Computer Music research at FEEC/Unicamp: a snapshot of 2019

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Abstract. *This is a lab report paper about the state of affairs in the computer music research group at the School of Electrical and Computer Engineering of the University of Campinas (FEEC/Unicamp). This report discusses the people involved in the group, the efforts in teaching and the current research work performed. Last, it provides some discussions on the lessons learned from the past few years and some pointers for future work.*

1. Introduction

The School of Electrical and Computer Engineering (FEEC) of the University of Campinas (Campinas) is located in the district of Barão Geraldo, in Campinas-SP, Brazil. It offers two undergraduate-level courses, namely Electrical Engineering (five years, with 70 students per year) and Computer Engineering (five years, with 90 students per year). Also, it offers graduate-level courses in Electrical Engineering, both in the MsC (two years) and PhD (four years) levels.

Computer music research at FEEC builds upon the existing Engineering *syllabi* as discussed in Section 2. As a consequence, a large amount of our research work draws from Engineering perspectives. Nevertheless, we have learned important lessons on fostering multidisciplinarity in computer music research. Insights on this topic are presented in Section 3.

2. Teaching

The computer music group at FEEC deeply relates to the Electrical Engineering (EE) and Computer Engineering (CE) courses. As shown in Table 1, both courses provide students with hours in three relevant topics: computer programming, digital signal processing, electronics, and embedded systems. Additionally, CE students are provided with 60h courses in artificial intelligence.

Table 1: Regular course hours in EE and CC related to relevant topics for computer music.

Topic	E.E.	C.E.
Computer Programming	60h	360h
Digital Signal Processing	240h	240h
Electronics and Embedded Systems	280h	200h
Artificial Intelligence	0h	60h

This background tends to direct research towards technical perspectives on computer music problems. As such, we can highlight the following problems:

1. Build Music Information Retrieval (MIR) systems and evaluate them using objective (Accuracy, Recall, Precision) measures,
2. Explore the impact of features in label prediction experiments,
3. Build digital musical instruments and digital musical interfaces based on electronic sensors and microcontrollers.

This naturally points our research to the interests of the NIME and ISMIR communities.

Although the regular courses yield a strong technical background, some other skills are only available in optional (elective) courses. These skills, shown in Table 2, are important to computer music, but are not currently present in the EE and EC courses.

Table 2: Computer music related skills that are currently missing in EE and EC courses.

Skills
Analyze musical pieces (aesthetically and culturally)
Perform qualitative analysis in audio results
Synthesize audio

Such skills can be employed in computer music research both to interpret results and to draw insight from artistic roots. Also, such skills favor the understanding of the meaning of results and can broaden the reach of the technical research. In special, they can foster the possibilities to:

1. Interpret the results of MIR systems under the light of artistic and cultural domain knowledge,
2. Draw insight on the sound characteristics that relate to specific features for further exploration,
3. Integrate synthesis and performance into the process of building digital musical instruments.

Although these skills can be acquired in elective courses within Unicamp, we decided that a more focused approach would be necessary. For such, we offer a series of advanced study courses that compose a study certificate in Sound Engineering.

2.1. Study Certificate: Sound Engineering

The study certificates at Unicamp began as an initiative to recognize the efforts of undergraduate-level students that acquired advanced knowledge. FEEC currently offers six different certificates, and the most active ones are in Biomedical Engineering and in Sound Engineering.

To earn a certificate in Sound Engineering, a student must receive credits related to four different courses,

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as shown in Table 3, as well as perform at least one semester of research in an audio-related field. The courses within the certificate aim at enabling students to perform research in computer music and in acoustics, which are two related fields that have active groups at FEEC.

Table 3: Computer music related skills that are currently missing in EE and EC courses.

Course	Hours	Content
Introduction to Sound Engineering	30h	Series of lectures with invited speakers aiming at providing an overview of the methods and current research in acoustics and computer music.
Sound Engineering 1	60h	Acoustics and electroacoustics. Modelling of loudspeakers, room, and environmental acoustics.
Sound Engineering 2	60h	Analysis and synthesis of audio signals. DSP and machine learning techniques. Audio synthesis using diverse techniques.
Elective	60h	Any audio-related course outside of FEEC

These courses were specifically designed to fit within the EE and CE *curricula*. As such, they have prerequisites in computer programming and in advanced calculus. This means that, although non-engineers can earn the certificate, they will have to go through all the base courses for such.

This is an impedance, but we have provided a complete guide on how to organize the workload throughout the courses. Currently, there are many students from the Music School that are taking calculus and programming courses in order to earn the certificate.

Also, we highlight that the Sound Engineering 1 and 2 courses are jointly offered as graduate-level courses. As a consequence, students that earn the certificate also earn credits that can be used in a MsC-level degree. This facilitates them to pursuit research in the field.

3. Discussion on Multidisciplinarity

The computer music research group started in 2015 at FEEC, and some important lessons have been learned. The main difficulty at this point has been successfully fostering multidisciplinarity, because this requires time and adequate environments.

Multidisciplinarity is a perspective, that is, a possible way of looking at problems. As such, computer music should not be seen as a set of engineering problems nor as a set of artistic problems.

We believe that fostering multidisciplinarity involves a change of perspective. This requires understanding one's background perspective. This means that before approaching multidisciplinarity students should be able to understand why they look at things the way they do.

Two important perspectives that are present within the university are the archetypical artistic and technical perspectives. The archetypical artistic perspective involves seeing things regarding their aesthetics and cultural impact, whereas the archetypical engineering perspective relates to a point of view in which problems can always be objectively defined, solved, and evaluated. Both perspectives are important in computer music, because CM-related research draws both from cultural/aesthetic discussions and from technical aspects to derive tools and solutions. However, it is very common that only one of these perspectives is reinforced in specific courses.

As a consequence, participating in computer music research requires a personal construction of conscience regarding one's own perspective. Also, it requires experimenting with other perspectives, as to build an embodied experience of them. This transcends the classroom possibilities, and requires an environment for free creation.

For such, we built a computer music electronics lab, in which computer music experiments can be performed. The laboratory has a standard electronics workbench, and is annexed to a recording studio. Currently, it is used to develop sensors, robots and other creative, CM-related artifacts. The users come from both the music and the engineering backgrounds, and they intentionally interact and learn from each other.

We still have not had science throughput from this specific interaction. This depends on further work, which is bounded to regular university schedule constrains.

Nevertheless, the participating students' progress is visible and the learning of technical skills has been accompanied by the learning of new perspectives by each one of them. We are glad to foster this environment and make it easier to embrace all different perspectives that compose our University.