The Audio Degradation Toolbox

http://code.soundsoftware.ac.uk/projects/audio-degradation-toolbox/

and its Application to Robustness Evaluation

Sebastian Ewert and Matthias Mauch

reverb

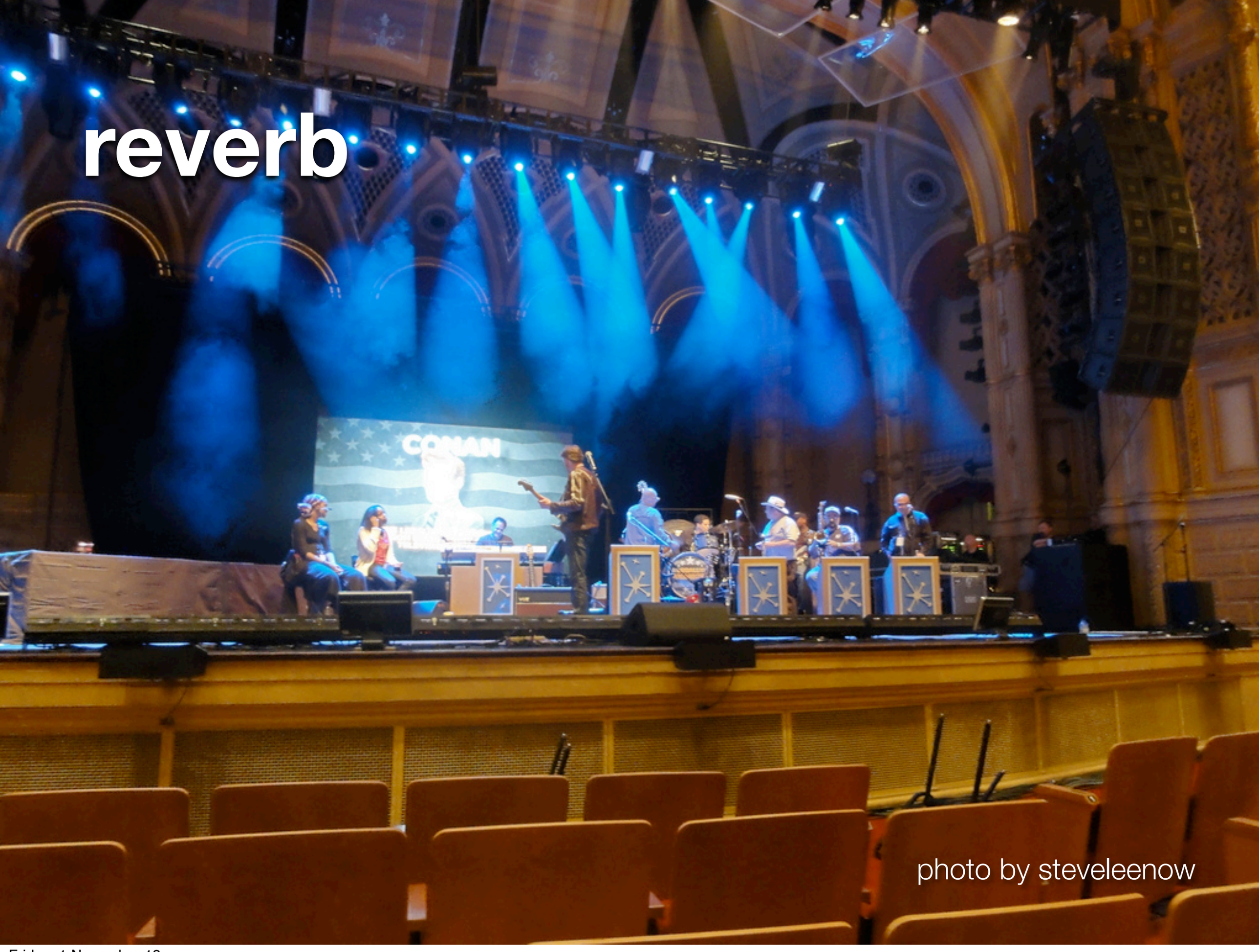

photo by steveleenow

lossy compression

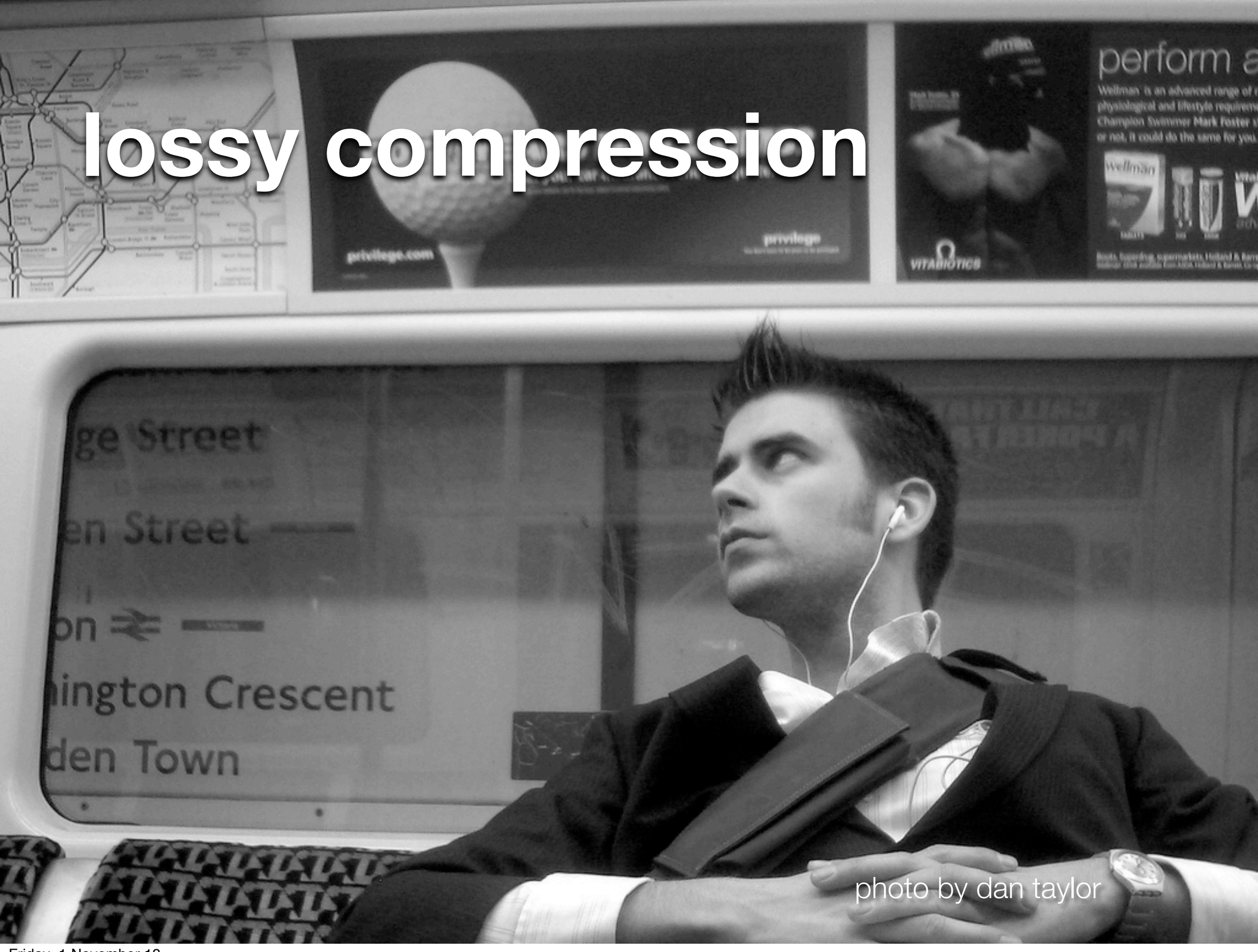

photo by dan taylor

bad analog-to-digital conversion

photo by emilio di fabio

low quality microphone

photo by JeffaCubed

Environmental noise

...and many other things degrade audio.

- irregular tape playback
- dynamic range compression in radio and tv broadcasts
- audio speedup on the radio
- noise
- clipping and other distortion
- ... and yet more.

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- most audio collections
  - contain some audio of low quality
  - contain recordings of different qualities
  - contain recording of *unknown* quality

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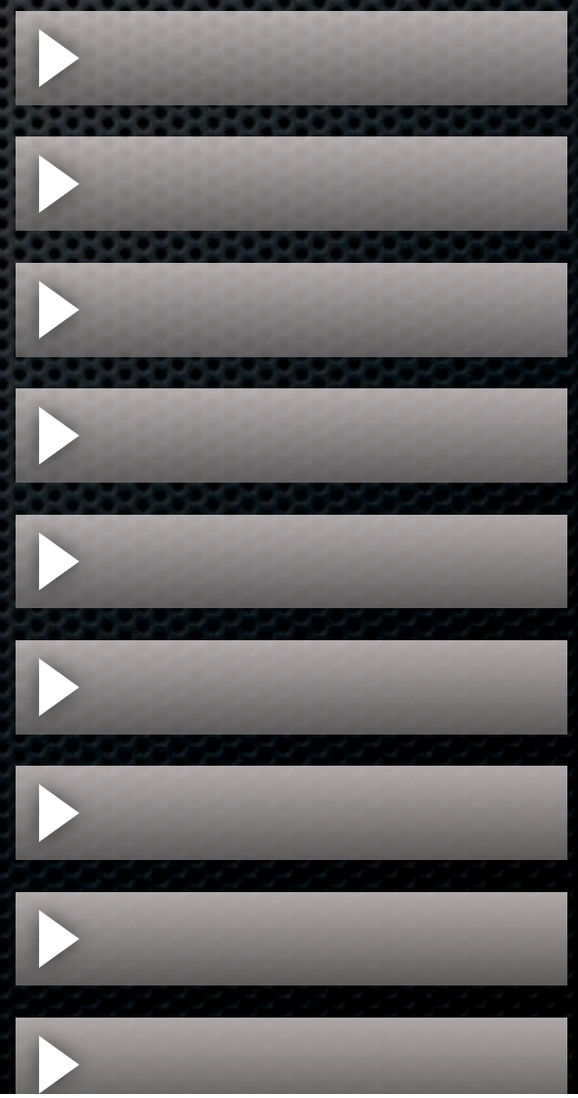
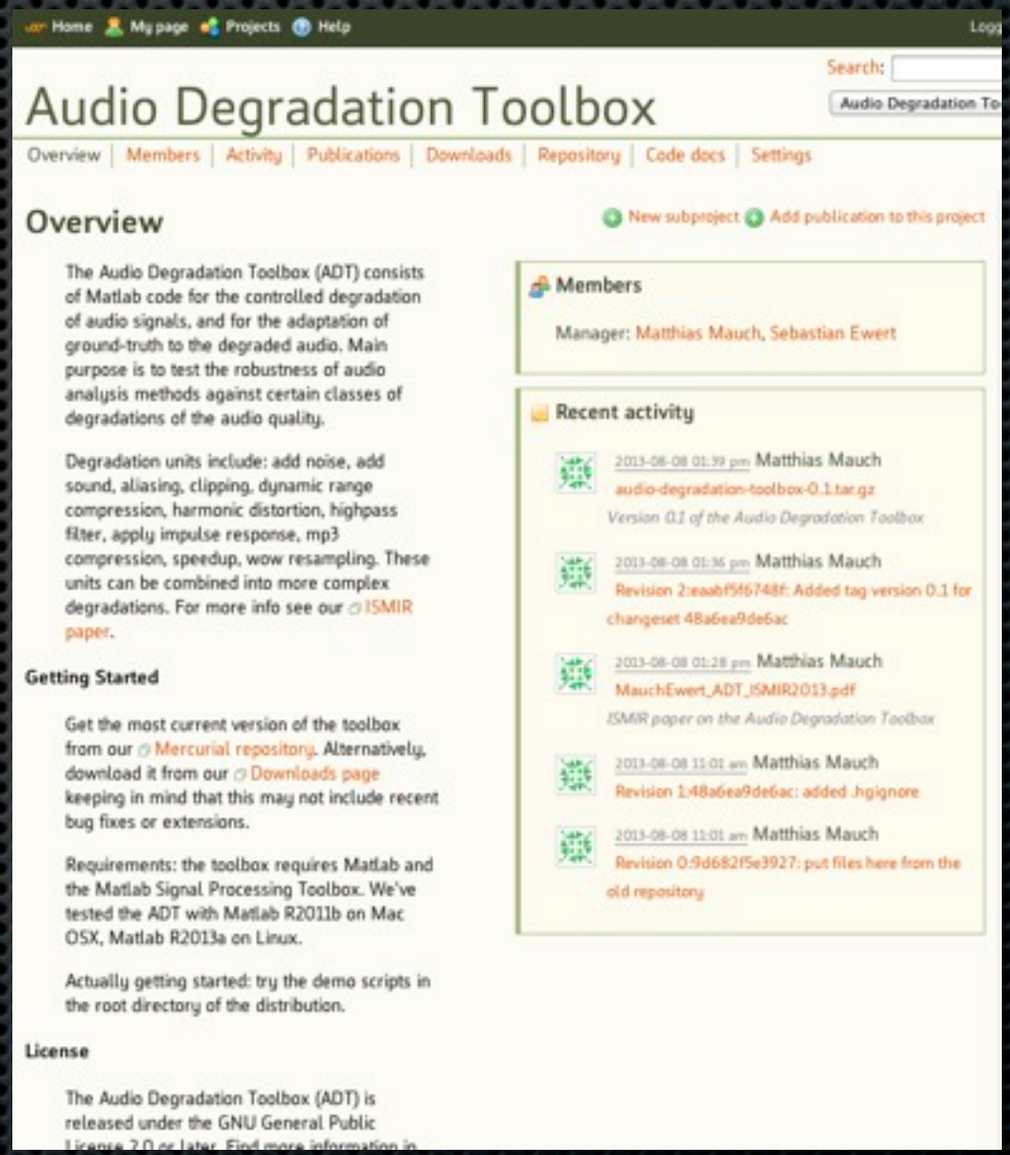


Impact on Music Informatics

- methods are usually tested only on one (or few) audio collections, hence:
  - feature extractors (etc.) might fail in the real world **affects MIR researchers' work**
  - if feature extractors work, it is not clear if they corrleate with content or audio quality **affects 'digital musicologists' and industry**

Audio Degradation Toolbox

- most comprehensive collection of Matlab code for audio degradation
- designed to make it easy to degrade audio in many different ways
- aim: encourage MIR researchers to test their algorithms under many different conditions



GPL open source on SoundSoftware

Degradation Units

- Add Noise
- Add Sound
- Attenuation
- Aliasing
- Clipping
- Delay
- Dynamic Range Compr.
- Apply Impulse Response
- High-pass filter
- Low-pass filter
- MP3 Compression
- Saturation
- Speedup
- Wow Resampling

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sounds included: pub sound env., vinyl crackle

room, microphone, speaker and vinyl player IRs

Degradation Unit Example

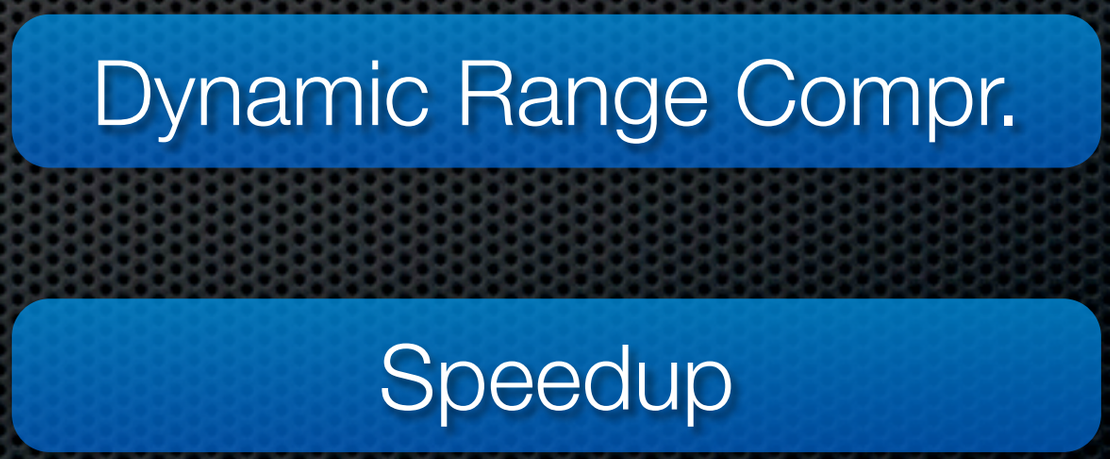
```
parameter.noiseColor = 'brown';
[audio_out, timestamps_out] =
   degradationUnit_addNoise(audio, samplingFreq,
                            timestamps, parameter)
```

- example sound before / after
- why “timestamps” — we’ll see later.

Degradations

- to make complex “Degradations” we can make chains from degradation units
  - ... like audio effects!

- Example: *Radio Broadcast* Degradation



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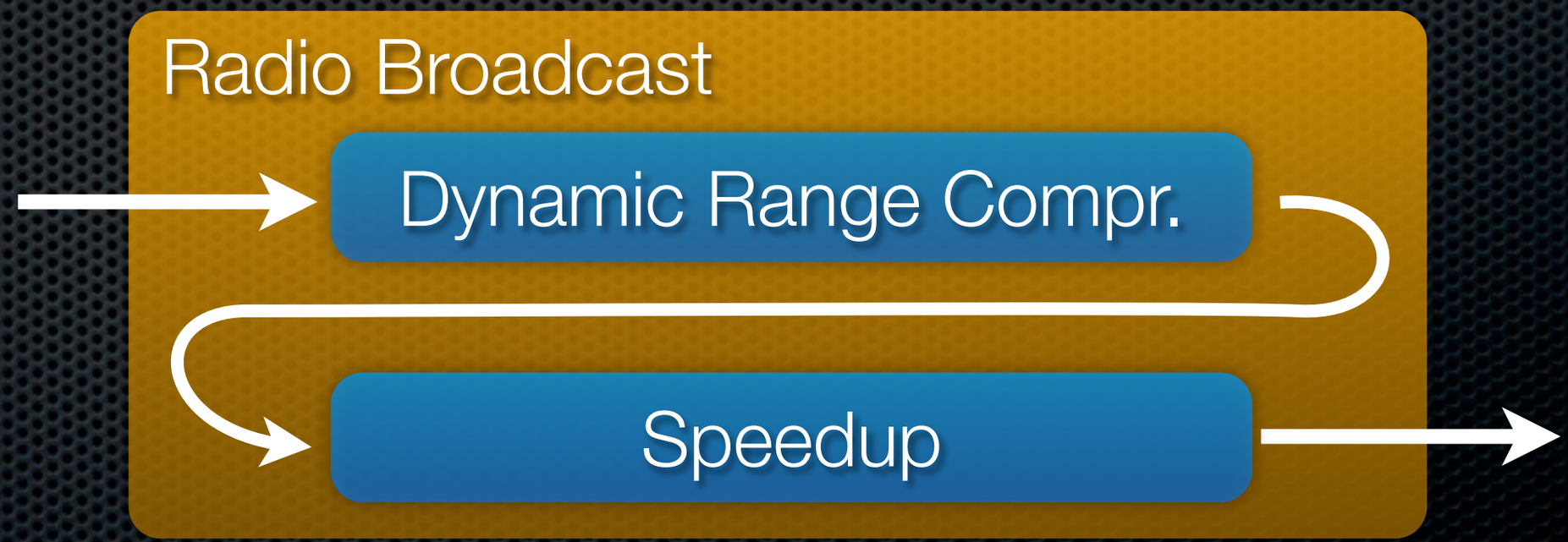

Degradations — examples

- Lots of audio examples (file://localhost/Users/matthiasm/code/audio-degradation-toolbox/html/audio_examples.html)
- Examples with spectrogram:
  - Wow resampling on cello (file6)
  - Live Recording on file1

Comparing to Ground Truth

- one main purpose:
  evaluate methods under different degradations
- **problem** — we have time-distorting degradations
- **solution:** every degradation can also transform ground truth to the time line of the degraded audio
- example: beat tracking ground truth after “Speedup” degradation

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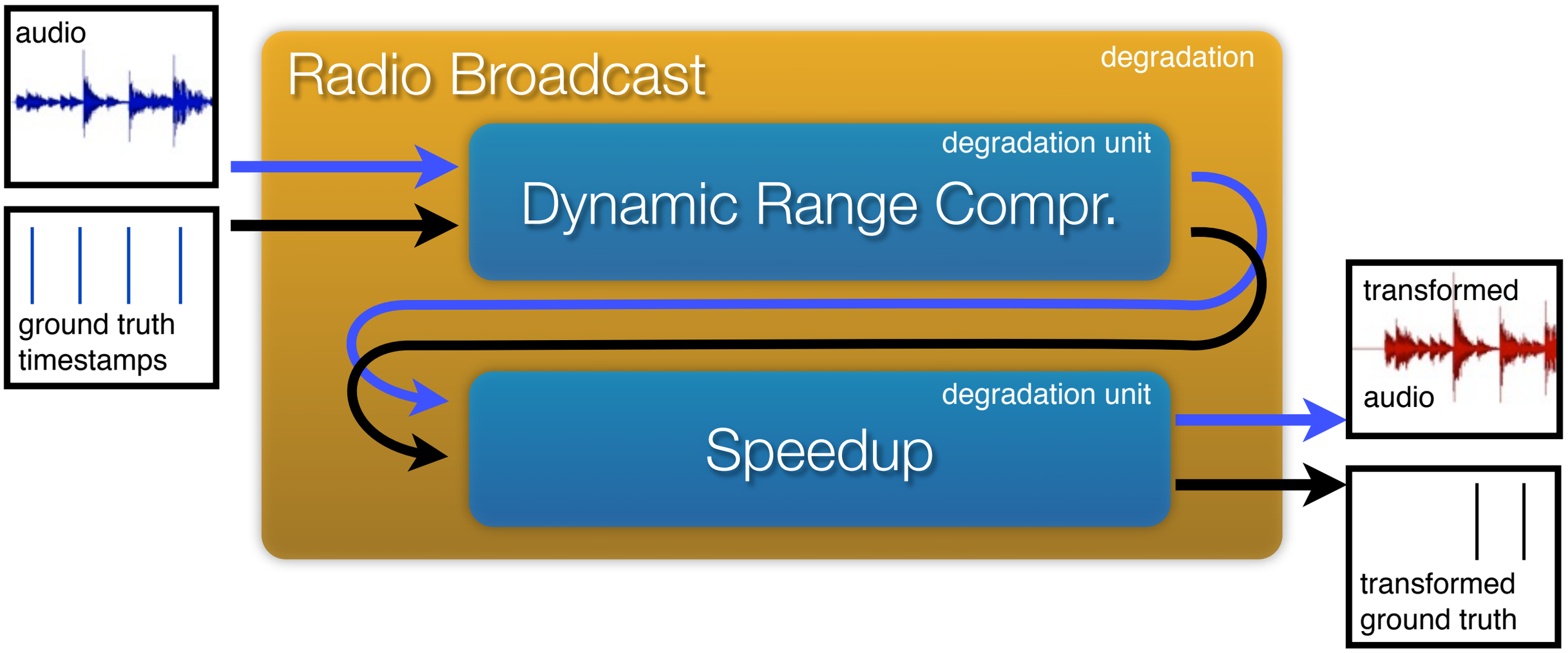
Revisit Example



Experiments on ‘Real-World’ Degradations

Live Recording

Radio Broadcast

Smartphone Playback

Smartphone Recording

Strong MP3 Compression

Vinyl Recording

Results I — Audio ID

- audio ID fails for most “Real-World” degradations, not for mp3
- robustness to pink noise is ok

	correct	incorrect	not identified
Original	**100**	0	0
Live	0	0	100
Radio	3	3	94
PhonePlay	0	1	99
PhoneRec	5	7	88
MP3	**100**	0	0
Vinyl	4	0	96

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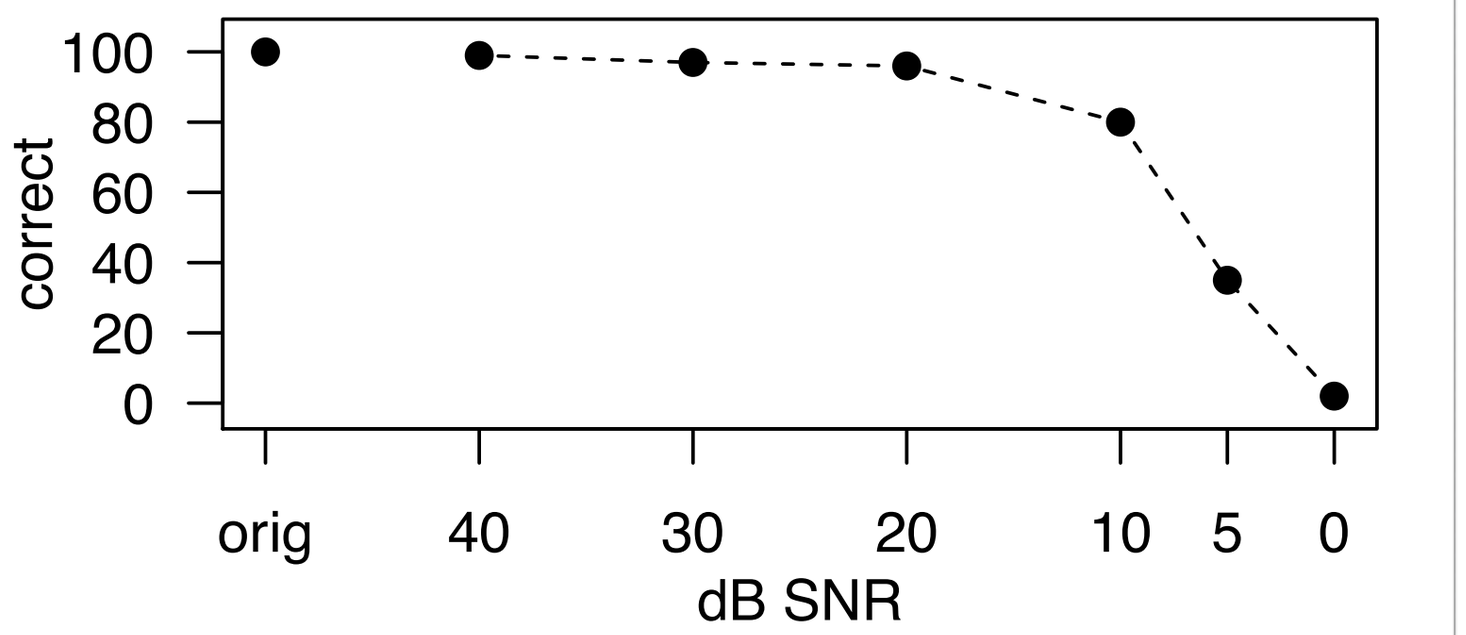
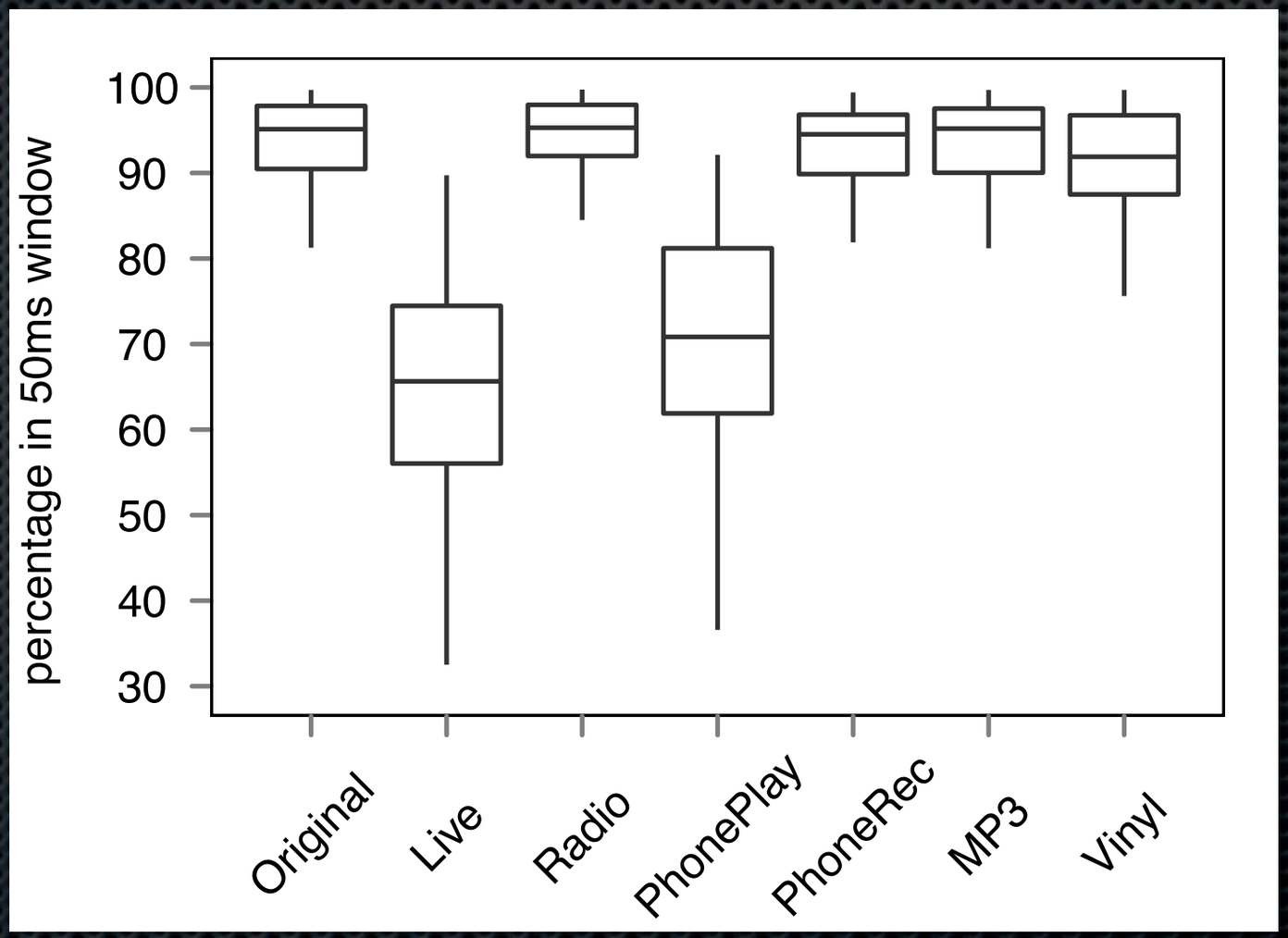


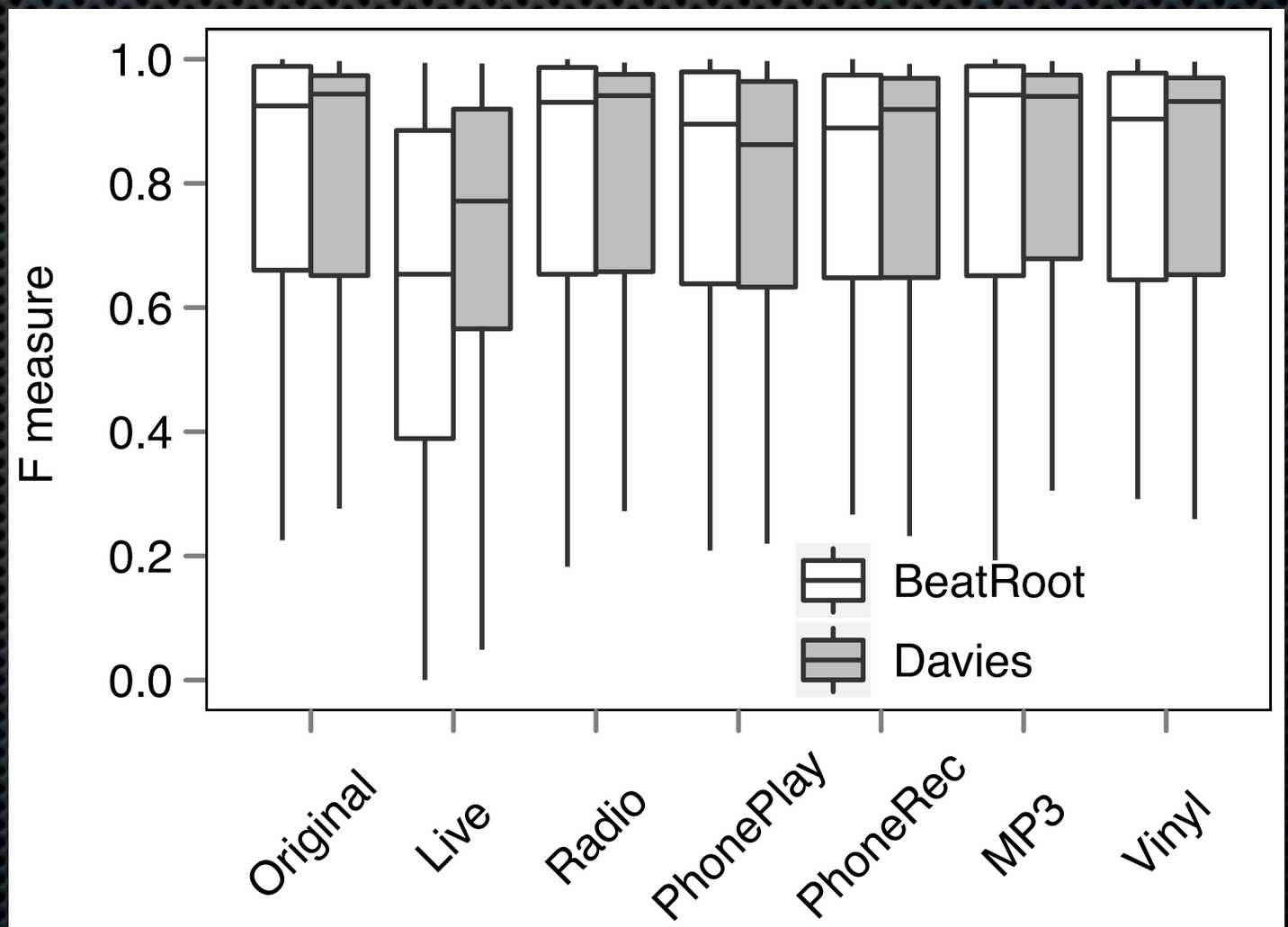
Results II — Score-to-audio alignment

- pretty much falls over for “Live” and “Phone Playback” degradations
- explanations: onset duplication; bass harmony missing



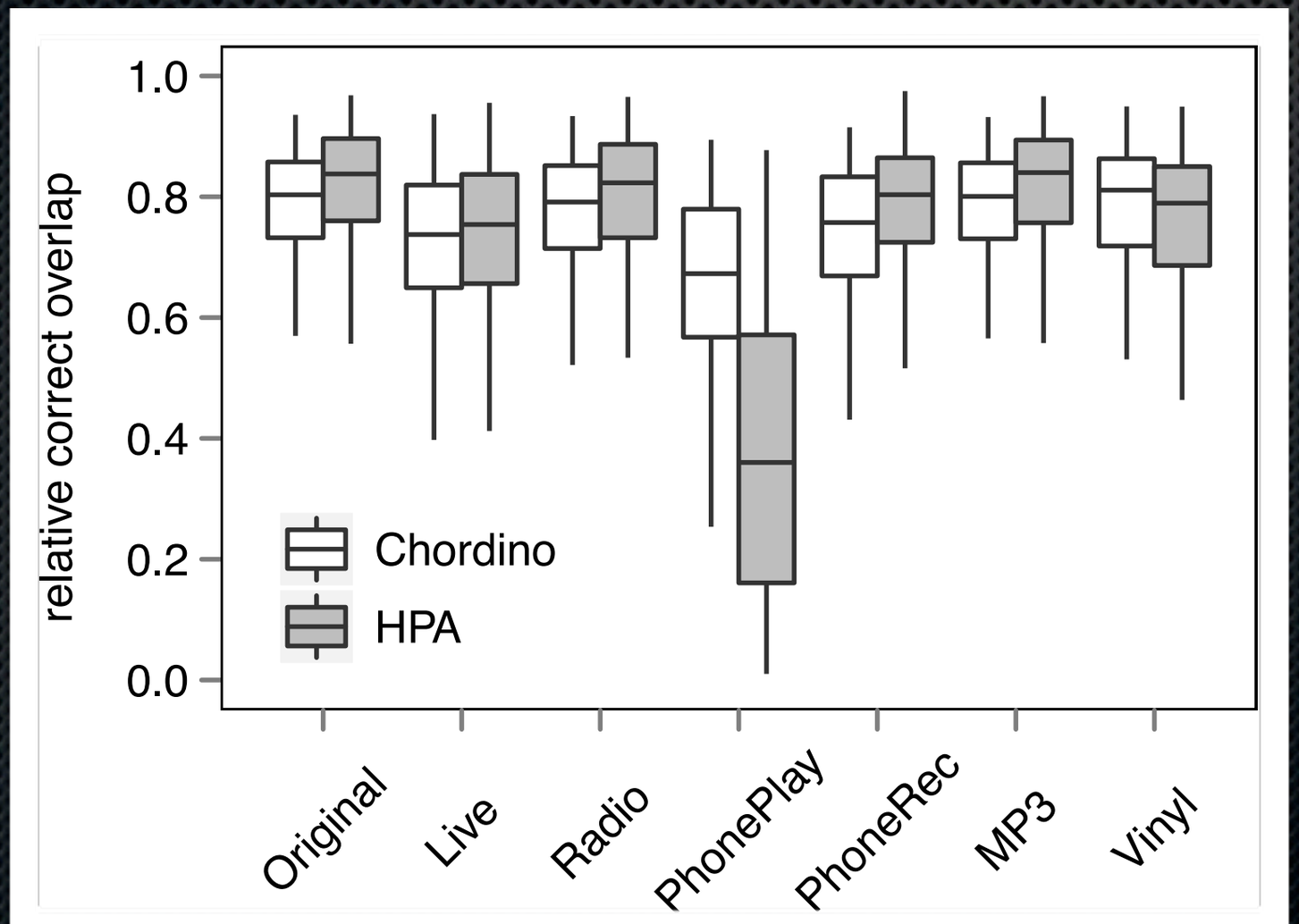
Results III — Beat-tracking

- compare two methods: BeatRoot, Davies
- very similar, but Davies more robust to “Live” degradation



Results IV — Chord recognition

- compare two methods: Chordino, HPA
- HPA usually better, Chordino more robust on “Phone Play”



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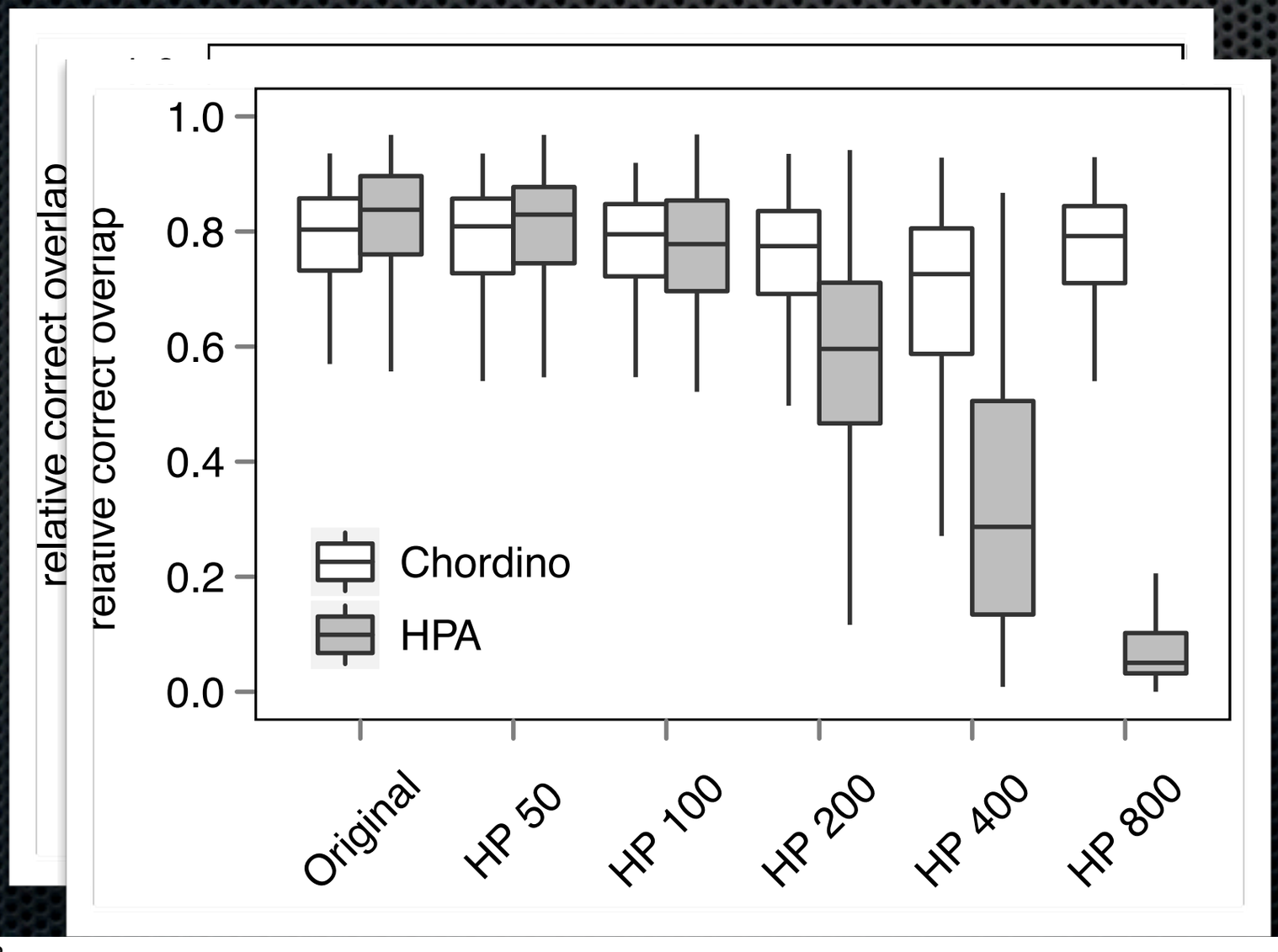

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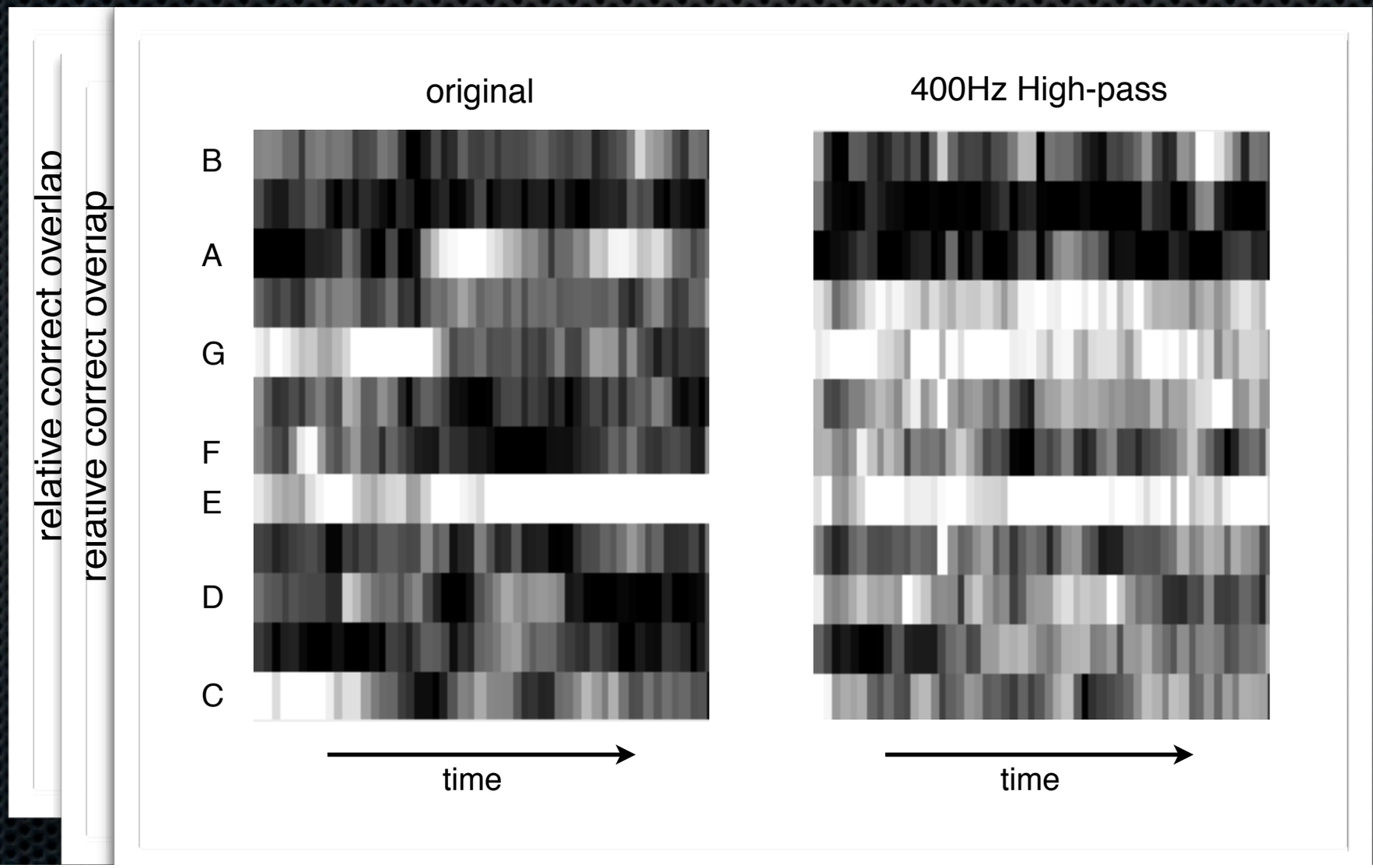

Summary

- Audio Degradation Toolbox offers
  - easy-to-use degradations
  - more comprehensive than other existing toolboxes
    - ground truth time-line transform to evaluate on time-warping degradations
- Results show: ADT is useful to detect strengths and weaknesses of MIR methods
- For paper, audio examples, source code: http://code.soundsoftware.ac.uk/projects/audio-degradation-toolbox

What's up next?

- convince everyone to use the ADT :)
- work with it ourselves...
  - degraded audio as additional training data
  - affect of degradation on human ground truth labelling