Applying Music Information Retrieval Techniques to Audio Production Education

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Context: How I spend my time (1/2)

- Research on automatic music classification
  - Using machine learning to "teach" computers to classify music into various types of categories
    - Genre, mood, artist, performer, composer, etc.
    - Typically learn to classify unknown music by training on labelled known exemplars
  - Emphasis on multimodal approaches
    - Audio, symbolic, lyrics, "cultural", etc.
- Development of open source music information retrieval (MIR) research software
  - Especially the jMIR framework

Context: How I spend my time (2/2)

- Teaching
  - Mainly sound recording, live computer music performance, psychoacoustics and basic music technology
  - Previously McGill music tech undergrads and sound recording Q-year students
  - Now I teach CEGEP students full-time
    - Both students in the music program and general students
  - Not automatic music classification or software development

Educational problems I have observed

- Students taking introductory courses in sound recording and production:
  - Are often very musical, but tend to short-change technical concerns
  - Often have a poor ear for detecting technical problems (at least initially)
- Teachers and TAs correcting assignments:
  - Spend a lot of time precisely annotating errors

Dare to dream . . .

- Wouldn't it be nice if there were some software that could automatically proofread mixes prepared by students for technical errors?
  - Like a spell checker or (good) grammar checker for audio engineering
- Benefits:
  - Would save markers a lot of time by automating error annotations
  - Would highlight technical errors to students before they submit their work
    - Helping them to recognize and correct errors independently
  - Could also be helpful to amateurs making mashups, with home studios, etc.?

Dreams can come true!

- jProductionCritic is a software tool designed to do exactly these things

Well, maybe not *perfectly* (1/2)

- jProductionCritic only detects technical errors
  - It does not even attempt to comment on the (essential) artistic aspects of mixes
  - And even technical errors are sometimes detected imperfectly (although usually quite well)

Well, maybe not *perfectly* (2/2)

- So, professorial intervention is still needed when grading assignments
  - But much less, and mostly just the fun parts
  - It is unlikely an automated system could ever replace an expert human anyway
- Also, jProductionCritic is intended specifically for markers, junior students, and amateurs
  - Pros and advanced students are welcome to use it, but they may not need it

Which technical errors are looked for?

- Dynamics
  - Digital clipping
  - Insufficient variety in dynamics
  - Insufficient dynamic range
  - Insufficient dynamic range compression
- Sustained noise and signal distortion
  - Ground loop hum
  - Narrowband noise
  - Phasing
  - DC bias
- Instantaneous noise
  - Edit clicks
  - Other instantaneous noise
- Channel problems
  - Stereo channel balance
  - Stereo channel similarity
  - Is not stereo
- Miscellaneous
  - Long silences
  - Duration
  - Encoding format

But I want even more error detectors!

- Like all jMIR components, jProductionCritic is designed to be highly extensible
  - Fully open source and free Java implementation
  - Error detectors are added as modular plug-ins
    - The software automatically handles updates to the configuration file, etc. when new error detectors are added
- jProductionCritic is not just a tool
  - It is also a kind of development framework designed to encourage MIR researchers to look more at audio production (and it's about time!)

But what about differences in style?

- Different styles of music can vary significantly
  - One style's error is another style's desirable aesthetic characteristic
  - e.g. Noise music vs. Baroque
- jProductionCritic is highly configurable
  - Each error checker can be turned on or off
    - e.g. dynamic compression vs. dynamic variety
  - Each error detector has its own settings controlling its sensitivity
  - So different sets of settings can be used for different styles
    - But good general default settings are available

What do I give jProductionCritic?

- A final stereo master mix
  - Makes sure no unchecked errors are introduced during the final mixdown
  - Exports of individual tracks can also be processed if one really wants to, however
- Any standard audio file format parsable by Java
  - WAV, AIFF, AU, MP3 ☹, etc.

What do I get back?

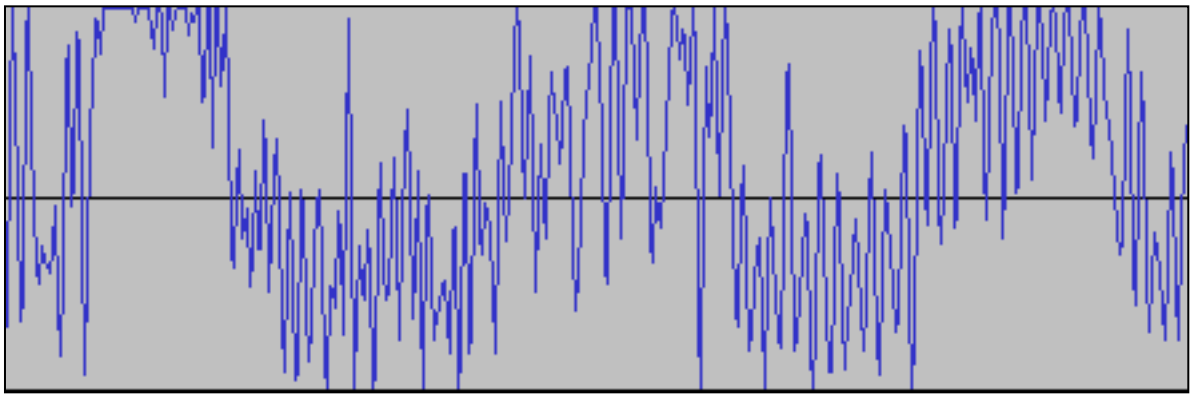
- Basic text reports
  - Text files and/or at the command line
- HTML reports
  - Can be published to a course page
- Audacity label tracks
  - So that errors can be seen synched to the waveform
- ACE XML and Weka ARFF files
  - Shhh, don't tell anyone, but jProductionCritic's output can also be used for machine learning!

But isn't this functionality already available?

- Pro Tools, Nuendo, etc. do include some basic technical error detection functionality
  - And there are VST and other plug-ins that add more
- BUT
  - No single rival offers anywhere near this number of error detectors (16) in one place
  - No rival offers jProductionCritic's integrated reporting or batch functionality
  - Many rivals are proprietary closed source black boxes
  - Most rivals are quite expensive
  - Rivals often focus on correction rather than detection
  - No rivals are designed with education in mind
  - Many of the competing algorithms seem surprisingly naïve . . .

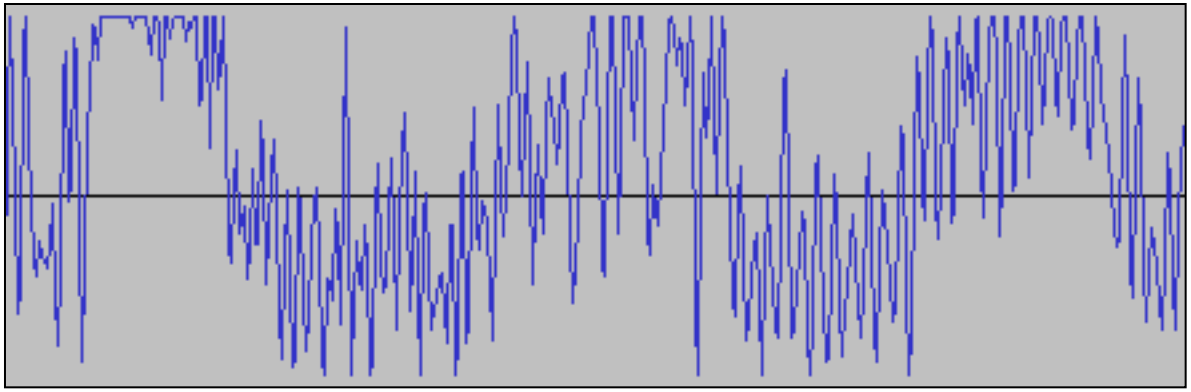
Example: Digital Clipping (1/2)

- What is typically done:
  - Detect clipping if samples are at the representational maximum
    - But normalized signals will be falsely noted as clipped!
  - Some systems therefore only detect clipping if more than a minimum number of consecutive samples are at the maximum



Example: Digital Clipping (2/2)

- Problem: Students are sneaky
  - If a recording clips, they may just attenuate the signal a little to trick the clipping detector
- Simple and relatively effective jProductionCritic solution:
  - Detect clipping if consecutive samples beyond a threshold at any signal level have the same value



Are the detection algorithms awesome?

- Short answer:
  - They are pretty good, but not necessarily super duper
- Most of them work quite well
  - But not perfectly
- They are almost all original
  - But many are based on improvements to existing ideas
- They are designed with the special needs of education in mind
  - e.g. as demonstrated with digital clipping just now
- They can all be improved
  - There are lots of people who know more than me about DSP, production and education

Yay community development!

- So, please feel free to propose improvements to the algorithms!
  - And please invent new ones!
- A primary goal of jProductionCritic is to encourage community involvement
- Goooooooooooooo open source!

But does jProductionCritic work?

- An evaluation was done based on 110 mixes from CEGEP student assignments
  - Live and studio recordings (classical and jazz)
  - Mashups (many genres)
- 44 of these were randomly selected and used to tune the error detectors
- The remaining 66 were used to test the tuned detectors
  - Compared results to those produced earlier via manual marking (and, later, remarking)
- Caveat: These results are certainly biased, as there was only one human corrector (me)

Experimental results

	True Positives	False Positives	False Negatives
Human	499	0	8
jPC	452	38	55

- jProductionCritic found 89% of the true errors
  - And 92% of the errors it detected were true errors
- The human corrector found 98%
  - Although the human was (seemingly) infinitely better at avoiding false positives

Discussion of results

- jProductionCritic is not as good as an expert human
  - But it is much better than inexpert students!
- It is also more than good enough to save an expert corrector a lot of time annotating errors
  - And even find a few that an expert corrector missed (8 in these experiments)
- Three error detectors were responsible for most of jProductionCritic's problems (73% of them):
  - Phasing (very very bad)
  - General background noise (very bad)
  - Non edit click instantaneous noise (badish)
- The other error detectors performed very well

More information

- Read the upcoming ISMIR paper:
  - November 4 to 8 in Curitiba, Brazil
  - www.ppgia.pucpr.br/ismir2013/
- Try jProductionCritic (and/or mod it):
  - jmir.sourceforge.net
  - There is a nice on-line manual
  - But it won't be posted until late October
- Le me know what you think:
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