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MIRZEX

MIREX 2014: Discovery of Repeated Themes & Sections

A Wavelet-Based Approach to the Discovery of Themes and Sections in Monophonic Melodies

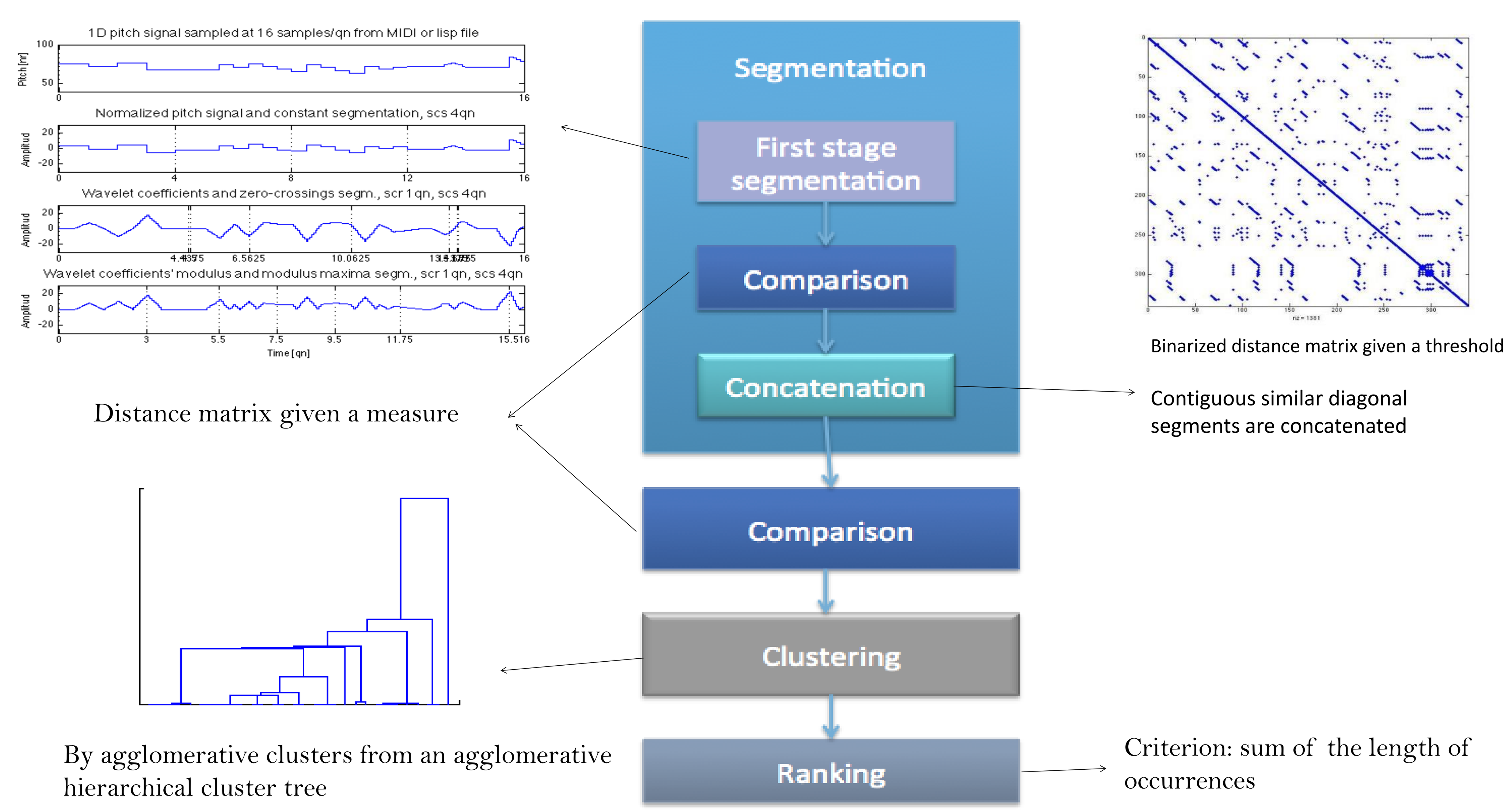
Gissel Velarde & David Meredith

The idea

- With a good melodic structure in terms of segments, it should be possible to gather similar segments into clusters and rank their salience within the piece. (See 'paradigmatic analysis' [3])

The Method

- The method follows and extends our previously reported approach to melodic segmentation and classification based on filtering with the Haar wavelet [4].
- The method uses the idea of "window connectivity information" from [2].



Results

- On the JKU Patterns Development Database monophonic version [1]
  - Training set: J. S. Bach, Fugue BWV 889, Beethoven's Sonata Op. 2, No. 1, Movement 3, Chopin's Mazurka Op. 24, No. 4, Gibbons's Silver Swan, and Mozart's Sonata K.282, Movement 2.
  - Test set: 5 pieces

Submission	Piece	n_P	n_Q	P_est	R_est	F1_est	P_occ (c=.75)	R_occ (c=.75)	F1_occ (c=.75)	P_3	R_3	F1_3	Runtime (s)	FFTP_est	FFP	P_occ (c=.5)	R_occ (c=.5)	F1_occ (c=.5)	P	R	F1
VM1 training	**mean**	**6.20**	**7.00**	**0.84**	**0.89**	**0.86**	**0.75**	**0.89**	**0.81**	**0.70**	**0.75**	**0.71**	**23.01**	**0.77**	**0.68**	**0.67**	**0.87**	**0.75**	**0.31**	**0.32**	**0.31**
	SD	2.59	0.00	0.17	0.07	0.12	0.15	0.11	0.12	0.19	0.10	0.14	10.34	0.11	0.14	0.15	0.09	0.12	0.26	0.22	0.23
VM1 test	**mean**	**8.20**	**7.00**	**0.70**	**0.80**	**0.73**	**0.49**	**0.81**	**0.60**	**0.54**	**0.47**	**0.49**	**100.80**	**0.67**	**0.48**	**0.45**	**0.75**	**0.56**	**0.17**	**0.16**	**0.16**
	SD	3.42	0.00	0.21	0.09	0.14	0.10	0.04	0.09	0.20	0.10	0.14	119.18	0.16	0.25	0.08	0.08	0.07	0.16	0.17	0.15
VM2 training	**mean**	**6.20**	**7.00**	**0.76**	**0.80**	**0.77**	**0.82**	**0.78**	**0.78**	**0.66**	**0.68**	**0.67**	**4.87**	**0.63**	**0.60**	**0.72**	**0.71**	**0.72**	**0.03**	**0.03**	**0.03**
	SD	2.59	0.00	0.17	0.11	0.13	0.09	0.20	0.13	0.19	0.17	0.17	1.51	0.06	0.18	0.12	0.18	0.15	0.06	0.06	0.06
VM2 test	**mean**	**8.20**	**6.40**	**0.65**	**0.63**	**0.63**	**0.60**	**0.58**	**0.57**	**0.53**	**0.42**	**0.46**	**20.29**	**0.50**	**0.44**	**0.46**	**0.61**	**0.52**	**0.06**	**0.07**	**0.06**
	SD	3.42	0.89	0.16	0.12	0.10	0.36	0.37	0.33	0.20	0.12	0.14	15.99	0.14	0.23	0.14	0.09	0.09	0.09	0.09	0.09

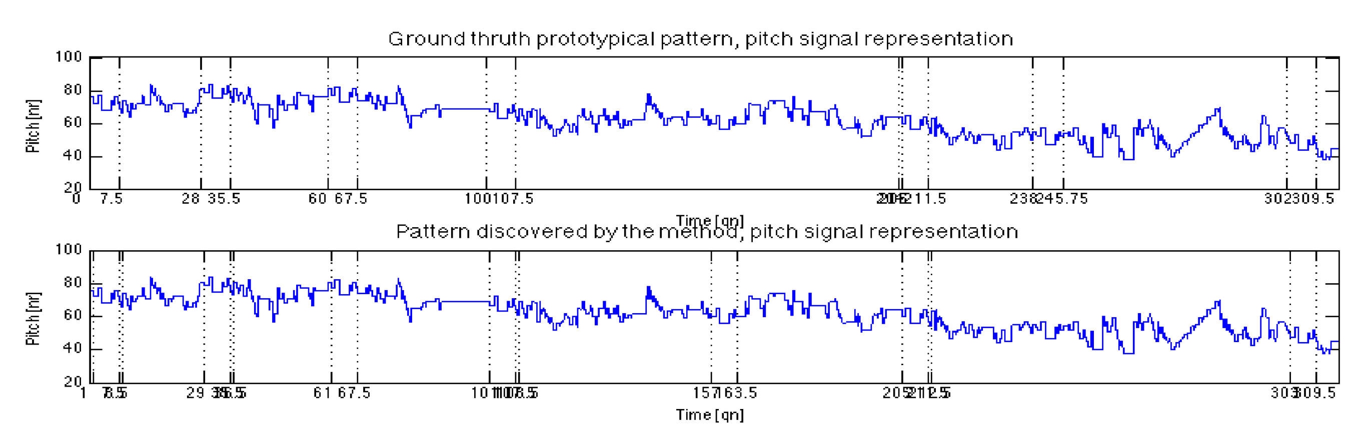
Training

Three Layer F1, ($\chi^2(1)=1.8$, $p=0.1797$): ->No significant difference
Standard F1, ($\chi^2(1)=4$, $p=0.045$): ->VM1 preferred
Runtime, ($\chi^2(1)=5$, $p=0.0253$): ->VM2 preferred

Test

Three Layer F1, ($\chi^2(1)=0.2$, $p=0.6547$): ->No significant difference
Standard F1, ($\chi^2(1)=3$, $p=0.0833$): ->No significant difference
Runtime, ($\chi^2(1)=5$, $p=0.0253$): ->VM2 preferred

Example: Bach's Fugue BWV 889 prototypical pattern



Submissions VM1 and VM2

For both submissions the parameters are: melodies sampled at 16 samples per quarter note (qn), Distance for both comparisons: city-block, Number of clusters: 7, Ranking criterion: Sum of the length of occurrences. VM1 differs from VM2 in the following parameters:

VM1	VM2
- Normalized pitch signal representation, - Constant segmentation at the scale of 1 qn, - Threshold for concatenation 0.1.	- Wavelet coefficients representation filtered by Haar at the scale of 1 qn - Modulus maxima segmentation at the scale of 4 qn - Threshold for concatenation 1

Conclusions

Our novel wavelet-based method performed better on the training than in the test dataset. This is difficult to study since we do not have access to the test dataset. For training and test datasets VM1 and VM2 show no significant difference in the results of the "three-layer" F1 score. On the other hand, for discovering exact occurrences, the difference between VM1 and VM2 becomes smaller in the training dataset and therefore it is suggested that there is no significant difference in the results of VM1 and VM2. However, there is a statistically significant difference in the runtime, suggesting that VM2 should be preferable for fast computation.

References

[1] T. Collins. Mirex 2014 competition: Discovery of repeated themes and sections, 2014. http://www.music-ir.org/mirex/wiki/2014:Discovery_of_Repeated_Themes_%26_Sections. Accessed on 12 May 2014.

[2] K. Jensen, M. Styczynski, I. Rigoutsos and G. Stephanopoulos: "A generic motif discovery algorithm for sequential data", Bioinformatics, 22:1, pp. 21-28, 2006.

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[4] G. Velarde, T. Weyde and D. Meredith: "An approach to melodic segmentation and classification based on filtering with the Haar-wavelet", *Journal of New Music Research*, 42:4, 325-345, 2013.

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