$$a_i(t) = \sum_{k=1}^{\infty} \delta(t - t_i^k).$$

$$D = (A^T A)^{-1} A^T X$$

Decoders: X A

① Random $x(t)$ ← white noise,

② $X \sim [x_0 \ x_1 \ x_2 \ \cdots]_{D \times N_t}$ $\quad N_t = \frac{T}{\Delta t}$

③ Enc: $a_i(t) = \sum_k \delta(t - t_i^k) = G_i[\alpha_i e_i x(t) + J_i^b]$

LIF

④ $$A = \begin{array}{c} a_1 \\ a_2 \\ a_3 \\ \vdots \\ i \end{array} \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & \cdots \\ \\ \\ \end{bmatrix}_{N \times N_t}$$

← Δt →

Random Signals

White Noise: ① Δt

② sample $x \sim N(0,1)$ at every Δt.

$x(t)$

or freq domain

① $X(\omega) = X(-\omega) = a + ib$.

② a and $b \sim N(0,1)$

Band Limited

① Set all $X(\omega) = \emptyset$ for $\omega > 2\pi F$

do ②

③ $F^{-1}(X(\omega)) = x(t)$

Decoders: $D = (AA^T)^{-1} A^T X$ ⇐

Filtering:

① $F(t) * G(t) = F(\omega) \cdot G(\omega)$

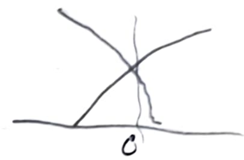
② : $\hat{x}(t) = \sum_i a_i(t) d_i$

$\hat{x}(t) * h(t) = \sum_i d_i (a_i(t) * h(t)) = \left(\sum_i d_i a_i(t)\right) * h(t)$

$\left(\sum_i a_i d_i\right) * h(t)$

Optimal Filter

$$h^*(t) = \arg\min_h \int_{-\infty}^{\infty} \left(x(t) - \hat{x}(t)\right)^2 dt$$



$$\hat{x}(t) = (a_1 d_1 + a_2 d_2) * h(t)$$

$$d_1 = -d_2$$

$$\hat{x}(t) = \underbrace{d_1 (a_1 - a_2)}_{r} * h(t).$$

time + "space"

or $(r * h)(t)$.

$\uparrow$ response

$$E = \int_{-\infty}^{\infty} \left(x(t) - (r * h)(t)\right)^2 dt.$$

$$E(\omega) = \int_{-\infty}^{\infty} \left|X(\omega) - R(\omega) \cdot H(\omega)\right|^2 d\omega$$

$$\frac{dE}{dH} = 0 \qquad \frac{dE}{dH} = 2\left(X(\omega) - R(\omega)H(\omega)\right)(-\bar{R})$$

$$= -2X\bar{R} + 2HR\bar{R}$$

$$\cancel{2}X\bar{R} = 2HR\bar{R}$$

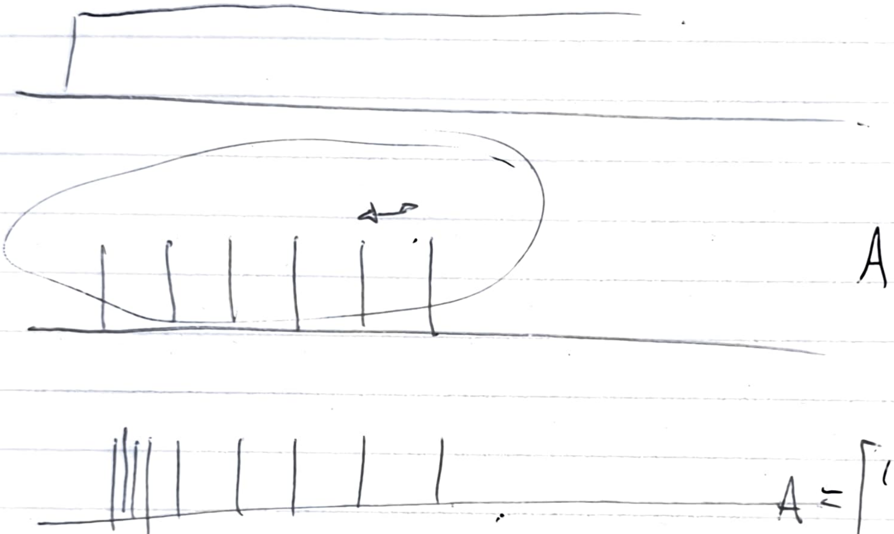
$$H = \frac{X\bar{R}}{|R|^2} \overset{\text{better}}{\Longrightarrow} \frac{(X\bar{R}) * W}{|R|^2 * W}$$

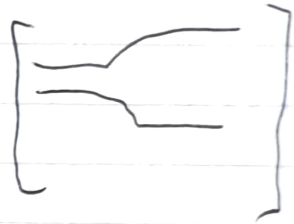
$\int h(t) = 1$

$$\hat{x} = \sum d_i a_i * h(t)$$

"spatial"

"split" temporal + spatial decode.



A = 

$A = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & \cdots \\ & & & & & \end{bmatrix}$

temporally sensitive decoders.