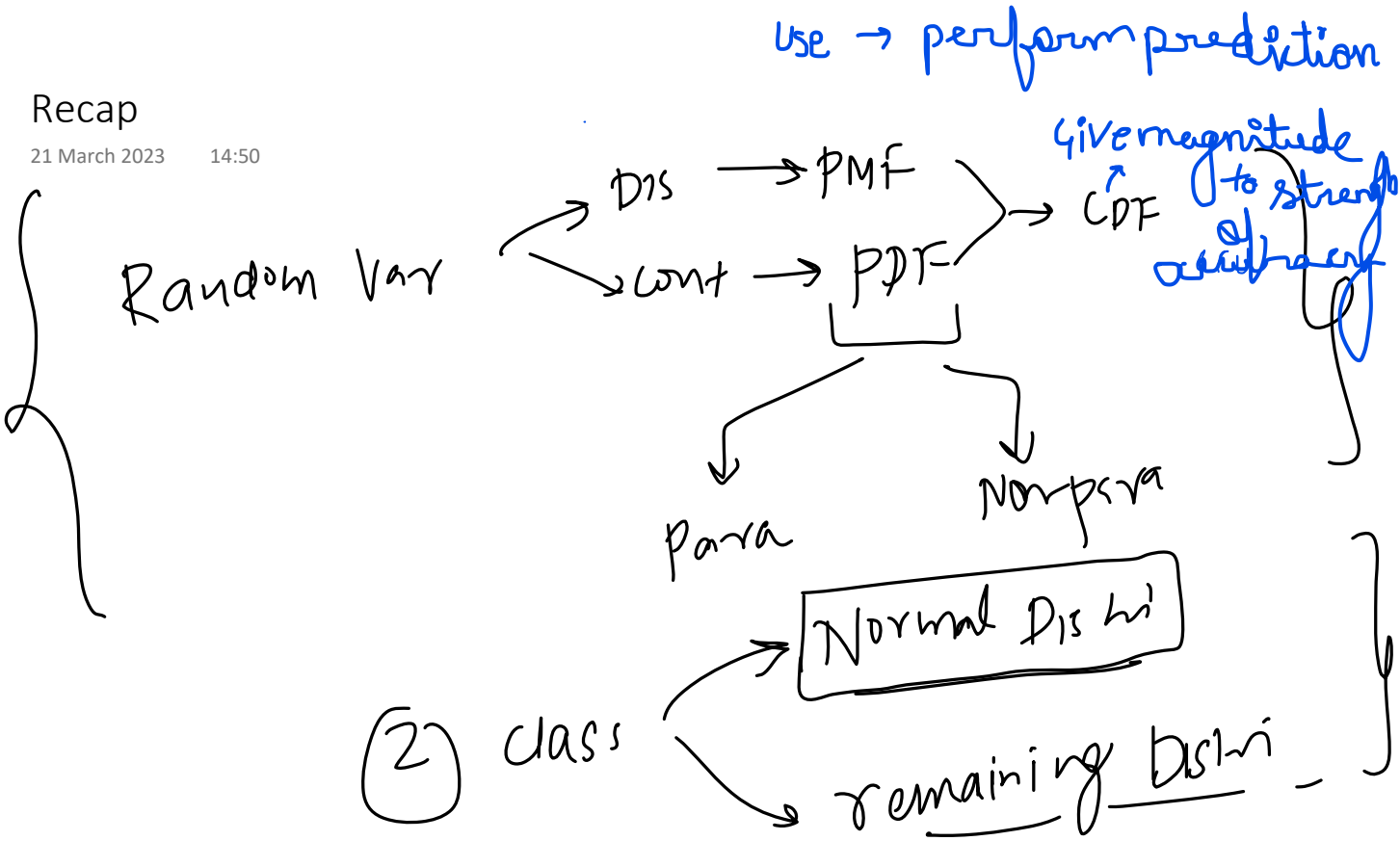
Recap

21 March 2023 14:50



How to use PDF in Data Science

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PDF → CDF

PDF $P(X = x)$

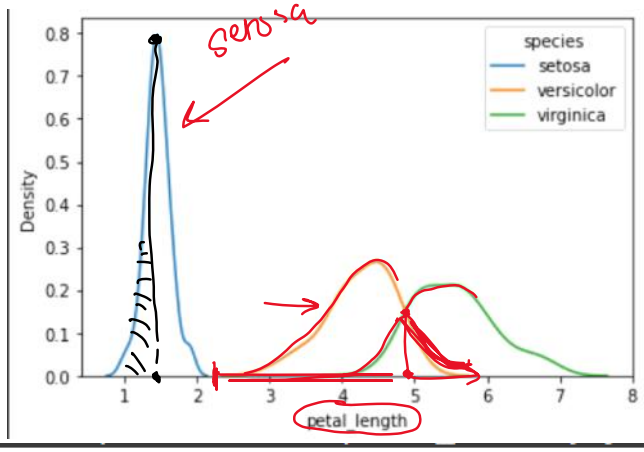
$2.3 < pl < 5$ → versicolor

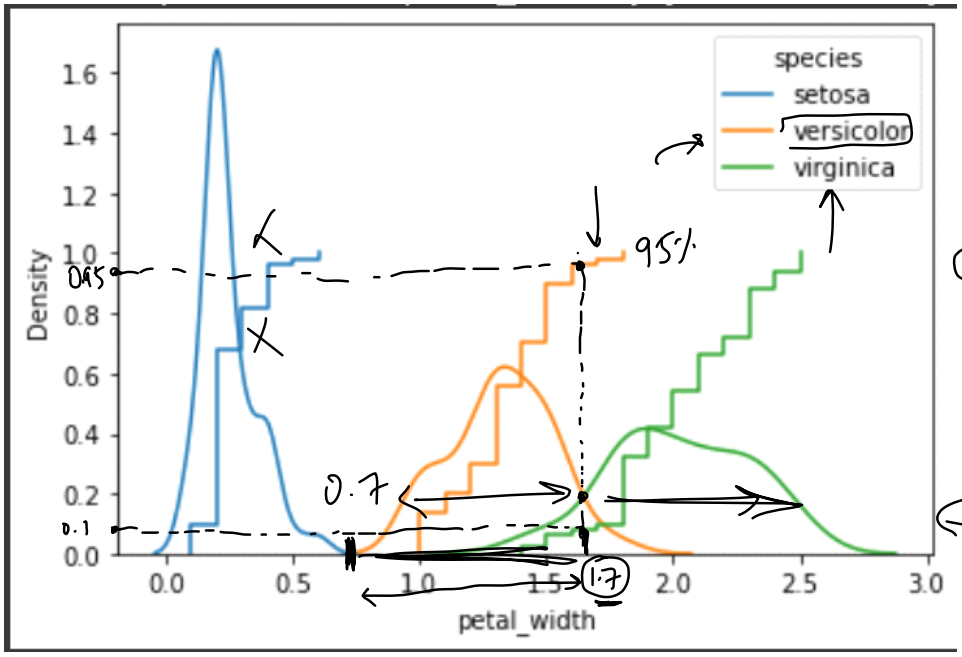
$P(X \leq x)$

$pl < 2.3$

> 2.3

$pl > 5$ virginica





95% of times

If $0.7 < pw < 1.7$ → versicolor

$pw > 1.7$ → virgin

90%

10% virgin

2D Density Plots

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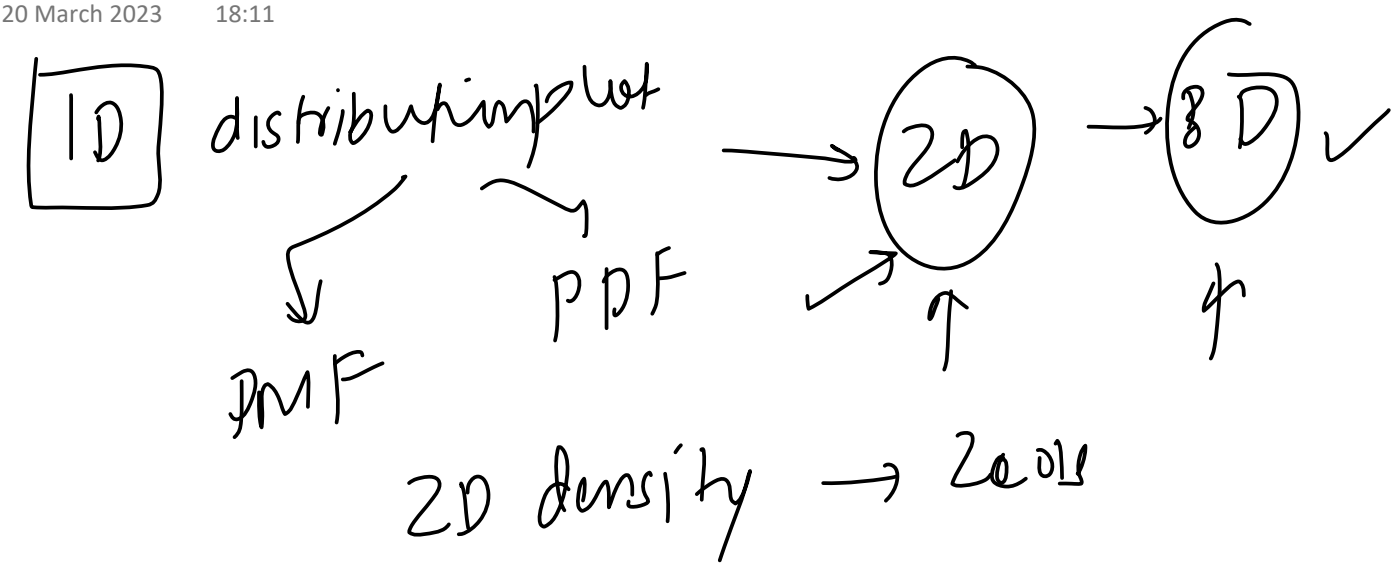
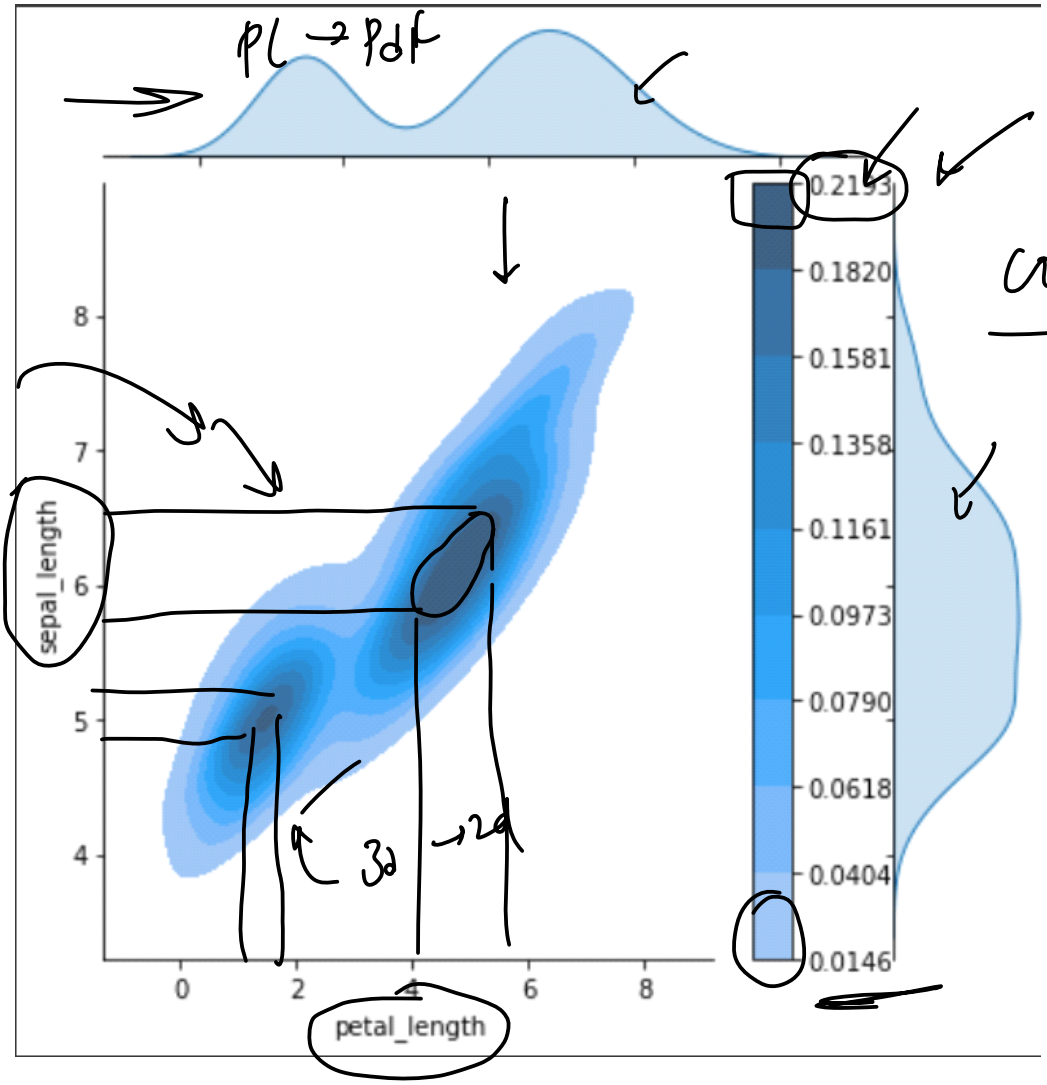


2D density → 2 cols



2D

Contour

sl - pl

3d → 2d

Color

Normal Distribution

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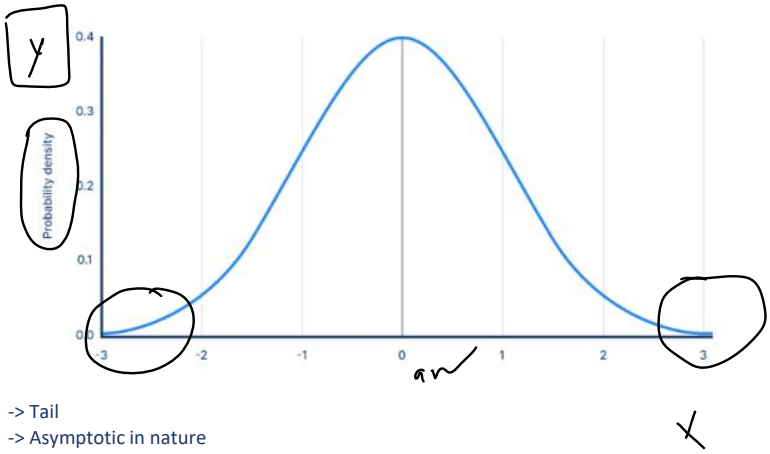
1. What is normal distribution?

Normal distribution, also known as Gaussian distribution, is a probability distribution that is commonly used in statistical analysis. It is a continuous probability distribution that is symmetrical around the mean, with a bell-shaped curve.



-> Tail
-> Asymptotic in nature
-> Lots of points near the mean and very few far away

The normal distribution is characterized by two parameters: the mean (μ) and the standard deviation (σ). The mean represents the centre of the distribution, while the standard deviation represents the spread of the distribution.

Denoted as:

$$X \sim N(\mu, \sigma)$$

Why is it so important?

Commonality in Nature: Many natural phenomena follow a normal distribution, such as the heights of people, the weights of objects, the IQ scores of a population, and many more. Thus, the normal distribution provides a convenient way to model and analyse such data.

PDF Equation of Normal Distribution

$$y = f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

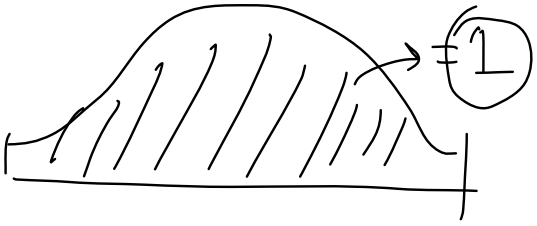
Parameters in Normal Distribution

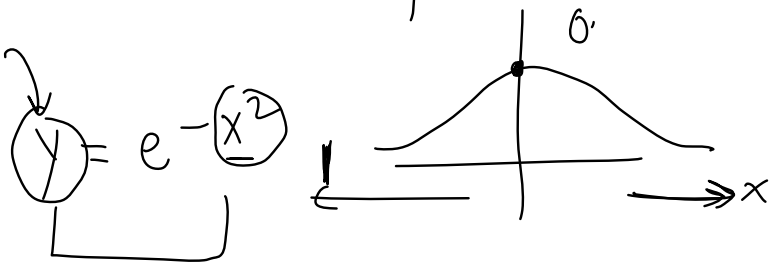
https://samp-suman-normal-dist-visualize-app-lkntug.streamlit.app/

Equation in detail:

$$y = e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

$\sigma\sqrt{2\pi}$





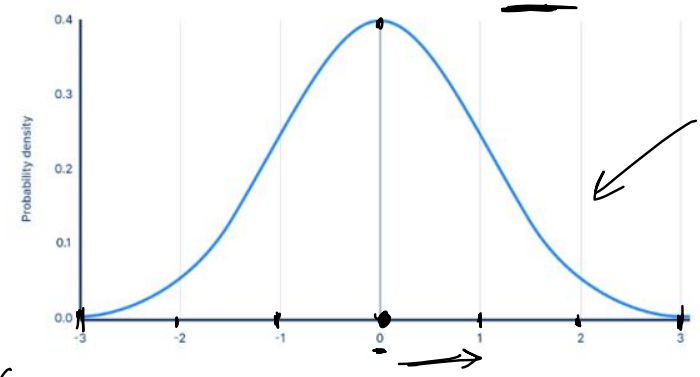
$$y = \frac{1}{e^{x^2}}$$

Standard Normal Variate

20 March 2023 18:08

- What is Standard Normal Variate

A Standard Normal Variate(Z) is a standardized form of the normal distribution with mean = 0 and standard deviation = 1.



Standardizing a normal distribution allows us to compare different distributions with each other, and to calculate probabilities using standardized tables or software.

Equation:

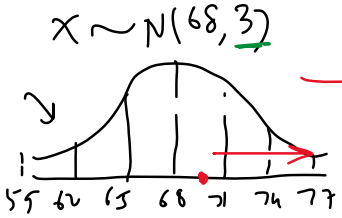
$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2}$$

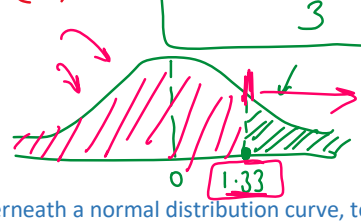
- How to transform a normal distribution to Standard Normal Variate

Refer Python code

Kya Fayda Standardize karne ka?

Suppose the heights of adult males in a certain population follow a normal distribution with a mean of 68 inches and a standard deviation of 3 inches. What is the probability that a randomly selected adult male from this population is taller than 72 inches?





- What are Z-tables

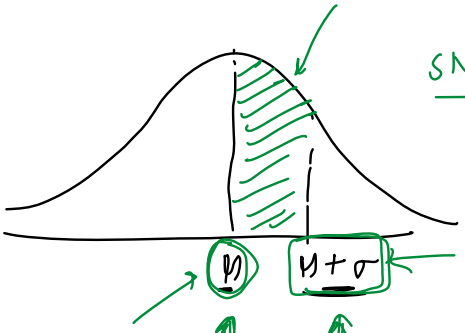
A z-table tells you the area underneath a normal distribution curve, to the left of the z-score

https://www.ztable.net/

For a Normal Distribution X~(u,std) what percent of population lie between mean and 1 standard deviation, 2 std and 3 std?

standard deviation, 2 std and 3 std.

$X \sim N(\mu, \sigma)$ %



SNV(z) →

$\mu \rightarrow$ ↓

$$z = \frac{x-\mu}{\sigma}$$

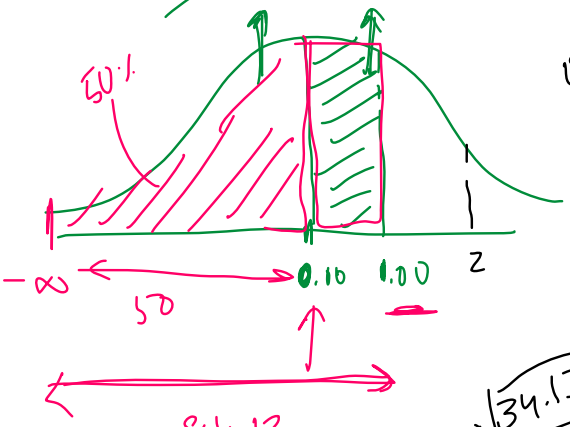
$$z = \frac{\mu-\mu}{\sigma} = 0$$

$$z = \frac{x-\mu}{\sigma} = \frac{\mu+\sigma-\mu}{\sigma}$$

0.9772 = 97%

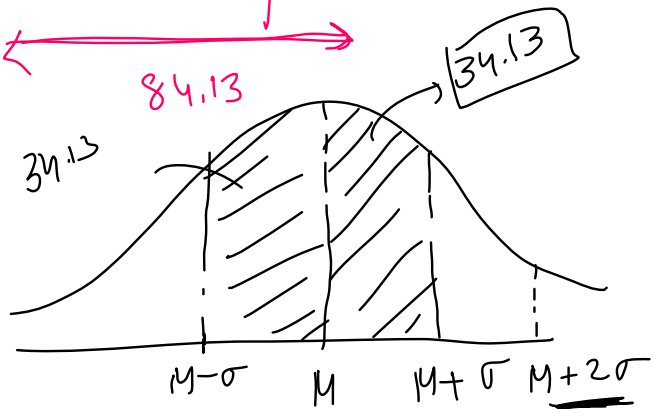
$$\frac{\sigma}{\sigma} = 1$$

84.13 − 50 = 34.13

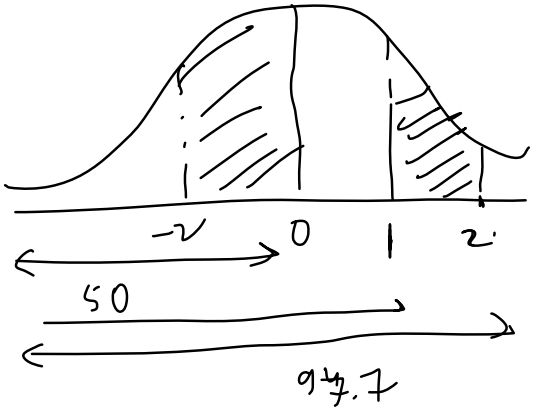


−1σ +1σ

64.28 %



$$z = \frac{\mu+2\sigma-\mu}{\sigma} = 2$$



Properties of Normal Distribution

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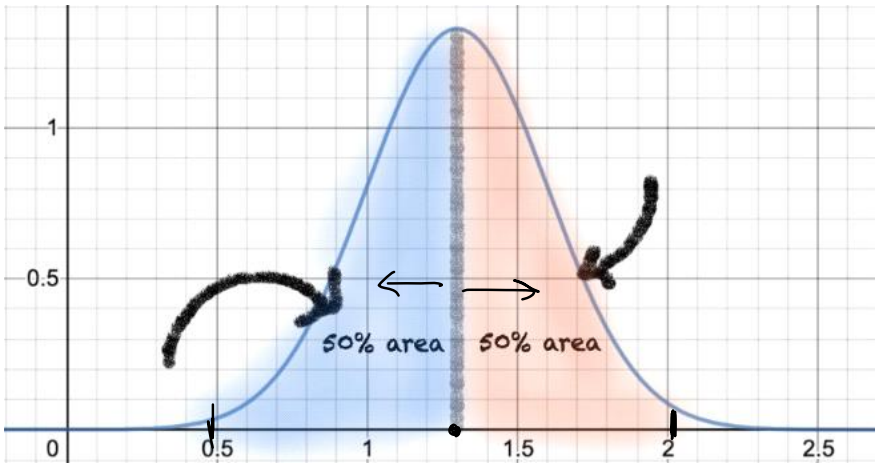
1. Symmetricity

The normal distribution is symmetric about its mean which means that the probability of observing a value above the mean is the same as the probability of observing a value below the mean. The bell-shaped curve of the normal distribution reflects this symmetry.



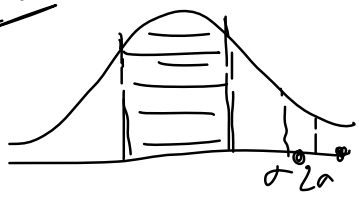
2. Measures of Central Tendencies are equal → mean → median → mode

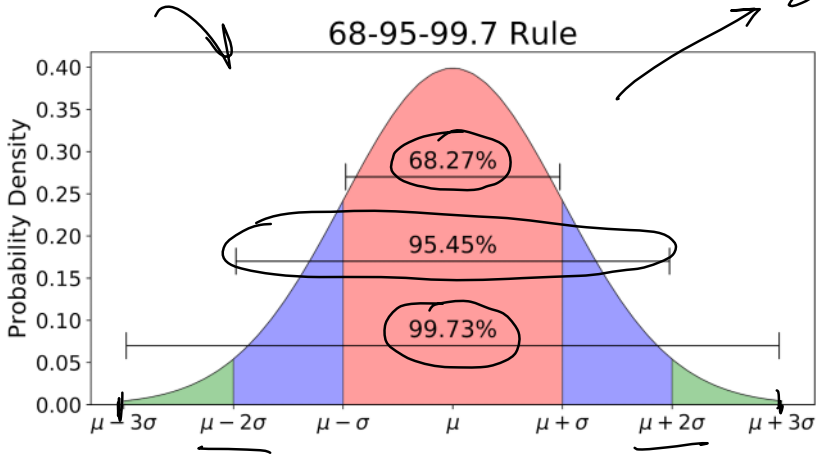
3. Empirical Rule

The normal distribution has a well-known empirical rule, also called the 68-95-99.7 rule, which states that approximately 68% of the data falls within one standard deviation of the mean, about 95% of the data falls within two standard deviations of the mean, and about 99.7% of the data falls within three standard deviations of the mean.

Standard normal variate

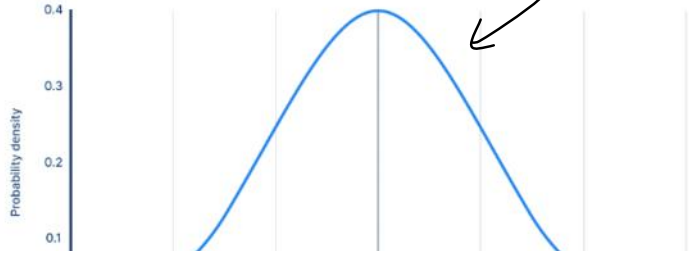
Z-table

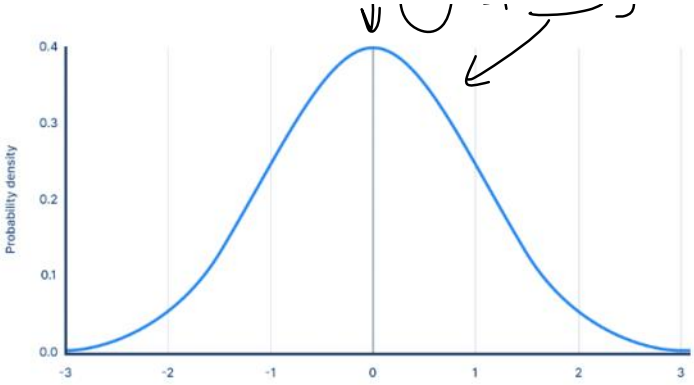




4. The area under the curve

1 → PDF




Probability density
0.4
0.3
0.2
0.1
0.0
-3
-2
-1
0
1
2
3

Skewness

Measure of Asymmetry

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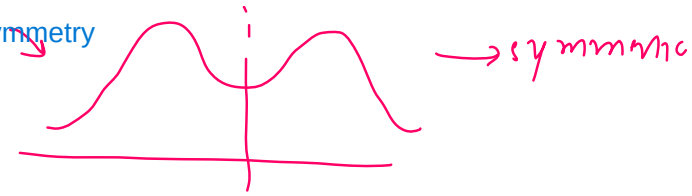


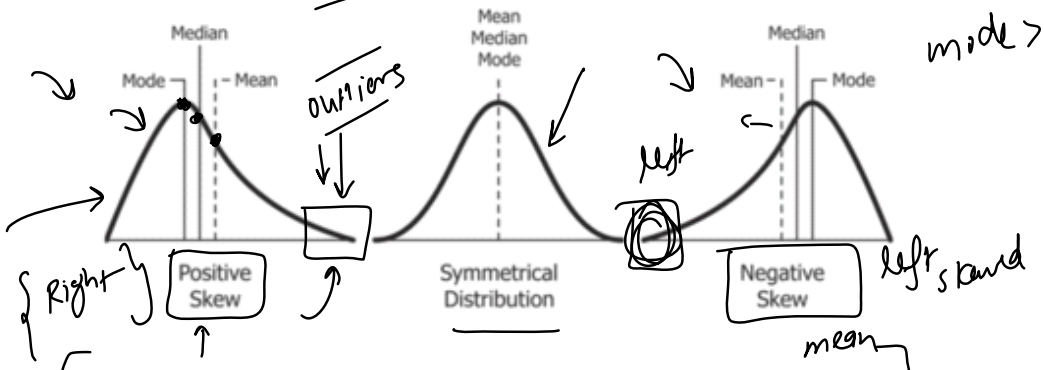
- What is skewness?

A normal distribution is a bell-shaped, symmetrical distribution with a specific mathematical formula that describes how the data is spread out. Skewness indicates that the data is not symmetrical, which means it is not normally distributed.

Skewness is a measure of the asymmetry of a probability distribution. It is a statistical measure that describes the degree to which a dataset deviates from the normal distribution.

In a symmetrical distribution, the mean, median, and mode are all equal. In contrast, in a skewed distribution, the mean, median, and mode are not equal, and the distribution tends to have a longer tail on one side than the other.

Skewness can be positive, negative, or zero. A positive skewness means that the tail of the distribution is longer on the right side, while a negative skewness means that the tail is longer on the left side. A zero skewness indicates a perfectly symmetrical distribution.

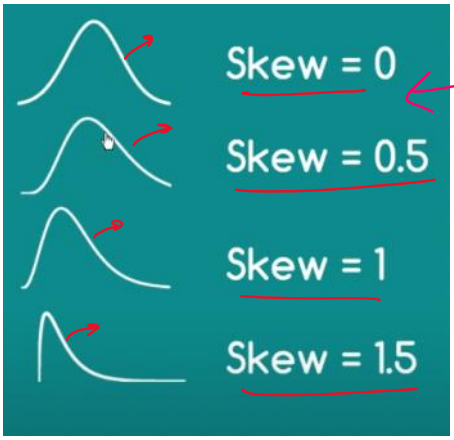


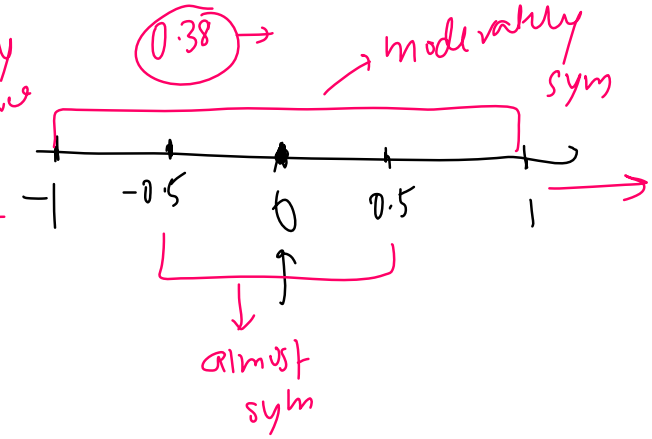
The greater the skew the greater the distance between mode, median and mean

- How skewness is calculated?

$$\frac{n}{(n-1)(n-2)}\sum\left(\frac{(x-\bar{x})}{s}\right)^3$$

- Python Example
- Interpretation





CDF of Normal Distribution

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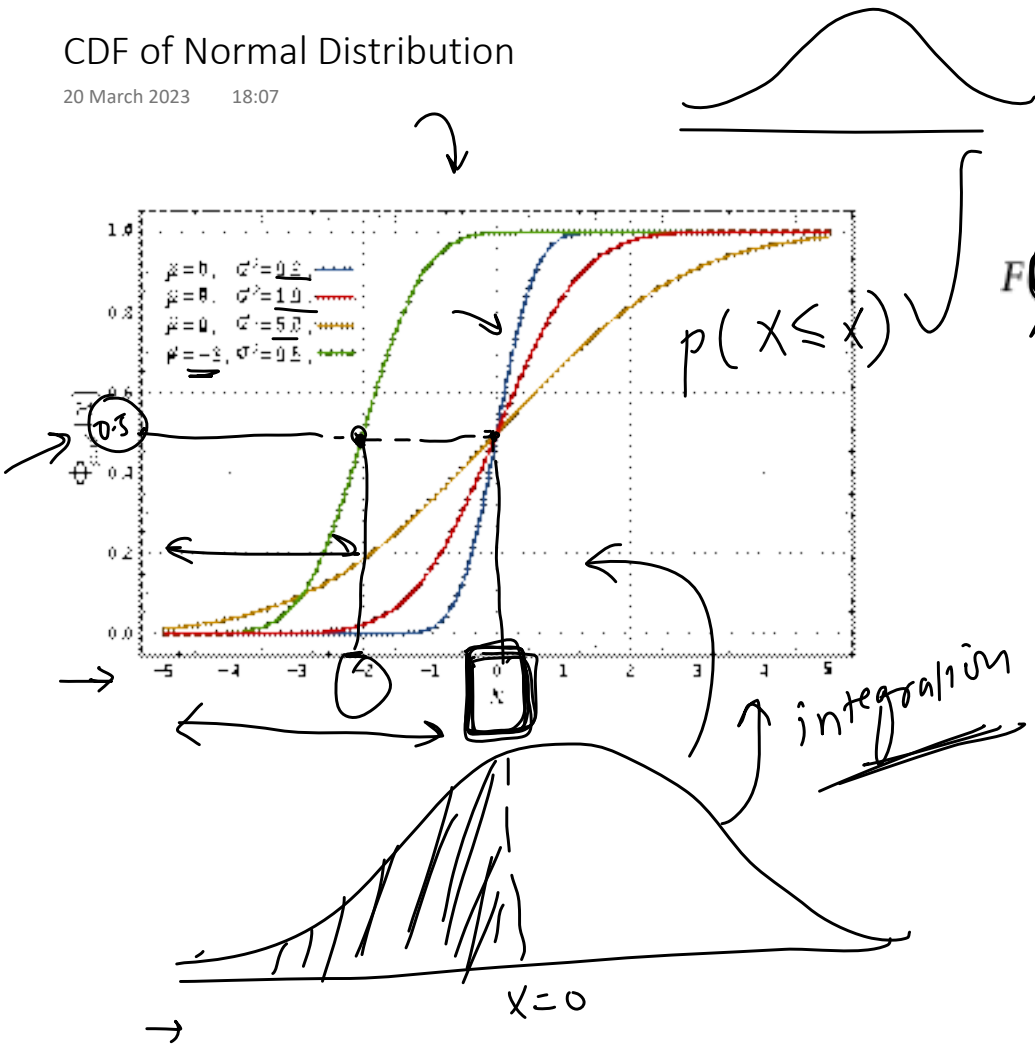

$$F(x) = p(X \le x) = \int_{-\infty}^{x} f(t)\,dt$$

$$= \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{(t-\mu)^2}{2\sigma^2}}\,dt.$$

Use in Data Science

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- Outlier detection
- Assumptions on data for ML algorithms -> Linear Regression and GMM
- Hypothesis Testing
- Central Limit Theorem

--- The data is clustered around the mean, indicating a high probability of occurrence in this region or greater concentration of data in that region.