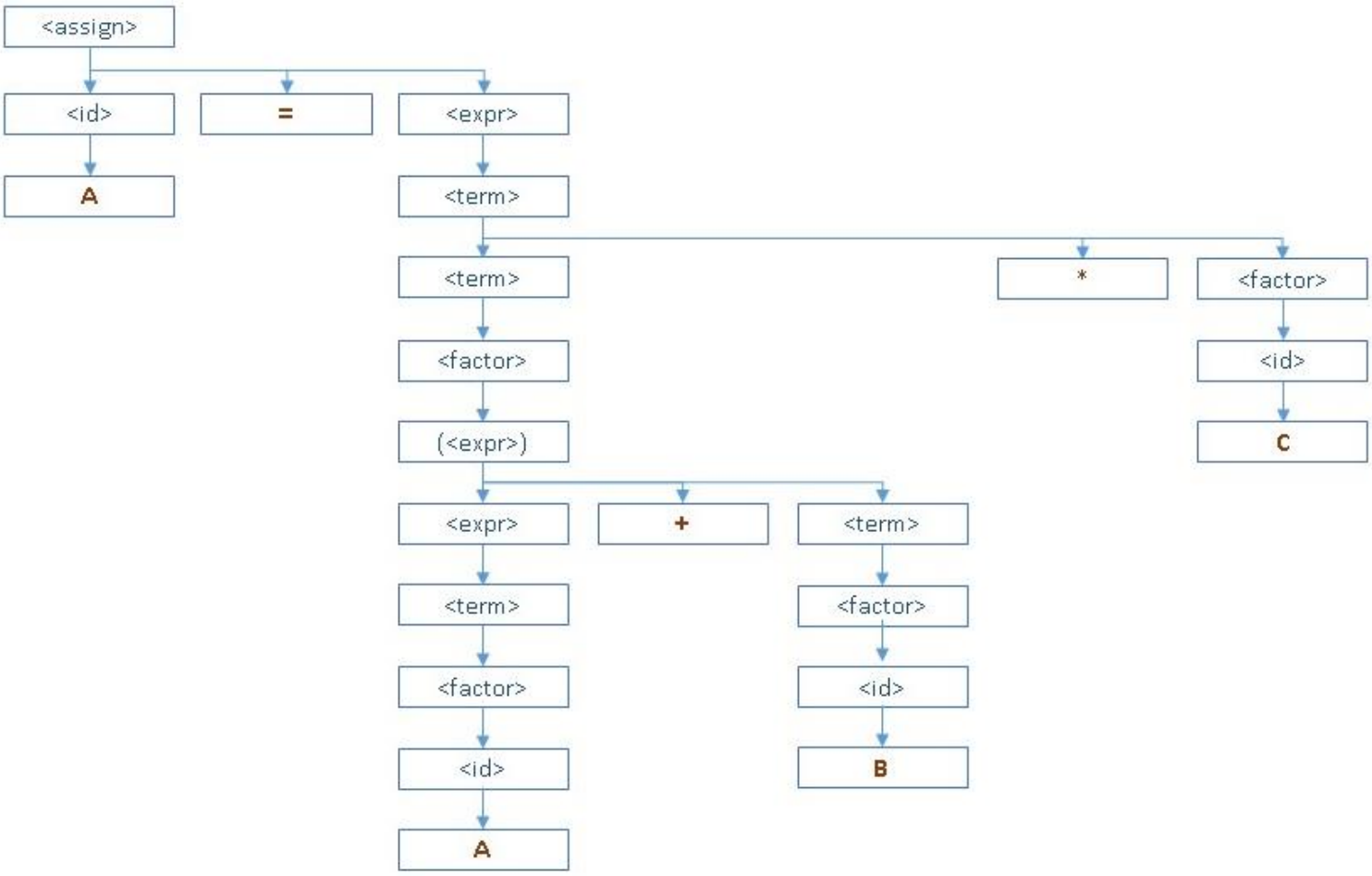
<assign> → <id> = <expr>
<id> → A | B| C
<expr> → <expr> * <term> | <term>
<term> → <factor> + <term> | <factor>
<factor> → (<expr>) | <id>



Problem 2

Using the grammar given in question 1 show parse tree and a leftmost deviation for each of the following statements:

A = (A + B) * C



<assign> → <id> = <expr>
<assign> → A = <term>
<assign> → A = <term> * <factor>
<assign> → A = <factor> * <factor>
<assign> → A = (<expr>) * <factor>
<assign> → A = (<expr> + <term>) * <factor>
<assign> → A = (<term> + <term>) * <factor>
<assign> → A = (<factor> + <term>) * <factor>
<assign> → A = (<id> + <term>) * <factor>
<assign> → A = (A + <term>) * <factor>
<assign> → A = (A + <factor>) * <factor>
<assign> → A = (A + <id>) * <factor>
<assign> → A = (A + B) * <factor>
<assign> → A = (A + B) * <id>
<assign> → A = (A + B) * C

Problem 3

Given the grammar in question 1, modify the grammar to add a unary minus operator that has higher precedence than + or *

<assign> → <id> = <expr>
<id> → A | B| C
<expr> → <expr> + <term> | <term>
<term> → <term> * <factor> | <factor>
<factor> → (<expr>) | <id> | – <id>

Problem 4

Describe, in English or in mathematic notation, the language defined by the following grammar.

<S> → <A><B><C>
<A> → a <A> | a
<B> → b <B> | b
<C> → c <C> | c

The outcome is a string that is comprised of a string of a's (1 a at minimum) concatenated by a string of b's (1 b at minimum) concatenated by a string of c's (1 c at minimum)

String = $a^i b^j c^k$ where {i, j, k} are integers >= 1

Problem 5

Write a grammar for the following language consisting of strings that have n copies of the letter a followed by the same number of copies of the letter b, where n > 0. For example, the strings ab, aabb, aaaabbbb are in the language, but a, aab, abb, ba, and aaabb are not.

<S> → a <S> b | ab

Problem 6

Compute the weakest precondition for each of the following assignment statements and post condition.

a = 2 * (b – 1) – 1 { a > 0 }
b = (c + 10) / 3 { b > 6 }

2 * (b – 1) – 1 > 0
b – 1 > 1/2

b > 3/2 (weakest pre-condition)

Weakest pre-condition is a range of b > 3/2 that maintains post-condition of a > 0

(c + 10) / 3 > 6
c + 10 > 18
c > 8 (weakest pre-condition)

Weakest pre-condition is a range of c > 8 that maintains post-condition of b > 6

Weakest pre-condition for both statements is a c > 8 as it maintains post-condition of b > 6 and a > 0

Problem 7

Compute the weakest precondition for each of the following sequences of assignment statements and their post condition.

a = 2 * b + 1; -------S1
b = a – 3; ------------S2
{ b < 0 }

a – 3 < 0
a < 3 (weakest precondition)

2 * b + 1 < 3
2 * b < 2
b < 1 (weakest precondition)

({b < 1} S1 {a < 3}, {a < 3} S2 {b < 0}) → ({b < 1} S1, S2 {b < 0})

Weakest pre-condition for both statements is a b < 0 as it maintains post-condition of b < 0 and b < 1

Problem 8

Let ∑ = {a, b}. For the following language, find a grammar that generates it.

L = { a^n b^{n-3} : n >=3 }

<S> = a <A>
<A> = a <B>
<B> = a <C>
<C> = a <C> b | λ

Problem 9

Practice derivations of the following English sentences from the grammar given below.