Important equations

- Probability of some event E:

$$\mathrm{P}(E) = \frac{n}{N}$$

- Number of permutations of r objects taken from a set of n objects:

$$\frac{n!}{(n-r)!}$$

- Number of combinations of r objects taken from a set of n objects:

$$\frac{n!}{r!(n-r)!}$$

- Number of subsets of a set of n objects: 2^n.
- Probability of something *not* happening:

$$\mathrm{P}(\overline{E}) = 1 - \mathrm{P}(E)$$

- Intersection. The probability of A and B, if they are independent, is:

$$\mathrm{P}(A \cap B) = \mathrm{P}(A) \cdot \mathrm{P}(B)$$

- Union. The probability of A or B, if they are mutually exclusive, is:

$$\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B)$$

- Conditional probability. The probability of A, given that B has occured is:

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

- Bayes' Law:

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

- Random variable: a function $\xi = \xi(\omega)$ whose value depends on the elementary events $\omega \in \Omega$: $P_\xi(x) = \mathrm{P}\{\xi = x\}$

- Mathematical expectation is a way of putting together the values and the probabilities. It's defined as:

$$\mathrm{E}\xi = \sum_{-\infty}^{\infty} x P_\xi(x)$$

- an important property of mathematical expectation:

$$\mathrm{E}(\xi_1 + \xi_2) = \mathrm{E}\xi_1 + \mathrm{E}\xi_2$$

- if ξ_1 and ξ_2 are independent random variables:

$$\mathrm{E}\xi_1\xi_2 = \mathrm{E}\xi_1\mathrm{E}\xi_2$$

- The *mean* is defined as follows:

$$\overline{x} = \frac{x_1 + x_2 + x_3 + \cdots + x_n}{n}$$

- The variance is defined as follows:

$$s_x^2 = \frac{(x_1 - \overline{x})^2 + (x_2 - \overline{x})^2 + \cdots + (x_n - \overline{x})^2}{n}$$

- standard deviation:

$$s_x = \sqrt{\frac{(x_1 - \overline{x})^2 + (x_2 - \overline{x})^2 + \cdots + (x_n - \overline{x})^2}{n}}$$

- mean with respect to some model:

$$\mu = \mathrm{E}(X)$$

- variance σ^2 is defined as follows:

$$\sigma_x^2 = \mathrm{E}[(X-\mu)^2]$$

- standard deviation is defined as:

$$\sigma_x = \sqrt{\mathrm{E}[(X-\mu)^2]}$$

- Chebychev's theorem says that at least $1 - \frac{1}{h^2}$ of the total probability is bounded by the area between the mean and h times the standard deviation.

- Binomial distribution:

$$\left(\begin{array}{c} N \\ n \end{array} \right) p^n q^{N-n}$$

- Binomial expectation: Np

- Standard deviation of a binomial experiment: $\sigma = \sqrt{Npq}$

- $n!$ can be approximated:

$$n! \sim n^n \times e^{-n}\sqrt{2\pi n}$$

- Normal distribution:

$$y = \frac{1}{\sqrt{2\pi}} e^{\frac{-x^2}{2}}$$

- Poisson distribution:

$$W_m = \frac{a^m}{m!} e^{-a}$$