EQ2401 - Project 1

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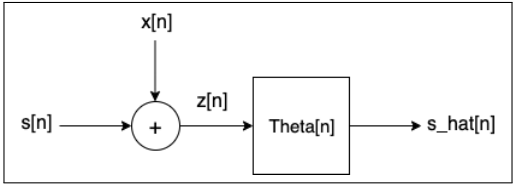
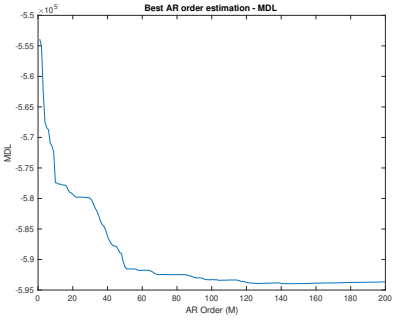
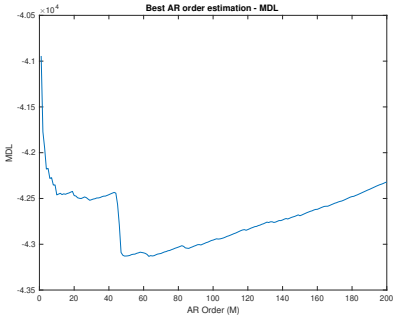
Problem and approach



- Extracting only noise from sound file (first 8000 samples)
- Modelling the signal and noise Spectrum estimation for
  - Parametric: AR - Estimating AR order with MDL and AIC (backup-slides and code)
  - Non-parametric: Blackman-Tuckey (backup-slides and code)
- Filtering: FIR Wiener, Causal Wiener, Non-causal Wiener
- Comparison of the three filter outputs

AR-Estimation (Minimum Description Length - MDL)





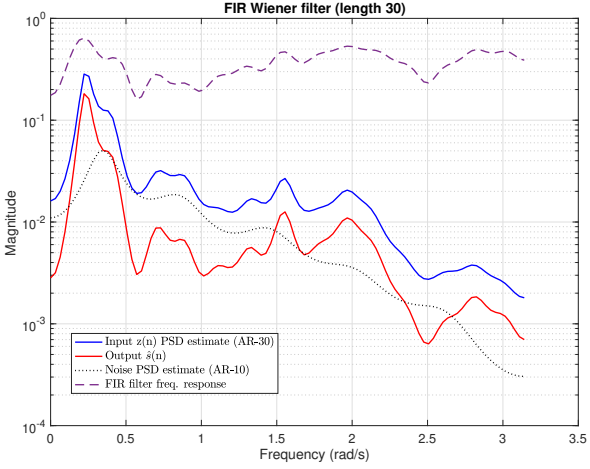
$$MDL(M) = N \ln b_{0,M}^2 + \frac{2M}{N} \tag{1}$$

- The best AR order according to MDL is M=142
- Numerical errors for CW and NCW for high M (not much improvement in output)
- Therefore, empirically, we pick order based on the first big drops: M = 30 for noisy signal and M = 10 for the vuvuzela noise

FIR Wiener Filter

- Use K last samples and a finite length filter
- Length used: 30

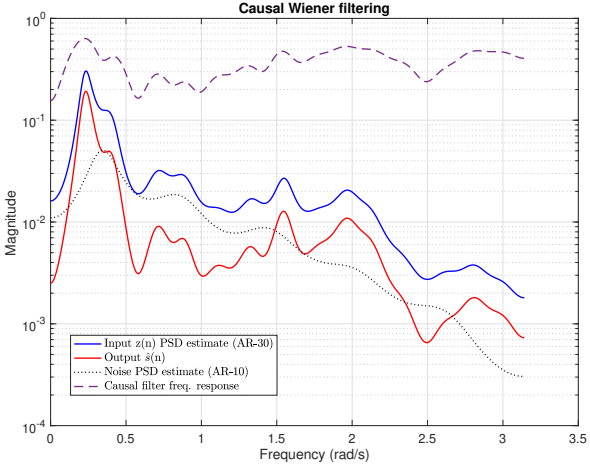
$$\hat{s}(n) = \sum_{k=0}^{K-1} \theta(k) z(n-k) \qquad (2)$$



Causal Wiener Filter

- Use all past samples

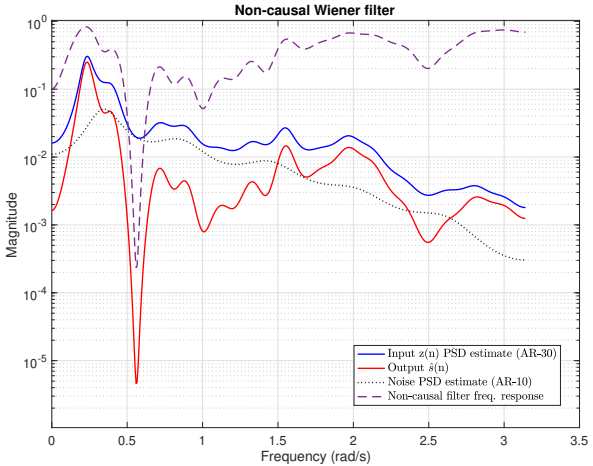
$$\hat{s}(n) = \sum_{k=0}^{\infty} \theta(n,k) z(n-k) \quad (3)$$



Non-Causal Wiener Filter

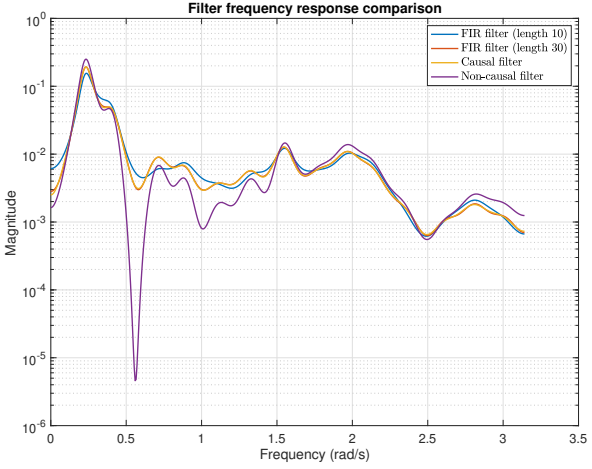
- Use all samples available
- Sharp drop to attenuate frequencies where signal power = noise power

$$\hat{s}(n) = \sum_{k=-\infty}^{\infty} \theta(n,k) z(n-k) \quad (4)$$



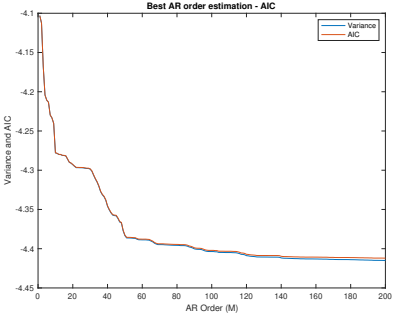
Comparison and Conclusions

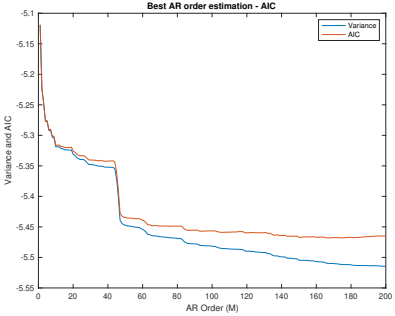
- Non-causal filter provides the best results, as it uses the most information
- Causal and FIR are almost indistinguishable at FIR length 30.
- For shorter FIR filter, causal filter performs better



Thank you!

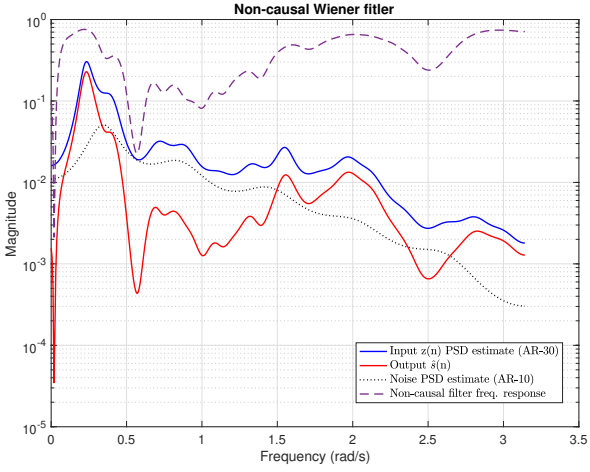
Back-up slide: AR-Estimation (Variance/AIC)



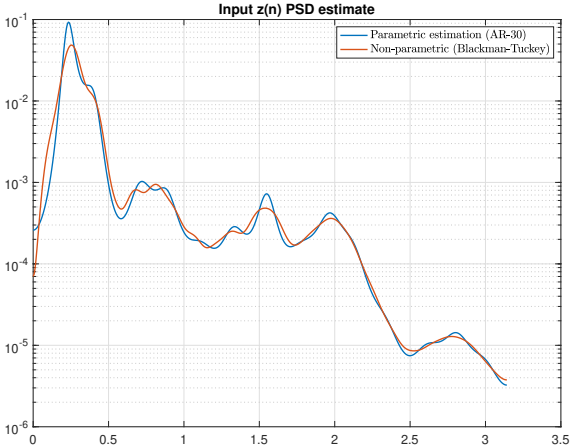


AIC: Akaike Information Criterion

Back-up slide: Non-causal with Blackman-Tuckey



Back-up slide: comparison AR vs BT



Back-up slide: Non-causal M=50