$$f_{true}(\underline{x})$$

linear models

$$f(\underline{X};\underline{\beta})$$

$$\boxed{\underline{y} = X\underline{\beta} + \underline{\varepsilon}}$$

nonlinear models

$$f(\underline{X};\underline{\theta})$$

Linear models

deterministic models

$\underline{\beta}$: deterministic unknown

LS

$\boxed{E(\underline{\varepsilon}) = \underline{0}}$

$E(\hat{\underline{\beta}}) = \underline{\beta}$

$Cov(\hat{\underline{\beta}})$?

LS

$\boxed{\begin{array}{l} E(\underline{\varepsilon}) = \underline{0} \\ Cov(\underline{\varepsilon}) = \sigma^2 \underline{I} \end{array}}$

$\hat{\underline{\beta}}$ is BLUE

Gauss-Markov theorem!

GLS

$\boxed{\begin{array}{l} E(\underline{\varepsilon}) = \underline{0} \\ Cov(\underline{\varepsilon}) = V \end{array}}$

$\hat{\underline{\beta}}_{GLS}$ is BLUE

Generalized G-M Th.

known $\boxed{p(\underline{\varepsilon})}$

ML

$\hat{\underline{\beta}}_{ML}$

asymptotic efficient

Bayesian model

$\boxed{\underline{\beta} \sim \text{prior distribution}}$

Nonlinear models

$f(\underline{X};\underline{\theta})$

Deterministic nonlinear models

$\underline{\theta}$: deterministic but unknown

NLS

$\hat{\theta}_{NLS}$

ML

$p(\underline{\varepsilon})$

$\hat{\theta}_{ML}$

asymptotically efficient / optimal

Bayesian nonlinear models

$\underline{\theta}$: unknown follow a prior distribution $p(\underline{\theta})$.

$\boxed{\text{Gaussian Process}}$