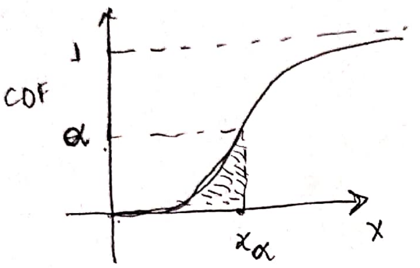
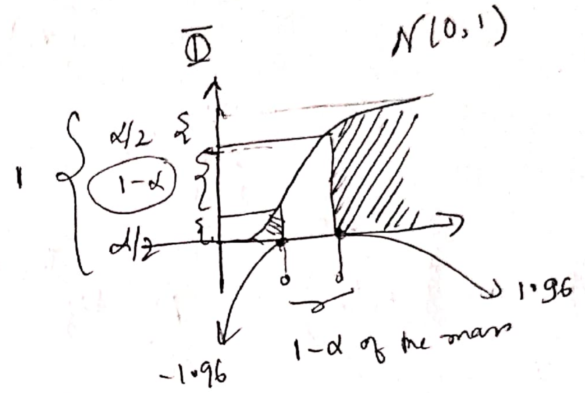
Bayes Rule:

$$p(X=x \mid Y=y) = \frac{p(X=x, Y=y)}{p(Y=y)}$$

$$= \frac{p(X=x)\, p(Y=y \mid X=x)}{\sum_{x'} p(X=x')\, p(Y=y \mid X=x')}$$





$P(X \le x_\alpha) = \alpha$ quantile

$F^{-1}(0.5)$ = median

$F^{-1}(0.25)$ & $F^{-1}(0.75)$ = upper & lower quartiles

$(\mu - 1.96\,\sigma,\ \mu + 1.96\,\sigma)$

$\mu \pm 2\sigma$

$$\mu = \mathbb{E}[X] \triangleq \sum_{x \in \mathcal{X}} x\, p(x)$$

$$\mathbb{E}[X] \triangleq \int_{\mathcal{X}} x\, p(x)\, dx$$

$$\mathrm{Var}[X] \triangleq \mathbb{E}\left[(X-\mu)^2\right] = \int_{\mathcal{X}} (x-\mu)^2\, p(x)\, dx$$

$$\sigma^2 = \mathbb{E}[X^2] - \mu^2$$

$$\boxed{\mathbb{E}[X^2] = \sigma^2 + \mu^2}$$

$$\mathrm{std}[X] \triangleq \sqrt{\mathrm{var}[X]}$$

Binomial

$X \in \{0, 1, 2, \ldots, n\}$: no of heads

$$p(k \mid \theta, n) = \binom{n}{k} \theta^k (1-\theta)^{n-k}$$

$$\frac{n!}{k!\,(n-k)!}\ \theta^k (1-\theta)^{n-k}$$

mean = θ

variance = $n\theta(1-\theta)$

Bernoulli Distribution's

$X \sim \mathrm{Ber}(\theta)$

$$\mathrm{Ber}(x|\theta) = \theta^{\mathbb{I}(x=1)} (1-\theta)^{\mathbb{I}(x=0)}$$

Multinomial

$$\mathrm{Mu}(\underline{x}|n, \underline{\theta}) \triangleq \binom{n}{x_1, x_2, \ldots, x_K} \prod_{j=1}^{K} \theta_j^{x_j}$$

$$\binom{n}{x_1 \ldots x_K} \triangleq \frac{n!}{x_1! x_2! \cdots x_K!}$$

$$n = \sum_{k=1}^{K} x_k$$

$$\mathrm{Mu}(\underline{x}|1, \underline{\theta}) = \prod_{j=1}^{K} \theta_j^{\mathbb{I}(x_j=1)}$$

$$\underline{x} \in \{0, 1, \ldots, n\}^K \; ; \; \sum_{k=1}^{K} x_k = n$$

Poisson Distribution

$X \in \{0, 1, 2, \ldots\}$

$\lambda > 0$

$X \sim \mathrm{Poi}(\lambda)$

$$\mathrm{Poi}(x|\lambda) = e^{-\lambda} \cdot \frac{\lambda^x}{x!}$$

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continuous :

$$\mathcal{N}(x|\mu, \sigma^2) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

precision $= \lambda = 1/\sigma^2$

centered on μ

$\mu = \mathbb{E}[X]$

$\sigma^2 = \mathrm{var}[X]$

c.d.f

$$\triangleq \Phi(x; \mu, \sigma) = \frac{1}{2}[1 + \mathrm{erf}(z/\sqrt{2})]$$

$$z = (x-\mu)/\sigma \; ; \; \mathrm{erf} \triangleq \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$$