625-600: Programming Assignment 1

Read every page very carefully before you begin.

1. Implement \texttt{deriv} to support:
   addition, subtraction, unary minus, multiplication, division, sqrt, log, exp, sin, cos, tan.
   \textit{→ HINT: use slide02 page 44 as a skeleton.}

2. Implement simplification routines \texttt{splus} etc. for all operators and integrate it into \texttt{derivplus}, etc.
   \textit{→ HINT: Integrate code in slide02 page 45 into code in page 44. (Code available on course web page, under the src/ directory.)}

3. Write a simple function \texttt{deriv-eval} to assign a numerical value to the variable and get a single number corresponding to the resulting derivative:
   \begin{verbatim}
   (deriv-eval '(+ ( * x x) (- 2 x)) 'x 20)
   \end{verbatim}
   * You must use recursion.

4. Write a recursive simplification function \texttt{simplify} that could simplify expressions like \begin{verbatim}
   (+ 0 (+ ( * x 0) x))
   \end{verbatim}
Programming Assignment 1: other conditions

1. Use only one variable (say \( X \)). Other symbols should be treated as constants (e.g. \( Y, Z, \ldots \)).

2. All operators should be binary operators: i.e. expressions like \((+ 1 2 3 4 5)\) do not need to be supported. Only those in the form of \((+ 1 2)\) are expected to be used.

3. The only exception is the unary minus operator \((- 10)\), which only has one argument.

4. You must check for division by zero and print an error message in case such an event occurs, especially for the deriv-eval function.
Programming Assignment 1: Example Inputs and Outputs

1. \( (\text{deriv} \ '(* \ (+ \ x \ 4) \ (+ \ x \ 5)) \ 'x) \)
   \[\rightarrow \ (+ \ (+ \ X \ 4) \ (+ \ X \ 5))\]

2. \( (\text{deriv} \ '/ \ (+ \ x \ 1) \ x) \ 'x) \)
   \[\rightarrow \ (/ \ (- \ X \ (+ \ X \ 1)) \ (* \ X \ X))\]

3. \( (\text{deriv-eval} \ '(* \ (+ \ x \ 4) \ (+ \ x \ 5)) \ 'x \ 10) \)
   \[\rightarrow \ 29\]

4. \( (\text{deriv-eval} \ '/ \ (+ \ x \ 1) \ x) \ 'x \ 5) \)
   \[\rightarrow \ -1/25\]
Programming Assignment 1: Required Material

Use the exact filename as shown below (in **bold**).

- Program code (**deriv.lsp**): put it in a single text file.
  - Ample indentation and documentation is **required**.
- Documentation (**README**): user manual (how to load and execute).
- Sample inputs and outputs (include in **README**)
  - 10 non-trivial examples, each containing a combination of more than 5 operators. Provide examples for **deriv**, **deriv-eval**, and **simplify**.
- Grading criteria:
  - **README**, test cases, comments, readability: 10%
  - deriv + splus etc.: 60%
  - deriv-eval: 10%
  - simplify: 20%
Programming Assignment 1: Important Grading Information

- Since the deriv functions call the simplification functions splus etc., if the simplification routine is broken, regardless of the deriv functions being correct, your call will result in an error. If this happens, both deriv and simplification will be graded as malfunctioning.

- If you got deriv functions to work, but if simplification is not working, take out the simplification code from your deriv functions so that at least your deriv functions work.
Programming Assignment 1: Submission

- Use the eCampus turnin form (http://ecampus.tamu.edu).
- Due: see course web page for the due date.
- Late policy: 1% late penalty per hour.
- Only include plain text ASCII files.
Academic Policy

- This is an **individual assignment**. No collaboration is allowed.

- Any suspected academic policy violations will be promptly reported to the **Aggie Honor System Office** (http://www.tamu.edu/aggiehonor/).

- For discussions regarding the assignment, frequently check out the **read-only bulletin board** on the course web page, since most of the Q-and-A’s will be uploaded there.
Differentiation rules

\( c: \) constant; \( f(x), g(x): \) functions of \( x; \) Lisp \((\text{exp} x \ y) = x^y\).

\[
\frac{d(f/g)}{dx} = \frac{1}{g^2} \left( g \frac{df}{dx} - f \frac{dg}{dx} \right)
\]

\[
\frac{df^c}{dx} = cf^{c-1} \frac{df}{dx}, \quad \frac{d\sqrt{f}}{dx} = \frac{1}{2\sqrt{f}} \frac{df}{dx}
\]

\[
\frac{d\log(f)}{dx} = \frac{1}{f} \frac{df}{dx}, \quad \frac{d\exp(f)}{dx} = \exp(f) \frac{df}{dx}
\]

\[
\frac{d\sin(f)}{dx} = \cos(f) \frac{df}{dx}, \quad \frac{d\cos(f)}{dx} = -\sin(f) \frac{df}{dx}
\]

\[
\frac{d\tan(f)}{dx} = (1 + \tan^2(f)) \frac{df}{dx}
\]