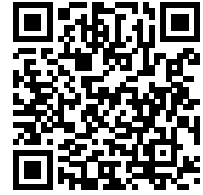


# Worksheet: L01 – Symbolic Reasoning

CSCI-534: Robot Planning & Manipulation

Spring 2020

<http://www.neil.dantam.name/rpm/B01-sym.pdf>



## 1. S-expressions:

(a) For expression  $2(x - 1) = 4$ :

i. Draw the equivalent abstract syntax tree:

ii. Write the equivalent S-expression:

iii. Draw the equivalent cons cell diagram.

(b) For expression  $a + bx + cx^2$ :

i. Draw the equivalent abstract syntax tree:

ii. Write the equivalent S-expression:

iii. Draw the equivalent cons cell diagram.

2. **List construction:** evaluate the following:

- (a) `(cons 'x 'y)`
- (b) `(cons 'x '(y z))`
- (c) `(cons 'x (list 'y 'z))`
- (d) `(list (+ 1 2 3))`
- (e) `(list '(+ 1 2 3))`
- (f) `(list '* (+ 2 2)'(- 2 2))`
- (g) `(list '+ '(* a 2) (* 3 4))`

3. **List templates:** Evaluate the following list templates:

- (a) `'(1 2 ,(+ 3 4))`
- (b) `'(,1 ,2 (+ 3 4))`
- (c) `'(+ 1 ,2 ,(+ 3 4))`
- (d) `'(1 2 ,@(list '+ '3 '4))`

4. **Recursive Evaluation:** For expression  $2(1 + 2 + 3) - 5$ :

- (a) Draw the equivalent abstract syntax tree:
- (b) Write the equivalent S-expression:
- (c) Show the steps of the recursive evaluation diagram:

Name:

5. **Partial Evaluation:** show the partial evaluation steps for  $e = \frac{a}{1+b+c} - d$ , where  $a = 3$ ,  $b = 5$ , and  $c = 7$ :

6. **Derivative s-expression:** For expression  $\frac{d}{dt} \frac{\sin t}{\cos t}$ :

(a) Write the equivalent s-expression:

(b) Draw the equivalent cons cell diagram:

7. **Differential calculus s-expression:** Write the following differential calculus rules in S-expression form:

(a)  $\frac{d}{dt} (f(t) - g(t)) \rightsquigarrow \frac{d}{dt} f(t) - \frac{d}{dt} g(t)$

(b)  $\frac{d}{dt} \left( \frac{f(t)}{g(t)} \right) \rightsquigarrow \frac{\frac{d}{dt} f(t)}{g(t)} - \frac{f(t) * \frac{d}{dt} g(t)}{(g(t))^2}$

Name:

8. **Symbolic differentiation:** Trace the steps of the recursive symbolic differentiation algorithm for the following expressions:

(a)  $\frac{d}{dt} \sin^2 t$

(b)  $\frac{d}{dx} (\ln x + a * x^2)$