GAtune

The GAtune system is based on a model of genetic encoding of a musical score, using interactive genetic algorithms. It can be used as an aid in composing music.

Genetic algorithms in GAtune

Population initialization

GAtune lets you save a population in a *.gene* file. So the algorithm can either start with a randomly generated population, or with a previously saved one.

You have the option to reinitialize a population (*File* → *Reset*), which replaces the individuals in the current generation, except for the protected ones (we'll get to that in a moment), with random ones. This option comes in handy when you come to a dead end i.e. the musical bars are very similar and/or applying the genetic operators doesn't lead to satisfactory results.

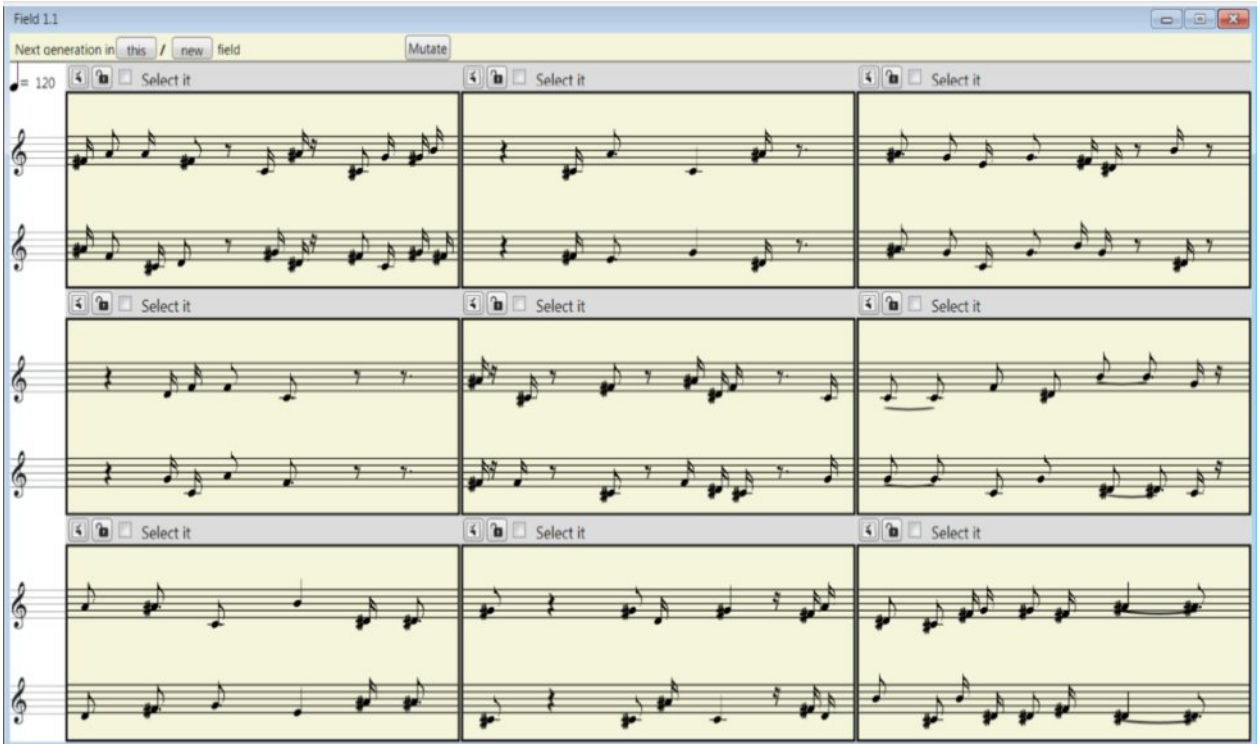


Figure 1 A population of random individuals

Parents selection

The selection of the parents for the next generation is completely user-controlled. You can evaluate an individual by viewing the musical bar it represents, and by listening to it (click). You can select/deselect it by using the checkbox. You can also protect an individual (click) i.e. make it immune to genetic operators. This means that it will be copied into the next generation.

Figure 2 shows the selection color codes: unselected, selected, protected, selected & protected.

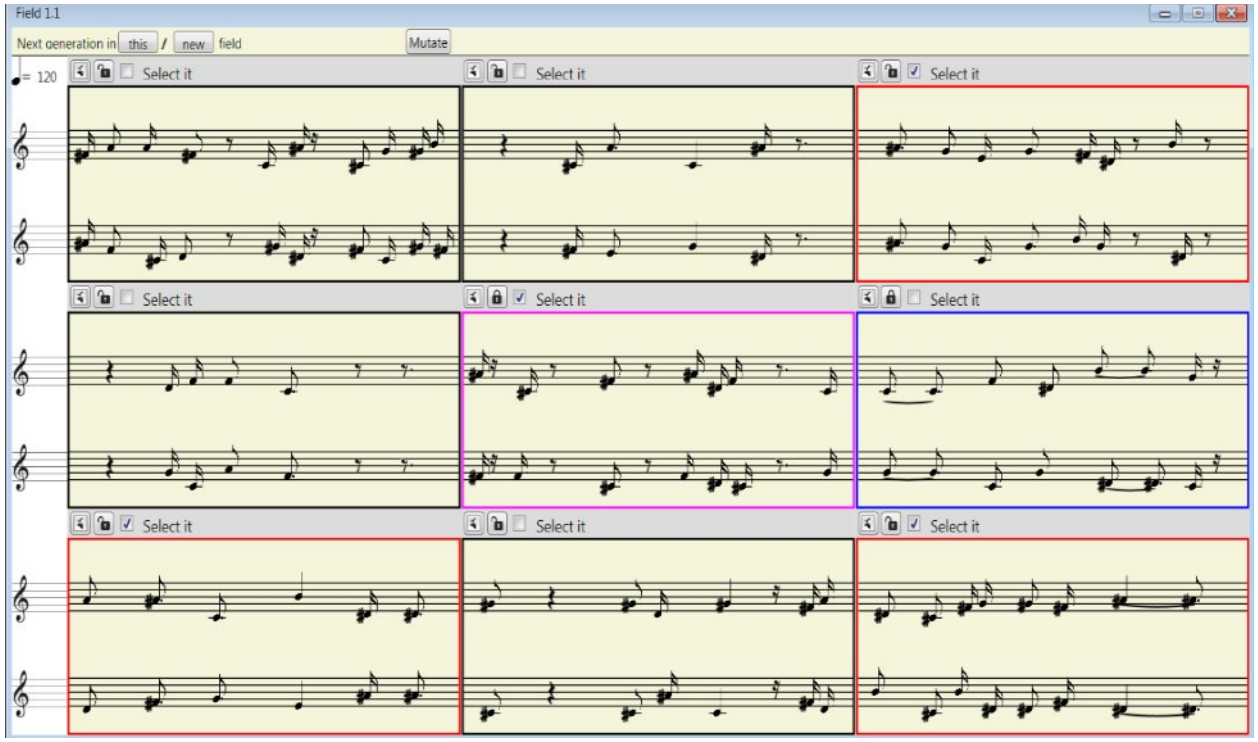


Figure 2 The selection types

To create the next generation, you have two possibilities: you generate them in the same field window or in a new one, in which case you can compare the two generations.

Genetic operators

Crossover

Typically, applying this operator assumes two parents are selected. GAtune implements the one-point crossover: a random cutting point is generated for the two parents, and the resulting parts are exchanged.

When generating a new population, either:

a) no individual is selected;
b) only one individual is selected;
c) at least two individuals are selected.

In case a), the new population is randomly generated. In case b), the selected individual is crossed over itself and then mutated to produce the new population. In case c), the following process is applied until the whole new population is generated: two random parents are chosen from the selected individuals, crossed over and then mutated, which results in two offspring.

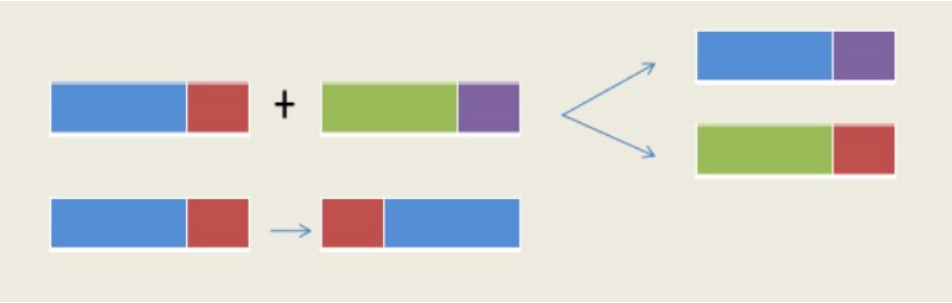


Figure 3 Two-parent and single-parent crossover

Figure 4 represents the new population obtained from the one in *Figure 2*. The new individuals are the offspring of the selected parents (the red ones) and you can see that the protected individuals are preserved (the magenta and blue ones). *Figure 5* shows an example of single-parent crossover. You can see that the selected individuals in the new population are identical. So, GAtune lets you manually mutate individuals: you select the ones you want to modify and click on the *Mutate* button in the field window.

Mutation

The mutation operator is automatically applied after crossover. As mentioned before, you can also apply it manually to selected individuals.

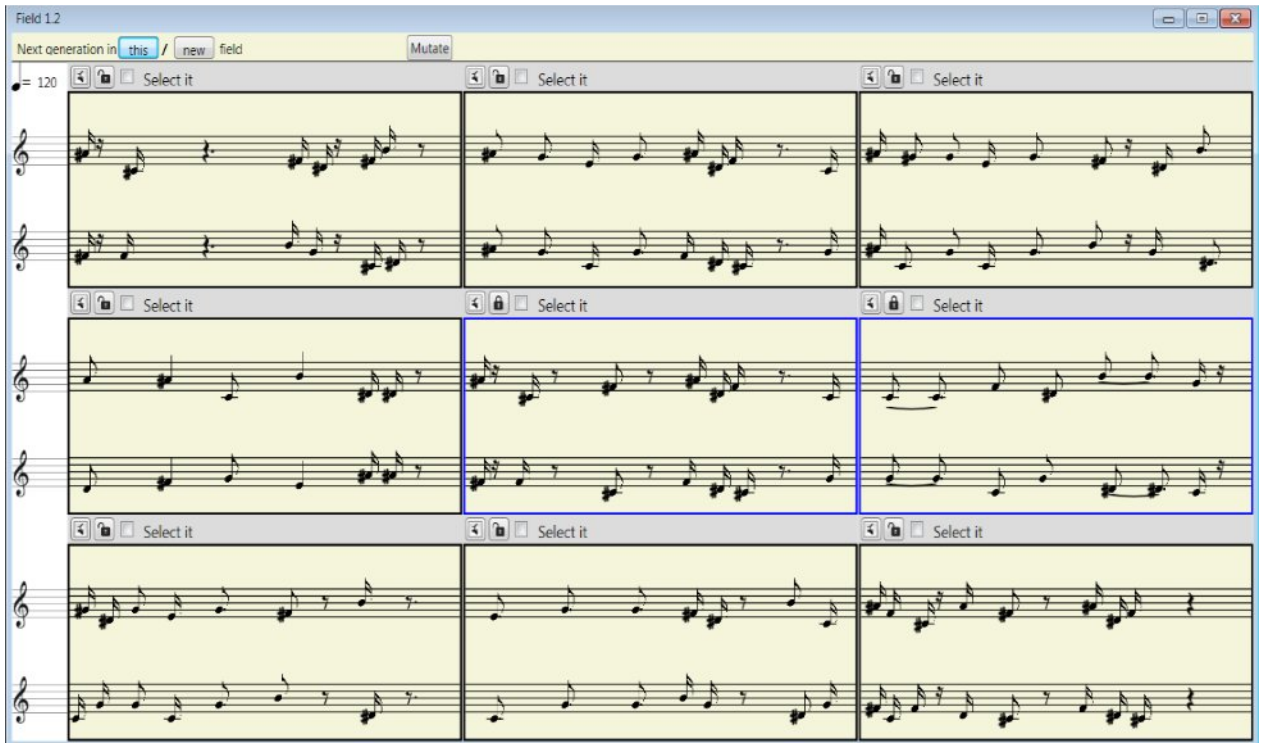
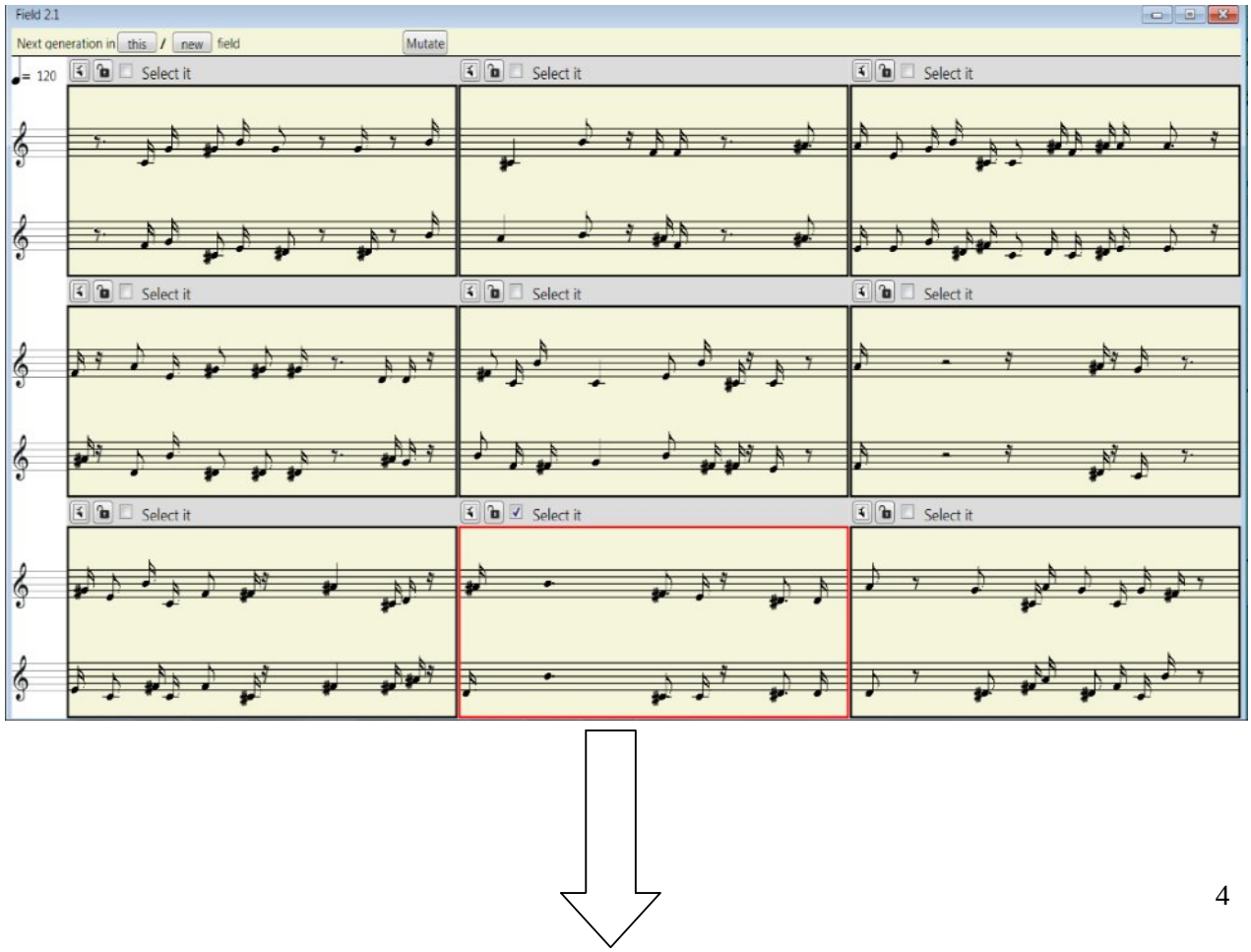


Figure 4 Two-parent crossover



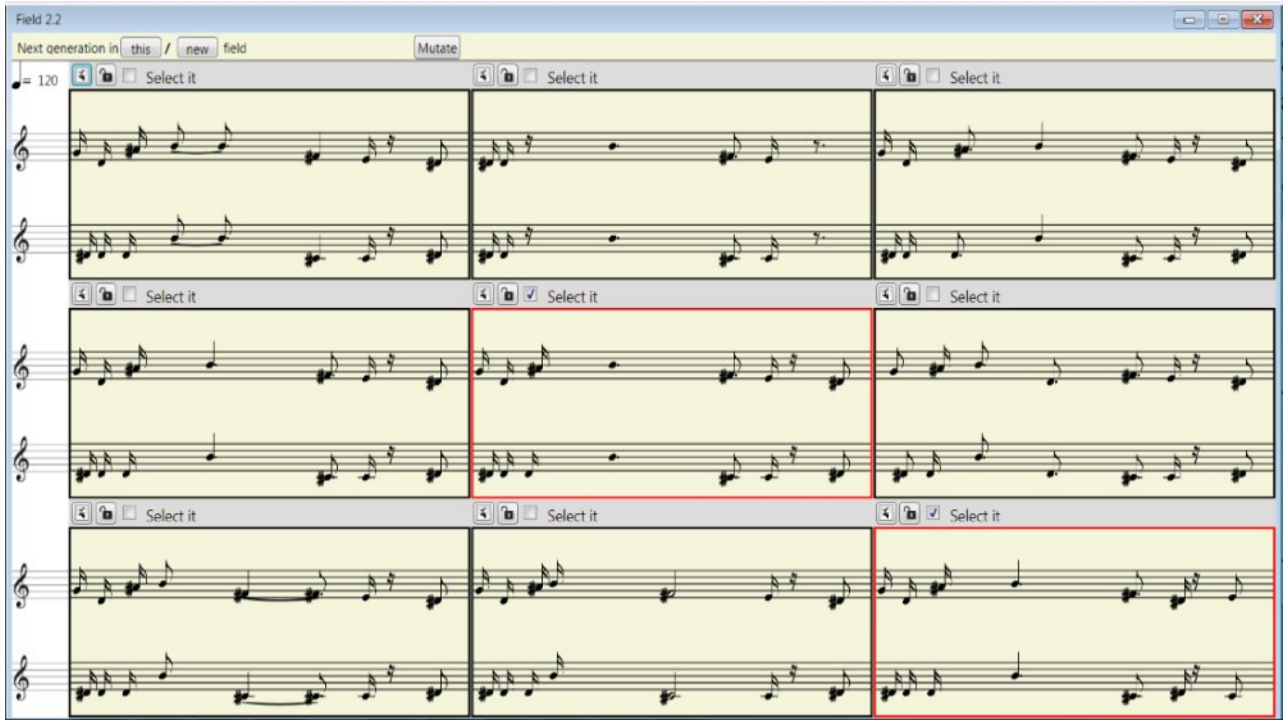


Figure 5 Single-parent crossover

GAtune user experience

The menu

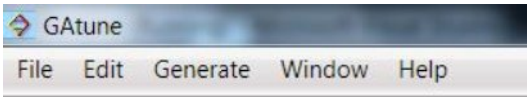


Figure 6 The menu bar

- *File*
  - *New*:
    - *Field*: creates a window that contains the individuals of a population;
    - *Score*: creates a window that can be used to assemble a melody from musical bars (individuals from field windows).
  - *Open...* displays a file selection windows for .gene and .score files;
  - *Save* saves the contents of the focused window (field or score) in a file;
  - *Save as...* displays a file selection windows for choosing/creating a .gene or .score file;
  - *Close* closes the focused window;

  - *Save as MIDI...* saves the contents of a .score file to a MIDI file;
  - *Reset* randomizes unprotected individuals from the focused field, or clears the musical bars from the focused score;
  - *Close all windows* does just what it says;
  - *Exit* closes the application.

- *Edit*
  - *Select all* selects all the individuals in the focused field, or all the musical bars in the focused score;
  - *Score edit*
    - *Shrink* shrinks the score window;
    - *Expand* expands the score window.
- *Generate*
  - *Next in this field* creates the next generation in this field;
  - *Next in new field* creates the next generation in a new field;
  - *Mutate it* mutates the selected individuals.

- *Window*
  - *Player* shows/hides the *Player* window;
  - *Bar Part Options* shows/hides the *Bar Part Options* window.
- *Help*
  - *GAtune Quick Guide* opens this document.

The field

This window contains the individuals of a population. Each individual consists of two parts, or solos. You can drag and drop the individuals onto the score window.

The score window

You can use this window to collect and arrange the musical bars created in the fields.

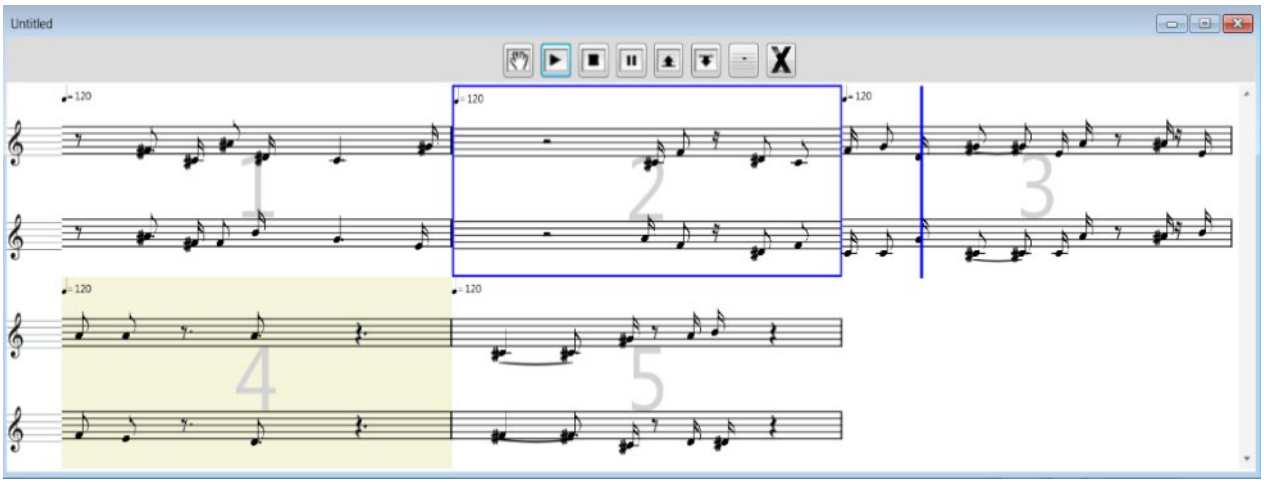


Figure 7 The score window

By clicking a bar, you select it and it becomes editable. The next click undoes the selection. Two bars can be switched by drag and drop.

There are two types of selection:

- *Primary selection*

   (de)frames the bar with a blue border. Clicking the button changes it into the "secondary mode" selection button. You can select only one bar in "primary mode" at a given moment.
- *Secondary selection*

   adds/removes a beige background to/from the bar. You can select any number of bars in "secondary mode" at a given moment. The option *Select all* in the *Edit* menu enables you to (de)select all the bars in the focused score. Pressing *Delete* removes the selected bars.

You can control the music playback by using the following buttons:

-  starts the playback. The starting point is the first bar in the score, unless there is a bar selected in "primary mode", in which case that bar becomes the starting point. The playback can be visually followed via a metronome;
-  stops the song;
-  pauses the song.

The rest of the buttons in the score window:

- shrinks the score by one line of bars;
- expands the score by one line of bars;
- adds an empty bar: if there's a bar selected in "primary mode", the empty bar is inserted after it, else the empty bar is appended to the score;
- deletes all the bars in the score.

The *Bar Part Options* window

When GAtune starts, two windows are displayed on the right. The one on top is the *Bar Part Options* window. It enables you to set parameters which control the playback for each of the two parts of the bar.

hides the window. You can make it visible again via the option *Part Option* in the *Window* menu.

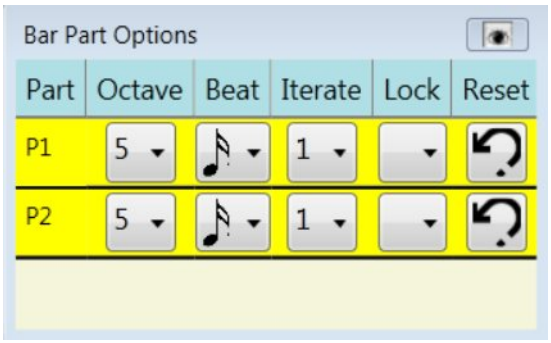


Figure 8 The *Bar Part Options* window

You can set the following parameters (they're applied to all the individuals in the focused field):

- octave : 3 - 7 (octave 5 contains middle C);
- unit beat: 16^{th}, 8^{th}, 4^{th};
- number of iterations: 1, 2, 4;
- lock: rhythm, melody, velocity (sound intensity).

The music clef corresponding to octaves in range 3 - 4 is F, and in range 5 – 7 - is G.

The unit beat designates the smallest duration in a bar, used to translate the genetic information into meaningful musical elements. For example, if the unit beat is 16^{th}, the whole bar consists of 16 notes/rests of duration 16^{th} each. These notes/rests can be combined to form longer ones according to the genetic information encoding, resulting in less than 16 notes/rests per bar.

The number of iterations refers to the bar pattern. A value of 1 means the bar structure is random. A value of 2 means the bar consists of two identical sections. A value of 4 means the bar consists of four identical sections.

The lock enables protecting the rhythm, melody or intensity, w.r.t. to mutation. For example, if you like the rhythm, but the melody not so much, you can lock the rhythm and then apply mutation.

↶ enables you to reset the parameters, for each part, to default i.e. octave 5, unit beat 16th, number of iterations 1, and no lock.

The *Player* window

The bottom window that is displayed on the right when GAtune starts is the *Player* window. It enables you to modify the tempo and the scale.  hides the window. You can make it visible again via the option *Player* in the *Window* menu.

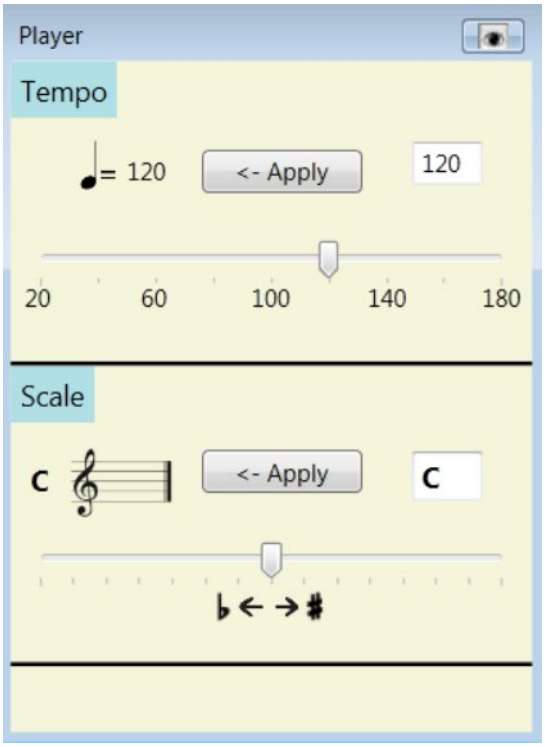


Figure 9 The *Player* window

The tempo parameter controls the playback speed and has a range of 20 – 180 quarter notes per minute. You can modify it by typing a value in the textbox or by moving the slider. Pressing *Apply* updates the bars in the focused window. If the focused window is a field, the tempo of all the contained individuals is updated, along with the tempo for the next generations. If the focused window is a score, the tempo of all the bars selected in "secondary mode" is updated.

The scale parameter controls what notes are used to generate the bars. GAtune supports the 15 major scales. Each of these is considered equal-tempered (i.e. it contains 12 notes) and the first note (the tonic) is the one that gives the scale name. For example, the D major scale in octave 5 is composed of: D5, D5#, E5, E5#, F5, G5, G5#, A5, A5#, B5, B6#, C6. Note that the sequence also contains notes in octave 6, even though the scale is in octave 5.

You can modify the scale parameter by moving the slider. The value will automatically be updated in the readonly textbox. The arrows below the slider indicate the direction for the scale. Moving to the right adds a sharp at each step, while moving to the left adds a flat at each step. Pressing *Apply* updates the bars in the focused window. If the focused window is a field, the contained individuals are transposed accordingly, and the updated value for the scale will be used for the next generations. If the focused window is a score, all the bars are transposed accordingly. Note that you can't drop a bar on a score window unless the scales match.