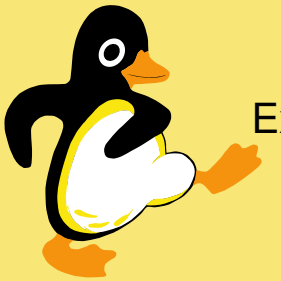

Experiments with Automatic Music-Composition

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Counterpoint

- Finds a counter voice to a given Melody
- “Cantus Firmus” is given, counter voice is Counterpoint or Contrapunctus
- Since the 14. Century in France and Italy
- Used for teaching: Improvisation and composition
- Well known Composers:
  - Giovanni Pierluigi da Palestrina (1525-1594)
  - Johann Sebastian Bach (1685-1750)
- Species counterpoint:
  very detailed rules organized in species
  (Johann Joseph Fux 1725)

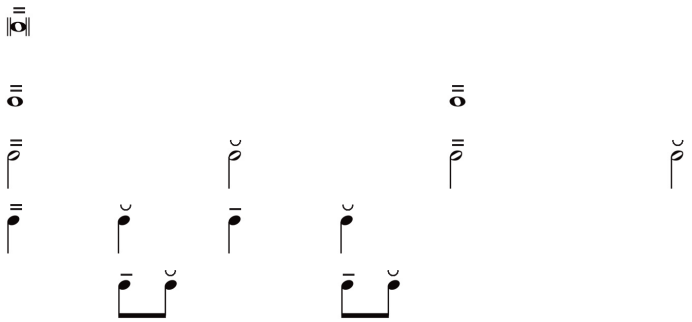
Counterpoint

- Wikipedia has some rules for the “Species Counterpoint”
- Species Counterpoint is only an example, there are other rule sets
- . . . e.g. with more than two voices
- Different rules for Cantus Firmus and for Counterpoint
- e.g. for Cantus Firmus only whole notes
- We distinguish rules for *melody* (temporal conditions) and rules for *harmony* (conditions among the two voices)

Counterpoint Rules

- Melody: “Contrary motion should dominate”
- Harmony: “Use no unisons except at the beginning or end”
- Combined harmony- und melody-checks:
  “Avoid moving in parallel fifth or octaves”
- Goal: Voices should be independent: In two voices
- For this there are rules about note lengths in a bar
- Different melody-rules for
  Cantus Firmus and Counterpoint
- Not yet implemented: Different rules at different beat positions

Beat positions heavy, half-heavy, light



= schwer
_ halbschwer
◡ leicht

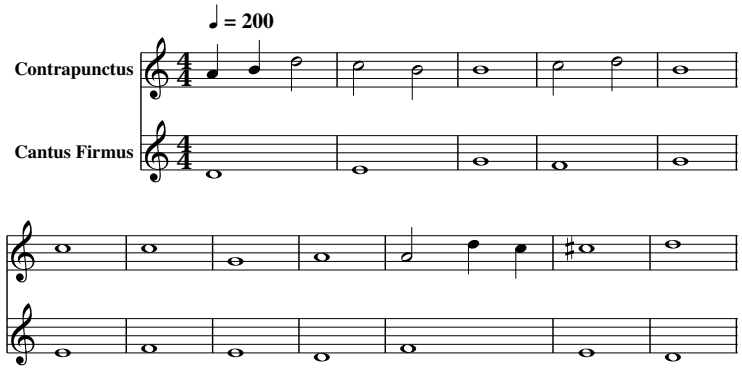
ABC-Notation

- Simple notation for music scores
- . . . with Open Source implementations
- Can generate printed music sheets
- Can generate MIDI
- Key-Value pairs describing the tune
- Notes A-G, next octave a-g, z for pause
- Higher tones with suffix(es) `'`, lower with suffix `,`
- appended length
- Accidentals `^G` or `_G`
- Bars represented with `|`
- . . . and a lot more we do not use

ABC-Notation

```
X: 1
M: 4/4
Q: 1/4=200
%%score (Contrapunctus) (CantusFirmus)
L: 1/8
V:CantusFirmus name="Cantus Firmus"
V:Contrapunctus name=Contrapunctus
K: DDor
[V:CantusFirmus] D8 |E8 |G8 |F8 |G8 |E8 |F8
    |E8 |D8 |F8 |E8 |D8 |
[V:Contrapunctus] A2 B2 d4 |c4 B4 |B8 |c4 d4
    |B8 |c8 |c8 |G8 |A8 |A4 d2 c2 |^c8 |d8 |
```


ABC-Notation



Software Features

- Simultaneous creation of Cantus Firmus and Counterpoint
- Optional: Specification of Cantus Firmus, creation of Counterpoint
- Several different rule-sets are possible, currently only one ad-hoc rule set
- Possible note-lengths in Counterpoint are currently hard-coded
- End-sequence is currently hard-coded

Constraint Satisfaction

- Constraint satisfaction problem (CSP)
- find assignment to variables so that all (or as many as possible) constraints are satisfied
- Difficult to solve analytically
- A solution is typically found with a search algorithm
- In the case of music there are *many* solutions
- . . . not all of them are equally “nice” or “good”
- . . . beauty is in the eye of the beholder

→ Future work

Search: Constraint Satisfaction

- Pitch represented as halftone (Integer)
- Melody constraints in a voice (can be different for Cantus Firmus and Counterpoint)
- Harmony-checks among the two voices
- Combined harmony and melody checks
- Search for an ideal combination of voices (or for given Cantus Firmus only the Counterpoint)
- Rules have a weight, we have *badness* and *ugliness*
- ugliness is “softer”

Search: Constraint Satisfaction

- Search for solutions with low weighted number of rule violations
- Search with evolutionary Algorithms (EA) (e.g. Genetic Algorithm, Differential Evolution)
- . . . or just with a depth first search
- Both search methods find different results
- . . . with naïve rules EA finds only whole notes for the counterpoint
- Depth first may not start backtracking or we will never find a solution due to timing constraints

Fuel for Discussion

- What constitutes a “good” melody?
- Does a melody become “better”
  - if we allow rule violations?
  - or even require them?

Software

- Packaged in Debian:
  - abcm2ps: Creates postscript from abc
  - abc2mid: Creates MIDI from abc
  - timidity: MIDI player
- Contrapunctus: github.com/schlatterbeck/contrapunctus
- Currently not a PyPi project yet

Contents