Sum symbol $\sum$

In mathematics we often have a sum of a lot of terms (e.g. numbers), the sum symbol $\sum$ helps us to express this more concisely.

Definition

$$\sum_{i=1}^{n} x_i = x_1 + x_2 + \ldots + x_n$$

Easy example

$$\sum_{i=1}^{4} i = 1 + 2 + 3 + 4 = 10$$

Hard example

$$\sum_{i=1}^{n} x_i * \beta_i = (x_1 * \beta_1) + (x_2 * \beta_2) + \ldots + (x_n * \beta_n)$$

Product symbol $\prod$

In mathematics we often have a product of a lot of terms (e.g. numbers), the prod symbol $\prod$ helps us to express this more concisely.

Definition

$$\prod_{i=1}^{n} x_i = x_1 * x_2 * \ldots * x_n$$

Easy example

$$\prod_{i=1}^{4} i = 1 * 2 * 3 * 4 = 24$$

Hard example

$$\prod i = 1^n p(x_i) = p(x_1) * p(x_2) \ldots * p(x_n)$$

Vector product $\vec{x}\vec{y}$

Definition Given two vectors with n elements

$$\vec{x} = \langle x_1, x_2, \ldots, x_n \rangle$$
$$\vec{y} = \langle y_1, y_2, \ldots, y_n \rangle$$

Then the vector product (inner dot product) is defined as:

$$\begin{aligned}\vec{x}\vec{y} &= \vec{x} \cdot \vec{y} \\ &= \sum_{i=1}^{n} x_i * y_i \\ &= x_1 * y_1 + x_2 * y_2 + \ldots + x_n * y_n\end{aligned}$$

Easy example Given two vectors with 3 elements

$$\begin{aligned}\vec{x} &= \langle 1, 2, 3 \rangle \\ \vec{y} &= \langle 4, 5, 6 \rangle \\ \vec{x}\vec{y} &= \sum_{i=1}^{n} x_i * y_i \\ &= 1 * 4 + 2 * 5 + 3 * 6 \\ &= 4 + 10 + 18 \\ &= 32\end{aligned}$$

Probability

Definition We want to express that an event y has a probability a
Then we write:

$$p(y) = a \tag{1}$$

Easy Example We want to express mathematically that it rains tomorrow with a probability of 50%, then we write:

$$p(\text{rains tomorrow}) = 0.5$$

Hard Example We want to express that y is with probability of 2% equal to 1, then we write:

$$p(\text{y=1}) = 0.02$$

Conditional Probability

Definition Given a event y, assuming an event x occurred has a probability a
Then we write (tip read the symbol | as "assuming" or "given"):

$$p(y|x) = a \tag{2}$$

Easy Example We want to express mathematically that it rains tomorrow with a probability of 75% assuming that it rained today, then we write:

$$p(\text{rains tomorrow}|\text{rained today}) = 0.75$$

Hard Example We want to express that y is with probability of 99% equal to 1, assuming that x is bigger than 5, then we write:

$$p(y = 1|x > 5) = 0.99$$

Get maximal value with $\max$

Definition Given a function f, then

$$\max_x f(x)$$

returns the biggest output $f(x)$ of f for all possible inputs x values.

Example Given a function f (visualized in figure 1):

$$f(x) = 1 - x^2$$

Then:

$$\max_x f(x) = 1$$

Due to $f(0) = 1$ being the biggest output of $f(x)$ for all possible values for x.

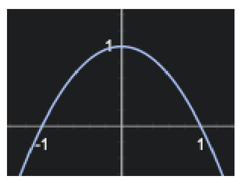

Figure 1: Plot of example function $f(x) = 1 - x^2$

Get argument of maximal value with $\arg\max$

Definition Given a function f, then

$$\arg\max_x f(x)$$

returns the parameter x of the biggest output of $f(x)$ for all possible values for x.

Example Given a function f (visualized in figure 1)

$$f(x) = 1 - x^2$$

Then:

$$\arg\max_x f(x) = 0$$

Due to $f(0) = 1$ having the biggest output of $f(x)$ when x is 0. Put differently $x = 0$ is the position where $f(x)$ is maximal, therefore $\arg\max_x f(x)$ returns us 0.