
Racket Assignment #5: RLP and HoFs

ABSTRACT:

This assignment aims to provide students with practice and familiarity in recursive list processing and higher-order functions. It consists of seven different tasks, each involving a combination of RLPs, HoFs, or both. The tasks include creating simple list generators, accumulation counting, zip, numbers to notes to ABC, Stella, chromesthetic renderings, and grapheme to color synesthesia.

Task 1: Simple List Generators

Task 1a – iota

Function Definition

```
1  #lang racket
2  (require 2htdp/image)
3
4  ( define ( snoc obj lst )
5     ( cond
6        ( ( empty? lst )
7          ( list obj )
8         )
9        ( else
10         ( cons ( car lst ) ( snoc obj ( cdr lst ) ) )
11        )
12       )
13    )
14
15 ( define ( iota n )
16    ( cond (
17             ( = n 1)
18            '( 1 )
19            )
20           ( else
21             ( snoc n ( iota ( - n 1 ) ) )
22             )
23           )
24    )
25
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( iota 10 )
'(1 2 3 4 5 6 7 8 9 10)
> ( iota 1 )
'(1)
> ( iota 12 )
'(1 2 3 4 5 6 7 8 9 10 11 12)
>
```

Task 1b – Same

Function Definition

```
( define ( same numTimes val )
   ( cond (
            ( = numTimes 0)
            '( )
           )
          ( else
            ( cons val ( same ( - numTimes 1 ) val ) )
           )
         )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( same 5 'five )
'(five five five five five)
> ( same 10 2 )
'(2 2 2 2 2 2 2 2 2 2)
> ( same 0 'whatever )
'()
> ( same 2 '( racket prolog haskell rust ) )
'((racket prolog haskell rust) (racket prolog haskell rust))
>
```

Task 1c – Alternator

Function Definition

```
( define ( alternator num lst )
   ( cond (
            ( = 0 num )
            '()
           )
          ( else
            ( cons ( car lst ) ( alternator ( - num 1 ) ( snoc ( car lst ) ( cdr lst ) ) ) )
           )
         )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( alternator 7 '( black white ) )
'(black white black white black white black)
> ( alternator 12 '( red yellow blue ) )
'(red yellow blue red yellow blue red yellow blue red yellow blue)
> ( alternator 9 '( 1 2 3 4 ) )
'(1 2 3 4 1 2 3 4 1)
> ( alternator 15 '( x y ) )
'(x y x y x y x y x y x y x y x)
>
```

Task 1d – Sequence

Function Definition

```
( define ( sequence num add )
   ( cond (
           ( = 0 num )
           '()
           )
          ( else
            ( map ( lambda ( x ) ( * x add )) (iota num ) ) )
            )

          )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( sequence 5 20 )
'(20 40 60 80 100)
> ( sequence 10 7 )
'(7 14 21 28 35 42 49 56 63 70)
> ( sequence 8 50 )
'(50 100 150 200 250 300 350 400)
>
```

Task 2: Counting

Task 2a – Accumulation Counting

Function Definition

```
( define ( a-count lst )
   ( cond
      ( ( empty? lst ) '() )
      ( else
        ( append ( iota ( car lst ) ) ( a-count ( cdr lst ) ) )
        )
      )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( a-count '( 1 2 3 ) )
'(1 1 2 1 2 3)
> ( a-count '( 4 3 2 1 ) )
'(1 2 3 4 1 2 3 1 2 1)
> ( a-count '( 1 1 2 2 3 3 2 2 1 1 ) )
'(1 1 1 2 1 2 1 2 3 1 2 3 1 2 1 2 1 1)
>
```

Task 2b – Repetition Counting

Function Definition

```
( define ( r-count lst )
   ( cond
      ( ( empty? lst ) '() )
      ( else
        ( append ( same (car lst ) ( car lst ) ) ( r-count (cdr lst) ) )
        )
      )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( r-count '( 1 2 3 ) )
'(1 2 2 3 3 3)
> ( r-count '( 4 3 2 1 ) )
'(4 4 4 4 3 3 3 2 2 1)
> ( r-count '( 1 1 2 2 3 3 2 2 1 1 ) )
'(1 1 2 2 2 2 3 3 3 3 3 3 2 2 2 2 1 1)
>
```

Task 2c – Mixed Counting Demo

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( a-count '( 1 2 3 ) )
'(1 1 2 1 2 3)
> ( r-count '( 1 2 3 ) )
'(1 2 2 3 3 3)
> ( r-count ( a-count '( 1 2 3 ) ) )
'(1 1 2 2 1 2 2 3 3 3)
> ( a-count ( r-count '( 1 2 3 ) ) )
'(1 1 2 1 2 1 2 3 1 2 3 1 2 3)
> ( a-count '( 2 2 5 3 ) )
'(1 2 1 2 1 2 3 4 5 1 2 3)
> ( r-count '( 2 2 5 3 ) )
'(2 2 2 2 5 5 5 5 5 3 3 3)
> ( r-count ( a-count '( 2 2 5 3 ) ) )
'(1 2 2 1 2 2 1 2 2 3 3 3 4 4 4 4 5 5 5 5 5 1 2 2 3 3 3)
> ( a-count ( r-count '( 2 2 5 3 ) ) )
'(1 2 1 2 1 2 1 2 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 1 2 3 1 2 3)
>
```

Task 3: Association Lists

Task 3a – Zip

Function Definition

```
( define ( zip lst1 lst2 )
   ( cond
      ( ( empty? lst1 ) '() )
      ( else
        ( cons ( list* ( car lst1) ( car lst2 ) ) ( zip ( cdr lst1 ) ( cdr lst2 ) ) )
        )
      )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( zip '(one two three four five) '(un deux trois quatre cinq) )
'((one . un) (two . deux) (three . trois) (four . quatre) (five . cinq))
> ( zip '() '() )
'()
> ( zip '( this ) '( that ) )
'((this . that))
> ( zip '( one two three ) '( (1) ( 2 2 ) ( 3 3 3 ) ) )
'((one 1) (two 2 2) (three 3 3 3))
>
```

Task 3b – Assoc

Function Definition

```
( define ( assoc obj lst )
   ( cond
      ( ( empty? lst ) '() )
      ( ( eq? obj ( caar lst ) ) ( car lst ) )
      ( else ( assoc obj ( cdr lst ) ) )
      )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( define al1
( zip '(one two three four ) '(un deux trois quatre ) ) ; # a-list -> zip
)
> ( define al2
( zip '(one two three) '( (1) (2 2) (3 3 3) ) ) ; # a-list -> zip
)
> al1
'((one . un) (two . deux) (three . trois) (four . quatre))
> ( assoc 'two al1 )
'(two . deux)
> ( assoc 'five al1 )
'()
> al2
'((one 1) (two 2 2) (three 3 3 3))
> ( assoc 'three al2 )
'(three 3 3 3)
> ( assoc 'four al2 )
'()
>
```

Task 3c – Establishing some Association Lists

Function Definition

```
( define scale-zip-CM
   ( zip ( iota 7 ) '("C" "D" "E" "F" "G" "A" "B") )
   )
( define scale-zip-short-Am
   ( zip ( iota 7 ) '("A/2" "B/2" "C/2" "D/2" "E/2" "F/2" "G/2") )
   )
( define scale-zip-short-low-Am
   ( zip ( iota 7 ) '("A,/2" "B,/2" "C,/2" "D,/2" "E,/2" "F,/2" "G,/2") )
   )
( define scale-zip-short-low-blues-Dm
   ( zip ( iota 7 ) '("D,/2" "F,/2" "G,/2" "_A,/2" "A,/2" "c,/2" "d,/2") )
   )
( define scale-zip-wholetone-C
   ( zip ( iota 7 ) '("C" "D" "E" "^F" "^G" "^A" "c") )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> scale-zip-CM
'((1 . "C") (2 . "D") (3 . "E") (4 . "F") (5 . "G") (6 . "A") (7 . "B"))
> scale-zip-short-Am
'((1 . "A/2") (2 . "B/2") (3 . "C/2") (4 . "D/2") (5 . "E/2") (6 . "F/2") (7 . "G/2"))
> scale-zip-short-low-Am
'((1 . "A,/2") (2 . "B,/2") (3 . "C,/2") (4 . "D,/2") (5 . "E,/2") (6 . "F,/2") (7 . "G,/2"))
> scale-zip-short-low-blues-Dm
'((1 . "D,/2") (2 . "F,/2") (3 . "G,/2") (4 . "_A,/2") (5 . "A,/2") (6 . "c,/2") (7 . "d,/2"))
> scale-zip-wholetone-C
'((1 . "C") (2 . "D") (3 . "E") (4 . "^F") (5 . "^G") (6 . "^A") (7 . "c"))
>
```

Task 4: Numbers to Notes to ABC

Task 4a – nr -> note

Function Definition

```
( define ( nr->note n lst)
   ( cond
      ( ( eq? n ( caar lst ) ) ( cdar lst ) )
      ( else ( nr->note n ( cdr lst ) ) )
      )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( nr->note 1 scale-zip-CM )
"C"
> ( nr->note 1 scale-zip-short-Am )
"A/2"
> ( nr->note 1 scale-zip-short-low-Am )
"A,/2"
>  ( nr->note 3 scale-zip-CM )
"E"
>  ( nr->note 4 scale-zip-short-Am )
"D/2"
> ( nr->note 5 scale-zip-short-low-Am )
"E,/2"
> ( nr->note 4 scale-zip-short-low-blues-Dm )
"_A,/2"
>  ( nr->note 4 scale-zip-wholetone-C )
"^F"
>
```

Task 4b – nrs -> notes

Function Definition

```
( define ( nrs->notes lst1 lst2 )
   ( map ( lambda (x) ( nr->note x lst2 ) ) lst1 )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( nrs->notes '(3 2 3 2 1 1) scale-zip-CM )
'("E" "D" "E" "D" "C" "C")
>  ( nrs->notes '(3 2 3 2 1 1) scale-zip-short-Am )
'("C/2" "B/2" "C/2" "B/2" "A/2" "A/2")
>  ( nrs->notes ( iota 7 ) scale-zip-CM )
'("C" "D" "E" "F" "G" "A" "B")
>  ( nrs->notes ( iota 7 ) scale-zip-short-low-Am )
'("A,/2" "B,/2" "C,/2" "D,/2" "E,/2" "F,/2" "G,/2")
> ( nrs->notes ( a-count '(4 3 2 1) ) scale-zip-CM )
'("C" "D" "E" "F" "C" "D" "E" "C" "D" "C")
>  ( nrs->notes ( r-count '(4 3 2 1) ) scale-zip-CM )
'("F" "F" "F" "F" "E" "E" "E" "D" "D" "C")
> ( nrs->notes ( a-count ( r-count '(1 2 3) ) ) scale-zip-CM )
'("C" "C" "D" "C" "D" "C" "D" "E" "C" "D" "E" "C" "D" "E")
>  ( nrs->notes ( r-count ( a-count '(1 2 3) ) ) scale-zip-CM )
'("C" "C" "D" "D" "C" "D" "D" "E" "E" "E")
>
```

Task 4c – nrs -> abc

Function Definition

```
( define ( nrs->abc lst1 lst2 )
   ( string-join ( nrs->notes lst1 lst2 ) )
   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
>  ( nrs->abc ( iota 7 ) scale-zip-CM )
"C D E F G A B"
> ( nrs->abc ( iota 7 ) scale-zip-short-Am )
"A/2 B/2 C/2 D/2 E/2 F/2 G/2"
> ( nrs->abc ( a-count '( 3 2 1 3 2 1 ) ) scale-zip-CM )
"C D E C D C C D E C D C"
> ( nrs->abc ( r-count '( 3 2 1 3 2 1 ) ) scale-zip-CM )
"E E E D D C E E E D D C"
>  ( nrs->abc ( r-count ( a-count '(4 3 2 1) ) ) scale-zip-CM )
"C D D E E E F F F F C D D E E E C D D C"
> ( nrs->abc ( a-count ( r-count '(4 3 2 1) ) ) scale-zip-CM )
"C D E F C D E F C D E F C D E F C D E C D E C D E C D C D C"
```

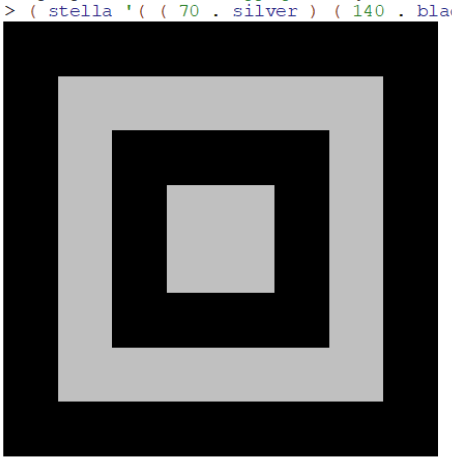
Task 5: Stella

Function Definition

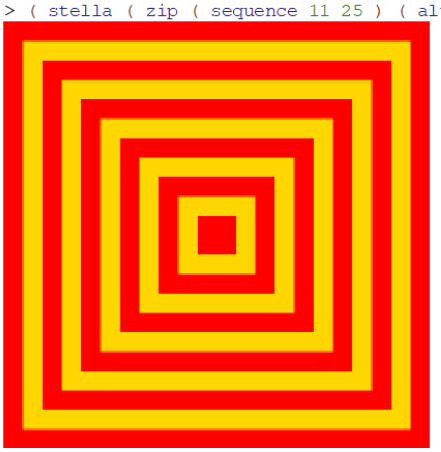
```
( define ( stella lst )
   ( foldr overlay empty-image ( map ( lambda (x) ( square ( car x ) 'solid ( cdr x ) ) ) lst ) )
   )
```

Function Demo

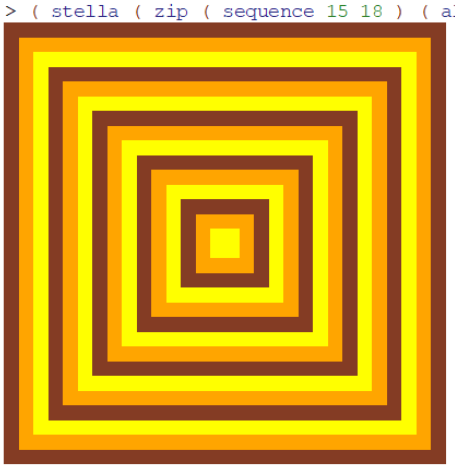
```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( stella '( ( 70 . silver ) ( 140 . black ) ( 210 . silver ) ( 280 . black ) ) )
```



```
> ( stella ( zip ( sequence 11 25 ) ( alternator 11 '( red gold ) ) ) )
```



```
> ( stella ( zip ( sequence 15 18 ) ( alternator 15 '( yellow orange brown ) ) ) )
```



```
>
```

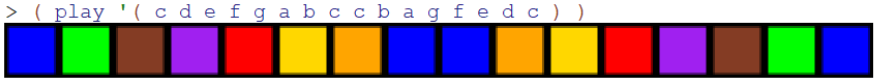
Task 6: Chromesthetic Renderings

Function Definition

```
( define pitch-classes '( c d e f g a b ) )

( define color-names '( blue green brown purple red yellow orange ) )

( define ( box color )
   ( overlay
     ( square 30 'solid color )
     ( square 35 'solid 'black )
    )
   )

( define boxes
   ( list
     ( box "blue" )
     ( box "green" )
     ( box "brown" )
     ( box "purple" )
     ( box "red" )
     ( box "gold" )
     ( box "orange" )
    )
   )

( define pc-a-list ( zip pitch-classes color-names ) )

( define cb-a-list ( zip color-names boxes ) )

( define ( pc->color pc )
   ( cdr ( assoc pc pc-a-list ) )
   )

( define ( color->box color )
   ( cdr ( assoc color cb-a-list ) )
   )

( define ( play pitches )
   ( foldr beside empty-image ( map ( lambda (c) ( color->box c ) ) ( map ( lambda (pitch) (
                                                                                pc->color
                                                                                pitch ) ) pitches ) ) )

   )
```

Function Demo

```
Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.
> ( play '( c d e f g a b c c b a g f e d c ) )
```



```
> ( play '( c c g g a a g g f f e e d d c c ) )
```

```
> ( play '( c d e c c d e c e f  g g e f g g ) )
```

```
>
```

Task 7: Grapheme to Color Synesthesia

Function Definition

```
( define AI ( text "A" 36 "orange" ) )

( define BI ( text "B" 36 "red" ) )

( define CI ( text "C" 36 "blue" ) )

( define DI ( text "D" 36 "Orange Red" ) )

( define EI ( text "E" 36 "Dark Red" ) )

( define FI ( text "F" 36 "Tomato" ) )

( define GI ( text "G" 36 "Violet Red" ) )

( define HI ( text "H" 36 "Lawn Green" ) )

( define II ( text "I" 36 "Maroon" ) )

( define JI ( text "J" 36 "Deep Pink" ) )

( define KI ( text "K" 36 "Hot Pink" ) )

( define LI ( text "L" 36 "Chartreuse" ) )

( define MI ( text "M" 36 "Crimson" ) )

( define NI ( text "N" 36 "Firebrick" ) )

( define OI ( text "O" 36 "Lime" ) )

( define PI ( text "P" 36 "Dark Green" ) )

( define QI ( text "Q" 36 "Spring Green" ) )

( define RI ( text "R" 36 "Light Coral" ) )

( define SI ( text "S" 36 "Sea Green" ) )

( define TI ( text "T" 36 "Dark Cyan" ) )

( define UI ( text "U" 36 "Royal Blue" ) )

( define VI ( text "V" 36 "Midnight Blue" ) )

( define WI ( text "W" 36 "Dark Slate Blue" ) )

( define XI ( text "X" 36 "Green Yellow" ) )

( define YI ( text "Y" 36 "Dark Magenta" ) )

( define ZI ( text "Z" 36 "Medium Orchid" ) )

( define alphabet '(A B C D E F G H I J K L M N O P Q R S T U V W X Y Z ) )

( define alphapic ( list AI BI CI DI EI FI GI HI II JI KI LI MI NI OI PI QI RI SI TI UI VI WI XI YI ZI ) )

( define a->i ( zip alphabet alphapic ) )

( define ( letter->image ltr )
   ( cdr ( assoc ltr a->i ) )
   )

( define ( gcs ltrs )
   ( foldr beside empty-image ( map ( lambda (ltr) ( letter->image ltr ) ) ltrs ) )

   )
```

Demos

Welcome to DrRacket, version 8.1 [cs].
Language: racket, with debugging; memory limit: 128 MB.

```
> alphabet
'(A B C)
> alphapic
(list A B C)
> ( display a->i )
((A . A) (B . B) (C . C))
> ( letter->image 'A )
A
> ( letter->image 'B )
B
> ( gcs '( C A B ) )
CAB
> ( gcs '( B A A ) )
BAA
> ( gcs '( B A B A ) )
BABA
>
```

Welcome to DrRacket, version 8.7 [cs].
Language: racket, with debugging; memory limit: 128 MB.

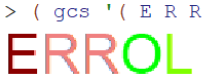
```
> ( gcs '( D A N D E L I O N ) )
```

```
> ( gcs '( A L P H A B E T ) )
```

```
> ( gcs '( S T A N D ) )
```

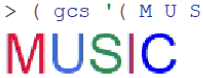
```
> ( gcs '( W H A T E V E R ) )
```

```
> ( gcs '( E R R O L ) )
```

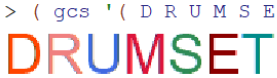


```
> ( gcs '( R A C K E T ) )
```

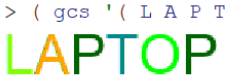
```
> ( gcs '( M U S I C ) )
```



```
> ( gcs '( D R U M S E T ) )
```



```
> ( gcs '( L A P T O P ) )
```



```
> ( gcs '( H E L L O ) )
```

```
>
```