

Indexing Music Collections through Graph Spectra



Università degli Studi di Milano

by Alberto Pinto*, Reinier H. van Leuken, M. Fatih Demirci,
Frans Wiering, Remco C. Veltkamp

Department of Information and Computing Sciences - Universiteit Utrecht (The Netherlands) and
* Dipartimento di Informatica e Comunicazione - Università degli Studi di Milano (Italy)

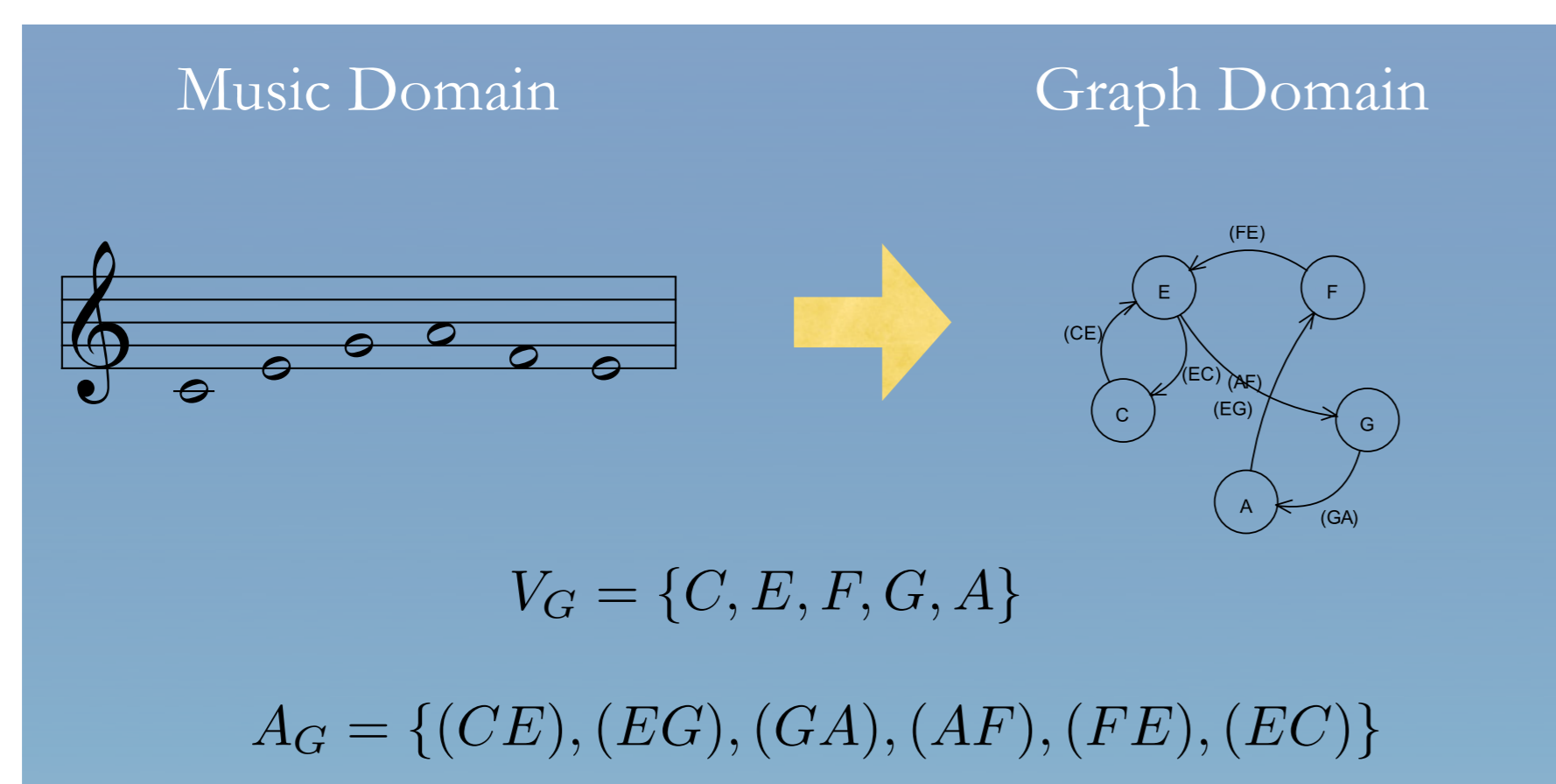
pinto@ dico.unimi.it, {reinier, mdemirci, Frans.Wiering, Remco.Veltkamp}@cs.uu.nl



Universiteit Utrecht

1 Graph Representation

- Pitch classes are mapped into graph nodes
- Intervals are mapped into graph arrows

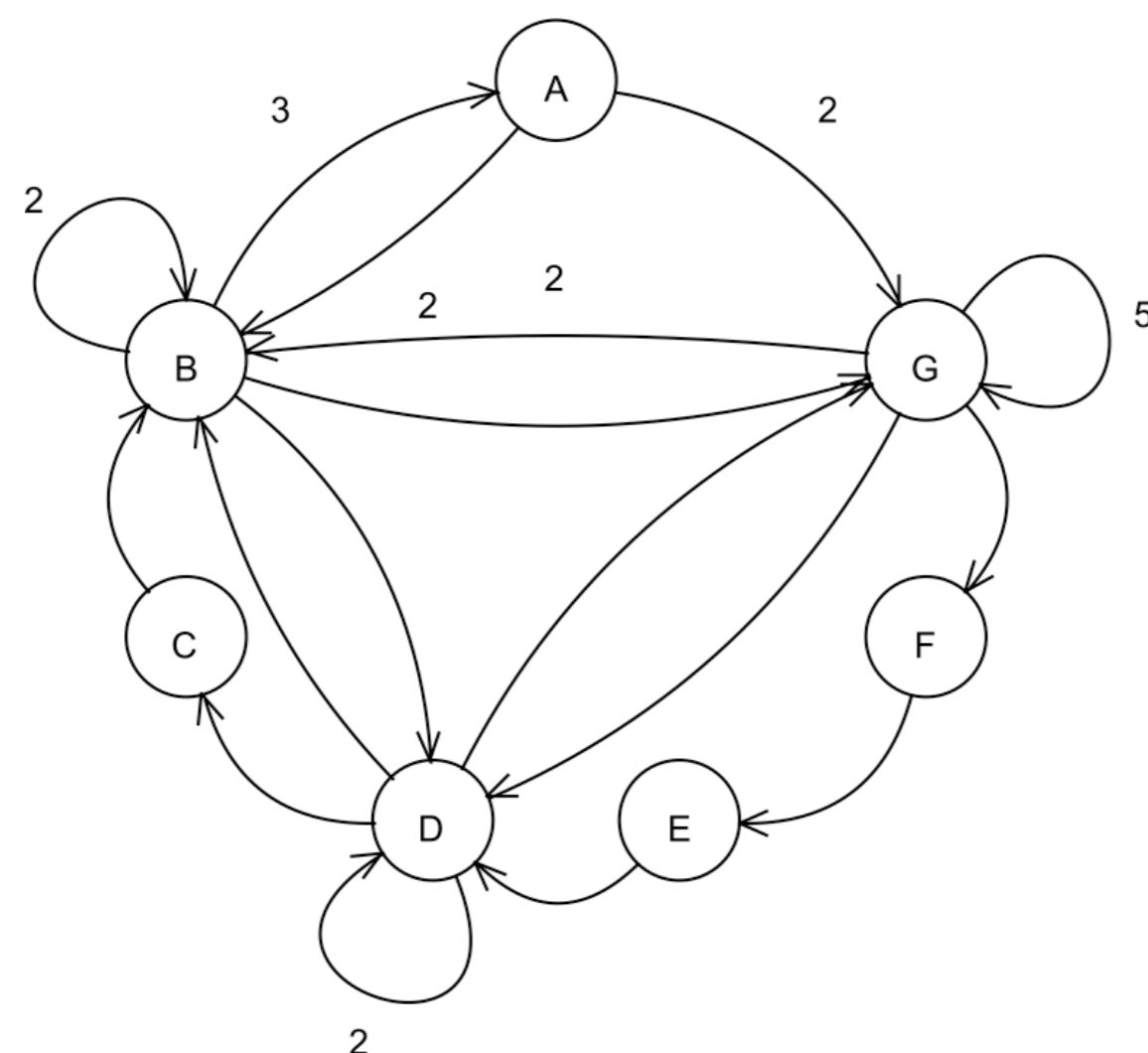


Graph representation of a melodic fragment.

1.1 Example



An instance of the folk song "In Frankrijk buiten de poorten" (2nd version), OGL19306-2.



Graph representation of the folk song OGL19306-2 shown here above.

2 Indexing

Algebraic structures are associated to the graph:

- Adjacency matrix $A(G)$
- Laplacian matrix $L(G) = D(G) - A(G)$

The topology of a graph is encoded through its Laplacian spectrum Λ .

$$L(G) = P\Lambda P^T \text{ where } \Lambda = \text{diag}(\lambda_1, \lambda_2, \dots, \lambda_{|V|})$$

2.1 Computing similarity

To compute the similarity between two graphs G_1 and G_2 , we compute the Euclidean distance between their signatures, which is inversely proportional to the structural similarity of the graphs.

$$d(G_1, G_2) = \sqrt{\sum_{i=0}^n (\Lambda_1(i, i) - \Lambda_2(i, i))^2}$$

3 Experiments

Test corpus: "Onder de groene linde", a large collection of Dutch folk songs.

- Experiments conducted on a subset of this resource, that consists of 141 songs, of which we used the first phrase.
- These songs have been classified in 18 classes or melody groups.

CRITERIA	NN	1 st tier	2 nd tier
LAPLACIAN	66%	44%	63%
ADJACENCY	58%	28%	48%
OPTI3	40%	39%	56%
EMD	64%	33%	50%
PTD	64%	30%	46%

Nearest neighbour (NN), first tier and second tier results on the *Onder de groene linde* collection, computed using Laplacian spectra and Adjacency spectra of the graphs.

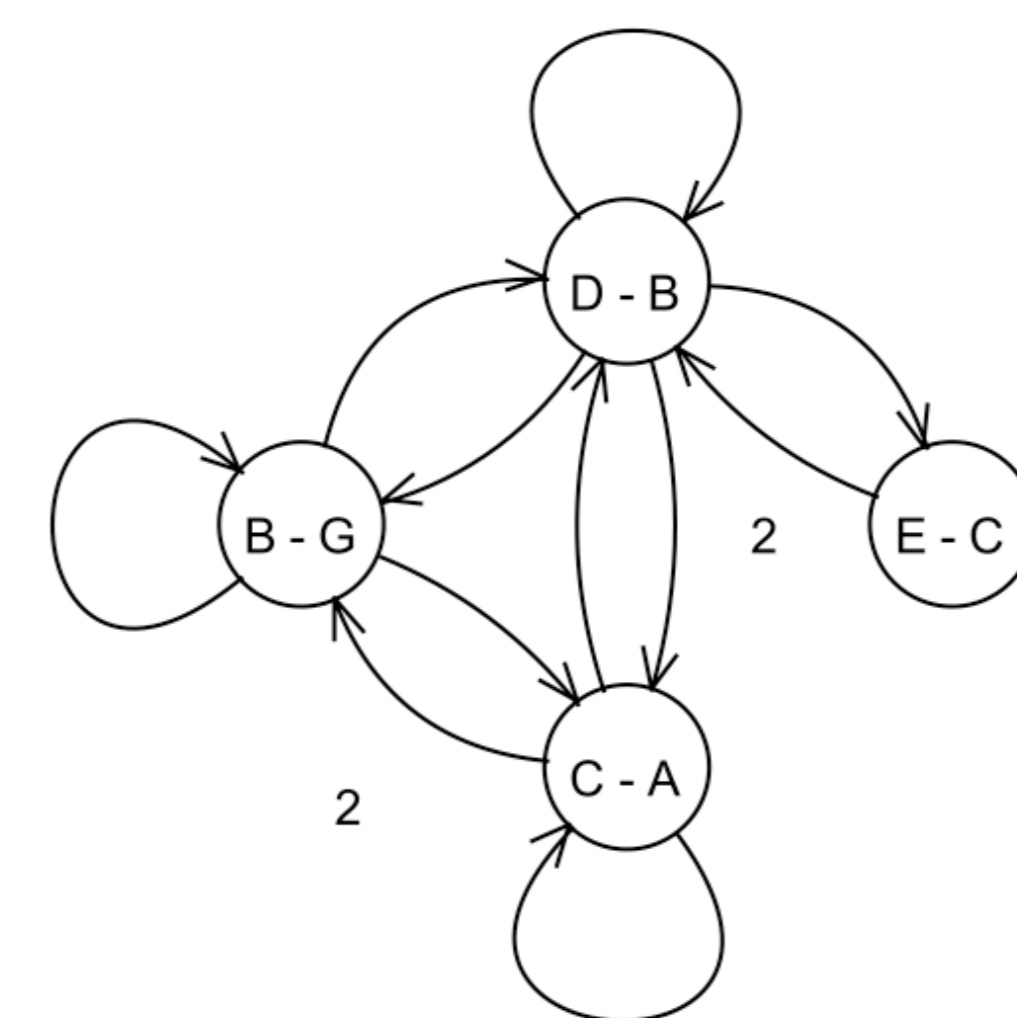
The results have been compared to the following melodic similarity measures:

- the optimal distance measure established by Müellensiefen and Frieler (Opti3)
- the Earth Mover's Distance (EMD)
- the Proportional Transportation Distance (PTD)

3.1 Example of structurally similar songs



Example of songs with similar structure: "Heer Halewijn" (3rd version) OGL19205 with its NN, OGL19107, instance of "Heer Halewijn" (4th version).



Graph representation of the folk songs OGL19205 and OGL19107 (without the eigenloop on B) shown here above. The two letters in each circle represent the pitch classes respectively in the first and in the second song.



PROFI

ISMIR 2007, Vienna, Austria

23-27 September 2007 - Vienna University of Technology



WITHCRAFT