**Instructions**

The way I have chose to represent a polynomial such as 5x2is by using the form:

((5((2 x))))

If the polynomial has an coefficient with more than one variable, such as 5xyz the variables must be in a consistent order throughout the polynomial calculation. 5xyz would be represented as:

((5((1 x)(1 y)(1 z))))

In my testing I have tried to include as many edge cases as possible. This involved testing with decimals, multi variable polynomials and polynomials of 0. I have used Common Lisp and used the SBCL compiler.

I have listed my examples, first with the standard mathematic representation, then my input the way I have chosen to implement it and finally the output.

**Addition**

(x + y) + (x + y)

(p+ '((1((1 x)))(1((1 y)))) '((1((1 x)))(1((1 y)))))

((2 ((1 X))) (2 ((1 Y))))

(5) + (10)

(p+ '((5())) '((10)))

15

(x + y) + (a + b)

(p+ '((1((1 x)))(1((1 y)))) '((1((1 a)))(1((1 b))))))

((1 ((1 A))) (1 ((1 B))) (1 ((1 X))) (1 ((1 Y))))

(4x2) + (5x2)

(p+ '((4((2 x)))) '((5((2 x)))))

((9 ((2 X))))

(5x2 + 3y3) + (0)

(p+ '((5((2 x)))(3((3 y)))) '()))

((5 ((2 X))) (3 ((3 Y))))

(5x3 + 3y3 + 4z2) + (6x3 + 4y + 9z2)

(p+ '((5((3 x)))(3((3 y)))(4((2 z)))) '((6((3 x)))(4((1 y)))(9((2 z))))))

((4 ((1 Y))) (13 ((2 Z))) (11 ((3 X))) (3 ((3 Y))))

(5x + 3y + 4z) + (6a + 4b + 9c)

(p+ '((5((1 x)))(3((1 y)))(4((1 z)))) '((6((1 a)))(4((1 b)))(9((1 c))))))

((6 ((1 A))) (4 ((1 B))) (9 ((1 C))) (5 ((1 X))) (3 ((1 Y))) (4 ((1 Z))))

(10x3 + 5) + (5x3 + 5)

(p+ '((10((3 x)))(5())) '((5((3 x)))(5())))

((15 ((3 X))) (10 NIL))

(5x3y2z2) + (-5x3y2z2)

(p+ '((5((3 x)(2 y)(2 z)))) '((-5((3 x)(2 y)(2 z)))))

NIL

**Subtraction**

(3x) – (1x)

(p- '((3((1 x)))) '((1((1 x))))))

((2 ((1 X))))

(7) – (3)

(p- '((7())) '((3()))))

((4 NIL))

(5x2 + 3y3) - (0)

(p- '((5((2 x)))(3((3 y)))) '()))

((5 ((2 X))) (3 ((3 Y))))

(10x + 4y4) – (10x + 4y4)

(p- '((10((1 x)))(4((4 y)))) '((10((1 x)))(4((4 y)))))

NIL

(2y2) – (-5y2)

(p- '((2((2 y)))) '((-5((2 y)))))

((7 ((2 Y))))

(1.5x0.5) - (3.2x0.5)

(p- '((1.5((0.5 x)))) '((3.2((0.5 x)))))

(-1.7 ((0.5 X))))

(0) – (5y2)

(p- '((0())) '((5((2 y))))))

((-5 ((2 Y))))

(5x + 3y + 4z) - (6a + 4b + 9c)

(p- '((5((1 x)))(3((1 y)))(4((1 z)))) '((6((1 a)))(4((1 b)))(9((1 c)))))

((-6 ((1 A))) (-4 ((1 B))) (-9 ((1 C))) (5 ((1 X))) (3 ((1 Y))) (4 ((1 Z))))

(5x3 + 3y3 + 4z2) - (6x3 + 4y + 9z2)

(p- '((5((3 x)))(3((3 y)))(4((2 z)))) '((6((3 x)))(4((1 y)))(9((2 z))))))

((-4 ((1 Y))) (-5 ((2 Z))) (-1 ((3 X))) (3 ((3 Y))))

(10x3 + 4y) - (0.5)

(p- '((10((3 x)))(4((1 y)))) '((0.5())))

((4 ((1 Y))) (10 ((3 X))) (-0.5 NIL))

**Multiplication**

(5x2 + 3y3) \* (0)

(p\* '((5((2 x)))(3((3 y)))) '()))

NIL

(10x3 + 4y) \* (0.5)

(p\* '((10((3 x)))(4((1 y)))) '((0.5())))

((2.0 ((1 Y))) (5.0 ((3 X))))

(3x2 + 7y5) \* (a3+5b2+2x2)

(p\* '((3((2 x)))(7((5 y)))) '((1((3 a)))(5((2 b)))(2((2 x)))))

((15 ((2 B) (2 X))) (56 ((2 X) (5 Y))) (3 ((3 A) (2 X))) (6 ((4 X))))

((2x + 3y­­­­­2) \* (3x2+2y2)) + (6x3)

(p+(p\* '((2((1 x)))(3((2 y)))) '((3((2 x)))(2((2 y))))) '((6((3 x)))))

((4 ((1 X) (2 Y))) (9 ((2 X) (2 Y))) (12 ((3 X))) (6 ((4 Y))))

(5x3y2z2) \* (3x3y2z2+1)

(p\* '((5((3 x)(2 y)(2 z)))) '((3((3 x)(2 y)(2 z)))(1())))

((5 ((3 X) (2 Y) (2 Z))) (-15 ((6 X) (4 Y) (4 Z))))

(5y-2) \* (5y2)

(p\* '((5((-2 y)))) '((5((2 y))))))

((25 ((0 Y))))

(3x2y3) \* (2)

(p\* '((3((2 x)(3 y)))) '((2()))))

((6 ((2 X) (3 Y))))

(1.5x2y3) \* (3.2x2)

(p\* '((1.5((2 x)(3 y)))) '((3.2((2 X))))))

((4.8 ((4 X) (3 Y))))

(1.5x0.5) \* (3.2x0.5)

(p\* '((1.5((0.5 x)))) '((3.2((0.5 x)))))

((4.8 ((1.0 X))))

(10x3 + 4y) \* (0.5x2)

(p\* '((10((3 x)))(4((1 y)))) '((0.5((2 x)))))

((2.0 ((2 X) (1 Y))) (5.0 ((5 X))))

**Addition, subtraction and multiplication**

(((5x3y2z2) \* (-5x3y2z2)) + (6x4y3)) – (-15x2)

(p-(p+(p\* '((5((3 x)(2 y)(2 z)))) '((-3((3 x)(2 y)(2 z)))(1()))) '((6((4 x)

(3 y)))))'((-15((2 x))))))

((15 ((2 X))) (5 ((3 X) (2 Y) (2 Z))) (6 ((4 X) (3 Y))) (-15 ((6 X) (4 Y) (4 Z))))

((3x3)+(3x3)) – (6x3)

(p-(p+ '((3((3 x)))) '((3((3 x))))) '((6((3 x)))))

NIL

((10x3 + 4y) \* (0.5x2)) – (3x5)

(p-(p\* '((10((3 x)))(4((1 y)))) '((0.5((2 x))))) '((3((5 x)))))

((2.0 ((2 X) (1 Y))) (2.0 ((5 X))))

((3x3)+(3x3)) \* (0x3)

(p\*(p+ '((3((3 x)))) '((3((3 x))))) '((0())))

NIL

((10x + 4y4) – (5x3 + 4z3)) \* (3y2)

(p\*(p- '((10((1 x)))(4((4 y)))) '((5((3 x)))(4((3 z))))) '((3((2 y))))))

((30 ((1 X) (2 Y))) (-12 ((2 Y) (3 Z))) (-15 ((3 X) (2 Y))) (12 ((4 Y) (3 Z))))