Data Science amb Python

Sprint 8 - Tasca del test d'hipòtesis

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Abril 2021

Exercises 1

Grab a sports theme dataset you like and select an attribute from the dataset. Calculate the p-value and say if you reject the null hypothesis by taking a 5% alpha.

In [1]:

```
# import libraries needed

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:

```
#Load dataset
from datetime import datetime


games = pd.read_csv('athlete_olympics.csv')

games.head()
```

Out[2]:

	ID	Sex	Age	Height	Weight	NOC	Season	Medal
0	1	M	24.0	180.0	80.0	CHN	Summer	NaN
1	2	M	23.0	170.0	60.0	CHN	Summer	NaN
2	3	M	24.0	NaN	NaN	DEN	Summer	NaN
3	4	M	34.0	NaN	NaN	DEN	Summer	Gold
4	5	F	21.0	185.0	82.0	NED	Winter	NaN

In [3]:

```
games.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 271116 entries, 0 to 271115
Data columns (total 8 columns):
 #   Column  Non-Null Count   Dtype  
---  ------  --------------   -----  
 0   ID      271116 non-null  int64  
 1   Sex     271116 non-null  object 
 2   Age     261642 non-null  float64
 3   Height  210945 non-null  float64
 4   Weight  208241 non-null  float64
 5   NOC     271116 non-null  object 
 6   Season  271116 non-null  object 
 7   Medal   39783 non-null   object 
dtypes: float64(3), int64(1), object(4)
memory usage: 16.5+ MB
```

In [4]:

```
# Replace the Age, Height and Weight NaN by their median.

games['Age'].fillna(games['Age'].median(), inplace=True)

games['Height'].fillna(games['Height'].median(), inplace=True)

games['Weight'].fillna(games['Weight'].median(), inplace=True)
```

In [5]:

```
games.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 271116 entries, 0 to 271115
Data columns (total 8 columns):
 #   Column  Non-Null Count   Dtype  
---  ------  --------------   -----  
 0   ID      271116 non-null  int64  
 1   Sex     271116 non-null  object 
 2   Age     271116 non-null  float64
 3   Height  271116 non-null  float64
 4   Weight  271116 non-null  float64
 5   NOC     271116 non-null  object 
 6   Season  271116 non-null  object 
 7   Medal   39783 non-null   object 
dtypes: float64(3), int64(1), object(4)
memory usage: 16.5+ MB
```

In [6]:

```
#Replace 'Medal' column Values with Zeros and 1

games['Medal'] = games['Medal'].fillna(0)
games['Medal'] =games['Medal'].replace(['Gold', 'Bronze', 'Silver'], [1, 1
games.head()
```

Out[6]:

	ID	Sex	Age	Height	Weight	NOC	Season	Medal
0	1	M	24.0	180.0	80.0	CHN	Summer	0
1	2	M	23.0	170.0	60.0	CHN	Summer	0
2	3	M	24.0	175.0	70.0	DEN	Summer	0
3	4	M	34.0	175.0	70.0	DEN	Summer	1
4	5	F	21.0	185.0	82.0	NED	Winter	0

In [ ]:

```
```

In [7]:

```
# show summary of Dataframe structure

games.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 271116 entries, 0 to 271115
Data columns (total 8 columns):
 #   Column  Non-Null Count   Dtype  
---  ------  --------------   -----  
 0   ID      271116 non-null  int64  
 1   Sex     271116 non-null  object 
 2   Age     271116 non-null  float64
 3   Height  271116 non-null  float64
 4   Weight  271116 non-null  float64
 5   NOC     271116 non-null  object 
 6   Season  271116 non-null  object 
 7   Medal   271116 non-null  int64  
dtypes: float64(3), int64(2), object(3)
memory usage: 16.5+ MB
```

In [8]:

```
games['Sex'].value_counts()
```

Out[8]:

```
M    196594
F     74522
Name: Sex, dtype: int64
```

In [9]:

```
games.describe()
```

Out[9]:

	ID	Age	Height	Weight	Medal
count	271116.000000	271116.000000	271116.00000	271116.000000	271116.000000
mean	68248.954396	25.502493	175.26374	70.539500	0.146738
std	39022.286345	6.287361	9.27917	12.578184	0.353845
min	1.000000	10.000000	127.00000	25.000000	0.000000
25%	34643.000000	22.000000	170.00000	63.000000	0.000000
50%	68205.000000	24.000000	175.00000	70.000000	0.000000
75%	102097.250000	28.000000	180.00000	75.000000	0.000000
max	135571.000000	97.000000	226.00000	214.000000	1.000000

In [10]:

```
games.isnull().sum()
```

Out[10]:

```
ID        0
Sex       0
Age       0
Height    0
Weight    0
NOC       0
Season    0
Medal     0
dtype: int64
```

Information about women

In [11]:

```
games_women = (games.loc[games['Sex']== 'F']).reset_index(drop=True)
games_women.head()
```

Out[11]:

	ID	Sex	Age	Height	Weight	NOC	Season	Medal
0	5	F	21.0	185.0	82.0	NED	Winter	0
1	5	F	21.0	185.0	82.0	NED	Winter	0
2	5	F	25.0	185.0	82.0	NED	Winter	0
3	5	F	25.0	185.0	82.0	NED	Winter	0
4	5	F	27.0	185.0	82.0	NED	Winter	0

In [12]:

```
games_women['Sex'].value_counts()
```

Out[12]:

```
F    74522
Name: Sex, dtype: int64
```

In [13]:

```
games_women.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 74522 entries, 0 to 74521
Data columns (total 8 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   ID      74522 non-null  int64  
 1   Sex     74522 non-null  object 
 2   Age     74522 non-null  float64
 3   Height  74522 non-null  float64
 4   Weight  74522 non-null  float64
 5   NOC     74522 non-null  object 
 6   Season  74522 non-null  object 
 7   Medal   74522 non-null  int64  
dtypes: float64(3), int64(2), object(3)
memory usage: 4.5+ MB
```

In [14]:

```
games_women.describe().round(1)
```

Out[14]:

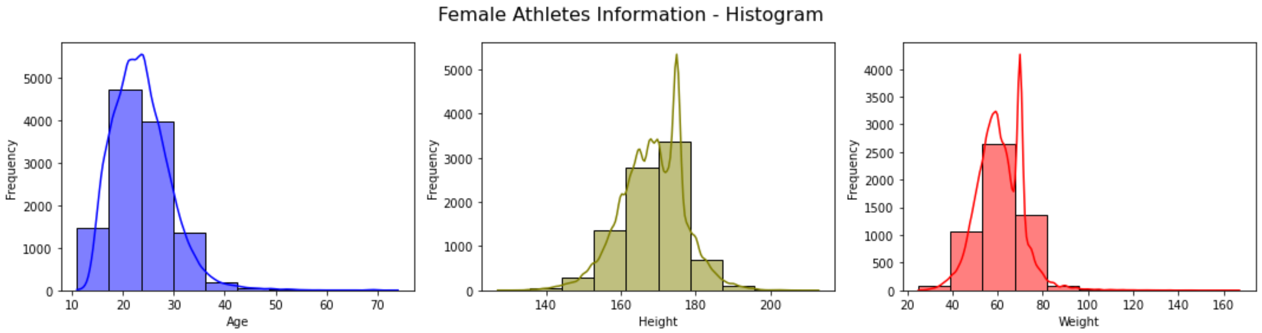
	ID	Age	Height	Weight	Medal
count	74522.0	74522.0	74522.0	74522.0	74522.0
mean	69956.7	23.7	168.5	61.1	0.2
std	38932.6	5.8	8.6	10.1	0.4
min	5.0	11.0	127.0	25.0	0.0
25%	36558.5	20.0	163.0	55.0	0.0
50%	70128.0	23.0	169.0	60.0	0.0
75%	103534.8	27.0	175.0	69.0	0.0
max	135568.0	74.0	213.0	167.0	1.0

In [ ]:

In [ ]:

In [15]:

```
# Histogram for Age , Height and Weight


fig, (ax1, ax2, ax3) = plt.subplots(figsize=(15, 4), ncols=3)


sns.histplot(data=games_women, x="Age", kde=True, stat="frequency", color='
sns.histplot(data=games_women, x="Height", kde=True, stat="frequency",colo
sns.histplot(data=games_women, x="Weight", kde=True, stat="frequency",colo

fig.suptitle('Female Athletes Information - Histogram', fontsize=16)

plt.tight_layout()

plt.show()
```



Next, it will be collected a simple random subset of women dataset of 300 observations.

In [16]:

```
#Random Sample of games_women

import random
random.seed(42)

k = 300
games_women_sample = games_women.sample(k).reset_index(drop=True)
games_women_sample.head()
```

Out[16]:

	ID	Sex	Age	Height	Weight	NOC	Season	Medal
0	116730	F	33.0	172.0	78.0	SUI	Winter	0
1	4809	F	17.0	163.0	59.0	QAT	Summer	0
2	43103	F	24.0	170.0	62.0	RUS	Summer	0
3	71236	F	49.0	164.0	48.0	FRA	Summer	0
4	122703	F	19.0	158.0	48.0	ROU	Summer	0

In [17]:

```
games_women_sample.shape
```

Out[17]:

```
(300, 8)
```

Weight attribute was selected

Women from olympic games(games_women dataset) weighted 61.1kg on average. I want to determine if the games_women_sample dataset provides strong evidence that women in olympic games weight more or less than the games_women dataset, versus the other possibility that there has been no change.

- **H0**:The average weight of women in the olympic games is 61.1 kg.
- **H1**:The average weight of women in the olympic games is more than 61.1 kg.

The test statistic is the sample mean because n = 300> 30

In [18]:

```
games_women_sample.describe().round(1)
```

Out[18]:

	ID	Age	Height	Weight	Medal
count	300.0	300.0	300.0	300.0	300.0
mean	71382.0	24.1	168.7	61.5	0.2
std	38757.0	6.0	8.4	10.5	0.4
min	2912.0	12.0	140.0	33.0	0.0
25%	35974.2	20.0	163.0	55.0	0.0
50%	71536.0	23.0	168.0	61.0	0.0
75%	108036.2	28.0	175.0	68.0	0.0
max	133592.0	49.0	202.0	136.0	1.0

- x = population mean
- mu = sample mean
- sigma = population standard deviation
- alpha = significance level
- n = sample size

The critical region could be obtained by selecting a k from the sample mean, so that CR = {mu <= k} where k is such that P (mu<=k | Ho: x = x0) = alpha = 0.05. That is under H0

Follow below the z_score table

z <= (k-x) = alpha

According to the z_table, for a alpha = 0.05, the z_table is 1.64

In [19]:

```
x = 61.1
alpha = 0.05
z_table = 1.64


k = x - z_table
k
```

Out[19]:

```
59.46
```

The sample mean is bigger than k (59.8 > 58.3), thre is no strong evidence to reject H0.

Altenative Method

In [20]:

```
# Function to find z-value

def z_value(x, mu, sigma, alpha,n):

    '''
    x = population mean
    mu = sample mean
    sigma = population standard deviation
    alpha = significance level
    n = sample size

    '''

    z_value = (mu - x)/(sigma/np.sqrt(n))


    return round(z_value,3)
```

In [21]:

```
10.1/(np.sqrt(300))
```

Out[21]:

```
0.583123771881522
```

In [22]:

```
x_z_score = z_value(61.1, 61.6, 10.1,0.05, 300)
x_z_score
```

Out[22]:

```
0.857
```

In [23]:

```
from scipy.integrate import quad

def normalProbabilityDensity(x):
    constant = 1.0 / np.sqrt(2*np.pi)
    return(constant * np.exp((-x**2) / 2.0) )


x_z_score_percentile, _ = quad(normalProbabilityDensity, np.NINF, x_z_score

print('Point Estimate Z-score Probability: ', round(x_z_score_percentile,
```

```
Point Estimate Z-score Probability:  0.804
```

In [24]:

```
p_value = (1-x_z_score_percentile)
print('p-value = ', round(p_value, 5))
```

```
p-value =  0.19572
```

Conclusion

In [25]:

```
alpha
print('p-value ', round(p_value, 4), '>', round(alpha, 4), 'alpha value')
```

```
p-value  0.1957 > 0.05 alpha value
```

CONCLUSIONS A large p-value indicates **weakly evidence against** the null hypothesis H0. We **cannot reject** the Null Hypothesis that the sample mean is equal to 61.1, at significance level equals to 0.05.

In [ ]:

Exercises 2

Continue with the sports theme dataset you like and select two attributes from the dataset. Calculate the p-value and say if you reject the null hypothesis by taking a 5% alpha.

Set up a hypothesis if there is a relationship between a weight female average and gain a medal

H0 : There is no difference if a woman gain a medal based on her weight

H1 : There is some difference if a woman gain a medal based on her weight

In [26]:

```
# Separate in group

women_medal = games_women_sample.groupby(['Medal'])
```

In [27]:

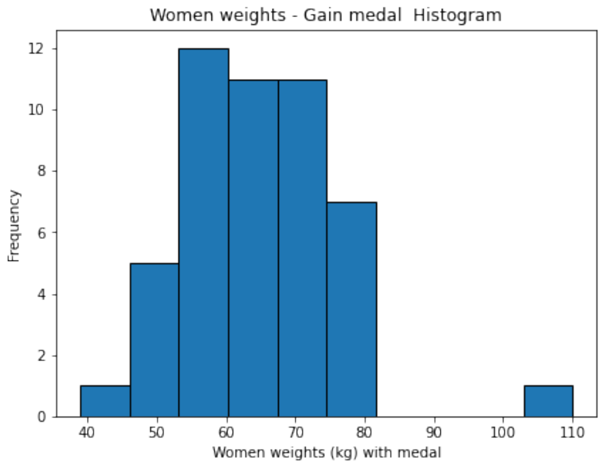
```
women_medal.Weight.count()
```

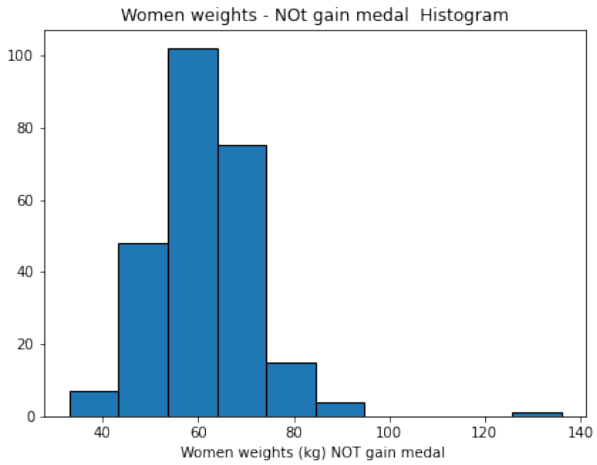
Out[27]:

```
Medal
0    252
1     48
Name: Weight, dtype: int64
```

In [28]:

```
fig = plt.figure(figsize=(15,5))

ax1 = fig.add_subplot(1, 2, 1)
s_medal = games_women_sample.loc[games_women_sample['Medal'] == 1]

ax1.hist(s_medal['Weight'], edgecolor='k')
plt.title("Women weights - Gain medal  Histogram",fontsize=12)
plt.xlabel("Women weights (kg) with medal")
plt.ylabel("Frequency")

ax2 = fig.add_subplot(1, 2, 2)
s_n_medal = games_women_sample.loc[games_women_sample['Medal'] == 0]

ax2.hist(s_n_medal['Weight'], edgecolor='k')
plt.title("Women weights - NOt gain medal  Histogram",fontsize=12)
plt.xlabel("Women weights (kg) NOT gain medal ")

plt.show()
```





In [29]:
```
women_medal.mean().round(2)
```

Out[29]:

	ID	Age	Height	Weight
Medal				
0	72243.97	24.01	168.23	60.97
1	66856.58	24.81	171.08	64.19

In [30]:
```
#group_smoke.loc(['nonsmoker','weight'])

x_no_medal = games_women_sample.loc[games_women_sample['Medal'] == 0].Weigh
x_medal = games_women_sample.loc[games_women_sample['Medal'] == 1].Weight.

x_point_estimate = (x_medal - x_no_medal )
round(x_point_estimate,3)
```

Out[30]:
```
3.217
```

In [31]:
```
#Compute the standard error of the point estimate of the population differe

women_medal.std().round(2)
```

Out[31]:

	ID	Age	Height	Weight
Medal				
0	38777.04	6.07	8.35	10.34
1	38741.01	5.30	8.36	11.21

In [32]:
```
se_medal = np.sqrt((10.68**2)/247 + (10.01**2)/53)
round(se_medal,2)
```

Out[32]:
```
1.53
```

In [33]:
```
z_score_medal = (x_point_estimate-0)/se_medal
z_score_medal
```

Out[33]:
```
2.097657669430991
```

In [34]:
```
from scipy.integrate import quad


def normalProbabilityDensity(x):
    constant = 1.0 / np.sqrt(2*np.pi)
    return(constant * np.exp((-x_point_estimate**2) / 2.0) )


x_z_score_percentile, _ = quad(normalProbabilityDensity, np.NINF, z_score_

print('Point Estimate Z-score Probability: ', round(x_z_score_percentile, 
```

```
Point Estimate Z-score Probability:  -0.0023
<ipython-input-34-c52ee754fa06>:9: IntegrationWarning: The integral is prob
ably divergent, or slowly convergent.
  x_z_score_percentile, _ = quad(normalProbabilityDensity, np.NINF, z_score
_medal)
```

In [35]:
```
p_value = (1-x_z_score_percentile)
print('p-value = ', round(p_value, 5))
```

```
p-value =  1.00226
```

CONCLUSIONS A large p-value indicates **weakly evidence against** the null hypothesis H0. We **cannot reject** the Null Hypothesis that there is no difference about Weight mean between who gains and who doesn't gain medal, at significance level equals to 0.05.

Exercises 3

Continue with the sports theme dataset you like and select three attributes from the dataset. Calculate the p-value and say if you reject the null hypothesis by taking a 5% alpha.

In [36]:
```
games_women_sample.head()
```

Out[36]:

	ID	Sex	Age	Height	Weight	NOC	Season	Medal
0	116730	F	33.0	172.0	78.0	SUI	Winter	0
1	4809	F	17.0	163.0	59.0	QAT	Summer	0
2	43103	F	24.0	170.0	62.0	RUS	Summer	0
3	71236	F	49.0	164.0	48.0	FRA	Summer	0
4	122703	F	19.0	158.0	48.0	ROU	Summer	0

In [37]:
```
print(round(games_women_sample[['Age', 'Height', 'Weight']].mean(),2))
```

```
Age         24.14
Height     168.68
Weight      61.48
dtype: float64
```

I would like to know if there is real difference between the age of the women according to their country

The three country I'm going to analyse are:

- France (FRA)
- Canada (CAN)
- United States (USA)

In [44]:
```
women_country = games_women_sample.loc[(games_women_sample['NOC']=='FRA')|

women_country.head()
```

Out[44]:

	ID	Sex	Age	Height	Weight	NOC	Season	Medal
3	71236	F	49.0	164.0	48.0	FRA	Summer	0
5	75872	F	29.0	158.0	48.0	FRA	Winter	1
8	69280	F	22.0	178.0	64.0	FRA	Summer	0
19	23739	F	28.0	165.0	63.0	CAN	Summer	0
21	46783	F	21.0	175.0	136.0	USA	Summer	0

In [45]:
```
women_country.NOC.value_counts()
```

Out[45]:
```
USA    28
CAN    14
FRA    11
Name: NOC, dtype: int64
```

In [47]:
```
women_country.groupby('NOC')[['Age']].mean().round(3)
```

Out[47]:

	Age
NOC	
CAN	24.429
FRA	25.364
USA	26.500

- H0 : the age average of the three countries are the same
- H1 : the age average of the three countries are not the same

In [48]:
```
women_country.groupby('NOC')[['Age']].std().transpose().round(3)
```

Out[48]:

NOC	CAN	FRA	USA
Age	4.767	8.88	7.671

In [49]:

```
import scipy.stats as stats
import researchpy as rp
import statsmodels.api as sm
from statsmodels.formula.api import ols
```

In [50]:

```
# isolate the variables of interest

rp.summary_cont(women_country['Age']).round(3)
```

Out[50]:

	Variable	N	Mean	SD	SE	95% Conf.	Interval
0	Age	53.0	25.717	7.225	0.992	23.725	27.709

In [51]:

```
rp.summary_cont(women_country['Age'].groupby(women_country['NOC'])).round(
```

Out[51]:

	N	Mean	SD	SE	95% Conf.	Interval
NOC						
CAN	14	24.429	4.767	1.274	21.676	27.181
FRA	11	25.364	8.880	2.677	19.398	31.329
USA	28	26.500	7.672	1.450	23.525	29.475

In [52]:

```
zstats, pvalue = stats.f_oneway(women_country['Age'][women_country['NOC'] =
                                women_country['Age'][women_country['NOC'] =
                                women_country['Age'][women_country['NOC'] =

print('z-statistics value = ', zstats.round(3), ' p-value = ', pvalue.round
```

```
z-statistics value =  0.391  p-value =  0.6786
```

CONCLUSIONS A large p-value indicates **weakly evidence against** the null hypothesis H0, i.e, the age average of the three (Canada, France and United States) countries are the same. We **cannot reject** the Null Hypothesis that there is no difference about Weight mean between who gains and who doesn't gain medal, at significance level equals to 0.05.

In [ ]: