An analysis of the Mongeau-Sankoff algorithm for music information retrieval

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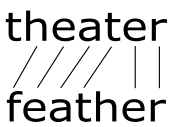
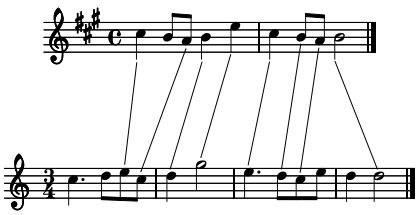
Sequence comparison

To determine the similarity (or dissimilarity) between two sequences, we can count the minimum number of transformations needed to obtain the second sequence from the first one. Allowed transformations typically include insertion, deletion and replacement.



In this example, the dissimilarity between the sequences is 3. The measure we just applied is an edit-distance measure.



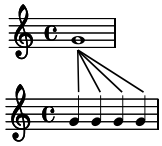
Trace linking two melodies.

The Mongeau-Sankoff measure

The Mongeau-Sankoff measure adapts these concepts to the comparison of musical sequences. A melody or tune is represented as a sequence of (pitch, duration) pairs.

The cost of an operation depends on the pitch difference of the notes involved in the operation, and on the duration difference.

Example of a fragmentation



Mongeau and Sankoff define two new kinds of transformation, that apply specifically to music: fragmentation and consolidation.

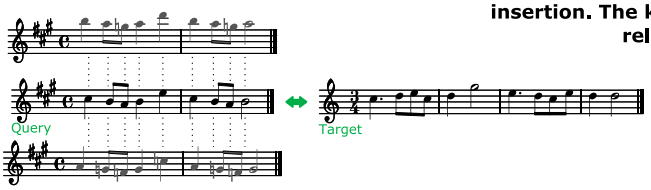
Proposed approach

We apply three variations to the measure in order to adapt it to the context of music information retrieval.

1. The measure is evaluated with all the possible transpositions of the query with respect to the target.
2. The weight associated to intervals is a distance function.
3. A parameter is added to the measure to represent the relative weight of the operations.

$$w(a_i, b_j) = w_{\text{interval}}(a_i, b_j) + k_1 w_{\text{length}}(a_i, b_j)$$
$$w(a_i, \varnothing) = k_3 L(a_i)$$
$$w(\varnothing, b_i) = k_3 L(b_i)$$

Weight formulas of substitution, deletion and insertion. The k_3 parameter allows to vary the relative weight of the operations.



A query and all its meaningful transpositions with respect to a target.

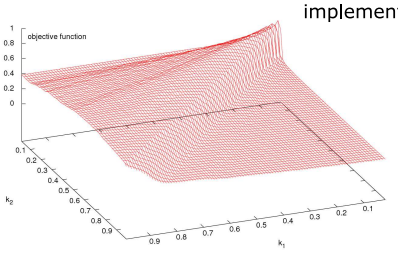
Experimental study

Parameter optimization

The optimal parameters were determined using exhaustive search, with the test collection from the MIREX 2005 Symbolic Similarity task.

Alignment	k_1	k_2	k_3	Objective
Local*	0.32	0.26	0.64	0.6138
All-to-some*	0.46	0.22	1.00	0.6417
Local	0.36	0.24	-	0.5919
All-to-some	0.57	0.34	-	0.5962
Global	0.78	-	-	0.5420

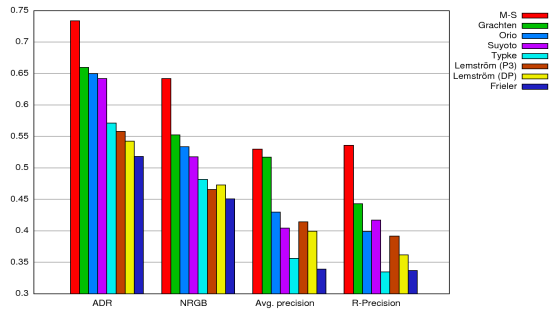
Parameter determination. *These configurations implement variation 3.



Optimization surface for the local alignment configuration.

Evaluation

We evaluated the quality of the measure with the MIREX 2005 evaluation collection.



Comparison of Mongeau-Sankoff to the MIREX 2005 results.

Alignment	ADR	NRGB	Average Prec.	R-Prec.	Total time
Local*	0.7337	0.6422	0.5298	0.5361	6.882
All-to-some*	0.6940	0.6044	0.4734	0.4817	5.893
Local	0.6763	0.6046	0.4601	0.4800	6.251
All-to-some	0.6720	0.5771	0.4420	0.4501	5.444
Global	0.6486	0.5586	0.4364	0.4369	5.494

Evaluation.*These configurations implement variation 3.

Music engraving by LilyPond.