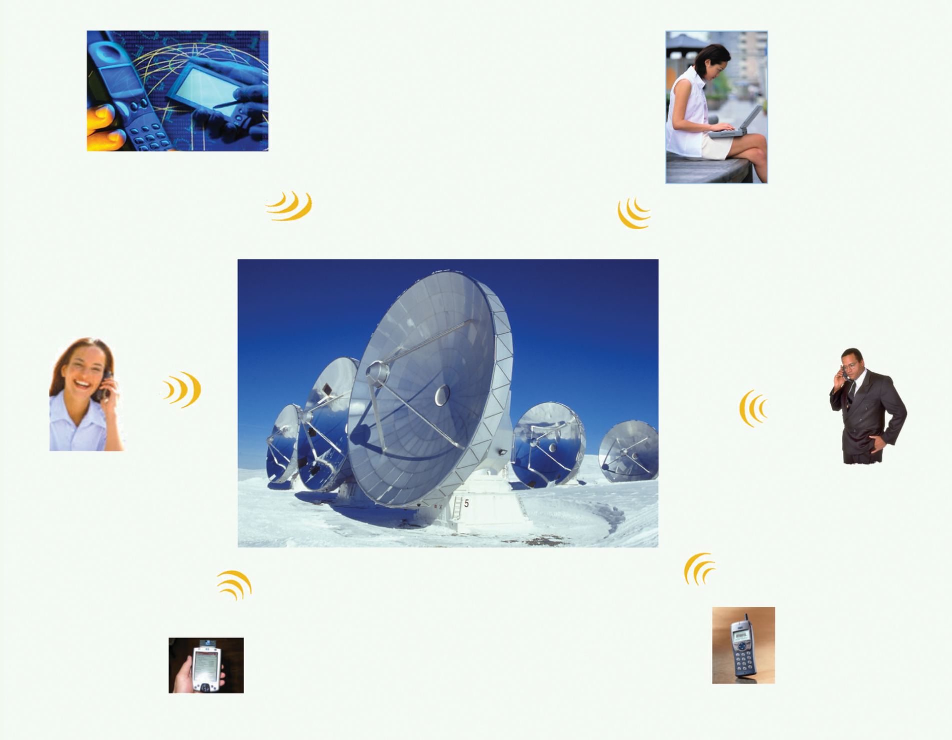
Blind source separation of convolutive mixtures

Problem



Problem statement:

A mixture of K statistically independent sources is observed by using N sensors, $N \geq K$.

Assumption on the mixture:

Linear filtering relation (but unknown) between the sources and the observations.

Goal:

We want to reconstruct the sources.

Possible applications:

- *Monitoring of radio-electrical spectrum*
- *Multi-speaker sound recording*
- *Biomedical signal processing, ...*

Proposed approach

Notations:

- $\{s_k(t)\}$, $k \in [1, ..., K]$ *the K sources.*
- $\{y_n(t)\}$, $n \in [1, ..., N]$ *the N observations.*
- *Model:*

$\forall\, n \in [1, ..., N]$,

$$y_n(t) = \sum_{k=1}^{K} [(H_{n,k} * s_k)\,(t)]$$

Deflation approach:

Determine a filter with N inputs and 1 output $g = (g_1, \ldots, g_N)$ *such that:*

$$r_g(t) = \sum_{n=1}^{N} [(g_n * y_n)\,(t)]$$

corresponds to one of the source signals. We subtract then the contribution of the extracted source from each sensor and we iterate the process.

Determination of the filter *g*:

Construction of contrast functions $J(r_g)$ *depending on the statistics of signal* r_g *having a global maximum when the sources are separated.*

For example:

$$J(r_g) = \left| \frac{\mathbf{E}(|r_g(t)|^4)}{(\mathbf{E}(|r_g(t)|^2))^2} - 2 \right|$$

if the source signals are stationary.

Some illustrations

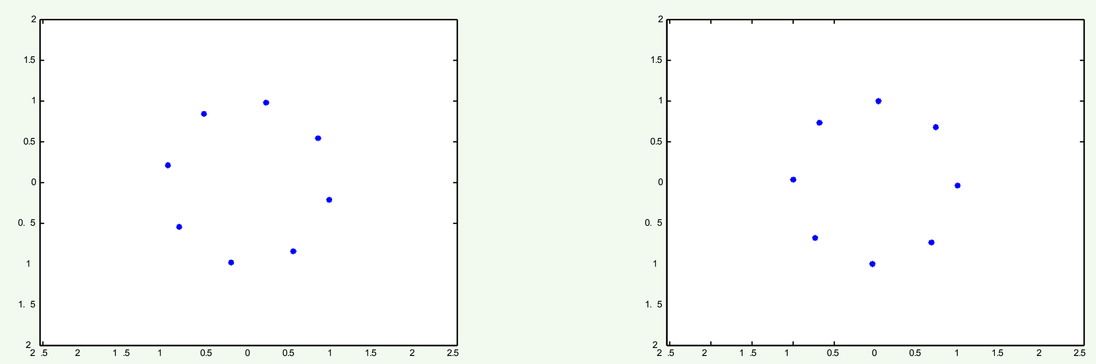
Context:

3 sources and 4 sensors, 3-path channel with fading.

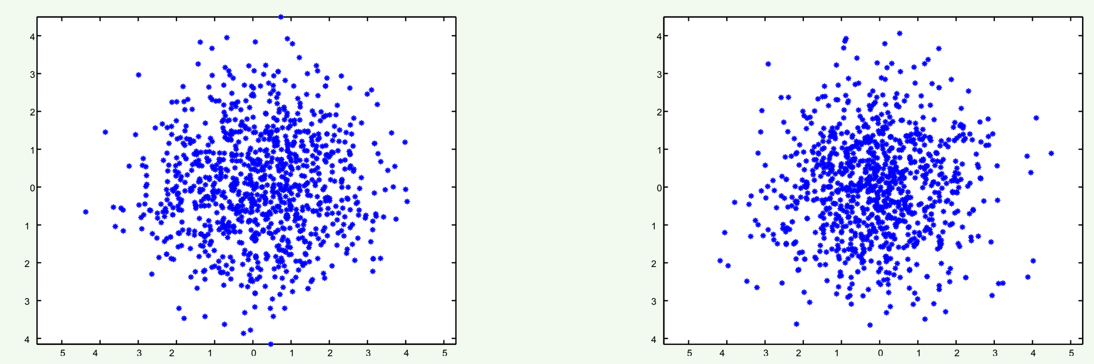
Sources:

CPM (continuous phase modulation) communication signals with modulus 1.

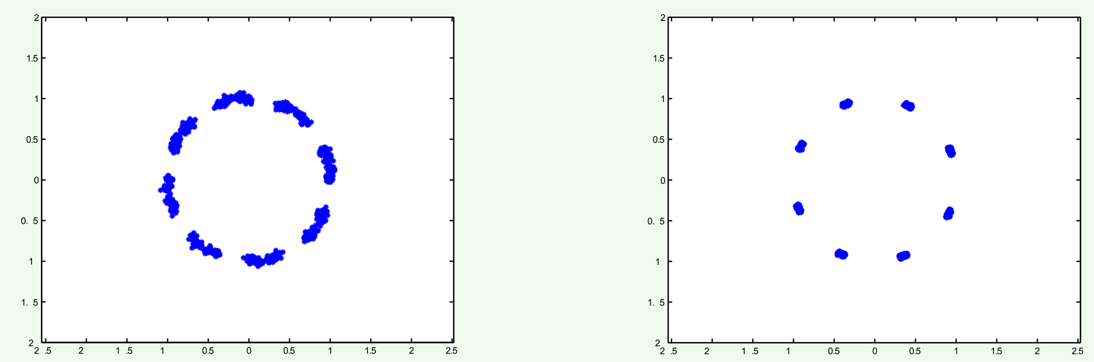
True sources:



Sensors:



Recovered sources:



Contact: Antoine Chevreuil, Elena Florian, Philippe Loubaton