Can I quote you on that?

(quasiquote expr) is like quote, but can selectively evaluate pieces. Much like quote can be abbreviated as ’, quasiquote is often shortened as `’. Quasiquote acts just like quote, except where the following two operators appear in the body of the quotation:

1. (unquote x) - give value of x. Can be abbreviated with , as in ,x.

2. (unquote-splicing x) - give value of x, assume it’s a list, and splice the element into the outer list. Can be abbreviated ,@ as in ,@x.

For example, if foo is bound to #t and bar is bound to (yay rah):

```
`(foo bar baz) ; (foo bar baz)
`(,foo bar baz) ; (#t bar baz)
`(foo ,bar baz) ; (foo (yay rah) baz)
`(foo ,@bar baz) ; (foo yay rah baz)
`(foo bar ,baz) ; error: unbound variable baz
`(,(not foo) bar baz) ; (#f bar baz)
```

As demonstrated by the last example, the unquoted expressions aren’t limited to just names.

If x is bound to 3, y is bound to (5 6), and z is bound to (7 8 9), use quasiquote to build the value (a 1 2 3 b 4 5 6 (7 8 9) c).

If name and value are bound, use quasiquote to build a define expression that would bind the name to the value.

If params and body are bound, use quasiquote to build a lambda expression with the given parameters and body.
And iff’n you know what I mean...

The and special form evaluates its arguments one at a time. If it ever encounters an expression that evaluates to #f, it skips evaluating the rest of the expressions, and immediately returns #f. If none of the expressions evaluate to #f, it returns the value of the last expression. That is:

\[
\begin{align*}
\text{(and #f (/ 1 0))} & \Rightarrow \text{#f, not an error!} \\
\text{(and #t 2)} & \Rightarrow 2 \\
\text{(and 2)} & \Rightarrow 2 \\
\text{(and)} & \Rightarrow \text{#t}
\end{align*}
\]

Write a syntactic transformer called and->if that changes any given and expression into a series of nested if statements.

...or iff’n you don’t...

Relatedly, the or special form evaluates its arguments one at a time, and returns the first non-false value that it sees. If none of its arguments are true, it returns #f. Write a syntactic transformer called or->if which changes and given or expression into a series of nested if statements.

Double the bubble, double the trouble!

Louis Reasoner thinks it would simplify the evaluator a lot to condense m-eval and m-apply as follows:

\[
\text{(define (m-eval exp env)}
\]

(cond ((self-evaluating? exp) exp)
  ((variable? exp) (lookup-variable-value exp env))
  ((quoted? exp) (text-of-quotation exp))
  ((assignment? exp) (eval-assignment exp env))
  ((definition? exp) (eval-definition exp env))
  ((if? exp) (eval-if exp env))
  ((lambda? exp)
    (make-procedure (lambda-parameters exp) (lambda-body exp) env))
  ((begin? exp) (eval-sequence (begin-actions exp) env))
  ((cond? exp) (m-eval (cond->if exp) env))
  ((let? exp) (m-eval (let->application exp) env))
  ((application? exp)
    (let ((procedure (m-eval (operator exp) env))
           (arguments (list-of-values (operands exp) env)))
      ;; code from m-apply inserted here
      (cond ((primitive-procedure? procedure)
              (apply-primitive-procedure procedure arguments))
            ((compound-procedure? procedure)
             (eval-sequence
              (procedure-body procedure)
              (extend-environment (procedure-parameters procedure) arguments
                                    env)))) ;; can just use env here
      (else (error "Unknown procedure type -- APPLY" procedure)))))
  (else (error "Unknown expression type -- EVAL" exp))))

Does this work? Why or why not?

See let rec. Rec, let, rec!

The let special form is very useful for defining local variables. Of course, it can also be used to define local procedures. What is the output of the following? Why?

(let ((fact
       (lambda (x)
         (if (= x 1)
           1
           (* x (fact (- x 1))))))
     (+ (fact 3) (fact 4)))

How might you extend let to fix this issue? Scheme has a special form which handles this case, called letrec. Write a syntactic transformer, letrec->let, for m-eval.
Is this the right place for an argument?

As we’ve alluded to a couple times already, some procedures in normal scheme can take an arbitrary number of arguments. This is done by providing an unusual parameter list to \texttt{lambda}, as follows:

\begin{verbatim}
(define foo (lambda (x y . z) (cons (+ x y) z)))
(\texttt{foo 1 2}) ; => (3)
(\texttt{foo 1 2 5}) ; => (3 5)
\end{verbatim}

Remember that \texttt{(x y . z)} is interpreted by the reader as an improper list – that is, the same as \texttt{(cons ’x (cons ’y ’z))}. Our version of \texttt{m-eval} doesn’t object to the lambda definition above, but fails to do the right thing when the lambda is called. Alter the \texttt{extend-environment} procedure to support this form.