Sound Analysis, Synthesis and Processing (offerto solo in inglese)

This course provides a comprehensive collection of fundamentals tools for audio synthesis and rendering; and for audio analysis and processing. A wide range of applications will be covered, including musical sound synthesis, 3D audio, restoration of historical recordings, sound classification and music information retrieval, sound localization and tracking, etc.
This course also includes a number of practical activities in the StudioLab of the Politecnico devoted to sound processing techniques for music production.
Minimum requirements for attending this course is a basic knowledge of signal processing. Contents:

Part 1 - Digital audio analysis and processing

In this first part of the course we cover relevant applications of digital audio signal processing for various applications, ranging from audio restoration to array processing.

- Sinusoidal modeling – windowing and resolution, peak localization and spectral interpolation, peak tracking over time and spectral continuation.
- Audio restoration - noise modeling, removal of typical audio artifacts: clicks, crackles, background noise, hissing noise, wow and flutter, nonlinear distortions.
- Fundamentals of microphone array signal processing
- Feature extraction and analysis: low-level descriptors (time-domain, spectral and timbral features), sound classification and similarity

Part 2 - Sound synthesis and spatial processing

In this second part we introduce techniques for sound synthesis and spatialization/reverberation; as well as tools for high-end rendering of audio signals. Using numerical methods and signal processing tools, we discuss traditional techniques for musical sound synthesis such as wavetable, additive, subtractive, granular and nonlinear synthesis techniques; more advanced sound synthesis solutions such as modal synthesis and sound synthesis through physical modeling.

We also introduce techniques for digital audio enhancement/improvement such as sound effects, reverberation and spatialization. Finally, we discuss advanced sound rendering techniques based on multi-channel processing, Vector-Based Amplitude Panning, and space-time audio processing (e.g. ambisonics and wavefield synthesis).