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Michele Della Ventura, *editor*

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Preface

This volume of proceedings from the conference provides an opportunity for readers to engage with a selection of refereed papers that were presented during the International Conference on New Music Concepts, Inspired Education and New Computer Science Generation. The reader will sample here reports of research on topics ranging from a diverse set of disciplines, including mathematical models in music, computer science, learning and conceptual change; teaching strategies, e-learning and innovative learning, neuroscience, engineering and machine learning.

This conference intended to provide a platform for those researchers in music, education, computer science and educational technology to share experiences of effectively applying cutting-edge technologies to learning and to further spark brightening prospects. It is hoped that the findings of each work presented at the conference have enlightened relevant researchers or education practitioners to create more effective learning environments.
This year we received 57 papers from 19 countries worldwide. After a rigorous review process, 24 paper were accepted for presentation or poster display at the conference, yelling an acceptance rate of 42%. All the submissions were reviewed on the basis of their significance, novelty, technical quality, and practical impact.

The Conferece featured three keynote speakers: Prof. **Giuditta Alessandrini** (Università degli Studi Roma TRE, Italy), Prof. **Renee Timmers** (The University of Sheffield, UK) and Prof. **Axel Roebel** (IRCAM Paris, France).
I would like to thank the Organizing Committee for their efforts and time spent to ensure the success of the conference. I would also like to express my gratitude to the program Committee members for their timely and helpful reviews. Last but not least, I would like to thank all the authors for they contribution in maintaining a high-quality conference and I hope in your continued support in playing a significant role in the Innovative Technologies and Learning community in the future.

March 2020

Michele Della Ventura

Conference Chair

Michele Della Ventura, Accademia Musicale Studio Musica, Treviso, Italy

Keynote Speakers

Giuditta Alessandrini, Università degli Studi Roma TRE, Italy
Renee Timmers, The University of Sheffield, UK
Axel Roebel, IRCAM Paris, France

International Scientific Committee

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Computational assistance leads to increased outcome diversity in a melodic harmonisation task.

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Abstract. This paper investigates the potential influence on human creativity resulting by the use of a creativity support tool in the music making domain. CHAMELEON is a computational melodic harmonisation assistant that is capable of harmonising given melodies according to a variety of harmonic idioms and/or their blends. This can offer human users the opportunity to explore a number of different -and potentially novel- solutions for a melodic harmonisation task. An experiment was conducted to evaluate possible effects both at the level of products (i.e., harmonisations) and at the level of user experience (i.e., questionnaires) as a result of interaction with CHAMELEON. Results indicated an increase in the harmonic diversity of the obtained harmonisations as well as an increase in the outcome satisfaction as a result of computational assistance.

Keywords. Creativity evaluation, creativity support tools, musical harmony

1 Introduction

Creativity support tools aim to enhance the creativity of humans in a variety of activities. Such tools can range from simple objects (e.g., a chisel for enhancing creativity in sculpture) to more complex systems of representation (e.g., the Western musical notation system for enabling sophisticated music creation). During the last decades there has been a rapid emergence of software applications for facilitating creative processes in science, engineering or the arts. Examples include very popular platforms such as Google Docs for collaborative writing, Final Cut for video editing, Photoshop for image processing, SPSS for statistical analysis and so on. Naturally, depending on the task and the extent to which it is deemed creative or not, such systems can be instead called productivity support tools. For example, a typesetting system such as LaTex maybe be deemed a creativity support tool for writing a novel but merely a productivity support tool for putting together the proceedings of a scientific conference. In many cases, such systems aim to enhance both the creativity and the productivity of their users at the same time.

Productivity is much better defined and measured in contrast to creativity which is an abstract construct. Performance, time and error rates are some of the standard metrics used for productivity measurement [1]. At the same time, research on creativity evaluation has also identified a number of components (e.g., originality, domain competence, value, divergence, etc.) upon which creativity, be it human or computational, can be assessed [2]. However, whereas scientific attempts to quantify and evaluate creativity have been ongoing for at least a couple of decades, the evaluation of creativity support tools is generally regarded a more recent field of research [3]. Usual approaches of study are the assessment of user experience utilising a framework of psychometric variables tailored for each task (e.g., [3] and [3]), the assessment of the artifacts that the users create through a panel of expert judges [5] or both [6].

This study constitutes an evaluation of CHAMELEON's contribution to a melodic harmonisation task that belongs to the latter category. CHAMELEON [7] is a melodic harmonisation assistant, that is a creativity support tool in the domain of music making. It is able to harmonise a given melody according to a number of different harmonic idioms and/or their blends. It does so by combining a generative implementation of the Conceptual Blending theory with statistical learning [7]. As a result, CHAMELEON, is capable of presenting a variety of diverse 'solutions' –some of which can also be rather unexpected– for melodic harmonisation at the push of a button.

The main hypothesis of this work is that this available diversity may potentially influence the perspective of a human user that performs a melodic harmonisation task. It is assumed that an on-demand stimulation of a user with a variety of a melodic harmonisation implementations may translate to a more explorative behavior from his/her side. To test this hypothesis, we designed an experiment where users performed a simple melodic harmonisation followed by a computationally supported melodic harmonisation on two similar melodies. The divergence of the produced harmonisations for each task was quantified using a number of idiom-independent harmonic similarity metrics. The user experience was also evaluated through post-task questionnaires that targeted to quantify the influence of a creativity support system in the manner of [4] and [3].

2 Method

Experiment

The experimental procedure comprised two phases. In phase one, participants were asked to harmonise the melody of a Greek traditional folk song called "Menexedes kai Zoumboulia" in minor mode (see Figure 1). Twenty-five participants, which were either students at the School of Music studies of the Aristotle University of Thessaloniki or experienced music composers, were asked to place chords at the positions indicated by arrows (i.e., harmonic rhythm was fixed) and to use satisfaction of personal preference as the sole criterion for their harmonisation, even at the cost of not conforming to standard harmonic rules. Voice leading was not at the center of this study therefore participants were advised to omit it in order to save time. In the second phase, participants were similarly asked to harmonise a melody of a folk lullaby from Southern Italy in minor mode (see Figure 1). The selected melodies for both experimental phases were very similar in terms of melody, rhythm and implied harmony.

Fig. 1. The two melodies used in the harmonisation task. The upper one was used for the simple harmonisation and the lower one was used for the computationally assisted harmonisation. Arrows indicate the requested harmonic rhythm.

TABLE I: GENERAL METRICS AND CORRESPONDING QUESTIONS OF THE POST-TASK QUESTIONNAIRE.

Metric	Question No.	7-point likert statement	
		Simple Harmonisation	**Computationally supported harmonisation**
Enjoyment	Q1	-	I would be interested to use CHAMELEON in the future
Expressive-ness	Q2	The harmonisation of a given melody gave me the opportunity to be creative	The use of CHAMELEON gave me the opportunity to be creative
	Q3	I was able to express my ideas	I was able to express my ideas
Outcome satisfaction	Q4	I am satisfied with my harmonisation	I am satisfied with my harmonisation
Ease of use	Q5	The process of harmonisation was easy	The process of harmonisation was easy
	Q6	-	The use of CHAMELEON was easily comprehensible
Collabora-tion	Q7	-	CHAMELEON provided me with some good ideas
	Q8	-	CHAMELEON provided me with some good solutions that I could not have reached myself
Ownership	Q9	I feel that the harmonisation belongs to me 100%	I feel that the final harmonisation belongs to me 100%
Exploration	Q10	-	The contact with CHAMELEON offered me a different harmonisation perspective
Immersion	Q11	I was able to maintain concentration on my task	The use of CHAMELEON helped me maintain concentration on my task
Productivity	Q12	I was productive	CHAMELEON affected my productivity positively

The directions regarding harmonic rhythm and voice leading were identical with phase one. However, this time participants were additionally presented with CHAMELEON and they were prompted to explore its capability to offer various harmonisations on this particular melody. After offering a short demonstration of the CHAMELEON's use, the experimenter made clear that the extent to which participants should exploit the solutions offered by CHAMELEON for their own harmonisations would be totally up to them. It was particularly stressed that it would be fine to even completely ignore CHAMELEON's output.

Each participant submitted one melodic harmonisation for each phase. For the computationally assisted harmonisation task they were additionally free to submit up to four example harmonisations produced by CHAMELEON which may had attracted their interest or even potentially influenced their own harmonisation. In addition to creating the harmonisations, participants filled in a post-task questionnaire to assess their experience for each phase. Table I resents the specific questions and the general metric categories according to [3] and [4].

Idiom-independent harmonic similarity metrics
The differences between harmonisations in the two phases were measured using Pitch Class Profiles (PCPs), General Chord Type (GCT) [8] and the isolated type component of GCTs (without root information). Specifically, features were developed, using the aforementioned components as follows:

1. *Shannon Information Entropy of the PCP*: PCP information has proven efficient for categorising music according to style [9]. The Shannon Information Entropy (SIE) of the PCP of each harmonisation was computed, as an indication of the plurality in chromatic content that the composers employed.
2. *Common GCTs*: the number of unique GCTs employed in a harmonization, as an indicate of the plurality in the harmonic pallet employed therein.
3. *Common chord types*: as above but restricted to the type component of the GCTs. This metric incorporates the types or "qualities" of the chord labels – e.g., in jazz guitar-style chord notations, whether a X7 or a Xm7 chord is included in the harmonisation under investigation.

3 Results

The 25 obtained harmonisations for both phases of the experiment were analysed using the three harmonic similarity metrics presented above. The distribution of the values failed to pass the Shapiro-Wilk normality test (at significance level p=.05) in five out of six cases. Therefore, we employed the non-parametric Wilcoxon signed-rank test, which does not assume data normality, to examine whether differences between the medians of the distributions are statistically significant. Table 1 shows the results of the test indicating that all differences are significant indeed. This means that when computationally supported, the participants produced harmonisations containing more chord types, more roots (based on the number of GCTs metric) and more uniformly distributed pitch classes (as indicated by the increased SIE of PCP). Figure 2 complements the above analysis by showing the boxplots of the scores on these metrics for each condition. It should be noted that the implied harmonies of the two melodies feature almost identical harmonic similarity metrics with 'Menexedes kai Zoumboulia' featuring an additional seventh chord that does not exist in the 'Lullaby' (number of GCTs = 4 vs. 3, number of chord types = 3 vs. 2 and Shannon information entropy = 1.775 for both). Therefore, the increased diversity observed in the produced harmonisations can not be attributed to a more diverge implied harmony in the 'Lullaby' melody.

TABLE II: RESULTS OF THE WILCOXON SIGNED-RANK TEST OF THE MEAN DISSIMILARITIES BETWEEN THE SIMPLE AND THE COMPUTATIONALLY SUPPORTED HARMONISATIONS.

Metric	z	r	p value	Median difference
No. of GCTs	-3.7	-.52	>.001	-3
No. of chord types	-2.9	-.41	.002	-2.4
Shannon inf. entropy	-3.8	-.54	>.001	-.17

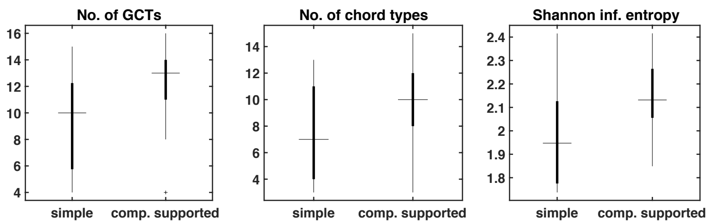

Fig. 2. Boxplots of the metrics of the obtained harmonisations for both the simple melodic harmonisation task and the computationally supported version.

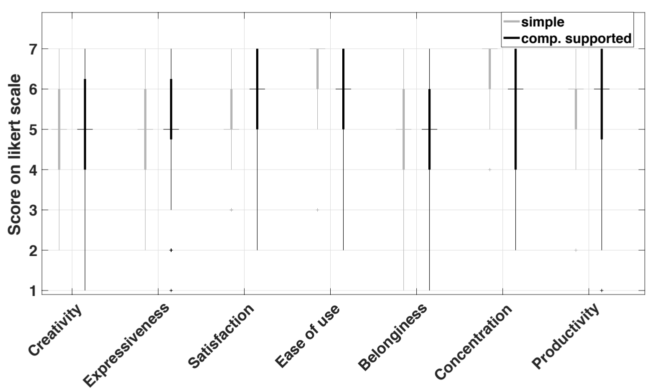

Fig. 3. Boxplots of the seven common questions of the post-task questionnaire for the simple and the computationally supported melodic harmonisation.

Figure 3 shows the boxplots concerning the seven common questions between the two tasks of the experiment (non-supported and supported melodic harmonisation). All the questions feature median values that exceed 5 for both tasks, which indicate at least medium agreement with all the statements appearing in Table I. Three out of the seven statements are significantly differentiated between the two conditions. According to the non-parametric Wilcoxon signed-rank test (due to lack of normality among the variables), participants found the process more demanding ($z = 2.5$, $r = .35$, $p = .013$, median difference = 1) and had a harder time keeping concentration ($z = 3.2$, $r =.45$, $p < .001$, median difference = 1) when using CHAMELEON but seemed to be more satisfied with their harmonisation when computationally supported ($z = -2.03$, $r = -.33$, $p = .042$, median difference = -1). This concurs with the completion times recorded for both phases which show that the computationally supported task took on average more time to complete ($z = -3.3$, $r = -.46$, $p = .01$, median difference = -15 minutes).

4 Discussion

This work presented an experiment aimed to evaluate the CHAMELEON harmonisation assistant as a creativity support tool. To this end, human users performed a melodic harmonisation task both without any external support and with the contribution of CHAMELEON. The evaluation consisted of comparing both between the end products of the two conditions and between the user experiences.

The products (i.e., harmonisations) were assessed computationally without the involvement of any human expert. The results indicated that the use of CHAMELEON led to harmonisations containing more diverse chord types and pitch classes although the implied harmony of the two different melodies was equally diverse. That is to say, given these two melodies as originating points, one would have no reason to expect a difference in the diversity of the harmonisations produced. Therefore, it can be assumed that the increase in harmonic diversity observed was due to interaction with CHAMELON. At this point, one design limitation of this study has to be acknowledged. The order by which these tasks were performed was not randomised, having the computationally assisted condition always succeeding the simple harmonisation. This was because it would not make sense to request from the users to perform a simple harmonisation after stimulating them with the wealth of solutions produced by CHAMELEON. In this case, the outcome would be most likely affected by their interaction with the computational system and could certainly not be called ‘simple’. Hence, there is always a possibility that the increased harmonic diversity observed regarding the outcome of the second task could be attributed to this fixed ordering.

However, the behaviourally acquired data indicate that our participants dedicated more time and effort in the computationally supported task which would not be expected had they been assigned a merely quite similar task lacking the computational support. This might seem like a sign of reduced productivity introduced by the use of CHAMELEON. On the other hand, it is reasonable that a more explorative approach should come at some cost, whereas the increased outcome satisfaction in the second condition combined with the production of more complex harmonisations overall seem to justify the extra effort invested.

5 Acknoweldgements

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This book presents a collection of selected papers that present the current variety of all aspect of the research at a high level, in the fields of music, education and computer science. The book meets the growing demand of practitioners, researchers, scientists, educators and students for a comprehensive introduction to key topics in these fields. The volume focuses on easy-to-understand examples and a guide to additional literature.

Michele Della Ventura, editor

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