CSC 344 Third Racket Programming Assignment Solution

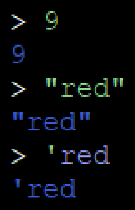
Learning Abstract: This programming assignment features several properties and abilities of the Lisp programming language as displayed in the Racket environment. These include simple capabilities like quote, atom, and define, as well as the more complex functions of list processing. Not only were these functions demonstrated on their own, but they were also then used all together to create some interesting programs at the end.

First Task: Historical Lisp

Parroting Racket interactions and definitions from “Lesson 7: Historical Lisp”.

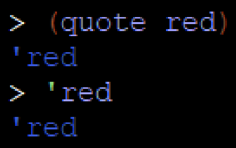
> Quote and Eval

Interactions - Constants 9 and “red” and ’red



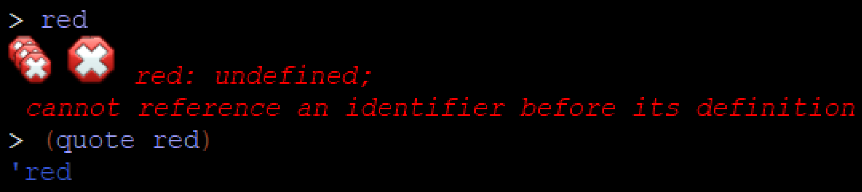
```
> 9
9
> "red"
"red"
> 'red
'red
```

Interactions - Variants of the quote special form



```
> (quote red)
'red
> 'red
'red
```

Interactions - Illustrating the “unbound variable” error



```
> red
red: undefined;
 cannot reference an identifier before its definition
> (quote red)
'red
```

Interactions - Examples of standard form evaluation

```
> (+ 3 4)
7
> (+(/ 3 1)(* 2 2))
7
> (+ 1 2 3 4 5 6 7 8 9 10)
55
> (/(* 10(+ 10 1))2)
55
```

Interactions - Illustrating the “unbound function” error

```
> (red yellow blue)
   red: undefined;
 cannot reference an identifier before its definition
```

> Car, Cdr, and Cons

Interactions - Examples of the car function

```
> (car '(apple peach cherry))
'apple
> (car '((lisp 1959)(prolog 1971)(haskell 1990)))
'(lisp 1959)
```

Interactions - Examples of the cdr function

```
> (cdr '(apple peach cherry))
'(peach cherry)
> (cdr '((lisp 1959)(prolog 1971)(haskell 1990)))
'((prolog 1971) (haskell 1990))
```

Interactions - Examples of the cons function

```
> (cons 'apple '(peach cherry))
'(apple peach cherry)
> (cons '(lisp 1959) '((prolog 1971)(haskell 1990)))
'((lisp 1959) (prolog 1971) (haskell 1990))
```

> Eq and Atom

Interactions - Examples of the eq? function

```
> (eq? 'a 'b)
#f
> (eq? 'a 'a)
#t
```

Interactions - Examples of the atom? function

```
> (define (atom? x)(not (or (pair? x)(null? x))))
> (atom? 'a)
#t
> (atom? '(a b c))
#f
> (atom? 4)
#t
> (atom? '(a . b))
#f
```

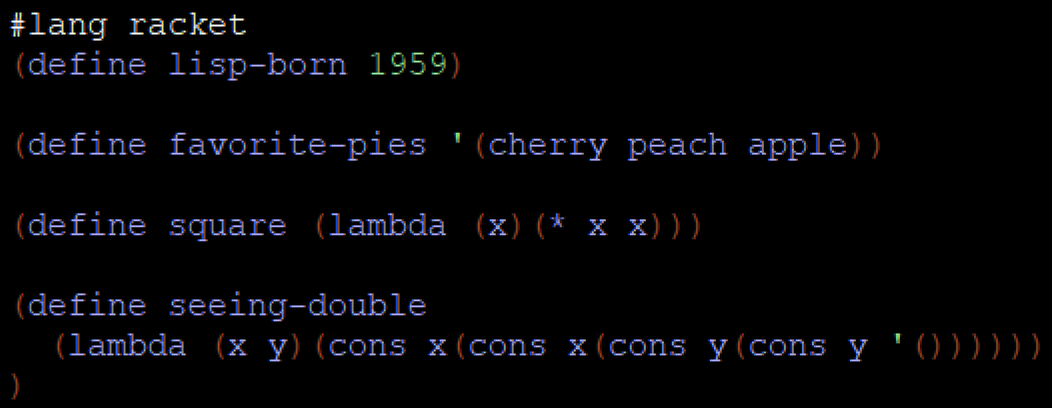
> Lambda

Interactions - Interactions featuring lambda function application

```
> ((lambda (x)(* x x))5)
25
> ((lambda (x)(* x x))9)
81
> ((lambda (x y)(cons x(cons x(cons y(cons y '())))))1 2)
'(1 1 2 2)
> ((lambda (x y)(cons x(cons x(cons y(cons y '())))))'hey 'now)
'(hey hey now now)

> ((lambda (a b c)
      (define s(/(+ a b c)2.0))
      (* s(- s a)(- s b)(- s c))
    )
    3 4 5
   )
36.0
```

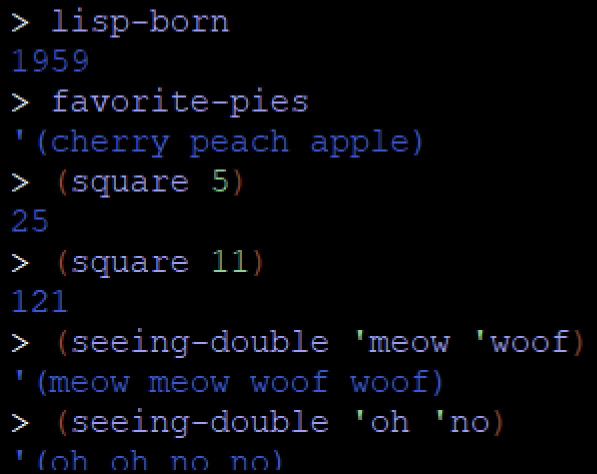
> Define

Definitions - Defining four items, two variables and two functions



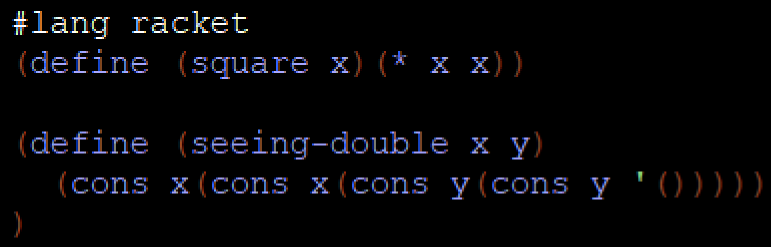
```
#lang racket
(define lisp-born 1959)

(define favorite-pies '(cherry peach apple))

(define square (lambda (x)(* x x)))

(define seeing-double
  (lambda (x y)(cons x(cons x(cons y(cons y '()))))))
)
```

Interactions - Referencing the two variables and applying the two functions



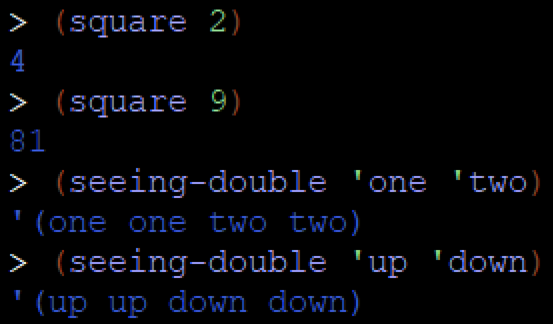
```
> lisp-born
1959
> favorite-pies
'(cherry peach apple)
> (square 5)
25
> (square 11)
121
> (seeing-double 'meow 'woof)
'(meow meow woof woof)
> (seeing-double 'oh 'no)
'(oh oh no no)
```

Definitions - Redefining the two functions (do it in a fresh pane)



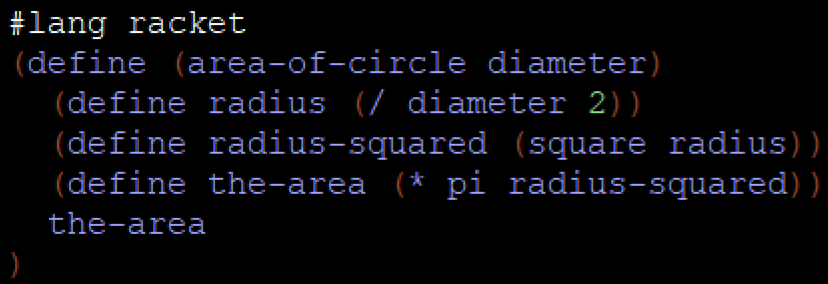
```
#lang racket
(define (square x)(* x x))

(define (seeing-double x y)
  (cons x(cons x(cons y(cons y '())))))
)
```

Interactions - Illustrating the application of these functions (even though this was not explicitly indicated in the lesson)



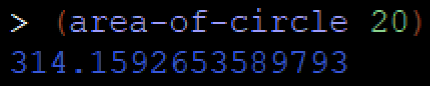
```
> (square 2)
4
> (square 9)
81
> (seeing-double 'one 'two)
'(one one two two)
> (seeing-double 'up 'down)
'(up up down down)
```

Definitions - Defining the area-of-circle function



```
#lang racket
(define (area-of-circle diameter)
  (define radius (/ diameter 2))
  (define radius-squared (square radius))
  (define the-area (* pi radius-squared))
  the-area
)
```

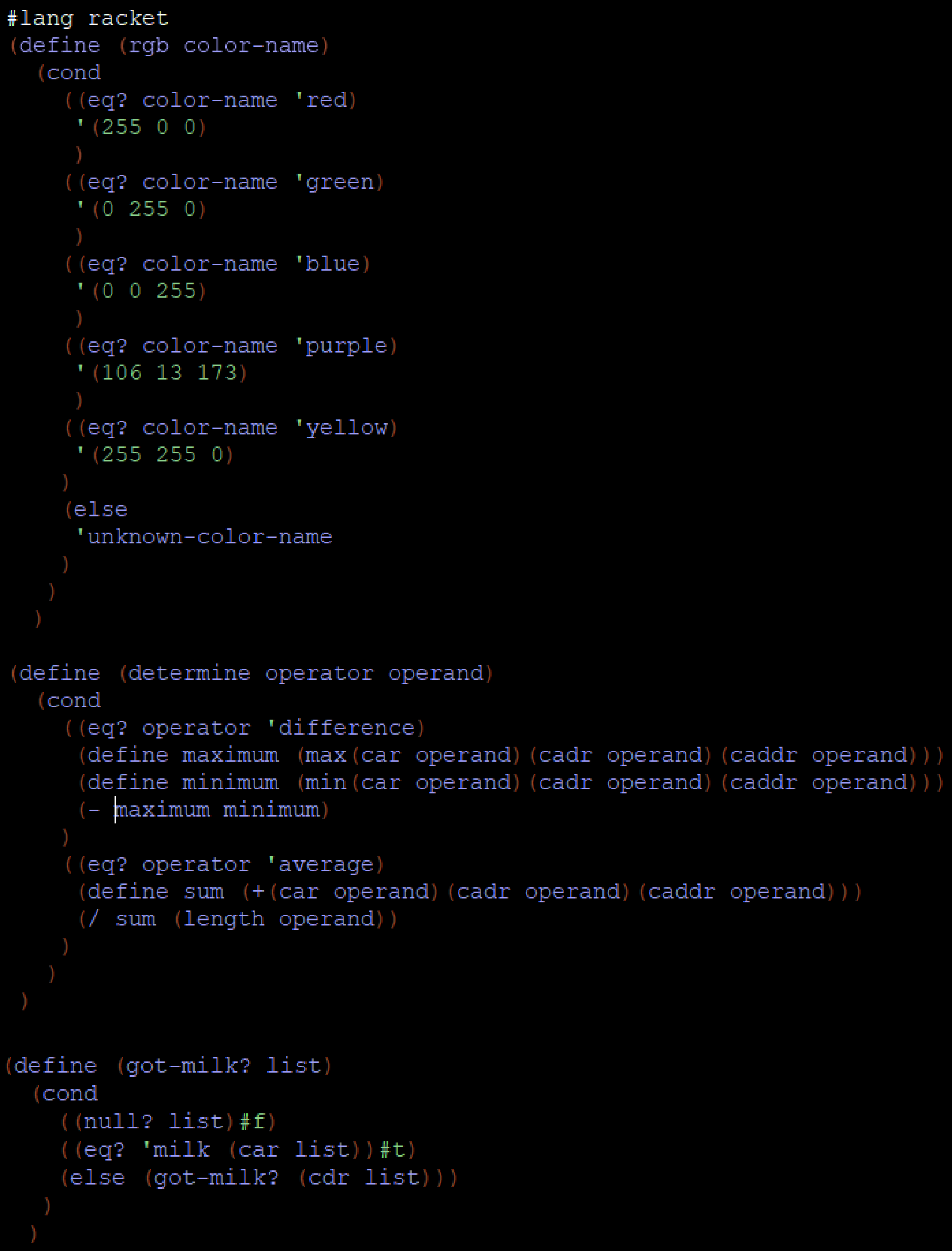
Interactions - Testing the area-of-circle function



```
> (area-of-circle 20)
314.1592653589793
```

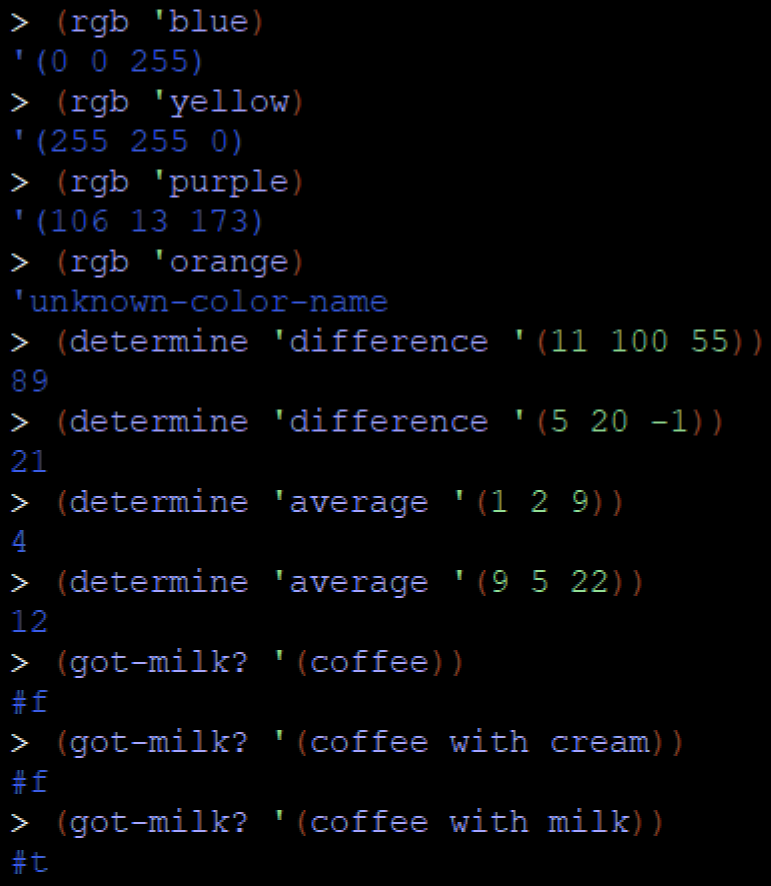
> Cond

Definitions - Defining the rgb, determine, and got-milk? functions



```
#lang racket
(define (rgb color-name)
  (cond
    ((eq? color-name 'red)
     '(255 0 0)
     )
    ((eq? color-name 'green)
     '(0 255 0)
     )
    ((eq? color-name 'blue)
     '(0 0 255)
     )
    ((eq? color-name 'purple)
     '(106 13 173)
     )
    ((eq? color-name 'yellow)
     '(255 255 0)
    )
    (else
     'unknown-color-name
    )
   )
  )

(define (determine operator operand)
  (cond
    ((eq? operator 'difference)
     (define maximum (max(car operand)(cadr operand)(caddr operand)))
     (define minimum (min(car operand)(cadr operand)(caddr operand)))
     (- maximum minimum)
    )
    ((eq? operator 'average)
     (define sum (+(car operand)(cadr operand)(caddr operand)))
     (/ sum (length operand))
    )
   )
 )

(define (got-milk? list)
  (cond
    ((null? list)#f)
    ((eq? 'milk (car list))#t)
    (else (got-milk? (cdr list)))
   )
  )
```

Interactions - Mimicking the demo illustrating application of the three functions



```
> (rgb 'blue)
'(0 0 255)
> (rgb 'yellow)
'(255 255 0)
> (rgb 'purple)
'(106 13 173)
> (rgb 'orange)
'unknown-color-name
> (determine 'difference '(11 100 55))
89
> (determine 'difference '(5 20 -1))
21
> (determine 'average '(1 2 9))
4
> (determine 'average '(9 5 22))
12
> (got-milk? '(coffee))
#f
> (got-milk? '(coffee with cream))
#f
> (got-milk? '(coffee with milk))
#t
```

Second Task: Referencers and Constructors

Parroting Racket interactions and definitions from “Lesson 8: Basic List Processing” that pertain expressly to referencers and constructors.

> Racket Session Featuring CAR, CDR, and CONS

Interactions - Applying CAR, CDR and CONS

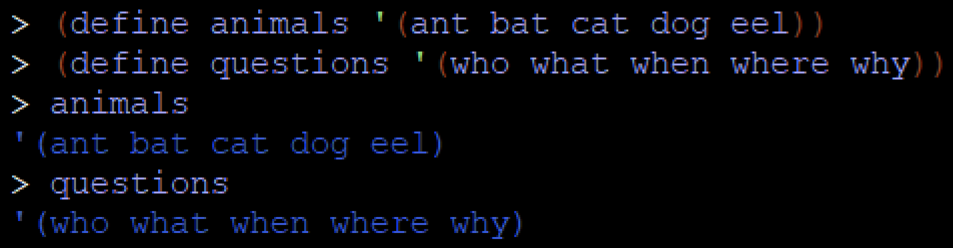
```
> (car '(red green blue))
'red
> (cdr '(red green blue))
'(green blue)
> (car '((1 3 5) seven nine))
'(1 3 5)
> (cdr '((1 3 5) seven nine))
'(seven nine)
> (car '("Desde El Alma"))
"Desde El Alma"
> (cdr '("Desde El Alma"))
'()
> (cons 'ESPRESSO '(LATTE CAPPUCCINO))
'(ESPRESSO LATTE CAPPUCCINO)
> (cons '(a b c) '(1 2 3))
'((a b c) 1 2 3)
> (cons 'SYMBOL '())
'(SYMBOL)
```

> Referencing a list element

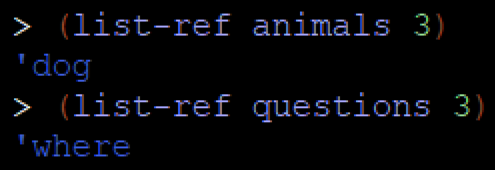
Interactions - Referencing a list element from scratch

```
> (define animals '(ant bat cat dog eel))
> (define questions '(who what when where why))
> animals
'(ant bat cat dog eel)
> questions
'(who what when where why)
> (car(cdr(cdr(cdr animals))))
'dog
> (car(cdr(cdr(cdr questions))))
'where
```

Interactions - Referencing a list element from using list-ref



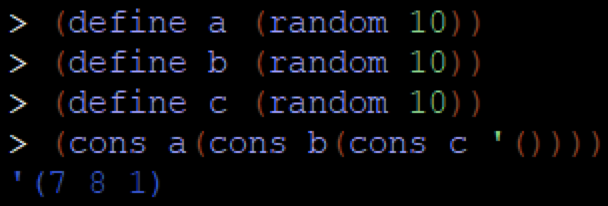
```
> (define animals '(ant bat cat dog eel))
> (define questions '(who what when where why))
> animals
'(ant bat cat dog eel)
> questions
'(who what when where why)
```



```
> (list-ref animals 3)
'dog
> (list-ref questions 3)
'where
```

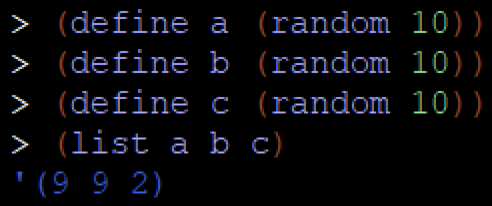
> Creating a list

Interactions - Creating a list from scratch



```
> (define a (random 10))
> (define b (random 10))
> (define c (random 10))
> (cons a(cons b(cons c '())))
'(7 8 1)
```

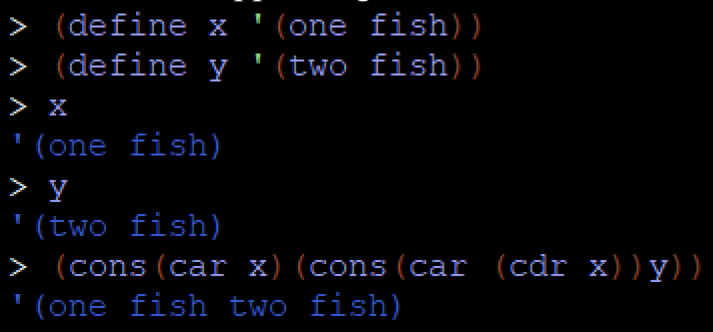
Interactions - Creating a list using list



```
> (define a (random 10))
> (define b (random 10))
> (define c (random 10))
> (list a b c)
'(9 9 2)
```

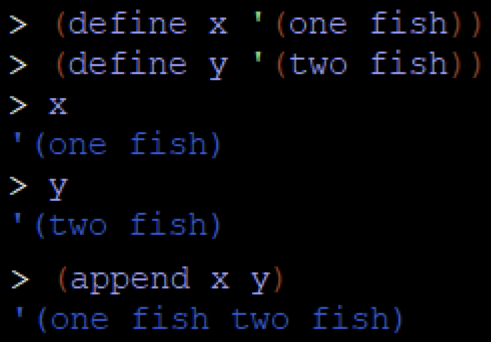
> Appending one list to another list

Interactions - Appending two lists from scratch



```
> (define x '(one fish))
> (define y '(two fish))
> x
'(one fish)
> y
'(two fish)
> (cons(car x)(cons(car (cdr x))y))
'(one fish two fish)
```

Interactions - Appending two lists using append

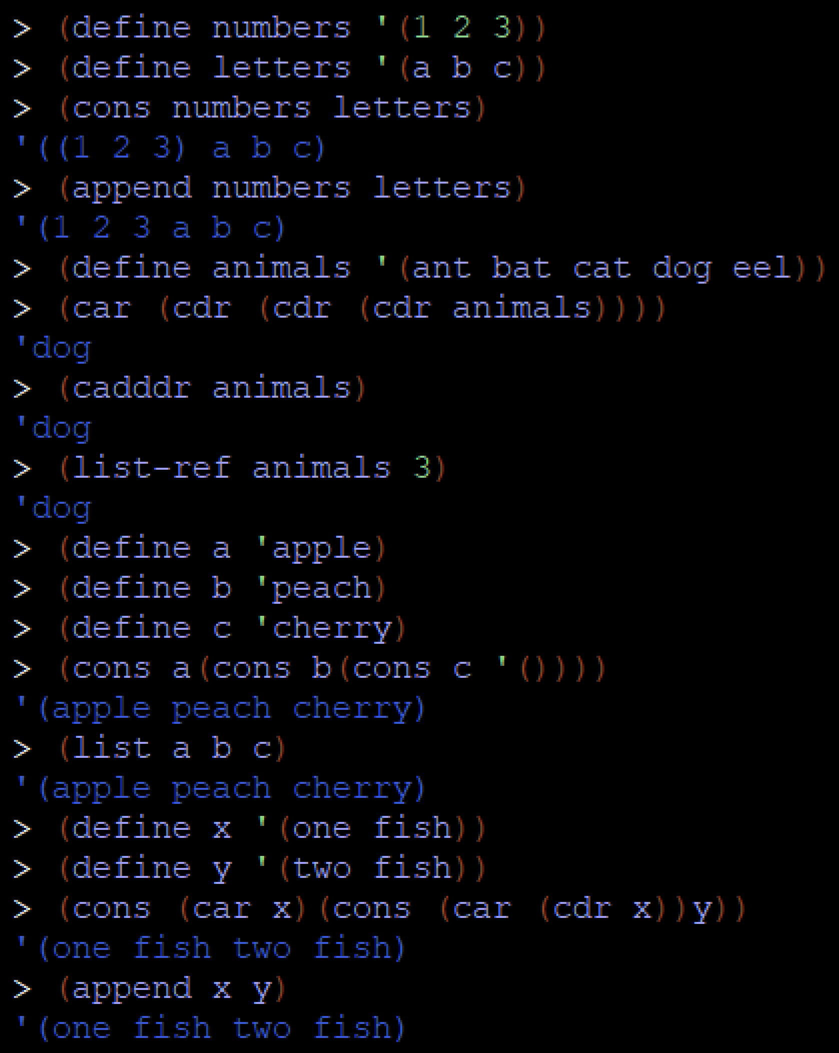


```
> (define x '(one fish))
> (define y '(two fish))
> x
'(one fish)
> y
'(two fish)
> (append x y)
'(one fish two fish)
```

> Redacted Racket Session Featuring Referencers and Constructors

Interactions - Mindfully doing the redacted session, for real

```
> (define languages '(racket prolog haskell rust))
> languages
'(racket prolog haskell rust)
> 'languages
'languages
> (quote languages)
'languages
> (car languages)
'racket
> (cdr languages)
'(prolog haskell rust)
> (car (cdr languages))
'prolog
> (cdr (cdr languages))
'(haskell rust)
> (cadr languages)
'prolog
> (cddr languages)
'(haskell rust)
> (first languages)
'racket
> (second languages)
'prolog
> (third languages)
'haskell
> (list-ref languages 2)
'haskell
```

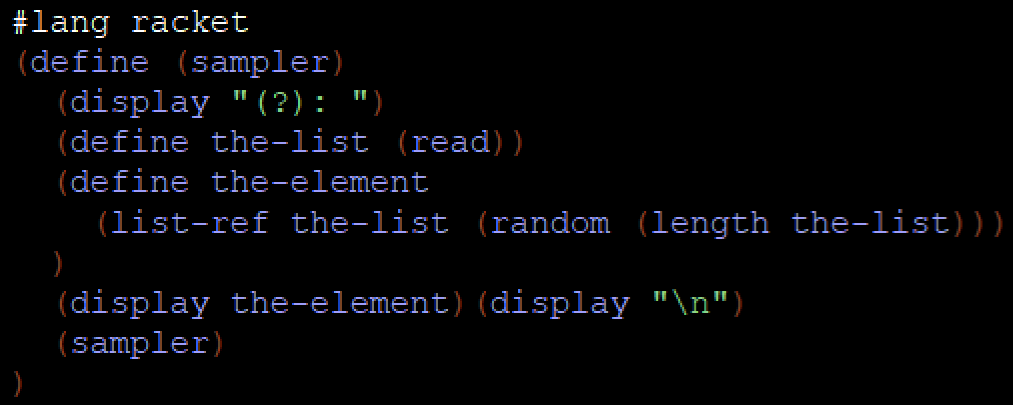


```
> (define numbers '(1 2 3))
> (define letters '(a b c))
> (cons numbers letters)
'((1 2 3) a b c)
> (append numbers letters)
'(1 2 3 a b c)
> (define animals '(ant bat cat dog eel))
> (car (cdr (cdr (cdr animals))))
'dog
> (cadddr animals)
'dog
> (list-ref animals 3)
'dog
> (define a 'apple)
> (define b 'peach)
> (define c 'cherry)
> (cons a(cons b(cons c '())))
'(apple peach cherry)
> (list a b c)
'(apple peach cherry)
> (define x '(one fish))
> (define y '(two fish))
> (cons (car x)(cons (car (cdr x))y))
'(one fish two fish)
> (append x y)
'(one fish two fish)
```

Third Task: Random Selection

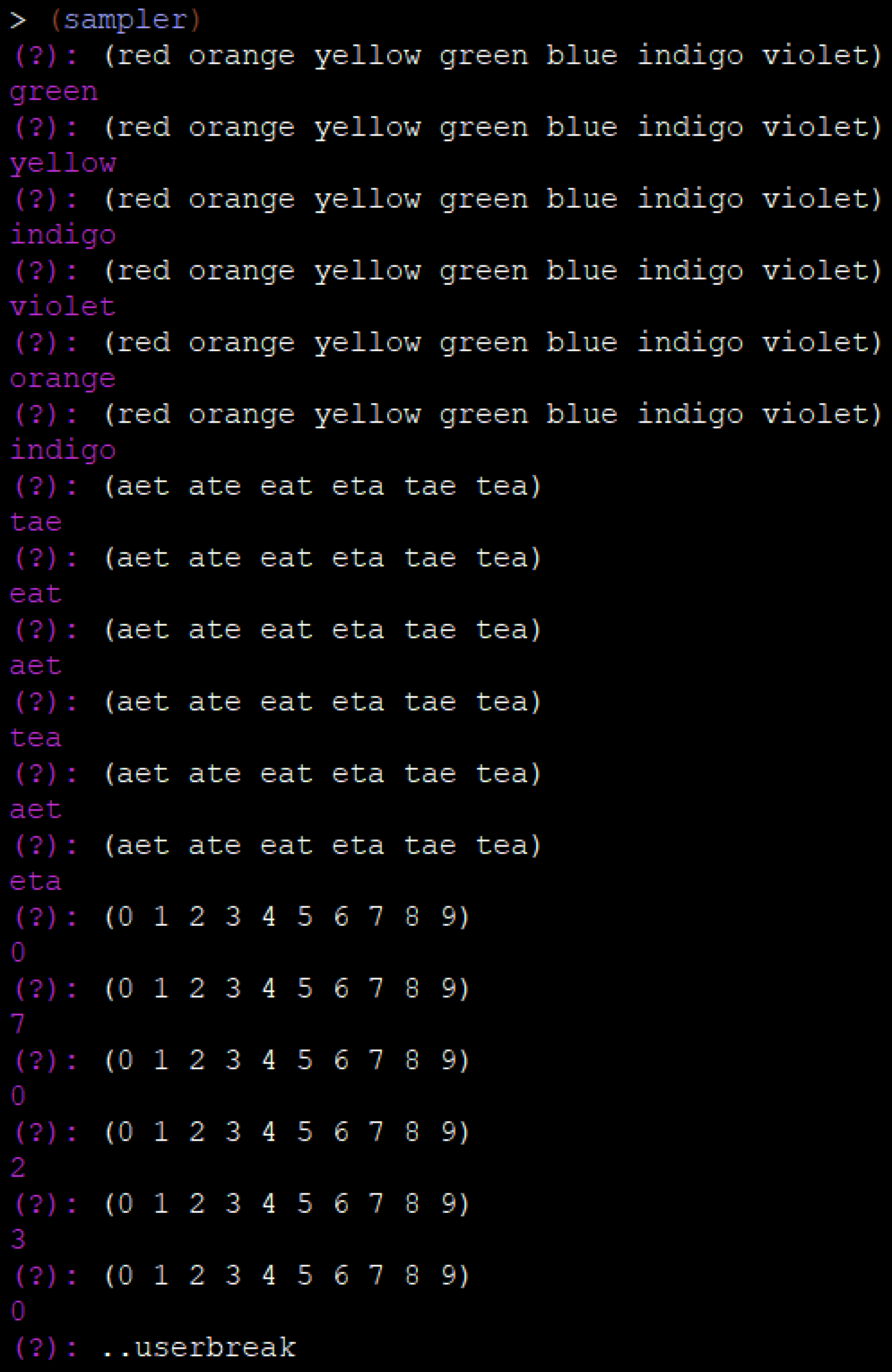
The simple little program presented selects an element at random from a given list. The list is provided by means of the read function, which will read any S-expression, including a list.

Definitions - Defining the sampler program



```
#lang racket
(define (sampler)
  (display "(?): ")
  (define the-list (read))
  (define the-element
    (list-ref the-list (random (length the-list))))
  )
  (display the-element)(display "\n")
  (sampler)
)
```

Interactions - Mimicking the sampler program demo



```
> (sampler)
(?): (red orange yellow green blue indigo violet)
green
(?): (red orange yellow green blue indigo violet)
yellow
(?): (red orange yellow green blue indigo violet)
indigo
(?): (red orange yellow green blue indigo violet)
violet
(?): (red orange yellow green blue indigo violet)
orange
(?): (red orange yellow green blue indigo violet)
indigo
(?): (aet ate eat eta tae tea)
tae
(?): (aet ate eat eta tae tea)
eat
(?): (aet ate eat eta tae tea)
aet
(?): (aet ate eat eta tae tea)
tea
(?): (aet ate eat eta tae tea)
aet
(?): (aet ate eat eta tae tea)
eta
(?): (0 1 2 3 4 5 6 7 8 9)
0
(?): (0 1 2 3 4 5 6 7 8 9)
7
(?): (0 1 2 3 4 5 6 7 8 9)
0
(?): (0 1 2 3 4 5 6 7 8 9)
2
(?): (0 1 2 3 4 5 6 7 8 9)
3
(?): (0 1 2 3 4 5 6 7 8 9)
0
(?): ..userbreak
```

Fourth Task: Playing Card Programming Language

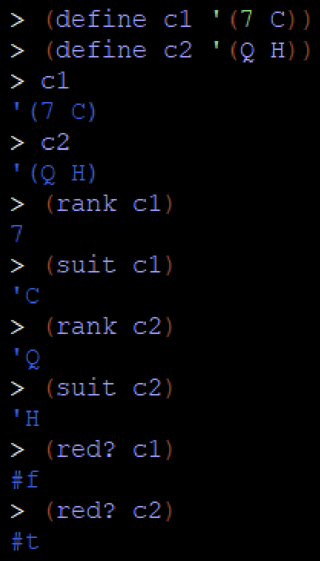
The code and demo for the playing card programming challenge presented at the end of Lesson 8 is presented here.

Definitions - Programming the card playing functionality

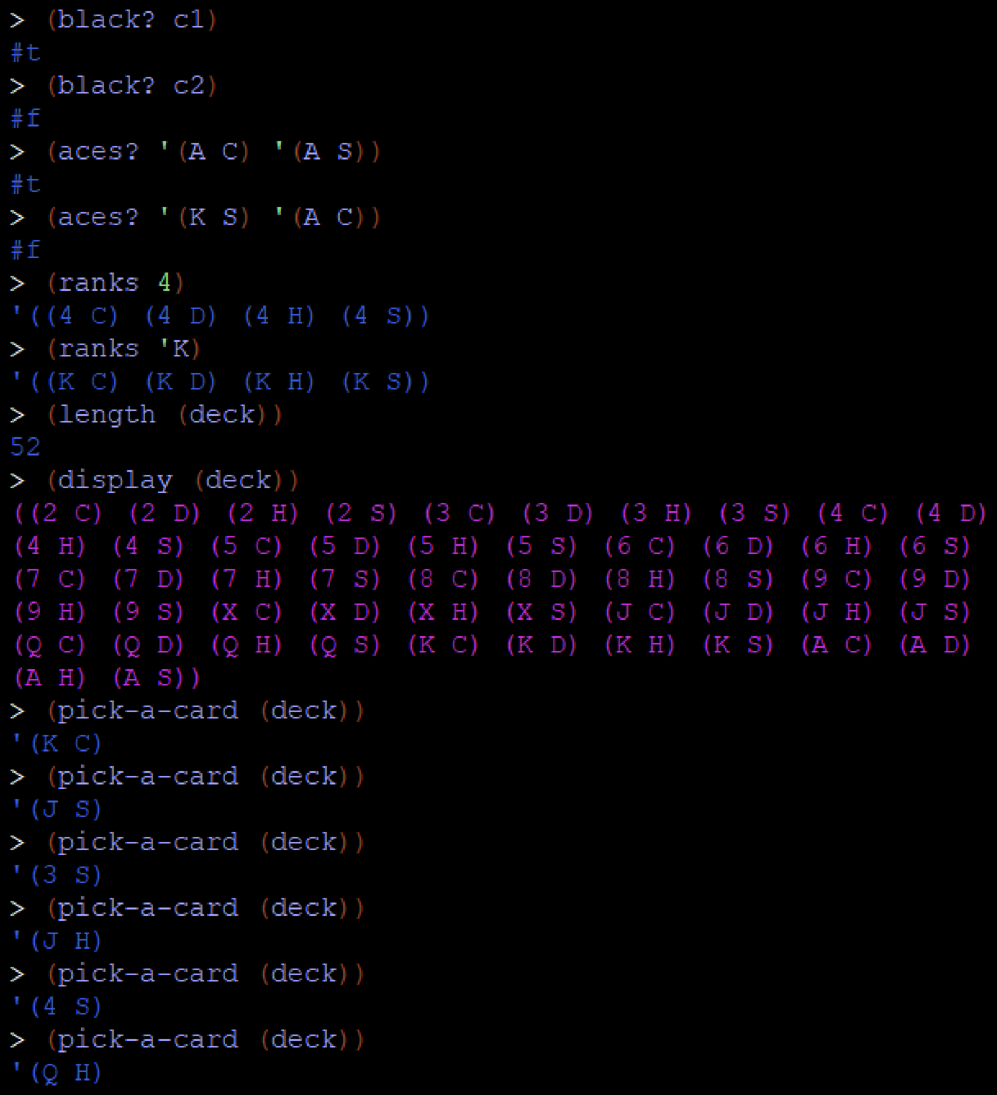
```racket
#lang racket
(define (ranks rank)
  (list
   (list rank 'C)
   (list rank 'D)
   (list rank 'H)
   (list rank 'S)
  )
 )

(define (deck)
  (append
   (ranks 2)
   (ranks 3)
   (ranks 4)
   (ranks 5)
   (ranks 6)
   (ranks 7)
   (ranks 8)
   (ranks 9)
   (ranks 'X)
   (ranks 'J)
   (ranks 'Q)
   (ranks 'K)
   (ranks 'A)
  )
 )

(define (pick-a-card cards)
  (list-ref cards (random (length cards)))
 )
```

```
(define (show card)
  (display (rank card))
  (display (suit card))
 )

(define (rank card)
  (car card)
 )

(define (suit card)
  (cadr card)
 )

(define (red? card)
  (or
   (equal? (suit card) 'D)
   (equal? (suit card) 'H)
  )
 )

(define (black? card)
  (not (red? card))
 )

(define (aces? card1 card2)
  (and
   (equal? (rank card1) 'A)
   (equal? (rank card2) 'A)
  )
 )
```

Interactions - Mimicking the card playing functionality demo



```
> (define c1 '(7 C))
> (define c2 '(Q H))
> c1
'(7 C)
> c2
'(Q H)
> (rank c1)
7
> (suit c1)
'C
> (rank c2)
'Q
> (suit c2)
'H
> (red? c1)
#f
> (red? c2)
#t
```



```
> (black? c1)
#t
> (black? c2)
#f
> (aces? '(A C) '(A S))
#t
> (aces? '(K S) '(A C))
#f
> (ranks 4)
'((4 C) (4 D) (4 H) (4 S))
> (ranks 'K)
'((K C) (K D) (K H) (K S))
> (length (deck))
52
> (display (deck))
((2 C) (2 D) (2 H) (2 S) (3 C) (3 D) (3 H) (3 S) (4 C) (4 D)
(4 H) (4 S) (5 C) (5 D) (5 H) (5 S) (6 C) (6 D) (6 H) (6 S)
(7 C) (7 D) (7 H) (7 S) (8 C) (8 D) (8 H) (8 S) (9 C) (9 D)
(9 H) (9 S) (X C) (X D) (X H) (X S) (J C) (J D) (J H) (J S)
(Q C) (Q D) (Q H) (Q S) (K C) (K D) (K H) (K S) (A C) (A D)
(A H) (A S))
> (pick-a-card (deck))
'(K C)
> (pick-a-card (deck))
'(J S)
> (pick-a-card (deck))
'(3 S)
> (pick-a-card (deck))
'(J H)
> (pick-a-card (deck))
'(4 S)
> (pick-a-card (deck))
'(Q H)
```