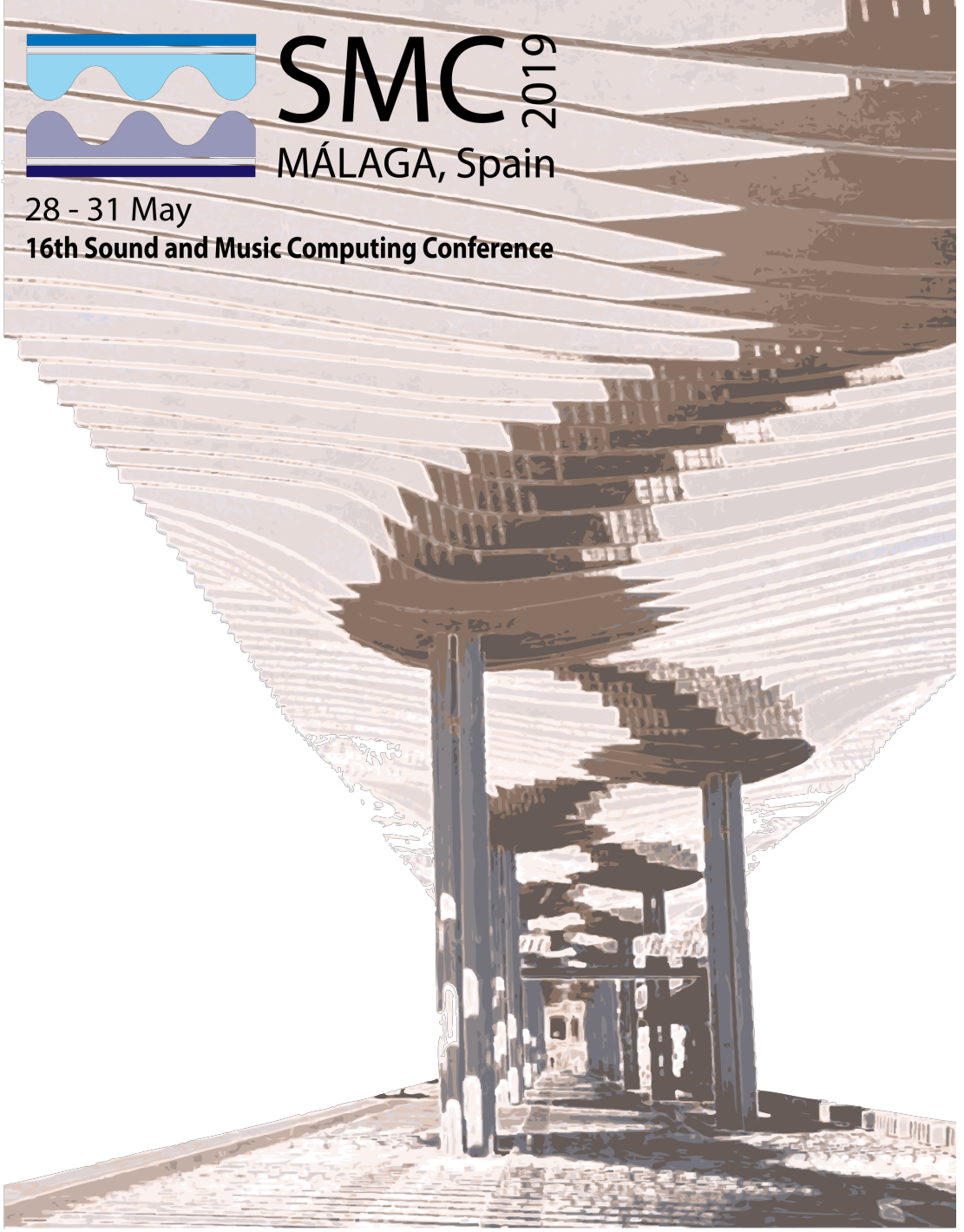

Program and Abstracts

SMC 2019

Program and Abstracts of the 16th Sound & Music Computing Conference

May 28 - 31, 2019
Málaga, Spain

SMC 2019 is organized by

ATIC Research Group
Universidad de Málaga

Website: *http://smc2019.uma.es*

Program and Abstracts of the
16th Sound & Music Computing Conference
SMC 2019

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ORGANIZATION

GRUPO DE APLICACIÓN DE LAS
TECNOLOGÍAS DE LA INFORMACIÓN
Y COMUNICACIONES

UNIVERSIDAD
DE MÁLAGA

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Contents

Welcome

Welcome to the **16th Sound & Music Computing Conference** (SMC 2019) and welcome to Málaga. The Application of Information and Communication Technologies Research group (ATIC) of Universidad de Málaga (UMA) is honored to organize this international conference. At the moment of writing this document, there are 150 people registered for SMC 2019 from 28 different countries (Australia, Austria, Canada, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, India, Ireland, Israel, Italy, Jamaica, Japan, Norway, Portugal, Republic of Korea, Singapore, Spain, Sweden, Switzerland, Taiwan, The Netherlands, UK and USA).

SMC 2019 takes place from 28 to 31 May 2019 and around this main conference two other important activities are worth to mention:

- The SMC 2019 associated Summer School from May 25-28, 2019.
- The First International Day of Women in Inclusive Engineering, Sound and Music Computing Research (WiSMC 2019) on May 28, 2019.

In addition to all this, the SMC participants will also have the opportunity to enjoy and contribute to a great Music Program and an awesome Social Program.

The **SMC 2019 Scientific & Music Program** includes:

- Three Keynote Talks by three magnificent speakers: Prof. Elvira Brattico, Dr. Anja Volk and Prof. Mark Sandler.
- Eight Oral Sessions.
- Three Poster Sessions.
- Three Demo Sessions.
- Three Music Sessions.

A very important part in any conference is networking. SMC 2019 will offer a great opportunity for that in a relaxed atmosphere thanks to its **Social Program** that includes:

- A Welcome Reception on Tuesday, May 28, where SMC 2019 participants will enjoy some typical Malaga Folklore and a nice cocktail.
- A Concert on Wednesday, May 29, at Sala Unicaja de Conciertos María Cristina.
- A Gala Dinner on Thursday, May 30, at "Los Patios de Beatas".

We want to thank the sponsors: Universidad de Málaga, FAST, Audio-Technica, Applied Sciences, Nordic SMC and Fundación Unicaja for their contribution to the conference and the collaborators Málaga Convention Bureau and Ayuntamiento de Málaga.

Special thanks to all the members of the SMC 2019 Conference Committee: Program Chairs, Summer School Chair, Music Chairs, Demo Chair, Local Committee and Program Committee. It has been a pleasure to work with all of them: Stefania Serafin and Federico Avanzini have been really efficient not only with the Scientific Program, but also with many other aspects related to the organization of SMC; Romain Michon has made a great job helping with the organization of the Summer School; Antonio Jurado-Navas and Juraj Kojs have made possible the Music Program we are going to enjoy. About Ana M. Barbancho, her help has gone far beyond the Demo Sessions organization, she has helped in many other things that are impossible to enumerate here. Also, we have to give our very special thanks to Alberto Peinado, graphical designer for the conference.

Also, we want to send our gratitude to all the reviewers that helped in the selection of the contributions that configure the SMC 2019 Scientific and Music Program.

Finally, we want to thank to those who really make this conference possible: the authors that sent their contributions and all the people attending the conference.

We have worked hard to prepare it, enjoy SMC 2019!

General Chairs, SMC 2019
Isabel Barbancho
Lorenzo J. Tardón

Málaga,
May 2019

Preface

The Sound and Music Computing Conference reaches its 16th edition!

This 16th Sound & Music Computing Conference (SMC 2019) takes place in Málaga, Spain, May 28-31, 2019 and it is organized by the Application of Information and Communication Technologies Research group (ATIC) of Universidad de Málaga (UMA).

SMC 2019 Topics of Interest include a wide selection of topics related to acoustics, psychoacoustics, music, technology for music, audio analysis, musicology, sonification, music games, machine learning, serious games, immersive audio, sound synthesis, etc.

Each year a specific topic of interest is highlighted. The theme of this year is **Music and Interaction**. This topic is as broad as the different ways in which a certain person (musician or not, engineer or not, artist or not...) may want to interact with music, depending on their personal interests and their specific relationship with music.

The interaction can be focused on music composition and creation, music performance, data mining, the influence of music on human beings, music learning, musical instruments, new sound development, reading music, etc.

SMC 2019 conference fosters the presentation of new methods for any kind of musical conversation or conversation through music, human-computer interaction through the lens of sound, interaction models from objects to bio and AI systems, new interfaces for playing music, interactive content discovery and recommendation, optical music recognition, music education, music games, sonification and any other music information retrieval related technology.

SMC 2019 is an interdisciplinary forum to share research, music, thoughts, needs and discoveries between musicians in a broad sense, computer science experts, music information retrieval researchers, etc. This interdisciplinary atmosphere will be the perfect place to come up with new ideas, applications and challenges to keep on working in this fantastic research topic that brings together art, technology and human perception.

SMC 2019 welcomed different types of contributions:

- **Papers** examining all the core topics of the Sound and Music Computing field; these contributions, that have been fully peer-reviewed, will be presented as oral presentation or poster.
- **Musical contributions** that make use of the possibilities technology offers nowadays to create music in a broad sense. Selected contributions will be performed at the scheduled music sessions.
- **Demos**, that are a novelty this year. Demo contributions, which have been very well accepted by the community, are intended to the presentation of preliminary results, ideas, applications or system prototypes that are not yet fully formed nor systematically evaluated, but of interest to the SMC community.

SMC 2019 has received 166 submission: 97 papers, 43 musical contributions and 26 demos. Out of them, SMC 2019 features 41 oral presentations, 33 posters, 24 musical pieces and 25 demos.

SMC 2019 had the help of 117 scientific reviewers and 37 music reviewers to examine all the submissions in order to compile the final Scientific and Music Program. The Program Chairs and the Music Chairs, together with the General Chairs, have made a great job making the final decisions and organizing the presentation of the different contributions in the Oral, Poster, Music and Demo Sessions.

A meet report with the conference abstracts and a cooperated special issue focused on 'Sound and Music Computing – Music and Interaction' that will include extended versions of selected contributions to the 2019 Sound and Music Computing Conference will be published by Applied Sciences, an Open Access Journal by MDPI.

In this book, you can find the whole program of SMC 2019. Together with the abstract of all the contributions that will be presented during the conference. The detailed schedule and information about all the scientific, musical and social it has been included.

We do think this is going to be a great SMC edition.

Enjoy SMC 2019!

SMC 2019 General Chairs
Isabel Barbancho
Lorenzo J. Tardón

Málaga
May 2019

SMC 2019 Program Chairs
Stefania Serafin
Federico Avanzini

SMC 2019
Conference Committee

General Chairs
Isabel Barbancho (Universidad de Málaga, Spain)
Lorenzo J. Tardón (Universidad de Málaga, Spain)

Program Chairs
Stefania Serafin (Aalborg University Copenhagen, Denmark)
Federico Avanzini (University of Milano, Italy)

Summer School Chair
Romain Michon (Stanford University, USA)

Music Chairs
Antonio Jurado-Navas (Universidad de Málaga, Spain)
Juraj Kojs (Slovakia/USA)
Spencer Topel (Dartmouth College, USA)

Demo Chair
Ana M. Barbancho (Universidad de Málaga, Spain)

Local Committee
Alberto Peinado (Universidad de Málaga, Spain)
Alejandro Villena (Universidad de Málaga, Spain)
Irene Gómez (Universidad de Málaga, Spain)
Jose María Gómez Belmonte (Universidad de Málaga, Spain)
M Luna Herruzo Torrico (Universidad de Málaga, Spain)
Juan Ignacio García Bartolomé Universidad de Málaga, Spain)
Moisés Marín Amador (Universidad de Málaga, Spain)

WiSMC 2019
Organizing Committee

General Chair
Isabel Barbancho (Universidad de Málaga, Spain)

Organizing Committee
Lorenzo J. Tardón (Universidad de Málaga, Spain)
Ana M. Barbancho (Universidad de Málaga, Spain)
Alberto Peinado (Universidad de Málaga, Spain)

Volunteer Interpreters
Laura Heredia Abolafio (Universidad de Málaga, Spain)
Celia Cámara Bernal (Universidad de Málaga, Spain)

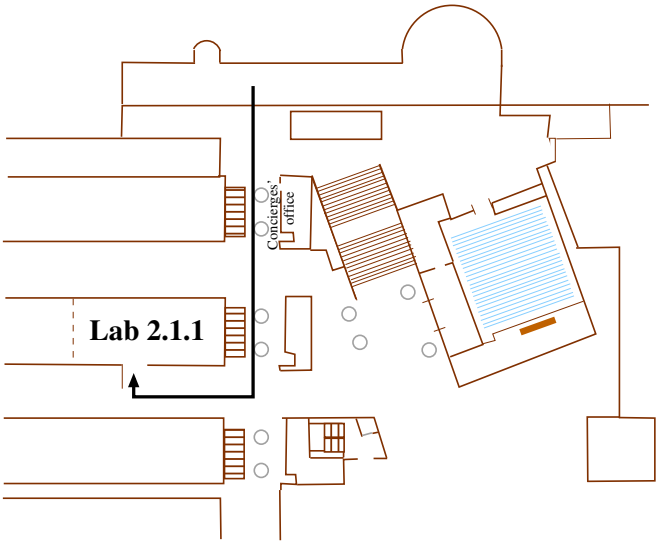
SMC 2019
Program Committee

Areti Andreopoulou, National and Kapodistrian University of Athens
Anastasia Georgaki, National and Kapodistrian University of Athens
Stefan Bilbao, University of Edinburgh
Jean Bresson, Institut de Recherche et Coordination Acoustique / Musique
Emma Frid, Royal Institute of Technology Stockholm
Lauren Hayes, Arizona State University
Alexander Refsum Jensenius, University of Oslo
Luca Andrea Ludovico, University of Milano
Andrew McPherson, Queen Mary University London
Romain Michon, GRAME Centre National de Création Musicale
Laurel Pardue, Queen Mary University London
Sandra Pauletto, University of York
Bob Sturm, Royal Institute of Technology Stockholm
Hiroko Terasawa, University of Tsukuba
Andrea Valle, University of Torino

Venues

Summer School Venues

Lab. 2.1.1 ETSI Telecomunicación
(*http://www.etsit.uma.es*)
Campus de Teatinos s/n, 29071 Málaga, Spain
Tel. +34 952 132 700



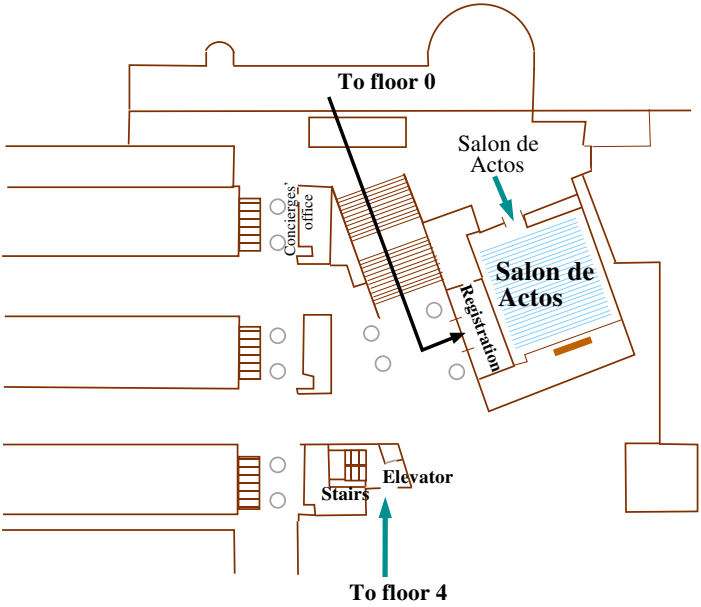
SMC 2019 Summer School at
Lab. 2.1.1 at ETSI Telecomunicación.

The Green Ray
(*http://www.link.uma.es/localizacion/*)
Ampliación Campus de Teatinos,
Bulevar Louis Pasteur, 47, 29590 Málaga, Spain
Tel. +34 951 953 104 / +34 951 953 125

SMC 2019 Summer School at
The Green Ray.

WiSMC 2019 and SMC 2019 Scientific Program Venue

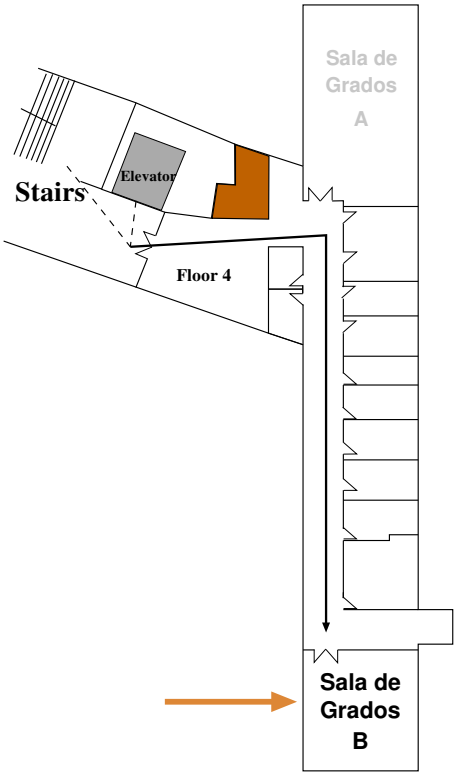
SMC 2019 Main Conference Venue
Salón de Actos, ETSI Telecomunicación
(*http://www.etsit.uma.es*)
Campus de Teatinos s/n, 29071 Málaga, Spain
Tel. +34 952 132 700



WiSMC & Technical Program at
Salón de Actos, ETSI Telecomunicación, lower floor.

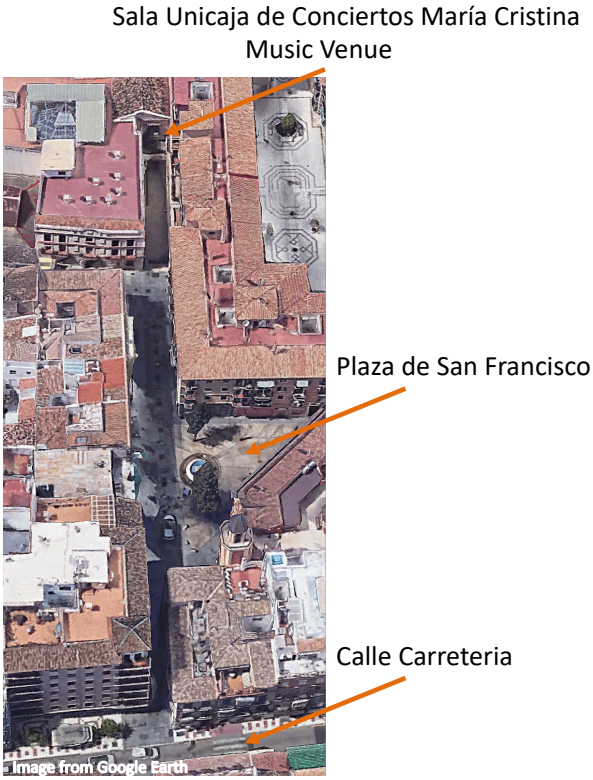
Music Program Venues

SMC 2019 Main Conference Venue
Sala de Grados B, ETSI Telecomunicación
(*http://www.etsit.uma.es*)
Campus de Teatinos s/n, 29071 Málaga, Spain
Tel. +34 952 132 700



Music Program at
ETSI Telecomunicación, Sala de Grados B, fourth floor.

SMC 2019 Music Venue
Sala Unicaja de Conciertos María Cristina
(*https://www.obrasocialunicaja.es/cultura/nuestros-centros/sala-unicaja-de-conciertos-maria-cristina/*)
Calle Marqués de Valdecañas 2, 29008 Málaga, Spain
Tel. +34 952 219 533



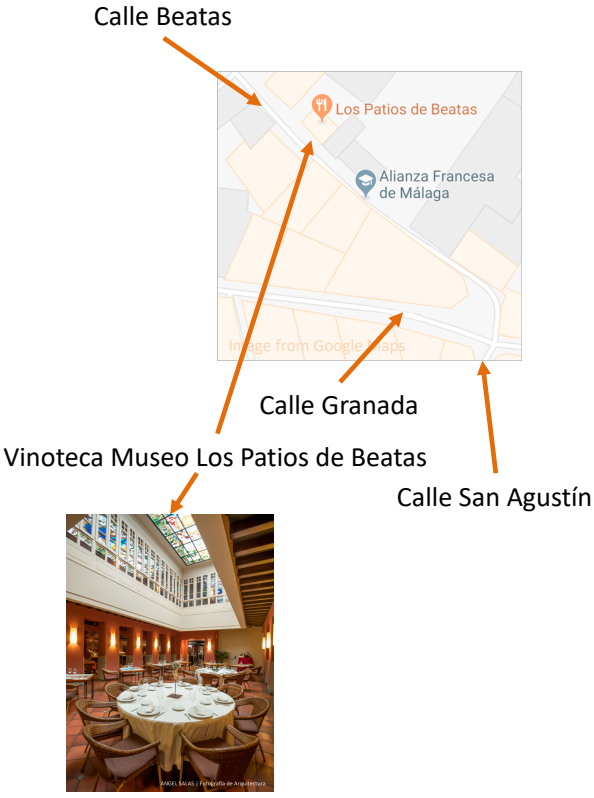
Music Program at
Sala Unicaja de Conciertos María Cristina.

Social Program Venues

SMC 2019 Welcome Reception
Rectorado del Parque, Universidad de Málaga
(*http://www.uma.es/media/fotos/image_7896.jpeg/*)
Avd. Cervantes, 2, 29016 Málaga, Spain

Welcome Reception at
Rectorado del Parque, Universidad de Málaga.

SMC 2019 Gala Dinner
Vinoteca Museo Los Patios de Beatas
(*http://lospatiosdebeatas.com/*)
Calle Beatas, 43, 29006 Málaga, Spain
Tel. +34 952 210 350



Gala dinner at
Vinoteca Museo Los Patios de Beatas.

SMC 2019 Conference and Events

Summer School

The theme of SMC 2019 Summer School will be **Music and Interaction**.

The summer school will take place from May 25 through May 28, 2019 at the Green Ray Building and ETSI Telecomunicación, Universidad de Málaga. This summer school is suitable for Computer Science, Electrical Engineering or Music Technology students enrolled in a MA/MSc/PhD program. Participants will learn about state-of-the-art techniques in music information retrieval, physical interaction and embedded systems for music under the guidance of leading experts in the field.

A maximum of 25 students will be selected for participating in the Summer School. Thanks to Nordic SMC and the ATIC Research group, selected students will be provided a scholarship to attend SMC 2019 Summer School.

WiSMC

The First International Day of Women in Inclusive Engineering, Sound and Music Computing Research (WiSMC) will take place in Malaga on May 28, 2019 at the Salón de Actos of ETSI Telecomunicacion, Málaga.

This day is specially addressed to pre-university students between 15 and 17 years old that have to decide what they want to study after finishing high school. We want both girls and boys to be aware that they can study anything they want and engineering is a good option no matter if you are a woman or a man. You only have to like it!

Nowadays, there are many people, men and women, who due to different reasons have certain prejudices regarding what a woman can or cannot do. It is necessary to make all women and men conscious of the fact that women can develop a successful professional career, without having to renounce being mothers and having a family.

Therefore, the aim of this First International Day of Women in Inclusive Engineering, Sound and Music Computing Research is to realize that it is necessary that both women and men work in collaboration, supporting each other, so that we all can reach fulfillment as individuals. Moreover, this approach can be extrapolated to anyone, regardless of their age, sexual orientation, race, religion, etc.

With this goal in mind, women with successful professional careers who have also formed a family will be invited to tell their life experience. Thus, girls, young women, and all the assistants will realize that women do not have to give up anything and that, with the adequate support from the rest of society, it is possible to achieve any kind of goal.

Scientific program

The SMC 2019 scientific program will take place between May 29 and May 31, at and around the Salón de Actos de la ETSI Telecomunicación of Universidad de Málaga. This scientific program will cover a wide selection of interesting topics related to acoustics, psychoacoustics, music, technology for music, audio analysis, musicology, sonification, music games, machine learning, serious games, immersive audio, sound synthesis, etc.

Among these topics, the theme of this year is Music and Interaction. This topic is as broad as the different ways in which a certain person (musician or not, engineer or not, artist or not...) may want to interact with music, depending on their personal interests and their specific relationship with music.

The interaction can be focused on music composition and creation, music performance, music data mining, the influence of music on human beings, music learning, musical instruments, new sound development, reading music, etc.

SMC 2019 conference will foster the presentation of new methods for any kind of musical conversation or conversation through music, human-computer interaction through the lens of sound, interaction models from objects to bio and AI systems, new interfaces for playing music, interactive content discovery and recommendation, optical music recognition, music education, music

games, sonification and any other music information retrieval related technology.

SMC 2019 will be an interdisciplinary forum to share research, music, thoughts, needs and discoveries between musicians in a broad sense, computer science experts, music information retrieval researchers, etc. This interdisciplinary atmosphere will be the perfect place to come up with new ideas, applications and challenges to keep on working in this fantastic research topic that brings together art, technology and human perception.

Eight oral sessions, three poster & demo sessions and three keynote talks will be scheduled for the attendants to enjoy novel discoveries, prototypes, ideas and concepts.

Music Program

SMC 2019 is open to music contributions as compositions, performances, installations, interfaces, audio-visual music, etc. Three music event will scheduled to display the selected music contributions; the first one, Music Session SMC, will be on May 29, 2019 at Sala Unicaja de Conciertos María Cristina: after the performance by the Rui-Silva duo and Dancers from the Conservatorio Superior de Danza de Malaga, selected musical pieces from the SMC 2019 call for music will be shown. On May 30 and May 31, Music Sessions M1 & M2 will take place at the Sala de Grados B of the main conference venue.

Social Program

On top of a great Scientific Program, SMC 2019 will offer to the participants an unforgettable stay.

The social program will provide participants with an opportunity to relax after meetings, to experience Málaga, and to network with other SMC participants.

The social program includes:

Tuesday, May 28 19:30	**Málaga Folklore and Welcome Cocktail**
Wednesday, May 29 18:30	**Concert at Sala Unicaja de Conciertos María Cristina**
Thursday, May 30 20:00	**Gala Dinner**

Málaga Folklore and Welcome Cocktail

The Welcome Cocktail will take place on May 28, 2019 at the building of the Universidad de Málaga known as Rectorado del Parque, located at Avd. Cervantes 2. There we will enjoy some typical Málaga Folklore, a nice cocktail and amazing views of our city.

Concert at Sala Unicaja de Conciertos María Cristina

On May 29, 2019 at Sala Unicaja de Conciertos María Cristina, we will enjoy a fantastic concert. This concert will have two parts:

In the first part, we will enjoy the Rui-Silva Duo performing music from Spanish Composers (Isaac Albéniz, Manuel de Falla, Enrique Granados, Joaquín Nin) and the art of dancers from the Conservatorio Superior de Danza de Malaga.

The second part will be devoted to selected musical pieces from the SMC 2019 call for music.

Sala Unicaja de Conciertos María Cristina is located at Marqués de Valdecañas Street, Number 2, 29008 Málaga).

Gala Dinner

On May 30, 2019, we will enjoy a fantastic dinner at 'Vinoteca Museo Los Patios de Beatas' located at Beatas Street, Number 43. The dinner is scheduled at 20:00.

Program at a Glance

Saturday, May 25

	Venue: Lab. 2.1.1, ETSI Telecomunicación
09:00-09:30	Registration
09:30-17:00	**Summer School**: Arduino and Audio

Sunday, May 26

	Venue: The Green Ray
09:00-09:30	Warm-up & Coffee
09:30-17:00	**Summer School**: Optical Music Recognition (OMR)

Monday, May 27

	Venue: The Green Ray
09:00-09:30	Warm-up & Coffee
09:30-17:00	**Summer School**: Wiring, Soldering and Enclosing Music

Tuesday, May 28

	Venue: The Green Ray
09:00-09:30	Warm-up & Coffee
09:30-17:00	**Summer School**: Music Recommendation

	Venue: Salón de Actos, ETSI Telecomunicación
09:00-14:30	**WiSMC**

	Venue: Rectorado de Parque
19:00-19:30	Registration
19:30-21:00	**Welcome Reception**

Wednesday, May 29

	Venue: ETSI Telecomunicación
09:00-09:30	Registration
09:30-10:00	**Welcome**
10:00-11:00	**Keynote 1**
11:00-11:30	**Poster & Demo Session 1** & Coffee
11:30-13:00	**Oral Session 1**
13:00-14:30	**Poster & Demo Session 1** & Lunch
14:30-16:30	**Oral Session 2**

	Venue: Sala Unicaja de Conciertos María Cristina
18:30-21:00	Concert & **Music Session at Sala Unicaja de Conciertos María Cristina**

Thursday, May 30

	Venue: ETSI Telecomunicación
09:00-10:30	**Oral Session 3**
10:30-11:00	**Poster & Demo Session 2** & Coffee
11:00-12:00	**Keynote 2**
12:00-13:00	**Oral Session 4**
13:00-14:30	**Poster & Demo Session 2** & Lunch
14:30-16:30	**Oral Session 5** & **Music Session 1**

	Venue: Vinoteca Museo Los Patios de Beatas
20:00-22:00	Gala Dinner

Friday, May 31

	Venue: ETSI Telecomunicación
09:00-10:30	**Oral Session 6**
10:30-11:00	**Poster & Demo Session 3** & Coffee
11:00-12:00	**Keynote 3**
12:00-13:00	**Oral Session 7**
13:00-14:30	**Poster & Demo Session 3** & Lunch
14:30-16:30	**Oral Session 8** & **Music Session 2**
16:30-17:00	Awards & Closing

Summer School Program

	Saturday, May 25	Sunday, May 26	Monday, May 27	Tuesday, May 28
09:00	REGISTRATION	Warm up & Coffee	Warm up & Coffee	Warm up & Coffee
09:30	ARDUINO AND AUDIO by DAVID CUARTIELLES	OPTICAL MUSIC RECOGNITION (OMR) by JORGE CALVO-ZARAGOZA	WIRING, SOLDERING AND ENCLOSING MUSIC by KOKA NIKOLADZE	MUSIC RECOMMENDATION by PETER KNEES
17:00				

Conference Program

	Tuesday, May 28	Wednesday, May 29	Thursday, May 30		Friday, May 31	
09:00		REGISTRATION	ORAL S3		ORAL S6	
09:30	WiSMC	WELCOME				
10:00		KEYNOTE 1				
10:30			COFFEE P2 & D2		COFFEE P3 & D3	
11:00		COFFEE P1 & D1	KEYNOTE 2		KEYNOTE 3	
11:30		ORAL S1				
12:00			ORAL S4		ORAL S7	
13:00		LUNCH POSTER P1 & DEMO D1	LUNCH POSTER P2 & DEMO D2		LUNCH POSTER P3 & DEMO D3	
14:30		ORAL S2	ORAL S5	MUSIC M1	ORAL S8	MUSIC M2
16:30					AWARDS & CLOSING	
17:00						
18:30		CONCERT MUSIC SMC				
19:00	REGISTRATION					
19:30	WELCOME RECEPTION					
20:00			DINNER			

Summer School Program: Music & Interaction

Saturday, May 25 Venue: ETSI Telecomunicación

09:00-09:30	Registration
09:30-17:00	**Summer School Day 1**

Arduino and Audio
David Cuartielles
Location: Lab 2.1.1, ETSI Telecomunicación

09:30-11:00	**Lecture Session I**
11:00-11:30	Coffee Break
11:30-13:00	**Lecture Session II**
13:00-14:00	Lunch
14:00-15:30	**Lecture Session III**
15:30-16:00	Coffee Break
16:00- 17:00	**Lecture Session IV**

Sunday, May 26 Venue: The Green Ray

09:00-09:30	Warm-up & Coffee
09:30-17:00	**Summer School Day 2**

Optical Music Recognition (OMR)
Jorge Calvo-Zaragoza
Location: The Green Ray

09:30-11:00	**Lecture Session I**
11:00-11:30	Coffee Break
11:30-13:00	**Lecture Session II**
13:00-14:00	Lunch
14:00-15:30	**Lecture Session III**
15:30-16:00	Coffee Break
16:00- 17:00	**Lecture Session IV**

Monday, May 27 Venue: The Green Ray

09:00-09:30	Warm-up & Coffee
09:30-17:00	**Summer School Day 3**

Wiring, Soldering and Enclosing Music
Koka Nikoladze
Location: The Green Ray

09:30-11:00	**Lecture Session I**
11:00-11:30	Coffee Break
11:30-13:00	**Lecture Session II**
13:00-14:00	Lunch
14:00-15:30	**Lecture Session III**
15:30-16:00	Coffee Break
16:00- 17:00	**Lecture Session IV**

Tuesday, May 28 Venue: The Green Ray

09:00-09:30	Warm-up & Coffee
09:30-17:00	**Summer School Day 4**

Music Recommendation
Peter Knees
Location: The Green Ray

09:30-11:00	**Lecture Session I**
11:00-11:30	Coffee Break
11:30-13:00	**Lecture Session II**
13:00-14:00	Lunch
14:00-15:30	**Lecture Session III**
15:30-16:00	Coffee Break
16:00- 17:00	**Lecture Session IV**

WiSMC 2019 Program

Tuesday, May 28 Venue: Salón de Actos, ETSI Telecomunicación

09:30-10:00	Welcome/Bienvenida
10:00-10:30	**The Joys and Sorrows of Academic Life and Transnational Mobility: How to Be Professor, Mother, Wife, Polyglot, Expat without Losing Your Mind** *Professor Elvira Brattico* Principal Investigator at the Center for Music in the Brain, Aarhus (Denmark)
10:30-11:00	**Ingeniería en Femenino** *Ana Rivera* Program Office Manager en la Division WDO de Keysight Technologies, S.A., Málaga (Spain)
11:00-11:30	**Is It Hard to Be a Mom and a Professor? My Personal View on Work-Life Balance** *Professor Stefania Serafin* President of the Sound and Music Computing Association, Aalborg University (Denmark)
11:30-12:00	Pausa / Break

12:00-12:30	**Diversity in Science and Engineering: Experiences with the Women in MIR Initiative**
	Anja Volk (MA, MSc, PhD)
	Assistant Professor in Information and Computing Sciences, Utrecht University (The Netherlands)
12:30-13:00	**'Women in R&D Management' or 'R&D Manager'? ¿Mujeres en el Mundo de la Gestión de la I+D o Directoras de I+D?**
	Dr. Gema Martín
	Directora I+D+i del Grupo Aganova, Málaga (SPAIN)
13:00-13:30	**From Black Swan to Management: Based on a True Story**
	Ana Pedraz
	Snr Manager Solutions Engineer, Iberia - Oracle, Málaga (SPAIN)
13:30-14:00	**Tabla Redonda / Round Table** **What else Can We Do to Boost Equal Opportunities in Engineering?**
	Moderador/Moderator: *Prof. Isabel Barbancho*
	Catedrática de Universidad en el Área de Teoría de la Señal y Comunicaciones, Universidad de Málaga (Spain)
14:00-14:15	**Clausura / Closing**

SMC 2019 Conference Program

Tuesday, May 28 Venue: Rectorado del Parque

19:00-19:30	Registration
19:30-21:00	**Welcome Reception**

Wednesday, May 29 Venue: ETSI Telecomunicación

09:00-09:30	Registration
09:30-10:00	Welcome
10:00-11:00	**Keynote Speaker 1**

Taming the untameable: How to study naturalistic music listening in the brain by means of computational feature extraction
Professor Elvira Brattico

11:00-11:30	**P1. Poster Session 1**	Session Chair: Hanna Järveläinen
	D1. Demo Session 1	Session Chair: Alberto Peinado
	Coffee	

P1. Poster Session 1

P1.1 DAW-Integrated Beat Tracking for Music Production
Brett Dalton, David Johnson and George Tzanetakis

P1.2 Interaction-based Analysis of Freely Improvised Music
Stefano Kalonaris

P1.3 Mechanical Entanglement: A Collaborative Haptic-Music Performance
Alexandros Kontogeorgakopoulos, George Sioros and Odysseas Klissouras

P1.4 State Dependency - Audiovisual Interaction through Brain States
Patrick Neff, Jan Schacher and Daniel Bisig

P1.5 Perceptual Evaluation of Modal Synthesis for Impact-Based Sounds
Adrián Barahona and Sandra Pauletto

P1.6 VIBRA - Technical and Artistic Issues in an Interactive Dance Project
Andreas Bergsland, Sigurd Saue and Pekka Stokke

P1.7 Musical Tempo and Key Estimation using Convolutional Neural Networks with Directional Filters
Hendrik Schreiber and Meinard Müller

P1.8 The Viking HRTF Dataset
Simone Spagnol, Kristján Bjarki Purkhús, Runar Unnthórsson and Sverrir Karl Björnsson

P1.9 Performing with Sound Sample-Controlled Gloves and Light-Controlled Arms
Justin Pecquet, Fotis Moschos, David Fierro and Frank Pecquet

P1.10 Melody Identification in Standard MIDI Files
Zheng Jiang and Roger Dannenberg

P1.11 Automatic Chord-Scale Recognition using Harmonic Pitch Class Profiles
Emir Demirel, Baris Bozkurt and Xavier Serra

D1. Demo Session 1

D1.1 Interacting with Digital Resonators by Acoustic excitation
Max Neupert and Clemens Wegener

D1.2 Melody Slot Machine
Masatoshi Hamanaka

D1.3 OM-AI: A Toolkit to Support AI-Based Computer-Assisted Composition Workflows in OpenMusic
Anders Vinjar and Jean Bresson

D1.4 URALi: a proposal of approach to real-time audio synthesis in Unity
Enrico Dorigatti

D1.5 A Sequencer with Decoupled Track Timing
Silvan David Peter and Gerhard Widmer

D1.6 Musicypher: Music for Message Encryption
Víctor Jaime Marín and Alberto Peinado

D1.7 A Platform for Processing Sheet Music and Developing Multimedia Application
Fu-Hai Frank Wu

D1.8 Capturing the Reaction Time to Distinguish between Voice and Music
Alejandro Villena-Rodríguez, Lorenzo J. Tardón, Isabel Barbancho, Ana M. Barbancho, Irene Gómez-Plazas and María-José Varela-Salinas

D1.9 Physical Models and Real-Time Control with the Sensel Morph
Silvin Willemsen, Stefan Bilbao, Nikolaj Andersson and Stefania Serafin

11:30-13:00 **S1. Oral Session 1** Session Chair: Stefania Serafin
Sonic Interactions

S1.1 Towards a High-Performance Platform for Sonic Interaction Interfaces
Stefano Fasciani and Manohar Vohra

S1.2 Digital Manufacturing for Musical Applications: A Survey of Current Status and Future Outlook
Doga Cavdir

S1.3 Real Time Audio Digital Signal Processing with Faust and the Teensy
Romain Michon, Yann Orlarey, Stéphane Letz and Dominique Fober

S1.4 Sound Design through Large Audience Interaction
Kjetil Falkenberg Hansen, Martin Ljungdahl-Eriksson and Ricardo Atienza

S1.5 Evaluating a Continuous Sonic Interaction: Comparing a Performable Acoustic and Digital Everyday Sound
Fiona Keenan and Sandra Pauletto

13:00-14:30 **P1. Poster Session 1**
D1. Demo Session 1
Lunch

14:30-16:30 **S2. Oral Session 2** Session Chair: Vesa Välimäki
Nordic SMC

S2.1 Adaptive Loudness Compensation in Music Listening
Leonardo Fierro, Jussi Rämö and Vesa Välimäki

S2.2 Toward Automatic Tuning of the Piano
Joonas Tuovinen, Jamin Hu and Vesa Välimäki

S2.3 Real-time Control of Large-scale Modular Physical Models using the Sensel Morph
Silvin Willemsen, Nikolaj Andersson, Stefania Serafin and Stefan Bilbao

S2.4 An Interactive Music Synthesizer for Gait Training in Neurorehabilitation
Prithvi Kantan and Sofia Dahl

S2.5 From Vocal Sketching to Sound Models by Means of a Sound-Based Musical Transcription System
Claudio Panariello, Mattias Sköld, Emma Frid and Roberto Bresin

S2.6 Tempo and Metrical Analysis by Tracking Multiple Metrical Levels Using Autocorrelation
Olivier Lartillot and Didier Grandjean

18:30-21:00 **Concert**
SMC. Music Session at Sala María Cristina

Thursday, May 30 Venue: ETSI Telecomunicación

09:00-10:30 **S3. Oral Session 3** Session Chair: Marcella Mandanici
Augmented and Virtual Realities

S3.1 Comparison and Implementation of Data Transmission Techniques through Analog Audio Signals in the Context of Augmented Mobile Instruments
Romain Michon, Yann Orlarey, Stéphane Letz and Dominique Fober

S3.2 Mass-Interaction Physical Models for Sound and Multi-Sensory Creation: Starting Anew
Jerome Villeneuve and James Leonard

S3.3 Exploring the Effects of Diegetic and Non-diegetic Audiovisual Cues on Decision-making in Virtual Reality
Anıl Çamcı

S3.4 OSC-XR: A Toolkit for Extended Reality Immersive Music Interfaces
David Johnson, Daniela Damian and George Tzanetakis

S3.5 No Strings Attached: Force and Vibrotactile Feedback in a Guitar Simulation
Andrea Passalenti, Razvan Paisa, Niels Christian Nilsson, Nikolaj S. Andersson , Federico Fontana, Rolf Nordahl and Stefania Serafin

10:30-11:00 **P2. Poster Session 2** Session Chair: Anja Volk
D2. Demo Session 2 Session Chair: Hendrik Schreiber
Coffee

P2. Poster Session 2

P2.1 RaveForce: A Deep Reinforcement Learning Environment for Music Generation
Qichao Lan, Jim Tørresen and Alexander Refsum Jensenius

P2.2 Music Temperaments Evaluation Based on Triads
Tong Meihui and Satoshi Tojo

P2.3 Composing Space in the Space: An Augmented and Virtual Reality Sound Spatialization System
Giovanni Santini

P2.4 Graph Based Physical Models for Sound Synthesis
Pelle Juul Christensen and Stefania Serafin

P2.5 ADPET: Exploring the Design, Pedagogy, and Analysis of a Mixed Reality Application for Piano Training
Lynda Joy Gerry, Sofia Dahl and Stefania Serafin

P2.6 A Model Comparison for Chord Prediction on the Annotated Beethoven Corpus
Kristoffer Landsnes, Liana Mehrabyan, Victor Wiklund, Robert Lieck, Fabian C. Moss and Martin Rohrmeier

P2.7 Sonic Characteristics of Robots in Films
Adrian B. Latupeirissa, Emma Frid and Roberto Bresin

P2.8 Virtual Reality Music Intervention to Reduce Social Anxiety in Adolescents Diagnosed with Autism Spectrum Disorder
Ali Adjorlu, Nathaly Belen Betancourt Barriga and Stefania Serafin

P2.9 Teach Me Drums: Learning Rhythms through the Embodiment of a Drumming Teacher in Virtual Reality
Mie Moth-Poulsen, Tomasz Bednarz, Volker Kuchelmeister and Stefania Serafin

P2.10 Real-time Mapping of Periodic Dance Movements to Control Tempo in Electronic Dance Music
Lilian Jap and Andre Holzapfel

P2.11 Increasing Access to Music in SEN Settings
Tom Davis, Daniel Pierson and Ann Bevan

D2. Demo Session 2

D2.1 Interacting with Musebots (that don't really listen)
Arne Eigenfeldt

D2.2 Extending Jamsketch: An Improvisation Support System
Akane Yasuhara, Junko Fujii and Tetsuro Kitahara

D2.3 Visualizing Music Genres using a Topic Model
Swaroop Panda, Vinay P. Namboodiri and Shatarupa Thakurta Roy

D2.4 CompoVOX: Real-Time Sonification of Voice
Daniel Hernán Molina Villota, Isabel Barbancho and Antonio Jurado-Navas

D2.5 Facial Activity Detection to Monitor Attention and Fatigue
Oscar Cobos, Jorge Munilla, Ana M. Barbancho, Isabel Barbancho and Lorenzo J. Tardón

D2.6 The Chordinator: An Interactive Music Learning Device
Eamon McCoy, John Greene, Jared Henson, James Pinder, Jonathon Brown and Claire Arthur

D2.7 Automatic Chord Recognition in Music Education Applications
Sascha Grollmisch and Estefania Cano

D2.8 Sonic Sweetener Mug
Signe Lund Mathiesen, Derek Victor Byrne and Qian Janice Wang

11:00-12:00 **Keynote Speaker 2**

Towards explicating implicit musical knowledge: how the computational modeling of musical structures mediates between curiosity-driven and application-oriented perspectives
Anja Volk (MA, MSc, PhD)

12:00-13:00 **S4. Oral Session 4** Session Chair: Emma Frid
SMC Tools and Methodologies

S4.1 A Framework for the Development and Evaluation of Graphical Interpolation for Synthesizer Parameter Mapping
Darrell Gibson and Richard Polfreman

S4.2 Composing with Sounds: Designing an Object Oriented Daw for the Teaching of Sound-Based Composition

Stephen Pearse, Leigh Landy, Duncan Chapman, David Holland and Mihai Eni

S4.3 Insights in Habits and Attitudes Regarding Programming Sound Synthesizers: A Quantitative Study
Gordan Kreković

13:00-14:30 **P2. Poster Session 2**
D2. Demo Session 2
Lunch

14:30-16:30 **S5. Oral Session 5** Session Chair: Federico Avanzini
Sound Synthesis & Analysis
M1. Music Session 1

S5. Oral Session 5

S5.1 Experimental Verification of Dispersive Wave Propagation on Guitar Strings
Dmitri Kartofelev, Joann Gustav Arro and Vesa Välimäki

S5.2 Real-Time Modeling of Audio Distortion Circuits with Deep Learning
Eero-Pekka Damskägg, Lauri Juvela and Vesa Välimäki

S5.3 MI-GEN~: An Efficient and Accessible Mass-Interaction Sound Synthesis Toolbox
James Leonard and Jerome Villeneuve

S5.4 Combining Texture-Derived Vibrotactile Feedback, Concatenative Synthesis and Photogrammetry for Virtual Reality Rendering
Eduardo Magālhaes, Emil Rosenlund Høeg, Gilberto Bernardes, Jon Ram Bruun-Pedersen, Stefania Serafin and Rolf Nordhal

S5.5 Percussion Synthesis using Loopback Frequency Modulation Oscillators
Jennifer Hsu and Tamara Smyth

S5.6 Deep Linear Autoregressive Model for Interpretable Prediction of Expressive Tempo
Akira Maezawa

S5.7 Metrics for the Automatic Assessment of Music Harmony Awareness in Children
Federico Avanzini, Adriano Baratè, Luca Andrea Ludovico and Marcella Mandanici

20:00-22:30 **Gala Dinner**

Friday, May 31 Venue: ETSI Telecomunicación

09:00-10:30 **S6. Oral Session 6** Session Chair: Roger Dannenberg
Music Information Processing

S6.1 Learning to Generate Music with BachProp
Florian Colombo, Johanni Brea and Wulfram Gerstner

S6.2 Offline Score Alignment for Realistic Music Practice
Yucong Jiang, Fiona Ryan, David Cartledge and Christopher Raphael

S6.3 Piano Score-Following by Tracking Note Evolution
Yucong Jiang and Christopher Raphael

S6.4 Adaptive Score-Following System by Integrating Gaze Information
Kaede Noto, Yoshinari Takegawa and Keiji Hirata

S6.5 Alternative Measures: A Musicologist Workbench for Popular Music
Beach Clark and Claire Arthur

10:30-11:00 **P3. Poster Session 3** Session Chair: Jean Bresson
D3. Demo Session 3 Session Chair: Ana M. Barbancho
Coffee

P3. Poster Session 3

P3.1 Autoencoders for Music Sound Modeling: a Comparison of Linear, Shallow, Deep, Recurrent and Variational Models
Fanny Roche, Thomas Hueber, Samuel Limier and Laurent Girin

P3.2 Polytopic Reconfiguration: a Graph-Based Scheme for the Multiscale Transformation of Music Segments and its Perceptual Assessment
Valentin Gillot and Frédéric Bimbot

P3.3 Non-Linear Contact Sound Synthesis for Real-Time Audio-Visual Applications using Modal Textures
Martin Maunsbach and Stefania Serafin

P3.4 Analysis of Vocal Ornamentation in Iranian Classical Music
Sepideh Shafiei

P3.5 VUSAA: An Augmented Reality Mobile App for Urban Soundwalks
Josué Moreno and Vesa Norilo

P3.6 A Framework for Multi-f0 Modeling in SATB Choirs
Helena Cuesta, Emilia Gómez and Pritish Chandna

P3.7 Representations of Self-Coupled Modal Oscillators with Time-Varying Frequency
Tamara Smyth and Jennifer Hsu

P3.8 SonaGraph. A Cartoonified Spectral Model for Music Composition
Andrea Valle

P3.9 Sound in Multiples: Synchrony and Interaction Design of Coupled-Oscillator Networks
Nolan Lem

P3.10 'Jazz Mapping' an Analytical and Computational Approach to Jazz Improvisation
Dimitrios Vassilakis, Anastasia Georgaki and Christina Anagnostopoulou

P3.11 Visual Pitch Estimation
A. Sophia Koepke, Olivia Wiles and Andrew Zisserman

D3. Demo Session 3

D3.1 Miningsuite: A Comprehensive Matlab Framework For Signal, Audio and Music Analysis, Articulating Audio And Symbolic Approaches
Olivier Lartillot

D3.2 Drawing Geometric Figures with Braille Description through a Speech Recognition System
África Chamorro, Ana M. Barbancho, Isabel Barbancho and Lorenzo J. Tardón

D3.3 Interactive Music Training System
Daniel Moreno, Isabel Barbancho, Ana M. Barbancho and Lorenzo J. Tardón

D3.4 Copying Clave – A Turing Test
Simon Blackmore

D3.5 Resonance Improviser: A System for Transmitting the Embodied Sensations of Vocalization between two People during Improvisation
Tejaswinee Kelkar and Lynda Joy Gerry

D3.6 Finding New Practice Material through Chord-Based Exploration of a Large Music Catalogue
Johan Pauwels and Mark B. Sandler

D3.7 Internal Complexity for Exploratory Interaction
Mads Hobye

D3.8 Adaptive Body Movement Sonification in Music and Therapy
Christian Baumann, Johanna Friederike Baarlink and Jan-Torsten Milde

11:00-12:00 **Keynote Speaker 3**

Music's changing fast; FAST is changing music
Professor Mark Sandler

12:00-13:30 **S7. Oral Session 7** Session Chair: Sofia Dahl
Multimodality and (e)motions

S7.1 VocalistMirror: A Singer Support Interface for Avoiding Undesirable Facial Expressions
Kin Wah Edward Lin, Tomoyasu Nakano and Masataka Goto

S7.2 Audiovisual Perception of Arousal, Valence, and Effort in Contemporary Cello Performance
Hanna Järveläinen

S7.3 Dancing Dots - Investigating the Link between Dancer and Musician in Swedish Folk Dance
Olof Misgeld, Andre Holzapfel and Sven Ahlbäck

13:00-14:30 **P3. Poster Session 3**
D3. Demo Session 3
Lunch

14:30-16:30 **S8. Oral Session 8** Session Chair: Olivier Lartillot
Machine Learning
M2. Music Session 2

S8. Oral Session 8

S8.1 Conditioning a Recurrent Neural Network to Synthesize Musical Instrument Transients
Lonce Wyse and Muhammad Huzaifah

S8.2 Predicting Perceived Dissonance of Piano Chords Using a Chord-Class Invariant CNN and Deep Layered Learning
Juliette Dubois, Anders Elowsson and Anders Friberg

S8.3 Belief Propagation Algorithm for Automatic Chord Estimation
Vincent P. Martin, Sylvain Reynal, Dogac Basaran and Hélène-Camille Crayencour

S8.4 HMM-Based Glissando Detection for Recordings of Chinese Bamboo Flute
Changhong Wang, Emmanouil Benetos, Xiaojie Meng and Elaine Chew

S8.5 Towards CNN-based Acoustic Modeling of Seventh Chords for Automatic Chord Recognition
Christon-Ragavan Nadar, Jakob Abeßer and Sascha Grollmisch

S8.6 From Jigs and Reels to Schottisar och Polskor: Generating Scandinavian-like Folk Music with Deep Recurrent Networks
Simon Mossmyr, Eric Hallström, Bob L. Sturm, Victor Hansjons Vegeborn and Jonas Wedin

S8.7 Modeling and Learning Rhythm Structure
Francesco Foscarin, Florent Jacquemard and Philippe Rigaux

16:30-17:00 **Awards & Closing**

SMC 2019 Music Program

Wednesday, May 29,18:30-21:00 Venue: Sala Unicaja de Conciertos María Cristina

Part I

Concert

Rui-Silva Duo
&
Dancers from the Conservatorio Superior de Danza de Malaga

1. **Isaac Albéniz**
   Malagueña (Arranged for Cello and Piano by Joachim Stutschewsky)

2. **Gaspar Cassadó**
   Requiebros

3. **Manuel de Falla**
   Danza nº1 "La vida breve"

4. **Enrique Granados**
   Danza nº5 "Andaluza"

5. **Enrique Granados**
   Intermezzo de "Goyescas" (Arranged for Cello and Piano by Gaspar Cassadó)

6. **Joaquín Nin**
   Andaluza from "Suite española"

Part II

SMC. Music Session at Sala Unicaja de Conciertos María Cristina

SMC.1 Chris Rhodes
Duet for Violin and Biofeedback

SMC.2 John Granzow
Axes

SMC.3 Akira Takaoka
Piano Sinfonia

SMC.4 Ricardo Climent
Duel of Strings: Lorenzo Triviño (non-virtual violin) vs. Virtual Violin

- ○ -

SMC.5 Amy Brandon
Seven Malagueña Fragments for Augmented Guitar

SMC.6 Lorenzo Ballerini, Massimo D'Amato and Alberto Gatti
Relazioni Digitali (Digital Relations)

SMC.7 Nicoletta Andreuccetti
Notturno Sole

Thursday, May 30, 14:30-16:30 Venue: Sala de Grados B
ETSI Telecomunicación

M1. Music Session 1

M.1 Arne Eigenfeldt
TinySounds: for voice and musebot ensemble

M.2 Jeffrey Weeter
Pattern Portrait: Cork

M.3 Man Jie
Enchanted AI

M.4 Frank Pecquet, Fotis Moschos, David Fierro and Justin Pecquet
Piamenca

M.5 Simon Blackmore
Cryptoguitar

M.6 Scott Barton
Machine Rhythm Study No. 2

- ○ -

M.7 Te Hao
Nebula II

M.8 Francesco Bossi
Acousmatic Scattering

M.9 Sever Tipei
Quilt

Friday, May 31, 14:30-16:30 Venue: Sala de Grados B
ETSI Telecomunicación

M2. Music Session 2

M2.1 Gordan Kreković
An Excerpt from Hologram Space

M2.2 Martyn Harry, James Dooley and Jamie Savan
Palimpsest

M2.3 Gil Dori
"Tenir el cap ple de..."

M2.4 Joshua Tomlinson
A Short Story

- ○ -

M2.5 Francesco Roberto Dani and Riccardo Novella
Mimesi

M2.6 Ji Won Yoon and Woon Seung Yeo
Childhood memories - distant but close

Highlights Summary

Summer School

Arduino and Audio

9:30-17:00 Saturday, May 25
Venue: ETSI Telecomunicación

David Cuartielles
Malmö University, Sweden

The Arduino and audio workshop looks at possible ways to create interactive sound production machines using Arduino boards. From low level bit-banging PCM on Arduino UNO as a way to make inexpensive sound toys, to the use of DAC in more modern processors. The workshop will have a strong hands-on component where all participants will make a small music instrument (or two) using 8-bit processors.

Biography

David Cuartielles, Arduino co-founder. He is a PhD in Interaction Design by Malmö University. He has specialized in the the creation of digital platforms, being one of them the Arduino prototyping system, that he co-founder in 2005. He has experiences in building large installations and small devices using 8-bit microcontrollers.

Optical Music Recognition (OMR)

9:30-17:00 Sunday, May 26
Venue: The Green Ray

Jorge Calvo-Zaragoza
University of Alicante, Spain

Optical Music Recognition (OMR) is the field that investigates how to teach computers to read musical scores. Bringing OMR to real use lowers the costs of making written music available in symbolic format, diversifying the sources for music information retrieval and digital musicology. State-of-the-art research and existing tools will be described so that attendees can integrate OMR into their own work.

Biography

Jorge Calvo-Zaragoza received his PhD degree in computer science from the University of Alicante (Spain) in 2016. In 2017, he joined the Single Interface for Music Score Searching and Analysis (SIMSSA) project at McGill University as a Postdoctoral Fellow, under the supervision of Prof. Ichiro Fujinaga. Currently, he is granted with a postdoctoral fellowship under the Juan de la Cierva programme of the Spanish Ministerio de Economía, Industria y Competitividad. He has authored more than 30 papers about Optical Music Recognition in peer-reviewed journals and international conferences.

Wiring, Soldering and Enclosing Music

9:30-17:00 Monday, May 27
Venue: The Green Ray

Koka Nikoladze
Norwegian Academy of Music, Norway

This one-day interactive workshop will focus on different aspects of engineering and crafting expressive musical interfaces for specific musical works. Koka will present and discuss some of his inventions and designs. He will also provide an in-depth view in his composition and engineering toolkits and workflows. Controlling a symphonic orchestra in realtime, performing with a

YouTube choir, playing a laptop with a viola bow - the workshop is planned to be highly informative, but also entertaining.

Biography

With academic backgrounds in performance, composition and music technology, Koka composes and performs on different European stages. Koka is also known for creating and building futuristic electromechanical musical instruments, some of which have become viral on social media. His futuristic work has triggered attention of media, such as ARTE, Discovery Channel, MTV, WIRED, etc. Koka is a PhD candidate at the Norwegian Academy of Music. His research project with the title "How to Hack Performers" focuses on composition and musical score communication in realtime.

Music Recommendation

9:30-17:00 Tuesday, May 28

Venue: The Green Ray

Peter Knees
Faculty of Informatics, TU Wien, Austria

During this one day course, the students will learn about different types of recommenders, user aspects, recommenders for creators, and even some business aspects of it. The user aspects will mainly focus on interaction.

Biography

Peter Knees, Assistant Professor of the Faculty of Informatics, TU Wien, Austria. For over a decade he has been an active member of the ISMIR community, reaching out to the related areas of multimedia, text IR, and recommender systems. Apart from serving on the program committees of major conferences in the field, he has organized several workshops on topics of media retrieval. He is an experienced teacher of graduate-level courses on recommender systems and information retrieval and has given tutorials on music information retrieval at RecSys, SIGIR, ECIR, RuSSIR, and the Indonesian Summer School on MIR.

WiSMC Speakers

Professor Elvira Brattico, PhD, is Principal Investigator at the Center for Music in the Brain, a center of excellence funded by the Danish National Research Foundation and affiliated with the Department of Clinical Medicine at Aarhus University and The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark. Moreover, in Finland she is Adjunct Professor ("Dosentti") of Biological Psychology at the University of Helsinki and of Music Neuroscience at the University of Jyväskylä. She has a background as classical concert pianist in Italy and holds a PhD in Cognitive Neuroscience and Brain Research Methods from the University of Helsinki (2007). During her academic career, she has published more than 140 scientific papers, including 2 books and several invited book chapters (e.g., Oxford University Press, Routledge). In her research, she is a recognized world pioneer in music research, particularly with regards to naturalistic music neuroscience combining MIR with brain signal. Moreover, she is a leader in music neuroaesthetics and neuroplasticity studies, as witnessed by her keynote addresses in several international conferences, associate editor appointments (e.g., Frontiers, Psychomusicology, PLOS ONE), and board membership of international scientific societies (e.g., International Association for Empirical Aesthetics, ESCOM Italy, Neuromusic) and training networks (Auditory Neuroscience, CICERO Learning). She also has wide experience with supervision and teaching having given several courses on experimental musicology, cognitive neuroscience, emotions, neurophysiology and brain research methods in Finland, Denmark, Italy and Spain. In her personal life, Prof Brattico enacts diversity and multiculturalism, having crossed disciplines (from a background in humanities to neuroscience research), countries (from Southern Italy to Nordic countries) and cultures. She is married to a Finn and is mother to 3 school-age children, fluent speakers of 4 languages. She is passionate for nature and culture, and strives to foster these passions in the young generations.

Professor Stefania Serafin has special responsibilities in sound in multimodal environments at Aalborg University in Copenhagen. She has been Associate Professor (2006-2012), and Assistant Professor (2003-2006) at Aalborg University Copenhagen. She received a Ph.D. in Computer-Based Music Theory and Acoustics from Stanford University in 2004, and a Master in Acoustics, Computer Science and Signal Processing Applied to Music from IRCAM (Paris) in 1997. She is the president of the Sound and Music Computing Association and project leader for the Nordic Sound and Music Computing Network. Her main research interest is sonic interaction design. Stefania has a 10 years old daughter who is half danish and half Italian who has a beautiful voice and sings in the children choir of the Danish radio.

Anja Volk (MA, MSc, PhD), Assistant Professor in Information and Computing Sciences (Utrecht University) has a dual background in mathematics and musicology which she applies to cross-disciplinary approaches to music. She has an international reputation in the areas of music information retrieval (MIR), computational musicology, and mathematical music theory. Her work has helped bridge the gap between scientific and humanistic approaches while working in interdisciplinary research teams in Germany, the USA and the Netherlands. In 2011, she started her own research group at Utrecht University at the intersection of MIR, musicology and cognition. Her research aims at enhancing our understanding of music as a fundamental human trait while applying these insights for developing music technologies that offer new ways of interacting with music. Anja has given numerous invited talks worldwide and held editorships in leading journals, including the Journal of New Music Research and Musicae Scientiae. She has co-founded several international initiatives, most notably the International So-

ciety for Mathematics and Computation in Music (SMCM), the flagship journal of the International Society for Music Information Retrieval (TISMIR), and the Women in MIR (WIMIR) mentoring program, which organizes yearly mentoring rounds with participants from academia and industry, in order to foster greater diversity in MIR. Anja's commitment to diversity and inclusion was recognized with the Westerdijk Award in 2018 from Utrecht University. She is also committed to connecting different research communities and providing interdisciplinary education for the next generation through the organization of international workshops, such as the Lorentz Center in Leiden workshops on music similarity (2015), computational ethnomusicology (2017) and music, computing, and health (2019).

Ana Rivera, Telecommunication Engineer from University of Málaga. She started her studies in 1988 and in 1994 she begun her professional career at CETECOM, a company from Málaga located at the Andalucía Technology Park (PTA), working in the Electromagnetic Compatibility Laboratory. In 2000, she became part of the R&D team of that company, renamed then AT4 Wireless. There, she developed several RF measurement systems for different mobile communication technologies: Bluetooth, Wimax, 3G and 4G. During that period, she performed diverse functions from project manager to head of the System Division. In 2012, after a process in which part of AT4 wireless was bought by Agilent, later Keysight, she became part of the WDO division where she currently works in the Program Office for the development of 5G technology projects. Ana is the mother of two girls and she is passionate about the world of productivity, innovation and creativity. She likes to share her free time among multiple hobbies like the design of agendas and organization and planning. She loves reading, writing and drawing.

Gema Martín, PhD. Gema Martín holds a Mathematics Degree, a Software Engineer PhD. and Master Degrees in different areas: Technological and Innovative Entrepreneurs Master, Software Engineering and Artificial Intelligence Master, Social Networks Master and Higher Educational Teaching Master. She has 13 years of experience in R&D Management in multiple sectors. She has worked as a Research Group Coordinator for 4 years in the Andalusian Center for Innovation and Information and Communication Technologies. She has worked as a R&D Manager for 4 years in an innovative SME in the Education sector, where she also led all the departments that were located in the Málaga company's headquarters. She has been a Professor at the European University. Currently, she holds the position of R&D Manager at AGANOVA. Personally, she is married and has a baby boy.

Ana Pedraz, Snr Manager Solutions Engineer Iberia - Oracle, She started her career in IT as a systems analyst in the UK in 1992, working for Brittany Ferries'IT department in Plymouth, UK. In 1998, she joined Digital Equipment Corporation (DEC) to manage their European Unix Systems. Within 3 years and after the DEC to Compaq and Compaq to Hewlett Packard acquisition, she started her career in Management, first looking after the Service delivered by HP to companies like Nestle and Sara Lee International in the EMEA South regions. After close to 17 years living in the UK, in 2009, she returned to Spain and continued working on her Services Management career, working in several countries until 2017 when she joined Oracle in Malaga to manage the Solutions Engineering department for Spain and Portugal. In her spare time, she leads the Oracle Woman Leadership community and coaches their interns thru an innovation program.

Keynote Talks

Keynote Talk 1

10:00-11:00 Wednesday, May 29

Taming the untameable: How to study naturalistic music listening in the brain by means of computational feature extraction

Elvira Brattico
Dept. Clinical Medicine - Center for Music In the Brain, Aarhus C, Denmark

Listening to musical sounds is a brain function that has likely appeared already tens of thousands of years ago, in homo sapiens and perhaps even in Neanderthal ancestors. The peripheral hearing apparatus has taken its shape to decompose sounds by transforming the air pressure waves into ion impulses and by extracting the frequencies in a way similar to a Fourier transform at the level of the basilar membrane in the inner ear. These neuronal codes are then transferred in the several relay stations of the central nervous system up to reaching the primary and non-primary auditory cerebral cortex. The ways those codes for musical sounds are obtained and represented in the cerebral cortex is only partially understood. For investigating this, various stimulation paradigms have been developed, most of them being distant from the naturalistic constantly-varying sound environments in order to maintain strict control over manipulated variables. This controlled approach limits the generalization of findings to real-life listening situations. In our recent studies, we introduced a novel experimental paradigm where participants are simply asked to naturalistically listen to music rather than to perform tasks in response to some artificial sounds. This free-listening paradigm benefits from music information retrieval, since it handles the computationally extracted features from the music as time series variables to be related to the brain signal. Our studies have advanced the understanding of music processing in the brain, demonstrating activity in large-scale networks connecting audio-motor, emotion and cognitive regions of the brain during listening to whole pieces of music.

Biography

Professor Elvira Brattico, PhD, is Principal Investigator at the Center for Music in the Brain, a center of excellence funded by the Danish National Research Foundation and affiliated with the Department of Clinical Medicine at Aarhus University and The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark. Moreover, in Finland she is Adjunct Professor ("Dosentti") of Biological Psychology at the University of Helsinki and of Music Neuroscience at the University of Jyväaskyläa. She has a background as classical concert pianist in Italy and holds a PhD in Cognitive Neuroscience and Brain Research Methods from the University of Helsinki (2007). During her academic career, she has published more than 140 scientific papers, including 2 books and several invited book chapters (e.g., Oxford University Press, Routledge). In her research, she is a recognized world pioneer in music research, particularly with regards to naturalistic music neuroscience combining MIR with brain signal. Moreover, she is a leader in music neuroaesthetics and neuroplasticity studies, as witnessed by her keynote addresses in several international conferences, associate editor appointments (e.g., Frontiers, Psychomusicology, PLOS ONE), and board membership of international scientific societies (e.g., International Association for Empirical Aesthetics, ESCOM Italy, Neuromusic) and training networks (Auditory Neuroscience, CICERO Learning). She also has wide experience with supervision and teaching having given several courses on experimental musicology, cognitive neuroscience, emotions, neurophysiology and brain research methods in Finland, Denmark, Italy and Spain.

Keynote Talk 2

11:00-12:00 Thursday, May 30

Towards explicating implicit musical knowledge: how the computational modeling of musical structures mediates between curiosity-driven and application-oriented perspectives

Anja Volk
Dept. Information and Computing Sciences, Utrecht University, Netherlands

Over the past decades we have witnessed a rapid development of music technology for many different application contexts, such as music recommender systems, music search engines, automatic music generation systems, and new interactive musical instruments. They have enabled new ways of accessing of and interacting with music. At the same time, the process of developing these new technologies employing an application-oriented perspective has revealed many open questions about music as a fundamental human trait. In this talk I will discuss how the explicit modeling of musical structures in the computational domain uncovers layers of implicit musical knowledge applied by expert and ordinary listeners when interacting with music. Starting from our research on developing online search methods for Dutch folk songs and on developing online music education systems, I will demonstrate how crucial concepts such as music similarity, harmonic variance, and repeated patterns, are scrutinized in the process of developing computational models. The explicit modeling within the computational context enhances our understanding of how we employ these concepts implicitly when interacting with music. This contributes to curiosity-driven research about music as a fundamental human trait, paving the way for cross-disciplinary approaches to music encompassing computer science, musicology and cognition.

Biography

Anja Volk (MA, MSc, PhD), Assistant Professor in Information and Computing Sciences (Utrecht University) has a dual background in mathematics and musicology which she applies to cross-disciplinary approaches to music. She has an international reputation in the areas of music information retrieval (MIR), computational musicology, and mathematical music theory. Her work has helped bridge the gap between scientific and humanistic approaches while working in in-

terdisciplinary research teams in Germany, the USA and the Netherlands. In 2011, she started her own research group at Utrecht University at the intersection of MIR, musicology and cognition. Her research aims at enhancing our understanding of music as a fundamental human trait while applying these insights for developing music technologies that offer new ways of interacting with music. Anja has given numerous invited talks worldwide and held editorships in leading journals, including the Journal of New Music Research and Musicae Scientiae. She has co-founded several international initiatives, most notably the International Society for Mathematics and Computation in Music (SMCM), the flagship journal of the International Society for Music Information Retrieval (TISMIR), and the Women in MIR (WIMIR) mentoring program, which organizes yearly mentoring rounds with participants from academia and industry, in order to foster greater diversity in MIR. Anja's commitment to diversity and inclusion was recognized with the Westerdijk Award in 2018 from Utrecht University. She is also committed to connecting different research communities and providing interdisciplinary education for the next generation through the organization of international workshops, such as the Lorentz Center in Leiden workshops on music similarity (2015), computational ethnomusicology (2017) and music, computing, and health (2019).

Keynote Talk 3

11:00-12:00 Friday, May 31

Music's changing fast; FAST is changing music

Mark Sandler
Centre for Digital Music, Queen Mary University of London, UK.

The FAST project (Fusing Audio and Semantic Technology for Intelligent Music Production and Consumption) with 5 years of UK funding, seeks to create a new technological ecosystem for recorded music that empowers people throughout the value chain, from professional performers to casual listeners, and thereby help them engage in new, more creative, immersive and dynamic musical experiences. In the future, music experiences will demand far richer musical information, that supplements the digital audio. FAST foresees that music content will be packaged in a flexible, structured way that combines audio recordings with rich, layered, standardised metadata to support interactive and adaptive musical experiences. The core unifying notion of FAST is the embodiment of these packages as Digital Music Objects, constructed using the Semantic Web concepts of ontologies, linked data and RDF. FAST therefore proposes to lay the foundations for a new generation of 'semantic audio' technologies that underpin diverse future music experiences. This keynote will describe the overall vision of FAST, and by highlighting some key outcomes (including some live demos) explore the notion of Digital Music Objects and where the occur in the music production-consumption value chain.

Biography

Mark Sandler, FREng, received the BSc and PhD degrees from the University of Essex, UK, in 1978 and 1984 respectively. He is Professor of Signal Processing and Founding Director of the Centre for Digital Music in the School of Electronic Engineering and Computer Science at Queen Mary University of London, UK. He has published nearly 500 papers in journals and conferences, graduated around 40 PhD students. He is Fellow of the Royal Academy of Engineering, IEEE, AES and IET. He is PI on the FAST Programme grant (semanticaudio.ac.uk) and co-investigator in the UKRI Centre for Doctoral Training in AI and Music (aim.qmul.ac.uk).

Abstracts

P1. Poster Session 1

11:00-11:30, 13:00-14:30 Wednesday, May 29

Session Chair: Hanna Järveläinen

P1.1 DAW-Integrated Beat Tracking for Music Production

Brett Dalton, David Johnson and George Tzanetakis

Rhythm analysis is a well researched area in music information retrieval that has many useful applications in music production. In particular, it can be used to synchronize the tempo of audio recordings with a digital audio workstation (DAW). Conventionally this is done by stretching recordings over time, however, this can introduce artifacts and alter the rhythmic characteristics of the audio. Instead, this research explores how rhythm analysis can be used to do the reverse by synchronizing a DAW's tempo to a source recording. Drawing on research by Percival and Tzanetakis, a simple beat extraction algorithm was developed and integrated with the Renoise DAW. The results of this experiment show that, using user input from a DAW, even a simple algorithm can perform on par with popular packages for rhythm analysis such as BeatRoot, IBT, and aubio.

P1.2 Interaction-Based Analysis of Freely Improvised Music

Stefano Kalonaris

This paper proposes a computational method for the analysis and visualization of structure in freely improvised musical pieces, based on source separation and interaction patterns. A minimal set of descriptive axes is used for eliciting interaction modes, regions and transitions. To this end, a suitable unsupervised segmentation model is selected based on

the author's ground truth, and is used to compute and compare event boundaries of the individual audio sources. While still at a prototypal stage of development, this method offers useful insights for evaluating a musical expression that lacks formal rules and protocols, including musical functions (e.g., accompaniment, solo, etc.) and form (e.g., verse, chorus, etc.).

P1.3 Mechanical Entanglement: A Collaborative Haptic-Music Performance

Alexandros Kontogeorgakopoulos, George Sioros and Odysseas Klissouras

Mechanical Entanglement is a musical composition for three performers. Three force feedback devices each containing two haptic faders are mutually coupled using virtual linear springs and dampers. During the composition, the performers feel each others' gestures and collaboratively process the music material. The interaction's physical modelling parameters are modified during the different sections of the composition. An algorithm which process three stereo channels, is stretching in and out-of-sync three copies of the same music. The performers are controlling the stretching algorithm and an amplitude modulation effect, both applied to recognisable classical and contemporary music recordings. Each of them is substantially modifying the length and the dynamics of the music and is simultaneously affecting subtly or abruptly the gestural behaviour of the other performers. At fixed points during the composition, the music becomes gradually in sync and the performers realign their gestures. This phasing game between gestures and sound, creates tension and emphasises the physicality of the performance.

P1.4 State Dependency - Audiovisual Interaction through Brain States

Patrick Neff, Jan Schacher and Daniel Bisig

Artistic installations using brain-computer interfaces (BCI) to interact with media in general, and sound in specific, have become increasingly numerous in the last years. Brain or mental states are commonly used to drive musical score or sound generation as well as visuals. Closed loop setups can emerge here which are comparable to the propositions of neurofeedback (NFB).

The aim of our audiovisual installation State Dependency, driven by brain states and motor imagery, was to enable the participant to engage in unbound exploration of movement through sound and space unmedi-

ated by one's corpo-reality. With the aid of an adaptive feedback loop, perception is taken to the edge.

We deployed a BCI to collect motor imagery, visual and cognitive neural activity to calculate approximate entropy (a second order measure of neural signal activity) which was in turn used to interact with the surround Immersive Lab installation. The use of entropy measures on motor imagery and various sensory modalities generates a highly accessible, reactive and immediate experience transcending common limitations of the BCI technology.

State dependency goes beyond common practice of abstract routing between mental or brain with external audiovisual states. It provides new territory of unrestrained kinaesthetic and polymodal exploration in an immersive audiovisual environment.

P1.5 Perceptual Evaluation of Modal Synthesis for Impact-Based Sounds

Adrián Barahona and Sandra Pauletto

The use of real-time sound synthesis for sound effects can improve the sound design of interactive experiences such as video games. However, synthesized sound effects can be often perceived as synthetic, which hampers their adoption. This paper aims to determine whether or not sounds synthesized using filter-based modal synthesis are perceptually comparable to sounds directly recorded. Sounds from 4 different materials that showed clear modes were recorded and synthesized using filter-based modal synthesis. Modes are the individual sinusoidal frequencies at which objects vibrate when excited. A listening test was conducted where participants were asked to identify, in isolation, whether a sample was recorded or synthesized. Results show that recorded and synthesized samples are indistinguishable from each other. The study outcome proves that, for the analysed materials, filter-based modal synthesis is a suitable technique to synthesize hit sound in real-time without perceptual compromises.

P1.6 VIBRA - Technical and Artistic Issues in an Interactive Dance Project

Andreas Bergsland, Sigurd Saue and Pekka Stokke

The paper presents the interactive dance project VIBRA, based on two workshops taking place in 2018. The paper presents the technical solutions applied and discusses artistic and expressive experiences. Central

to the discussion is how the technical equipment, implementation and mappings to different media has affected the expressive and experiential reactions of the dancers.

P1.7 Musical Tempo and Key Estimation using Convolutional Neural Networks with Directional Filters

Hendrik Schreiber and Meinard Müller

In this article we explore how the different semantics of spectrograms' time and frequency axes can be exploited for musical tempo and key estimation using Convolutional Neural Networks (CNN). By addressing both tasks with the same network architectures ranging from shallow, domain-specific approaches to deep variants with directional filters, we show that axis-aligned architectures perform similarly well as common VGG-style networks developed for computer vision, while being less vulnerable to confounding factors and requiring fewer model parameters.

P1.8 The Viking HRTF Dataset

Simone Spagnol, Kristján Bjarki Purkhús, Runar Unnthórsson and Sverrir Karl Björnsson

This paper describes the Viking HRTF dataset, a collection of head-related transfer functions (HRTFs) measured at the University of Iceland. The dataset includes fullsphere HRTFs measured on a dense spatial grid (1513 positions) with a KEMAR mannequin with 20 different artificial left pinnae attached, one at a time. The artificial pinnae were previously obtained through a custom molding procedure from 20 different lifelike human heads. The analyses of results reported here suggest that the collected acoustical measurements are robust, reproducible, and faithful to reference KEMAR HRTFs, and that material hardness has a negligible impact on the measurements compared to pinna shape. The purpose of the present collection, which is available for free download, is to provide accurate input data for future investigations on the relation between HRTFs and anthropometric data through machine learning techniques or other state-of-the-art methodologies.

P1.9 Performing with Sound Sample-Controlled Gloves and Light-Controlled Arms

Justin Pecquet, Fotis Moschos, David Fierro and Frank Pecquet

Interacting with media: The TransTeamProject (T3P) works on developing interactive gloves techniques - and other materials, with sound and/or

visual samples. Piamenca continues the work developed in Transpiano1 with a specific emphasis on visual content such as transforming sound into lights, in this case together with a strong vernacular inspiration (Flamenco). The T3P creative project is involved with art music - as opposed to commercial music - together with technical perspectives. After contextualizing the state of the art in the specific field of "body gesture technology", this paper will explain how Piamenca relates to computers in a practical sense – methods and processes to produce media transformations (both audio and visual) - and will comment on their integration in terms of sound, music and audio-visual performance. It will finally demonstrate some ideas such as trans-music orientations with regard to enhancement theories in relation with the transhumanism movement [1].

P1.10 Melody Identification in Standard MIDI Files

Zheng Jiang and Roger Dannenberg

Melody identification is an important early step in music analysis. This paper presents a tool to identify the melody in each measure of a Standard MIDI File. We also share an open dataset of manually labeled music for researchers. We use a Bayesian maximum-likelihood approach and dynamic programming as the basis of our work. We have trained parameters on data sampled from the million song dataset [1, 2] and tested on a dataset including 1703 measures of music from different genres. Our algorithm achieves an overall accuracy of 89% in the test dataset. We compare our results to previous work.

P1.11 Automatic Chord-Scale Recognition using Harmonic Pitch Class Profiles

Emir Demirel, Baris Bozkurt and Xavier Serra

This study focuses on the application of different computational methods to carry out a "modal harmonic analysis" for Jazz improvisation performances by modeling the concept of chord-scales. The Chord-Scale Theory is a theoretical concept that explains the relationship between the harmonic context of a musical piece and possible scale types to be used for improvisation. This work proposes different computational approaches for the recognition of the chordscale type in an improvised phrase given the harmonic context. We have curated a dataset to evaluate different chordscale recognition approaches proposed in this study, where the dataset consists of around 40 minutes of improvised monophonic Jazz solo performances. The dataset is made publicly available

and shared on freesound.org. To achieve the task of chord-scale type recognition, we propose one rule-based, one probabilistic and one supervised learning method. All proposed methods use Harmonic Pitch Class Profile (HPCP) features for classification. We observed an increase in the classification score when learned chordscale models are filtered with predefined scale templates indicating that incorporating prior domain knowledge to learned models is beneficial. This study has its novelty in presenting a first computational analysis on chord-scales in the context of Jazz improvisation.

D1. Demo Session 1

11:00-11:30, 13:00-14:30 Wednesday, May 29

Session Chair: Alberto Peinado

D1.1 Interacting with Digital Resonators by Acoustic Excitation

Max Neupert and Clemens Wegener

This demo presents an acoustic interface which allows to directly excite digital resonators (digital waveguides, lumped models, modal synthesis and sample convolution). Parameters are simultaneously controlled by the touch position on the same surface. The experience is an intimate and intuitive interaction with sound for percussive and melodic play.

D1.2 Melody Slot Machine

Masatoshi Hamanaka

This paper describes our interactive music system called the "Melody Slot Machine", which enables control of a holographic performer. Although many interactive music systems have been proposed, manipulating performances in real time is difficult for musical novices because melody manipulation requires expert knowledge. Therefore, we developed the Melody Slot Machine to provide an experience of manipulating melodies by enabling users to freely switch between two original melodies and morphing melodies.

D1.3 OM-AI: A Toolkit to Support AI-Based Computer-Assisted Composition Workflows in OpenMusic

Anders Vinjar and Jean Bresson

We present ongoing works exploring the use of artificial intelligence and machine learning in computer-assisted music composition. The OM-AI

library for OpenMusic implements well-known techniques for data classification and prediction, in order to integrate them in composition workflows. We give examples using simple musical structures, highlighting possible extensions and applications.

D1.4 URALi: a Proposal of Approach to Real-Time Audio Synthesis in Unity

Enrico Dorigatti

This paper aims to give a basic overview about the URALi (Unity Realtime Audio Library) project, that is currently under development. URALi is a library that aims to provide a collection of software tools to realize real-time sound synthesis in applications and softwares developed with Unity.

D1.5 A Sequencer with Decoupled Track Timing

Silvan David Peter and Gerhard Widmer

Sequencers almost exclusively share the trait of a single master clock. Each track is laid out on an isochronously spaced sequence of beat positions. Vertically aligned positions are expected to be in synchrony as all tracks refer to the same clock. In this work we present an experimental implementation of a decoupled sequencer with different underlying clocks. Each track is sequenced by the peaks of a designated oscillator. These oscillators are connected in a network and influence each other's periodicities. A familiar grid-type graphical user interface is used to place notes on beat positions of each of the interdependent but asynchronous tracks. Each track clock can be looped and node points specify the synchronisation of multiple tracks by tying together specific beat positions. This setup enables simple global control of microtiming and polyrhythmic patterns.

D1.6 Musicypher: Music for Message Encryption

Víctor Jaime Marín and Alberto Peinado

An Android application has been developed to encrypt messages using musical notes that can be automatically played from the smartphone and/or stored in a midi file to be transmitted over any available connection. The app has been designed to recover the original message on-the-fly detecting the notes played by a different device. The main objective of this project is to make known the relationship between cryptography and music showing old systems (XVII century) implemented

in modern devices, the smartphones, using the tools they provide us, such as the microphone, the speakers, and the internal storage.

D1.7 A Platform for Processing Sheet Music and Developing Multimedia Application

Fu-Hai Frank Wu

Imaging when reading sheet music on computing devices, users could listen audio synchronizing with the sheet. To this end, the sheet music must be acquired, analyzed and transformed into digitized information of melody, rhythm, duration, chord, expressiveness and physical location of scores. As we know, the optical music recognition (OMR) is an appropriate technology to approach the purpose. However, the commercial OMR system of numbered music notation is not available as best as our knowledge. In the paper, we demonstrate our proprietary OMR system and show three human-interactive applications: sheet music browser and multimodal accompanying and games for sight-reading of sheet music. With the illustration, we hope to foster the usage and obtain the valuable opinions of the OMR system and the applications.

D1.8 Capturing the Reaction Time to Distinguish between Voice and Music

Alejandro Villena-Rodríguez, Lorenzo J. Tardón, Isabel Barbancho, Ana M. Barbancho, Irene Gómez-Plazas and María-José Varela-Salinas

Reaction times (RTs) are an important source of information in experimental psychology and EEG data analysis. While simple auditory RT has been widely studied, response time when discriminating between two different auditory stimuli have not been determined yet. The purpose of this experiment is to measure the RT for the discrimination between two different auditory stimuli: speech and instrumental music.

D1.9 Physical Models and Real-Time Control with the Sensel Morph

Silvin Willemsen, Stefan Bilbao, Nikolaj Andersson and Stefania Serafin

In this demonstration we present novel physical models controlled by the Sensel Morph interface.

S1. Oral Session 1 Sonic Interactions

11:30-13:00 Wednesday, May 29

Session Chair: Stefania Serafin

S1.1 Towards a High-Performance Platform for Sonic Interaction Interfaces

Stefano Fasciani and Manohar Vohra

In this paper we introduce a hardware platform to prototype interfaces of demanding sonic interactive systems. We target applications featuring a large array of analog sensors requiring data acquisition and transmission to computers at fast rates, with low latency, and high band- width. This work is part of an ongoing project which aims to provide designers with a cost effective and accessible platform for fast prototyping of complex interfaces for sonic interactive systems or musical instruments. The high performances are guaranteed by a SoC FPGA. The functionality of the platform can be customized without requiring significant technical expertise. In this paper, we discuss the principles, the current design, and the preliminary evaluation against common microcontroller-based platforms. The proposed platform can sample up to 96 analog channels at rates up to 24 kHz and stream the data via UDP to computers with a sub millisecond latency.

S1.2 Digital Manufacturing for Musical Applications: A Survey of Current Status and Future Outlook

Doga Cavdir

In the design of new musical instruments, from acoustic to digital, merging conventional methods with new technologies has been one of the most commonly adopted approaches. Incorporation of prior design expertise with experimental or sometimes industrial methods suggests new directions in both design for musical expression and development of new manufacturing tools. This paper describes key concepts of digital manufacturing processes in musical instrument design. It provides a review of current manufacturing techniques which are commonly used to create new musical interfaces and dis- cusses future directions of digital fabrication which are applicable to numerous areas in music research, such as digital musical instrument (DMI) design, interaction de- sign, acoustics,

performance studies, and education. Additionally, the increasing availability of digital manufacturing tools and fabrication labs all around the world make these processes an integral part of the design and music classes. Examples of digital fabrication labs and manufacturing techniques used in education for student groups whose age ranges from elementary to university level are presented. In the context of this paper, it is important to consider how the growing fabrication technology will influence the design and fabrication of musical instruments, as well as what forms of new interaction methods and aesthetics might emerge.

S1.3 Real Time Audio Digital Signal Processing with Faust and the Teensy

Romain Michon, Yann Orlarey, Stéphane Letz , and Dominique Fober

In the design of new musical instruments, from acoustic to digital, merging conventional methods with new technologies has been one of the most commonly adopted approaches. Incorporation of prior design expertise with experimental or sometimes industrial methods suggests new directions in both design for musical expression and development of new manufacturing tools. This paper describes key concepts of digital manufacturing processes in musical instrument design. It provides a review of current manufacturing techniques which are commonly used to create new musical interfaces and dis- cusses future directions of digital fabrication which are applicable to numerous areas in music research, such as digital musical instrument (DMI) design, interaction de- sign, acoustics, performance studies, and education. Additionally, the increasing availability of digital manufacturing tools and fabrication labs all around the world make these processes an integral part of the design and music classes. Examples of digital fabrication labs and manufacturing techniques used in education for student groups whose age ranges from elementary to university level are presented. In the context of this paper, it is important to consider how the growing fabrication technology will influence the design and fabrication of musical instruments, as well as what forms of new interaction methods and aesthetics might emerge.

S1.4 Sound Design through Large Audience Interaction

Kjetil Falkenberg Hansen, Martin Ljungdahl-Eriksson , and Ricardo Atienza

In collaboration with Volvo Cars, we presented a novel design tool to a large public of approximately three million people at the three leading motor shows in 2017 in Geneva, Shanghai and New York. The purpose

of the tool was to explore the relevance of interactive audio-visual strategies for supporting the development of sound environments in future silent cars, i.e., a customised sonic identity that would alter the sonic ambience for the driver and by-passers. This new tool should be able to efficiently collect non-experts' sonic preferences for different given contexts. The design process should allow for a high-level control of complex synthesised sounds. The audience interacted individually using a single-touch selection of colour from five palettes and applying it by pointing to areas in a colour-book painting showing a road scene. Each palette corresponded to a sound, and the colour nuance in the palette corresponded to certain tweaking of the sound. In effect, the user selected and altered each sound, added it to the composition, and finally would hear a mix of layered sounds based on the colouring of the scene. The installation involved large touch screens with high quality headphones. In the study presented here, we examine differences in sound preferences between two audiences and a control group, and evaluate the feasibility of the tool based on the sound designs that emerged.

S1.5 Evaluating a Continuous Sonic Interaction: Comparing a Performable Acoustic and Digital Everyday Sound

Fiona Keenan and Sandra Pauletto

This paper reports on the procedure and results of an experiment to evaluate a continuous sonic interaction with an everyday wind-like sound created by both acoustic and digital means. The interaction is facilitated by a mechanical theatre sound effect, an acoustic wind machine, which is performed by participants. This work is part of wider research into the potential of theatre sound effect designs as a means to study multisensory feedback and continuous sonic interactions. An acoustic wind machine is a mechanical device that affords a simple rotational gesture to a performer; turning its crank handle at varying speeds produces a wind-like sound. A prototype digital model of a working acoustic wind machine is programmed, and the acoustic interface drives the digital model in performance, preserving the same tactile and kinaesthetic feedback across the continuous sonic interactions. Participants' performances are elicited with sound stimuli produced from simple gestural performances of the wind-like sounds. The results of this study show that the acoustic wind machine is rated as significantly easier to play than its digital counterpart. Acoustical analysis of the corpus of participants' performances

suggests that the mechanism of the wind machine interface may play a role in guiding their rotational gestures.

S2. Oral Session 2 Nordic SMC

14:30-16:30 Wednesday, May 29

Session Chair: Vesa Välimäki

S2.1 Adaptive Loudness Compensation in Music Listening

Leonardo Fierro, Jussi Rämö and Vesa Välimäki

The need for loudness compensation is a well known fact arising from the nonlinear behavior of human sound perception. Music and other sounds are mixed and mastered at a certain loudness level, usually louder than the level at which they are commonly played. This implies a change in the perceived spectral balance of the sound, which is largest in the low-frequency range. As the volume setting in music playing is decreased, a loudness compensation filter can be used to boost the bass appropriately, so that the low frequencies are still heard well and the perceived spectral balance is preserved. The present paper proposes a loudness compensation function derived from the standard equal-loudness-level contours and its implementation via a digital first-order shelving filter. Results of a formal listening test validate the accuracy of the proposed method.

S2.2 Toward Automatic Tuning of the Piano

Joonas Tuovinen, Jamin Hu and Vesa Välimäki

The tuning of a piano is a complicated and time-consuming process, which is usually left for a professional tuner. To make the process faster and non-dependent on the skills of a professional tuner, a semi-automatic piano tuning system is developed. The aim of the system is to help a non-professional person to tune a grand piano with the help of a computer and a motorized tuning machine. The system composes of an aluminum frame, a stepper motor, an Arduino processor, a microphone, and a laptop computer. The stepper motor changes the tuning of the piano strings by turning the pins connected to them whereas the aluminum frame holds the motor in place. The Arduino controls the motor. The microphone and the computer are used as a part of a closed loop control system, which is used to tune the strings automatically. The control system tunes the strings by minimizing the difference between the

current and optimal fundamental frequency. The current fundamental frequency is obtained with an inharmonicity coefficient estimation algorithm, and the optimal fundamental frequency is calculated with a novel tuning process, called the Connected Reference Interval (CRI) tuning. With the CRI process, a tuning close to that of a professional tuner is achieved with a deviation of 2.5 cents (RMS) between the keys A_0 and G_5 and 8.1 cents (RMS) between $G\#_5$ and C_8, where the tuner's results are not very consistent.

S2.3 Real-time Control of Large-scale Modular Physical Models using the Sensel Morph

Silvin Willemsen, Nikolaj Andersson, Stefania Serafin and Stefan Bilbao

In this paper, implementation, instrument design and control issues surrounding a modular physical modelling synthesis environment are described. The environment is constructed as a network of stiff strings and a resonant plate, accompanied by user-defined connections and excitation models. The bow, in particular, is a novel feature in this setting. The system as a whole is simulated using finite difference (FD) methods. The mathematical formulation of these models is presented, alongside several new instrument designs, together with a real-time implementation in JUCE using FD methods. Control is through the Sensel Morph.

S2.4 An Interactive Music Synthesizer for Gait Training in Neurorehabilitation

Prithvi Kantan and Sofia Dahl

Rhythm-based auditory cues have been shown to significantly improve walking performance in patients with numerous neurological conditions. This paper presents the design, implementation and evaluation of a gait training device capable of real-time synthesis and automated manipulation of rhythmic musical stimuli, as well as auditory feedback based on measured walking parameters. The proof-of-concept was evaluated with six healthy participants, as well as through critical review by one neurorehabilitation specialist. Stylistically, the synthesized music was found by participants to be conducive to movement, but not uniformly enjoyable. The gait capture/feedback mechanisms functioned as intended, although discrepancies between measured and reference gait parameter values may necessitate a more robust measurement system. The specialist acknowledged the potential of the gait measurement and auditory feedback as novel rehabilitation aids, but stressed the need for additional

gait measurements, superior feedback responsiveness and greater functional versatility in order to cater to individual patient needs. Further research must address these findings, and tests must be conducted on real patients to ascertain the utility of such a device in the field of neurorehabilitation.

S2.5 From Vocal Sketching to Sound Models by Means of a Sound-Based Musical Transcription System

Claudio Panariello, Mattias Sköld, Emma Frid and Roberto Bresin

This paper explores how notation developed for the representation of sound-based musical structures could be used for the transcription of vocal sketches representing expressive robot movements. A mime actor initially produced expressive movements which were translated to a humanoid robot. The same actor was then asked to illustrate these movements using vocal sketching. The vocal sketches were transcribed by two composers using sound-based notation. The same composers later synthesized new sonic sketches from the annotated data. Different transcriptions and synthesized versions of these were compared in order to investigate how the audible outcome changes for different transcriptions and synthesis routines. This method provides a palette of sound models suitable for the sonification of expressive body movements.

S2.6 Tempo and Metrical Analysis by Tracking Multiple Metrical Levels Using Autocorrelation

Olivier Lartillot and Didier Grandjean

We present a method for tempo estimation from audio recordings based on signal processing and peak tracking, and not depending on training on ground-truth data. First an accentuation curve, emphasising the temporal location and accentuation of notes, is based on a detection of bursts of energy localised in time and frequency. This enables to detect notes in dense polyphonic texture, while ignoring spectral fluctuation produced by vibrato and tremolo. Periodicities in the accentuation curve are detected using an improved version of autocorrelation function. Hierarchical metrical structures, composed of a large set of periodicities in pairwise harmonic relationships, are tracked over time. In this way, the metrical structure can be tracked even if the rhythmical emphasis switches from one metrical level to another.

This approach, compared to all the other participants to the MIREX Audio Tempo Extraction from 2006 to 2018, is the third best one among

those that can track tempo variations. While the two best methods are based on machine learning, our method suggests a way to track tempo founded on signal processing and heuristics-based peak tracking. Besides, the approach offers for the first time a detailed representation of the dynamic evolution of the metrical structure. The method is integrated into MIRtoolbox, a Matlab toolbox freely available.

S3. Oral Session 3 — 09:00-10:30 Thursday, May 30
Augmented and Virtual Realities

Session Chair: Marcella Mandanici

S3.1 Comparison and Implementation of Data Transmission Techniques through Analog Audio Signals in the Context of Augmented Mobile Instruments

Romain Michon, Yann Orlarey, Stéphane Letz and Dominique Fober

Augmented mobile instruments combine digitally-fabricated elements, sensors, and smartphones to create novel musical instruments. Communication between the sensors and the smartphone can be challenging as there doesn't exist a universal lightweight way to connect external elements to this type of device. In this paper, we investigate the use of two techniques to transmit sensor data through the built-in audio jack input of a smartphone: digital data transmission using the Bell 202 signaling technique, and analog signal transmission using digital amplitude modulation and demodulation with Goertzel filters. We also introduce tools to implement such systems using the FAUST programming language and the Teensy development board.

S3.2 Mass-Interaction Physical Models for Sound and Multi-Sensory Creation: Starting Anew

Jerome Villeneuve, and James Leonard

Mass-interaction methods for sound synthesis, and more generally for digital artistic creation, have been studied and explored for over three decades, by a multitude of researchers and artists. However, for a number of reasons this research has remained rather confidential, subsequently overlooked and often considered as the odd-one-out of physically-based synthesis methods, of which many have grown exponentially in

popularity over the last ten years. In the context of a renewed research effort led by the authors on this topic, this paper aims to reposition mass-interaction physical modelling in the contemporary fields of Sound and Music Computing and Digital Arts: what are the core concepts? The end goals? And more importantly, which relevant perspectives can be foreseen in this current day and age? Backed by recent developments and experimental results, including 3D mass-interaction modelling and emerging non-linear effects, this proposed reflection casts a first canvas for an active, and resolutely outreaching, research on mass-interaction physical modelling for the arts.

S3.3 Exploring the Effects of Diegetic and Non-diegetic Audiovisual Cues on Decision-making in Virtual Reality

Anıl Çamcı

The user experience of a virtual reality intrinsically depends upon how the underlying system relays information to the user. Auditory and visual cues that make up the user interface of a VR help users make decisions on how to proceed in a virtual scenario. These interfaces can be diegetic (i.e. presented as part of the VR) or non-diegetic (i.e. presented as an external layer superimposed onto the VR). In this paper, we explore how auditory and visual cues of diegetic and non-diegetic origins affect a user's decisionmaking process in VR. We present the results of a pilot study, where users are placed into virtual situations and are expected to make choices upon conflicting suggestions as to how to complete a given task. We analyze the quantitative data pertaining to user preferences for modality and diegetic-quality. We also discuss the narrative effects of the cue types based on a follow-up survey conducted with the users.

S3.4 OSC-XR: A Toolkit for Extended Reality Immersive Music Interfaces

David Johnson, Daniela Damian and George Tzanetakis

Currently, developing immersive music environments for extended reality (XR) can be a tedious process requiring designers to build 3D audio controllers from scratch. OSCXR is a toolkit for Unity intended to speed up this process through rapid prototyping, enabling research in this emerging field. Designed with multi-touch OSC controllers in mind, OSC-XR simplifies the process of designing immersive music environments by providing prebuilt OSC controllers and Unity scripts for designing custom ones. In this work, we describe the toolkit's infrastruc-

ture and perform an evaluation of the controllers to validate the generated control data. In addition to OSC-XR, we present UnityOscLib, a simplified OSC library for Unity utilized by OSC-XR.We implemented three use cases, using OSCXR, to inform its design and demonstrate its capabilities. The Sonic Playground is an immersive environment for controlling audio patches. Hyperemin is an XR hyperinstrument environment in which we augment a physical theremin with OSC-XR controllers for real-time control of audio processing. Lastly, we add OSC-XR controllers to an immersive T-SNE visualization of music genre data for enhanced exploration and sonification of the data. Through these use cases, we explore and discuss the affordances of OSC-XR and immersive music interfaces.

S3.5 No Strings Attached: Force and Vibrotactile Feedback in a Guitar Simulation

Andrea Passalenti, Razvan Paisa, Niels Christian Nilsson, Nikolaj S. Andersson, Federico Fontana, Rolf Nordahl and Stefania Serafin

In this paper we propose a multisensory simulation of plucking guitar strings in virtual reality. The auditory feedback is generated by a physics-based simulation of guitar strings, and haptic feedback is provided by a combination of high fidelity vibrotactile actuators and a Phantom Omni haptic device. Moreover, we present a user study (n=29) exploring the perceived realism of the simulation and the relative importance of force and vibrotactile feedback for creating a realistic experience of plucking virtual strings. The study compares four conditions: no haptic feedback, vibrotactile feedback, force feedback, and a combination of force and vibrotactile feedback. The results indicate that the combination of vibrotactile and force feedback elicits the most realistic experience, and during this condition, the participants were less likely to inadvertently hit strings after the intended string had been plucked. Notably, no statistically significant differences were found between the conditions involving either vibrotactile or force feedback, which points towards an indication that haptic feedback is important but does not need to be high fidelity in order to enhance the quality of the experience.

P2. Poster Session 2

10:30-11:00, 13:00-14:30 Thursday, May 30

Session Chair: Anja Volk

P2.1 RaveForce: A Deep Reinforcement Learning Environment for Music Generation

Qichao Lan, Jim Tørresen and Alexander Refsum Jensenius

RaveForce is a programming framework designed for a computational music generation method that involves audio sample level evaluation in symbolic music representation generation. It comprises a Python module and a SuperCollider quark. When connected with deep learning frameworks in Python, RaveForce can send the symbolic music representation generated by the neural network as Open Sound Control messages to the SuperCollider for non-real-time synthesis. SuperCollider can convert the symbolic representation into an audio file which will be sent back to the Python as the input of the neural network. With this iterative training, the neural network can be improved with deep reinforcement learning algorithms, taking the quantitative evaluation of the audio file as the reward. In this paper, we find that the proposed method can be used to search new synthesis parameters for a specific timbre of an electronic music note or loop.

P2.2 Music Temperaments Evaluation Based on Triads

Tong Meihui and Satoshi Tojo

It is impossible for one temperament to achieve optimally both of consonance and modulation. The dissonance level has been calculated by the ratio of two pitch frequencies, however in the current homophonic music, the level should be measured by chords, especially by triads. In this research, we propose to quantify them as Dissonance Index of Triads (DIT).We select eight well-known temperaments and calculate seven diatonic chords in 12 keys and compare the weighted average and standard deviation to quantify the consonance, and then we visualize our experimental results in a two-dimensional chart to compare the tradeoffs between consonance and modulation.

P2.3 Composing Space in the Space: An Augmented and Virtual Reality Sound Spatialization System

Giovanni Santini

This paper describes a tool for gesture-based control of sound spatialization in Augmented and Virtual Reality (AR and VR). While the increased precision and availability of sensors of any kind has made possible, in the last twenty years, the development of a considerable number of interfaces for sound spatialization control through gesture, their integration with VR and AR has not been fully explored yet. Such technologies provide an unprecedented level of interaction, immersivity and ease of use, by letting the user visualize and modify position, trajectory and behaviour of sound sources in 3D space. Like VR/AR painting programs, the application allows to draw lines that have the function of 3D automations for spatial motion. The system also stores information about movement speed and directionality of the sound source. Additionally, other parameters can be controlled from a virtual menu. The possibility to alternate AR and VR allows to switch between different environment (the actual space where the system is located or a virtual one). Virtual places can also be connected to different room parameters inside the spatialization algorithm.

P2.4 Graph Based Physical Models for Sound Synthesis

Pelle Juul Christensen and Stefania Serafin

We focus on physical models in which multiple strings are connected via junctions to form graphs. Starting with the case of the 1D wave equation, we show how to extend it to a string branching into two other strings, and from there how to build complex cyclic and acyclic graphs. We introduce the concept of dense models and show that a discretization of the 2D wave equation can be built using our methods, and that there are more efficient ways of modelling 2D wave propagation than a rectangular grid. We discuss how to apply Dirichlet and Neumann boundary conditions to a graph model, and show how to compute the frequency content of a graph using common methods. We then prove general lower and upper bounds computational complexity. Lastly, we show how to extend our results to other kinds of acoustical objects, such as linear bars, and how to add dampening to a graph model. A reference implementation in MATLAB and an interactive JUCE/C++ application is available online.

P2.5 ADPET: Exploring the Design, Pedagogy, and Analysis of a Mixed Reality Application for Piano Training

Lynda Gerry, Sofia Dahl and Stefania Serafin

One of the biggest challenges in learning how to play a musical instrument is learning how to move one's body with a nuanced physicality. Technology can expand available forms of physical interactions to help cue specific movements and postures. This cueing can reinforce new sensorimotor couplings to enhance motor learning and performance. Using Mixed Reality (MR), we present a system that allows students to share a first-person audiovisual perspective with a piano teacher. Students place their hands into the virtual gloves of a teacher. Motor learning and audio-motor associations are reinforced through motion feedback and spatialized audio. The Augmented Design to Embody a Piano Teacher (ADEPT) application is an early design prototype of this piano training system.

P2.6 A Model Comparison for Chord Prediction on the Annotated Beethoven Corpus

Kristoffer Landsnes, Liana Mehrabyan, Victor Wiklund, Robert Lieck, Fabian Moss and Martin Rohrmeier

This paper models predictive processing of chords using a corpus of Ludwig van Beethoven's string quartets. A recently published dataset consisting of expert harmonic analyses of all Beethoven string quartets was used to evaluate an n-gram language model as well as a recurrent neural network (RNN) architecture based on long-short-term memory (LSTM). We compare model performances over different periods of Beethoven's creative activity and provide a baseline for future research on predictive processing of chords in full Roman numeral representation on this dataset.

P2.7 Sonic Characteristics of Robots in Films

Adrian B. Latupeirissa, Emma Frid and Roberto Bresin

Robots are increasingly becoming an integral part of our everyday life. Expectations on robots could be influenced by how robots are represented in science fiction films. We hypothesize that sonic interaction design for real-world robots may find inspiration from sound design of fictional robots. In this paper, we present an exploratory study focusing on sonic characteristics of robot sounds in films. We believe that findings

from the current study could be of relevance for future robotic applications involving the communication of internal states through sounds, as well for sonification of expressive robot movements. Excerpts from five films were annotated and analysed using Long Time Average Spectrum (LTAS). As an overall observation, we found that robot sonic presence is highly related to the physical appearance of robots. Preliminary results show that most of the robots analysed in this study have "metallic" voice qualities, matching the material of their physical form. Characteristics of robot voices show significant differences compared to voices of human characters; fundamental frequency of robotic voices is either shifted to higher or lower values, and the voices span over a broader frequency band.

P2.8 Virtual Reality Music Intervention to Reduce Social Anxiety in Adolescents Diagnosed with Autism Spectrum Disorder

Ali Adjorlu, Nathaly Belen Betancourt Barriga and Stefania Serafin

This project investigates the potentials of Head-Mounted-Display (HMD) based Virtual Reality (VR) that incorporates musical elements as a tool to perform exposure therapy. This is designed to help adolescents diagnosed with Autism Spectrum Disorder (ASD) to deal with their social anxiety. An application was developed that combines the possibility of singing in VR while a virtual audience provides feedback. A pilot test was conducted on four adolescents diagnosed with ASD from a school for adolescents with special needs in Denmark. All four participants had shown signs of social anxiety according to their teachers. The initial results from this pilot study indicate that despite the participants' were capable of singing in front of the virtual audience without reporting a major level of social anxiety.

P2.9 Teach Me Drums: Learning Rhythms through the Embodiment of a Drumming Teacher in Virtual Reality

Mie Moth-Poulsen, Tomasz Bednarz, Volker Kuchelmeister and Stefania Serafin

This paper investigates how to design an embodied learning experience of a drumming teacher playing hand drums, to aid higher rhythm understanding and accuracy. By providing novices the first-person perspective of a drumming teacher while learning to play a West-African djembe drum, participants' learning was measured objectively by their ability to follow the drumming teachers rhythms.

Participants subjective learning was assessed through a self assessment questionnaire measuring aspects of flow, user-experience, oneness, and presence. Two test iterations were conducted. In both there was found no significance difference in participants' ability to follow the drumming teacher' s tempo for the experimental group exposed to the first-person perspective of the teacher in a Virtual Reality (VR) drum lesson, versus the control group exposed to a 2D version of the stereoscopic drum lesson. There was found a significant difference in the experimental group' s presence scores in the first test iteration, and a significant difference in experimental group' s oneness scores in the second test iteration. Participants' subjective feelings indicated enjoyment and motivation to the presented learning technique in both groups.

P2.10 Real-time Mapping of Periodic Dance Movements to Control Tempo in Electronic Dance Music

Lilian Jap and Andre Holzapfel

Dancing in beat to the music of one's favorite DJ leads oftentimes to a powerful and euphoric experience. In this study we investigate the effect of putting a dancer in control of music playback tempo based on a real-time estimation of body rhythm and tempo manipulation of audio. A prototype was developed and tested in collaboration with users, followed by a main study where the final prototype was evaluated. A questionnaire was provided to obtain ratings regarding subjective experience, and open-ended questions were posed in order to obtain further insights for future development. Our results imply the potential for enhanced engagement and enjoyment of the music when being able to manipulate the tempo, and document important design aspects for real-time tempo control.

P2.11 Increasing Access to Music in SEN Settings

Tom Davis, Daniel Pierson and Ann Bevan

This paper presents some of the outcomes of a one year Higher Education Innovation Fund1 funded project examining the use of music technology to increase access to music for children within special educational need (SEN) settings. Despite the widely acknowledged benefits of interacting with music for children with SEN there are a number of well documented barriers to access. These barriers take a number of forms including financial, knowledge based or attitudinal. The aims of this project were to assess the current music technology provision in SEN

schools within a particular part of the Dorset region, UK, determine the barriers they were facing and develop strategies to help the schools overcome these barriers. An overriding concern for this project was to leave the schools with lasting benefit and meaningful change. As such an Action Research methodology was followed, which has at its heart an understanding of the participants as co-researchers helping ensure any solutions presented met the needs of the stakeholders. The presumption by the researchers was that the schools needed new technology to help overcome barriers. However, although technological solutions to problems were presented to the school, it was found that the main issues were around the flexibility of equipment to be used in different locations, staff time and staff attitudes to technology. These issues were addressed through the Action Research methodology to ensure that the technology designed worked for these particular use case scenarios.

D2. Demo Session 2

10:30-11:00, 13:00-14:30 Thursday, May 30

Session Chair: Hendrik Schreiber

D2.1 Interacting with Musebots (that don't really listen)

Arne Eigenfeldt

TinySounds is a collaborative work for live performer and musebot ensemble. Musebots are autonomous musical agents that interact, via messaging, to create a musical performance with or without human interaction.

D2.2 Extending Jamsketch: An Improvisation Support System

Akane Yasuhara, Junko Fujii and Tetsuro Kitahara

We previously introduced JamSketch, a system which enabled users to improvise music by drawing a melodic outline. However, users could not control the rhythm and intensity of the generated melody. Here, we present extensions to JamSketch to enable rhythm and intensity control.

D2.3 Visualizing Music Genres using a Topic Model

Swaroop Panda, Vinay P. Namboodiri and Shatarupa Thakurta Roy

Music Genres serve as an important meta-data in the field of music information retrieval and have been widely used for music classification

and analysis tasks. Visualizing these music genres can thus be helpful for music exploration, archival and recommendation. Probabilistic topic models have been very successful in modelling text documents. In this work, we visualize music genres using a probabilistic topic model. Unlike text documents, audio is continuous and needs to be sliced into smaller segments. We use simple MFCC features of these segments as musical words. We apply the topic model on the corpus and subsequently use the genre annotations of the data to interpret and visualize the latent space.

D2.4 CompoVOX: Real-Time Sonification of Voice

Daniel Hernán Molina Villota, Isabel Barbancho and Antonio Jurado-Navas

It has been developed an interactive application that allows sonify human voice and visualize a graphic interface in relation to the sounds produced. This program has been developed in MAX MSP, and it takes the spoken voice signal, and from its treatment, it allows to generate an automatic and tonal musical composition.

D2.5 Facial Activity Detection to Monitor Attention and Fatigue

Oscar Cobos, Jorge Munilla, Ana M. Barbancho, Isabel Barbancho and Lorenzo J. Tardón

In this contribution, we present a facial activity detection system using image processing and machine learning techniques. Facial activity detection allows monitoring people emotional states, attention, fatigue, reactions to different situations, etc., in a non-intrusive way. The designed system can be used in many fields such as education and musical perception. Monitoring the facial activity of a person can help us to know if it is necessary to take a break, change the type of music that is being listened to or modify the way of teaching the class.

D2.6 The Chordinator: An Interactive Music Learning Device

Eamon McCoy, John Greene, Jared Henson, James Pinder, Jonathon Brown and Claire Arthur

The Chordinator is an interactive and educational music device consisting of a physical board housing a “chord stacking” grid. There is an 8x4 grid on the board which steps through each of the eight columns from left to right at a specified tempo, playing the chords you have built in each column. To build a chord, you place blocks on the board which represent major or minor thirds above blocks that designate a root (or

bass) note represented as a scale degree. In the bottom row, the user specifies a bass (root) note, and any third blocks placed above it will add that interval above the bass note. Any third blocks placed above other third blocks add an additional interval above the prior one, creating a chord. There are three rows above each root allowing either triads or seventh chords to be built. This interface combined with the board design is intended to create a simple representation of chord structure. Using the blocks, the user can physically "build" a chord using the most fundamental skills, in this case "stacking your thirds." One also learns which chords work the best in a sequence. It provides quick satisfaction and a fun, interactive way to learn about the structure of chords and can even spark creativity as people build interesting progressions or try to recreate progressions they love from their favorite music.

D2.7 Automatic Chord Recognition in Music Education Applications

Sascha Grollmisch and Estefania Cano

In this work, we demonstrate the market-readiness of a recently published state-of-the-art chord recognition method, where automatic chord recognition is extended beyond major and minor chords to the extraction of seventh chords. To do so, the proposed chord recognition method was integrated in the Songs2See Editor, which already includes the automatic extraction of the main melody, bass line, beat grid, key, and chords for any musical recording.

D2.8 Sonic Sweetener Mug

Signe Lund Mathiesen, Derek Victor Byrne and Qian Janice Wang

Eating is one of the most sensory of all activities that we take part in. Apart from tasting, it involves both the food and the environment. The multitude of different sensory inputs (from the smell of the food and the colour of the plate, to the lighting in the room and the ambient soundscape) all affect the way we think about and perceive our food. Much like eating, listening is a fundamental part of most lives; and similar to the role of food, music can modulate our feelings, our mood, and our experiences in life.

This demo explores the common link between these two phenomena, specifically the way in which what we taste can be influenced by what we listen to.

S4. Oral Session 4
SMC Tools and Methodologies

12:00-13:00 Thursday, May 30

Session Chair: Emma Frid

S4.1 A Framework for the Development and Evaluation of Graphical Interpolation for Synthesizer Parameter Mappings

Darrell Gibson and Richard Polfreman

This paper presents a framework that supports the development and evaluation of graphical interpolated parameter mapping for the purpose of sound design. These systems present the user with a graphical pane, usually two-dimensional, where synthesizer presets can be located. Moving an interpolation point cursor within the pane will then create new sounds by calculating new parameter values, based on the cursor position and the interpolation model used. The exploratory nature of these systems lends itself to sound design applications, which also have a highly exploratory character. However, populating the interpolation space with "known" preset sounds allows the parameter space to be constrained, reducing the design complexity otherwise associated with synthesizer-based sound design. An analysis of previous graphical interpolators is presented and from this a framework is formalized and tested to show its suitability for the evaluation of such systems. The framework has then been used to compare the functionality of a number of systems that have been previously implemented. This has led to a better understanding of the different sonic outputs that each can produce and highlighted areas for further investigation.

S4.2 Composing with Sounds: Designing an Object Oriented Daw for the Teaching of Sound-Based Composition

Stephen Pearse, Leigh Landy, Duncan Chapman, David Holland and Mihai Eni

This paper presents and discusses the Compose With Sounds (CwS) Digital Audio Workstation (DAW) and its approach to sequencing musical materials. The system is designed to facilitate the composition within the realm of Sound-based music wherein sound objects (real or synthesised) are main musical unit of construction over traditional musical notes. Unlike traditional DAW's or graphical audio programming environments (such as Pure Data, Max MSP etc.) that are based around interactions

with sonic materials within tracks or audio graphs, the implementation presented here is based solely around sound objects. To achieve this a bespoke cross-platform audio engine known FSOM (Free Sound Object Mixer) was created in C++. To enhance the learning experience, imagery, dynamic 3D animations and models are used to allow for efficient exploration and learning. All tools within the system are controlled by a flexible permissions system that allows users or workshop leaders to create sessions with specific features based on their requirements. The system is part of a suite of pedagogical tools currently in development for the creation of experimental electronic music.

S4.3 Insights in Habits and Attitudes Regarding Programming Sound Synthesizers: A Quantitative Study

Gordan Kreković

Sound synthesis represents an indispensable tool for modern composers and performers, but achieving desired sonic results often requires a tedious manipulation of various numeric parameters. In order to facilitate this process, a number of possible approaches have been proposed, but without a systematic user research that could help researchers to articulate the problem and to make informed design decisions. The purpose of this study is to fill that gap and to investigate attitudes and habits of sound synthesizer users. The research was based on a questionnaire answered by 122 participants, which, beside the main questions about habits and attitudes, covered questions about their demographics, profession, educational background and experience in using sound synthesizers. The results were quantitatively analyzed in order to explore relations between all those dimensions. The main results suggest that the participants more often modify or create programs than they use existing presets or programs and that such habits do not depend on the participants' education, profession, or experience.

S5. Oral Session 5
Sound Synthesis & Analysis

14:30-16:30 Thursday, May 30

Session Chair: Federico Avanzini

S5.1 Experimental Verification of Dispersive Wave Propagation on Guitar Strings

Dmitri Kartofelev, Joann Gustav Arro and Vesa Välimäki

Experimental research into the fundamental acoustic aspects of musical instruments and other sound generating devices is an important part of the history of musical acoustics and of physics in general. This paper presented experimental proof of dispersive wave propagation on metal guitar strings. The high resolution experimental data of string displacement are gathered using video-kymographic high-speed imaging of the vibrating string. The experimental data are indirectly compared against a dispersive Euler-Bernoulli type model described by a PDE. In order to detect the minor wave features associated with the dispersion and distinguish them from other effects present, such as frequency-dependent dissipation, a second model lacking the dispersive (stiffness) term is used. Unsurprisingly, the dispersive effects are shown to be minor but definitively present. The results and methods presented here in general should find application in string instrument acoustics.

S5.2 Real-Time Modeling of Audio Distortion Circuits with Deep Learning

Eero-Pekka Damskägg, Lauri Juvela and Vesa Välimäki

This paper studies deep neural networks for modeling of audio distortion circuits. The selected approach is black-box modeling, which estimates model parameters based on the measured input and output signals of the device. Three common audio distortion pedals having a different circuit configuration and their own distinctive sonic character have been chosen for this study: the Ibanez Tube Screamer, the Boss DS-1, and the Electro-Harmonix Big Muff Pi. A feedforward deep neural network, which is a variant of the WaveNet architecture, is proposed for modeling these devices. The size of the receptive field of the neural network is selected based on the measured impulse-response length of the circuits. A real-time implementation of the deep neural network is presented, and it is shown that the trained models can be run in real time on a modern desktop computer. Furthermore, it is shown that three minutes

of audio is a sufficient amount of data for training the models. The deep neural network studied in this work is useful for real-time virtual analog modeling of nonlinear audio circuits.

S5.3 MI-GEN~: An Efficient and Accessible Mass-Interaction Sound Synthesis Toolbox

James Leonard and Jerome Villeneuve

Physical modelling techniques are now an essential part of digital sound synthesis, allowing for the creation of complex timbres through the simulation of virtual matter and expressive interaction with virtual vibrating bodies. However, placing these tools in the hands of the composer or musician has historically posed challenges in terms of a) the computational expense of most real-time physically based synthesis methods, b) the difficulty of implementing these methods into modular tools that allow for the intuitive design of virtual instruments, without expert physics and/or computing knowledge, and c) the generally limited access to such tools within popular software environments for musical creation. To this end, a set of open-source tools for designing and computing mass-interaction networks for physically-based sound synthesis is presented. The audio synthesis is performed within Max/MSP using the gen~ environment, allowing for simple model design, efficient calculation of systems containing single-sample feedback loops, as well as extensive real-time control of physical parameters and model attributes. Through a series of benchmark examples, we exemplify various virtual instruments and interaction designs.

S5.4 Combining Texture-Derived Vibrotactile Feedback, Concatenative Synthesis and Photogrammetry for Virtual Reality Rendering

Eduardo Magãlhaes, Emil Rosenlund Høeg, Gilberto Bernardes, Jon Ram Bruun-Pedersen, Stefania Serafin and Rolf Nordhal

This paper describes a novel framework for real-time sonification of surface textures in virtual reality (VR), aimed towards realistically representing the experience of driving over a virtual surface. A combination of capturing techniques of real-world surfaces are used for mapping 3D geometry, texture maps or auditory attributes (aural and vibrotactile) feedback. For the sonification rendering, we propose the use of information from primarily graphical texture features, to define target units in concatenative sound synthesis. To foster models that go beyond current generation of simple sound textures (e.g., wind, rain, fire), towards

highly "synchronized" and expressive scenarios, our contribution draws a framework for higher-level modeling of a bicycle's kinematic rolling on ground contact, with enhanced perceptual symbiosis between auditory, visual and vibrotactile stimuli. We scanned two surfaces represented as texture maps, consisting of different features, morphology and matching navigation. We define target trajectories in a 2-dimensional audio feature space, according to a temporal model and morphological attributes of the surfaces. This synthesis method serves two purposes: a real-time auditory feedback, and vibrotactile feedback induced through playing back the concatenated sound samples using a vibrotactile inducer speaker.

S5.5 Percussion Synthesis using Loopback Frequency Modulation Oscillators

Jennifer Hsu and Tamara Smyth

In this work, we apply recent research results in loopback frequency modulation (FM) to real-time parametric synthesis of percussion sounds. Loopback FM is a variant of FM synthesis whereby the carrier oscillator "loops back" to serve as a modulator of its own frequency. Like FM, more spectral components emerge, but further, when the loopback coefficient is made time varying, frequency trajectories that resemble the nonlinearities heard in acoustic percussion instruments appear. Here, loopback FM is used to parametrically synthesize this effect in struck percussion instruments, known to exhibit frequency sweeps (among other nonlinear characteristics) due to modal coupling. While many percussion synthesis models incorporate such nonlinear effects while aiming for acoustic accuracy, computational efficiency is often sacrificed, prohibiting real-time use. This work seeks to develop a real-time percussion synthesis model that creates a variety of novel sounds and captures the sonic qualities of nonlinear percussion instruments. A linear, modal synthesis percussion model is modified to use loopback FM oscillators, which allows the model to create rich and abstract percussive hits in real-time. Musically intuitive parameters for the percussion model are emphasized resulting in a usable percussion sound synthesizer.

S5.6 Deep Linear Autoregressive Model for Interpretable Prediction of Expressive Tempo

Akira Maezawa

Anticipating a human musician's tempo for a given piece of music using a predictable model is important for interactive music applications,

but existing studies base such an anticipation based on hand-crafted features. Based on recent trends in using deep learning for music performance rendering, we present an online method for multi-step prediction of the tempo curve, given the past history of tempo curves and the music score that the user is playing. We present a linear autoregressive model whose parameters are determined by a deep convolutional neural network whose input is the music score and the history of tempo curve; such an architecture allows the machine to acquire a music performance idioms based on musical contexts, while being able to predict the timing based on the user's playing. Evaluations show that our model is capable of improving the tempo estimate over a commonly-used baseline for tempo prediction by 18%.

S5.7 Metrics for the Automatic Assessment of Music Harmony Awareness in Children

Federico Avanzini, Adriano Baratè, Luca Andrea Ludovico and Marcella Mandanici

In the context of a general research question about the effectiveness of computer-based technologies applied to early music-harmony learning, this paper proposes a web-based tool to foster and quantitatively measure harmonic awareness in children. To this end, we have developed a web interface where young learners can listen to the leading voice of well-known music pieces and associate chords to it. During the activity, their actions can be monitored, recorded, and analyzed. An early experimentation involved 45 school teachers, whose performances have been measured in order to get user-acceptance opinions from domain experts and to determine the most suitable metrics to conduct automated performance analysis. This paper focuses on the latter aspect and proposes a set of candidate metrics to be used for future experimentation with children.

S6. Oral Session 6
Music Information Processing

09:00-10:30 Friday, May 31

Session Chair: Roger Dannenberg

S6.1 Learning to Generate Music with BachProp

Florian Colombo, Johanni Brea and Wulfram Gerstner

As deep learning advances, algorithms of music composition increase in performance. However, most of the successful models are designed for specific musical structures. Here, we present BachProp, an algorithmic composer that can generate music scores in many styles given sufficient training data. To adapt BachProp to a broad range of musical styles, we propose a novel representation of music and train a deep network to predict the note transition probabilities of a given music corpus. In this paper, new music scores generated by BachProp are compared with the original corpora as well as with different network architectures and other related models. A set of comparative measures is used to demonstrate that BachProp captures important features of the original datasets better than other models and invite the reader to a qualitative comparison on a large collection of generated songs.

S6.2 Offline Score Alignment for Realistic Music Practice

Yucong Jiang, Fiona Ryan, David Cartledge and Christopher Raphael

In a common music practice scenario a player works with a musical score, but may jump arbitrarily from one passage to another in order to drill on difficult technical challenges or pursue some other agenda requiring non-linear movement through the score. In this work we treat the associated score alignment problem in which we seek to align a known symbolic score to audio of the musician's practice session, identifying all "do-overs" and jumps. The result of this effort facilitates a quantitative view of a practice session, allowing feedback on coverage, tempo, tuning, rhythm, and other aspects of practice. If computationally feasible we would prefer a globally optimal dynamic programming search strategy; however, we find such schemes only barely computationally feasible in the cases we investigate. Therefore, we develop a computationally efficient off-line algorithm suitable for practical application. We present examples analyzing unsupervised and unscripted practice sessions on clarinet, piano and viola, providing numerical evaluation of our score-

alignment results on hand-labeled ground-truth audio data, as well as more subjective and easy-to-interpret visualizations of the results.

S6.3 Piano Score-Following by Tracking Note Evolution

Yucong Jiang and Christopher Raphael

Score following matches musical performance audio with its symbolic score in an on-line fashion. Its applications are meaningful in music practice, performance, education, and composition. This paper focuses on following piano music — one of the most challenging cases. Motivated by the time-changing features of a piano note during its lifetime, we propose a new method that models the evolution of a note in spectral space, aiming to provide an adaptive, hence better, data model. This new method is based on a switching Kalman filter in which a hidden layer of continuous variables tracks the energy of the various note harmonics. The result of this method could potentially benefit applications in de-soloing, sound synthesis and virtual scores. This paper also proposes a straightforward evaluation method. We conducted a preliminary experiment on a small dataset of 13 minutes of music, consisting of 15 excerpts of real piano recordings from eight pieces. The results show the promise of this new method.

S6.4 Adaptive Score-Following System by Integrating Gaze Information

Kaede Noto, Yoshinari Takegawa and Keiji Hirata

In actual piano practice, people of different skill levels exhibit different behaviors, for instance leaping forward or to an upper staff, miskeying, repeating, and so on. However, many of the conventional score following systems hardly adapt such accidental behaviors depending on individual skill level, because conventional systems usually learn the frequent or general behaviors. We develop a sc ore-following system that can adapt a user's individuality by combining keying information with gaze, because it is well-known that the gaze is a highly reliable means of expressing a performer's thinking. Since it is difficult to collect a large amount of piano performance data reflecting individuality, we employ the framework of the Bayesian inference to adapt individuality. That is, to estimate the user's current position in piano performance, keying and gaze information are integrated into a single Bayesian inference by Gaussian mixture model (GMM). Here, we assume both the keying and gaze information conform to normal distributions. Experimental results

show that, taking into account the gaze information, our score-following system can properly cope with repetition and leaping to an upper row of a staff, in particular.

S6.5 Alternative Measures: A Musicologist Workbench for Popular Music

Beach Clark and Claire Arthur

The objective of this project is to create a digital "workbench" for quantitative analysis of popular music. The workbench is a collection of tools and data that allow for efficient and effective analysis of popular music. This project integrates software from pre-existing analytical tools including music21 but adds methods for collecting data about popular music. The workbench includes tools that allow analysts to compare data from multiple sources. Our working prototype of the workbench contains several novel analytical tools which have the potential to generate new musicological insights through the combination of various datasets. This paper demonstrates some of the currently available tools as well as several sample analyses and features computed from this data that support trend analysis. A future release of the workbench will include a user-friendly UI for non-programmers.

P3. Poster Session 3

10:30-11:00, 13:00-14:30 Friday, May 31

Session Chair: Jean Bresson

P3.1 Autoencoders for Music Sound Modeling: a Comparison of Linear, Shallow, Deep, Recurrent and Variational Models

Fanny Roche, Thomas Hueber, Samuel Limier and Laurent Girin

This study investigates the use of non-linear unsupervised dimensionality reduction techniques to compress a music dataset into a low-dimensional representation which can be used in turn for the synthesis of new sounds. We systematically compare (shallow) autoencoders (AEs), deep autoencoders (DAEs), recurrent autoencoders (with Long Short- Term Memory cells – LSTM-AEs) and variational autoencoders (VAEs) with principal component analysis (PCA) for representing the high-resolution short-term magnitude spectrum of a large and dense dataset of music notes into a lower-dimensional vector (and then convert it back to a magnitude spectrum used for sound resynthesis). Our experiments were

conducted on the publicly available multi-instrument and multi-pitch database NSynth. Interestingly and contrary to the recent literature on image processing, we can show that PCA systematically outperforms shallow AE. Only deep and recurrent architectures (DAEs and LSTM-AEs) lead to a lower reconstruction error. The optimization criterion in VAEs being the sum of the reconstruction error and a regularization term, it naturally leads to a lower reconstruction accuracy than DAEs but we show that VAEs are still able to outperform PCA while providing a low-dimensional latent space with nice "usability" properties. We also provide corresponding objective measures of perceptual audio quality (PEMO-Q scores), which generally correlate well with the reconstruction error.

P3.2 Polytopic Reconfiguration: a Graph-Based Scheme for the Multi-scale Transformation of Music Segments and its Perceptual Assessment

Valentin Gillot and Frédéric Bimbot

Music is a sequential process for which relations between adjacent elements play an important role. Expectation processes based on alternations of similarity and novelty contribute to the structure of the musical flow. In this work, we explore a polytopic representation of music, which accounts for expectation systems developing at several timescales in parallel. After recalling properties of polytopic representations for describing multi-scale implication processes, we introduce a scheme for recomposing musical sequences by simple transformations of their support polytope. A specific set of permutations (referred to as Primer Preserving Permutations or PPP) are of particular interest, as they preserve systems of analogical implications within musical segments. By means of a perceptual test, we study the impact of PPP-based transformations by applying them to the choruses of pop songs in midi format and comparing the result with Randomly Generated Permutations (RGP). In our test, subjects are asked to rate musical excerpts reconfigured by PPP-based transformations versus RGP-based ones in terms of musical consistency and of attractiveness. Results indicate that PPP-transformed segments score distinctly better than RGP-transformed for the two criteria, suggesting that the preservation of implication systems plays an important role in the subjective acceptability of the transformation. Additionally, from the perspective of building an automatic recomposition system for artistic creation purposes, we introduce, in appendix, the preliminary version of an automatic method for decomposing segments into low-scale

musical elements, taking into account possible phase-shifts between the musical surface of the melody and the metrical information.

P3.3 Non-Linear Contact Sound Synthesis for Real-Time Audio-Visual Applications using Modal Textures

Martin Maunsbach and Stefania Serafin

Sound design is an integral part of making a virtual environment come to life. Spatialization is important to the perceptual localization of sounds, while the quality determines how well virtual objects come to life. The implementation of pre-recorded audio for physical interactions in virtual environments often requires a vast library of audio files to distinguish each interaction from the other.

This paper explains the implementation of a modal synthesis toolkit for the Unity game engine to automatically add impact and rolling sounds to interacting objects. Position- dependent sounds are achieved using a custom shader that can contain textures with modal weighting parameters.

The two types of contact sounds are synthesized using a mechanical oscillator describing a mass-spring system. We describe the discretization methods adopted, the solution of the nonlinear interaction and an implementation in the Unity game engine.

P3.4 Analysis of Vocal Ornamentation in Iranian Classical Music

Sepideh Shafiei

In this paper we study tahrir, a melismatic vocal ornamentation which is an essential characteristic of Persian classical music and can be compared to yodeling. It is considered the most important technique through which the vocalist can display his/her prowess. In Persian, nightingale's song is used as a metaphor for tahrir and sometimes for a specific type of tahrir. Here we examine tahrir through a case study. We have chosen two prominent singers of Persian classical music one contemporary and one from the twentieth century. In our analysis we have appropriated both audio recordings and transcriptions by one of the most prominent ethnomusicologists, Masudiyeh, who has worked on Music of Iran. This paper is the first step towards computational modeling and recognition of different types of tahrirs. Here we have studied two types of tahrirs, mainly nashib and farāz, and their combination through three different performance samples by two prominent vocalists. More than twenty types of tahrirs have been identified by Iranian musicians and music theorists.

We are currently working on developing a method to computationally identify these models.

P3.5 VUSAA: An Augmented Reality Mobile App for Urban Soundwalks

Josué Moreno and Vesa Norilo

This paper presents VUSAA, an augmented reality soundwalking application for Apple iOS Devices. The application is based on the idea of Urban Sonic Acupuncture, providing site-aware generative audio content aligned with the present sonic environment. The sound-generating algorithm was implemented in Kronos, a declarative programming language for musical signal processing. We discuss the conceptual framework and implementation of the application, along with the practical considerations of deploying it via a commercial platform. We present results from a number of soundwalks so far organized and outline an approach to develop new models for urban dwelling.

P3.6 A Framework for Multi-f0 Modeling in SATB Choirs

Helena Cuesta, Emilia Gómez and Pritish Chandna

Fundamental frequency (f_0) modeling is an important but relatively unexplored aspect of choir singing. Performance evaluation as well as auditory analysis of singing, whether individually or in a choir, often depend on extracting f_0 contours for the singing voice. However, due to the large number of singers, singing at a similar frequency range, extracting the exact individual pitch contours from choir recordings is a challenging task. In this paper, we address this task and develop a methodology for modeling pitch contours of SATB choir recordings. A typical SATB choir consists of four parts, each covering a distinct range of pitches and often with multiple singers each. We first evaluate some state-of-the-art multi-f_0 estimation systems for the particular case of choirs with a single singer per part, and observe that the pitch of individual singers can be estimated to a relatively high degree of accuracy. We observe, however, that the scenario of multiple singers for each choir part (i.e. unison singing) is far more challenging. In this work we propose a methodology based on combining a multi-f_0 estimation methodology based on deep learning followed by a set of traditional DSP techniques to model f_0 and its dispersion instead of a single f_0 trajectory for each choir part. We present and discuss our observations and test our framework with different singer configurations.

P3.7 Representations of Self-Coupled Modal Oscillators with Time-Varying Frequency

Tamara Smyth and Jennifer Hsu

In this work we examine a simple mass-spring system in which the natural frequency is modulated by its own oscillations, a self-coupling that creates a feedback system in which the output signal "loops back" with an applied coefficient to modulate the frequency. This system is first represented as a mass-spring system, then as an extension of well-known frequency modulation synthesis (FM) coined "loopback FM", and finally, as a closed-form representation that has a form similar to the transfer function of a "stretched" allpass filter with time-varying delay, but with the fundamental difference that it is used here as a time-domain signal, the real part of which is the sounding waveform. This final representation allows for integration of instantaneous frequency in the FM representation and ultimately a mapping from its parameters to those of loopback FM. In addition to predicting the sounding frequency (pitch glides) of loopback FM for a given carrier frequency and time-varying loopback coefficient, or equivalently of the self-coupled oscillator for a given natural frequency and coupling coefficient, the closed form representation is seen to be a more accurate representation of the system as it does not introduce a unit-sample delay in the feedback loop, nor is it as numerically sensitive to sampling rate.

P3.8 SonaGraph. A Cartoonified Spectral Model for Music Composition

Andrea Valle

This paper presents SonaGraph, a framework and an application for a simplified but efficient harmonic spectrum analyzer suitable for assisted and algorithmic composition. The model is inspired by the analog Sonagraph and relies on a constant-Q bandpass filter bank. First, the historical Sonagraph is introduced, then, starting from it, a simplified ("cartoonified") model is discussed. An implementation in SuperCollider is presented that includes various utilities (interactive GUIs, music notation generation, graphic export, data communication). A comparison of results in relation to other tools for assisted composition is presented. Finally, some musical examples are discussed, that make use of spectral data from SonaGraph to generate, retrieve and display music information.

P3.9 Sound in Multiples: Synchrony and Interaction Design of Coupled-Oscillator Networks

Nolan Lem

Systems of coupled-oscillators can be employed in a variety of algorithmic settings to explore the self-organizing dynamics of synchronization. In the realm of audio-visual generation, coupled oscillator networks can be usefully applied to musical content related to sound synthesis, rhythmic generation, and compositional design. By formulating different models of these generative dynamical systems, I outline different methodologies from which to generate sound from collections of interacting oscillators and discuss how their rich, non-linear dynamics can be exploited in the context of sound-based art. A summary of these mathematical models are discussed and a range of applications are proposed in which they may be useful in producing and analyzing sound. I discuss these models in relationship to one of my own kinetic sound sculptures to analyze to what extent they can be used to characterize synchrony as an analytical tool.

P3.10 Jazz Mapping an Analytical and Computational Approach to Jazz Improvisation

Dimitrios Vassilakis, Anastasia Georgaki and Christina Anagnostopoulou

“Jazz mapping" is a multi-layered analytical approach to jazz improvisation. It is based on hierarchical segmentation and categorization of segments, or constituents, according to their function in the overall improvisation. The approach aims at identifying higher-level semantics of transcribed and recorded jazz solos. At these initial stages, analytical decisions are rather exploratory and rely on the input of one of the authors and experienced jazz performer. We apply the method to two well-known solos, by Sonny Rollins and Charlie Parker, and discuss how improvisations resemble story-telling, employing a broad range of structural, expressive and technical tools, usually associated with linguistic production, experience, and meaning. We elucidate the implicit choices of experienced jazz improvisers, who have developed a strong command over the language and can communicate expressive intent, elicit emotional responses, and unfold musical “stories” that are memorable and enjoyable to fellow musicians and listeners. We also comment on potential artificial intelligence applications of this work to music research and performance.

P3.11 Visual Pitch Estimation

A. Sophia Koepke, Olivia Wiles and Andrew Zisserman

In this work, we propose the task of automatically estimating pitch (fundamental frequency) from video frames of violin playing using vision alone. Here, we consider only monophonic violin playing (where only one note is being played at a time).

In order to investigate this task, we curate a new dataset of monophonic violin playing. We propose a Convolutional Neural Network (CNN) architecture that is trained using a student-teacher strategy to distil knowledge from the audio domain to the visual domain. At test time, our network takes video frames as input and directly regresses the pitch. We train and test this architecture on different subsets of our new dataset.

We show that this task (i.e. pitch prediction from vision) is actually possible. Furthermore, we verify that the network has indeed learnt to focus on salient parts of the image, e.g. the left hand of the violin player is used as a visual cue to estimate pitch.

D3. Demo Session 3

10:30-11:00, 13:00-14:30 Friday, May 31

Session Chair: Ana M. Barbancho

D3.1 Miningsuite: A Comprehensive Matlab Framework For Signal, Audio and Music Analysis, Articulating Audio And Symbolic Approaches

Olivier Lartillot

The MiningSuite is a free open-source and comprehensive Matlab framework for the analysis of signals, audio recordings, music recordings, music scores, other signals such as motion capture data, etc., under a common modular framework. It adds a syntactic layer on top of Matlab, so that advanced operations can be specified using a simple and adaptive syntax. This makes the Matlab environment very easy to use for beginners, and in the same time allows power users to design complex workflows in a modular and concise way through a simple assemblage of operators featuring a large set of options. The MiningSuite is an extension of MIRtoolbox, a Matlab toolbox that has become a reference tool in MIR.

D3.2 Drawing Geometric Figures with Braille Description through a Speech Recognition System

África Chamorro, Ana M. Barbancho, Isabel Barbancho and Lorenzo J. Tardón

In this contribution, a system that represents drawings of geometric figures along with their description transcribed in Braille controlled by means of commands acquired by a speech recognition scheme is presented. The designed system recognizes the spoken descriptions needed to draw simple geometric objects: shape, colour, size and position of the figures in the drawing. The speech recognition method selected is based on a distance measure defined with Mel Frequency Cepstral Coefficients (MFCCs). The complete system can be used by both people with visual and with hearing impairments thanks to its interface which, in addition to showing the drawing and the corresponding transcription in Braille, also allows the user to hear the description of commands and final drawing.

D3.3 Interactive Music Training System

Daniel Moreno, Isabel Barbancho, Ana M. Barbancho and Lorenzo J. Tardón

In this contribution, we present an interactive system for playing while learning music. The game is based on different computer games controlled by the user with a remote control. The remote control has been implemented using inertial measurement sensors (IMU) for 3D tracking. The computer games are programming in Python and allow to practice rhythm as well as the tune, ascending or descending, of musical notes.

D3.4 Copying Clave – A Turing Test

Simon Blackmore

A blindfolded instructor (evaluator) plays a clave pattern. A computer captures and repeats the pattern. After 1 minute the experiment stops. This process is repeated by a human who also tries to copy the clave. After another minute they stop and the evaluator assesses both performances.

D3.5 Resonance Improviser: A System for Transmitting the Embodied Sensations of Vocalization Between Two People During Improvisation

Tejaswinee Kelkar and Lynda Joy Gerry

This is a system prototype for joint vocal improvisation between two people that involves sharing embodied sensations of vocal production. This is accomplished by using actuators that excite two participants' rib cages with each other's voices, turning a person's body into a loud speaker. A microphone transmits vocal signals and the players are given a Max Patch to modulate the sound and feel of their voice. The receiver hears the other person's speech and effects through their own body (as if it were their own voice), while also feeling the resonance of the sound signal as it would resonate in the chest cavity of the other. The two players try to re-enact and improvise a script prompt provided to them while not knowing what the other person can hear, of their voice. The game may or may not turn collaborative, adversarial, or artistic depending on the game play.

D3.6 Finding New Practice Material through Chord-Based Exploration of a Large Music Catalogue

Johan Pauwels and Mark B. Sandler

Our demo is a web app that suggests new practice material to music learners based on automatic chord analysis. It is aimed at music practitioners of any skill set, playing any instrument, as long as they know how to play along with a chord sheet. Users need to select a number of chords in the app, and are then presented with a list of music pieces containing those chords. Each of those pieces can be played back while its chord transcription is displayed in sync to the music. This enables a variety of practice scenarios, ranging from following the chords in a piece to using the suggested music as a backing track to practice soloing over.

D3.7 Internal Complexity for Exploratory Interaction

Mads Hobye

When designing interactive sound for non-utilitarian ludic interaction, internal complexity can be a way of opening up a space for curiosity and exploration. Internal complexity should be understood as non-linear mappings between the input and the parameters they affect in the output

(sound). This paper presents three different experiments which explore ways to create internal complexity with simple interfaces for curious exploration.

D3.8 Adaptive Body Movement Sonification in Music and Therapy

Christian Baumann, Johanna Friederike Baarlink and Jan-Torsten Milde

In this paper we describe the ongoing research on the development of a body movement sonification system. High precision, high resolution wireless sensors are used to track the body movement and record muscle excitation. We are currently using 6 sensors. In the final version of the system full body tracking can be achieved. The recording system provides a web server including a simple REST API, which streams the recorded data in JSON format. An intermediate proxy server preprocesses the data and transmits it to the final sonification system. The sonification system is implemented using the web audio api. We are experimenting with a set of different sonification strategies and algorithms. Currently we are testing the system as part of an interactive, guided therapy, establishing additional acoustic feedback channels for the patient. In a second stage of the research we are going to use the system in a more musical and artistic way. More specifically we plan to use the system in cooperation with a violist, where the acoustic feedback channel will be integrated into the performance.

S7. Oral Session 7 — 12:00-13:00 Friday, May 31
Multimodality and (e)motions

Session Chair: Sofia Dahl

S7.1 VocalistMirror: A Singer Support Interface for Avoiding Undesirable Facial Expressions

Kin Wah Edward Lin, Tomoyasu Nakano and Masataka Goto

We present VocalistMirror, an interactive user interface that enables a singer to avoid their undesirable facial expressions in singing video recordings. Since singers usually focus on singing expressions and do not care about facial expressions, when watching singing videos they recorded, they sometimes notice that some of their facial expressions

are undesirable. VocalistMirror allows a singer to first specify their undesirable facial expressions in a recorded video, and then sing again while seeing a realtime warning that is shown when the facial expression of the singer becomes similar to one of the specified undesirable expressions. It also displays Karaoke-style lyrics with piano-roll melody and visualizes acoustic features of singing voices. iOS ARKit framework is used to quantify the facial expression as a 52-dimensional vector, which is then used to compute the distance from undesirable expressions. Our experimental results showed the potential of the proposed interface.

S7.2 Audiovisual Perception of Arousal, Valence, and Effort in Contemporary Cello Performance

Hanna Järveläinen

Perceived arousal, valence, and effort were measured continuously from auditory, visual, and audiovisual cues using a recorded performance of a contemporary cello piece. Effort (perceived exertion of the performer) was added for two motivations: to investigate its potential as a measure and its association with arousal in audiovisual perception. Fifty-two subjects participated in the experiment. Results were analyzed using Activity Analysis and functional data analysis. Arousal and effort were perceived with significant coordination between participants from auditory, visual, as well as audiovisual cues. Significant differences were detected between auditory and visual channels but not between arousal and effort. Valence, in contrast, showed no significant coordination between participants. Relative importance of the visual channel is discussed.

S7.3 Dancing Dots - Investigating the Link between Dancer and Musician in Swedish Folk Dance

Olof Misgeld, Andre Holzapfel and Sven Ahlbäck

The link between musicians and dancers is generally described as strong in many traditional musics and this holds also for Scandinavian Folk Music - spelmansmusik. Understanding the interaction of music and dance has potential for developing theories of performance strategies in artistic practice and for developing interactive systems. In this paper we investigate this link by having Swedish folk musicians perform to animations generated from motion capture recordings of dancers. The different stimuli focus on motions of selected body parts as moving white dots on a computer screen with the aim to understand how different movements can provide reliable cues for musicians. Sound recordings of fiddlers

playing to the ”dancing dot” were analyzed using automatic alignment to the original music performance related to the dance recordings. Interviews were conducted with musicians and comments were collected in order to shed light on strategies when playing for dancing. Results illustrate a reliable alignment to renderings showing full skeletons of dancers, and an advantage of focused displays of movements in the upper back of the dancer.

S8. Oral Session 8 Machine Learning

14:30-16:30 Friday, May 31

Session Chair: Olivier Lartillot

S8.1 Conditioning a Recurrent Neural Network to synthesize musical instrument transients

Lonce Wyse and Muhammad Huzaifah

A Recurrent Neural Network (RNN) is trained to predict sound samples based on audio input augmented by control parameter information for pitch, volume, and instrument identification. During the generative phase following training, audio input is taken from the output of the previous time step, and the parameters are externally controlled allowing the network to be played as a musical instrument. Building on an architecture developed in previous work, we focus on the learning and synthesis of transients – the temporal response of the network during the short time (tens of milliseconds) following the onset and offset of a control signal. We find that the network learns the particular transient characteristics of two different synthetic instruments, and furthermore shows some ability to interpolate between the characteristics of the instruments used in training in response to novel parameter settings. We also study the behavior of the units in hidden layers of the RNN using various visualization techniques and find a variety of volume-specific response characteristics.

S8.2 Predicting Perceived Dissonance of Piano Chords Using a Chord-Class Invariant CNN and Deep Layered Learning

Juliette Dubois, Anders Elowsson and Anders Friberg

This paper presents a convolutional neural network (CNN) able to predict the perceived dissonance of piano chords. Ratings of dissonance

for short audio excerpts were combined from two different datasets and groups of listeners. The CNN uses two branches in a directed acyclic graph (DAG). The first branch receives input from a pitch estimation algorithm, restructured into a pitch chroma. The second branch analyses interactions between close partials, known to affect our perception of dissonance and roughness. The analysis is pitch invariant in both branches, facilitated by convolution across log-frequency and octave-wide max-pooling. Ensemble learning was used to improve the accuracy of the predictions. The coefficient of determination ($R2$) between rating and predictions are close to 0.7 in a cross-validation test of the combined dataset. The system significantly outperforms recent computational models. An ablation study tested the impact of the pitch chroma and partial analysis branches separately, concluding that the deep layered learning approach with a pitch chroma was driving the high performance.

S8.3 Belief Propagation Algorithm for Automatic Chord Estimation

Vincent P. Martin, Sylvain Reynal, Dogac Basaran and Hélène-Camille Crayencour

This work aims at bridging the gap between two completely distinct research fields: digital communications and Music Information Retrieval. While works in the MIR community have long used algorithms borrowed from speech signal processing, text recognition or image processing, to our knowledge very scarce work based on digital communications algorithms has been produced. This paper specifically targets the use of the Belief Propagation algorithm for the task of Automatic Chord Estimation. This algorithm is of widespread use in iterative decoders for error correcting codes and we show that it offers improved performances in ACE by genuinely incorporating the ability to take constraints between distant parts of the song into account. It certainly represents a promising alternative to traditional MIR graphical models approaches, in particular Hidden Markov Models.

S8.4 HMM-Based Glissando Detection for Recordings of Chinese Bamboo Flute

Changhong Wang, Emmanouil Benetos, Xiaojie Meng and Elaine Chew

Playing techniques such as ornamentations and articulation effects constitute important aspects of music performance. However, their computational analysis is still at an early stage due to a lack of instrument

diversity, established methodologies and informative data. Focusing on the Chinese bamboo flute, we introduce a two-stage glissando detection system based on hidden Markov models (HMMs) with Gaussian mixtures. A rule-based segmentation process extracts glissando candidates that are consecutive note changes in the same direction. Glissandi are then identified by two HMMs. The study uses a newly created dataset of Chinese bamboo flute recordings, including both isolated glissandi and real-world pieces. The results, based on both frame- and segment-based evaluation for ascending and descending glissandi respectively, confirm the feasibility of the proposed method for glissando detection. Better detection performance of ascending glissandi over descending ones is obtained due to their more regular patterns. Inaccurate pitch estimation forms a main obstacle for successful fully-automated glissando detection. The dataset and method can be used for performance analysis.

S8.5 Towards CNN-based Acoustic Modeling of Seventh Chords for Automatic Chord Recognition

Christon-Ragavan Nadar, Jakob Abeßer and Sascha Grollmisch

In this paper, we build upon a recently proposed deep convolutional neural network architecture for automatic chord recognition (ACR). We focus on extending the commonly used major/minor vocabulary (24 classes) to an extended chord vocabulary of seven chord types with a total of 84 classes. In our experiments, we compare joint and separate classification of the chord type and chord root pitch class using one or two separate models, respectively. We perform a large-scale evaluation using various combinations of training and test sets of different timbre complexity. Our results show that ACR with an extended chord vocabulary achieves high f-scores of 0.97 for isolated chord recordings and 0.66 for mixed contemporary popular music recordings. While the joint ACR modeling leads to the best results for isolated instrument recordings, the separate modeling strategy performs best for complex music recordings. Alongside with this paper, we publish a novel dataset for extended-vocabulary chord recognition which consists of synthetically generated isolated recordings of various musical instruments.

S8.6 From Jigs and Reels to Schottisar och Polskor: Generating Scandinavian-like Folk Music with Deep Recurrent Networks

Eric Hallström, Simon Mossmyr, Bob L. Sturm, Victor Hansjons Vegeborn and Jonas Wedin

The use of recurrent neural networks for modeling and generating music has been shown to be quite effective for compact, textual transcriptions of traditional music from Ireland and the UK. We explore how well these models perform for textual transcriptions of traditional music from Scandinavia. This type of music has characteristics that are similar to and different from that of Irish music, e.g., mode, rhythm, and structure. We investigate the effects of different architectures and training regimens, and evaluate the resulting models using three methods: a comparison of statistics between real and generated transcriptions, an appraisal of generated transcriptions via a semi-structured interview with an expert in Swedish folk music, and an exercise conducted with students of Scandinavian folk music. We find that some of our models can generate new transcriptions sharing characteristics with Scandinavian folk music, but which often lack the simplicity of real transcriptions. One of our models has been implemented online at http://www.folkrnn.org for anyone to try.

S8.7 Modeling and Learning Rhythm Structure

Francesco Foscarin, Florent Jacquemard and Philippe Rigaux

We present a model to express preferences on rhythmic structure, based on probabilistic context-free grammars, and a procedure that learns the grammars probabilities from a dataset of scores or quantized MIDI files. The model formally defines rules related to rhythmic subdivisions and durations that are in general given in an informal language. Rules preference is then specified with probability values. One targeted application is the aggregation of rules probabilities to qualify an entire rhythm, for tasks like automatic music generation and music transcription. The paper also reports an application of this approach on two datasets.

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28 - 31 May
16th Sound and Music Computing Conference

Summer School Program

	Saturday, May 25	Sunday, May 26	Monday, May 27	Tuesday, May 28
09:00	REGISTRATION	Warm up & Coffee	Warm up & Coffee	Warm up & Coffee
09:30	ARDUINO AND AUDIO by DAVID CUARTIELLES	OPTICAL MUSIC RECOGNITION (OMR) by JORGE CALVO-ZARAGOZA	WIRING, SOLDERING AND ENCLOSING MUSIC by KOKA NIKOLADZE	MUSIC RECOMMENDATION by PETER KNEES
17:00				

Conference Program

	Tuesday, May 28	Wednesday, May 29	Thursday, May 30		Friday, May 31	
09:00		REGISTRATION	ORAL S3		ORAL S6	
09:30	WiSMC	WELCOME				
10:00		KEYNOTE 1				
10:30			COFFEE P2 & D2		COFFEE P3 & D3	
11:00		COFFEE P1 & D1	KEYNOTE 2		KEYNOTE 3	
11:30		ORAL S1				
12:00			ORAL S4		ORAL S7	
13:00		LUNCH POSTER P1 & DEMO D1	LUNCH POSTER P2 & DEMO D2		LUNCH POSTER P3 & DEMO D3	
14:30		ORAL S2	ORAL S5	MUSIC M1	ORAL S8	MUSIC M2
16:30					AWARDS & CLOSING	
17:00						
18:30		CONCERT MUSIC SMC				
19:00	REGISTRATION					
19:30	WELCOME RECEPTION					
20:00			DINNER			

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