Language Constructs

1. Primitives: simplest entities in the language
   - evaluate to themselves (1) self-evaluating primitives: numbers, strings, booleans (true, false)
   - examples:
     - numbers: +, -, *, /, >, <, >=, <=, =
     - strings: string-length, string=? , . . .
     - booleans: boolean/and, boolean/or, boolean/not
   - evaluate to a procedure
   - examples: symbols +, -, . . . are names for primitive procedures
     (look-up procedures in a special table; see environment model later)

2. Combinations: compound elements built by combining smaller ones (primitive procedures and subexpressions)

   (foo a b c)  First expression after left parenthesis must be a procedure to be applied; a, b, c are subexpressions representing the procedure's arguments

   - evaluate subexpressions, then apply value of the operator

   \[
   \begin{align*}
   \text{procedure} & \quad \text{subexpressions} \\
   (+ 3 4) & \quad (+ (+ 3 4) (+ 10 11) (+ 1 1)) \\
   (+ 7 2 1 2) & \quad 30
   \end{align*}
   \]

3. Abstractions: compound elements can be named and used as single entities
   - needs a special form called define (why?)

   (define bar 4)
   (define foo +)
   (foo bar 3)
   (define foo*2 (* foo 2))
   (define foo*2 (* (foo 3 4) 2))
Examples

(* 5 99)

495

(+5 99)

error: need space between symbols so + can evaluate to a procedure

(* (5 99))

error: procedure name repeated after '; 5 is not a procedure

(* -5 99)

-495

(* (- 5 99))

-94

What special characters have we seen so far in Scheme? paren + space

Problems

What is the result printed by the Scheme interpreter for each expression? Assume that the first 7 expressions are evaluated in order.

1. 42
   42

2. (/ 5 2)
   2½ (note: Some implementations may leave this as 5/2)

3. (+(* 2 3) (- 4 8))
   (+ 6 -4)

4. +
   # primitive +

5. (define + (* 2 5))
   nothing prints out; value is unspecified

6. (* 2 +)
   10
   20

7. (+ 2 5)
   error: + is not a procedure anymore

8. Write the Scheme expression representing the following (assume that + has not been redefined):

\[
\frac{5 + 4 + (2 - (3 - (6 + 3/4)))}{3(6 - 2)(2 - 7)}
\]

\[
\left( \left( \left( \left( \left( \left( \left( \left( + \ 5 \ 4 \ (- \ 2 \ (- \ 3 \ (+ \ 6 \ 3/4))) \right) \right) \right) \right) \right) \right) \right)
\]

\[
(\ star \ 3 \ (- \ 6 \ 2) \ (- \ 2 \ 7))
\]

\[
(1 \ (+ \ 5 \ 4 \ (- \ 2 \ 3 \ (+ \ 6 \ 3/4)))
\]

\[
(* \ 3 \ (- \ 6 \ 2) \ (- \ 2 \ 7))
\]