Real Time Signal Processing with Symmetric and Asymmetric Support Intervals

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Outline

Introduction and Motivation

Problem Outline

Problem Approach and Steps

Code Comments

Results and Conclusions

Importance of Real Time Signal Processing

What is real time signal processing?

- Applications
  - Speech recognition
  - Audio signal processing
  - Video compression
  - Weather forecasting
  - Economic forecasting
  - Medical imagining (e.g., CAT, MRI)
  - And more...

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What is the problem?

Goal: We wish to reconstruct some generated signal $\hat{x}$ that has been distorted by some error and convolution processes.

Solution: Take the convolution inverse of $\hat{x}$ to reconstruct the signal.

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Problem Approach Overview

1. Specify problem settings
   - $y = a * x + \nu, \quad \nu\ (0, \sigma^2\delta).$
   - $\hat{x} = r * y$
     - $r = P^{-1}q$
   - Choose some $\Delta = [-d, d] \rightarrow$ initial estimate of x
   - Choose some $\Delta = [T, \tau] \rightarrow$ initial estimate of x
2. Compute optimal Δ for r
   - $H(\Delta) = E(\hat{x}_i - x_i)^2 = f_0 - \langle q, P^{-}1q \rangle \Delta$
   - Plot $H(\Delta)$ vs $d \rightarrow$ optimal $d \rightarrow$ optimal r
3. Simulation of measurement and processing
4. Illustrate the result of estimation
   - $\sqrt{E(\hat{x}_i - x_i)^2} = \sqrt{H}$

Problem Strategy: Step 1

Specify the main ingredients of simulated measurement system:

- Specify point spread function (influence function) a,
  - Symmetric
  - Asymmetric
- Covariance function ϕ for the signal x:

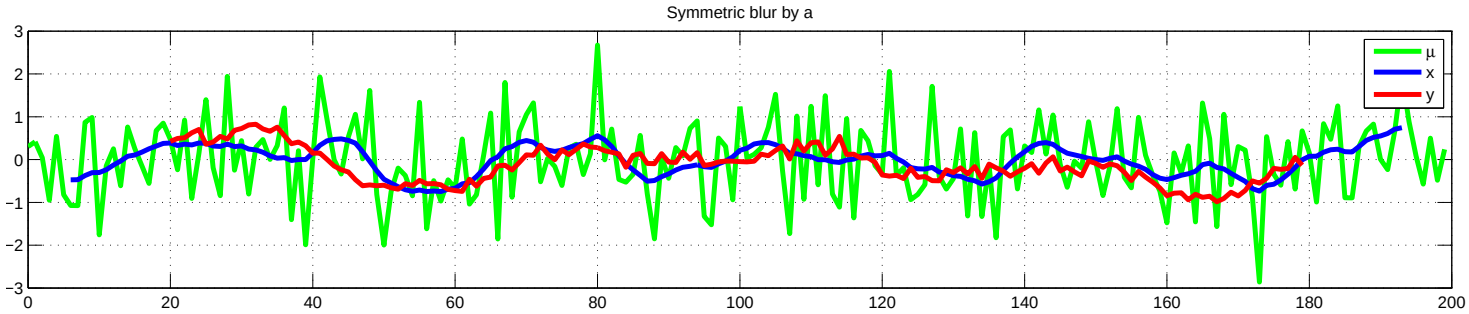
$$\phi = Cov(x) = b * b^* \tag{1}$$

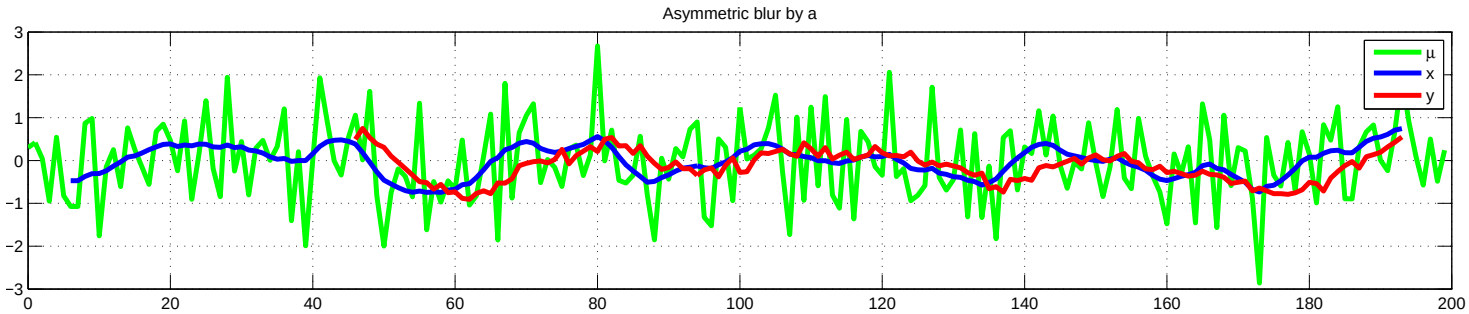
- Variance σ^2 of the independent components of the additive random noise ν

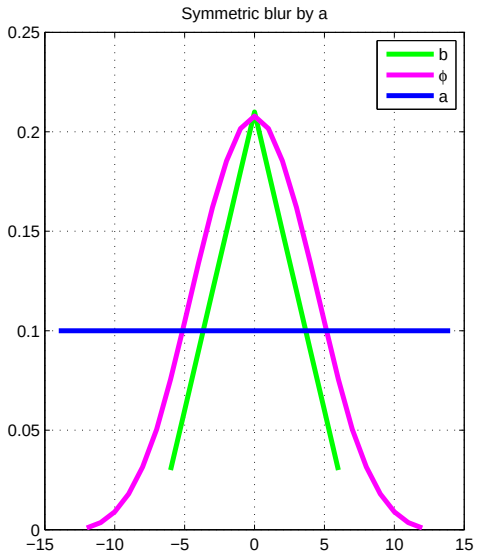
$$y = a * x + \nu, \;\; \nu \; (0, \sigma^2 \delta). \tag{2}$$

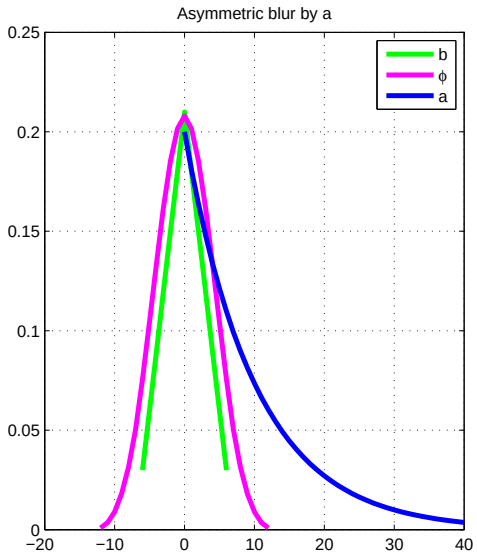
- Choose support interval $\Delta = [-d, d]$ or $\Delta = [T, \tau]$

Signal and Covariance Setup









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References

[1] Golubtsov, P. (2015). Theoretical Big Data Analytics course notes.