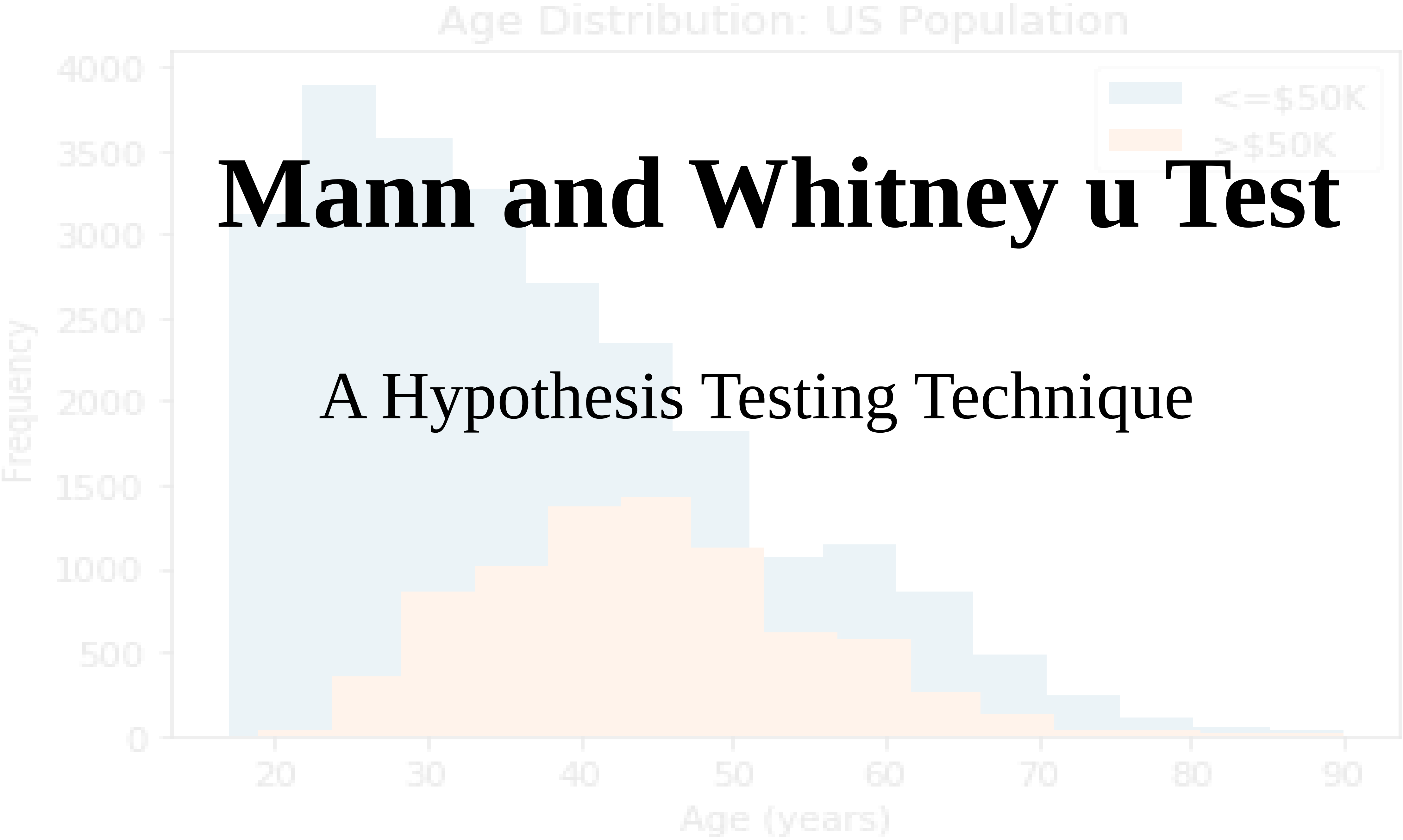
Mann and Whitney u Test

A Hypothesis Testing Technique



Introduction

- Mann and Whitney's U-test is the **non-parametri**c statistic hypothesis test that is used to analyze the **difference between two independent samples of ordinal data**.
- **Non-parametric** methods allow statistical inference without making the assumption that the sample has been taken from a particular distribution **(i.e. normal)** .
- Here we are provided two **randomly drawn samples** and we have to verify whether these two samples is from the same population.

Assumptions for Mann Witney test

- All values of both groups are **independent of each other.**
- The values of the independent variable should be in an **ordinal manner** (means they can be compared to each other and ranked in order of highest to lowest).
- The variable should be **two independent**, categorical groups.
- The **null hypothesis** in Mann-Whitney U-test is always the same **i.e. there is no significant difference between the two samples.**
- Mann Whitney test is applied to two distribution that **need not be normally distributed but should have the same curve shape**. For Example: If one curve (of a sample) has longer right-tailed, the other curve (or other samples) should also have a longer right tail…..Blah Blah Blah

puzzled with this theory as me…???

- **Don’t worry I will Explain you this topic with the help of an easy example**

Example:

A Pharma organization created a new drug to cure sleepwalking and observed the result on a group of 5 patients after a month. Another group of 5 has been taking the old drug for a month. The organization then asked the individuals to record the number of sleepwalking cases in the last month. The result of Sleepwalk cases in a month-

Old Drug	7	8	4	9	8
New Drug	3	4	2	1	1

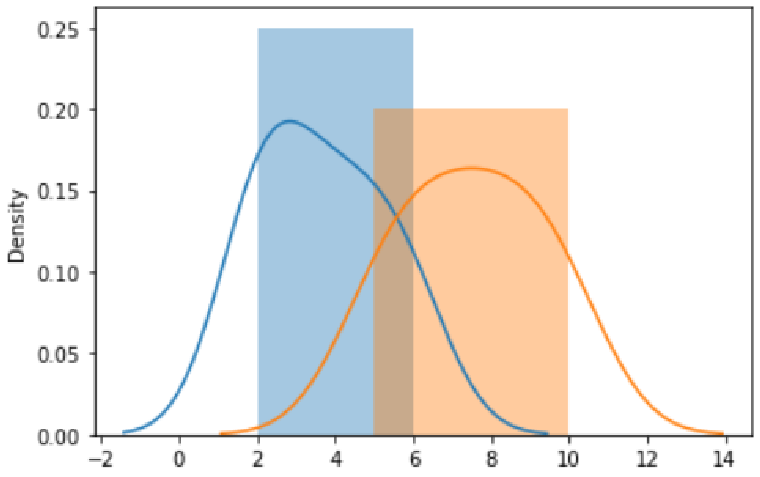
If you look at the table , the number of sleepwalking cases recorded in a month while taking the new drug is lower as compared to the cases reported while taking the old drug.

Plot time

```
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

```
sns.distplot(batch_1)
sns.distplot(batch_2)
```

```
<AxesSubplot:ylabel='Density'>
```



Significant difference between 2 samples

Testing Process Begins…

- Let's see how Mann Whitney U test works here. We are interested in knowing whether the two groups taking different drugs, report the same number of sleepwalking cases or not.

$$H_0: The\ two\ groups\ report\ same\ number\ of\ cases$$
$$H_1: The\ two\ groups\ report\ different\ number\ of\ cases$$

- **I am selecting 5% level of significance for this test**. The next step is to set a **test statistic**.
- For Mann Whitney U test, the **test statistic** is denoted by **U** which is the minimum of U1 and U2.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

where R_1 is the sum of ranks of group 1, R_2 is the sum of ranks of group 2
n_1 is the size of group 1 and n_2 is the size of group 2

Till now we know:

n1=5 and n2=5 as they are sample size
alpha = 0.5
R1=? and R2=?
U1=? and U2=?

Now its time to find Ranks and here are they-

Old Drug	7	8	4	9	8
New Drug	3	4	2	1	1

	ND	ND	ND	ND	ND	OD	OD	OD	OD	OD
Sample	1	1	2	3	4	4	7	8	8	9
Ranks	1	2	3	4	5	6	7	8	9	10

First arrange observations of both samples in increasing order then calculate ranks by checking the observation is greater and equal to how many elements before it.

From the left check a specific elements is greater then equal to how many elements upto it –
1 is greater then equal to itself, so 1
Second 1 is greater then equal to previous 1 and itself, so 2
2 is greater then equal to 1,1,2 so 3
3 is greater then equal to 1,1,2,3 so 4
4 is greater then equal to 1,1,2,3,4 so 5 ……. And so on

Testing Process Continues…

When there is a tie, We assign the mean rank when there are ties in a sample to make sure that the sum of ranks in each sample of size n is same. Therefore, the sum of ranks will always be equal to

$$\frac{n(n+1)}{2}$$

	ND	ND	ND	ND	ND	OD	OD	OD	OD	OD
Sample	1	1	2	3	4	4	7	8	8	9
Rank	1.5	1.5	3	4	5.5	5.5	7	8.5	8.5	10

There are 2 ones, so (1+2)/2 = 1.5 assign 1.5 to both 1 and like this do with 4 and 8

Testing Process Continues…

- The next step is to compute the sum of ranks for group 1 and group 2.
- R1 = 15.5 1.5+1.5+3+4+5.5=15.5 ranks of 1st sample
  R2 = 39.5 5.5+7+8.8+8.8+10=39.5 ranks of 2nd sample
- Using the formula of U1 & U2, compute their values.
- U1 = 24.5 U1=5*5+(5*6)/2-15.5 = 24.5
  U2 = 0.5 U2=5*5+(5*6)/6-39.5 = 0.5
- Now, U = min(U1, U2) = 0.5

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

where R_1 is the sum of ranks of group 1, R_2 is the sum of ranks of group 2
n_1 is the size of group 1 and n_2 is the size of group 2

Testing Process Continues…

- For Mann Whitney U test, the value of **U lies in the range(0, n1*n2)** where **0 indicates that the two groups are completely different** from each other and **n1*n2 indicates some relation between the two groups**. Also, U1 + U2 is always equal to n1*n2. Notice that the value of U is 0.5 here which is very close to 0.

- Now, we determine a critical value or a p-value (denoted by p) using Table for critical values which is in next page. We take n1=5 ,n2=5 , and alpha=0.5 (Table is in next page)

Critical Values for the mean witney

n_2	α	n_1																	
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3	.05	--	0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
	.01	--	0	0	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
4	.05	--	0	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14
	.01	--	--	0	0	0	1	1	2	2	3	3	4	5	5	6	6	7	8
5	.05	0	1	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
	.01	--	--	0	1	1	2	3	4	5	6	7	7	8	9	10	11	12	13
6	.05	1	2	3	5	6	8	10	11	13	14	16	17	19	21	22	24	25	27
	.01	--	0	1	2	3	4	5	6	7	9	10	11	12	13	15	16	17	18
7	.05	1	3	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
	.01	--	0	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	24
8	.05	2	4	6	8	10	13	15	17	19	22	24	26	29	31	34	36	38	41
	.01	--	1	2	4	6	7	9	11	13	15	17	18	20	22	24	26	28	30
9	.05	2	4	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48
	.01	0	1	3	5	7	9	11	13	16	18	20	22	24	27	29	31	33	36
10	.05	3	5	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
	.01	0	2	4	6	9	11	13	16	18	21	24	26	29	31	34	37	39	42
11	.05	3	6	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
	.01	0	2	5	7	10	13	16	18	21	24	27	30	33	36	39	42	45	48
12	.05	4	7	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
	.01	1	3	6	9	12	15	18	21	24	27	31	34	37	41	44	47	51	54
13	.05	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
	.01	1	3	7	10	13	17	20	24	27	31	34	38	42	45	49	53	56	60
14	.05	5	9	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
	.01	1	4	7	11	15	18	22	26	30	34	38	42	46	50	54	58	63	67
15	.05	5	10	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
	.01	2	5	8	12	16	20	24	29	33	37	42	46	51	55	60	64	69	73
16	.05	6	11	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
	.01	2	5	9	13	18	22	27	31	36	41	45	50	55	60	65	70	74	79
17	.05	6	11	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105
	.01	2	6	10	15	19	24	29	34	39	44	49	54	60	65	70	75	81	86
18	.05	7	12	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
	.01	2	6	11	16	21	26	31	37	42	47	53	58	64	70	75	81	87	92
19	.05	7	13	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
	.01	3	7	12	17	22	28	33	39	45	51	56	63	69	74	81	87	93	99
20	.05	8	14	20	27	34	41	48	55	62	69	76	83	90	98	105	112	119	127
	.01	3	8	13	18	24	30	36	42	48	54	60	67	73	79	86	92	99	105

We get critical value=2 which is a critical value

Hurrah! We get the final result

$$Reject\ H_0 : U \leq critical\ value$$
$$Accept\ H_0 : U > critical\ value$$

We get critical Value =2 from the table and U is 0.5, 0.5 <= 2 so it means We will reject the null Hypothesis and conclude that the there's no significant evidence to state that two groups report same number of sleepwalking cases.

Conclusion: We can say the new drug works as after taking new drug sleepwalking cases are not same as before.

Codes For Mann Witney u Test…

Mann Witney u Test

In [1]:
```python
# code for Mann-Whitney U test
from scipy.stats import mannwhitneyu
# Take batch 1 and batch 2 data as per above example
batch_1 =[3, 4, 2, 6, 2, 5]
batch_2 =[9, 7, 5, 10, 8, 6]

# perform mann whitney test
stat, p_value = mannwhitneyu(batch_1, batch_2)
print('Statistics=%.2f, p=%.2f' % (stat, p_value))
# Level of significance
alpha = 0.05
# conclusion
if p_value < alpha:
    print('Reject Null Hypothesis (Significant difference between two samples)')
else:
    print('Do not Reject Null Hypothesis (No significant difference between two samples)')
```

```
Statistics=2.00, p=0.01
Reject Null Hypothesis (Significant difference between two samples)
```

In [ ]: