This is just a text with beamer presentations because I want other theme colors

We want more colors

David Anchieta

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Outline

- Single tone case
 - Maximum likelihood estimators of frequency and amplitude
 - Computing probability density functions



Estimating frequency and amplitude of a single tone

Theorem



Estimating frequency and amplitude of a single tone

Given a complex sinusoid defined by:

$$r(t) = A_1 e^{j2\pi f_1 t} + z(t)$$

Where z(t) is a complex Gaussian white noise with zero mean and variance σ^2 .

Givens a set of samples from r(t), how could we estimate the values of A_1 and f_1 ?

Note on Maximum Likelihood Estimation #1

- It's a method to estimate parameters of a statistical model.
- The value of the Maximum Likelihood Estimator of a parameter must make the observed data more likely.

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An example of maximum likelihood estimator: The sample mean of a set of n observations from a random variable X.

$$M_n = \frac{1}{n} \sum_{i=1}^n X_i$$

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$$\lim_{n\to\infty} M_n = \mathrm{E}\{X\}$$

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Defining the PDF of the frequency

Being N the number of samples and T_s the sampling period $1/f_s$, we have.

$$\mathbf{r} = [r(0) \ r(T_s) \ r(2T_s) \dots r((N-1)T_s)]^T$$

$$\mathbf{e_1} = [e^{j2\pi f_1 0} \ e^{j2\pi f_1 T_s} \dots e^{j2\pi f_1(N-1)T_s}]^T$$

$$\mathbf{r} = A_1 \mathbf{e_1} + \mathbf{n}$$

$$p(\mathbf{r}|f_1, A_1) = \frac{1}{\pi^N \sigma^{2N}} \exp\left[-\frac{(\mathbf{r} - A_1 \mathbf{e_1})'(\mathbf{r} - A_1 \mathbf{e_1})}{\sigma^2}\right]$$

$$p(\mathbf{r}|A_1) = \int p(\mathbf{r}|f_1, A_1)p(f_1)df_1$$

$$p(f_1|\mathbf{r}, A_1) = \frac{p(\mathbf{r}|f_1, A_1)p(f_1)}{p(\mathbf{r}|A_1)}$$

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David Anchieta