The ACTOR Project

Orchestration and Perception Research at McGill

Funded by

FRQSC TSG 1 April 2013 – 31 March 2017

SSHRC PDG 1 April 2015 – 31 March 2018 (with IRCAM & HEM)

Killam Research Fellowship 1 August 2016 – 31 July 2018

FRQSC TSG 1 April 2017 – 31 March 2021

CFI 1 April 2015 – 31 March 2020

McGill
Schulich School of Music
École de musique Schulich

People

- **Psychology**: Stephen McAdams, Catherine Guastavino

- **Text analysis**: Catherine Guastavino

- **Signal analysis**: Philippe Depalle

- **Music theory**: Robert Hasegawa, Meghan Goodchild

- **Composition**: John Rea, Philippe Leroux

- **Sound recording**: Martha de Francisco

- **Conducting**: Guillaume Bourgogne

- **Digital archiving**: Ichiro Fujinaga, Cynthia Leive

Facilities

- **Music Perception and Cognition Lab**

- **CIRMMT**

- **MultiMedia Room**

- **Tanna Schulich Recital Hall**

- **Pollack Concert Hall**

- **McGill Symphony Orchestra**

- **McGill Wind Orchestra**

- **McGill Contemporary Music Ensemble**

Aims

- Analysis/cataloguing of orchestral techniques and their perceptual effects
    - As described in orchestration treatises and composers' writings
    - As found in scores of representative works

- Development of data mining techniques for analysis of treatises and symbolic score representations

- Extended development and perceptual testing of a computer-aided orchestral rendering environment [OrchSim->OrchPlayMusic]

- Experimentation on perception of orchestral effects

- Integration of perceptual principles into IRCAM's Orchids and proposed extension by HEM

- Development of elements of a theory of orchestration (grounded in perception where possible)

Research themes

- Primary focus on role of timbre perception and auditory scene analysis principles in orchestration practice

- I: Timbre and auditory grouping
  - Perceptual fusion and blend
  - Voice segregation

- II: Timbre and musical structure
  - Thematic/motivic segmentation and sectional emphasis
  - Role in underscoring formal functions in music

- III: Timbre and harmony

- IV: Role of spatial position of sound sources and room acoustics

- V: Influence of performance interpretation

Research stages

1. Analysis of orchestration treatises

2. Score analysis and repertoire selection

3. Data-mining of scores for examples of perceptual phenomena (primarily auditory grouping at present)

4. CAOR of orchestrations and re-orchestrations (or subsets of instruments therein) proposed by composers and CAO environments

5. Perceptual experimentation

6. Integration into a scalable, queryable database

Auditory grouping processes

- **Concurrent grouping**
  - Auditory fusion – organization of acoustic surface into musical events

- **Sequential grouping**
  - Auditory streaming – connection of events into musical streams
  - Formation of orchestral layers

- **Segmental grouping**
  - Auditory segmentation – "chunking" of event streams into musical units of various sizes (several seconds to a couple of minutes)

Auditory grouping processes

Auditory grouping mechanisms

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Perceptual properties

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Musical function of the perceptual properties

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Psychological foundation for orchestration theory

Treatise analysis

- Analyses of chapters related to orchestration in
    - Piston (1955), *Orchestration*
    - Read (1979), *Style and Orchestration*
    - Adler (2002), *The Study of Orchestration*, 3rd ed. s
    - Koechlin (1954-59), *Traité d'orchestration*, vol. 3
    - all scanned and OCR'd

- Analysis categories
    - searching for text related to fusion, segregation, timbral contrasts, stratification, *Klangfarbenmelodien*, orchestral gestures, timbral qualities, various other orchestration techniques

Score analysis

- Empirical analysis method
  - Individually
    - Examine the score and listen to recording(s)
    - Annotate salient examples of orchestral devices on PDF
  - Pairs
    - Compare analyses, develop joint analysis by consensus
    - Catalogue details for database
  - Whole group
    - Share analyses, discuss issues, refine analysis categories

Score analysis

- Annotations
  - Span of measures
  - Start and end timing of recording(s)
  - Type of device
  - Instrumentation
  - Notes (free text)
  - Strength rating (1-5)
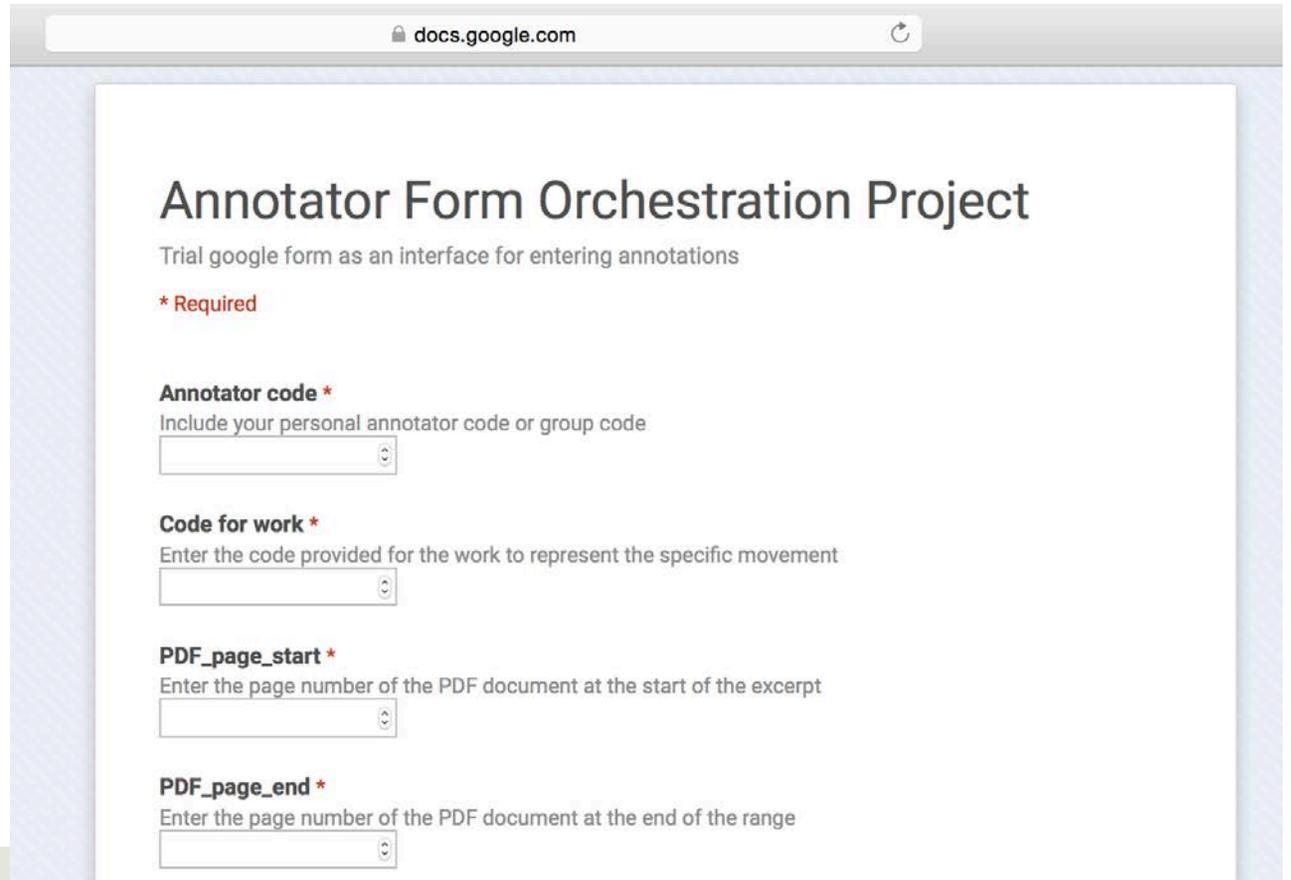
docs.google.com

Annotator Form Orchestration Project

Trial google form as an interface for entering annotations

* Required

Annotator code *
Include your personal annotator code or group code

Code for work *
Enter the code provided for the work to represent the specific movement

PDF_page_start *
Enter the page number of the PDF document at the start of the excerpt

PDF_page_end *
Enter the page number of the PDF document at the end of the range

Score analysis

Database – orchard.actor-project.org

ORCHestration Analysis and Research Database

- 4300 annotations in 75 movements
  - Mozart, Haydn, Beethoven, Schubert, Berlioz, Mendelssohn, Wagner, Verdi, Smetana, Rimsky-Korsokov, Bizet, Borodin, Bruckner, Brahms, Mahler, Strauss, Mussorgsky, Sibelius, d'Indy, Debussy, Ravel, Vaughan Williams, Holst, Ticheli

- Design
  - Relational database backend (PostgreSQL)
  - Indexing and search engine (Apache Solr)
  - Web application server (Django)

- Functionality
  - Simple and complex queries
  - View annotated scores and stream musical clips
  - Upload future analyses and integrate into collection

Database – orchard.actor-project.org

Database - ORCHARD

Perceptual experiments

- Blend perception
  - Aim: understand conditions under which instruments blend together more or less strongly
  - Blend in the sense of perceptual fusion into a single sound image
  - Selected excerpts with various blend strengths and combinations of instrumental choirs
  - Rendered in full context in *OrchSim*
  - Extracted only instruments involved in a blend
  - Ratings of multiplicity and blend

- Similar approach to segregation of concurrent blended instrument groups

Future projects related to ACTOR

- Database
  - Import more score analysis data
  - Integrate perceptual results
  - Integrate treatise analyses
  - Integrate machine-readable scores (OMR) and acoustic analyses
  - Data mining of annotations, machine-readable scores, acoustic properties and perceptual results for common characteristics of different techniques/effects
  - Integrate with OrchPlayMusic Library
  - Integrate into ACTOR online pedagogical website

Future projects

- Perception experiments
  - Experiments to refine subcategories of categories based on perceptual grouping
  - Extension to other aspects of orchestration
  - Counter-factuals/reorchestrations and renderings to test hypotheses
  - Analysis of performance differences and their æsthetic impact
  - Timbre, voice leading, formal functions and harmony

Other partners

- Conservatoire national supérieur de musique et de danse de Paris

- Haute école de musique de Genève

- Les clés de l'écoute & Sonic Solveig (Paris)

- Orchestre symphonique de Montréal

- Applied Acoustics Systems (Montreal)

Conservatoire national supérieur de musique et de danse de Paris

- Orchestration courses at different levels and prix d'orchestration

- Multiple orchestrations of a given piano piece each year

- Recorded by CNSMDP orchestra

CONSERVATOIRE NATIONAL SUPÉRIEUR DE MUSIQUE ET DE DANSE DE PARIS

Haute école de musique de Genève

- Computer-aided orchestration (ORVEO and e-orch projects)
  - Orchis/Pléione

- Pedagogical applications in teaching orchestration with new digital tools

- Recording live musicians interpreting results of CAO – evaluate musical relevance and playability

- Strong interest in role of spatial position of instruments on realization of orchestration goals

Architecture and application of orchestration tools

1- Target sound (static or average)

2- Extraction of audio decriptors

3- Orchestration engine (Orchidée)
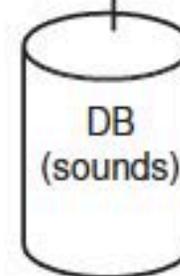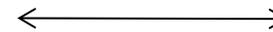
4- Orchestration proposal

5- Simulation, corrections and export for writing

Current limitations

- Instrumental knowledge

- Timbre description

- No model for unisons

- Some playing styles cannot be handled

- Global constraints only

LES CLES DE L'ECOUTE
Producer of shows for orchestras

Clés de L'écoute

Mediation through live shows

Four strong axes

- High-quality content

- Transdisciplinarity

- Accessibility

- Interactivity

Digital products
Mediation through interaction

Sonic Solveig

Publisher of interactive musical content

Transmedia

Prolonging the concert experience

Befpre and after thanks to digital media

Nutcracker

a transmedia project
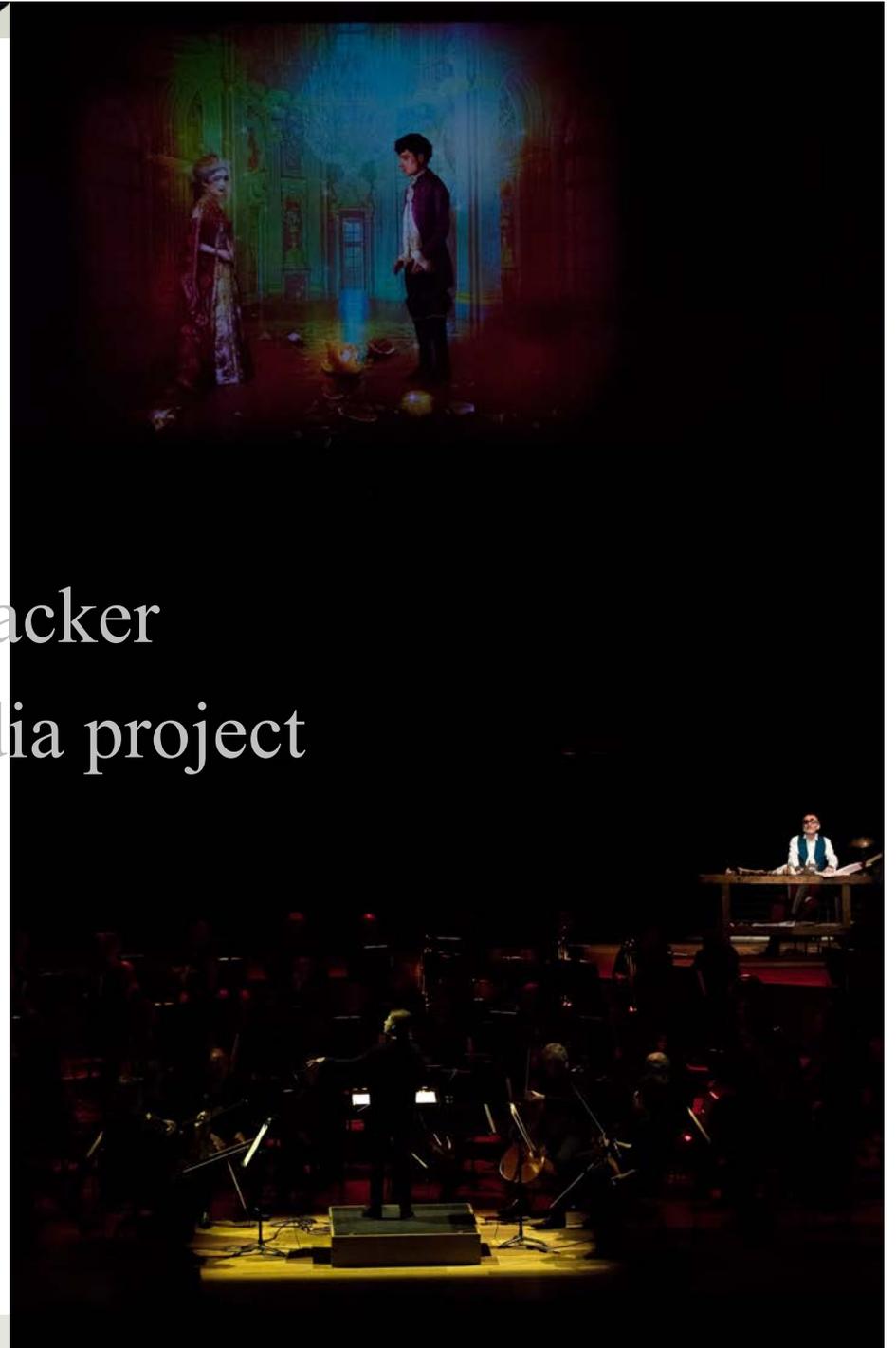
The collection App&Symphonies

Games of rhythm, orchestration, timbre and sound memory

Actuellement disponible sur appstore

Nov 2016 – sur tout support tablette / mobile / ordinateur

Français et Anglais

En cours de production

Nov 2016 – sur tout support tablette / mobile / ordinateur

Français et Anglais

En développement

2018 – sur tout support tablette / mobile / ordinateur

Forthcoming digital collaborations

LES CLES DE L'ECOUTE

Ses partenaires

Orchestre PHILHARMONIQUE DE STRASBOURG
ORCHESTRE NATIONAL

ORCHESTRE DE PARIS

PHILHARMONIE DE PARIS

Les Siècles

OPÉRA DE DIJON

Orchestre National du Capitole de Toulouse

LOUVRE

OPERA DE MASSY
Direction Jack-Henri Soumère
PARIS SUD

Orchestre symphonique de Montréal

- ◻ Pedagogical events in collaboration with Les clés de l'écoute and Sonic Solveig

- ◻ Access to rehearsals for young composers to see how conductors put together an orchestral piece

- ◻ Access to musicians and conductors for interviews on interpretation and realization of orchestration

oSm ORCHESTRE SYMPHONIQUE DE MONTRÉAL

Applied Acoustics Systems

- Applied Acoustics Systems is a Montreal-based company founded in 1998.

- We specialize in sound synthesis by physical modeling.

- Our product line includes precise emulations of acoustic and electronic instruments as well as a wide range of unfamiliar instruments with distinctive timbres.

A|A|S
Applied Acoustics Systems

What do we bring?

- Strong background in sound synthesis and modeling of musical instruments.

- Practical expertise in the development of computer-based synthesizers and the control of synthesis.

What do we expect from the project?

- Our specific interest lies in the control of timbre in synthesized sources.

- Physical models involve numerous parameters each with a large range of possible values

- The task of adjusting these parameters is very difficult especially when trying to reproduce specific instruments.

- Through this project, we would like to develop automatic adjustment methods of these parameters based on perceptual models.

- We have begun to use evolutionary search algorithms to automatically explore the sound space of synthesis algorithms using timbral features.

- We would like to further develop this approach and combine this to learning algorithms in order to be able to automatically adjust physical model parameters and obtain specific types of timbres.

- Ultimately this would allow to improve the ability to reproduce acoustic instruments with physical models

- More generally this would allow to apply orchestration criteria to electronic sounds and new instrumental timbres.