ORPHEUS

INSTITUUT

THE POWER OF MUSICAL NETWORKS

Orpheus Seminar 2018

February 21 - 22, 2018

Orpheus Institute, Ghent (Belgium)

INTRODUCTION

Networks are everywhere these days. In effect, the new information technologies are interconnecting all aspects of our world, enabling unseen levels of social, political and economic interdependencies that characterise our times. The notion of Networks has become an extremely powerful metaphor, serving as a cornerstone for understanding this new complex, interconnected world.
Networks have transformed the creation, production and dissemination of art such as to change its very nature as a cultural artefact or human activity. Such a powerful trope allows for a wider range of interpretations and development. Moreover, it can serve as the ideal bridge between conceptual considerations from the technological and scientific domains, and creative, compositional, conceptual or explanatory enquiries from the artistic field.
This seminar provides a forum for exploring these ideas and approaches, their commonalities and representations and for considering the wider creative and explanatory potential of networks.

Music, Thought and Technology

This seminar is organised in the context of the research cluster Music, Thought and Technology (MTT) at the Orpheus Institute. MTT posits a fundamental relationship between these three aspects of human behaviour. Taking its cue from recent research in technology theory, in new media and digital culture, MTT proposes a radical reorientation of the space and terms in which we think about music, exploring these ideas through creative projects.
Put simply, our common repertory of operational concepts is largely derived from technology; this therefore seems the natural place to look for constructive or explanatory models. Technology is fundamentally constitutive of music, its experience, practices and culture. Like all art, music could be seen to function in the context of a common sense of the possible, of the operations and relationships that it might embody, extend or reveal. This sense of the possible derives primarily from science, technology and their cognates such as natural philosophy or cosmology. Music is literally inconceivable without technologies. They participate in the imagining and apprehending of music, but in a bidirectional process also become part of the broader repertoire of conceptual operations that inform human thought at any given cultural moment. There is a continuum from the 'hard' technologies of instruments or reproduction through the materials of composition to the mental models we use to understand music. Engagement with music is thus also technical. The techniques of music are inseparably linked with its technologies of imagining, creation and production.
In our self-consciously technological age above all, technology provides a common set of ideas, metaphors and behaviours. It is the natural place to look for discourse that reaches across the many approaches to composition, sound art and improvisation that characterise contemporary musical activity irrespective of style or genre – including the vast body of inherited work for which we constantly search for new relevance.
At the same time, researchers investigating new areas of computer science and artificial intelligence are posing new questions about the nature of digital objects, concepts and experience. Musical works, we suggest, have much in common with virtual or digital objects. They exist in a unique state of materiality/immateriality: while they are intensely bound to direct experience, to technologies, techniques and materials, this physicality can exist in multiple instantiations, they can be manipulated, engaged with and acted upon as cultural abstractions. In cultural terms, music is the area of human activity in which we deal with the virtual, with the constructive relationship between human affect and abstract structures or formal systems. Digital humanities research and computer-based creation use the same repertory of tools; both are acts of musical imagination extended and explored through technology. The boundaries become increasingly blurred.

SCHEDULE

WEDNESDAY 21 FEBRUARY

13.00 WELCOME

13.10 – 14.10 KEYNOTE 1: **Fernando Rosas** - *Understanding Complexity through Networks*

14.10 – 14.40 *BREAK*

14.40 – 16.00 PRISMATIC NETWORKS:
> **Nicholas Brown** (20 min.) - *What can network theory tell us about polyphony?*
> **Yixue Wang** & **Emőke-Ágnes Horvát** (20 min. - remote) - *Men at the Core: Genderrelated Differences in Collaboration between Musical Artists*
> **Jonas Roberts** (20 min. - remote) - *Sounds Like Me: The Plausibility of Aesthetic Judgement in Networked Societies*
+ DISCUSSION (20 min.)

16.00 – 16.30 *BREAK*

16.30 – 18.00 CREATIVE NETWORKS:
> **Johannes Mulder** (20 min.) - *The Crack(le)s in the Network*
> **Stefano Kalonaris** (20 min.) - *Two-mode Musical Networks: a conceptual blend for systemic interaction*
> **Oded Ben-Tal** (30 min.) - *Creative Networks: AI, folk-music, and re-imagining a tradition*
+ DISCUSSION (20 min.)

18.00 – 19.30 *BREAK / DINNER*

19.30 – 20.30 PERFORMANCES:
> **Hannah Reardon-Smith** & **Hanna Kölbel** - *Sympoiesis in Free Improvisation*
> **Kyriakos Charalampides** - *The Rhythmanalyst: a sonification network in the observer/observed intersection*
> **Tiernan Cross** - *An Expansive Real-Time Approachto Sound-Based Music Composition Amongst Network-Driven Spaces*

20.30 – 20.45 *BREAK*

20.45 – 21.30 KEYNOTE 2: **Chris Chafe** (remote)
Introduction to telematic performance and *TN_CC*JI&JP: Networked performance*
(with **Juan Parra** and **Jonathan Impett)**

THURSDAY 22 FEBRUARY

9.30 – 11.00 HISTORICAL NETWORKS:
> **Jeannette Jones** (20 min.) - *L'arbre et le réseau: Musical Networks, Ecology, and Post-Patronage in Late Fifteenth-century France*
> **Panu Heimone**n (20 min. - remote) - *Morality, 18th century performance, and dialogue: How performancevalues circulate in actor networks*
> **Mollie Ables** (20 min. - remote) - *Musicians' Networks in Early Modern Venice Through Archival Documents*
+ DISCUSSION (30 min.)

11.00 – 11.30 *BREAK*

11.30 – 12.30 KEYNOTE 3: **David Rosenboom** - *Music of Many Nows — Musical Configuration Spaces and the Networked Possible*

12.30 – 14.00 *LUNCH*

14.00 – 15.30 EXPLANATORY NETWORKS:
> **Cornelia Metzig** (20 min.) - *Measures for Melody Comparison and Genealogy Construction*
> **Ann Warde** (20 min.) - *Doubtful Sound*
> **Cristián Huepe** (30 min. - remote) - *Music as a complex system: From networks to criticality*
+ DISCUSSION (20 min.)

15.30 – 16.00 FINAL DISCUSSION

16.00 *END OF THE SEMINAR*

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Understanding Complexity through Networks

Fernando Rosas

Science have traditionally tried to develop simple representations of complicated systems. This aim is usually achieved by decomposing the system into it smallest constituents, and studying each of them thoroughly. But what happen with phenomena that are destroyed as soon as these parts are separated? These complex systems are composed by many parts where the point of interest is not each individual constituent but their interactions. The study of these interactions is called “complexity science”. Far from being a mere scientific niche, complexity science has lately become crucial for understanding our increasingly interconnected world.

One of the most pervasive and fundamental concepts of complexity science if the notion of an abstract network. We live nowadays immerse in different networks: social networks, transportation networks, economical networks, etc. Each of these network are composed by elements that are connected to some others. A key idea of complexity science is to neglect specific differences and focus in the structure of these connections. Therefore, an abstract network is introduce as an entity composed just by nodes and edges that connect them, where the nodes have no intrinsic meaning besides the structure that their edges create. As such, networks are essentially a way of encoding complex arrays of interdependencies. Interestingly, this abstract framework allows to compare different networks in a common ground and look for commonalities and specific differences between them.

The main goal of the talk is to introduce the basic elements of network analysis in an intuitive way. We will cover the fundamental definitions, classical results and some algorithms. Finally, we will explore some avenues of how these tools can be exploited in the context of art creation and analysis.

Fernando Rosas received the B.A. degree in music composition and philosophy (Minor), the B.Sc. degree in mathematics, and the M.S. and Ph.D. degree in engineering sciences from the Pontificia Universidad Católica de Chile (PUC). He received the “Academic Award” for the Department of Mathematics of the PUC having the best scores of his promotion, and was the recipient of a CONICYT Doctoral Fellowship from the Chilean Ministry of Education in 2008, a “F+” Scholarship from the KU Leuven University in 2013, and a Marie Słodowska -Curie Individual Fellowship from the European Union in 2016. His research interests lay in the interface between communication theory, complexity science and neuroscience.

*Introduction to telematic performance and TN_CC*JI&JP: Networked performance*

Chris Chafe

Until now, “network room” has been an enclosed space only in metaphor, where for the connected inhabitants, the place is a network location to gather and interact (chat rooms, game rooms, etc.). We describe an actual network room for musical interactions in which plausible, room-like reverberation is spawned between endpoints of our network audio software. Each new user becomes a node in a mesh and all sounds entering the mesh are reverberated by the mesh. The medium in which these echoes exist is not, however, air but the Internet and the acoustical properties differ because of the medium’s distinct “physical laws.”

Chris Chafe: Networked celleto
Jonathan Impett: Trumpet and electronics
Juan Parra C: Guitar and electronics

Chris Chafe is a composer, improvisor, cellist and music researcher with an interest in computer music composition and interactive performance. He has been a long-term denizen of the Center for Computer Research in Music and Acoustics where he directs the center and teaches computer music courses. Three year-long research periods were spent at IRCAM, Paris, and The Banff Center, composing and developing methods for computer sound synthesis. He is continuing the SoundWIRE experiments for musical collaboration over the Internet. An active performer, he has performed in Europe, the Americas and Asia. Discs of his works are available from Centaur Records. In the past year he has performed with Roberto Morales, Simon Rose, Pauline Oliveros, Roscoe Mitchell, Mark Dresser, and Dave Douglas, among others. A sound installation, The End of Winter, was recently featured at the Pasadena Museum of California Art. His doctorate in music composition was completed at Stanford in 1983.

Music of Many Nows
—Musical Configuration Spaces and the Networked Possible—

David Rosenboom

I often speak about propositional music as a mode of musical thinking in which the act of composing embraces building proposed models of worlds, universes, evolution, brains, consciousness, or whole domains of thought and life, and then proceeding to make dynamical musical embodiments of these models, inviting us to experience them in spontaneously emerging sonic forms. This talk will draw from selected examples of my work over several decades that explore how propositional models for musical worlds have energized my composer-performer practice, which often collapses distinctions among formal percepts and embraces a dynamic dimensionality in musical structures that may be fundamentally emergent and/or co-creative and often involve network-able configurations that synthesize time.

Topics to be explored include: the propositional music paradigm for composition, configuration spaces and spontaneous music, adjacent and contingent possibilities in networked configurations, realizations through improvisation, conundrums about emergent time and experienced time, the fine structure of the musical present and configurations with many nows, deviant resonances appearing in mappings of natural phenomena onto music with implications for designing instruments and interactive systems (including advanced BCMI—Brain Computer Music Interface), collaborative strategies across malleable time-spaces, linked complex self-organizing systems, and notation as interface.

David Rosenboom (b. 1947) is a composer, performer, interdisciplinary artist, author and educator known as a pioneer in American experimental music. During his long career, he has explored ideas about the spontaneous evolution of musical forms, languages for improvisation, new techniques in scoring for ensembles, multi-disciplinary composition and performance, cross-cultural collaborations, performance art and literature, interactive multi-media and new instrument technologies, generative algorithmic systems, art-science research and philosophy, and extended musical interface with the human nervous system. He holds the Richard Seaver Distinguished Chair in Music at California Institute of the Arts, where he has been Dean of The Herb Alpert School of Music since 1990 and serves as a board member of the Center for New Performance. He taught at Mills College from 1979 to 1990, where he held the Darius Milhaud Chair and was Professor of Music, Head of the Music Department, and Director of the Center for Contemporary Music. In the 1970s he was founding faculty and a professor in the Music Department at York University in Toronto. He studied at the University of Illinois in the 1960s with Salvatore Martirano, Lejaren Hiller, Kenneth Gaburo, Gordon Binkerd, Paul Rolland, Jack McKenzie, Soulima Stravinsky and others and was later awarded the George A. Miller Professorship as a visiting artist there. He has also taught or held positions in the Center for Creative and Performing Arts at the State University of New York at Buffalo, at Bard College, Simon Fraser University, San Francisco Art Institute, California College of Arts and Crafts, Center for Advanced Musical Studies at Chosen Vale and Ionian University in Greece. His work is widely presented around the world. Recent highlights have included a fifty-year retrospective of his music presented in a series of performances at the new Whitney Museum of American Art in New York (2015), a six-month exhibition of his work with brainwave music at Centre Pompidou-Metz in France (2015-2016), a four-month exhibition of his work in computer music at Whitechapel Gallery in London (2015-2016), a retrospective of his music for piano(s) at Tokyo Opera City Recital Hall (2016), the premiere of his Nothingness is Unstable, a work for electronics, acoustic sources and 3-dimentional sound diffusion at ISSUE Project Room in Brooklyn (2017), and numerous publications, recordings, festival performances and keynote speeches at international conferences. Following his retrospective at the Whitney Museum, he was lauded in The New York Times as an "avatar of experimental music." Rosenboom is a Yamaha Artist. www.davidrosenboom.com

< PRISMATIC NETWORKS >

What can network theory tell us about polyphony?

Nicholas Brown

‘Polyphony’, in music, refers to the quality or texture of a musical composition. It can be understood as a function of two or more musical elements where each has a certain independence of ‘motion’. Often, we say these elements have a ‘linear’ quality and use the phrase, ‘melodic line’. Lines ‘move’ and ‘counterpoint’ inheres in the nature of that ‘movement’. Theorists characterize linear motion with terms such as ‘similar’, ‘oblique’ and ‘contrary’. In this paper, however, I explore the possibility of using paradigms from network science as a way of investigating polyphonic textures. I address individual, small-scale musical events in complex, polyphonic textures in terms of their situatedness or involvement with other events or event-clusters. I illustrate my talk with analyses of polyphonic complexity in existing repertoire. Overall, I imagine polyphony as a network of performative acts, each of which is necessarily separated from - yet also demonstrates interconnectedness with – other, contemporaneous acts of sound-making.

Nicholas Brown is a composer, performer and writer, who creates musical works using a variety of time-based media and writes about theoretical issues in contemporary music practice. He has also composed an extensive body of concert and film music that has been presented at international festivals and venues such as the BBC Promenade Concerts; Huddersfield Contemporary Music Festival; Science Gallery, Dublin; Cambridge Festival of Ideas; Haarlem Koorbiennale (NL); and the Three Choirs Festival (UK). As a writer, he has published articles on issues in the philosophy of music in contemporary practice, especially the use of digital technologies in computer-mediated composition. Nicholas was educated at Magdalen College, Oxford University and Manhattan School of Music, New York. He currently holds the post of Ussher Assistant Professor in Sonic Arts at Trinity College Dublin and is an Associate Researcher at the Orpheus Institute, Ghent. www.nicholasbrown.co.uk Twitter: @ngbrown

Men at the Core: Genderrelated Differences in Collaboration between Musical Artists?

Yixue Wang & Emőke-Ágnes Horvát

Although gender differences in collaboration have been perceived in many contexts, such as in scientific collaboration and the workspace, there is limited research on understanding gender differences in artistic collaboration, specifically in the music industry. This lack of knowledge might contribute to the low recognition of female artists and could result in gender-related disparities in artistic leadership and innovation. Our proposal investigates the ability of collaboration networks to provide explanatory means to uncover and foster the creative potential of musical artists based on global data about music production over several decades.

To understand gender-related differences in collaboration, we use song features deduced by state-of-the-art music information retrieval as well as crowdsourced artist metadata from the platforms Echonest and MusicBrainz. Specifically, we compare male and female musical artists regarding their collaboration networks, the sonic features of their works and genre attributions by online listeners. Fig. 1 shows the percentage of female solo artists worldwide and illustrates the broad global coverage of our dataset.

Our large-scale computational analysis shows significant differences in sonic features, such as ‘danceability’ and ‘valence.’ Furthermore, the number and the type of genres that are associated with men and women, differ significantly. The number of genres associated with male artists is on average 50% higher than the number of genres associated with female artists. Electronic, hip hop, and techno are typically linked with men, while R&B, dance, and soul are characteristic of women. These differences enable building random forests and logistic regression models that can detect the gender of a song’s creator with an AUC score of 0.85. This score quantifies the accuracy of machine learning models: it equals to 1 when gender detection is perfect and is 0.50 in case of random guessing. The sonic features and genres used here are a reflection of how music sounds to and is perceived by listeners. While these characteristics are likely to influence collaborations between artists indirectly due to similarities in the music they produce, the second part of our analysis focuses on specific network features.

To uncover the differences in the way male and female musicians collaborate, we examine the structure of the collaboration network with respect to various notions of centrality. Being a highly connected artist in the center of the network is likely to assure increased exposure to others’ ideas and result in more creative recombination. Our network modelling addresses the following questions: Who has more collaborators? Whose collaborators are highly connected themselves? Is the artist positioned in the core or at the periphery of the network? How ‘close’ is an artist to everyone else in the collaboration network though chains of collaborator of a collaborator (and so on)? We find that according to all these dimensions of centrality male artists are associated with more advantageous collaboration patterns than females. Moreover, when looking at the propensity to collaborate with female artists, men tend to collaborate more frequently with women than women among themselves. This result holds even when we statistically account for the facts that there are less female artists and that they collaborate on fewer occasions. Our machine learning models expanded with network features distinguish the work of female and male artists with an AUC score of 0.91.

These findings intrigue us to study further the collaboration network with the goal of exploring the link between collaboration patterns, productivity, and recognition. We hope that our research will be able to provide successful collaboration strategies to support gender equity and promote female artists’ long-term success in the music industry.

Yixue Wang is a Ph.D. student in Technology and Social Behavior at Northwestern University's joint program between the Department of Electrical Engineering and Computer Science and the Department of Communication Studies. Her research interests are in computational social science, data science for social good, and spatial analysis. She is particularly interested in how social networks, media exposure, and geospatial environment influence propagation,reinforcement, or polarization of ideas and attitudes. She is a member of the Science of Networks in Communities (SONIC) research group and is also a Data Science fellow at the Northwestern Data Science Initiative.

Emőke-Ágnes Horvát (Dr. rer. nat., Heidelberg University 2013) is an Assistant Professor at Northwestern University's School of Communication, an affiliated faculty of the Northwestern Institute on Complex Systems (NICO), and the Department of Management and Organizations of the Kellogg School of Management (by courtesy). With a background in physics, computer science, film, and media, she deploys social computing to measure, understand, and forecast the collective behavior of networked crowds in large-scale sociotechnical systems like peer-to-peer platforms. Her current research develops empirical and theoretical methods to support creativity and predict success in culture industries, identify expressions of collective intelligence and opportunities for innovation in crowdsourcing communities, as well as detect shared misconceptions and biases in online capital markets. Her work uses an interdisciplinary data-driven approach and builds on techniques from network science, machine learning, statistics, and exploratory visualization. Professor Horvát developed and teaches a 'Cultural Analytics' graduate course that is designed to train students for careers at the intersection of creative occupations and data science. She serves on the editorial board of PLOS One. Her research is funded by the National Science Foundation (USA) through a CISE CRII award.

Sounds Like Me: The Plausibility of Aesthetic Judgement in Networked Societies

Jonas Roberts

This paper will explore the relationship between social media, online identities and the process of aesthetic judgements in the 21st century. Facebook, Twitter, Instagram and, even, to some extent, Spotify provide a space for the construction of Hyperreal identities, where certain performative aspects of identity - in particular those related to the Arts - are distilled into a secure, yet fluid, digital artefact. These platforms become a conduit for digital impression management. What I aim to investigate is how this affects judgements both of taste and value. Is it possible, presuming it ever was, for a disinterested aesthetic attitude to arise whilst an individual's active, and unconscious, value judgements are bound up in the very form of their identity? When I make a decision to listen to X music on Spotify or Youtube, or decide to post a link to Y song on my facebook profile I participate in a hyperreal construction of my own ego-identity both in digital networks and my own imagined self-world; I become entrenched in a web of cultural, social and linguistic value-relationships associated with the music X or the music Y. If this is the case and ones online, and internal, relationship with the arts is forcibly bound up in identity construction how then, if at all, can sufficient critical distance for disinterested aesthetic judgement be attained?

Jonas Roberts is an MRes student at the University of Liverpool. His research currently focuses on the representations of body and sexuality in Viennese Opera in the early 20th century - in particular the works of Richard Strauss and Alban Berg - through the lens of Critical Theory; primarily the Dialectic of Enlightenment. Part of this research, on the Rule of the Father in Richard Strauss' Elektra, at international conference X Jornades Jam in Barcelona while Sounds Like Me has been presented at the NYDCTP conference in Liverpool. Beyond this his wider research interests include Aesthetics, Epistemology and Musical Modernism.

The Crack(le)s in the Network

Johannes Mulder

n this paper I propose the thesis that, while the Internet painfully unearths the fault lines in society, the cracks in the musical (computer) network can offer new perspectives on music performance and technology.
My research is centred on electronic amplification practices in music. One key element in my work is the minute (in relation to our perception) timing difference as a consequence of the vast difference in speed between sound in air and sound as an electronic signal. With the now common DSP processes in music performance these timing issues can be formalised in latency. In some applications this latency can be considered a negligible issue, but when introducing Internet streaming (whether audio, video or both) these (often varying) latencies become notable, often substantiating in the range of musical timing. Combining my questions around the timing of acoustic and electronically remediated sound with the challenges of real time but asynchronous network performance, extends the possibilities of research into the nature of music performance and music technology.
For instance, in a collaborative research project with Dr. Juan Parra we query the practice of emulating pre-digital analogue technologies (e.g. a magnetic tape delay system) with DSP processes on computers when performing historical (i.e. mid 20th century) electro acoustic works. In this instance we assumed a contemporary computer system to be networked, giving raise to the question: where lies the boundary between emulation and the affordance of new approaches to performing such works? In the performance practice component of this project we organised a number of (inter) networked concerts with musicians contributing to concerts from different parts of the world. Extending the experimental music context with networked concerts renegotiates the notional difference between music and sound, and the relation between sound technology and music performance.
It reshuffles actants and agency, not fundamentally changing what we (as performers/technologists) do, but changing the perspective on how we do. One element of the project with Dr. Parra concerns the crackles in the Network, the audible artefacts as a consequence of network latency. One suggestion we brought forward is that these sounds can be equated to tape noise, and other crackles of the analogue world. This fuzzy element of digital networks in entertainment technology is a strong metaphor that derails the understanding of (networked) technology as a rational system that affords agents tointeract in rational ways. From this perspective any technological choice can be thought of asan aesthetic choice, while functionally instability seeps through the cracks in the network.

Johannes (Jos) Mulder is a passionate sound engineer, researcher and educator, currently employed by Murdoch University in Perth. Music is the gist in his broad education and professional experience. Initially trained as a Tonmeister he specialised in Live Sound working internationally with top performers from different traditions, with a focus on contemporary electroacoustic music. In addition to music and technology skills he developed an interest in the wider organisational, socio-cultural and historical aspects of the use of electronic amplification in the performance arts. A Masters degree in Arts Policy and Management (2008) and a PhD (2013) explored bridging the gap between technology, its creative use and broader discussions of the performance arts and society.Heoffers a unique combination of experience, knowledge and education together with an ability to find original focus in complex situations and a dedication to share, not in a prescriptive way but as a stimulant for excellence.His broad basis connects theory and practice each supporting the other in impactful research and clear and inspiring teaching.

Two-mode Musical Networks: a conceptual blend for systemic interaction

Stefano Kalonaris

The notion of network has provided musicians and composers with fecund analogies for exploring novel perspectives on musical creation. While it is tempting to attempt subjective mappings between the two domains (networks and music), it is also paramount to be aware of the intrinsic constraints posed by both and how these can be overcome or subverted for artistic objectives, to avoid weak conceptual blends and frameworks open to criticism.

Conceptual blending is a cognitive process that allows the integration of two or more input spaces, via selective projection of a generic space which contains all the elements in common. This process, also referred to as conceptual integration network, is implicitly used when constructing analogies and metaphors, and it is arguable that including important axioms of the input spaces might result in more powerful blends.

In the case of networks and music, for example, when associating self-organisational properties of large networks to the emergent behaviours of collective musical improvisation, ecological approaches often ignore that musical networks, such as an ensemble, are relatively small. Therefore, they do not abide by the so-called power law, the signature of complexity and emergence.

Consequently, auxiliary strategies are often needed to validate these analogies, such as employing philosophical stances that allow the injection of (an arbitrarily large) inanimate agency into the framework. A drawback of this strategy is that the system is thus deprived of the affordance to be examined through sociometric data, that can be used to re-construct the dynamical development of the network or, borrowing from Bruno Latour, to reassemble the social.

Another approach could be relaxing the constraints of both the network model and the compositional/musical design. In either case, these strategies might lead to weaker mappings, perhaps diminishing the power of both the network and the music.

With this in mind, and instead of using scale-free network models, this talk proposes a musical interaction design system that employs the two-mode (a.k.a. affiliation) network, which comprises actors and events.

Since the main assumptions (e.g. the fixed number of players and their potential equivalence) of the musical context examined (an ensemble) are not violated by the two-mode network model, such graph might be a good candidate for use in the context of networked music performance.

In this paper, the notion of network is thus employed at three different levels: as a mode of interaction between players, as the technology used to achieve this, and as a method for conceptual integration.

Besides a theoretical blueprint for this model, some speculative practical applications are also considered.

For example, maintaining a sufficiently flexible definition of the events in the affiliation network can provide a framework for both music improvisers and composers alike. Since the events (their number and time occurrence) and their action space (what happens in a given event) can be subjectively defined, the concept of authorship and the continuum between improvisation--design--composition can be arbitrarily explored.

Stefano Kalonaris is a sound technologist, musician and researcher who specialises in Interactive Music Systems, investigating game-theoretical approaches to networked music performance and improvisational interfaces for human-computer interaction. Stefano holds a PhD from the Sonic Arts Research Centre, Queen's University Belfast, and he has performed at international venues and festivals, including Sonorities, Diffrazioni, Café Oto, STEIM, the London Jazz Festival and many others.

Creative Networks: AI, folk-music, and re-imagining a tradition

Oded Ben-Tal & Bob L. Sturm

Our research combines online social networks (crowd-sourcing, folk music communities) and computational networks (neural networks) as mutually reinforcing streams toward creative ends. We are applying recurrent neural networks to model “session” music, e.g., traditional music of Ireland and the UK. Enthusiasts of this music live around the world, and the online forum http://thesession.org enables them to connect and share the music using a textual transcription language known as “ABC notation”. Currently, the users of thesession.org have contributed more than 23,000 transcriptions to its repository. We have used this collection of transcriptions as training material for a recurrent neural network. This results in a computational network that can be “inverted” to generate an endless number of new transcriptions that exhibit many of the characteristics of the original transcriptions. It can even be modified to generate other material deviating from the original style to varying degrees.

What does this endeavour contribute to music - a complex, multifaceted human activity? Music data is a necessarily reductive and limited representation of some aspects of music. Generating novel music data strings remains merely an exercise in engineering until it engages with performers, composers and listeners. Hence, one main pillar of our research has been to develop evaluation approaches that are musically meaningful to these three kinds of users. We have solicited input from the users at thesession.org about the generated transcriptions. We have been collaborating with a network of professional musicians playing session music in London. We have had several performers/improvisers engage with the AI outputs in performance. We also used the system ourselves, in our own different ways, as a tool in the process of composition. Finally, we have organised several public concerts. This helps us probe the capacity of our artificial network to contribute to music practice. Our research shows there is much creative potential through leveraging a social network in conjunction with a computational one.

Oded Ben-Tal is a composer and researcher working at the intersection of music, computing, and cognition. His composition include both acoustic pieces, works combining instruments with electronics and multimedia work. Much of his recent composition work focuses on techniques borrowed from machine listening research for interaction between performers and computers. His compositions have been performed around the world including Italy, The US, Korea, Denmark, Isreal and the UK. He is a senior lecturer at the Music Department, Kingston University and is a Co-I, with Dr. Sturm, on a current AHRC funded project.

Bob L. Sturm is currently a Lecturer in Digital Media at the Centre for Digital Music in the School of Electronic Engineering and Computer Science, Queen Mary University of London. He specialises in audio and music signal processing, machine listening, and evaluation. He is the PI on an AHRC funded project: Data science for the study of calypso-rhythm through history He organised the 2016 HORSE workshop at QMUL, which focused on sanity in applied machine learning.

L'arbre et le réseau: Musical Networks, Ecology, and Post-Patronage in Late Fifteenth-century France

Jeannette Jones

I explore the potential of networks to reveal aspects of a musical environment in France located in the kingdom of France in the fifteenth century, using the language of ecology to explore questions of cultural sustainability. A poem provides my initial case study of these networks, the substantial funereal lament honoring the Johannes Ockeghem by the rhétoriqueur court poet and musician Guillaume Crétin, Déploration…sur le trépas de Jean Ockeghem, which names groups of musicians and poets in the call to mourn France's great musical servant. I argue that the lists in the poem outline a network of people connected through French language and music.

Crétin's poem reveals an ecology of musical operations in smaller courts, churches, and municipalities. The historiography of musical patronage inherently creates a narrative that reinforces modern conceptions of a hierarchical patriarchy, drawing on arborial metaphors of the family tree. I seek to problematize this historiography of patronage through a post-patronage model that draws on new research about forest ecology. Scientists have shown that the invisible sustaining infrastructure of trees in forests is an underground system called mycorrhizal networks. If science has improved our understanding of the relationships of trees, then perhaps it can help us improve our ideas about family trees. I hope to push this discussion beyond the metaphorical through an exploration of interdiscursive analysis, examining how the scientist and the historian develop language to ask similar questions in their respective dialogues.

Jeannette Jones is a PhD candidate in historical musicology at Boston University, working with Joshua Rifkin. Her dissertation title is "Musical Networks in the Kingdom of France, 1461-1498." Her research interests span from music history and culture in fifteenth-century France to music and disability studies. She is a contributor to the forthcoming collection titled Gaspar van Weerbeke: New Interpretations, and her essay, "Imagined Hearing: Music-making in Deaf Culture," appears in The Oxford Handbook of Music and Disability (2015).

Morality, 18th century performance, and dialogue: How performance values circulate in actor networks

Panu Heimonen

Present paper examines how the social is transmitted in musical networks designed for researching performance practice in late classical style. Circulation of the social takes place in flat actor networks (ANT, Actor network theory) and also in networks that extend from bodily experience to moral values. We are in other words juxtaposing Latour's (2005) material-semiotic approach with Tarasti's (2015) existential semiotic approach comprising individual and social meanings that sees the world as though from an artwork's idealistic and subjective perspective. The approaches are clearly complementary in that Latour brings out the networked materialistic surroundings of an artwork whereas Tarasti's is an exceedingly humanistic approach. In the interpretation of late 18th century musical performance both angles are needed. Technological advances in instrument building on the one hand and the sphere of philosophical ideas on the other hand are to be considered. In ANT technical-material innovations are on an equal footing with humanistic ideas. Enlightenment thinkers such as Rousseau, Hume and Mandeville provide the moral theoretic background and are interpreted in terms of existential semiotic individual and social meaning. ANT makes global knowledge local, macrolevel phenomena are conceived as networks. This makes it possible to draw on theory fragments to be used in experimentation and to examine the combined effects on musical performance of networks of moral characteristics and those of musical instruments as technical artefacts. This is based on the inclination of actants in ANT to derive their nature from networks.

A value theoretic layer can now be posed over the conventional phrase structural level. Holistic network effects could be exerted on certain theme complexes. What makes this kind of joint meanings possible is to see musical discourse as a conversation where dialogue between themes is taking place. We get the relevant cultural ideas such as Humean benevolence or self-interest from enlightenment history of ideas and are able to localize them in the kind of dialogue that is perceived in musical discourse. An example is Mozart's piano concerto d-minor KV 466 1st movement where entry theme in bars 77-87 expresses self-interest and related isolation from society leading to tragic experience on the one hand, but also arouses a sense of benevolence when seen as a part in a dialogue between the calm and solemn entry theme and the tragic and forward-moving orchestral introduction. While ingredients of these cultural and musical events circulate in our two networks, they occasionally materialize in appropriate places in musical discourse. These enlightenment moral values of benevolence and self-interest can be ascribed to the dialogue, which can then be analyzed into component parts. Depending on the circulation in the networks one gets different musical interpretations. Moreover, the precise temporal properties in this dialogue can be experimented with and analyzed in performance with historical instruments. In this case benevolence is embodied in the musical dialogue while it at the same time exists as a philosophical idea. These different elements form part of a constellation of networks where the elements of ANT provide support for the inner existential experience of a performer.

Panu Heimonen has been educated at the Sibelius-Academy (MA, Music theory and analysis) and the University of Helsinki (MA, Musicology, Philosophy). At present he pursues doctoral studies at the University of Helsinki. His research centres on music analysis and narrative theory with applications to various musical contexts, including musical performance. He has special interest in bringing together narrative ways of analysing music with traditional music analytical techniques such as Schenkerian analysis and musical Formenlehre. Besides the music of F Liszt he works on music analytical and narratological questions as they relate to first movement concerto form in WA Mozart's piano concertos. He has published in the journal Res Facta Nova ("Concerto Questions"). His other research interests include intertextuality in music analysis.

Musicians' Networks in Early Modern Venice Through Archival Documents

Mollie Ables

Following a series of cultural and economic shifts in the late seventeenth century, the average career path for a Venetian musician was dramatically different than in previous decades. Musicians were less likely to hold a single salaried post and most held multiple posts during their career. This altered the existing musical networks among musicians and the different institutions that employed them. To examine how networks of musicians functioned during this period, I focused on the career of Giovanni Legrenzi, a prominent and successful musician who worked in Venice from 1670 to his death in 1690. I researched the four sacred Venetian institutions that employed Legrenzi during this time and created a bimodal network graph linking musicians to institutions through the documents that indicate their relationship. The node attributes include transcriptions of the documents, which are primarily payment, hiring, and termination records. The graph demonstrates different kinds of networks, but also serves as a repository for transcriptions of archival texts: http://musiciansinvenice.com/dissertation. The visualization offers new perspectives on the roles of individuals in a larger musical culture; grouping the people and institutions by centrality results in multiple sub-groups, demonstrating shared institutions and implied communities.

This network graph is the first step in creating a public-facing source for other scholars, and I am currently expanding the network to include musicians and institutions outside of Legrenzi's immediate orbit. In this presentation, I will also explore ways of including a wider variety of documents into the visualization; this includes institutional administrative documents – including payment, hiring, and termination records – but also tourist guides published in the late seventeenth and early eighteenth centuries, and notarial records kept by Venice's different parishes.

Mollie Ables is a Visiting Assistant Professor at Wabash College in Crawfordsville, Indiana. She recently completed her doctorate in musicology at Indiana University, where she participated in the HASTAC (Humanities, Arts, Science, and Technology Alliance and Collaboratory) and the IU Institute for Digital Arts & Humanities programs in developing her approaches to archival sources. Her research focuses on sacred music in seventeenth-century Venice, particularly its social, political, and institutional history.

Measures for Melody Comparison and Genealogy Construction

Cornelia Metzig & Caroline Colijn

We can all hear that certain melodies have characteristics of a certain genre, often linked to a country of origin, or sometimes resemble each other despite dierent origins. Why is this so? To address this, we analysed (monophonic) folk tunes from dierent countries. We recorded and converted from .wav with the R-Package tuneR [1] into note time series, and extracted various features. Dierent keys are not considered, all analysis is with respect to the tonic note. Here we focus on the occurrence of notes, the lengths that the melody stays on each note, as well as the occurring intervals, intervals of longer successions (three or four notes). These were analysed by the number of occurrence, as well as separately for each starting note (such that e.g. a minor third starting on the tonic is a dierent feature than a minor third starting on the third).
With these features, we are a looking at dierent ways to represent the similarity of songs as networks. We construct networks where two songs share a link if the distance of features is below a certain threshold. Another method we used is to construct trees (networks without loops) using the neighbour-joining algorithm [3], to uncover other possible links (although the samples used here do not originate from one source). Despite the simplicity of the features used here, results are insightful. As expected, melodies from non-western countries appear far from the western melodies by most of the dierent measures used, and melodies from some countries have less variety than others.
These methods can also give insight about how listeners retain music, in the sense that the features that discriminate the songs in the most plausible way are the ones that humans are likely to use. It can also unravel how much of the perceived dierences are indeed due to the melody and not to context (typical instruments, text, language, production), or if preferences for certain melodies correlates with their similarity. On the other hand, this could be used in music creation in various ways, for example to create a specic style. Further possible extensions of this work are to use features that use rhythm, time signature, and song structure. As to the analysis methods, we aim to use other tools to study phylogenetic proximity, such as phyloDAG [2], which does not insist on the contruction of a tree. Applications could be to use the method it on less known folk tunes to uncover in uences. It would also be possible to train a classier (like the random forest algorithm) on these, to give a likelihood of origin for a tune.

[1] Uwe Ligges. tuner{analysis of music. 2013.
[2] Quan Nguyen et al. Likelihood-based phylogenetic network inference by approximate structural expectation maximization. 2015.
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Cornelia Metzig is a postdoctoral researcher at Imperial College London. She has a degree in physics and in applied mathematics, and a PhD in complex systems from the University of Grenoble, France. Her main research interests are dynamic networks, epidemic spreading, and phylogenetics. Previously she has worked in complexity economics, social networks and machine learning.

Doubtful Sound

Ann Warde

Animal social network theory has recently become a standard tool in the study of behavioral ecology. It has been particularly useful in the investigation of links between cetacean social and communication networks involving sound. I am in the midst of working with social network data from a study of dolphins in Doubtful Sound, New Zealand. The study was led by zoologist David Lusseau and resulted in a number of papers, including "The emergent properties of a dolphin social network," published in 2003. I am interested to explore these data because they represent a social network in which individuals appear to be taking on different kinds of roles and interacting differently with other members of the group. For me this means that musical activity based on these data may possess an interesting kind of emergent clustering behavior.

My use of network data is as a means of asking and answering questions. The composition follows, to some extent, from my earlier piece Berubah. As one aspect of that composition I constructed an interactive system in which two performers influenced the behavior of signal processing techniques applied to their instruments. I am now using the Doubtful Sound data as the basis for a decision-making procedure that determines the details of signal processing applied to recordings of animal sounds. The system responds to the amplitude of sounds played on an acoustic instrument. Amplitude values are captured by a microphone and used in one version of the network as edge probabilities that determine which kind of signal processing technique will be used. A second version of the same network employs amplitude values as the basis for determining significant parameter values for whichever signal-processing technique is currently active.

The system is intended for performance in conjunction with any kind of acoustic amplitudegenerating system. Currently I have been working with the composition Cassiopeia (1962), by the American ONCE group composer George Cacioppo. Its one-page iconic graphic score (included in John Cage's Notations) visually represents a pitch network of nodes and edges, with a pitch letter next to each node. A configuration of multiple pathways is clearly delineated, with the size of each pitch node indicating relative dynamic markings. The composition is for solo piano, with any kind of additional "theatrical" material; in this case I have chosen to accompany the piano with the interactively processed animal sound recordings.

What interests me specifically about working with what are actually three, layered, networks is the opportunity this system presents for an investigation of the extent and nature of musical coherency, and also of potential emergent properties, that each network layer represents individually, and for a perceptual investigation of the musical behavior that results from their simultaneous combination. I would like to present a 20-minute paper, which will include recorded excerpts from an in-process performance of the work.

Ann Warde is an independent composer, sound artist, and researcher. Her experimental projects are frequently informed by her previous scientific work with whale sounds as an analyst and programmerat the Cornell Lab of Ornithology. Her work has been recognized by a 2015-16 Fulbright Scholar awardat the University of York's Contemporary Music Research Centre, a Mellon Postdoctoral Fellowship at Cornell, through artist residencies at Mills College and at the Virginia Center for the Creative Arts, andby the West German Radio's Forum for Young Composers. Her research and writings include contributions to Aquatic Conservation, Asian Music, the Journal of the Acoustical Society of America, and the Leonardo Music Journal. Ann's compositions are published by Material Press; Dawn's Chorus appears on the Leonardo Music Journal #22 CD. website: zsonics.org

Music as a complex system: From networks to criticality

Cristián Huepe

While music has always been related to science through acoustics and perception, the development of new technologies allows us to view it today in the context of complex systems. For example, the use of algorithms and machines in music production and performance results in a set of interacting parts that can be studied as a networked dynamical system. I addition, in a different context, new brain scanning technologies allow us to explore the complex neurological dynamics that underlie our responses to music. Furthermore, even in the context of music appreciation, the interactions between listeners that precede the emergence of new musical styles can be mapped today to complex social network dynamics using information gathered from online listeners.

In this talk, I will describe how music can be considered an emergent phenomenon of a complex system and discuss the artistic, scientific, and technological implications of this perspective. I will start by presenting work that relates music and complex systems by testing different approaches for sonifying the dynamics of a flock or swarm. I will then describe recent attempts to generate minimal musical structures starting from a simple dynamical system. Finally, I will present ongoing efforts to show that music displays self-organized critical dynamics. These type of dynamics have been observed in many living systems. They correspond to processes that are at the critical point between chaotic dynamics (which would not be robust enough to support life) and stationary or repetitive dynamics (which would not be adaptable enough to support life). In a similar way, we expect music to be at critical point between being too chaotic to be understood and too monotonous to be interesting. Following this perspective, I will describe recent work in which we train dynamical Boolean networks to reproduce a musical corpus and then investigate the criticality of the resulting dynamical networks.

Dr. Cristián Huepe is a theoretical physicist and electronic musician conducting research in complex systems, nonlinear nonequilibrium dynamics, statistical physics, and the interface between arts and science. His current work focuses on the dynamics of collective motion, active matter, complex networks, opinion formation, multi-scale evolution, and understanding music as a complex system.
Dr. Huepe obtained his PhD in Physics at the École Normale Supérieure in Paris, after completing undergraduate studies in his native Chile. He was then a postdoctoral scholar in Chicago, first at the University of Chicago and later at Northwestern University. Since 2006, Dr. Huepe has worked as an unaffiliated scientist and head of CHuepe Labs Inc., developing various research projects, contracts, and collaborations. As a musician, he has produced and released several albums, performing in Europe, North and South America, and Asia, both as a solo artist and as a member of the Makers of Sense duo. He is currently an adjunct professor at Northwestern University and external faculty member at the Northwestern Institute on Complex System in the USA, as well as an associate researcher at Beijing Normal University in China and at the SCL-SoL lab in Chile.

Sympoiesis in Free Improvisation

Hannah Reardon-Smith & Hanna Kölbel

> *Sympoiesis* is a simple word; it means 'making-with.' . . . Sympoiesis is a word proper to complex, dynamic, responsive, situated, historical systems. It is a word for worlding-with, in company. Sympoiesis enfolds autopoiesis and generatively unfurls and extends it.
> —Donna Haraway, *Staying with the Trouble* (58).

> Entanglement bursts categories and upbends identities.
> —Anna Löwenhaupt Tsing, *The Mushroom at the End of the World* (137).

Hanna Kölbel and Hannah Reardon-Smith will present the possibilities of thinking free improvisation using ecological network theories and sympoiesis. Drawing on texts by Donna Haraway and Anna Löwenhaupt Tsing, they propose a group improvisation practice built on an extended Lokta-Voltera formula that describes mutualistic interspecies interaction. It will include formulating tasks, rephrasing the models for the musicians taking part, searching for and defining the co-efficients' values, and suggesting a sort of etiquette manual for improvising. The presentation will include a short introduction to their ideas, followed by a collaborative performance with guest artists Primož Sukič, Kaja Farszky, and Filipa Botelho.

Improvising is always 'making-with': when playing a solo we are responding to the space, the audience, the instrument and its failings, our body (and its co-inhabitants) and its failings, our histories; when playing with others we need to deal with an exponentially expanded field that contains all of these things and more for each person involved. Playing with others can be especially rich and generative, leading to rapid developments in new directions, growing into each other: involution. Thinking free improvisation in terms of sympoiesis as defined by Haraway – complex networks of ecological interaction between forces known and unknown, present and intangible – gives us a rich and fertile humus from which to grow ideas of freedom and musicking.

One main aspect of mutualistic interspecies relationships is that the same rules apply for each participant. In the case of the symbionts mycorrhizae fungi: "neither the fungus nor the plant can florish without the activity of the other" (Anna Lowenhaupt Tsing, The Mushroom at the End of the World, 138). When a space is shared, the quality or the way of inhabiting this space also matters; the space is altered and renderered capable of changing by its inhabitants. In this sense all the capacities of a single being matter for the other/s.

Free improvisation can be a tool for forcing into existence new forms of musical relations. Musical utterances become mere possibilities that reach out to unkown places, and rely on a collective intelligence to develop. As Tsing has demonstrated, any attempt to track the inner logics of a fungal network and coming to a definitive conclusion will not be successful; nevertheless, it is exactly these non-conclusive outcomes that form a better understanding of fungal expertise. In the same way, we do not intend to map a complete and conclusive sympoietic theory of the complexity of network relations in free improvisation, but to make use of these ideas to interrogate our own practices and experiences, and to access new creative possibilities.

The cellist Hanna Kölbel (Germany/Belgium) is a chamber musician, contemporary music expert, and curator of her own concerts. For the year 2017 she received a scholarship of the Kunststiftung Baden Württemberg to support her art.
She is a founding member of Pierrot Quartett, a classical string quartet based in Germany that is fed by the extensive repertoire of its genre, and Down the Rabbit Hole, a trio that is committed to the emerging scene within contemporary music. With those formations she offers a broad sprectrum of expression from the classical cello sound through extended techniques and free improvisation to performance art with choreographies, electronic music and voice acrobatics.
Hanna Kölbel was invited to show her work at BIG BANG festival 2017 Athen, IZLOG festival 2017 Zagreb, Consejo Nacional de las Artes Escénicas 2016 Havanna, and Imaginale 2015 Mannheim. She resides in Belgium, playing as a guest musician with ensembles ICTUS and NADAR.
She has graduated at the Musikhochschule Stuttgart with distinction, learning with Prof. Conradin Brotbek, finishing an artistic and pedagogical Bachelor 2013 and a Master 2015 in contemporary music. In 2017 she received the Advanced Master of Contemporary Music in the School of Arts in Ghent with her thesis „ecosystems of co_creation".

Hannah Reardon-Smith (Australia) is flutist, improviser, composer, conductor, and co-artistic director of Brisbane-based contemporary art music ensemble Kupka's Piano. She is also a founding member of improvisation trio Rogue Three (Brisbane/Melbourne: flute/s, trombone, and recorder/s) and newly formed duo Richard&Linda (flute/s, electric guitar, and live electronics) with Liam Flenady. She has performed in international festivals including ManiFESTE (Paris), IMD (Darmstadt, DE), SPOR (Aarhus, DK), Kunstenfestival des Arts (Brussels), BIFEM (Bendigo, AU), Totally Huge New Music Festival (Perth), and the Queensland Music Festival (Brisbane).
Currently, Hannah is a PhD candidate at the Queensland Conservatorium, Griffith University, under the supervision of Assoc Prof Vanessa Tomlinson and Dr Louise Denson. Her project is to explore a queer-feminist thinking of free improvisation, and to feature the work and voices of women and non-binary folk practicing in the field. She previously completed an Advanced Master in Contemporary Music Performance at the School of Arts in Ghent, Belgium (2014-2016), under the mentorship of ensemble ICTUS and flutists Mike Schmid (ICTUS) and Helen Bledsoe (musikFabrik), where she undertook a detailed study of Richard Barrett's codex scores for improvising ensembles.
Recipient of the 2010 James Carson Flute Prize, Hannah is a casual performing member of the Queensland Symphony Orchestra, and freelances as a writer, performer, yoga teacher, and disability support worker. She blogs at stayandmakekin.wordpress.com and hannahreardonsmith.com.

The Rhythmanalyst: a sonification network in the observer/observed intersection

Kyriakos Charalampides

Field recording has been an established method for musical expression for more than half a century. Besides the valuable contribution of this tendency to contemporary music, the act itself often remains covered by vagueness. The bipolar between the sound-signifier and the signified-sound has been discussed and analysed extensively during the last decades. An alternative approach to that problem may be found in Henri Lefebvre's theories of constructive social space and Rhythmanalysis. The "Rhythmanalyst" is a sonification network inspired by Lefebvre's ideas that aim to explore this potential. Its main objective is to provide an alternative approach to field recording in which the attention is shifted from the capturing of a sonic environment to the action-reaction chain between a subject and its surroundings. The network consists of four modules that capture: perceptible sonic and visual motion, autonomic nervous reactions and brainwave activity. An algorithm responsible for the analysis of the grasped data classifies periodic correspondences between perceptible motion and biological reactions in order to sonify the grasped situation. The "Rhythmanalyst" aims to study the utility of Lefebvre's ideas to contemporary music. Additionally, the development of the system aims to discuss the utility of networks for the adaptation of philosophical theories to contemporary sound studies.

Kyriakos Charalampides is a sound engineer and composer based in The Hague. His interest moves around environmentally emerged aesthetics. He has been involved as a post-production engineer in several music and film productions. During the last years, he is occupied with applications of Rhythmanalysis in sonification. He holds a BSc in sound engineering and music technology and a MMus from the Institute of Sonology in which he is currently a research associate.

An Expansive Real-Time Approach to Sound-Based Music Composition Amongst Network-Driven Spaces

Tiernan Cross

Network-based realities and the sonic information filtered freely across their planes have consequently reconfigured our experiences of sound. They have altered the way in which our minds creatively approach music and its internal structuring as sonic matter, resulting in new narrative opportunities for compositional practice. This paper will discuss the methodology, results and findings of the author's most recent research that questions what it is to broaden the horizon of field recording beyond the physical sense of sonic immediacy toward the simultaneous inclusion of network-based realisms. In doing so this research explores a remodelled representation of what constitutes a modern electroacoustic composer's proximate sonic environment amongst today's network-driven atmospheres.

Whilst notions of field recording are nothing new; the conscious and creative reflection of audible matter formulated across network spaces has the potential to enhance technoetic practice in sound-based composition. Accompanying this paper will be the demonstration of an audio device that is capable of recording real-time, multi-channel inputs from physical and virtual acoustic spaces concurrently before melding them together through algorithm. This device aims to explore how sonification across network environments has the capacity to impact our cognitive understanding of immediate sound fields and in turn formulate new methods of artistic creation.

Tiernan Cross is music composer, sound artist and researcher based in Sydney, Australia. Tiernan is currently completing postgraduate research through the Sydney Conservatorium of Music focusing on musique concrète, neurological conditioning and post-biological sound aesthetics. Classically trained under Australian composer Christopher Gordon through the Australian Film, Television & Radio School's postgraduate program and at the Sydney School of Architecture under William Martens, Tiernan's work has been exhibited and performed in China, France, Canada, Spain, Australia and Germany. In 2018 Tiernan will be the Spatial Sound Institute's Artist in Residence in Budapest, before exhibiting works at Shiro Oni Studios in Gunma, Japan. His latest work Yamanote Loop (2017) premiered at the Acoustic Squared Festival at the Sydney Recital Hall. In late 2017 Tiernan exhibited works alongside research at the Central Academy of Fine Arts Museum in Beijing before embarking to Seoul, Korea to work on his latest commission, Communion. Tiernan is also a graduate of Griffith University, holding a Bachelor of Communications, focusing on new artistic media and professional writing.

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