General

polynomial.lisp was created using the SBCL implementation of Common Lisp.

Representation

In this representation, polynomials are represented by a list of terms where each term is represented as: (coeffecient xexponent yexponent zcomponent ...). There can be any number of exponents following the coeffecient, representing any symbol such as *x*/a/p's component, as long as they are in the same order across terms for input. For example:

- $3x^2$ = (3 2)
- $-2y^3$ (-2 0 3)
- $4xz^2$ = (4 1 0 2)
- a^5 = (1 5)
- $2xy^3a^2$ = (2 1 3 0 2)
- xyz = (1 1 1 1)

Therefore, a list of terms $2xy + x^2 + 3$ = ((2 1 1) (1 2) (3))

Notes:

- A valid way to call the p+ function is: (p+'((1 2)) '((3 2) (2 0 1)))
- Please note that (p+'(1 2) '((3 2) (2 0 1))) is invalid - p+ takes 2 arguments which are lists of lists. In this example the first argument is just a list - correct this to: (p+'**(**(1 2)**)** '((3 2) (2 0 1)))
- As input does not need to be validated and polynomial division does not need to be implemented in this assignment, writing x^2 as (1 1 0) is not a valid input due to the trailing 0 - *i.e* terms inputted should not finish with a 0. x^2 should therefore be represented as (1 1). However, in certain cases, (1 1 0) may be outputted after using p* which is equal to (1 1).
- In testing, where the output is successful,the given output may be out of order but still matches the expected output terms.

Polynomial Testing

Number	Input	Expected Output	Success/Fail
1	1+1 (p+ '((1)) '((1)))	2 ((2))	Success: matches expected output
2	4+(-5) (p+ '((4)) '((-5)))	-1 ((-1))	Success: matches expected output
3	49 - 7 (p- '((49)) '((7)))	42 ((42))	Success: matches expected output
4	30 - 30 (p- '((30)) '((30)))	0 ((0))	Success: matches expected output
5	12 * 7 (p* '((12)) '((7)))	84 ((84))	Success: matches expected output
6	-11 * 3	-33	Success: matches expected output

	(p* ’((-11)) ‘((3)))	((-33)	
7	(x + y) - y (p-’((1 1) (1 0 1)) ‘((1 0 1))	x (1 1)	Success: matches expected output
8	x + y (p+ ‘((1 1)) ‘((1 0 1)))	x + y ((1 1) (1 0 1))	Success: matches expected output
9	x - (y + z) (p- ‘((1 1)) ‘((1 0 1) (1 0 0 1)))	x - y -z ((1 1) (1 0 1) (1 0 0 1))	Success: matches expected output
10	x * y (p* ‘((1 1)) ‘((1 0 1)))	xy ((1 1 1))	Success: matches expected output
11	((3 * 4) + 2) -x (p- (p+ (p* ‘((3)) ‘((4))) ‘((2))) ‘((1 1)))	14 - x ((14) (-1 1))	Success: matches expected output
12	(2x + y + z) + (3x + 5y -z) (p+’((2 1) (1 0 1) (1 0 0 1)) ‘((3 1) (5 0 1) (-1 0 0 1)))	(5x + 6y) ((5 1) (6 0 1))	Success: matches expected output
13	(2x² + 2x) + (3x² + 3x) (p+ ‘((2 2) (2 1)) ‘((3 2) (3 1)))	5x² + 5x ((5 2) (5 1))	Success: matches expected output
14	(x² + 3) + (3x² + y + 1) (p+’((1 2) (3)) ‘((3 2) (1 0 1) (1)))	4x² + y + 4 ((4 2) (1 0 1) (4))	Success: matches expected output
15	(y² + 0) * (2 + x²) (p* ‘((1 0 2) (0)) ‘((2) (1 2)))	2y²+ y²x² ((2 0 2) (1 2 2))	Success: matches expected output
16	(5x² + 3x) - (5x² + x) (p-’((5 2) (3 1)) ‘((5 2) (1 1))	2x ((2 1))	Success: matches expected output
17	(5xy + x³ + z + a²) - (3xy + 2xy + 2z -5a²) (p-’((5 1 1) (1 3) (1 0 0 1) (1 0 0 0 2)) ‘((3 1 1) (2 1 1) (2 0 0 1) (-5 0 0 0 2)))	6a² + x³ - z ((6 0 0 0 2) (1 3) (-1 0 0 1))	Success: matches expected output
18	(2x² - x³ + 3x⁴) * 4x (p* ‘((2 2) (-1 3) (3 4)) ‘((4 1)))	(8x³ - 4x⁴ + 12x⁵) ((8 3) (-4 4) (12 5))	Success: matches expected output

19	0 * (2x-3+y) (p* ‘((0)) ‘((2 1) (-3) (1 0 1)))	0 ((0))	Success: matches expected output
20	$(7x^3 - x^2 + 21) + (4y^4 + 2x^3y - x^3)$ (p+’((7 3) (-1 2) (21)) ‘((4 0 4) (2 3 1) (-1 3)))	$6x^3 + 4y^4 + 2x^3y - x^2 + 21$ ((6 3) (4 0 4) (2 3 1) (-1 2) (21))	Success: matches expected output
21	$(z^2 - 2x^3) - (z^2 + 3y^2 + x^3)$ (p-’((1 0 0 2) (-2 3)) ‘((1 0 0 2) (3 0 2) (1 3)))	$- 3x^3 - 3y^2$ ((-3 3) (-3 0 2))	Success: matches expected output
22	$(xyz + y^2) - (21 - 5x^4yz + z^2)$ (p-’((1 1 1 1) (1 0 2)) ‘((21) (-5 4 1 1) (1 0 0 2)))	$xyz + y^2 - 21 + 5x^4yz - z^2$ ((1 1 1 1) (1 0 2) (-21) (5 4 1 1) (-1 0 0 2)	Success: matches expected output
23	$(7xy + y) * (2y^2 + 4x)$ (p*’((7 1 1) (1 0 1)) ‘((2 0 2) (4 1)))	$28x^2y + 14xy^3 + 4xy + 2y^3$ ((28 2 1) (14 1 3) (4 1 1) (2 0 3))	Success: matches expected output
24	$(4x^3 - 2x^2 + 19) + (3x^4 + 2x^3y - y^3)$ (p+’((4 3) (-2 2) (19)) ‘((3 4) (2 3 1) (-1 0 3)))	$3x^4 +2x^3y + 4x^3 - 2x^2 - y^3 + 19$ ((3 4) (2 3 1) (4 3) (-2 2) (-1 0 3) (19))	Success: matches expected output
25	$(3xy^3 - 2x^2 + 14z^3 - 2yz^2 + 19) - (xy^3 - 7x^2 + 2z^3 + 2yz^2 + 72)$ (p- ‘((3 1 3) (-2 2) (14 0 0 3) (-2 0 1 2) (19)) ‘((1 1 3) (-7 2) (2 0 0 3) (2 0 1 2) (72)))	$5x^2 + 2xy^3 - 4yz^2 + 12z^3 - 53$ ((5 2) (2 1 3) (-4 0 1 2) (12 0 0 3) (-53))	Success: matches expected output
26	$(x + 2)(x - 3)(x + 4)(x - 1)$ (p*(p* ‘((1 1) (2)) ‘((1 1) (-3))) (p* ‘((1 1) (4)) ‘((1 1) (-1))))	$x^4 + 2x^3 - 13x^2 - 14x + 24$ ((1 4) (2 3) (-13 2) (-14 1) (24))	Success: matches expected output
27	$((x+1)(x-1)) - (x^2 -1)$ (p-(p* ‘((1 1) (1)) ‘((1 1) (-1))) ‘((1 2) (-1)))	0 ((0))	Success: matches expected output
28	((2x -3) + (x + y)) + (-2x -y) (p+(p+ ‘((2 1) (-3)) ‘((1 1) (1 0 1))) ‘((-2 1) (-1 0 1)))	x - 3 ((1 1) (-3))	Success: matches expected output
29	$(x^2y + x^2y^2z^2a^2) * a^2b^2$	$x^2ya^2b^2 + x^2y^2z^2a^4b^2$	Success: matches

	(p* '((1 2 1) (1 2 2 2 2)) '((1 0 0 0 2 2)))	((1 2 1 0 2 2) (1 2 2 2 4 2))	expected output
30	$(2x^3 + xy^2 -z) * (y^2 - x + z)$ (p* '((2 3) (1 1 2) (-1 0 0 1)) '((1 0 2) (-1 1) (1 0 0 1)))	$-2x^4+2x^3y^2+2x^3z-x^2y^2+xy^4+xy^2z+xz-y^2z-z^2$ ((-2 4) (2 3 2) (2 3 0 1) (-1 2 2) (1 1 4) (1 1 2 1) (1 1 0 1) (-1 0 2 1) (-1 0 0 2))	Success: matches expected output
31	$(x^2y - x^2y) * (y - y)$ (p* '((1 2 1) (-1 2 1)) '((1 0 1) (-1 0 1)))	0 ((0))	Success: matches expected output
32	$x^4y * z^4 * y^4 * x * x^2 * 10$ (p* (p* (p*(p* (p* '((1 4 1)) '((1 0 0 4))) '((1 0 4))) '((1 1))) '((1 2))) '((10)))	$10x^7y^5z^4$ ((10 7 5 4))	Success: matches expected output
33	$(x^4- x^4 +y^2 - y^2) * (15x^2 + y^2)$ (p* '((1 4) (-1 4) (1 0 2) (-1 0 2)) '((15 2) (1 0 2)))	0 ((0))	Success: matches expected output
34	$((2xy^3 - x -2x^3) + 2x^3y + x) * (2x^2y^2 + x)$ (p*(p+(p- '((2 1 3)) '((1 1) (2 3))) '((2 3 1) (1 1))) '((2 2 2) (1 1)))	$4x^5y^3 -4x^5y^2 + 2x^4y-2x^4+4x^3y^5 + 2x^2y^3$ ((4 5 3) (-4 5 2) (2 4 1) (-2 4) (4 3 5) (2 2 3))	Success: matches expected output
35	$((-2x^2y + y^2) + (4xy + 2y^2)) * (y^2)$ (p*(p+ '((-2 2 1) (1 0 2)) '((4 1 1) (2 0 2))) '((1 0 2)))	$-2x^2y^3 + 4xy^3+ 3y^4$ ((-2 2 3) (4 1 3) (3 0 4))	Success: matches expected output
36	$((a + b^2) * c^3) - (c + d^3)$ (p- (p* (p+ '((1 1)) '((1 0 2))) '((1 0 0 3))) '((1 0 0 1) (1 0 0 0 3)))	$ac^3+b^2c^3-c-d^3$ ((1 1 0 3) (1 0 2 3) (-1 0 0 1) (-1 0 0 0 3))	Success: matches expected output
37	$((3x^2 + 2yz^2) * (20y -x^2)) * (3y +4x)$ (p*(p* '((3 2) (2 0 1 2)) '((20 0 1) (-1 2))) '((3 0 1) (4 1)))	$-12x^5 +240x^3y - 8x^3yz^2 + 160xy^2z^2 - 9x^4y + 180x^2y^2 - 6x^2y^2z^2 + 120y^3z^2$ ((-12 5) (240 3 1) (-8 3 1 2) (160 1 2 2) (-9 4 1) (180 2 2) (-6 2 2 2) (120 0 3 2))	Success: matches expected output

38	((2x² - 4) +(3xy - y²)) - (250x² - 200xy -350y²) (p-(p+ ‘((2 2) (-4)) ‘((3 1 1) (-1 0 2))) ‘((250 2) (-200 1 1) (-350 0 2)))	-4 -248x² + 203xy + 349y² ((-4) (-248 2) (203 1 1) (349 0 2))	Success: matches expected output
39	((2x² - 4) +(3xy - y²)) - (250x² - 200xy -350y²) - (-4 -248x² + 203xy + 349y²) (p-(p-(p+ ‘((2 2) (-4)) ‘((3 1 1) (-1 0 2))) ‘((250 2) (-200 1 1) (-350 0 2))) ‘((-4) (-248 2) (203 1 1) (349 0 2)))	0 ((0))	Success: matches expected output
40	(((10 – 28y) – ((2x + 3z) * (12y – 3z)) + (3xy – 3y²)) * (8xz – 8y²))) (p* (p+ (p- '((10) (-28 0 1)) (p* '((2 1) (3 0 0 1)) '((12 0 1) (-3 0 0 1)))) '((3 1 1) (-3 0 2))) '((8 1 0 1) (-8 0 2 0)))	-168x²yz + 48x²z² + 168xy³-72xy²z - 288xyz² -224xyz + 72xz³ + 80xz +24y⁴ + 288y³z + 244y³-72y²z² -80y² ((-168 2 1 1) (48 2 0 2) (168 1 3) (-72 1 2 1) (-288 1 1 2) (-224 1 1 1) (72 1 0 3) (80 1 0 1) (24 0 4) (288 0 3 1) (244 0 3) (-72 0 2 2) (-80 0 2))	Success. Although (-80 0 2), (168 1 3), (24 0 4) (224 0 3) are outputted with an extra 0 in their list - such as (168 1 3 0). These terms represent the same value in my representation, however.