What constitutes a musical pattern?

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Background

- Musical patterns are diverse.
- Evaluation of pattern discovery algorithms is hard.

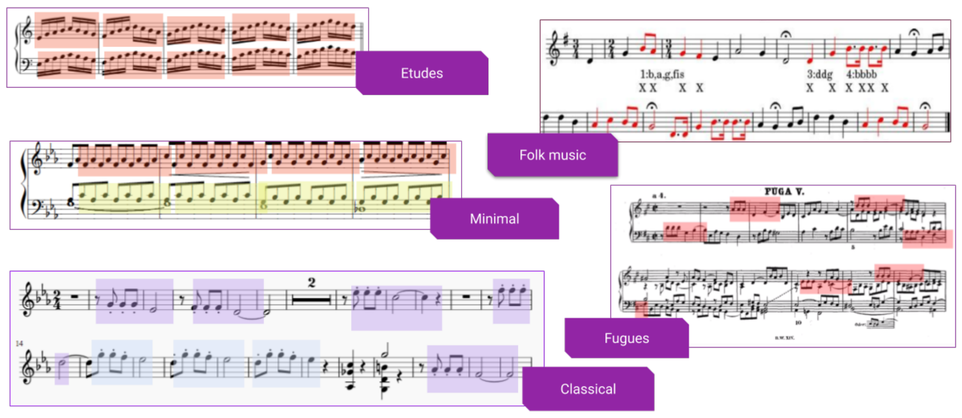


Figure 1: Patterns in music

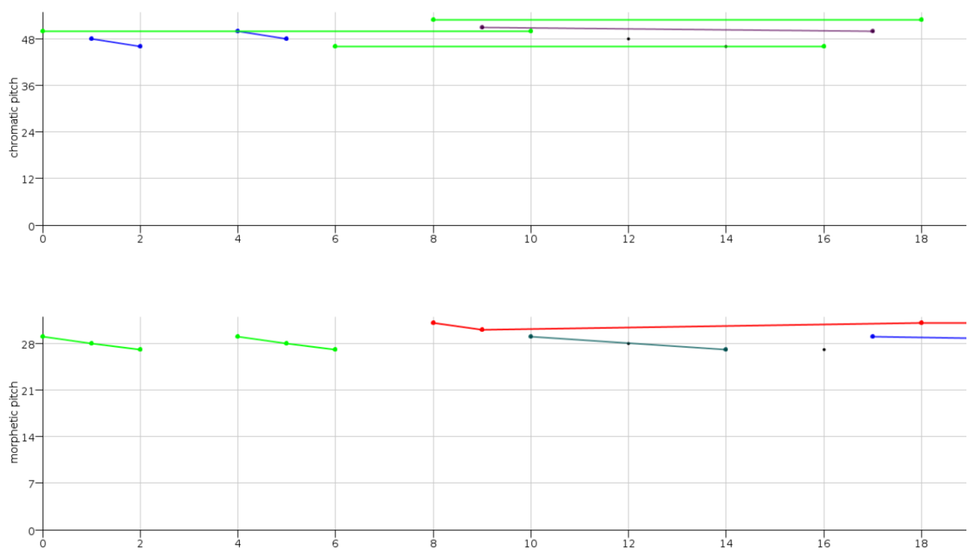
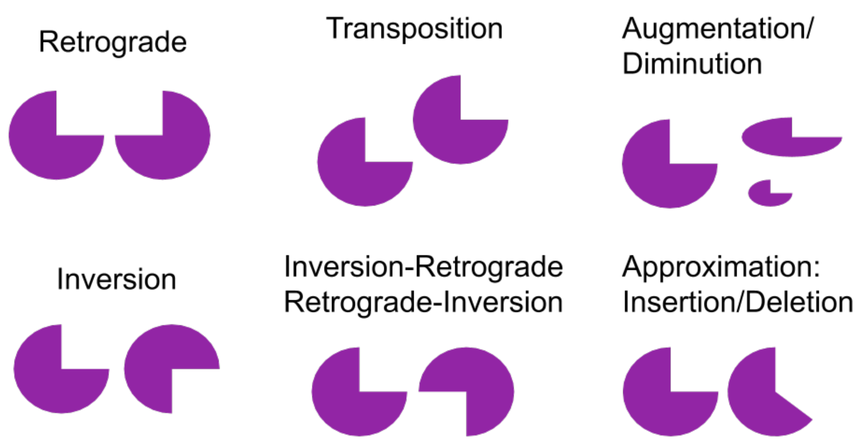


Figure 2: Same music, different algorithms discover different patterns

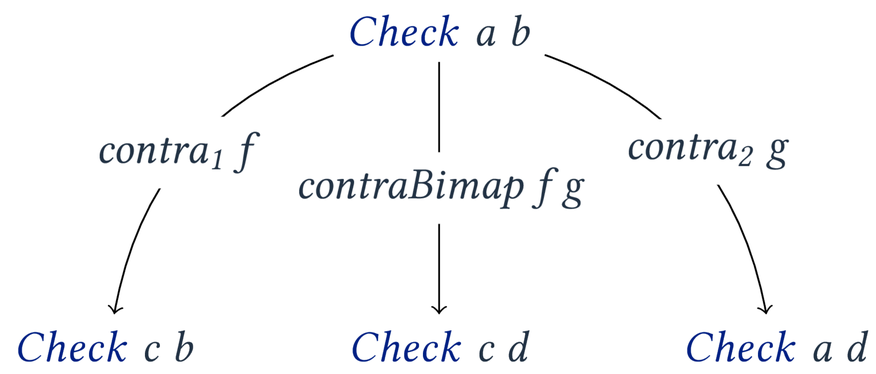
Musical Transformations

Taking a relative perspective, relate occurrences to each other via musical transformations: *Occurrence*1 <=> *Occurrence*2



Assembling checkers: Contravariant Bifunctor

```
checkBasedOnTime :: (Pattern -> Time) ->
  ↪  HomCheck Time -> HomCheck Pattern
```

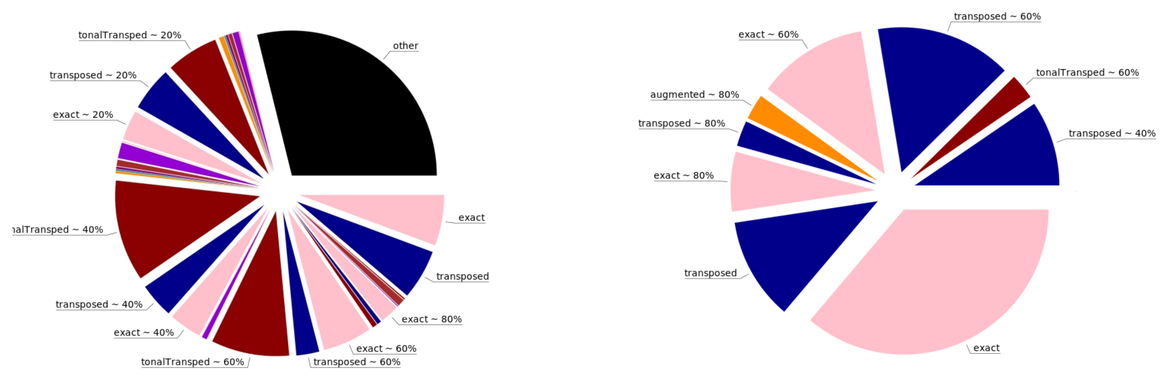


Implementation in Haskell

```
class ContravariantBifunctor p where
  contra1 :: (c -> a) -> p a b -> p c b
  contra1 f = contraBimap f id
  contra2 :: (d -> b) -> p a b -> p a d
  contra2 g = contraBimap id g
  contraBimap f g = contra1 f . contra2 g
instance ContravariantBifunctor Check where
  contraBimap f g p = (\ x y -> (f x <=> g y) p)
```

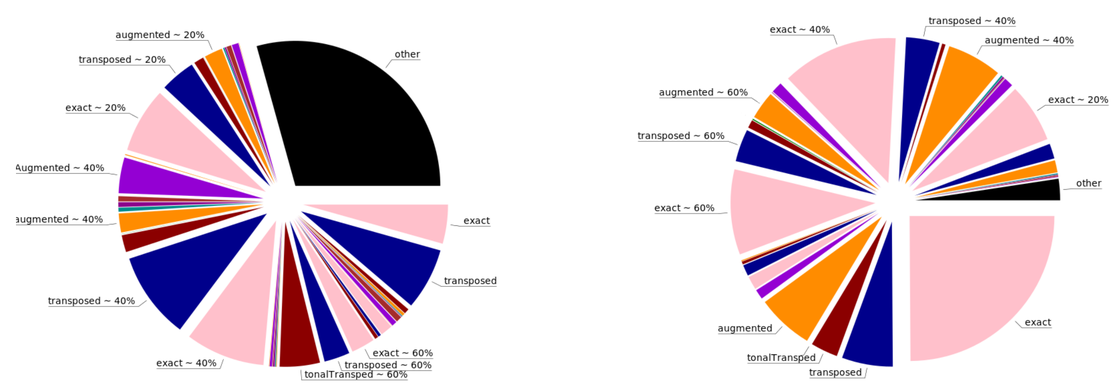
Results: Classical

Differences between human annotations and algorithmic results in a (mainly) classical music dataset (JKU-PDD).



Results: Folk

Differences between human annotations and algorithmic results in a Dutch folk song dataset (MTC-ANN).



Query and Discovery

Querying comes for free!

```
data UserQuery a = ToPattern a => Check Pattern :@ a
query1 :: UserQuery (Music Pitch)
query1 = (transpositionOf ~~ 0.5) :@ (line $ map ($qn) [c 4, e
 ↪  4, g 4, c 5])
query2 :: UserQuery (Time, Time)
query2 = (transpositionOf ~~ 0.5) :@ (21 `upTo` 28)
```

Conclusions

- Category theory and Haskell in modelling and implementing higher order comparison: compare occurrence relations using musical transformations.
- Implications for music:
  - Differences between musical pattern discovery algorithms and experts annotations.
  - Differences between different corpora.
- Useful pattern query/discovery tool:
  `https://github.com/omelkonian/hs-pattrans`

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