EE16A

Reminders

- HW drops, discussion drops
- HKN

Today:

- Orthogonal Matching Pursuit
  ↳ Unsupervised learning.
- Break "n-equations - n-unknowns" barrier.
- Design.

Designing the OMP algorithm.

Goal:
- Decode / Learn individual messages from transmitters given a combination of messages at the receiver.
- Limited number of observations / equations.

Background:
- IOT
- Gold codes. ± 1's "Binary sequences"

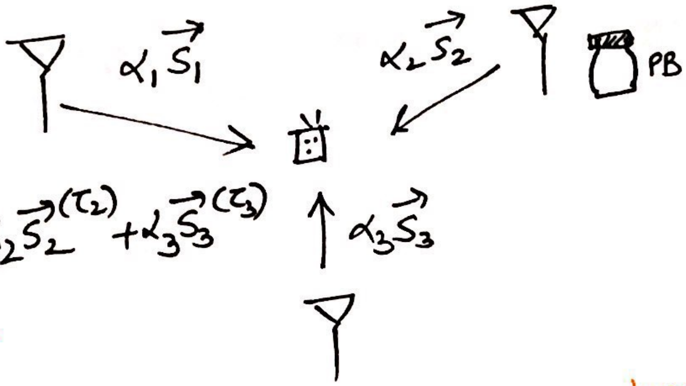
$\langle \vec{s}_i , \vec{s}_j \rangle \approx 0$, $\langle \vec{s}_i^{\,(\tau_i)}, \vec{s}_j^{\,(\tau_j)} \rangle \approx 0$ | $\langle \vec{s}_i^{\,(\tau_i)}, \vec{s}_j^{\,(\tau_j)} \rangle \approx 0$

$i \neq j$ approximately. shift code

$$\langle \vec{s}_i , \vec{s}_i \rangle = \langle \vec{s}_i^{\,(\tau_i)}, \vec{s}_i^{\,(\tau_i)} \rangle = \|\vec{s}_i\|^2 = N$$

$$\underbrace{1^2 + 1^2 + (-1)^2 + \cdots + (-1)^2}_{N} = N$$

Modulation. $\alpha_i \vec{S_i}$ $\alpha_i \in \mathbb{R}$ real number



Receive

shift

$$\vec{y} = \alpha_1 \vec{S_1}^{(\tau_1)} + \alpha_2 \vec{S_2}^{(\tau_2)} + \alpha_3 \vec{S_3}^{(\tau_3)}$$

message code

known

$$N \left\{ \begin{bmatrix} | & | & | \\ \vec{S_1}^{(\tau_1)} & \vec{S_2}^{(\tau_2)} & \vec{S_3}^{(\tau_3)} \\ | & | & | \end{bmatrix} \right. \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} = \begin{bmatrix} \vec{y} \end{bmatrix}$$

Just one transmitter

100

$$\vec{y} = \alpha_1 \cdot \vec{S_1}^{(\tau_1)} \qquad A\vec{x} = \vec{b}$$

① Find shift for max correlation. $\mathrm{circcorr}(\vec{y}, \vec{S_1})$.

$\rightarrow$ got (τ_1).

② Use least squares.

$$\vec{x} = (A^T A)^{-1} A^T \cdot \vec{b}$$

Can you generalize?

$i_1, i_2, i_3 \rightarrow$ device names. ③

$$\vec{y} = \alpha_{i_1} \vec{S}_{i_1}^{(\tau_{i_1})} + \alpha_{i_2} \cdot \vec{S}_{i_2}^{(\tau_{i_2})} + \alpha_{i_3} \vec{S}_{i_3}^{(\tau_{i_3})}$$

Unknowns: $\alpha_{i_1}, \alpha_{i_2}, \alpha_{i_3}, \tau_{i_1}, \tau_{i_2}, \tau_{i_3}, i_1, i_2, i_3$