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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.

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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 Evalutation:** 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:

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

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

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

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

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