Echo-aware signal processing for audio scene analysis

Diego Di Carlo

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Jury members:	Laurent Girin (reviewer - president) Simon Doclo (reviewer) Fabio Antonacci (examiner) Renaud Seguier (examiner)

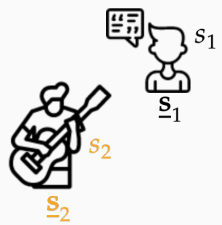
Université de Rennes 1, IRISA/INRIA, Panama research group

Colophon: Metropolis Beamer Template based on Alexander Honorat and Antoine Chatalic. Icon from Flikon.com

Introduction

Echo-aware signal processing for audio scene analysis

Current Scenario



Sound

- produced by sources

Echo-aware signal processing for audio scene analysis

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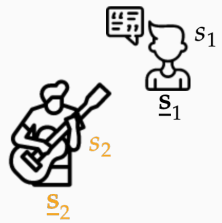

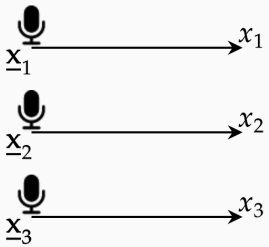

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- produced by sources
- recorded by (array of) microphones

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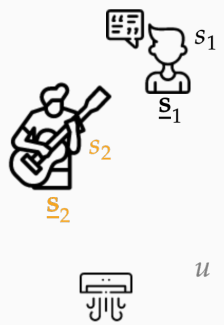

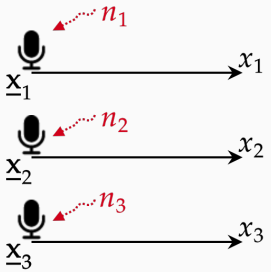

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- corrupted by noise

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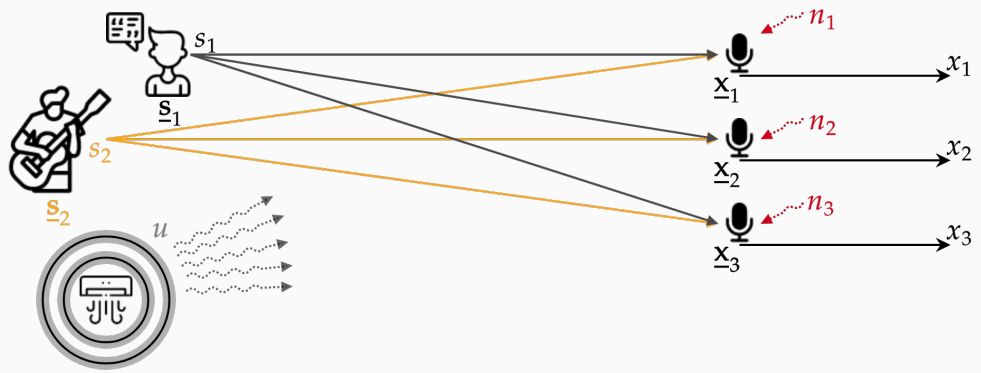

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- propagates in the space

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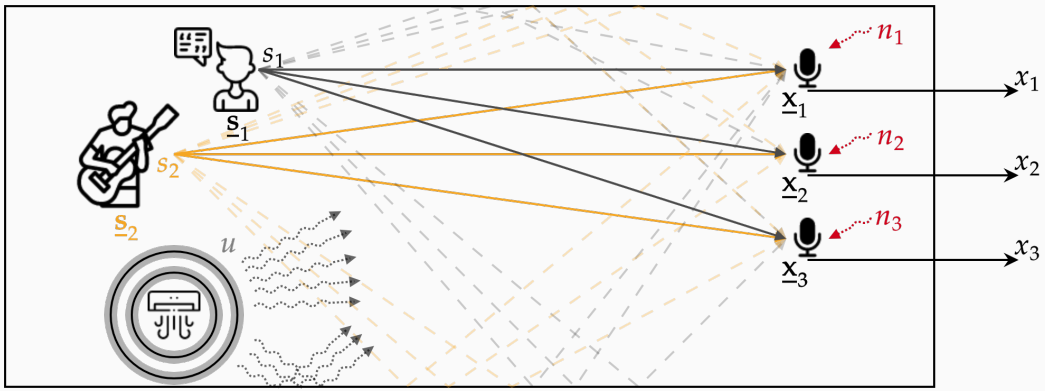
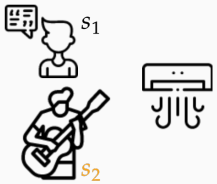


Sound

- produced by sources
- recorded by (array of) microphones
- corrupted by noise
- propagates in the space
- interacts with the room
  ↪ reverberation

Echo-aware signal processing for audio scene analysis

Semantic information



on nature and content

Echo-aware signal processing for audio scene analysis

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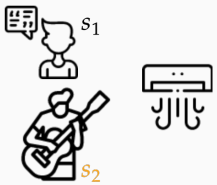

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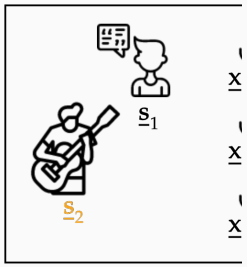
Spatial information



on position and geometry

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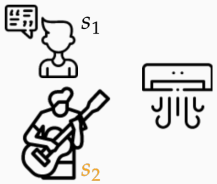

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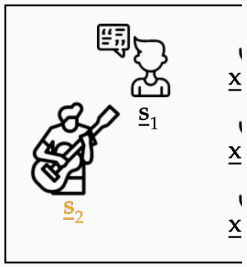

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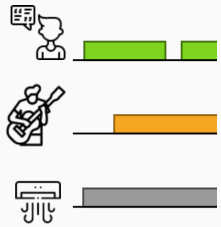
Temporal information



on events activity

Echo-aware signal processing for audio scene analysis

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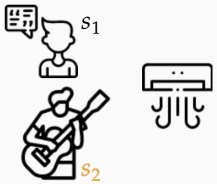

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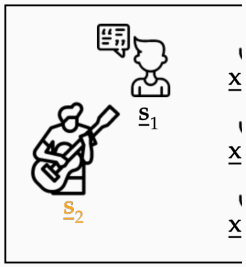

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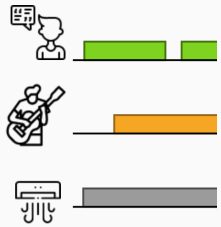

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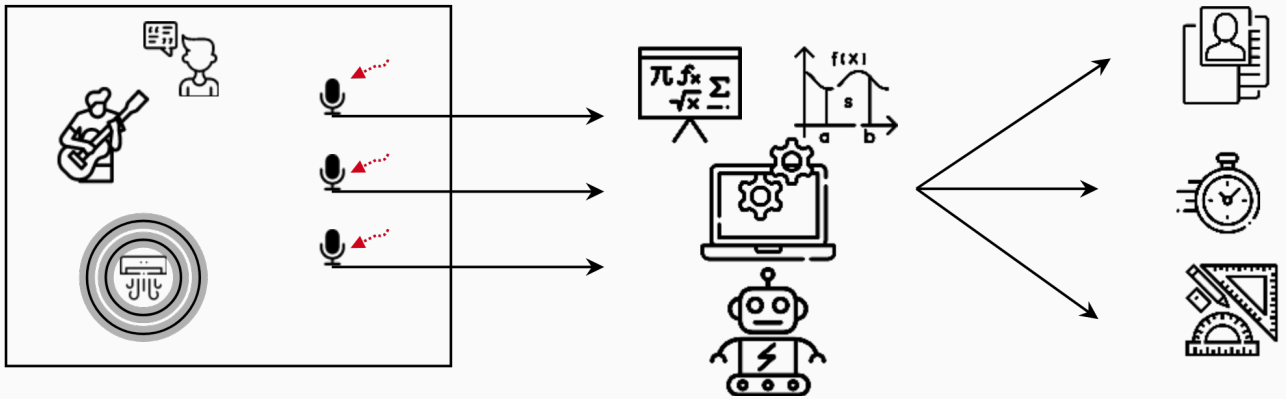
Audio Scene Analysis

Extraction and organization of all the information in the sound



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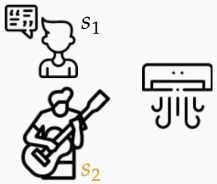

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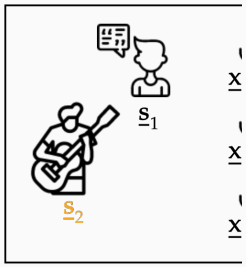

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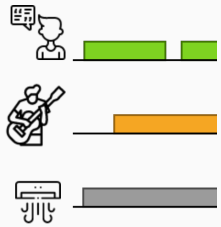

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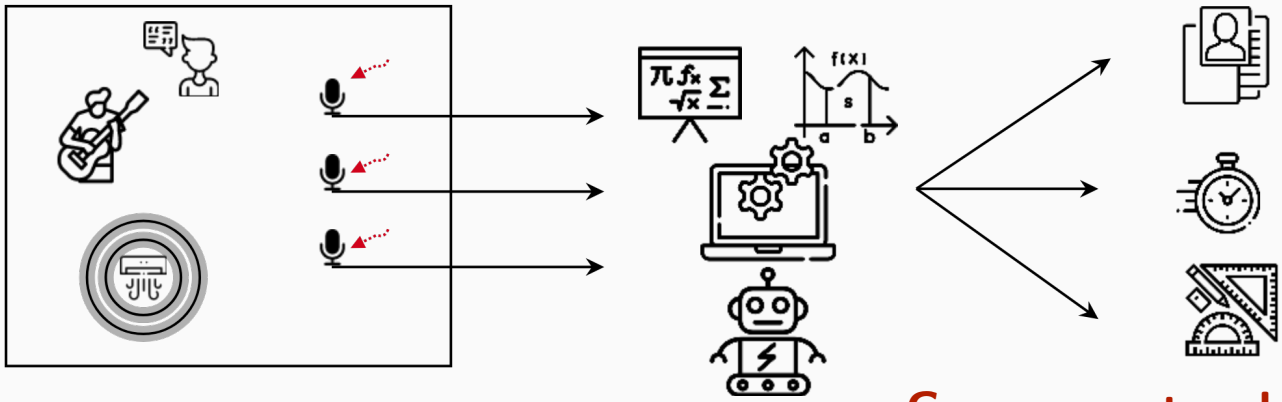

Can computer do it?

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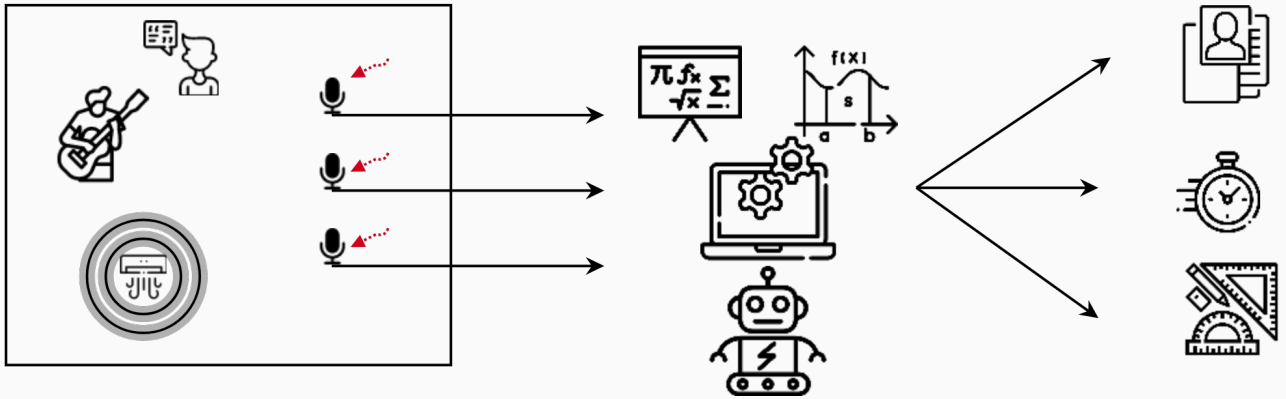

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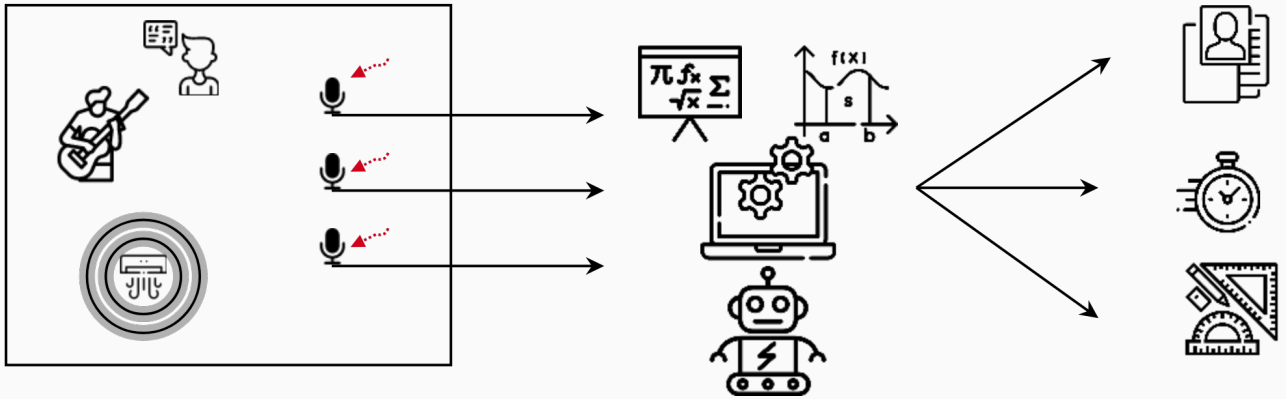

Signal Processing

Mathematical models, frameworks and tools to tackle and solve such problems

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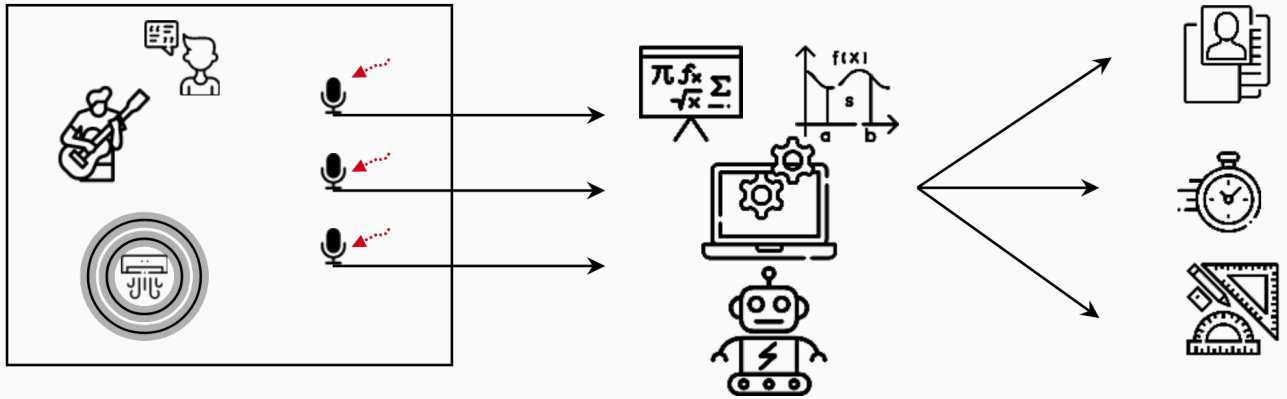

Signal Processing

Mathematical models, frameworks and tools to tackle and solve such problems

Some (inverse) problems

- Speaker Identification
- Sound Source Separation (SSS)
- Speech Enhancement (SE)
- Automatic Speech Recognition (ASR)
- Voice Activity Detection
- Diarization
- RT_{60} estimation
- Acoustic Channel Estimation
- Wall Absorption Estimation

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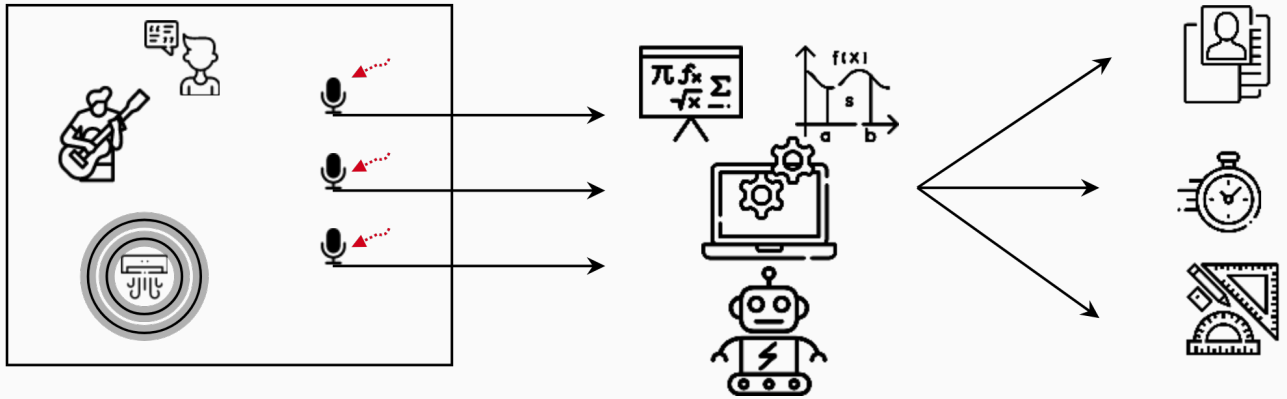

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Echo-aware signal processing for audio scene analysis

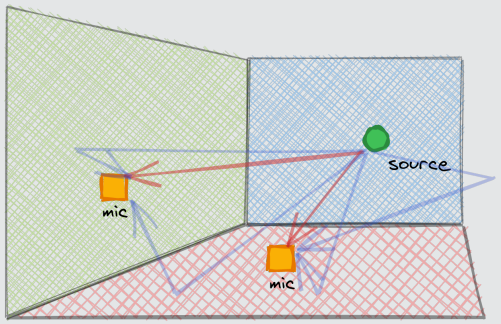
Sound interacts with indoor environment:

it is reflected,
specularly and diffusely
+ it is absorbed,
+ it is transmitted,
+ and other.

} = all reverberation

Acoustic Echoes

- Elements of reverberation
- Specular reflection standing out for time and strength
- Repetition of a sound but after
  - time $\Leftrightarrow$ distance
  - same content



Everyday examples:

Outline and contributions

Thesis title:

Audio Scene Analysis

↓

context and problems

Outline and contributions

Thesis title:

Audio Scene Analysis	Signal Processing
↓	↓
context and problems	models and frameworks

Outline and contributions

Thesis title:

Audio Scene Analysis	Signal Processing	Echo-aware
↓	↓	↓
context and problems	models and frameworks	better processing

Outline and contributions

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Audio Scene Analysis	Signal Processing	Echo-aware
↓	↓	↓
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Thesis content:

How to estimate them?

- Analytical method
- Learning-based method

How to use them?

- Source Separation
- Source Localization
- Speech Enhancement
- Room Geometry Estimation

Where to find them?

Echo-aware database for estimation and application

References i