

DECONVOLUTION BASICS*

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Abstract

How to isolate two convolved signals.

1 Definition

Deconvolution is exactly what it sounds like: the undoing of convolution. This means that instead of mixing two signals like in convolution, we are isolating them. This is useful for analyzing the characteristics of the input signal and the impulse response when only given the output of the system. For example, when given a convolved signal $y(t) = x(t) * h(t)$, the system should isolate the components $x(t)$ and $h(t)$ so that we may study each individually. An ideal deconvolution system is shown below:

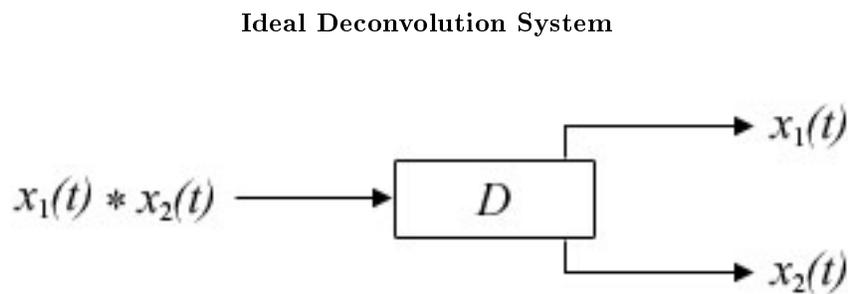


Figure 1: A system that performs deconvolution separates two convolved signals.

2 Approach

Instead of producing one system that outputs both the convolved signals, it will be much easier for our purposes to consider separate systems that output one of the signals at a time. Thus, we desire the following systems:

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Separate Systems

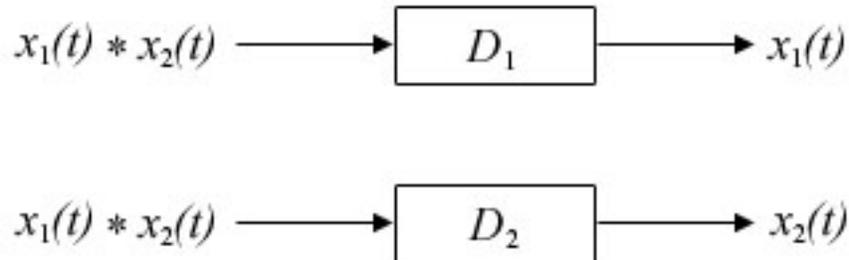


Figure 2: The process of deconvolution is facilitated by splitting the process into separate systems.

What it looks like each of these systems is doing is annihilating the undesired signal. This is, in fact, exactly correct. This system is a **homomorphic filter**.

Definition 1: Homomorphic Filter

A **homomorphic filter** is a system which accepts a signal composed of two components and returns the signal with one of the components removed.

A frequently applied method is to convert the convolution of two signals into a sum, and then implement a homomorphic filter to remove one of the signal components. This is the basis for cepstral analysis, so we will cover this later. A diagram of this method follows:

A Possible Deconvolution Method

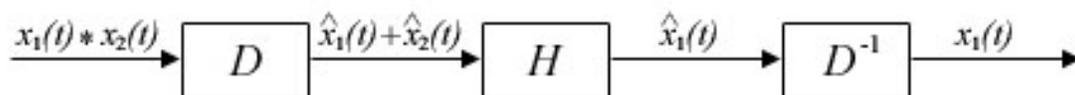


Figure 3: This is the basic deconvolution method implemented in cepstral analysis.

The isolation of two convolved signals depends greatly on the characteristics of both signals. Thus, a wide variety of deconvolution methods exist. Since this is a study on speech analysis, we will cover only the deconvolution methods which focus the signals of the source filter model: the excitation signal and the impulse response of the vocal tract filter.

3 Deconvolution Methods for Speech Analysis

A few deconvolution methods that we will use in speech analysis are:

- Cepstral Analysis¹
- Linear Predictive Coding²

We study the first of these in the next area covering the cepstrum³.

4 References

Rabiner, Lawrence R, and Schafer, Ronald W. *Digital Processing of Speech Signals*. Bell Laboratories, 1978.

¹"Cepstrum" <<http://cnx.org/content/m12469/latest/>>

²"Linear Predictive Coding in Voice Conversion" <<http://cnx.org/content/m12473/latest/>>

³"Cepstrum" <<http://cnx.org/content/m12469/latest/>>