haspie – A Musical Harmonisation Tool based on ASP

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September 6, 2017

Motivation

- Musical teaching is still very traditional nowadays.
- Self-teaching of music theory is hard.

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- Self-teaching of music theory is hard.
- There are not many tools to aid and guide students and self-taught students.
- Composition tools seek results assuming that the user knows musical theory.
- There are intelligent composers: CHASP, Vox Populi, ANTON...

Example: Harmonisation

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- Harmony is a very important subject in music theory learning
- Choral music is the root of this subject
- Exercises consist in choosing chords sequences and completing musical pieces
- Already existing tools do not apply to this particular field

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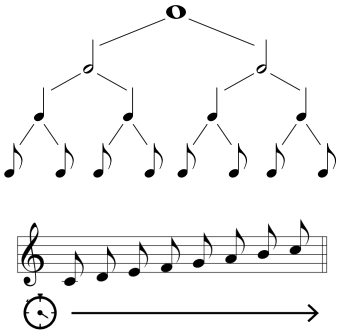
2. Given a certain harmonisation, be able to complete on purpose blank sections of any incomplete voice of the score
3. Add new voices that complement the voices already in the score

Overview

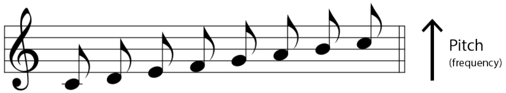
Figures and Rhythm

- Every note is represented by a figure that determines it's length
- Each figure can be subdivided in two shorter figures
- Rhythm is created by combining figures of different lengths with special symbols called silences



Melody

- Horizontal dimension of music
- Pitch is represented by the height at which the note is written, higher position means higher pitch



▸ Play

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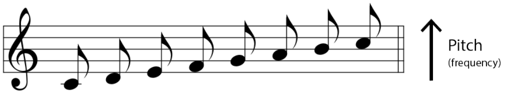

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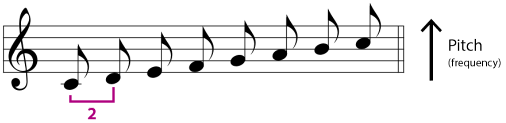

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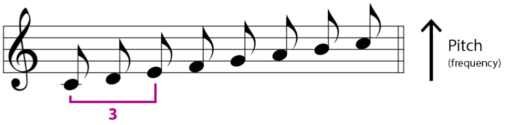

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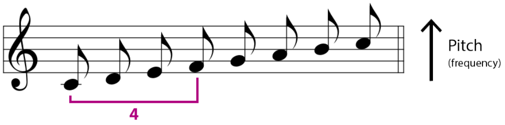
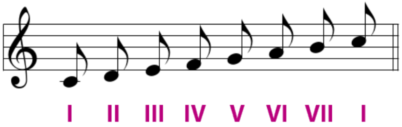


Play

Tonality

- The tonality is the set of sounds given by a certain scale



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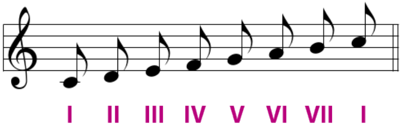
- The tonality is the set of sounds given by a certain scale
- The different sounds of a tonality are abstracted in grades
- This abstraction allows to use notes by the role they play in the tonality, regardless of the sound of the note.



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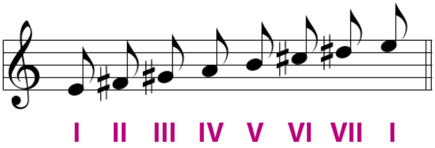

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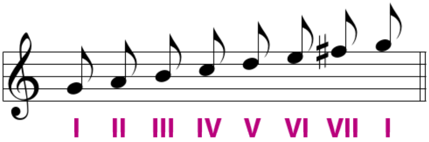

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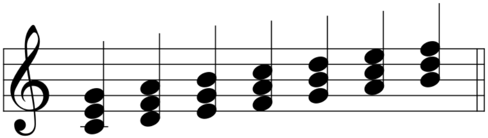
Harmony

- Vertical dimension of music
- Only present in polyphonic pieces or pieces with polyphonic instruments
- Two notes or more of different voices that play at the same time form a chord



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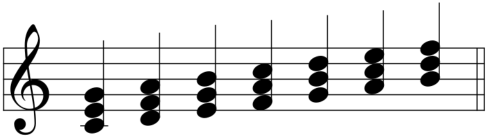
- Fundamental chords of the scale are built adding the third and fifth notes of the root



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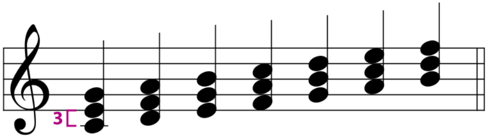

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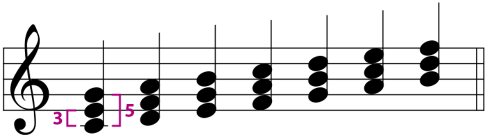

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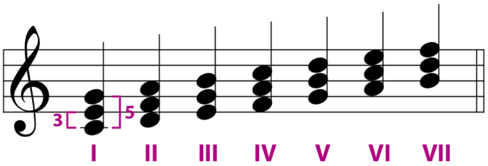
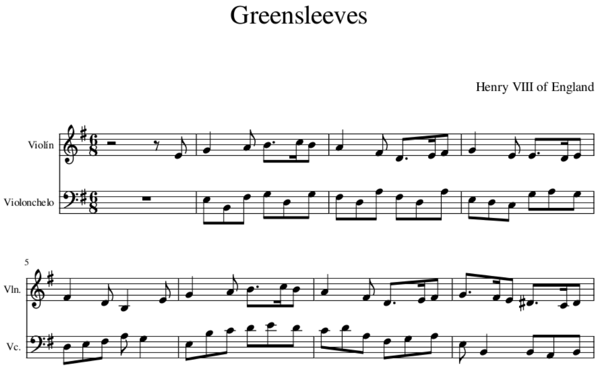


Play

Overview

Demonstration: Greensleeves



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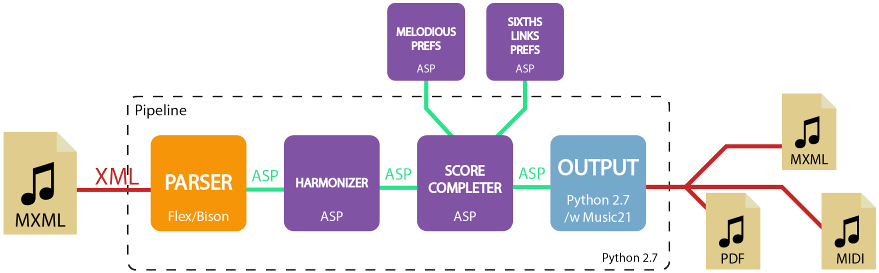
haspie's Architecture



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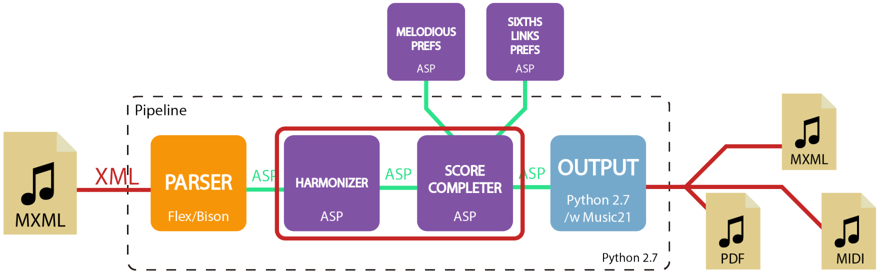
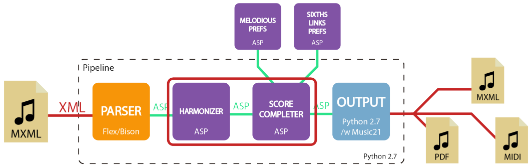


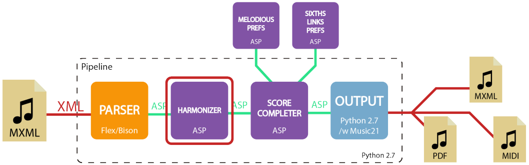
ASP Core



Answer Set Programming:

- Independent of the solving process and its heuristics
- The power and flexibility of ASP lays on this independence
- The problem only needs to be specified by rules and constraints

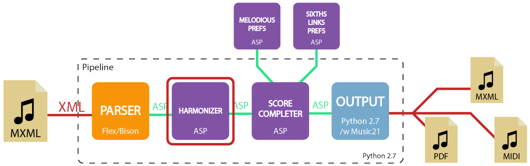
Harmonisation



- Notes are converted to grades of the scale given the key and mode

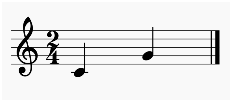
```
octave(V,((N - base) / 12),T) :- note(V,N,T), N >= 0.
sem_tones(V,((N - base) \ 12),T) :- note(V,N,T), N >= 0.
grade(V,1,T) :- sem_tones(V,3,T).
grade(V,2,T) :- sem_tones(V,5,T).
grade(V,3,T) :- sem_tones(V,7,T).
```

Harmonisation



- Notes are converted to grades of the scale given the key and mode
- Chords are assigned to the harmonisable times of the score
- Errors are computed and the solver determines the fittest chords for each section

```
1 { chord(HT,C) : pos_chord(C) } 1 :- htime(HT).
```



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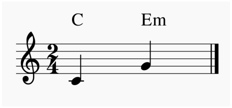
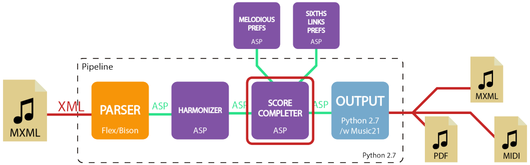


Score Completion



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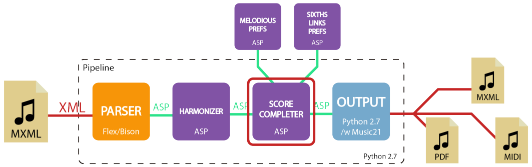

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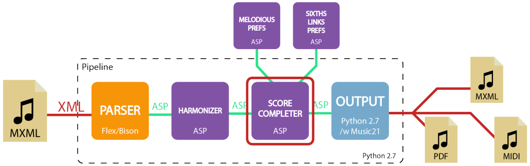

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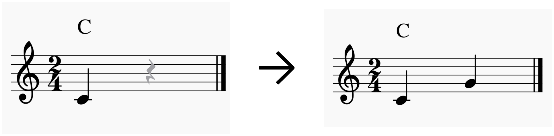
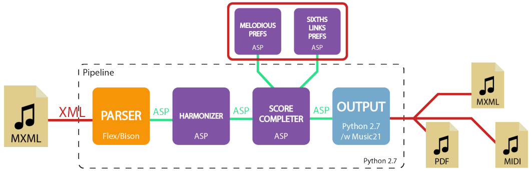
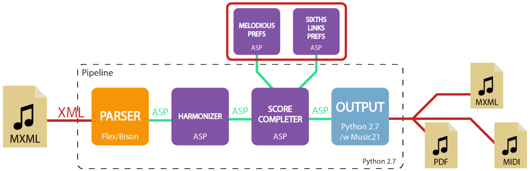


Melodious Preferences Modules



Despite not composing melodiously, haspie has modules that improve the melody

Melodious Preferences Modules



Despite not composing melodiously, haspie has modules that improve the melody

- Melodious Preferences:
  - Checks the tendency of the voices in the score and tries to imitate them
  - Reduces the melodic jumps between notes and the amount of repeated consecutive sounds
- Sixths Link:
  - Tries to find common progressions in choral music
  - If able, continues these common progressions of chords

User Configuration

ASP optimization:

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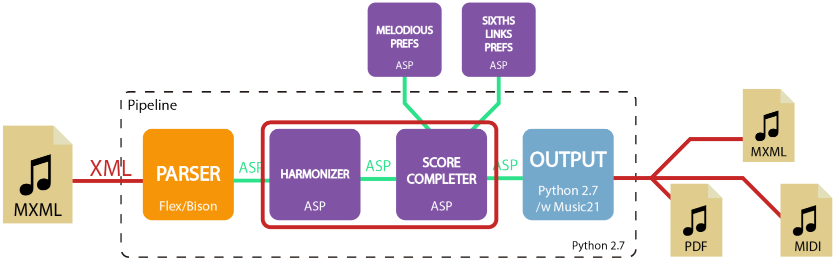
- The style of the resulting scores produced by the tool is determined by the optimization of many predicates
- These optimizations are weighted to be able to specify the significance of each of the measured predicates
- Users can define their own preferences by making use of configuration files

```
  #minimize[out_error(_,_) = chord_errorinstrongw
              @ chord_errorinstrongp].
  #minimize[same_chord(_,_) = chord_samechordw
              @ chord_samechordp].
  #minimize[out_error_weak(_,_) = chord_errorinweakw
              @ chord_errorinweakp].
```

haspie's Architecture



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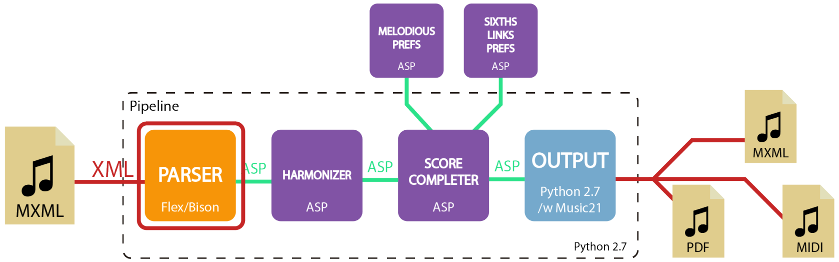

Parser and Preprocessor

- The project also included the development of a lightweight MusicXML parser
- Written in C with the libraries Flex and Bison
- Transforms the score in MusicXML to the ASP logic facts that the ASP module uses later

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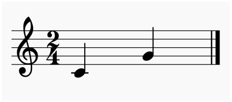
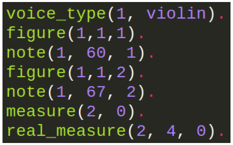
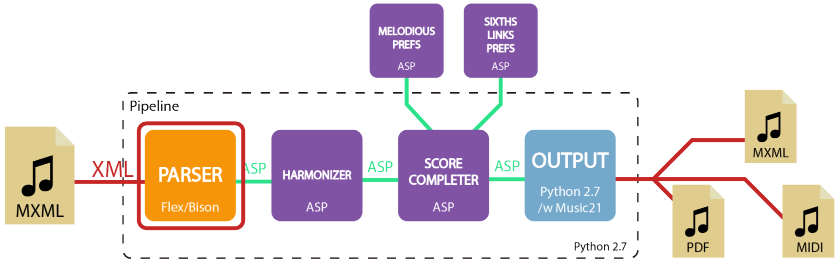
- Written in C with the libraries Flex and Bison
- Transforms the score in MusicXML to the ASP logic facts that the ASP module uses later
- Performs various tasks as:
    - Subdivides notes to the length of the smallest figure in the score
    - Detects most likely key from the score's clef
    - Reads measure sizes
    - Transforms chord names annotated on score to grades





```
voice_type(1, violin).
figure(1,1,1).
note(1, 60, 1).
figure(1,1,2).
note(1, 67, 2).
measure(2, 0).
real_measure(2, 4, 0).
```

haspie's Architecture



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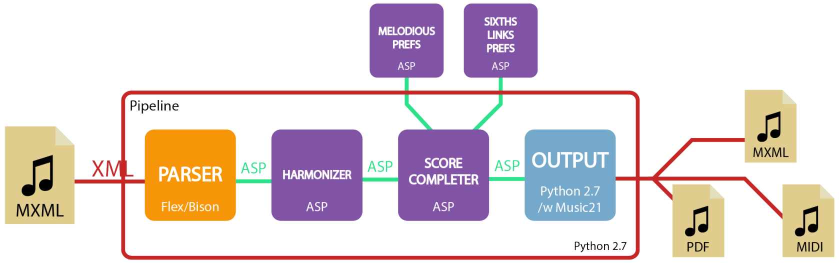
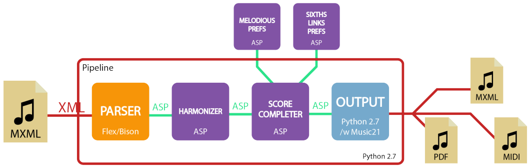


Pipeline & Output Module



- Written in Python with the toolkit Music21
- Gives feedback to the user and allows the selection of the desired solution
- Transforms the internal representation of the solution to a Music21 representation
- Some supported formats are Lilypond, PDF, Musescore, MusicXML or MIDI

Overview

Conclusions & Future Work

- About 200 ASP lines
- Good results in terms of harmony
- User still needs ASP knowledge to use it

Future Work:

- Improve output and correct representation mistakes
- Research about modulation and implement it in the tool
- Include rhythmic patterning in the new generated voices

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Source available at github.com/trigork/haspie

Thank you!