Task 12 - Population-Based Crossover Methods

This task features a bonus task: the implementation of a new display method that abides by the ABC notation constraints of MuseScore, an application that rivals EasyABC. I pivoted to using MuseScore due to numerous issues I encountered with EasyABC. While performing the demo for the *perform-crossovers* method, EasyABC frequently refused to play some samples and crashed when edits were made to listen to one melody at a time. I am not sure if this is a Windows issue, an issue with using multiple voice channels, or a skill issue. I tried looking up EasyABC playback issues and most of the complaints and subsequent solutions were by and for Mac users. Instead of wasting time on getting EasyABC to behave, I decided to switch to MuseScore. MuseScore handles ABC notation similarly, although it does not allow for live editing of the notation, so I adjusted the display method with this in mind for convenience.

This task also implemented the *perform-crossovers* method, where multiple crossovers can be performed within a population. The *perform-one-crossover* method calls on the *interactive-selection* method to allow the user to rank the population selection before "double-crossover" takes place. This will be edited in the future to limit user fatigue while maintaining variation.

MuseScore Display Demo

```
[2]> ( setf po ( initial-population ) )
#<POPULATION #x1AAE4D69>
[3]> ( setf selection ( select-individuals po ) )
(#<MUSIC #x1AAD10F1> #<MUSIC #x1AAD0C6D> #<MUSIC #x1AAD06F9>)
[4]> ( musescore-display selection )
----------------Selection---------------
X:1
T:Selection
C:Dystopian Tuesday
M:4/4
L:1/4
Q:1/4=120
V:S clef=treble name=Melody1 snm=Melody1
V:A clef=treble name=Melody2 snm=Melody2
%%score [ ( S ) ( A ) ]
K:C
%%MIDI program 0
```

```
V:S
F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2 D2 F/2 z4
|]
V:A
B2, A, B4, A, G2, F4, E4, D2, z4 |]
V:S
D F/2 A2 E2 D/2 C C D/2 E2 F2 F/2 F/2 B F E2 G F G/2 z4 |]
V:A
E C2 A E2 A G G2 A2 A/2 G/2 D/2 C/2 D2 F2 D C z4 |]
V:S
F/2 D2 C B C/2 D2 G/2 D/2 C2 F2 C B E C E D E2 z4 |]
V:A
C C G/2 F/2 D2 E C/2 C E D D2 D/2 B F2 C2 B E2 z4 |]
NIL
```

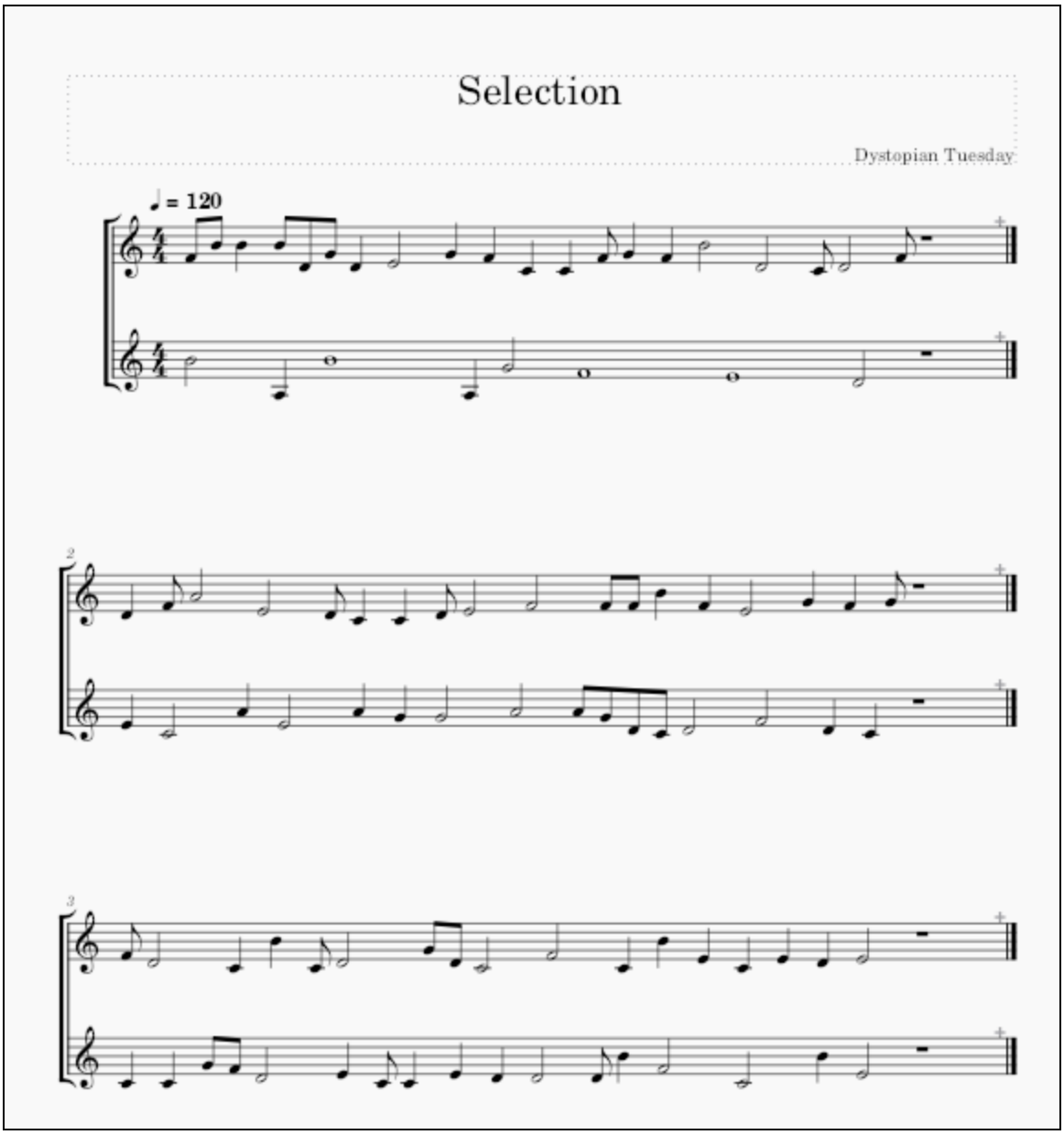
MuseScore Display GUI

How to Import ABC Notation (video instructions):

1. Using MuseScore, ensure you have the ABC Import plugin installed and enabled. It can be found here. ****This only works with MuseScore 4****
2. Click "Plugins" at the top of the screen and select "ABC Import" from the drop-down menu.
3. Copy the ABC Notation and input into the text editor pop-up.
4. Click the "Import" button at the bottom-right corner of the pop-up. At this point, a file-path for the ABC notation file has been copied to your clipboard automatically. Paste that file-path and navigate to the designated file.
5. Select "Open."

Some Display Notes

- All selections are displayed on the same score. Music samples are denoted by the following identifiers:
    - A tiny numeric subscript at the top left of a piece (terminal output for ranking coincides with this number)
    - A whole rest at the end of melody1 and melody2
    - A double bar at the end of melody
- MuseScore allows for easy melody isolation – all a user has to do is click on desired melody to highlight it and play on its own


Selection
Dystopian Tuesday
♩ = 120


Selection
Dystopian Tuesday
♩ = 120

MuseScore Display Code

```
; Option to print in ABC Notation for MuseScore usage

; toggle EasyABC mode
( setf *easyabc-mode* nil )

; Method to display all selections on one composition score in ABC
notation
( defmethod musescore-display ( ( selection list ) )
    ( format t "----------------Selection----------------~%" )
    ( format t "X:1~%")
    ( format t "T:Selection~%" )
    ( format t "C:Dystopian Tuesday~%" )
    ( format t "M:4/4~%" )
    ( format t "L:1/4~%" )
    ( format t "Q:1/4=120~%")
    ( format t "V:S clef=treble name=Melody1 snm=Melody1~%" )
    ( format t "V:A clef=treble name=Melody2 snm=Melody2~%" )
    ( format t "%%score [ ( S ) ( A ) ]~%")
    ( format t "K:C~%" )
    ( format t "%%MIDI program 0~%" )
    ( mapcar #'musescore-display-helper selection )
    nil

)

; Helper method to display a single selection
( defmethod musescore-display-helper ( ( m music ) )
    ( format t "V:S~%" )
    ( display-melody1 m )
    ( format t " z4 |]~%")
    ( format t "V:A~%" )
    ( display-melody2 m )
    ( format t " z4 |]~%")
)
```

Perform Crossovers Demo

```
[2]> ( demo--perform-crossovers )
------------------------------------------------------------------
-

Generation 1 population ...




------------------------------------------------------------------
-----------------Selection----------------
X:1
T:Selection
C:Dystopian Tuesday
M:4/4
L:1/4
Q:1/4=120
V:S clef=treble name=Melody1 snm=Melody1
V:A clef=treble name=Melody2 snm=Melody2
%%score [ ( S ) ( A ) ]
K:C
%%MIDI program 0
V:S
F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2 D2 F/2 z4
|]
V:A
B2, A, B4, A, G2, F4, E4, D2, z4 |]
V:S
D F/2 A2 E2 D/2 C C D/2 E2 F2 F/2 F/2 B F E2 G F G/2 z4 |]
V:A
E C2 A E2 A G G2 A2 A/2 G/2 D/2 C/2 D2 F2 D C z4 |]
V:S
F/2 D2 C B C/2 D2 G/2 D/2 C2 F2 C B E C E D E2 z4 |]
V:A
C C G/2 F/2 D2 E C/2 C E D D2 D/2 B F2 C2 B E2 z4 |]
[Sample 0] Melody 1 ranking (out of 10)? 5
Melody 2 ranking (out of 10)? 4
```

```
[Sample 1] Melody 1 ranking (out of 10)? 3
Melody 2 ranking (out of 10)? 2

[Sample 2] Melody 1 ranking (out of 10)? 7
Melody 2 ranking (out of 10)? 4

Selected melody1-m =
------------------MUSIC SAMPLE 21------------------
Melody 1: F/2 D2 C B C/2 D2 G/2 D/2 C2 F2 C B E C E D E2
Melody 2: C C G/2 F/2 D2 E C/2 C E D D2 D/2 B F2 C2 B E2

Total Rank: 11
Melody1 Rank: 7
Melody2 Rank: 4
--------------------------------------------------
Selected melody1-f =
------------------MUSIC SAMPLE 23------------------
Melody 1: F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2
D2 F/2
Melody 2: B2, A, B4, A, G2, F4, E4, D2,

Total Rank: 9
Melody1 Rank: 5
Melody2 Rank: 4
--------------------------------------------------
Selected melody2-m =
------------------MUSIC SAMPLE 23------------------
Melody 1: F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2
D2 F/2
Melody 2: B2, A, B4, A, G2, F4, E4, D2,

Total Rank: 9
Melody1 Rank: 5
Melody2 Rank: 4
--------------------------------------------------
Selected melody2-f =
------------------MUSIC SAMPLE 21------------------
Melody 1: F/2 D2 C B C/2 D2 G/2 D/2 C2 F2 C B E C E D E2
Melody 2: C C G/2 F/2 D2 E C/2 C E D D2 D/2 B F2 C2 B E2

Total Rank: 11
```

```
Melody1 Rank: 7
Melody2 Rank: 4
--------------------------------------------------
the crossover =
------------------MUSIC SAMPLE 0------------------
Melody 1: F/2 D2 C B C/2 D2 G/2 D/2 C2 F2 C B E D2 C/2 D2 F/2
Melody 2: B2, A, D2 E C/2 C E D D2 D/2 B F2 C2 B E2

Total Rank: 20
Melody1 Rank: 12
Melody2 Rank: 8
--------------------------------------------------
the possibly mutate individual =
------------------MUSIC SAMPLE 0------------------
Melody 1: F/2 D2 C B C/2 D2 G/2 D/2 C2 F2 C B E D2 C/2 D2 F/2
Melody 2: B2, A, D2 E C/2 C E D D2 D/2 B F2 C2 B E2

Total Rank: 20
Melody1 Rank: 12
Melody2 Rank: 8
--------------------------------------------------
the renumbered individual =
------------------MUSIC SAMPLE 1------------------
Melody 1: F/2 D2 C B C/2 D2 G/2 D/2 C2 F2 C B E D2 C/2 D2 F/2
Melody 2: B2, A, D2 E C/2 C E D D2 D/2 B F2 C2 B E2

Total Rank: 20
Melody1 Rank: 12
Melody2 Rank: 8
--------------------------------------------------
------------------------------------------------------------
-

Generation 1 population ...

1     #<MUSIC #x1AAE184D>  20



------------------------------------------------------------
-----------------Selection----------------
```

```
X:1
T:Selection
C:Dystopian Tuesday
M:4/4
L:1/4
Q:1/4=120
V:S clef=treble name=Melody1 snm=Melody1
V:A clef=treble name=Melody2 snm=Melody2
%%score [ ( S ) ( A ) ]
K:C
%%MIDI program 0
V:S
A2 F/2 A D2 F2 D2 E/2 G2 G/2 G/2 C2 G/2 A/2 D2 D C z4 |]
V:A
B, B, B, B2, A4, A4, A, B4, A, A, z4 |]
V:S
G2' G2' F' G' F' D2' B2' B' D' A2' A/2' C/2' C' C' E2' z4 |]
V:A
G' D2' A2' C' A/2' F' B2' G2' D' F' B' C' E2' C/2' G2' z4 |]
V:S
A C2 B/2 F2 E2 A2 B2 D C2 D/2 C/2 E/2 E E2 C z4 |]
V:A
E E2 F/2 A2 G2 E2 F2 F E2 F/2 E/2 G/2 G G2 E z4 |]
[Sample 0] Melody 1 ranking (out of 10)? 3
Melody 2 ranking (out of 10)? 4

[Sample 1] Melody 1 ranking (out of 10)? 1
Melody 2 ranking (out of 10)? 2

[Sample 2] Melody 1 ranking (out of 10)? 3
Melody 2 ranking (out of 10)? 3

Selected melody1-m =
------------------MUSIC SAMPLE 20------------------
Melody 1: A2 F/2 A D2 F2 D2 E/2 G2 G/2 G/2 C2 G/2 A/2 D2 D C
Melody 2: B, B, B, B2, A4, A4, A, B4, A, A,

Total Rank: 7
Melody1 Rank: 3
Melody2 Rank: 4
-------------------------------------------------
```

```
Selected melody1-f =
------------------MUSIC SAMPLE 15------------------
Melody 1: A C2 B/2 F2 E2 A2 B2 D C2 D/2 C/2 E/2 E E2 C
Melody 2: E E2 F/2 A2 G2 E2 F2 F E2 F/2 E/2 G/2 G G2 E

Total Rank: 6
Melody1 Rank: 3
Melody2 Rank: 3
--------------------------------------------------
Selected melody2-m =
------------------MUSIC SAMPLE 20------------------
Melody 1: A2 F/2 A D2 F2 D2 E/2 G2 G/2 G/2 C2 G/2 A/2 D2 D C
Melody 2: B, B, B, B2, A4, A4, A, B4, A, A,

Total Rank: 7
Melody1 Rank: 3
Melody2 Rank: 4
--------------------------------------------------
Selected melody2-f =
------------------MUSIC SAMPLE 15------------------
Melody 1: A C2 B/2 F2 E2 A2 B2 D C2 D/2 C/2 E/2 E E2 C
Melody 2: E E2 F/2 A2 G2 E2 F2 F E2 F/2 E/2 G/2 G G2 E

Total Rank: 6
Melody1 Rank: 3
Melody2 Rank: 3
--------------------------------------------------
the crossover =
------------------MUSIC SAMPLE 0------------------
Melody 1: A2 F/2 A D2 F2 D2 B2 D C2 D/2 C/2 E/2 E E2 C
Melody 2: B, B, B, B2, A4, A4, A, B4, A, A,

Total Rank: 13
Melody1 Rank: 6
Melody2 Rank: 7
--------------------------------------------------
the possibly mutate individual =
------------------MUSIC SAMPLE 0------------------
Melody 1: A F/2 A D2 F2 D2 B2 D C2 D/2 C/2 E/2 E E2 C
Melody 2: B, B, B, B2, A4, A4, A, B4, A, G4,
```

```
Total Rank: 13
Melody1 Rank: 6
Melody2 Rank: 7
--------------------------------------------------
the renumbered individual =
------------------MUSIC SAMPLE 2------------------
Melody 1: A F/2 A D2 F2 D2 B2 D C2 D/2 C/2 E/2 E E2 C
Melody 2: B, B, B, B2, A4, A4, A, B4, A, G4,

Total Rank: 13
Melody1 Rank: 6
Melody2 Rank: 7
--------------------------------------------------
------------------------------------------------------------------
-

Generation 1 population ...

1     #<MUSIC #x1AAA599D>  20
2     #<MUSIC #x1AABE6D1>  13



------------------------------------------------------------------
-----------------Selection----------------
X:1
T:Selection
C:Dystopian Tuesday
M:4/4
L:1/4
Q:1/4=120
V:S clef=treble name=Melody1 snm=Melody1
V:A clef=treble name=Melody2 snm=Melody2
%%score [ ( S ) ( A ) ]
K:C
%%MIDI program 0
V:S
B/2 A/2 C2 E/2 G D/2 D/2 F/2 D/2 F F A/2 F2 C E/2 C2 F B F/2 G
E2 z4 |]
V:A
```

```
C2 A/2 E2 F F/2 G F D/2 F B D/2 F/2 E/2 G A/2 C D/2 E/2 F2 C2
B/2 z4 |]
V:S
F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2 D2 F/2 z4
|]
V:A
B2, A, B4, A, G2, F4, E4, D2, z4 |]
V:S
D F/2 A2 E2 D/2 C C D/2 E2 F2 F/2 F/2 B F E2 G F G/2 z4 |]
V:A
E C2 A E2 A G G2 A2 A/2 G/2 D/2 C/2 D2 F2 D C z4 |]
[Sample 0] Melody 1 ranking (out of 10)? 4
Melody 2 ranking (out of 10)? 1

[Sample 1] Melody 1 ranking (out of 10)? 32

[ERROR] A ranking must be a natural number x such that -1 < x <
11.
Melody 1 ranking (out of 10)? 3
Melody 2 ranking (out of 10)? 6

[Sample 2] Melody 1 ranking (out of 10)? 7
Melody 2 ranking (out of 10)? 0

Selected melody1-m =
------------------MUSIC SAMPLE 22------------------
Melody 1: D F/2 A2 E2 D/2 C C D/2 E2 F2 F/2 F/2 B F E2 G F G/2
Melody 2: E C2 A E2 A G G2 A2 A/2 G/2 D/2 C/2 D2 F2 D C

Total Rank: 7
Melody1 Rank: 7
Melody2 Rank: 0
--------------------------------------------------
Selected melody1-f =
------------------MUSIC SAMPLE 16------------------
Melody 1: B/2 A/2 C2 E/2 G D/2 D/2 F/2 D/2 F F A/2 F2 C E/2 C2 F
B F/2 G E2
Melody 2: C2 A/2 E2 F F/2 G F D/2 F B D/2 F/2 E/2 G A/2 C D/2
E/2 F2 C2 B/2

Total Rank: 5
```

```
Melody1 Rank: 4
Melody2 Rank: 1
--------------------------------------------------
Selected melody2-m =
------------------MUSIC SAMPLE 23------------------
Melody 1: F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2
D2 F/2
Melody 2: B2, A, B4, A, G2, F4, E4, D2,

Total Rank: 9
Melody1 Rank: 3
Melody2 Rank: 6
--------------------------------------------------
Selected melody2-f =
------------------MUSIC SAMPLE 16------------------
Melody 1: B/2 A/2 C2 E/2 G D/2 D/2 F/2 D/2 F F A/2 F2 C E/2 C2 F
B F/2 G E2
Melody 2: C2 A/2 E2 F F/2 G F D/2 F B D/2 F/2 E/2 G A/2 C D/2
E/2 F2 C2 B/2

Total Rank: 5
Melody1 Rank: 4
Melody2 Rank: 1
--------------------------------------------------
the crossover =
------------------MUSIC SAMPLE 0------------------
Melody 1: D F/2 A2 E2 D/2 C C D/2 E2 F2 F/2 F/2 B F B F/2 G E2
Melody 2: B2, A, B4, A, G2, F4, E4, D2,

Total Rank: 18
Melody1 Rank: 11
Melody2 Rank: 7
--------------------------------------------------
the possibly mutate individual =
------------------MUSIC SAMPLE 0------------------
Melody 1: D F/2 A2 E2 D/2 C C D/2 E2 F2 F/2 F/2 B F B F/2 G E2
Melody 2: B2, A, B4, A, G2, F4, E4, D2,

Total Rank: 18
Melody1 Rank: 11
Melody2 Rank: 7
```

```
--------------------------------------------------
the renumbered individual =
------------------MUSIC SAMPLE 3------------------
Melody 1: D F/2 A2 E2 D/2 C C D/2 E2 F2 F/2 F/2 B F B F/2 G E2
Melody 2: B2, A, B4, A, G2, F4, E4, D2,

Total Rank: 18
Melody1 Rank: 11
Melody2 Rank: 7
--------------------------------------------------
------------------------------------------------------------
-

Generation 1 population ...

1     #<MUSIC #x1AAA58D9>  20
2     #<MUSIC #x1AAA62C5>  13
3     #<MUSIC #x1AAE5EA1>  18



------------------------------------------------------------
-----------------Selection----------------
X:1
T:Selection
C:Dystopian Tuesday
M:4/4
L:1/4
Q:1/4=120
V:S clef=treble name=Melody1 snm=Melody1
V:A clef=treble name=Melody2 snm=Melody2
%%score [ ( S ) ( A ) ]
K:C
%%MIDI program 0
V:S
F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2 D2 F/2 z4
|]
V:A
B2, A, B4, A, G2, F4, E4, D2, z4 |]
V:S
```

```
D/2' F/2' G/2' A' F' C2' B2' E' B/2' E/2' G/2' F/2' F/2' G/2' C'
B/2' B' B2' C' F/2' E/2' D2' z4 |]
V:A
A' B2' F/2' E/2' G/2' D2' C2' E/2' F' C' F/2' B/2' G/2' F/2' B2'
F/2' B' D/2' G/2' C' B/2' E' z4 |]
V:S
G2 B2 C/2 B2 E2 B/2 D E2 G C D2 B2 E2 z4 |]
V:A
B2 A/2 D A F E2 F/2 D/2 F2 A2 C/2 C/2 C2 B D/2 G2 E z4 |]
[Sample 0] Melody 1 ranking (out of 10)? 4
Melody 2 ranking (out of 10)? 2

[Sample 1] Melody 1 ranking (out of 10)? 2
Melody 2 ranking (out of 10)? 2

[Sample 2] Melody 1 ranking (out of 10)? 1
Melody 2 ranking (out of 10)? 2

Selected melody1-m =
------------------MUSIC SAMPLE 23------------------
Melody 1: F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2
D2 F/2
Melody 2: B2, A, B4, A, G2, F4, E4, D2,

Total Rank: 6
Melody1 Rank: 4
Melody2 Rank: 2
--------------------------------------------------
Selected melody1-f =
------------------MUSIC SAMPLE 8------------------
Melody 1: D/2' F/2' G/2' A' F' C2' B2' E' B/2' E/2' G/2' F/2'
F/2' G/2' C' B/2' B' B2' C' F/2' E/2' D2'
Melody 2: A' B2' F/2' E/2' G/2' D2' C2' E/2' F' C' F/2' B/2'
G/2' F/2' B2' F/2' B' D/2' G/2' C' B/2' E'

Total Rank: 4
Melody1 Rank: 2
Melody2 Rank: 2
--------------------------------------------------
Selected melody2-m =
------------------MUSIC SAMPLE 23------------------
```

Melody 1: F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G F B2 D2 C/2 D2 F/2
Melody 2: B2, A, B4, A, G2, F4, E4, D2,

Total Rank: 6
Melody1 Rank: 4
Melody2 Rank: 2

Selected melody2-f =
------------------MUSIC SAMPLE 8------------------
Melody 1: D/2' F/2' G/2' A' F' C2' B2' E' B/2' E/2' G/2' F/2' F/2' G/2' C' B/2' B' B2' C' F/2' E/2' D2'
Melody 2: A' B2' F/2' E/2' G/2' D2' C2' E/2' F' C' F/2' B/2' G/2' F/2' B2' F/2' B' D/2' G/2' C' B/2' E'

Total Rank: 4
Melody1 Rank: 2
Melody2 Rank: 2
---
the crossover =
------------------MUSIC SAMPLE 0------------------
Melody 1: F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G/2' C' B/2' B' B2' C' F/2' E/2' D2'
Melody 2: B2, A, F/2' E/2' G/2' D2' C2' E/2' F' C' F/2' B/2' G/2' F/2' B2' F/2' B' D/2' G/2' C' B/2' E'

Total Rank: 10
Melody1 Rank: 6
Melody2 Rank: 4
---
the possibly mutate individual =
------------------MUSIC SAMPLE 0------------------
Melody 1: F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G/2' C' B/2' B' B2' C' F/2' E/2' D2'
Melody 2: B2, A, F/2' E/2' G/2' D2' C2' E/2' F' C' F/2' B/2' G/2' F/2' B2' F/2' B' D/2' G/2' C' B/2' E'

Total Rank: 10
Melody1 Rank: 6
Melody2 Rank: 4

```
the renumbered individual =
------------------MUSIC SAMPLE 4------------------
Melody 1: F/2 B/2 B B/2 D/2 G/2 D E2 G F C C F/2 G/2' C' B/2' B'
B2' C' F/2' E/2' D2'
Melody 2: B2, A, F/2' E/2' G/2' D2' C2' E/2' F' C' F/2' B/2'
G/2' F/2' B2' F/2' B' D/2' G/2' C' B/2' E'

Total Rank: 10
Melody1 Rank: 6
Melody2 Rank: 4
--------------------------------------------------
------------------------------------------------------------------
-

Generation 1 population ...

1     #<MUSIC #x1AAA58D9>  20
2     #<MUSIC #x1AAA62C5>  13
3     #<MUSIC #x1AAA62E9>  18
4     #<MUSIC #x1AAF0099>  10



------------------------------------------------------------------
-----------------Selection----------------
X:1
T:Selection
C:Dystopian Tuesday
M:4/4
L:1/4
Q:1/4=120
V:S clef=treble name=Melody1 snm=Melody1
V:A clef=treble name=Melody2 snm=Melody2
%%score [ ( S ) ( A ) ]
K:C
%%MIDI program 0
V:S
E A2 A/2 D D2 A/2 G2 E/2 F B2 C2 F2 F G/2 C2 z4 |]
V:A
F4, F, F4, A2, G, G4, F4, z4 |]
V:S
```

```
B/2 D/2 E/2 F F F2 A2 D B E2 G/2 B B2 F2 A2 F z4 |]
V:A
F/2 F/2 G/2 A A A2 E2 F F G2 B/2 F F2 A2 E2 A z4 |]
V:S
D2 B G/2 G B C C/2 E D2 B/2 F D/2 D G/2 B B G2 B2 G/2 z4 |]
V:A
D2' B' G/2' G' B' C' C/2' E' D2' B/2' F' D/2' D' G/2' B' B' G2'
B2' G/2' z4 |]
[Sample 0] Melody 1 ranking (out of 10)? 3
Melody 2 ranking (out of 10)? 4

[Sample 1] Melody 1 ranking (out of 10)? 6
Melody 2 ranking (out of 10)? 1

[Sample 2] Melody 1 ranking (out of 10)? 1
Melody 2 ranking (out of 10)? 1

Selected melody1-m =
------------------MUSIC SAMPLE 9------------------
Melody 1: B/2 D/2 E/2 F F F2 A2 D B E2 G/2 B B2 F2 A2 F
Melody 2: F/2 F/2 G/2 A A A2 E2 F F G2 B/2 F F2 A2 E2 A

Total Rank: 7
Melody1 Rank: 6
Melody2 Rank: 1
--------------------------------------------------
Selected melody1-f =
------------------MUSIC SAMPLE 19------------------
Melody 1: E A2 A/2 D D2 A/2 G2 E/2 F B2 C2 F2 F G/2 C2
Melody 2: F4, F, F4, A2, G, G4, F4,

Total Rank: 7
Melody1 Rank: 3
Melody2 Rank: 4
--------------------------------------------------
Selected melody2-m =
------------------MUSIC SAMPLE 19------------------
Melody 1: E A2 A/2 D D2 A/2 G2 E/2 F B2 C2 F2 F G/2 C2
Melody 2: F4, F, F4, A2, G, G4, F4,

Total Rank: 7
```

```
Melody1 Rank: 3
Melody2 Rank: 4
--------------------------------------------------
Selected melody2-f =
------------------MUSIC SAMPLE 9------------------
Melody 1: B/2 D/2 E/2 F F F2 A2 D B E2 G/2 B B2 F2 A2 F
Melody 2: F/2 F/2 G/2 A A A2 E2 F F G2 B/2 F F2 A2 E2 A

Total Rank: 7
Melody1 Rank: 6
Melody2 Rank: 1
--------------------------------------------------
the crossover =
------------------MUSIC SAMPLE 0------------------
Melody 1: B/2 D/2 E/2 F F F2 A2 D B E2 G/2 B B2 F2 A2 F
Melody 2: F4, F, F4, A2, G, F F2 A2 E2 A

Total Rank: 14
Melody1 Rank: 9
Melody2 Rank: 5
--------------------------------------------------
the possibly mutate individual =
------------------MUSIC SAMPLE 0------------------
Melody 1: B/2 D/2 E/2 F F F2 A2 D B E2 G/2 B B2 F2 A2 F
Melody 2: F4, F, F4, A2, G, F F2 A2 E2 A

Total Rank: 14
Melody1 Rank: 9
Melody2 Rank: 5
--------------------------------------------------
the renumbered individual =
------------------MUSIC SAMPLE 5------------------
Melody 1: B/2 D/2 E/2 F F F2 A2 D B E2 G/2 B B2 F2 A2 F
Melody 2: F4, F, F4, A2, G, F F2 A2 E2 A

Total Rank: 14
Melody1 Rank: 9
Melody2 Rank: 5
--------------------------------------------------
--------------------------------------------------------------
-
```

```
Generation 1 population ...

1      #<MUSIC #x1AAA58D9>  20
2      #<MUSIC #x1AAA62C5>  13
3      #<MUSIC #x1AAA62E9>  18
4      #<MUSIC #x1AAA630D>  10
5      #<MUSIC #x1AAD178D>  14



------------------------------------------------------------------------
-
NIL
[3]>
```

Perform Crossovers Demo Code

```
; Demo of perform-crossovers method.
( defmethod demo--perform-crossovers ( &aux cp np )
    ( setf cp ( initial-population ) )
    ( setf np ( empty-population cp ) )
    ( format t
"------------------------------------------------------------------------")
    ( display np )
    ( format t
"~%~%------------------------------------------------------------------------")
    ( setf *crossover-demo* t )
    ( dotimes ( i 3 )
        ( perform-one-crossover cp np )
        ( format t
"------------------------------------------------------------------------")
        ( display np )
        ( format t
"~%~%------------------------------------------------------------------------")
    )
    ( setf *crossover-demo* nil )
    nil
)
```

Perform Crossovers Code

```
; Population-Based Crossover Methods

; Var for toggling debug statements for testing population crossover
( setf *crossover-demo* nil )

; Number of crossovers -- will be toggled, set for demo purposes currently
( defconstant *nr-crossovers* 3 )

; Method to perform a crossover for the amount of times desginated
; by *nr-crossovers*
( defmethod perform-crossovers ( ( cp population ) ( np population ) )
    ( dotimes ( i *nr-crossovers* )
        ( perform-one-crossover cp np )
    )
)

; Method to perform one crossover
;  1. Chooses selection of individuals.
;  2. Chooses most fit melody1 and 2nd best melody1
;     for mother1 and father1, respectively.
;  3. Chooses most fit melody2 and 2nd best melody2
;     for mother2 and father2, respectivelly.
;  4. Performs crossover.
;  5. Copies and renumbers music sample.
;  6. Adds new music sample to next generation.
( defmethod perform-one-crossover ( ( cp population ) ( np population ) )
    ( let ( selection melody1-m melody1-f melody2-m melody2-f c mm )

        ( setf selection ( select-individuals cp ) )
        ( interactive-selection selection )

        ( setf melody1-m ( most-fit-melody1 selection ) )
        ( setf melody1-f ( most-fit-melody1 ( remove melody1-m selection )
) )
        ( if *crossover-demo* ( format t "Selected melody1-m = ~%" ) )
```

```
        ( if *crossover-demo* ( display-music-sample melody1-m ) )
        ( if *crossover-demo* ( format t "Selected melody1-f = ~%" ) )
        ( if *crossover-demo* ( display-music-sample melody1-f ) )

        ( setf melody2-m ( most-fit-melody2 selection ) )
        ( setf melody2-f ( most-fit-melody2 ( remove melody2-m selection )
) )
        ( if *crossover-demo* ( format t "Selected melody2-m = ~%" ) )
        ( if *crossover-demo* ( display-music-sample melody2-m ) )
        ( if *crossover-demo* ( format t "Selected melody2-f = ~%" ) )
        ( if *crossover-demo* ( display-music-sample melody2-f ) )

        ( setf c ( double-crossover melody1-m melody1-f melody2-m
melody2-f ) )
        ( if *crossover-demo* ( format t "the crossover = ~%" ) )
        ( if *crossover-demo* ( display-music-sample c ) )

        ( maybe-mutate c )
        ( if *crossover-demo* ( format t "the possibly mutate individual =
~%" ) )
        ( if *crossover-demo* ( display-music-sample c ) )

        ( setf ( music-num c ) ( + 1 ( size np ) ) )
        ( if *crossover-demo* ( format t "the renumbered individual = ~%"
) )
        ( if *crossover-demo* ( display-music-sample c ) )

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

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


    )
    nil
)
```