(Un)Like Schumann: Applying Cope's Music Signature Pattern Matching Algorithms to Tchaikovsky's "Children's Album"

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Abstract

This work refers to a preliminary study looking into **applying pattern matching algorithms working with music signatures** to the "Children's Album" by Pyotr Tchaikovsky*.

Though music signatures introduced by Cope** are usually used for author identification and computer music generation, we make an effort to use them for **analysis of origins and links of the existing compositions**. We take Tchaikovsky's "Children's Album" as an interesting case, where we can try to apply the computational models to resolving the questions, which are usually mostly in scope of musicology studies.

TCHAIKOVSKY
1840 – 1893

Though the studies of rich metaphors hidden in the musical compositions*** lay mostly in scope of art and musicology, there is still large space for formal methods based on mathematical models and computer technology that can be helpful in discovering complementary insights to how the composition is structured, what are its relationships to the precursors' works, and how it affects the later works of the same or other authors.

Specifically, our experiments demonstrate that one can find only a few Schumann signatures in the pieces from the "Children's Album", in contradiction to the Tchaikovsky's note in the published version claiming the imitation of Schumann's approach. Thus, our **experimental results can provide additional important insights for musicologists searching to unravel the possible reasons of significant transformations that occurred on the way from the accurately organized manuscript to the first published edition**. The previous studies addressing this issue are mostly in the scope of music theory, with almost no involvement of computational approaches to music analysis.

Techniques based on formal mathematical methods and computer technology, though being unable to completely resolve these issues, bring new data to the discourse of musicology and art.

* P. Tchaikovsky (1878) Children's Album. Op 39. *Yurgenson.*
** D. Cope (1989) Experiments in musical intelligence (EMI): Non-linear linguistic-based composition. *J. of New Music Research, 18(1-2)*, 117–139.
*** *Presentation contains the links to mp3 audio samples of the music compositions by Tchaikovsky and Schumann performed (though not perfectly) and recorded by Evgeny Pyshkin on his Yamaha digital piano and processed using Logic Pro 10.6.3 software.*

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Introduction: Phenomenon and Studies of Pyotr Tchaikovsky's "Children's Album"*

- In our earlier work*, in the scope of a conceptualization of the analysis of Pyotr Tchaikovsky's "Children's Album" (Op. 39), an **approach based on David Cope's signatures** is sketched as a promising way to help musicologists in resolving a number of riddles posed by Tchaikovsky in his famous cycle of 24 piano pieces thought to be for children.

- The analysis of possible sources, metaphors, and renditions of this masterpiece originally published as far as in 1878 by Yurgenson, still remains a constant topic of interest for researchers**.

  - A challenging question: can we completely accept the author's claim that the compositions from the "Children's Album" are a form of imitation of Schumann's Pieces for the Youth***, even with respect to the **subtitle** appeared in the first published edition by Yurgenson.

  - Interestingly, such a subtitle is missing in the manuscript, though the latter is a fascinating example of the accurately presented and organized hand-written work.

ROBERT & KLARA SCHUMANN
1810 – 1856   1819 – 1896

* E. Pyshkin (2021) Towards demystifying transformations of Tchaikovsky's Children's album with support of computational models: Problem conceptualization. *Proc. ADVCOMP-2021*, 6–10.
** See references [5][6][27][28] in the conference paper.
*** R. Schumann (1848) 43 Clavierstücke für die Jugend. *Schuberth and Co.*

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Music Signatures as Small Stylistic Patterns

- D. Cope defined a **signature as a short sequence of contiguous intervals** found in more than one work by the same composer*.

- The idea of signature is to represent a **composition-independent pattern**, which does not sound as an excerpt from a particular work, but rather represents a characteristic description of one of composer's style elements.

- **Signatures portray patterns combining melody, harmony and rhythm information**, with possible transformations of interval, pitch, rhythm and voice exchange. Even transformed, the patterns can still be recognized by ear.

- Pattern matching methods based on signature elicitation can be applied to authorship identification, along with other known approaches**. However, **signatures are not only helpful for authorship attribution**, but also for in-depth analysis of music compositions to discover the characteristics of style, their genesis, and their development.

Chopin. Nocturne in B Major, Op. 36 No.2 (1837) (a)

Chopin. Nocturne in B Major, Op. 36 No.2 (1837) (b)

Chopin. Nocturne in C Sharp Minor, Op. posth. (1830) (c)

Chopin. Waltz in A Flat Major, Op. 34 No. 1 (1838) (d)

* D. Cope (1991) Computers and musical style. Oxford University Press.
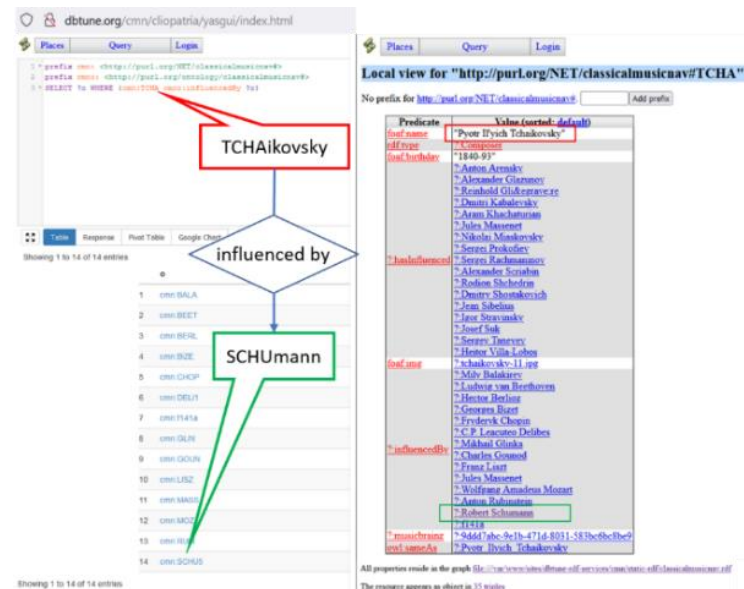** See references [13] – [21] in the conference paper,

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Relationships to Works of Schumann and Others: Case Study*

- Admitting Schumann's influence to Tchaikovsky does not lead us to automatically judge the "Children's Album" as an imitation of Schumann's pieces for the young (also with long history of editions but rather few scholarly studies**)

Schumann op 68	Tchaikovsky Op 39
Melody Humming Song	Mama (3)
Soldier	March of Wooden Soldiers (5)
Chorale	Morning Prayer (1) In Church (23)
The Wild Horsman	Toy Horse Play (4)
Sicilienne	Old French Song (16)
First Loss	The Doll is Sick (7) Old French Song (16)
The Reaper's Song	Italian Song (15)
Echoes from the Theatre	Waltz (9)
Sheherazade In Memoriam	Sweet Dream (21)

http://dbtune.org/cmn/

- Case Study Goals
  - In the process of study, we need to investigate, what are the suitable computational approaches that may contribute to style identification.
  - Applying the signature elicitation software to obtain new data showing the links between the compositions from "Children's Album" and the works of other composers that influenced the style of Tchaikovsky.

* Revised slide from the ADVCOMP-2021 presentation.
** B. R. Appel (2014) Actually, taken directly from family life: Robert Schumann's Album fur die Jugend. Princeton University Press, 171–202.

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Signature Elicitation: Experiment at a Glance

The signature discovery process was organized using the software we developed based on Cope's algorithms adapted to the present-day standard music analysis tools available in numerous Python libraries such as Music21.

1. In each single composition, find the patterns appearing 5 to 12 times. These patterns are considered as signature candidates.

2. Collect the candidates across the different available works of the given composer.

3. From the complete list of collected patterns, eliminate the patterns that do not appear often enough (i. e., in less than 10% of all the analyzed works of the same composer).

4. Compare the found patterns against the patterns of different composers and eliminate the patterns, which are frequently used by other composers, as such patterns that appear to characterize the epoch rather than a particular composer's style.

TABLE I. SIGNATURES FOUND IN TCHAIKOVSKY'S "CHILDREN'S ALBUM"

Composer	Acronym	Signatures (including variations)	Compositions
Tchaikovsky	TCH	19	13
Haydn	HAY	20	8
Beethoven	BEE	9	8
Mozart	MOZ	8	7
Vivaldi	VIV	13	5
Bach	BAC	1	1
Schumann	SCH	5	3

TABLE II. SIGNATURE DISTRIBUTION

| No.	TCH	HAY	BEE	MOZ	VIV	BAC	SCH	Total
1					1			1
2	1		1	1				3
3	1						2	3
4	1		1					2
5								0
6	1	1			1			3
7			1					1
8		1						1
9	1	3	1	2	2			9
10				1				1
11	1			1		1		3
12		1					1	2
13			1					1
14	4			1				5
15			1	1				2
16		1						1
17		3	2					5
18		9	1	1	3			14
19	3							3
20								0
21	2							2
22	1				6		2	9
23	1							1
24	3							3
All	19	20	9	8	13	1	5	75
All*	18	11	8	7	4	1	3	52

* excluding No. 18 and No. 22, where disproportionately big number of signatures of one composer is found compared to others

● TCHaikovsky ● SCHumann ● VIValdi

Figure 5. Repeating patterns in No. 22 "Lark's Song".

Bottom Line Quick Analysis

- Schumann **signature variations** are only found in 3 compositions:
  - No. 3 "Mama" (2 cases)
  - No. 12 "Russian song" (quite surprisingly perhaps), and
  - No. 22 "Lark's Song" (2 cases).

- We can also see that in all these cases the characteristic signatures of Schumann appear along with other signatures, particularly, in No.22, when, in addition to those of Schumann, we discovered 7 signatures of other composers.

- From the experiments with the signature database, we learned that the recognition rate for particular composers is unstable and ranges between around 50% to 80% . Even if we acknowledge that some unique Schumann signatures were missed due to the imperfectness of automatic signature elicitation process, we can still argue that **compared to other discovered signatures, there is a very low number of Schumann's cases**.

- **Though**, in concordance with Cope's definition, **an imitation of style does not assume appearance of signatures of the imitated composers, their very rare occurrences provide a rationale for disputing the possibility for deliberate imitation of Schumann's style by Tchaikovsky.**

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Discussion: Towards Analysis of Structural Transformations of "Children's Album"

- The question of attributing Tchaikovsky's masterpiece as an imitation of Schumann is important as a part of the broader challenge: to approach possible explanations on **why we find so many disruptive transformations in the first published edition compared to the so accurately prepared manuscript.**

- If we can provide a good rationale for understating the author's claim on imitation, we can also call into question the meaningfulness (or rather meaninglessness) of those transformations destroying the structure of the album as an indissociable whole, and deforming the micro-cycles and internal links existing in the manuscripts.
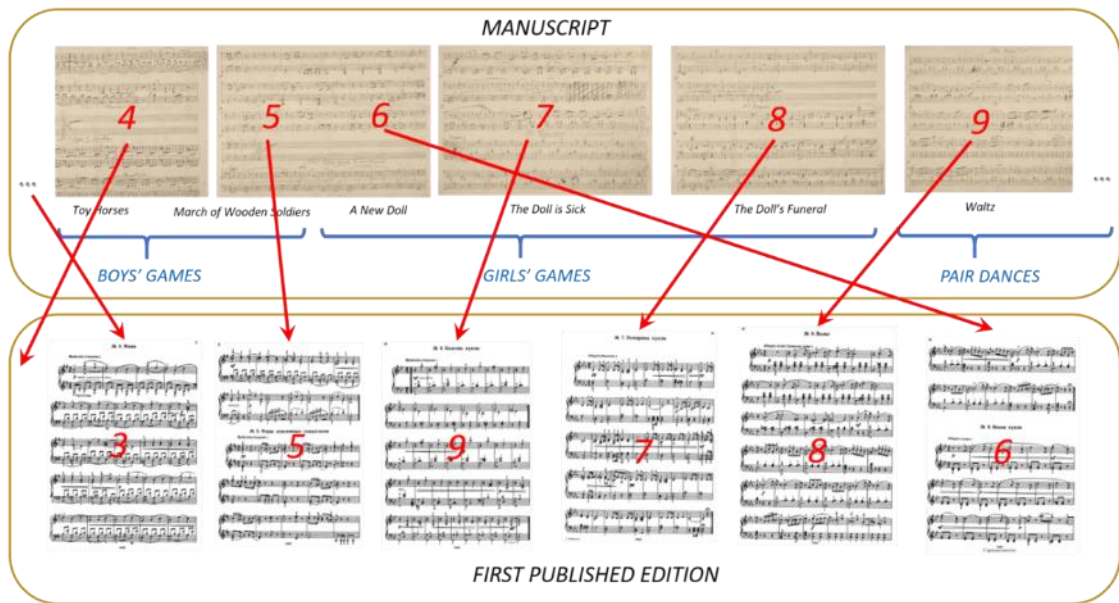
- **Micro-cycles** in "Children's Album" (original order – examples)
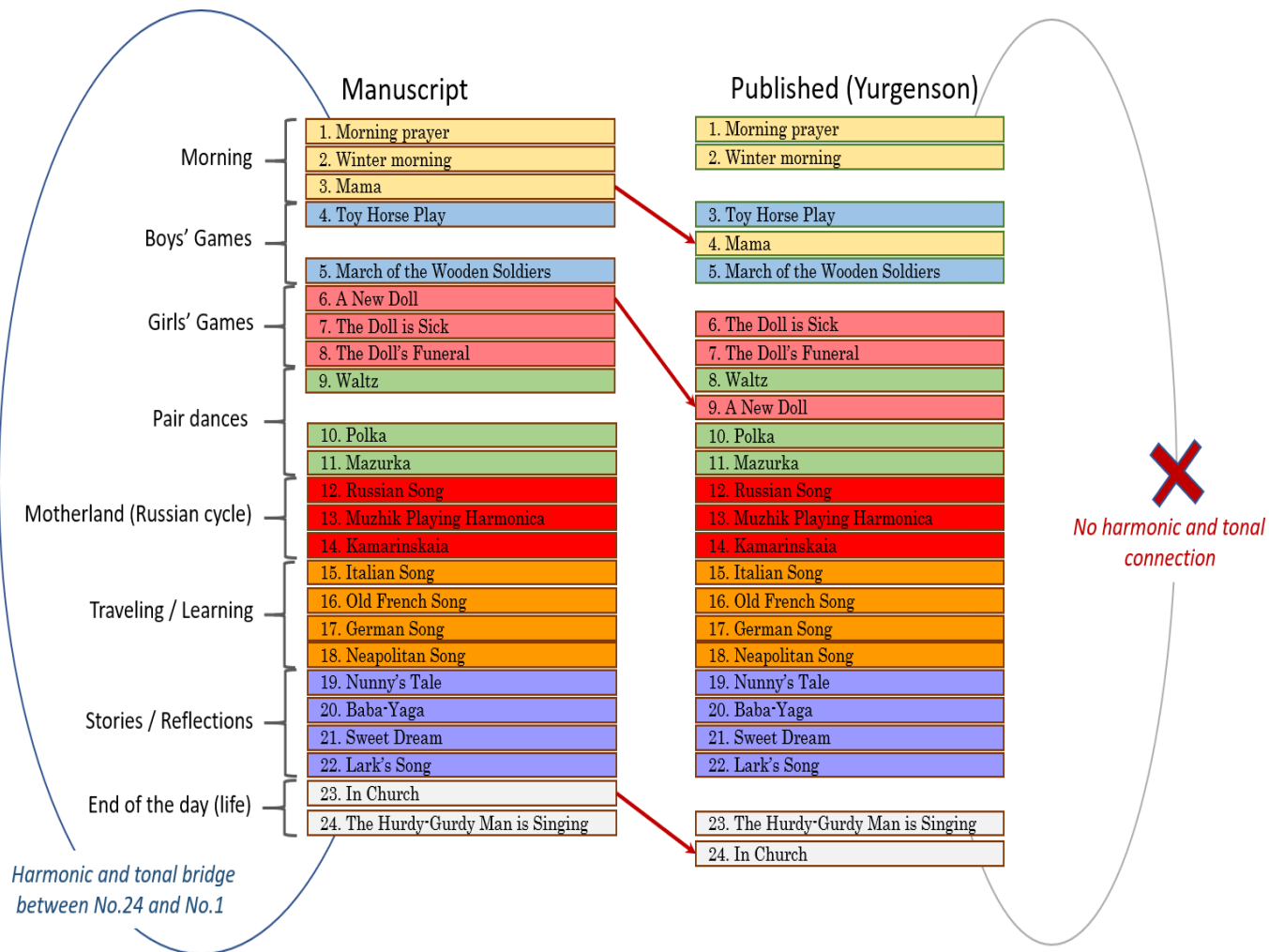 - Morning/Birth
    - 1. Morning Prayer
    - 2. Winter Morning
    - 3. Mama   *Perhaps O.k. ☺…*
  - Boy's Games
    - 4. Toy Horse Play
    - 5. March of Wooden Soldiers
  - Girl's Games
    - 6. A New Doll
    - 7-8. The Doll is Sick and The Doll's Funeral
  - Pair Dances
    - 9. Waltz
    - …   *???…*

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Techniques incorporating the formal mathematical methods and computational approaches could not (fortunately) completely resolve the above-mentioned questions; however, they could produce a number of important additional insights to the problems usually addressed exclusively from the musicology and human science positions.

Manuscript

Published (Yurgenson)

Morning
1. Morning prayer
2. Winter morning
3. Mama
4. Toy Horse Play

Boys' Games

5. March of the Wooden Soldiers

Girls' Games
6. A New Doll
7. The Doll is Sick
8. The Doll's Funeral
9. Waltz

Pair dances
10. Polka
11. Mazurka

Motherland (Russian cycle)
12. Russian Song
13. Muzhik Playing Harmonica
14. Kamarinskaia
15. Italian Song

Traveling / Learning
16. Old French Song
17. German Song
18. Neapolitan Song

Stories / Reflections
19. Nunny's Tale
20. Baba-Yaga
21. Sweet Dream
22. Lark's Song

End of the day (life)
23. In Church
24. The Hurdy-Gurdy Man is Singing

Published (Yurgenson):
1. Morning prayer
2. Winter morning
3. Toy Horse Play
4. Mama
5. March of the Wooden Soldiers
6. The Doll is Sick
7. The Doll's Funeral
8. Waltz
9. A New Doll
10. Polka
11. Mazurka
12. Russian Song
13. Muzhik Playing Harmonica
14. Kamarinskaia
15. Italian Song
16. Old French Song
17. German Song
18. Neapolitan Song
19. Nunny's Tale
20. Baba-Yaga
21. Sweet Dream
22. Lark's Song
23. The Hurdy-Gurdy Man is Singing
24. In Church

Harmonic and tonal bridge between No.24 and No.1

No harmonic and tonal connection

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Conclusion

The results we obtained from our preliminary experiments are very interesting, though not sufficient, and need to be reexamined after extending the dataset with respect to the following important types of input:

- Compositions with expected high degree of style similarity, which were attributed by their authors as imitations; and
- Characteristic compositions (e.g., by Tchaikovsky), where style similarity was reported by musicology experts.

The discussed **signature elicitation models do not oppose an idea to use machine learning approaches** to music style identification. On the one hand, we already mentioned a number of deep learning methods suggested by different researchers for author identification and style recognition. These models often work with the input represented in the form of spectrograms.
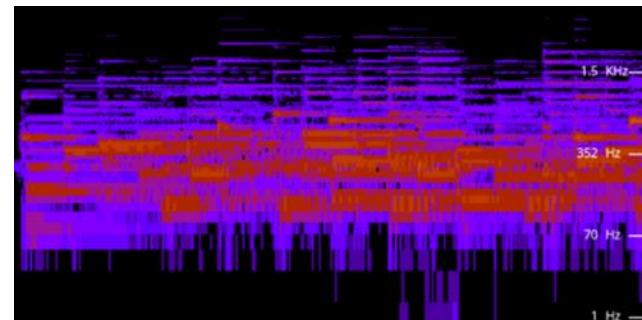
"The hurdy-gurdy man is singing" spectrogram

We admit that playing with pattern matching settings and further adjustments of the signature elicitation algorithms might affect the specific signature scores we obtain from these algorithms. However, our preliminary experiments demonstrate that the relative distribution of signatures between different composers does not fluctuate too heavily upon the changes in pattern matching controlling parameters; thus, making our qualitative judgements well-reasoned, though not conclusive.

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