Sparse adaptive representations for musical signals

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The *representation* problem is a key aspect of many signal processing tasks: problems are generally more easily solved when the signal is represented in such a way that its characteristics can be extracted simply. This is clearly the case for musical signal processing tasks such as segmentation, transcription, classification,... where some preprocessing "transform" is generally performed before adapted algorithms may be run.

The standard representations for musical signals are the time and the (local) frequency representations. In this chapter, the emphasis is put on alternative representations, which aim at displaying the information in some "parameter space", suitable for the considered signal processing task. This includes parametric representations (for example, deterministic or probabilistic models involving sinusoids, and variants including transients and random layers), and "elementary waveform" representations, in which a signal is modeled as a linear superposition of waveforms, generated using simple transformation rules (e.g. signal expansions with respect to orthonormal bases or frames in the signal space). While both types of approaches are fairly different from practical as well as methodological points of view, they share many common characteristics, which we shall try to emphasize. For example, in both situations, the parameters of the models, or the coefficients of the waveform expansion, may be put in correspondance with putative "sound objects", which makes further processing easier.

After the introduction, we review in the second section of this chapter a number of (classical) parametric models that can be used to represent musical signals, and corresponding algorithms. The third section describes in more detail "elementary waveforms" approaches to signal representation : we compare several transforms, with an emphasis on overcomplete parameter spaces in which audio signals can be sparsely represented. Finally (section 4), the approaches described above are compared in a number of typical signal processing situations.