Language Proposal: Cb (C flat)
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Background / Motivation:

General purpose languages usually require various libraries and long complex lines of code to write music. We aim to make this process easy by providing musicians with a concise language dedicated to the generation of music. Cb will provide programmers of all levels with the tools needed to focus solely on the generation of music. Providing efficient and user-friendly programming methods to implement musical composition is our goal. We have mainly focused on music as a collection of notes and chords. This would allow the creation of many musical structures, especially guitar tabs, incredibly easy.

Our syntax uses keywords that are common in music theory, which includes notes, chords, scale, and many more. This familiarity makes a beginner feel at home with the language and use the basic concepts of music in a powerful way. The idea is for a user to write their music program and have it compile into a MIDI file. The resulting MIDI file could then be played with a program like iTunes or be drafted into music on the musical staff with a program such as finale.

Language Definition:

Primitives:
int
- signed

note
- note n = (A#, 0, 1)
- note whole_rest = (R, whole)
- note n = (<pitch>, <octave>, <duration>)

chord
- chord c = ([], <duration>)
- (Empty chord as shown above equivalent to a rest
- chord c = ([C, E, G], whole*3)

scale
- scale s = [Bb, C, D, Eb, F, G, A]
- compiler forces a scale to be 7 notes
stanza

- an ordering of notes and chords
- stanza \( st = [Bm, F\_\text{sharp}, A, E, G, D, Em^2, F#^2] \)
- compiler would expand the above into
  - stanza \( st = [Bm, F\#, A, E, G, D, Em, Em, F\#, F\#] \)

white = General keywords

grey = Control keywords

dark grey = Operator keywords

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{int}</td>
<td>used to declare a field for a 32-bit signed two's complement integer ( int \ &lt;\textit{var}&gt; = &lt;\textit{value}&gt; )</td>
</tr>
<tr>
<td>\textit{note}</td>
<td>used to declare a field for a 3 element array where the first element takes in a pitch (int</td>
</tr>
<tr>
<td>\textit{chord}</td>
<td>used to declare a field for a 2 element array where the first element takes in an array of notes (notes[]) and the second element takes in duration (int) ( chord \ &lt;\textit{var}&gt; = [&lt;\textit{notes}&gt;, &lt;\textit{duration}&gt;] )</td>
</tr>
<tr>
<td>\textit{scale}</td>
<td>used to declare a field for a 8 element array where each element takes in a pitch (int</td>
</tr>
<tr>
<td>\textit{stanza}</td>
<td>used to declare a field for an ( n ) element array where each element takes in either a note or a chord ( stanza \ &lt;\textit{var}&gt; = [&lt;\textit{notes_and/or_chords}][&gt;] )</td>
</tr>
<tr>
<td>\textit{score}</td>
<td>used to declare a field for an ( n ) element array where each element takes in a stanza ( score \ &lt;\textit{var}&gt; = [&lt;\textit{stanzas}&gt;] )</td>
</tr>
<tr>
<td>\textit{sixteenth}</td>
<td>reserved word to represent a duration that will be one-sixteenth of the base beat duration value ( note \ \textit{sixteenth_rest} = (R, \textit{sixteenth}) )</td>
</tr>
<tr>
<td>\textit{eighth}</td>
<td>reserved word to represent a duration that will be one-eighth of the base beat duration value ( note \ \textit{eighth_rest} = (R, \textit{eighth}) )</td>
</tr>
<tr>
<td>\textit{quarter}</td>
<td>reserved word to represent a duration that will be one-quarter of the base beat duration value ( note \ \textit{quarter_rest} = (R, \textit{quarter}) )</td>
</tr>
<tr>
<td>\textit{half}</td>
<td>reserved word to represent a duration that will be 2 times the base beat duration value</td>
</tr>
</tbody>
</table>
### Note durations
- **Half rest**
  - Base duration: \( \frac{1}{4} \) beat
  - Value: \( R, \) half
  - Notation: \( (R, \text{half}) \)

### Whole rest
- A reserve word to represent a duration that will be 4 times the base beat duration value.
  - Value: \( R, \) whole
  - Notation: \( (R, \text{whole}) \)

### Music pitches

#### A
- Reserved word to represent the music pitch 'A' note as an int
  - Value: \( A, \) whole
  - Notation: \( (A, \text{whole}) \)

#### A#
- Reserved word to represent the music pitch 'A#' note as an int
  - Value: \( A#, \) whole
  - Notation: \( (A#, \text{whole}) \)

#### Bb
- Reserved word to represent the music pitch 'Bb' note as an int
  - Value: \( Bb, \) whole
  - Notation: \( (Bb, \text{whole}) \)

#### B
- Reserved word to represent the music pitch 'B' note as an int
  - Value: \( B, \) whole
  - Notation: \( (B, \text{whole}) \)

#### B#
- Reserved word to represent the music pitch 'B#' note as an int
  - Value: \( B#, \) whole
  - Notation: \( (B#, \text{whole}) \)

#### C
- Reserved word to represent the music pitch 'C' note as an int
  - Value: \( C, \) whole
  - Notation: \( (C, \text{whole}) \)

#### Cb
- Reserved word to represent the music pitch 'Cb' note as an int
  - Value: \( Cb, \) whole
  - Notation: \( (Cb, \text{whole}) \)

#### C#
- Reserved word to represent the music pitch 'C#' note as an int
  - Value: \( C#, \) whole
  - Notation: \( (C#, \text{whole}) \)

#### Db
- Reserved word to represent the music pitch 'Db' note as an int
  - Value: \( Db, \) whole
  - Notation: \( (Db, \text{whole}) \)

#### D
- Reserved word to represent the music pitch 'D' note as an int
  - Value: \( D, \) whole
  - Notation: \( (D, \text{whole}) \)

#### D#
- Reserved word to represent the music pitch 'D#' note as an int
  - Value: \( D#, \) whole
  - Notation: \( (D#, \text{whole}) \)

#### Eb
- Reserved word to represent the music pitch 'Eb' note as an int
  - Value: \( Eb, \) whole
  - Notation: \( (Eb, \text{whole}) \)

#### E
- Reserved word to represent the music pitch 'E' note as an int
  - Value: \( E, \) whole
  - Notation: \( (E, \text{whole}) \)

#### E#
- Reserved word to represent the music pitch 'E#' note as an int
  - Value: \( E#, \) whole
  - Notation: \( (E#, \text{whole}) \)

#### Fb
- Reserved word to represent the music pitch 'Fb' note as an int
  - Value: \( Fb, \) whole
  - Notation: \( (Fb, \text{whole}) \)

#### F
- Reserved word to represent the music pitch 'F' note as an int
  - Value: \( F, \) whole
  - Notation: \( (F, \text{whole}) \)

#### F#
- Reserved word to represent the music pitch 'F#' note as an int
  - Value: \( F#, \) whole
  - Notation: \( (F#, \text{whole}) \)

#### Gb
- Reserved word to represent the music pitch 'Gb' note as an int
  - Value: \( Gb, \) whole
  - Notation: \( (Gb, \text{whole}) \)
<table>
<thead>
<tr>
<th>G</th>
<th>reserved word to represent the music pitch 'G' note as an int note n = (G, whole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G#</td>
<td>reserved word to represent the music pitch 'G#' note as an int note n = (G#, whole)</td>
</tr>
<tr>
<td>Ab</td>
<td>reserved word to represent the music pitch 'Ab' note as an int note n = (Ab, whole)</td>
</tr>
<tr>
<td>R</td>
<td>reserved word to represent a rest (syntactic sugar for note with no pitch and a duration) note n = (R, whole)</td>
</tr>
<tr>
<td>use</td>
<td>specifies to include external files use &quot;&lt;filename&gt;&quot;</td>
</tr>
<tr>
<td>method</td>
<td>declares a routine which will specify a procedure of primitive manipulations method &lt;name&gt; &lt;return_value_type&gt; { &lt;statements&gt; }</td>
</tr>
<tr>
<td>if</td>
<td>declares an if statement which evaluates a boolean expression; if true, the block following immediately after the expression will be evaluated if (expression) { &lt;statements&gt; }</td>
</tr>
<tr>
<td>else</td>
<td>used in conjunction with if, which evaluates a boolean expression; if false, the block immediately following the else keyword will be evaluated if (expression) { &lt;statements&gt; } else { &lt;statements&gt; }</td>
</tr>
<tr>
<td>while</td>
<td>declares a while statement that evaluates a boolean expression; if true, the block immediately following the while keyword will be repeatedly evaluated until the boolean expression returns false while (expression) { &lt;statements&gt; }</td>
</tr>
<tr>
<td>for &lt;x&gt; : &lt;list&gt;</td>
<td>Declares a for-each statement that will execute the proceeding block for each element x in the list for &lt;object&gt;:&lt;list_of_objects&gt; {&lt;expression&gt;}</td>
</tr>
<tr>
<td>return</td>
<td>specifies what to return at the end of a method method &lt;name&gt; &lt;return_value_type&gt; { &lt;statements&gt; return &lt;instance_of_return_value&gt; }</td>
</tr>
<tr>
<td>++</td>
<td>finds all notes within object type and increase the pitch by a half step &lt;note/chord/stanza/score&gt;++</td>
</tr>
<tr>
<td>--</td>
<td>finds all notes within object type and decrease the pitch by a half step &lt;note/chord/stanza/score&gt;--</td>
</tr>
<tr>
<td>^+</td>
<td>finds all notes within object type and increase by one octave &lt;note/chord/stanza/score&gt;^+</td>
</tr>
<tr>
<td>^-</td>
<td>finds all notes within object type and decrease by one octave &lt;note/chord/stanza/score&gt;^-</td>
</tr>
<tr>
<td>==</td>
<td>evaluates left hand side and right hand side for strict equality &lt;object&gt; == &lt;object&gt;</td>
</tr>
<tr>
<td>%</td>
<td>performs modulo for int arithmetic &lt;int&gt; % &lt;int&gt;</td>
</tr>
</tbody>
</table>
<,>,>=,<\= evaluates left hand side and right hand side for basic math comparisons

\[ \text{<int> [\text{<,>\=,\<\=>}] <int>} \]

**Operators:**

- `<chord>++` (increment all notes in chord half step)
- `<chord>--` (decrement all notes in chord half step)
- `<note>++` (increment note half step)
- `<note>--` (decrement note half step)
- `<note>^+` (raise note 1 octave)
- `<note>^-` (lower note 1 octave)
- `==` (tests equality)
- `>, <, <=, >=` (arithmetic comparers)
- `%` modulo for int arithmetic

**Built In Methods:**

- `<scale>.major()` returns the major chord for that scale
- `<scale>.minor()` returns the minor chord for that scale
- `<scale>.diminished()` returns the diminished chord for that scale
- `<scale>.augmented()` returns the augmented chord for that scale
- `<stanza>.first(int n)` //returns a stanza of the first n elements
- `<stanza>.append(stanza s)` //appends all items in s to `<stanza>`
- `<stanza>.append(note n)` //appends the note to `<stanza>`
- `<stanza>.append(chord c)` //appends the chord to `<stanza>`
- `score.add(stanza s)`
- `score.add(chord c)`
- `score.add(note n)`
- `score.compose(int beats_per_minute)`

**Commenting:**

// comments out everything to the right on the line as in C
Strongly Typed:
After debating whether to implement a strongly typed language or a weakly typed language, we have decided to force a strongly typed language. We feel this provides 2 advantages to users

1. Easier to understand and keep track of which variables are what
2. Compiler can catch more mistakes which will be better for novice programmers

Case Sensitive:
As we need to separate B (the note B) and b (which signifies flat) we have decided to implement the language in a case sensitive manner.

Flow Statements:
if <thing> is <thing>
until
else if
else
while
until
for

Methods:
Methods are of the form:
method <return type> <name>[[optional parameters]]
{
   <method body>
   return <thing>
}

The primary goal of a method is to create pieces of music that uses similar patterns, as demonstrated in the sample method "heptatonicBluesScale", and enable composers to write different operations on notes, chords or stanzas that their particular style of music requires.
Sample Programs:

**Hot Cross Buns (musical hello world)**

note q_D = (D, quarter)
note q_C = (C, quarter)
note h_Bb = (Bb, half)
note e_C = (C, eighth)
note e_Bb = (Bb, eighth)

stanza hcb = [q_D, q_C, h_Bb]

score hot_cross_buns = [hcb*2, penny, hcb]
score.compose(120) //basically like saying exit(0) in C

**Cole’s Program**

use "stdchords"

// Set the default duration to 110 beats per minute and meta detail of title
score score = Score.new(duration: 110, title: "Hotel California")

// The duration of Eminor and F# minor is doubled and chords are concatenated into array (a stanza).
stanza s1 = [B_m, F#_ma, A_ma, E_ma, G_ma, D_ma, E_m*2, F#_ma*2]

// Append Em and F# to the first 6 chord elements from first stanza and assign it to stanza 2
stanza s2 = s1.first(6).append(Em).append(F#)

stanza chorus = [G, D, Em, Bm7, G, D, Em, F#]

// Join stanza1, chorus, stanza2 and chorus and put it into the score
score.put(stanza1, chorus, stanza2, chorus)

//Generate the midi file
score.compose(120)

**Sample Methods:**

//This method forms the heptatonic blues scale based on a given note.
method <stanza> <heptatonicBluesScale>(note begin)
{
    stanza bluesScale = []
    int i = 0
    while ( i < 9 )
    {
    
}
if(i==0 || i==1){
    bluesScale += begin+i
}
else if(i%2 == 0){
    bluesScale += ((begin+i)++)
}
else if(i%2 == 1){
    bluesScale += begin+i
}
i = i + 1
return bluesScale
}

Useful Information:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>A#/Bb</th>
<th>B</th>
<th>C</th>
<th>C#/Db</th>
<th>D</th>
<th>D#/Eb</th>
<th>E</th>
<th>F</th>
<th>F#/Gb</th>
<th>G</th>
<th>G#/Ab</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>#5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Any note can be computed as:

<int> mod 12