Task 11 - Copy

This task implements the copy methods of the genetic algorithm. Helper methods to select the most fit individual, establish an empty population, and copy a music sample were added. The *perform-one-copy* method chooses the most fit individual from a population, calls *maybe-mutate*, copies the result into a renumbered individual, and adds the individual to the next generation list. *perform-copies* performs this at the population level by calling *perform-one-copy* on a number of copies as determined by the **pc-c** constant.

Copy Music Sample Demo

```
[2]> ( demo--copy-music-sample )
------------------MUSIC SAMPLE 1------------------
Melody 1: A2 A/2 B2 C/2 E B/2 C/2 G E/2 A2 F G2 C/2 A2 F/2 E F2
F2 B F/2 A
Melody 2: A4, G2, G, G2, B, A2, F, A2, F2, F, A4, B2,

Total Rank: 0
Melody1 Rank: 0
Melody2 Rank: 0
-------------------------------------------------
------------------MUSIC SAMPLE 2------------------
Melody 1: A2 A/2 B2 C/2 E B/2 C/2 G E/2 A2 F G2 C/2 A2 F/2 E F2
F2 B F/2 A
Melody 2: A4, G2, G, G2, B, A2, F, A2, F2, F, A4, B2,

Total Rank: 0
Melody1 Rank: 0
Melody2 Rank: 0
-------------------------------------------------
NIL
```

Copy Music Sample Demo Code

```
; Method to demo copy-music-sample
( defmethod demo--copy-music-sample ( &aux m )
    ( setf m ( generate-music-sample 1 ) )
    ( display-music-sample m )
```

```
    ( setf copy ( copy-music-sample 2 m ) )
    ( display-music-sample copy )
)
```

Copy Music Sample Code

```
; Method to copy a music sample to a new object
( defmethod copy-music-sample ( n ( m music ) )
    ( make-instance 'music
        :melody1 ( music-melody1 m )
        :melody2 ( music-melody2 m )
        :melody1-rank ( music-melody1-rank m )
        :melody2-rank ( music-melody2-rank m )
        :rank ( music-rank m )
        :num n
    )

)
```

Perform Copies Demo

```
[3]> ( demo--perform-copies )
------------------------------------------------------------------
--


Generation 1 population ...




------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 52------------------
Melody 1: A2 C E2 F/2 E/2 G2 E/2 G2 A2 B F A/2 C2 B/2 A2 B A A C
D/2
Melody 2: B, A4, A4, B2, A2, A, A2, B4, G4,

Total Rank: 18
Melody1 Rank: 8
Melody2 Rank: 10
------------------------------------------------
```

```
Possibly mutated individual =
------------------MUSIC SAMPLE 52------------------
Melody 1: A2 C E2 F/2 E/2 G2 E/2 G2 A2 B F A/2 C2 B/2 A2 B A A C
D/2
Melody 2: B, A4, A4, B2, A2, A, A2, B4, G4,

Total Rank: 18
Melody1 Rank: 8
Melody2 Rank: 10
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 1------------------
Melody 1: A2 C E2 F/2 E/2 G2 E/2 G2 A2 B F A/2 C2 B/2 A2 B A A C
D/2
Melody 2: B, A4, A4, B2, A2, A, A2, B4, G4,

Total Rank: 18
Melody1 Rank: 8
Melody2 Rank: 10
--------------------------------------------------
------------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB601E9>  18



------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 94------------------
Melody 1: E2' C2' C' B/2' F/2' E2' D/2' F/2' A' B/2' B2' A' B'
C2' C' C2' B/2' G2' B2'
Melody 2: F2 D B/2 G2 E/2 B2 E2 E/2 C A2 D F/2 B C/2 A/2 G/2 A/2
B/2 D/2 C2 F/2 E C C/2

Total Rank: 10
Melody1 Rank: 1
Melody2 Rank: 9
```

```
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 94------------------
Melody 1: E2' C2' C' B/2' F/2' E2' D/2' F/2' A' B/2' B2' A' B'
C2' C' C2' B/2' G2' B2'
Melody 2: F2 D B/2 G2 E/2 B2 E2 E/2 C A2 D F/2 B C/2 A/2 G/2 A/2
B/2 D/2 C2 F/2 E C G2

Total Rank: 10
Melody1 Rank: 1
Melody2 Rank: 9
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 2------------------
Melody 1: E2' C2' C' B/2' F/2' E2' D/2' F/2' A' B/2' B2' A' B'
C2' C' C2' B/2' G2' B2'
Melody 2: F2 D B/2 G2 E/2 B2 E2 E/2 C A2 D F/2 B C/2 A/2 G/2 A/2
B/2 D/2 C2 F/2 E C G2

Total Rank: 10
Melody1 Rank: 1
Melody2 Rank: 9
--------------------------------------------------
------------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB601E9>  18
2     #<MUSIC #x1AB85309>  10



------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 95------------------
Melody 1: B/2' D' E/2' G/2' E/2' B/2' C2' E/2' F/2' B2' C2' A'
D/2' A/2' B2' D/2' E/2' G' F2' F2' B/2' C' G/2' E' G/2'
Melody 2: A' G/2' C2' E' B2' F/2' A/2' D/2' A/2' B2' G' G2' F'
G2' C' B/2' A2' A' C/2' G/2' A' G/2' B/2'
```

```
Total Rank: 17
Melody1 Rank: 9
Melody2 Rank: 8
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 95------------------
Melody 1: B/2' D' E/2' G/2' E/2' B/2' C2' E/2' F/2' B2' C2' A'
D/2' A/2' B2' D/2' E/2' G' F2' F2' B/2' C' G/2' E' G/2'
Melody 2: A' G/2' C2' E' B2' F/2' A/2' D/2' A/2' B2' G' G2' F'
G2' C' B/2' A2' A' C/2' G/2' A' G/2' B/2'

Total Rank: 17
Melody1 Rank: 9
Melody2 Rank: 8
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 3------------------
Melody 1: B/2' D' E/2' G/2' E/2' B/2' C2' E/2' F/2' B2' C2' A'
D/2' A/2' B2' D/2' E/2' G' F2' F2' B/2' C' G/2' E' G/2'
Melody 2: A' G/2' C2' E' B2' F/2' A/2' D/2' A/2' B2' G' G2' F'
G2' C' B/2' A2' A' C/2' G/2' A' G/2' B/2'

Total Rank: 17
Melody1 Rank: 9
Melody2 Rank: 8
--------------------------------------------------
------------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB601E9>  18
2     #<MUSIC #x1AB85309>  10
3     #<MUSIC #x1AB9A04D>  17



------------------------------------------------------------Se
lected individual =
```

```
 ------------------MUSIC SAMPLE 1------------------
Melody 1: A2 C E2 F/2 E/2 G2 E/2 G2 A2 B F A/2 C2 B/2 A2 B A A C
D/2
Melody 2: B, A4, A4, B2, A2, A, A2, B4, G4,

Total Rank: 18
Melody1 Rank: 8
Melody2 Rank: 10
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 1------------------
Melody 1: A2 C E2 F/2 E/2 G2 E/2 G2 A2 E/2 F A/2 C2 B/2 A2 B A A
C D/2
Melody 2: B, A4, A4, B2, A2, A, A2, B4, C,

Total Rank: 18
Melody1 Rank: 8
Melody2 Rank: 10
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 4------------------
Melody 1: A2 C E2 F/2 E/2 G2 E/2 G2 A2 E/2 F A/2 C2 B/2 A2 B A A
C D/2
Melody 2: B, A4, A4, B2, A2, A, A2, B4, C,

Total Rank: 18
Melody1 Rank: 8
Melody2 Rank: 10
--------------------------------------------------
--------------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB601E9>  18
2     #<MUSIC #x1AB85309>  10
3     #<MUSIC #x1AB9A04D>  17
4     #<MUSIC #x1ABAE159>  18
```

```
------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 3------------------
Melody 1: D/2 F2 A2 A/2 F2 B/2 A2 F G2 F2 A2 C2 G D/2 C F A C
Melody 2: A4, B, A4, A4, A4, G2, G, F4,

Total Rank: 11
Melody1 Rank: 5
Melody2 Rank: 6
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 3------------------
Melody 1: D/2 F2 A2 A/2 F2 B/2 A2 F G2 F2 A2 C2 G D/2 C F A B
Melody 2: A4, D2, A4, A4, A4, G2, G, F4,

Total Rank: 11
Melody1 Rank: 5
Melody2 Rank: 6
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 5------------------
Melody 1: D/2 F2 A2 A/2 F2 B/2 A2 F G2 F2 A2 C2 G D/2 C F A B
Melody 2: A4, D2, A4, A4, A4, G2, G, F4,

Total Rank: 11
Melody1 Rank: 5
Melody2 Rank: 6
--------------------------------------------------
------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB600D5>  18
2     #<MUSIC #x1AB60AB5>  10
3     #<MUSIC #x1AB60AD9>  17
4     #<MUSIC #x1AB60B15>  18
5     #<MUSIC #x1AB61A75>  11
```

```
----------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 2------------------
Melody 1: A2' A/2' B' F2' G2' G2' E/2' B/2' D/2' G2' D' F' G2'
E' C2' B/2' F/2' G/2' E/2' D' G/2' C/2'
Melody 2: D2 D2 G C/2 E C2 B2 A C D2 E2 F D2 A/2 C2 C B/2 A/2

Total Rank: 5
Melody1 Rank: 2
Melody2 Rank: 3
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 2------------------
Melody 1: A2' A/2' B' F2' G2' G2' E/2' B/2' D/2' G2' D' F' G2'
E' C2' B/2' F/2' G/2' E/2' D' G/2' C/2'
Melody 2: D2 D2 G C/2 E C2 B2 A C D2 E2 F D2 A/2 C2 C B/2 A/2

Total Rank: 5
Melody1 Rank: 2
Melody2 Rank: 3
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 6------------------
Melody 1: A2' A/2' B' F2' G2' G2' E/2' B/2' D/2' G2' D' F' G2'
E' C2' B/2' F/2' G/2' E/2' D' G/2' C/2'
Melody 2: D2 D2 G C/2 E C2 B2 A C D2 E2 F D2 A/2 C2 C B/2 A/2

Total Rank: 5
Melody1 Rank: 2
Melody2 Rank: 3
--------------------------------------------------
----------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB600D5>  18
2     #<MUSIC #x1AB60AB5>  10
```

```
3     #<MUSIC #x1AB60AD9>  17
4     #<MUSIC #x1AB60B15>  18
5     #<MUSIC #x1AB61A75>  11
6     #<MUSIC #x1AB77C89>  5



------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 3------------------
Melody 1: B/2' D' E/2' G/2' E/2' B/2' C2' E/2' F/2' B2' C2' A'
D/2' A/2' B2' D/2' E/2' G' F2' F2' B/2' C' G/2' E' G/2'
Melody 2: A' G/2' C2' E' B2' F/2' A/2' D/2' A/2' B2' G' G2' F'
G2' C' B/2' A2' A' C/2' G/2' A' G/2' B/2'

Total Rank: 17
Melody1 Rank: 9
Melody2 Rank: 8
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 3------------------
Melody 1: B/2' D' E/2' G/2' E/2' B/2' C2' E/2' F/2' B2' C2' A'
D/2' A/2' A/2' D/2' E/2' G' F2' F2' B/2' C' G/2' E' G/2'
Melody 2: A' G/2' C2' E' B2' F/2' A/2' D/2' A/2' B2' G' G2' F'
G2' C' B/2' E' A' C/2' G/2' A' G/2' B/2'

Total Rank: 17
Melody1 Rank: 9
Melody2 Rank: 8
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 7------------------
Melody 1: B/2' D' E/2' G/2' E/2' B/2' C2' E/2' F/2' B2' C2' A'
D/2' A/2' A/2' D/2' E/2' G' F2' F2' B/2' C' G/2' E' G/2'
Melody 2: A' G/2' C2' E' B2' F/2' A/2' D/2' A/2' B2' G' G2' F'
G2' C' B/2' E' A' C/2' G/2' A' G/2' B/2'

Total Rank: 17
Melody1 Rank: 9
Melody2 Rank: 8
--------------------------------------------------
```

```
------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB600D5>  18
2     #<MUSIC #x1AB60AB5>  10
3     #<MUSIC #x1AB60AD9>  17
4     #<MUSIC #x1AB60B15>  18
5     #<MUSIC #x1AB61A75>  11
6     #<MUSIC #x1AB77C89>  5
7     #<MUSIC #x1AB93295>  17



------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 68------------------
Melody 1: D G/2 C/2 A2 C A2 E/2 G E/2 A D B2 E2 C/2 G/2 F2 C2 C
F2 F
Melody 2: E/2 B E G B A/2 C D G2 E F/2 B2 D/2 E2 B/2 B G A/2 D2
B A2 B

Total Rank: 7
Melody1 Rank: 0
Melody2 Rank: 7
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 68------------------
Melody 1: D G/2 C/2 A2 C A2 E/2 G E/2 A D B2 E2 C/2 G/2 F2 C2 C
F2 F
Melody 2: E/2 B E G B A/2 C D G2 E F/2 B2 D/2 E2 B/2 B G A/2 D2
B A2 B

Total Rank: 7
Melody1 Rank: 0
Melody2 Rank: 7
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 8------------------
```

```
Melody 1: D G/2 C/2 A2 C A2 E/2 G E/2 A D B2 E2 C/2 G/2 F2 C2 C
F2 F
Melody 2: E/2 B E G B A/2 C D G2 E F/2 B2 D/2 E2 B/2 B G A/2 D2
B A2 B

Total Rank: 7
Melody1 Rank: 0
Melody2 Rank: 7
--------------------------------------------------
------------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB600D5>  18
2     #<MUSIC #x1AB60AB5>  10
3     #<MUSIC #x1AB60AD9>  17
4     #<MUSIC #x1AB60B15>  18
5     #<MUSIC #x1AB61A75>  11
6     #<MUSIC #x1AB77C89>  5
7     #<MUSIC #x1AB93295>  17
8     #<MUSIC #x1ABABCA9>  7



------------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 76------------------
Melody 1: G2' C/2' G' F' C' E' G' F2' C/2' A2' F' G' F/2' D' E2'
D' F' C' C/2' E/2' F' G' G/2'
Melody 2: G2 C/2 G F C E G F2 C/2 A2 F G F/2 D E2 D F C C/2 E/2
F G G/2

Total Rank: 11
Melody1 Rank: 4
Melody2 Rank: 7
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 76------------------
```

```
Melody 1: G2' C/2' G' F' C' E' G' F2' C/2' A2' F' G' D' D' E2'
D' F' C' C/2' E/2' F' G' G/2'
Melody 2: G2 C/2 G F C E G F2 C/2 A2 F G F/2 D E2 D F F2 C/2 E/2
F G G/2

Total Rank: 11
Melody1 Rank: 4
Melody2 Rank: 7
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 9------------------
Melody 1: G2' C/2' G' F' C' E' G' F2' C/2' A2' F' G' D' D' E2'
D' F' C' C/2' E/2' F' G' G/2'
Melody 2: G2 C/2 G F C E G F2 C/2 A2 F G F/2 D E2 D F F2 C/2 E/2
F G G/2

Total Rank: 11
Melody1 Rank: 4
Melody2 Rank: 7
--------------------------------------------------
------------------------------------------------------------------
--


Generation 1 population ...

1      #<MUSIC #x1AB600D5>  18
2      #<MUSIC #x1AB60AB5>  10
3      #<MUSIC #x1AB60AD9>  17
4      #<MUSIC #x1AB60B15>  18
5      #<MUSIC #x1AB61A75>  11
6      #<MUSIC #x1AB77C89>  5
7      #<MUSIC #x1AB60B81>  17
8      #<MUSIC #x1AB60BA5>  7
9      #<MUSIC #x1AB60BED>  11



------------------------------------------------------------Se
lected individual =
 ------------------MUSIC SAMPLE 93------------------
```

```
Melody 1: C2' B/2' C' F' F/2' F/2' G2' F' E' E' C/2' A2' F/2'
F/2' F' C/2' A' G' D2' A2' C2' A/2'
Melody 2: B, B2, B, G2, G, B, A2, G4, B2, A2, G2, F4,

Total Rank: 9
Melody1 Rank: 8
Melody2 Rank: 1
--------------------------------------------------
Possibly mutated individual =
------------------MUSIC SAMPLE 93------------------
Melody 1: C2' B/2' C' F' F/2' F/2' G2' F' E' E' C/2' A2' A2'
F/2' F' C/2' A' G' D2' A2' C2' A/2'
Melody 2: B, B2, B, G2, G, G2, A2, G4, B2, A2, G2, F4,

Total Rank: 9
Melody1 Rank: 8
Melody2 Rank: 1
--------------------------------------------------
Renumbered individual =
------------------MUSIC SAMPLE 10------------------
Melody 1: C2' B/2' C' F' F/2' F/2' G2' F' E' E' C/2' A2' A2'
F/2' F' C/2' A' G' D2' A2' C2' A/2'
Melody 2: B, B2, B, G2, G, G2, A2, G4, B2, A2, G2, F4,

Total Rank: 9
Melody1 Rank: 8
Melody2 Rank: 1
--------------------------------------------------
------------------------------------------------------------------
--


Generation 1 population ...

1     #<MUSIC #x1AB600A5>  18
2     #<MUSIC #x1AB60A85>  10
3     #<MUSIC #x1AB60AA9>  17
4     #<MUSIC #x1AB60AE5>  18
5     #<MUSIC #x1AB60B21>  11
6     #<MUSIC #x1AB60B45>  5
7     #<MUSIC #x1AB60B81>  17
```

```
8       #<MUSIC #x1AB60BA5>  7
9       #<MUSIC #x1AB60BED>  11
10      #<MUSIC #x1AB75EC1>  9



------------------------------------------------------------------
NIL
```

Perform Copies Demo Code

```
; Method to demo perform-copies
( defmethod demo--perform-copies ( &aux cp np )
    ( setf cp ( initial-population ) )
    ( assign-random-ranks ( population-individuals cp ) )
    ( setf np ( empty-population cp ) )
    ( format t
"-------------------------------------------------------------------------~%" )
    ( display np )
    ( format t
"~%~%-------------------------------------------------------------------" )
    ( setf *copy-demo* t )
    ( dotimes ( i 10 )
        ( perform-one-copy cp np )
        ( format t
"-------------------------------------------------------------------------~%" )
        ( display np )
        ( format t
"~%~%-------------------------------------------------------------------" )
    )
    ( setf *copy-demo* nil )
)
```

Perform Copies Code

```
( setf *copy-demo* nil )

; Constant denoting percentage of copies
( defconstant *pc-c* 40 )

; Method to perform the number of copies as directed by
; the number assigned to *pc-c*
```

```
( defmethod perform-copies ( ( cp population ) ( np population ) )
    ( dotimes ( i ( nr-copies ) )
        ( perform-one-copy cp np )
    )
)

; Method to calculated the number of copies
; using the *population-size*
( defmethod nr-copies ()
    ( * ( / *pc-c* 100 ) *population-size* )
)

; Method to select the most fit individual from
; a selection
( defmethod select-individual ( ( p population )
    &aux i candidates rn )
    ( setf candidates ( select-individuals p ) )
    ( setf mfi ( most-fit-music-sample candidates ) )
    mfi
)

; Method to calculate the most fit music sample
; based on total rank (melody1-rank + melody2-rank)
( defmethod most-fit-music-sample ( ( selection list ) &aux max-value
max-individual )
    ( setf max-individual ( max-val selection 0 #'music-rank ) )
    max-individual
)

; Method to display a music sample with its melodies and rankings
( defmethod display-music-sample ( ( m music ) )
    ( format t "------------------MUSIC SAMPLE ~A------------------~%" (
music-num m ))
    ( display-all-melodies m )
    ( format t "Total Rank: ~A~%" ( music-rank m ) )
    ( format t "Melody1 Rank: ~A~%" ( music-melody1-rank m ) )
    ( format t "Melody2 Rank: ~A~%" ( music-melody2-rank m ) )
    ( format t "-------------------------------------------------~%")
)
; Method to perform one copy
```

```
;  1. Selects a music sample
;  2. Maybe mutates
;  3. Copies music sample to new music sample obj
;  4. Appends to new population
( defmethod perform-one-copy ( ( cp population ) ( np population )
    &aux x m mm new-i )
    ( setf m ( select-individual cp ) )
    ( if *copy-demo* ( format t "Selected individual = ~% ") )
    ( if *copy-demo* ( display-music-sample m ) )

    ( maybe-mutate m )
    ( if *copy-demo* ( format t "Possibly mutated individual = ~&" ) )
    ( if *copy-demo* ( display-music-sample m ) )
    ( setf ( music-num m) ( + 1 ( size np ) ) )
    ( if *copy-demo* ( format t "Renumbered individual = ~&" ) )
    ( if *copy-demo* ( display-music-sample m) )

    ( setf new-i ( copy-music-sample ( + 1 ( size np ) ) m ) )

    ( setf
        ( population-individuals np )
        ( append ( population-individuals np ) ( list new-i ) )
    )
)

; Method to instantiate an empty population
( defmethod empty-population ( ( cp population ) &aux np )
    ( setf np ( make-instance 'population ) )
    ( setf ( population-individuals np ) () )
    ( setf ( population-generation np ) ( + 1 ( population-generation cp )
) )
    np
)
```