Probability and Random Variables:

* $P(A\cup B)=P(A)+P(B)-P(A\cap B)$

$$P(A^c)=1-P(A)$$

$$P(A\mid B)=\frac{P(A\cap B)}{P(B)}$$

$$P(A\cap B)=P(A)P(B\mid A)$$

$$P(A\cap B\cap C)=P(A)P(B\mid A)P(C\mid A\cap B)$$

* For the partition $\{A_1,A_2,\cdots,A_k\}$:

$$P(B)=\sum_{i=1}^{k}P(B\mid A_i)P(A_i)$$

$$P(A_i\mid B)=\frac{P(B\mid A_i)P(A_i)}{P(B)}$$

$$\binom{n}{r}=\frac{n!}{r!(n-r)!}\ ,\quad n!=n(n-1)\cdots(1)$$

* $F(x)=P(X\le x)=\begin{cases}\sum_{t\le x}f(t)\\ \int_{-\infty}^{x}f(t)\,dt\end{cases}$

* $E(x)=\mu_X=\begin{cases}\sum_{\text{all }x}x\,f(x)\\ \int_{-\infty}^{\infty}x\,f(x)\,dx\end{cases}$

$$Var(x)=\sigma_X^2=E[(X-\mu)^2]=\begin{cases}\sum_{all\ x}(X-\mu)^2 f(x)\\ \int_{-\infty}^{\infty}(X-\mu)^2\,f(x)\,dx\end{cases}$$

$$Var(x)=\sigma_x^2=E(X^2)-\mu^2$$

* Thebychev inequality:

$$P(\mu-k\sigma<X<\mu+k\sigma)\ge 1-\frac{1}{k^2}$$

Probability Distributions:

* $f(x)=P(X=x)=\frac{1}{k}\quad,\ x=x_1,x_2,\ldots,x_k$

$$E(X)=\mu_X=\sum_{i=1}^{k}x_i/k,$$

$$Var(X)=\sigma_X^2=\sum_{i=1}^{k}(x_i-\mu)^2/k$$

* $f(x)=P(X=x)=\binom{n}{x}p^x(1-p)^{n-x}$

$$E(X)=\mu_X=np,$$

$$Var(X)=\sigma_X^2=np(1-p)$$

* $f(x)=P(X=x)=\frac{\binom{K}{x}\binom{N-k}{n-x}}{\binom{N}{n}}$

$$E(X)=\mu_X=n\frac{K}{N},$$

$$Var(X)=\sigma_X^2=n\frac{K}{N}\left(1-\frac{K}{N}\right)\frac{N-n}{N-1}$$

* $f(x)=P(X=x)=\frac{\mu^x e^{-\mu}}{x!}$

$$\mu=\lambda t,$$

$$E(X)=\mu,$$

$$Var(X)=\sigma_X^2=\mu$$

* $f(x)=\frac{1}{B-A}\ ,\ A<X<B$

$$E(X)=\mu_X=\frac{B+A}{2}$$

$$Var(X)=\sigma_X^2=\frac{(B-A)^2}{12}$$

* $f(x)=\frac{1}{\beta}e^{-\frac{x}{\beta}}\ ,\ X>0$

$$E(X)=\mu_X=\beta$$

$$Var(X)=\sigma_X^2=\beta^2$$

Sampling Distributions:

* $\overline{X}=\sum_{i=1}^{n}X_i/n$

$$S^2=\frac{\sum_{i=1}^{n}(X_i-\overline{X})^2}{n-1}=\frac{\sum_{i=1}^{n}X_i^2-n(\overline{X})^2}{n-1}$$

$$\overline{X}\sim N(\mu,\frac{\sigma}{\sqrt{n}})$$

$$\frac{\overline{X}-\mu}{\sigma/\sqrt{n}}\sim N(0,1)$$

$$\frac{\overline{X}-\mu}{S/\sqrt{n}}\sim t(n-1)$$

$$(\overline{X}_1-\overline{X}_2)\sim N(\mu_1-\mu_2,\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}})$$

* $\hat{p}\sim N(p,\sqrt{\frac{pq}{n}})\ ;\quad q=1-p$

$$(\hat{p}_1-\hat{p}_2)\sim N(p_1-p_2,\sqrt{\frac{p_1q_1}{n_1}+\frac{p_2q_2}{n_2}})$$

Confidence Intervals:

$$\overline{X}\pm Z_{\frac{\alpha}{2}}\frac{\sigma}{\sqrt{n}}$$

$$\overline{X}\pm t_{\frac{\alpha}{2}}\frac{S}{\sqrt{n}}$$

$$(\overline{X}_1-\overline{X}_2)\pm Z_{\frac{\alpha}{2}}\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}$$

$$(\overline{X}_1-\overline{X}_2)\pm t_{\frac{\alpha}{2}}\ S_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}$$

$$S_p^2=\frac{(n_1-1)S_1^2+(n_2-1)S_2^2}{n_1+n_2-2}$$

$$\hat{p}\pm Z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}\hat{q}}{n}}\quad;\ \hat{q}=1-\hat{p}$$

$$(\hat{p}_1-\hat{p}_2)\pm Z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1}+\frac{\hat{p}_2\hat{q}_2}{n_2}}$$

$$s.e.(\overline{X})=\frac{\sigma}{\sqrt{n}}$$

$$e=Z_{\frac{\alpha}{2}}\frac{\sigma}{\sqrt{n}}$$

$$n=\left(Z_{\frac{\alpha}{2}}\frac{\sigma}{e}\right)^2$$

Test Statistics:

$$Z=\frac{\overline{X}-\mu_o}{\sigma/\sqrt{n}}$$

$$T=\frac{\overline{X}-\mu_o}{S/\sqrt{n}}$$

$$Z=\frac{(\overline{X}_1-\overline{X}_2)-d}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}}$$

$$T=\frac{(\overline{X}_1-\overline{X}_2)-d}{S_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}$$

$$Z=\frac{\hat{p}-p_o}{\sqrt{\frac{p_oq_o}{n}}}=\frac{X-np_o}{\sqrt{np_oq_o}}$$

$$Z=\frac{\hat{p}_1-\hat{p}_2}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$$

$$\hat{p}=\frac{X_1+X_2}{n_1+n_2}=\frac{n_1\hat{p}_1+n_2\hat{p}_2}{n_1+n_2}$$