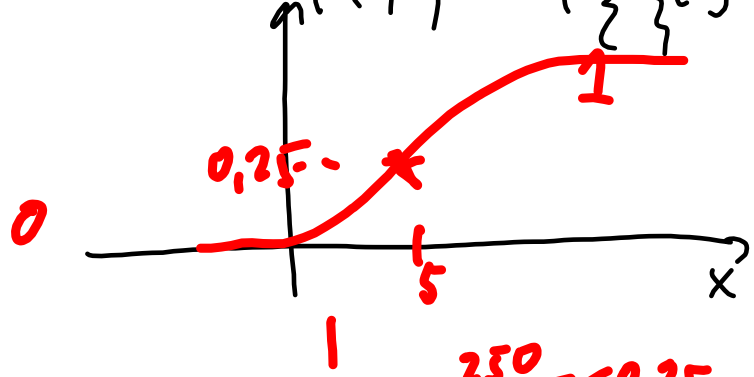
$F(x,n) = P\{\xi[n] < x\}$

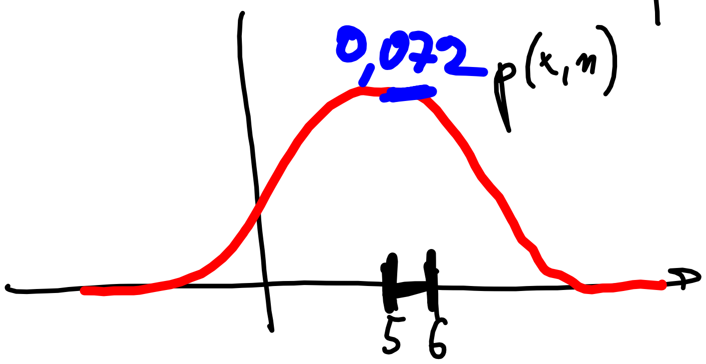


$$\rho = \frac{m}{V}$$

$$v = \frac{l}{t}$$

$$\frac{250}{1000} = 0,25$$

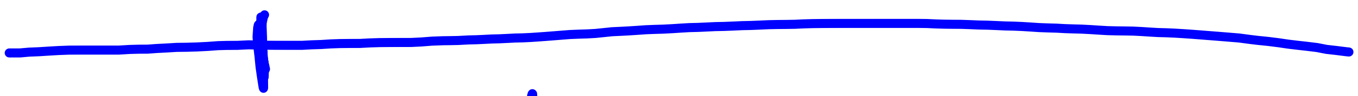
F.H.R.P.



72 hodnot mezi 5 a 6

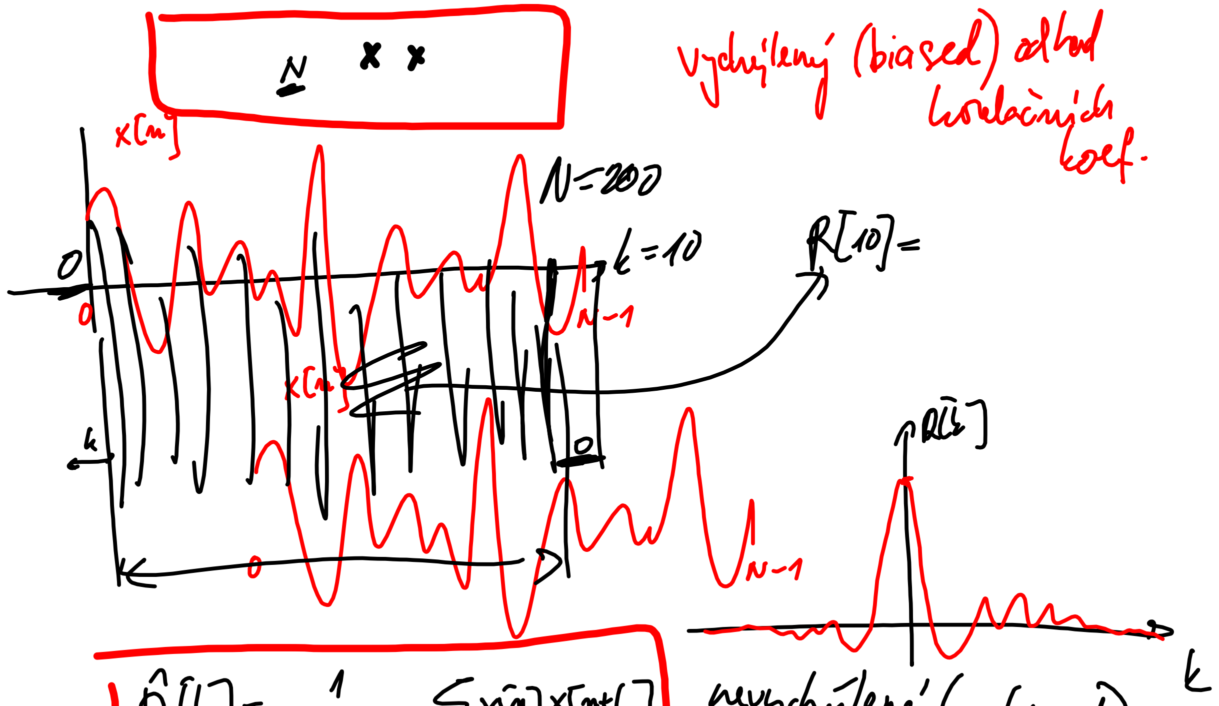
$\frac{72}{1000} = 0,072 \quad P\{\xi[n] \in \langle 5,6 \rangle\}$

$\frac{72/1000}{j.i.} = 0,072$ hus~~ta~~ pravd!



n ← odhaduje pro tento čas.

Vychýlený (biased) odhad korelačních koef.



$$\boxed{\hat{R}[k] = \frac{1}{N-k}\sum x[n]\,x[n+k]}$$ nevychýlené (unbiased)

N = délka střední výkon $P = \frac{1}{N}\sum_{n=0}^{N-1} x^2[n]$ $\hat{R}[k] = \frac{1}{N}\sum_{n=0}^{N-1} x[n]x[n+k]$

pro $k=0$ $R[0] = \frac{1}{N}\sum x^2[n] = P$

rozptyl $D = \frac{1}{N}\sum_{n=0}^{N-1}(x[n]-a)^2$ pro nulovou střední hodnotu $a = 0$

$$\boxed{D = P = R[0]}$$

pro $a \neq 0$:

$$\boxed{P = R[0] = D + a^2}$$

Spektrální analýza n.s.

korelační koef $R[k]$

~~klasická FT~~

$$G(e^{j\omega}) = DTFT\{R[k]\}$$

$G(e^{j\omega})$ spektrální hustota výkonu

$$G(e^{j\omega}) = \sum_{k=-\infty}^{\infty} R[k]\, e^{-j\omega k}$$

co? normovaná kruhová frekvence.

$$R[k] = \frac{1}{2\pi}\int_{-\pi}^{\pi} G(e^{j\omega})\, e^{+j\omega k}\, d\omega$$

DFT/FFT

Wiener-Chinchin

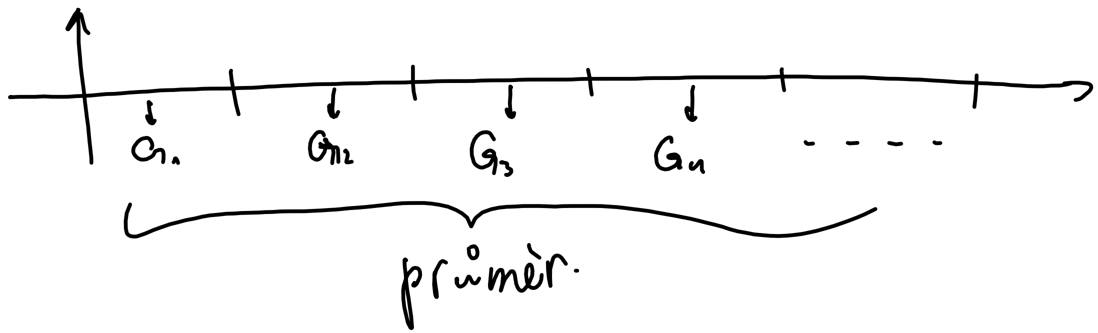
$$x[n] \longrightarrow R[k] \longrightarrow G(e^{j\omega})$$

odhad přímo ze signálu:

$$G\left(e^{jk\frac{2\pi}{N}}\right) = \frac{|X[k]|^2}{N}$$

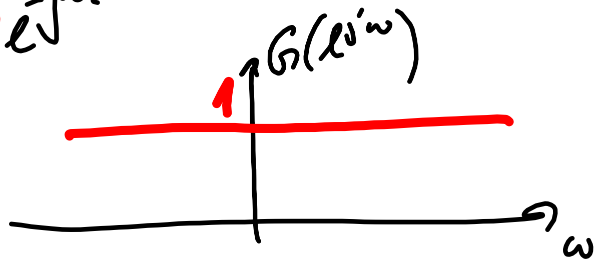
málo robustní!

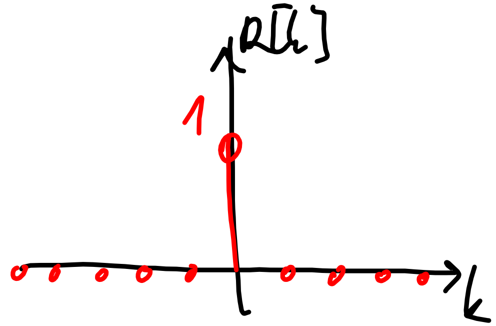
Welchova metoda:



BÍLÝ ŠUM

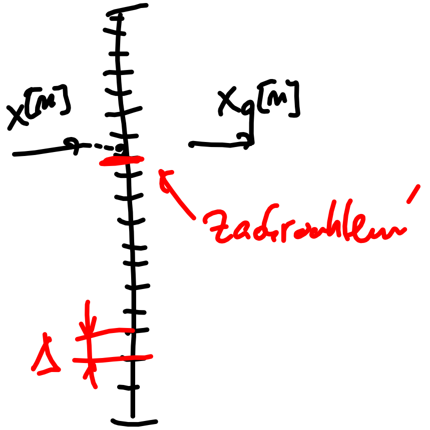
$$G(e^{j\omega}) = \sum_{k=-\infty}^{\infty} R[k]\, e^{-j\omega k}$$





$$= R[0] \cdot e^{-j\omega \cdot 0} = 1 \cdot 1 = \underline{1}$$

KVANTOVÁNÍ



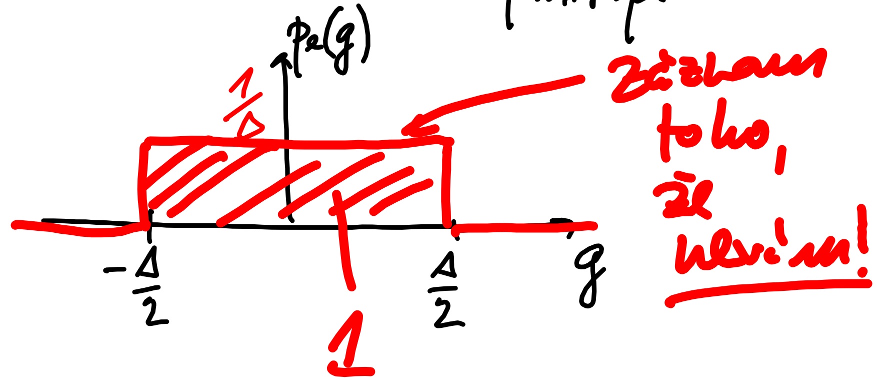
CHYBA KVANTOVÁNÍ:

$e[n] = x[n] - x_q[n]$

VÝKON CHYBOVÉHO SIGNÁLU ??

$P = D + a^2$

f.h.r.p.



kvantovací hladiny $L = 2^b$

$b = 8, 16, 24$ bitů

uniformní kvant. - kvantovací krok Δ

$a = 0$

$$P = D + 0 = D = \int_{-\infty}^{\infty} p_e(g)\,(g - \underset{0}{a})^2\,dg = \int_{-\frac{\Delta}{2}}^{\frac{\Delta}{2}} \frac{1}{\Delta} g^2\,dg = \frac{1}{\Delta}\left[\frac{g^3}{3}\right]_{-\frac{\Delta}{2}}^{\frac{\Delta}{2}} =$$

$$= \frac{1}{\Delta}\left(\frac{\frac{\Delta^3}{2^3}}{3} - \frac{-\frac{\Delta^3}{2^3}}{3}\right) = \frac{1}{\Delta}\left(\frac{\Delta^3}{24} + \frac{\Delta^3}{24}\right) = \frac{1}{\cancel{\Delta}}\cdot\frac{\Delta^{3}}{12} = \frac{\Delta^2}{12}$$