MUSI 6201/4457: Audio Content Analysis

syllabus

Fall 2023

Course Details

class time	MW 3:00–4:15pm
location	West Village 163
credits	3 credit hours

Instructor Information

	instructor
name	Alexander Lerch
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location	Couch 205 (840 McMillan St)
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	Teaching Asisstants
name	Ashvala Vinay
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name	Karn Watcharasupat
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Office Hours	TBA

1 General Information

1.1 Course Description

Introduction to the software-based analysis of digital music signals. This course covers the basic approaches for musical content analysis and teaches students to approach this class of problems and think algorithmically. Topics include pitch tracking, beat tracking, audio feature extraction, and genre classification. The classes focus is on the audio signal processing part of music information retrieval.

1.2 Prerequisites

The course will be open to any interested students in the Music Tech BS, MS, and PhD programs. Prior coursework or experience in (digital) signal processing and machine learning is expected. Programming experience and familiarity with (Matlab and) Python will be helpful.

1.3 Learning Outcomes

After successful completion of the class, the students will be able to

- summarize and explain baseline approaches to typical tasks in Music Information Retrieval,
- describe and apply evaluation methods and metrics for audio content analysis systems,
- implement audio analysis systems in Python, and
- successfully complete a team project in conception, literature survey, proposal, implementation, evaluation, and presentation.

2 Grading

The following evaluative tools will be utilized in measuring progress towards obtaining the learning outcomes:

exercises & assignments	45%
exercises & participation	10%
project	45%
presentation (proposal)	5%
presentation (midterm)	5%
presentation (final)	5%
paper	10%
algorithmic design and implementation	20%

2.1 Description of Graded Components

If not explicitly mentioned otherwise, students in the undergraduate section of the class will work on the same components but with adjusted expectations for grading.

- **exercises & assignments:**
  Assignments will be posted according to the tentative schedule outlined in Sect. 4.1. All assignments will contribute to the assignment grade with equal weight. If in-class exercises are part of the assignments, their grade will be part of the assignment grade. Assignments will be one or two questions shorter for the undergraduate section of the class.
- **exercises & participation:**
  Participation in class and in the forum with questions and answers as well as performance in in-class exercises not part of assignments.
- **project:**
  Each group (3 students) will work on a class project. The core of this project has to be a MIR algorithm developed by the team, but there is no additional restrictions: it might be a research project, an application for a specific task, a web service, etc.

2.2 Grading and Grading Policies

All graded components will be graded in points. The final grade for the course will be determined by dividing the total points earned by the number of points possible for each of the categories listed above.
These numbers will be converted into a letter grade according to the following scale:

A	100–90%
B	89–80%
C	79–70%
D	69–60%
F	59% and below

Grades may be assigned per group or individually as announced (e.g., projects are in some cases per group, quizzes are usually per individual).

3 Course Materials

3.1 Video Lectures

Videos of a previous iteration of the class are accessible at:
`https://www.audiocontentanalysis.org/class`
The online video player should allow you to switch between slides and camera view.

3.2 Text Book

The text book for this class is available:

> Alexander Lerch (2023), *An Introduction to Audio Content Analysis: Music Information Retrieval Tasks and Applications*, 2nd Edition Jon Wiley & Sons, Hoboken

It can be accessed free of charge here (access to this site may be restricted from off-campus, use VPN):
`https://ieeexplore.ieee.org/book/9965970`

3.3 Additional (Optional) Reading

- Li, T., Ogihara, M. and Tzanetakis, G. (Eds.) (2012), *Music Data Mining*. CRC Press
- Klapuri, A. and Davy, M. (Eds.) (2006), *Signal Processing Methods for Music Transcription*. Springer
- Mueller, M. (2015), *Fundamentals of Music Processing*. Springer

3.4 Additional Resources

Additional resources are available on github. Additional resources include:

- slides (pdf), `https://github.com/alexanderlerch/ACA-Slides`
- links to Matlab code for plots in the slides, `https://github.com/alexanderlerch/ACA-Plots`
- audio examples, `https://github.com/alexanderlerch/ACA-Slides/audio`

3.5 Software

Assignments are due in the language announced (commonly python). The project work can be done in any programming language approved after discussion with the instructor. The most common choices are Python and Matlab. Matlab is accessible at `www.matlab.gatech.edu`.
With respect to tools, **prepare to use github** (github.gatech.edu or github.com or some other version control system). I recommend using the github issues in connection with milestones to keep track of your project progress. Other recommended tools are

- Zotero for bibliography management, and
- LaTeX for scientific typesetting.

4 Course Expectations & Guidelines

4.1 Course Schedule

The class will be structured into the following parts: the lecture, the in-class exercises, the assignments, and the project work. The tentative schedule, subject to change, is shown in Table 1.

Since all classes do not progress at the same rate, it may be necessary to modify the above schedule as circumstances dictate. For example, the number and frequency of assignments may be altered or the schedule of the classes may be changed. In either of these cases, adequate notification will be given and be discussed in class.

Week	Topics	Modules	potential in-class exercises	Assignment & *notes*
1	introduction	0.0, 1.0, 2.0, 3.1	project topic brainstorm	
2	features	3.2, 3.3, 3.4, 3.6	spectrogram, correlation, features	ACF pitch tracking
3	inference	3.7, 4	feature extraction	*labor day*
4	data and evaluation	5, 6	feature space visualization	feature extraction & selection
5	project proposals			
6	pitch tracking	7.1, 7.2, 7.3,	HPS, AMDF	monophonic pitch trackers
7	pitch tracking and tuning frequency	7.3, 7.4	NMF, tuning freq	
8	key/chord detection, intensity	7.5, 7.6, 8	pitch chroma	*fall break*
9	mid-term project presentation			key/chord detection
10	onset,tempo detection	9.1, 9.2, 9.3, 9.4, 9.5,9.6	tempo detection	
11	structure, alignment	9.7, 10	DTW	
12	genre classification	12		genre classification
13	audio fingerprinting, music similarity	11,13		
14	mood classification	14	regression	*thxgiving*
15	music performance assessment	16		
16	project work			

Table 1: planned class schedule

4.2 Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit or .

- `http://www.catalog.gatech.edu/policies/honor-code/` or
- `http://www.catalog.gatech.edu/rules/18/`.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

4.3 Accommodations for Individuals with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (often referred to as ADAPTS) at (404)894-2563 or

- `http://disabilityservices.gatech.edu`

as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

4.4 Assignment Turn-In

All assignments and exercises have to be submitted to canvas unless announced otherwise. Each submission should contain source code as well as a document with plots and comments, structured by the tasks/questions as headers. The code and code documentation of the project work has to be turned in as a link to a online repository such as github.com or github.gatech.edu.

4.5 Attendance and Participation

You are expected to attend the sessions unless you have a compelling reason not to do so. In any case active participation either synchronously or asynchronously is expected.

4.6 Extensions, Late Assignments, Missed Exams

All assignments, papers, and other artifacts are due **ON THE DUE DATE**. The due date will be announced per assignment/task on t-square. A penalty of **TEN POINTS PER 24 HOURS** will be applied to all late assignments/tasks and late project papers. Documented illnesses and family emergencies are excepted. Quizzes and exams cannot be made up unless you have a valid, documented excuse.

4.7 Student Use of Mobile Devices in the Classroom

The use of mobile devices in the classroom is prohibited unless explicitly allowed by the instructor.

4.8 Student-Faculty Expectations

At Georgia Tech we believe that it is important to continually strive for an atmosphere of mutual respect, acknowledgment, and responsibility between faculty members and the student body. See

- `http://www.catalog.gatech.edu/rules/22`

for an articulation of some basic expectations — that you can have of me, and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

4.9 Diversity

The School of Music community of faculty, staff, and students aspires to create and nurture an environment that is supportive of all backgrounds where different views and ideas are respected and encouraged. In all our pursuits, we commit to justice, diversity, equity, and inclusion with regard to race, national origin, language, age, sexual orientation, gender, religion, and ability. Moreover, we will encourage intellectual inquiry and respectful exchange that cements our dedication to these principles.

4.10 Grievances and Concerns

Students should first discuss any concerns with the relevant faculty member; if it is not possible to come to resolution with the faculty member, students may then report the matter to the appropriate administrator (Chair or Associate Chair or Director of Studies) of the department of instruction or report it here:

- `http://www.contact.gatech.edu/academicgrievance`

The GT grievance policy can be found at

- `https://provost.gatech.edu/reporting-units/conflict-resolution-ombuds/academic-grievance-policy`.