Jesús Yair Ramírez Islas - A01275404

```
1 import numpy as np
2 import matplotlib.pyplot as plt
3 import pandas as pd
4 import math
5 import scipy.stats as stats
6 import scipy.stats as st
```

Si tienes problemas con Python, puedes hacer tu análisis en Excel, pero deberás escribir un reporte de tu análisis, resultados e interpretación y entregar el file excel más el reporte.

Si decides usar el Notebook Python, puedes describir tu procedimiento, resultados en interpretación como notas de texto y entregar el Notebook

Si usas RStudio, puedes describir tu procedimiento, resultados en interpretación como notas de texto y entregar el Markdown

-Los datos son reales, entonces hay que asegurarse que se puedan aplicar los métodos estadísticos estudiados, intervalos de confianza y pruebas de hipótesis.

-Las muestras contienen un número de datos que no sería lo ideal para hacer cálculos a mano (tipo promedio o varianza). Si por alguna razón quieres hacer los cálculos a mano, puedes decidir seleccionar sólo una parte de la muestra, pero esto podría implicar trabajar con muestras pequeñas y podría llevar a problemas para poblaciones sesgadas.

-Si quieres usar la tabla de la t-Student, puedes bajarla aquí:
https://cms.dm.uba.ar/academico/materias/1ercuat2015/probabilidades_y_estadistica_C/tabla_tstudent.pdf

-Puedes enriquecer tu análisis con gráficos, descripción e interpretación de los mismos

-Si haces una prueba de hipótesis, acuérdate de explicar cuáles son tus hipótesis, la significancia α, si es de dos colas o una cola y cuál método escogiste y por qué ('unequal' o 'pooled', t_student o normal etc..). También debes argumentar tus conclusiones y explicar por qué se rechaza o no la hipótesis nula.

-Si calculas intervalos de confianza debes interpretar el resultado.

-No es necesario usar todos los datos de la base de datos, puedes decidir enfocarte sólo en algunas variables, argumentando por qué las elegiste.

-Explicar si hay limitaciones o problemas que podrían estar relacionados con el análisis.

Aquí abajo se escriben los criterios de evaluación de las competencias a partir del examen argumentativo:

Ponderación	Criterio de evaluación
0.25	En la evidencia "examen argumentativo" se observa: * Identifica problemáticas a resolver a través de la aplicación de las metodologías estadísticas estudiadas.
0.25	En la evidencia "examen argumentativo" se observa: * Justifica y aplica conceptos de probabilidad y estadística para la propuesta de solución de un problema de aplicación real.
0.25	* Plantea a través de un pretotipo-diagrama, diagrama de Venn, diagrama de flujo, mapa, esquema, etc- la propuesta de solución al problema bajo estudio
0.25	En la evidencia "examen argumentativo" se observa: * Argumenta sobre las condiciones de validez estadística de su solución y las limitaciones o supuestos bajo los cuales puede ser aplic
0.33	En la evidencia "examen argumentativo" se observa: * Utiliza argumentos válidos en sus razonamientos.
0.33	En la evidencia "examen argumentativo" se observa: * Obtiene conclusiones estadísticamente correctas en sus análisis e identifica falacias en interpretaciones de tipo estadístico.
0.34	En la evidencia "examen argumentativo" se observa: * Realiza el análisis de una problemática de forma lógica y fundamentada en métodos estadísticos.
0.500	En la evidencia "examen argumentativo" se observa: * Fundamenta estadísticamente una propuesta de solución a una problemática específica.
0.5	En la evidencia "examen argumentativo" se observa: * Argumenta sobre la conveniencia e impacto, así como limitaciones, de las propuestas de solución con base en los análisis estadístic

El file contiene las cracterísticas físicas de diferentes especies (Seker, Barbunya, Bombay, Cali, Dermosan, Horoz and Sira) de frijoles, tomadas de la base de datos: https://archive.ics.uci.edu/ml/datasets/Dry+Bean+Dataset#

Se quiere establecer si el tamaño promedio de diferentes especies es diferente. En el file hay diferentes variables y puedes elegir, por ejemplo, de comparar el perímetro o el diámetro o el área. Deberás contestar a la pregunta:

¿Hay una diferencia significativa entre el tamaño promedio de frijoles BOMBAY y de frijoles CALI?

Puedes importar el csv file y trabajar con el dataframe o usar los arrays que vienen abajo, separados ya para las dos especies que debes analizar.

```
1 datos = pd.read_excel('/content/Dry_Bean_Dataset-1.xlsx')
2 datos.head()
3 #datos['Class'].astype('category').cat.categories
```

```
#datos['Class'].astype('category').cat.categories
```

	Area	Perimeter	MajorAxisLength	MinorAxisLength	AspectRation	Eccentricity	Conve
0	28395	610.291	208.178117	173.888747	1.197191	0.549812	
1	28734	638.018	200.524796	182.734419	1.097356	0.411785	
2	29380	624.110	212.826130	175.931143	1.209713	0.562727	
3	30008	645.884	210.557999	182.516516	1.153638	0.498616	
4	30140	620.134	201.847882	190.279279	1.060798	0.333680	

```
#dataframe para BOMBAY
datos_BOMBAY = datos[datos['Class']=='BOMBAY']
```

```
#dataframe para CALI
datos_CALI = datos[datos['Class']=='CALI']
```

```
#Número elementos de las muestras
N1 = len(datos_BOMBAY)
N2 = len(datos_CALI)
```

```
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```

```
print("El tamaño de la muestra del area de frijoles BOMBAY es:",len(muestra_BOMBAY_area))
```

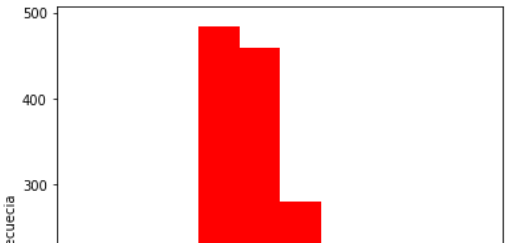
```
El tamaño de la muestra del area de frijoles BOMBAY es: 522
```

```
print("El tamaño de la muestra del area de frijoles CALI es:",len(muestra_CALI_area))
```

```
El tamaño de la muestra del area de frijoles CALI es: 1630
```

```
#Apesar de tener una muestra de datos grande, vamos a ver como es la distribucion de los datos
#para frijoles CALI:
fig = plt.figure(figsize=(6, 6))
ax = fig.add_subplot(111)
ax.set_ylabel('Frecuecia')
ax.set_xlabel('Area')
ax.text(0.1, 175, 'Normal population',fontsize='large',color='Green')
plt.hist(muestra_CALI_area,color="RED")
```

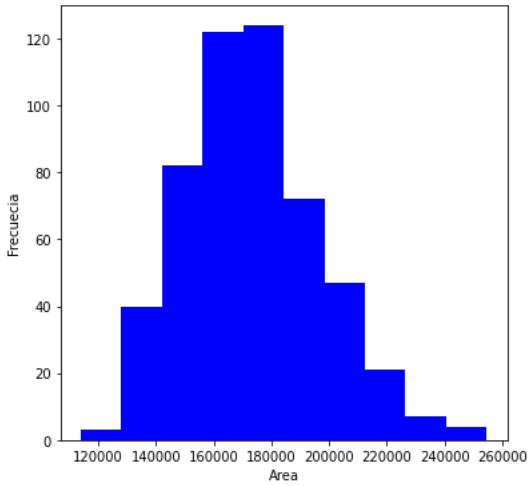
```
(array([  8.,  49., 196., 484., 459., 280., 108.,  33.,  10.,   3.]),
 array([ 45504. ,  52580.8,  59657.6,  66734.4,  73811.2,  80888. ,
         87964.8,  95041.6, 102118.4, 109195.2, 116272. ]),
 <a list of 10 Patch objects>)
```



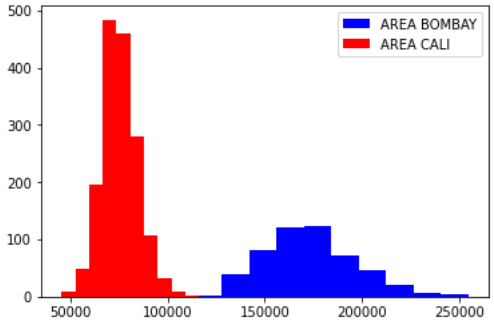

```
1 #para frijoles BOMBAY:
2 fig = plt.figure(figsize=(6, 6))
3 ax = fig.add_subplot(111)
4 ax.set_ylabel('Frecuecia')
5 ax.set_xlabel('Area')
6 ax.text(0.1, 175, 'Normal population',fontsize='large',color='Green')
7 plt.hist(muestra_BOMBAY_area,color="BLUE")
```

```
(array([  3.,  40.,  82., 122., 124.,  72.,  47.,  21.,   7.,   4.]),
 array([114004. , 128065.2, 142126.4, 156187.6, 170248.8, 184310. ,
        198371.2, 212432.4, 226493.6, 240554.8, 254616. ]),
 <a list of 10 Patch objects>)
```

Normal population




```
1 plt.hist(muestra_BOMBAY_area,color="BLUE", label='AREA BOMBAY')
2 plt.hist(muestra_CALI_area,color="RED", label='AREA CALI')
3 plt.legend(loc='upper right')
4 plt.show()
```



Dado que lo que desamos responder es: ¿Hay una diferencia significativa entre el tamaño promedio de frijoles BOMBAY y de frijoles CALI?

Plantemos la hipotesis nula: H_0:No es signifiactiva la diferencia entre los tamaños de ambos frijoles

Plantemos la hipotesis alternativa: H_1:Es signifiactiva la diferencia entre los tamaños de ambos frijoles

```
#agregamos una funcion que calcualar t star
def calcula_t(confidence, dof,opcion='dos colas'):
  import scipy.stats as st
  grados_libertad = dof
  alfa = 1-confidence
  alfa_medios = alfa/2.
  if(opcion=='dos_colas'):
    return -st.t(grados_libertad).ppf(alfa_medios)
  else:
    return  -st.t(grados_libertad).ppf(alfa)
```

```
#otra funcion para calcular pvalue
def calcula_pvalue(dof,t_score):
  import scipy.stats as st
  return 1-st.t(dof).cdf(t_score)
```

Dado que no conocemos la desviacion poblacional usaremos t-student, podemos usar por que nuestra muestra es grande y se observo un comportamiento normal

```
media1 = muestra_BOMBAY_area.mean()
muestra1 = muestra_BOMBAY_area
media2 = muestra_CALI_area.mean()
muestra2 = muestra_CALI_area
var1 = muestra1.var(ddof=1)
var2 = muestra2.var(ddof=1)
N1=len(muestra_BOMBAY_area)
N2=len(muestra_CALI_area)
print('diferencia=',media1-media2)
stderror=math.sqrt(var1/N1+var2/N2)
dof = (var1/N1+var2/N2)**2/(((var1/N1)**2/(N1-1))+((var2/N2)**2/(N2-1)))
print('dof=',dof)
print('standard error',stderror)
t_star=calcula_t(0.95,dof) #el 0.95 representa un nivel de confianza de 95% lo elegi por que el problema no indica un nivel ideal y los co
print('tstar=',t_star)
```

```
diferencia= 97946.8483440284
dof= 575.8542710829356
standard error 1047.124250315325
tstar= 1.6475040168938215
```

```
#Calculamos el intervalo de confianza
confint = [(media1-media2)-t_star*stderror,(media1-media2)+t_star*stderror]
print(confint)
```

```
[96221.70693544697, 99671.98975260984]
```

Dado que este intervalo de confianza NO contiene 0, se rechaza la hipotesis nula y podemos decir que la diferencia es significativa.

```
t_score = (media1-media2)/math.sqrt(var1/N1+var2/N2)
pvalue= calcula_pvalue(dof,t_score)
print("El t_score = ",t_score)
print("El p-value = ",pvalue)
```

```
El t_score =  93.53889790493653
El p-value =  0.0
```

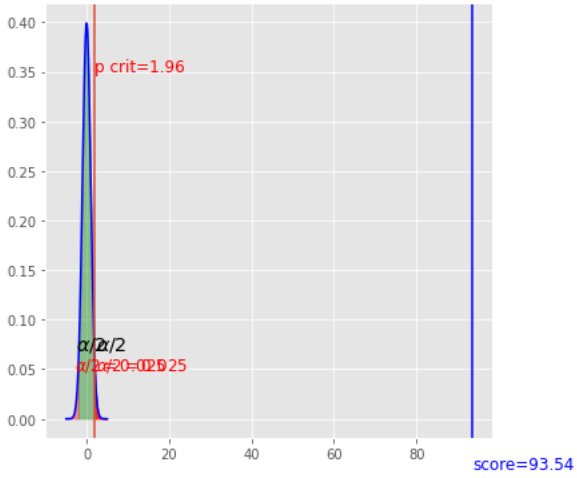
```
## FUNCIÓN PARA VISUALIZAR EL RESULTADO DE LA PRUEBA DE HIPÓTESIS
plt.style.use('ggplot')

def plot_PH(score,dof,test='ztest',alfa=0.05,option='dos colas'):
  mu = 0
  sigma = 1
  if(option=='dos colas'):
    alfa_medios = alfa/2.
    if(test=='ztest'):
      if(score > 0):
        z_c=-st.norm.ppf(alfa_medios)
      else:
        z_c=st.norm.ppf(alfa_medios)
```

```
  else:
    if(score > 0):
      z_c = -st.t(dof).ppf(alfa/2)
    else:
      z_c = st.t(dof).ppf(alfa/2)
  x=np.linspace(mu-5*sigma, mu+5*sigma,1000)
  iq=stats.norm(mu,sigma)

  fig = plt.figure(figsize=(6, 6))
  plt.plot(x,iq.pdf(x),'b')
  if(score > 0):
    px=np.arange(z_c,5,0.01)
    px1=np.arange(-5,-z_c,0.01)
    px2=np.arange(-z_c,z_c,0.01)
    px3=np.arange(score,5,0.01)
  else:
    px=np.arange(-5,z_c,0.01)
    px1=np.arange(-z_c,5,0.01)
    px2=np.arange(z_c,-z_c,0.01)
    px3=np.arange(-5,score,0.01)

  plt.fill_between(px, iq.pdf(px),alpha=0.8,color='red',interpolate=True )
  plt.fill_between(px1, iq.pdf(px1),alpha=0.4,color='red',interpolate=True )
  plt.fill_between(px2, iq.pdf(px2),alpha=0.4,color='green',interpolate=True)
  plt.fill_between(px3, iq.pdf(px3),alpha=0.4,color='blue',interpolate=True)
  plt.axvline(x=z_c)
  plt.axvline(x=score,color='blue')

  plt.text(z_c,0.35,'p crit=%s'%(round(z_c,2)),fontsize='large',color='red')
  plt.text(score,-0.05,'score=%s'%(round(score,2)),fontsize='large',color='blue')
  plt.text(-2.5,0.07,r'$\alpha/2$',fontsize='x-large')
  plt.text(2.1,0.07,r'$\alpha/2$',fontsize='x-large')
  #plt.text(-2.9,0.38,'significancia',fontsize='x-large')
  #plt.text(-2.4,0.35,r'$\alpha=%s$'%(alfa),fontsize='x-large')
  plt.text(-3,0.05,r'$\alpha/2=%s$'%(alfa_medios),fontsize='large',color='red')
  plt.text(2.1,0.05,r'$\alpha/2=%s$'%(alfa_medios),fontsize='large',color='red')
  plt.show()

if(option=='una cola'):
  alfa_medios = alfa/2.
  if(test=='ztest'):
    if(score > 0):
      z_c=-st.norm.ppf(alfa)
    else:
      z_c=st.norm.ppf(alfa)
  else:
    if(score > 0):
      z_c =-st.t(dof).ppf(alfa)
    else:
      z_c =st.t(dof).ppf(alfa)
  x=np.linspace(mu-3*sigma, mu+3*sigma,1000)
  iq=stats.norm(mu,sigma)

  fig = plt.figure(figsize=(6, 6))
  plt.plot(x,iq.pdf(x),'b')
  if(score > 0):
    px=np.arange(z_c,3,0.01)
    px2=np.arange(-3,score,0.01)
    px3=np.arange(score,3,0.01)

  else:
    px=np.arange(-3,z_c,0.01)
    px2=np.arange(z_c,3,0.01)
    px3=np.arange(-3,score,0.01)

  plt.fill_between(px, iq.pdf(px),alpha=0.8,color='red',interpolate=True )
  #plt.fill_between(px1, iq.pdf(px1),alpha=0.4,color='green',interpolate=True )
  plt.fill_between(px2, iq.pdf(px2),alpha=0.4,color='green',interpolate=True)
  plt.fill_between(px3, iq.pdf(px3),alpha=0.4,color='blue',interpolate=True)
  plt.axvline(x=z_c)
  plt.axvline(x=score,color='blue')
  plt.text(z_c,0.35,'p crit=%s'%(round(z_c,2)),fontsize='large',color='red')
  plt.text(score,-0.05,'score=%s'%(round(score,2)),fontsize='large',color='blue')
  #plt.text(-2.5,0.07,r'$\alpha/2$',fontsize='x-large')
  plt.text(2.1,0.07,r'$\alpha$',fontsize='x-large')
  #plt.text(-2.9,0.38,'significancia',fontsize='x-large')
  #plt.text(-2.4,0.35,r'$\alpha=%s$'%(alfa),fontsize='x-large')
```

```
    #plt.text(-3,0.05,r'$\alpha/2=%s$'%(alfa_medios),fontsize='large',color='red')
    plt.text(2.1,0.05,r'$\alpha=%s$'%(alfa),fontsize='large',color='red')
    plt.show()

```

Añadimos una prueba de dos colas para observar el comportamiento de del score

```
plot_PH(t_score,dof,'ttest',alfa=0.05,option='dos colas')
```



Al observar que el score es mayor que el valor de alfa/2, podemos afirmar que la hipostesis nula se rechaza, por lo que nuestra hipotesis alternativa es verdadera diciendonos que la direfencia del area entre ambos frijoles si es significativa

```
#incluimos esto solo para verificar el pvalue con un metodo distinto
from scipy import stats as st
import statsmodels.stats.api as sms
```

```
muestraA = muestra_BOMBAY_area
muestraB = muestra_CALI_area
st.ttest_ind(muestraA,muestraB,equal_var='False')
```

```
Ttest_indResult(statistic=138.22430263277695, pvalue=0.0)
```

Al observar que ambos son iguales podemos estar seguros del resultado de nuestro pvalue

Finalmente, al observar los resultados de las pruebas conlcluimos que los hay una diferencia significativa entre el tamaño promedio de frijoles BOMBAY y de frijoles CALI