Inferential statistics:2

Case study 1:

Niki.ai is a startup. They develop different AI solutions and provide these solutions as a service. When they started the company, they deployed all there AI models in AWS and provided APIs to customers to communicate with those models. They observed that cloud service was expensive and the research that they were doing was very good, hence they decided to move all the models to in house servers.

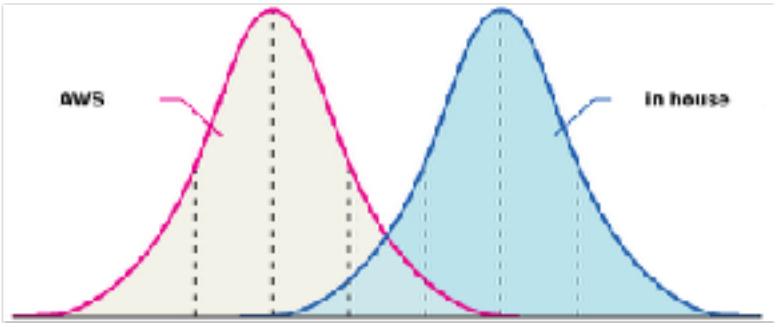
After moving all the APIs and models to in house server, technical team made a observation on response time of individual models. Sample of those observations are given below.

Services	AWS response time	In House response time
Sentiment Analysis	32	96
Named entity detection	16	78
Category classification	12	64
Snippeting tool	34	84

How would you find is there any significant difference after moving models to in house servers?

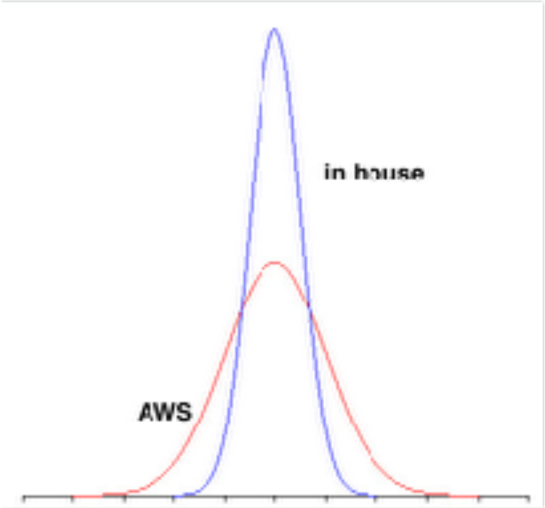
First is **Plotting distribution**

Plotting distribution for IR service



Mean of IR service response time in AWS = 5 sec
Mean of IR service response time in house = 20 sec

mean can not show change in distribution because distribution has other parameters too. so, it can not infer that the change has significant.



Mean of IR service response time in AWS = 5 sec
Mean of IR service response time in house = 5.3 sec

Is there any significant change in the new distribution?

Person A	Yes
Person B	Yes
Person C	No
Person D	No

Can not say.

T Test

https://www.youtube.com/watch?v=pTmLQvMM-1M
https://www.youtube.com/watch?v=1Ldl5Zfcm1Y

1. **What is t-test?**
2. **What is the purpose of t-test?**
3. **What is critical value?**
4. **Are you conducting a one-tailed or two tailed test?**
5. **Is the data is paired or not?**

What is t-test?

A t-test is a statistic that checks if two means are reliably different from each other .

What is the purpose of t-test?

Statistic way of finding is there any significant change in the new distribution compared to the old one.

What is the critical value?

1. Let's say we wan't to represent whether there is a significant change or not how would you represent it?

P(significant change | (OD,ND)) + p(no significant change | (OD,ND)) = 1
OD = old distribution
ND = New distribution

2. Critical value probability = p(no significant change | (OD,ND))

$P_{critical} = 0.05$

p(no significant change | (OD,ND)) = 0.05

P(significant change | (OD,ND)) + 0.05 = 1

P(significant change | (OD,ND)) = 0.95

$P_{critical} >= 0.05$

There is only less than 5% chance that there is significant change in the New data distribution compared to old

Are you conducting a one-tailed or two tailed test?

Two Tailed test: Is there any reliable significant change?
One Tailed test: Is new distribution performed well over old distribution?

https://www.statisticshowto.datasciencecentral.com/probability-and-statistics/hypothesis-testing/one-tailed-test-or-two/

Is the data is paired or not?

	Height	
	Boys	girls
	72	66
	68	67
	69	68
	78	70
	64	61
	63	62
	77	71
	74	70
	73	68
Mean	70.88888889	67
std deviation	5.30199124	3.5

	Boy Height	
	Age 5	Age 15
	54	69
	45	78
	56	64
	47	63
	45	61
	48	62
	39	71
	44	70
	45	68
Mean	47	67.33333333
std deviation	5.196152423	5.431390246

How we do it?

1. For given dataset define a hypothesis:

   H_o = mean of the new distribution is same as the mean of the old distribution
   H_a = mean of the new distribution is not same as the mean of the old distribution

2. Calculate the t-value:

$$= \frac{\left|\overline{X_1} - \overline{X_2}\right|}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

   X_1 = mean of old distribution
   X_2 = mean of new distribution
   S_1 = St.Deviation of old distribution
   S_2 = St.Deviation of new distribution
   n1 = Number of samples in old distribution
   n2 = Number of samples in new distribution

3. Define probability for critical value:

   Let's say I want my inference to be 95% sure about mean of new distribution is significantly vary with respect to old mean. That is,

   P(significant change | (OD,ND)) = 95%
   $P_{critical} = 0.05$

4. Using probability for critical value find critical value using t table

5. If t-value > critical value then reject the null hypothesis or else accept the null hypothesis

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Case study 1 solution

Example:

The technical team of amazon has observed that the particular API is slow in server A compared to Server B. Given response time of that API in both the server as below,

Server1	Server2
11	12
12	14
15	12
11	12
12	14
15	15
12	12
15	14
11	12
12	14

How will you validate(or infer) the proposed argument is right or wrong?

H_o : mean of the response time of API in server A = mean of the response time of API in server B
H_a : mean of the response time of API in server A != mean of the response time of API in server B

Case study 2:

The technical team of amazon has observed that the particular API is slow in server A compared to Server B & C. Given response time of that API in all the server as below,

Server1	Server2	Server3
11	12	12
12	14	13
15	12	14
11	12	12
12	14	13
15	15	14
12	12	12
15	14	12
11	12	14
12	14	13
12	12	14
15	14	13
11	14	13
[illegible]	[illegible]	[illegible]

How will you validate(or infer) the proposed argument is right or wrong?

H_o : mean of the RT of API in server A = mean of the RT of API in server B = mean of the RT of API in server C
H_a : At least one difference among the means

ANOVA

Analysis of variance

$$F = \frac{between\ groups}{within\ groups}$$

Case study 2 solution

Chi-squared Test

Let' say John is flipping a **fair** coin. He flipped the coin for 50 times and he observed that 28 times he has got head and 22 times he has got tail. Now he wants to understand whether the coin is actually behaving as a fair coin or not.
How you can help John to infer this?

Solution https://www.youtube.com/watch?v=CS_BKChyPuc

H_o : There is no significant difference between observed and expected frequencies
H_a : There is significant difference between observed and expected frequencies

Let's plot a chart which represents what he observed during the experiment and what John was accepting from the Experiment

	Head	Tail
Expected	25	25
Observed	28	22

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i} = \frac{(28 - 25)^2}{25} + \frac{(22 - 25)^2}{25} = 0.72$$

Degree of freedom = Number of possible outcomes - 1
= 2 - 1
= 1

Prob(Critical value) = 0.05

Critical value = 3.84

Thank you