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Meschede, 27th September 2023.

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# **Math stuff for pyspark**

## 1 Simulation of a Dataset

In order to generate a large dataset which fulfills the requirements ( $n \gg 10^9, k \gg 10^5$ ), the generation of the values needs to be done in a distributed fashion. PySpark does not have a pre-defined function to generate an entire dataset suited for OLS, therefore this function is implemented manually. At first, the following values need to be initialized:

- $n$  - number of rows/samples
- $k$  - number of columns/features
- $\vec{\beta}$  - beta, the coefficients of the function
- $cov$  - a covariance vector that determines the covariance to the first column for each column

In this implementation,  $n$  and  $k$  need to be set by the user while  $\vec{\beta}$  and  $cov$  are generated randomly by numpy. For generating the actual dataset, `pyspark.mllib.random.RandomRDDs.normalVectorRDD(sc, n, k)` is used. This function creates an rdd containing  $n$  vectors, each containing  $k$  entries, where each entry is generated from a standard-normal distribution.

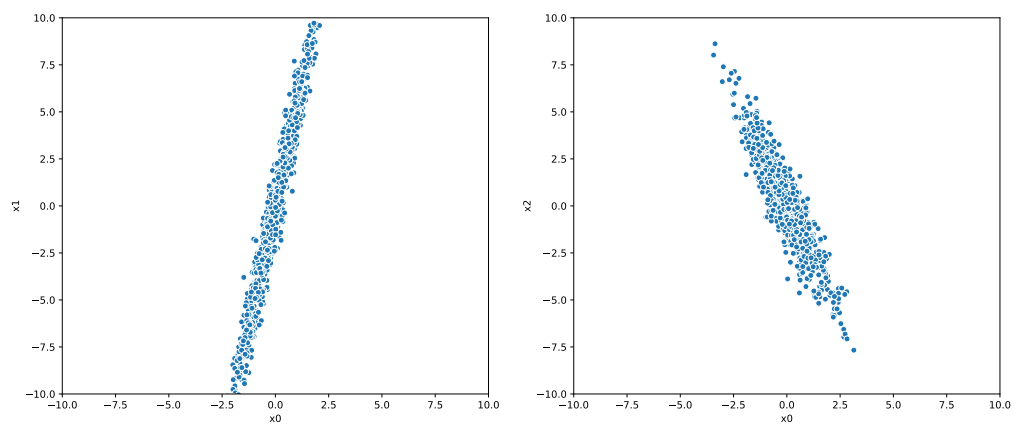
After generating this random noise matrix, the user-defined-function `createRow(noise)` is applied to the rdd, which returns two values,  $\vec{x}$  (1) and  $y$  (2).

With noise as  $\epsilon$  and  $cov$  as  $c$ :

$$\vec{x} = (\epsilon_0, \epsilon_0 c_1 + \epsilon_1, \dots, \epsilon_0 c_i + \epsilon_i) \quad (1)$$

$$y = \vec{x} \cdot \vec{\beta} \quad (2)$$

Applying this function produces an RDD where the first element is the  $x$ -vector, and the second element is the target variable. The resulting feature matrix (consisting out of  $n$   $\vec{x}$  vectors) therefore consists out of  $k$  columns, where every column is linearly dependent on the first column, plus additional noise. An exemplary distribution is visualized in figure 1.



**Figure 1:** *exemplary generated dataset*