Audio Signal Processing Review

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Why Analyze Signal?

- Recognition, Behavior, Environment, Ecology…
- To understand the information in the signal

- When the recorded sound is not what you want?
-

Why?

- (1) Many kinds of noises
- (2) Too many sounds recorded

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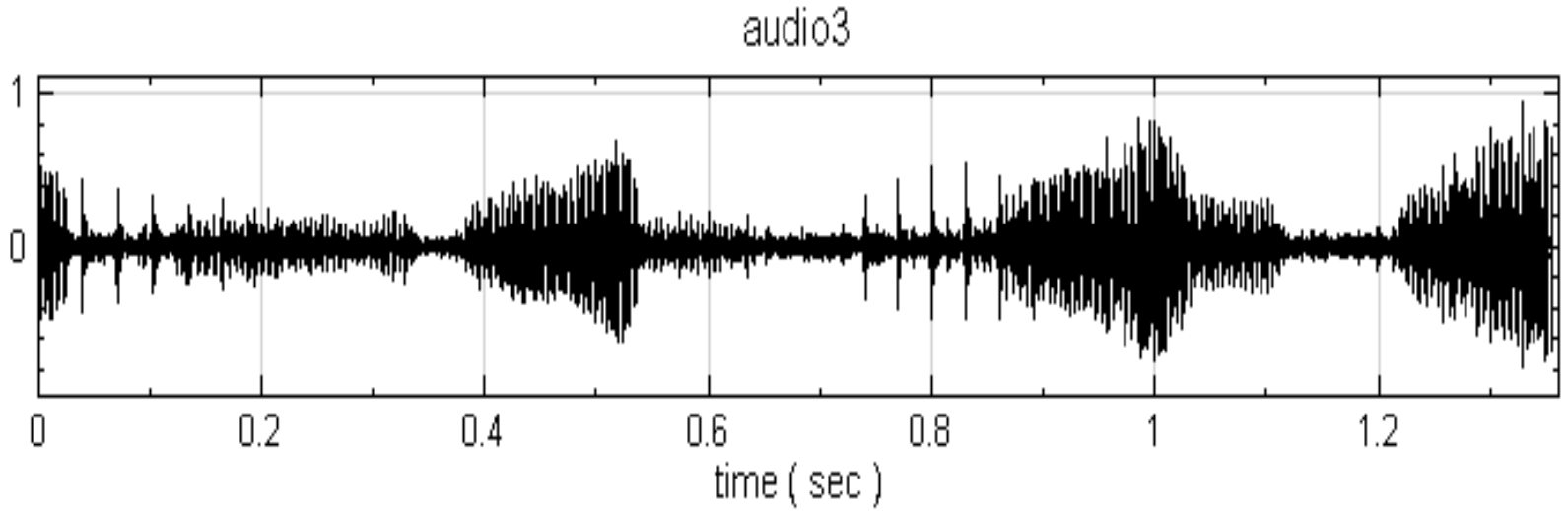
How to “read” sound?

- (1) Listening
- (2) Plotting time signal
- (3) Fourier Transform (Freq domain)
- (4) Time Frequency Analysis(Freq domain)



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How to reduce Noise

- (1) Hardware: microphone: Solve a little.
- (2) Software: filter it out !
- How?

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Filter:

- Two Purposes:
- (1) Restoring signal – Signal contain Noise

- (2) Separate signal – Too many sounds
-

Filter(Goal,Freq Type, Pattern)

- Goal = restore or separate signal
- Freq= different or overlap
- Pattern = Specific or non-specific (specific=color noise, same rhythm,..)

- Examples:

Talking in a airplane (restoring, overlap-freq, Specific)

- A Cricket (Bat) and a Frog (separate, diff-freq, Non-spec)

- Talking in a tunnel (restore, overlap-freq, Non-spec)
  Two Men Talking (separate: overlap-freq, Non-spec)

- Baby's heartbeat, Mother's breath & heartbeat
  (separate, overlap-freq,Non-spec)

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That is why study Freq (page 2)

- Has to know Freq More
- (3) FFT(Spectrum)

  Do you know When that Freq Happen?

  Contain Not Enough Information

  Filter? Recognition? Behavior?

- (4) TFA(STFT, Wavelet, HHT)
- I Believe it does Better Job than (3)

  Since it give us more (time) information

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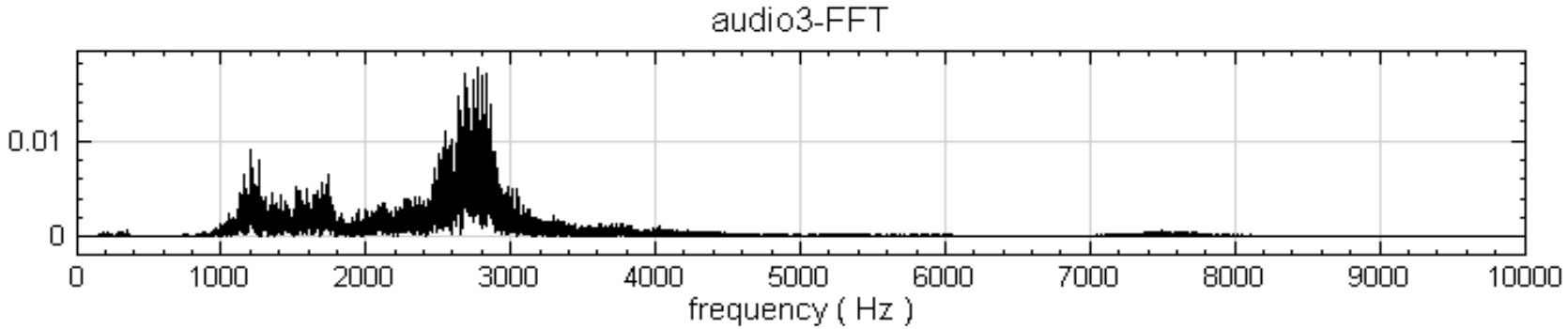
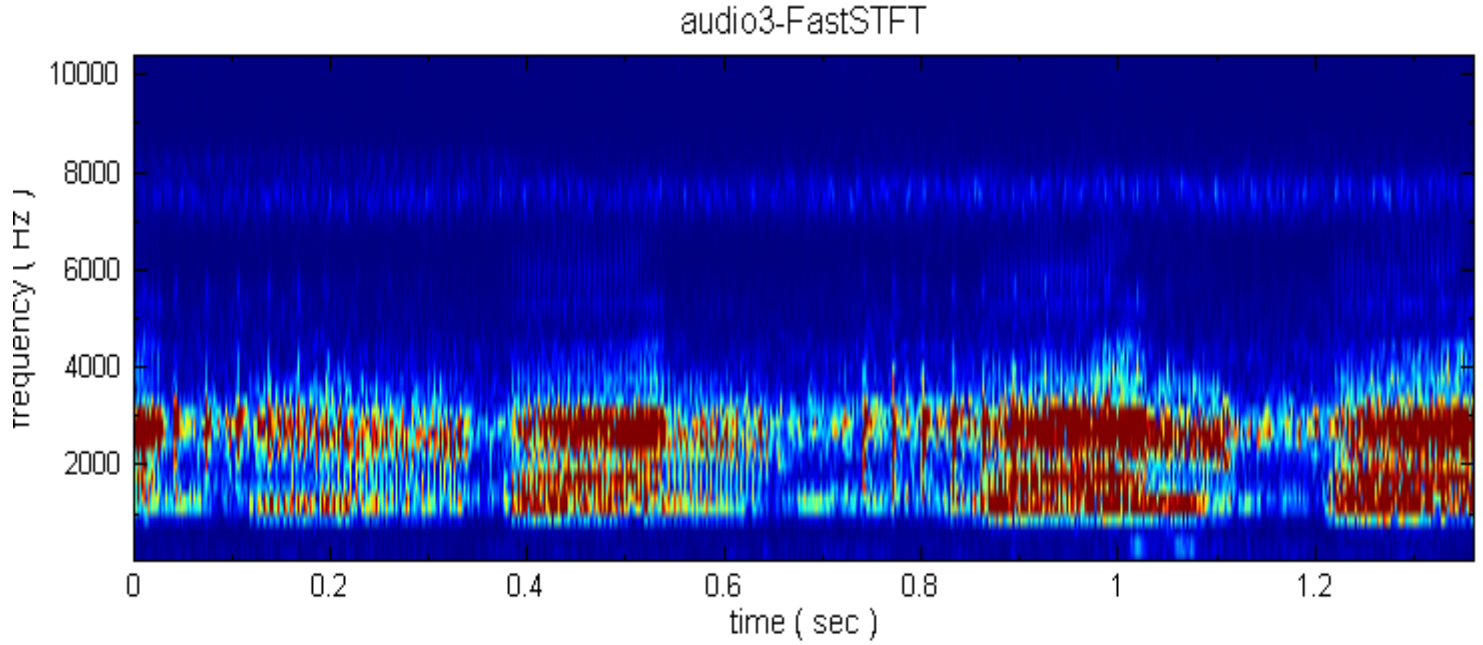
Frequency Domain





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How to choose Filter
Filter(Goal, Freq Type, Pattern)

- Different Freq => non-adaptive filter
- Examples: FIR, Gaussian Filter, IIR

- Restore Signal:
- Examples: Wiener filter

- Play: Visual Signal

Do we Solve the Problem?

- If the frequency is overlaped and non-specific?

- How ? Effectively ?

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New Technique to Separate Signal

- New Technique developed in the past 10 years
- (1) TFA based(1990+-) =>

  Overlap and non-specific, not effective
- (2) EMD (1998 by Nordon E. Huang): contain “rich Information”

- => partial overlap?
- => Combined with (1), (3)
- (3) ICA (1990), audio ICA(200x)
- => Overlap and non-specific

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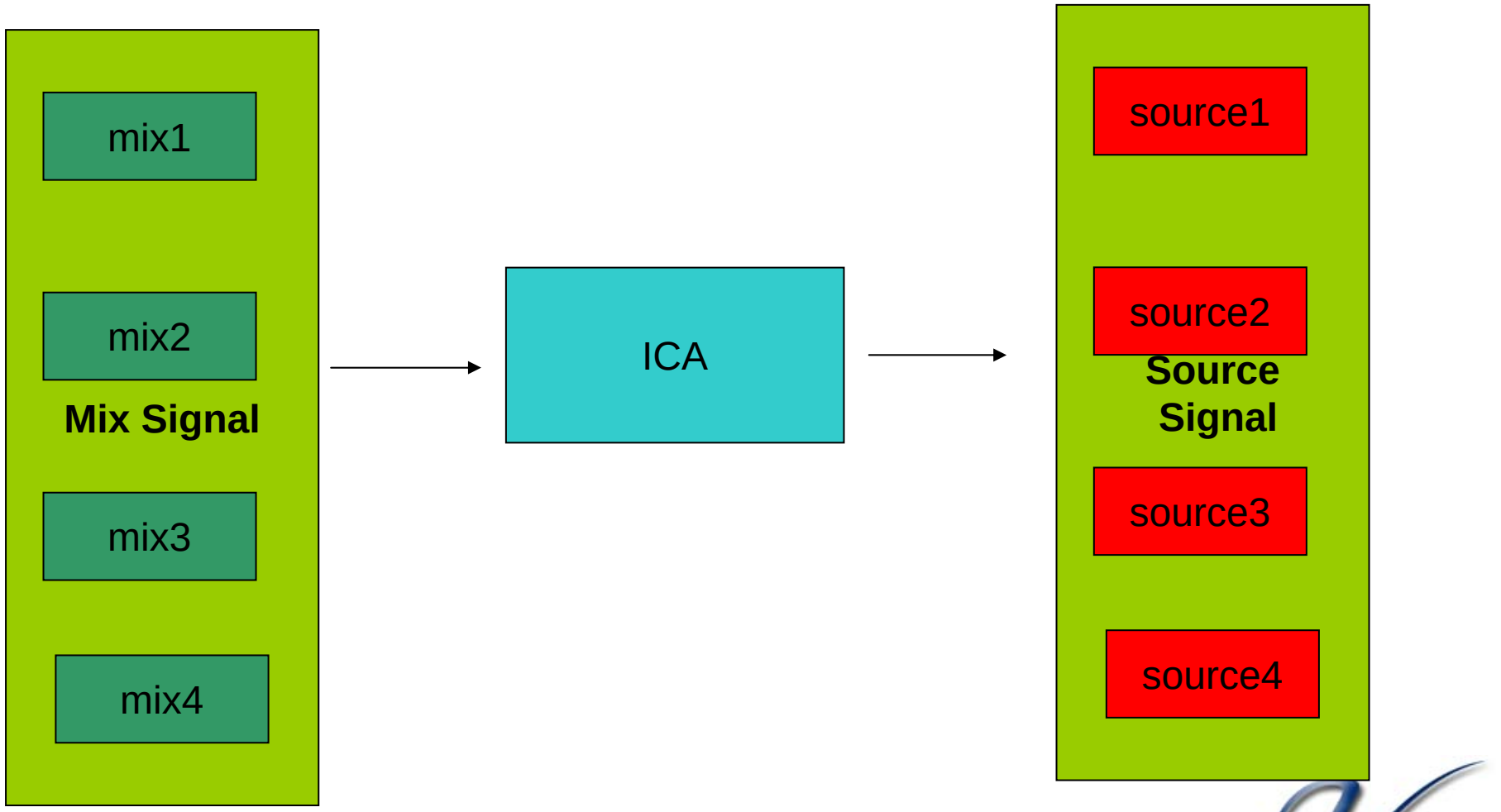
How ICA works?

More Microphones ! !



ICA

Stands for Independent Component Analysis

Progress: Can solve signal traveling at infinity speed

Audio ICA : mostly in Lab. ⇔ Solution !!!

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Difficulties in Applying ICA

- (1) sound travel at finite speed ~= 340 m/s
- =>

  signal does not arrive at the same time

- (2) Reverberation

- (3) Noise degrades its performance

  Audio ICA : mostly in Lab.

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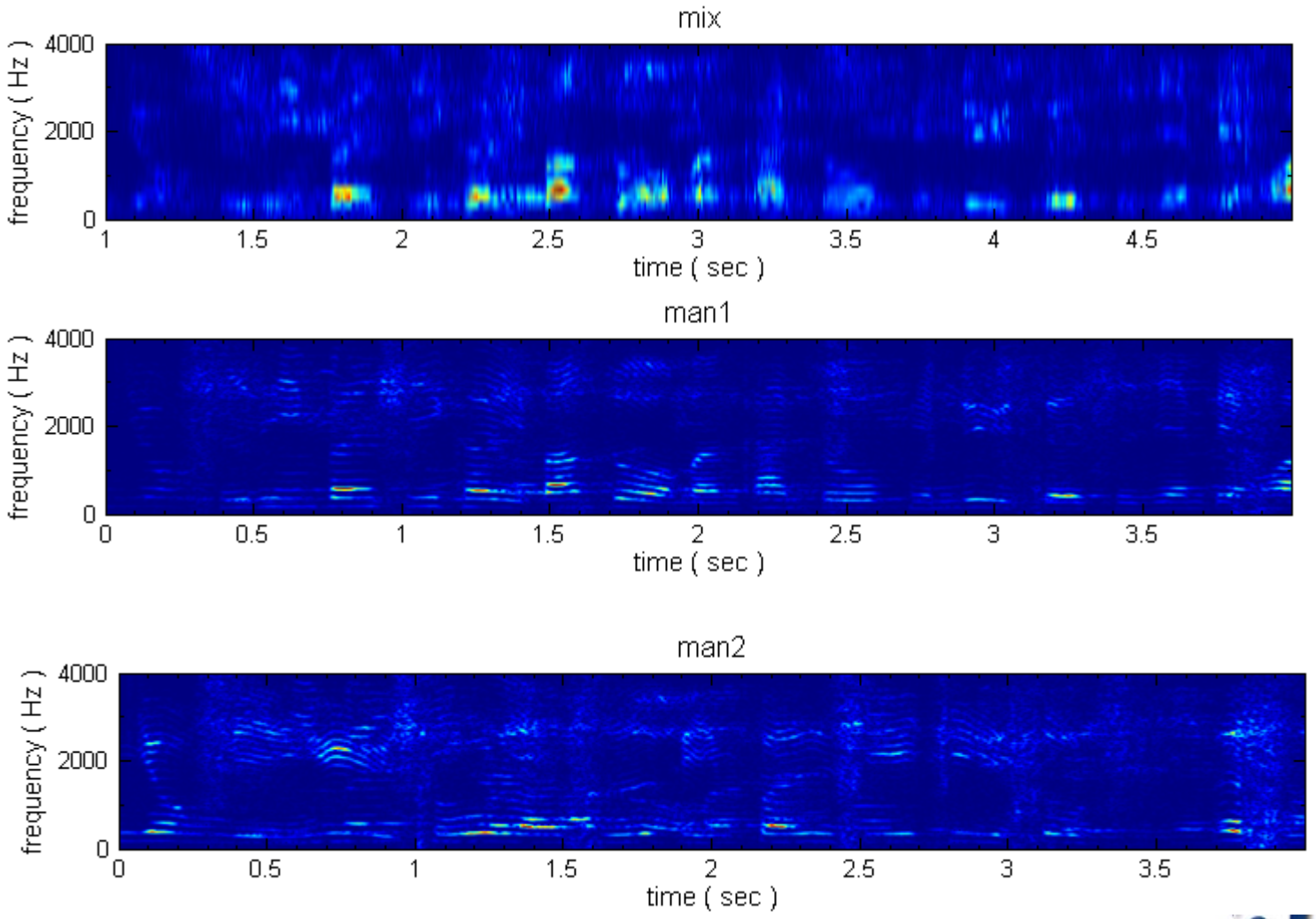
Example: Two men Talking
Filter(separate, overlap Freq, Non-specific)



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Quantify on Quality

- SNR – signal to noise ratio
- SIR -- signal to interference ratio
- Recognition
- Arts -- music