ECE 341 - Homework #13

t-Tests with Two Populations. Summer 2024

Let

- X = 4d10 (the sum of four 10-sided dice) plus 0.5 (X wins on ties)
- Y = 5d10 (the sum of five 10-sided dice)

Monte-Carlo Simulation

1) Run a Monte-Carlo simulation with 100,000 rolls for X and Y. From this, determine the probability that X will win any given game.

Code:

```
WIN = 0;

for i=1:1e5
   dx = ceil(10*rand(1,4));
   dy = ceil(10*rand(1,5));

   X = sum(dx) + 0.5;
   Y = sum(dy);
   if(X > Y) WIN = WIN + 1; end
end

disp(WIN)
```

Results (10 trials, 100,000 games per trial):

```
28381, 28485, 28281, 28399, 28269, 28420, 28208, 28271, 28335, 28639
```

90% confidence interval: The odds of X winning any given game in is the range of (28.295% ... 28.422%)

```
>> DATA =[28381, 28485, 28281, 28399, 28269, 28420, 28208, 28271, 28335, 28639];
>> n = length(DATA)

n =    10

>> x = mean(DATA)

x =  2.8369e+004

>> s = std(DATA) / sqrt(n)

s =   40.0591

>> x + 1.833*s

ans =  2.8442e+004

>> x - 1.833*s

ans =  2.8295e+004
```

t-Test: Sample Size = 4

2) Take four measurements of X and Y. From this data, determine

- The mean and standard devation of X
- The mean and standard devation of Y
- The probability that X will win any given game using a student-t test.

```
x:    25    16    23    29

y:    39    35    23    35
```

Mean and standard deviation of x:

```
Xx =   23.2500
Sx =    5.4391
```

Mean and standard deviation of y

```
Xy =    33
Sy =    6.9282
```

Mean and standard deviation of w = x - y

```
>> Xw = mean(x) - mean(y)
    Xw =   -9.7500
>> Sw = sqrt( var(x) + var(y))
    Sw =    8.8081
```

t-score:

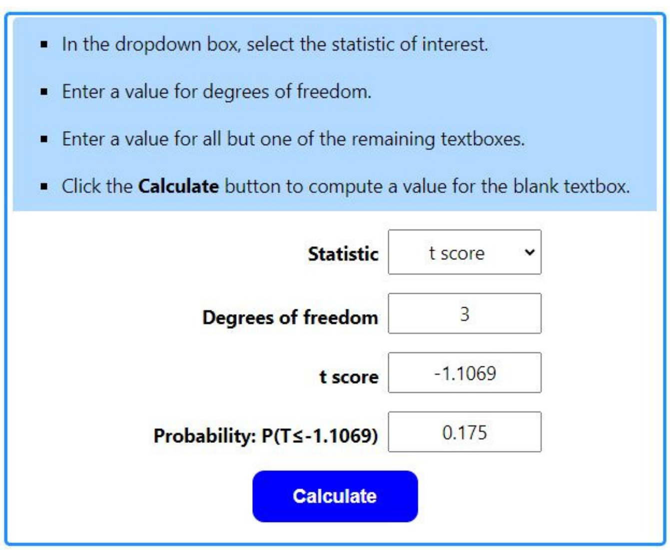
```
>> t = Xw / Sw
    t =   -1.1069
```

>>

From StatTrek, p = 0.175

From the data, X has a 17.5% chance of winning any given game

vs. 28.29% chance using 100,000 rolls with a Monte-Carlo simulation



t-Test: Sample Size = 20

3) Take twenty measurements of X and Y. From this data, determine

- The mean and standard devation of X
- The mean and standard devation of Y
- The probability that X will win any given game using a student-t test

Mean and standard deviation of x:

```
Xx =     24
Sx =     6.6807
```

Mean and standard deviation of y:

```
Xy =   28.4000
Sy =    6.6285
```

Mean and standard deviation of w = x - y:

```
>> Xw = mean(x) - mean(y)
Xw =   -4.4000

>> Sw = sqrt( var(x) + var(y) )
Sw =    9.4111
```

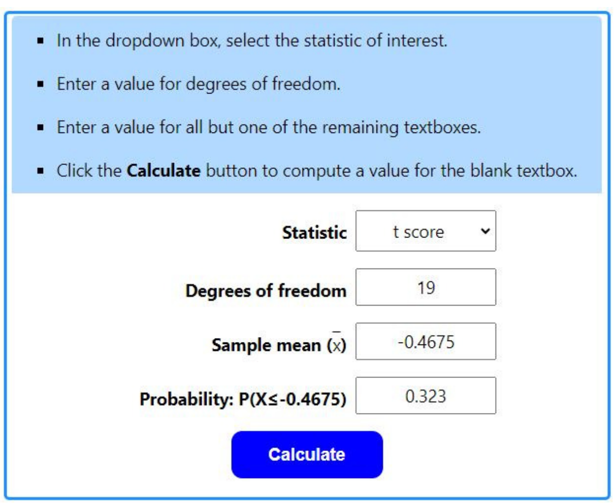
t-score

```
>> t = Xw / Sw
t =   -0.4675
```

>>

From StatTrek, this t-score corresponds to a probabilit of 32.3%

vs. 28.29% chance using 100,000 rolls with a Monte-Carlo simulation



t-Test: Sample Size = 100

4) Take 100 measurements of X and Y. From this data, determine

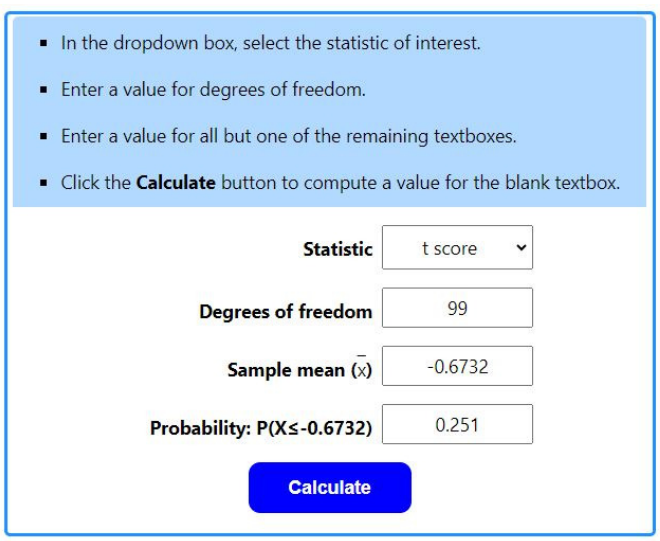
- The mean and standard devation of X
- The mean and standard devation of Y
- The probability that X will win any given game using a student-t test

```
Xx =   22.6700

Sx =    5.1523

Xy =   28.0900

Sy =    6.1858

Xw =   -5.4200

Sw =    8.0505

t =   -0.6732
```

From StatTrek, this corresponds to a probability of 25.1%

vs. 28.29% chance using 100,000 rolls with a Monte-Carlo simulation

Method	Sample Size	probability
Monte-Carlo	100,000	28.29%
t-Test	4	17.5%
t-Test	20	32.3%
t-Test	100	25.1%



Reaction Time

5) Go to the Human Benchmark Dashboard

```
https://humanbenchmark.com/tests/reactiontime
```

(population A): April 30, 3pm

{248, 230, 233, 241, 235} ms

(population B): May 1, 8am

{214, 217, 231, 224, 216} ms

6) From your results, determine the probability that

Individual: A's time will be less than B's time next time you run the experiment

```
>> A = [248, 230, 233, 241, 235];
>> B = [214, 217, 231, 224, 216];
>> Xw = mean(A) - mean(B)

Xw =    17

>> Sw = sqrt(var(A) + var(B))

Sw =   10.0300

>> t = Xw / Sw

t =    1.6949
```

From StatTrek, this corresponds to a probability of 0.083

There is an 8.3% chance that A will be faster than B next experiment

Population:

```
>> Sw = sqrt(var(A)/5 + var(B)/5)

Sw =    4.4855

>> t = Xw / Sw

t =    3.7900
```

From StatTrek, this corresponds to a tail with an area of 0.01

There is a 1% chance that A was overall faster than B

You know more about populations than inividuals.

Aim Trainer

7) Go to the Human Benchmark Dashboard

`https://humanbenchmark.com/tests/aim`

(population A): Record your time to hit 30 targets with both eyes open

Time = {992ms, 851ms}

(population B): Record your time to hit 30 targets with a different condition (opposite hand,)

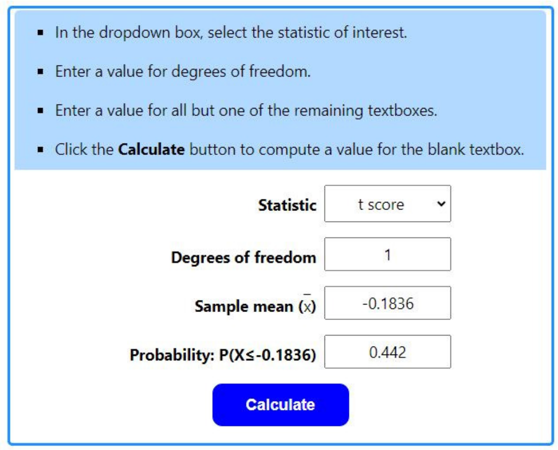
Time = {973ms, 815ms}

8) From your results, determine the probability that

Individual: A's time will be less than B's time next time you run the experiment

```
>> A = [992, 851];
>> B = [973,815];
>> Xw = mean(A) - mean(B)

Xw =   27.5000

>> Sw = sqrt(var(A) + var(B))

Sw =  149.7414

>> t = Xw / Sw

t =    0.1836
```

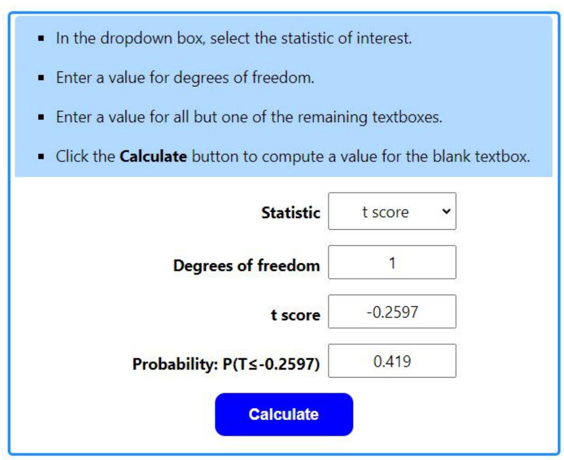
From StatTrek, this corresponds to a probability of 0.442%



A's reaction time will be less than B's with a probability of 44.2%

Population:

```
>> Xw = mean(A) - mean(B)

Xw =   27.5000

>> Sw = sqrt(var(A)/2 + var(B)/2)

Sw =  105.8832

>> t = Xw / Sw

t =    0.2597
```



From StatTrek, this corresponds to a tail with a probability of 41.9%

A's average reaction time is less than B's with a probability of 41.9%