In [1]:
```
from IPython.display import Image
```

1.Summary

Thank you for taking the time to complete Quora Data Challenge! We're excited about you continuing the interview process with us.

The data challenge simulates a typical experiment analysis you would be expected to work on at Quora. In this challenge, we will provide several datasets and ask you to analyze the results and provide product recommendations for a particular experiment.

The Google form is not timed but we expect you to spend around 1-2 hours answering the questions. While working on these problems, please document your process and code in any tools you are comfortable with. They don't have to be very organized but should demonstrate your thinking. We will ask you to submit that at the end. Feel free to refer to any online resources if necessary.

Suppose you are a Data Scientist on the Mobile team at Quora. The team has just introduced a new UI design to the Quora app. The goal of the new design is to increase user engagement (measured by minutes spent on site). The team ran an A/B test to evaluate the change. Using the data, help the team understand the impact of the UI change better.

In [ ]:
```

```

https://www.zhihu.com/question/20458233/answer/1724891055

A/B Testing isn't an useful testing as new experiences. There will be two trends, first is that people like old way and old experience, thats called change aversion. Second is thay they like new staff, so they don't attract by the change due to its convienent, instead they just explore the new feature when they first met new things and next time they will back to normal when they have explored everything. Thats called novelty effect.

what is going to be the plateaued experience so that i can actually make a robust decision.

Table Schema

t1_user_active_min.csv This table contains active minutes data logged after experiment started(2019-02-06 to 2019-07-05). Each row represents the total number of minutes spent on site for each user on a date. If a user never visited the site for a given date, there wouldn't be data for that uid on that date. (for 50000 user, there are 3376 users never logged in Feb to May time period)

- uid: user ID
- dt: date when corresponding active minutes are registered
- active_mins: number of minutes spent on site for the date

t2_user_variant.csv This table contains users’ treatment assignment. Each row represents the assignment information for a unique user.

- uid: user ID
- variant_number: the experiment variant user is in. 0 for control, 1 for treatment
- dt: date when user entered the experiment, should be ‘2019-02-06’ for all users
- signup_date: the date string that user signed up on

t3_user_active_min_pre.csv This table contains active minutes data before the experiment started. It has a similar format as t1, except the dt range can extend before the experiment start date. ('2018-08-10' to '2019-02-05')

- uid: user ID
- dt: date when corresponding active minutes are registered
- active_mins: number of minutes spent on site for the date

t4_user_attributes.csv This table contains data about some user attributes. Each row represents attributes of a unique user.

- uid: user ID
- user_type: segment that a user belongs to, measured by activity level of the user. Can be ‘new_user’, ‘non_reader’, ‘reader’ or ‘contributor’
- gender: user gender. Can be ‘male’, ‘female’ or ‘unknown’

In [ ]:

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```

In [ ]:

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```

In order to measure the experiment effect on user engagement, let's say you want to perform a t-test of the difference in minutes spent on site, what would be your unit of analysis (i.e. when conducting a t-test, we calculate means and variances of two samples. What does each data point represent in the samples?)? *

- Total minutes per user in each group (number of data points in each group = number of users in that group)
- Total minutes per user per day in each group (number of data points in each group = number of users in that group x number of days of the experiment)
- Total minutes per group per day (number of data points in each group = number of days of the experiment)

Why do you think the other choices are not correct? Hint: think of the key assumptions of running a t-test.

Total minutes per user per day in each group regard each datapoint as in individual independent happening

we want to increase 'user' spend time increase or not.

Why do you think the other choices are not correct? Hint: think of the key assumptions of running a t-test. *

For the t-test assumption, if the distribution are not normal distribution, we need to follow the assumption: the population variance are equal. For second part, the variance are differnet becuase each user login days are not equal. For thrid option, the two part have differnet users login per day. So their population variance won't be equal.

Please enter the lower bound of your confidence interval (e.g. if the confidence Interval is [-1.00, 2.00], enter -1.00) = -38.591763263087756

Please enter the upper bound of your confidence interval (e.g. if the confidence Interval is [-1.00, 2.00], enter 2.00) = 38.22913569692153

In [ ]:

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T-Test Assumptions

1. The first assumption made regarding t-tests concerns the scale of measurement. The assumption for a t-test is that the scale of measurement applied to the data collected follows a continuous or ordinal scale, such as the scores for an IQ test.
2. The second assumption made is that of a simple random sample, that the data is collected from a representative, randomly selected portion of the total population.
3. The third assumption is the data, when plotted, results in a normal distribution, bell-shaped distribution curve. When a normal distribution is assumed, one can specify a level of probability (alpha level, level of significance, p) as a criterion for acceptance. In most cases, a 5% value can be assumed.
4. The fourth assumption is a reasonably large sample size is used. A larger sample size means the distribution of results should approach a normal bell-shaped curve.
5. The final assumption is homogeneity of variance. Homogeneous, or equal, variance exists when the standard deviations of samples are approximately equal.

In [ ]:

N > 100 T-distribution equal to normal distribution

Initial hypothesis: change the UI from A to B will increase customer active minutes on this page

Which metric to use?

- Total minutes per group? No, Total minues from Group A or Group B can not real reflct in impact
- Total minutes per user? No, We have two group, we need caculate active minutes by group classification
- Total minutes per user in each group? We split group into control group and experinment group. If we groupby 'uid', we got 40000 control group and 10000 experinment. The data points will be 40000: 10000
- Total minutes per user per day in each group? Further more, the data point will be each raw data point without any preprocess

If we envolve all user pre-experiment data, we might need to caculate the difference between different time and ratio of increase/all data point.

(unique user who increase time spend) / (unique users who accessd in this group)

In [ ]:

```

```

In [ ]:

```

```

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3.Preprocess

Click this Link back to Top

3.1 Hyperparameters

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In [1]:

```
class HyperParameters(object):
    """:arg
    This class will be used to transmit hyperparameters between class.parameters
    Most of class can inherit this class and its hyperparameters




    """
    def __init__(self):
        """:arg



        """
        # we use this to test whether other class read HyperParameters() successfully
        self.TEST = 1

        # you can change this root path in this class and import_data() function will s
        self.ROOTPATH = 'D:\\OneDrive\\03_Academic\\23_Github\\44_Quora_Data_Challenge\

        # confidence inveral value
        self.ALPHA = 0.95
```

3.2 Import Data

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In [2]:

```
from class_31_hyperparameters import HyperParameters

import pandas as pd
# measure running time
from time import time

import os


class ImportData(HyperParameters):
    """:arg


    """
    def __init__(self):
        """:arg
        """
        HyperParameters.__init__(self)

    def import_data(self):
        """:arg
        Use this function to complete import data process
        """
        print("*" * 50, "Start import data", "*" * 50)
        start_time = time()

        path_t1 = os.path.join(self.ROOTPATH, 't1_user_active_min.csv')
        path_t2 = os.path.join(self.ROOTPATH, 't2_user_variant.csv')
        path_t3 = os.path.join(self.ROOTPATH, 't3_user_active_min_pre.csv')
        path_t4 = os.path.join(self.ROOTPATH, '9999')

        df_t1 = pd.read_csv(path_t1)
        df_t2 = pd.read_csv(path_t2)
        df_t3 = pd.read_csv(path_t3)
        df_t4 = pd.read_csv(path_t4)

        return (df_t1, df_t2, df_t3, df_t4)
```

3.3.EDA

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In [3]:

```
from class_31_hyperparameters import HyperParameters

# use sns for visulization
import seaborn as sns
# numpy
import numpy as np
# solve statistical problem
from scipy import stats
```

```
class EDA(HyperParameters):
    """:arg
    Preproceess EDA



    """
    def __init__(self):
        """:arg
        """
        HyperParameters.__init__(self)

    def outlier_eda(self, df):
        """:arg
        We use several way to detect and remove outliers

        Args:
        -------
        df:DataFrame
            This can be data_t1 or data_t3. These two dataframe need ourlier detect and

        """
        # first we need to make sure this is outlier or error exist
        # we use boxplot() to demenstrate outliers
        sns.boxplot(x=df['active_mins'])
        # use z-score to eliminate outliers, the output is for indivudal data point
        z_score = np.abs(stats.zscore(df['active_mins']))
        # set a z-score threshold, any greater than this value will be eliminate
        z_threshold = 3
        print(z_threshold)
        # filter that ooutlier rows in dataframe
        index_outlier = np.where(z_score > z_threshold)
        # print out result
        print('We have {} data points are outliers'.format(len(index_outlier[0])))
        # drop these rows by index
        df = df.drop(index_outlier[0])

        return df
```

3.4 Join Data

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In [4]:

```
from class_31_hyperparameters import HyperParameters

import pandas as pd
# test normal distribution
from scipy import stats

class JoinData(HyperParameters):
    """:arg
    """
```

```
    def __init__(self):
        """:arg
        """
        HyperParameters.__init__(self)

    def join_data_uid(self, df_t1, df_t2, df_t3, df_t4):
        """:arg
        We use function join to dataframe


        """
        # outer join df_t1 and df_t2 by uid
        df_t1t2 = pd.merge(df_t1, df_t2, on=['uid'], how='outer')
        # clean data drop NaN by row
        df_clean = df_t1t2.dropna(axis=0)
        # print clearn process
        print("Before {}, After {}".format(df_t1t2.shape[0], df_clean.shape[0]))
        # split into control group and treatment group and aggregate by user
        df_control = df_clean[df_clean['variant_number'] == 0].groupby(['uid'], as_inde
        # unit is total time spend per user per group, sometimes average or middle migh
        df_treat = df_clean[df_clean['variant_number'] == 1].groupby(['uid'], as_index=

        return df_clean, df_control, df_treat

    def join_data_group(self, df_t1, df_t2, df_t3, df_t4):
        """:arg
        We use function join to dataframe


        """
        # outer join df_t1 and df_t2 by uid
        df_t1t2 = pd.merge(df_t1, df_t2, on=['uid'], how='outer')
        # clean data drop NaN by row
        df_clean = df_t1t2.dropna(axis=0)
        # print clearn process
        print("Before {}, After {}".format(df_t1t2.shape[0], df_clean.shape[0]))
        # split into control group and treatment group and aggregate by user
        df_control = df_clean[df_clean['variant_number'] == 0].groupby(['dt_x'], as_ind
        # unit is total time spend per user per group, sometimes average or middle migh
        df_treat = df_clean[df_clean['variant_number'] == 1].groupby(['dt_x'], as_index

        return df_clean, df_control, df_treat

    def join_data_dt(self, df_t1, df_t2, df_t3, df_t4):
        """:arg
        I choose the unit is 'Total minutes per user per day in each group.
        First, we split data into control (not chagne)  and treatment (changed) group
        Second, we aggregate data records (88197 / 34175) in each group by date(['dt_x'
        This meaning is, in this group, everyday the total minutes from user log in act
        Typically, we have different log in user number in this whole 150 experiment da
        Third, we divide everyday total mintues by the number of user who log in this d

        They we can test them with normal distribution. If you want to calculate t-test
        be normal distribution (stats.shapiro(df))


        """
        # outer join df_t1 and df_t2 by uid
        df_t1t2 = pd.merge(df_t1, df_t2, on=['uid'], how='outer')
        # clean data drop NaN by row
```

```
        df_clean = df_t1t2.dropna(axis=0)
        # print clearn process
        print("Before {}, After {}".format(df_t1t2.shape[0], df_clean.shape[0]))
        # split into control group and treatment group and aggregate by user
        df_dt_control = df_clean[df_clean['variant_number'] == 0].groupby(['dt_x'], as_
        # unit is total time spend per user per group, sometimes average or middle migh
        df_dt_treat = df_clean[df_clean['variant_number'] == 1].groupby(['dt_x'], as_in
        # we caculate how many user log in each day
        df_usr_control = df_clean[df_clean['variant_number']==0].groupby(['dt_x'], as_i
        # caculate how many user login each day in treatment group
        df_usr_treat = df_clean[df_clean['variant_number']==1].groupby(['dt_x'], as_ind

        # (total minutes per day) / (number of users who login in each day)
        df_control = df_dt_control['active_mins'].divide(df_usr_control['uid'])
        df_treat = df_dt_treat['active_mins'].divide(df_usr_treat['uid'])

        print('For df_control, its normal distribution test is {}'.format(stats.shapiro
        print('For df_treat, its normal distribution test is {}'.format(stats.shapiro(d

        return df_clean, df_control, df_treat
```

3.5 Hypothesis

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In [21]:

```
from class_31_hyperparameters import HyperParameters

import numpy as np
import seaborn as sns
# this model will output degree of freedom
import statsmodels.stats.weightstats as st
from scipy import stats


class Hypothesis(HyperParameters):
    """:arg
    We use this class to calculate statical data and judge reject or accept hypothesis

    """
    def __init__(self):
        """:arg
        """
        HyperParameters.__init__(self)


    def ttest_ind(self, df_control, df_treat):
        """:arg


        Args:
        ------
        df_control:Series
```

```
        """
        print('Distribution of control group')
        sns.boxplot(x = df_control)
        sns.distplot(df_control)

        # caculate t-test for tow independtant dataset
        # because we caculate with total minutes, so the user rate 40000:10000 is imbal
        # we need divide df_control with 4 to achieve same total minutes for 10000 user
        # t_value is t statical
        t_value, p_two, degree_free = st.ttest_ind(x1 = df_control
                                                   , x2 = df_treat
                                                   , usevar='unequal')
        # use a diiffernt function for t-test
        t_stat, p_value = stats.ttest_ind(df_control, df_treat, equal_var=False)
        # default confidence interval is 95%, so one side alpha = (1-95%)/2 = 0.025
        if (p_two < 1-self.ALPHA):
            print('P-value {} < {}'.format(p_two, 1-self.ALPHA))
            print('Reject H0 (control and treatment dont have siginificent differnet) h
            print('Accept H1 (control and treatment have siginificent different) hypoth
        else:
            print('P-value {} > {}'.format(p_two, 1 - self.ALPHA))
            print('Accept H0 (control and treatment dont have siginificent differnet) h
            print('Reject H1 (control and treatment have siginificent different) hypoth

        # start cacualte confidence interval (right tail=0.025) (two tail=0.05)
        # we have 150-200 data point, so when check t-distribution table,
        t_ci = stats.t.ppf(q = self.ALPHA, df=150)
        # sample number
        control_num = df_control.shape[0]
        treat_num = df_treat.shape[0]
        # cacualte stand diviation
        control_std = df_control.std()
        treat_std = df_treat.std()
        # cacualte se
        se = np.sqrt( np.square(control_std)/control_num + np.square(treat_std)/treat_n
        #
        sample_mean = df_control.mean() - df_treat.mean()
        # calcuate confidenal interval
        upper_bound = sample_mean - t_ci * se
        lower_bound = sample_mean + t_ci * se

        return (t_value, p_two, degree_free, t_stat, p_value, upper_bound, lower_bound)
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

7 Main Function

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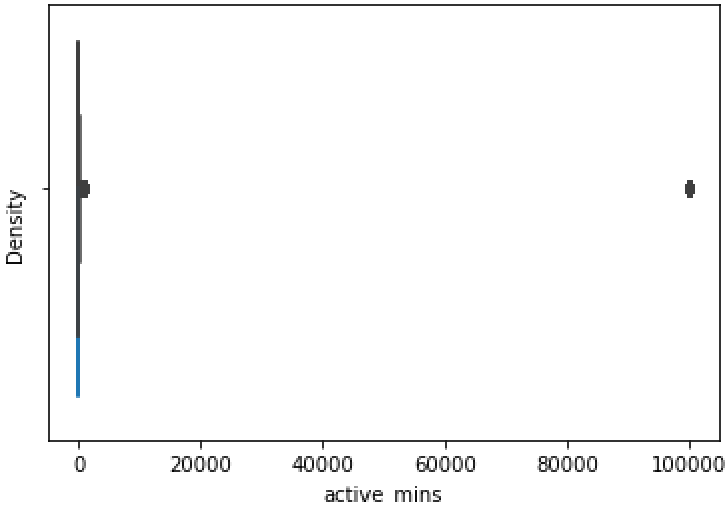
In [22]:

```
from class_31_hyperparameters import HyperParameters
from class_32_import_data import ImportData
from class_33_eda import EDA
from class_34_join_data import JoinData
from class_35_hypothesis import Hypothesis


def main():
    """:arg
    All program running here by sequence

    1.import data
    2.Through EDA delete outliers
    3.Join data and split control and treatment

    """
    class_import = ImportData()
    (df_t1, df_t2, df_t3, df_t4) = class_import.import_data()

    class_eda = EDA()
    # clean df_t1 dataframe by deleting outliers
    df_t1 = class_eda.outlier_eda(df_t1)

    class_join = JoinData()
    # outer join t1 table and t2 table
    df_clean, df_control, df_treat = class_join.join_data_dt(df_t1, df_t2, df_t3, df_t4

    class_hypo = Hypothesis()
    (t_value, p_two, degree_free
     , t_stat, p_value, upper_bound, lower_bound) = class_hypo.ttest_ind(df_control, df_


    return (df_t1, df_t2, df_t3, df_t4, df_clean, df_control, df_treat
            , t_value, p_two, degree_free, t_stat, p_value, upper_bound, lower_bound)


if __name__=="__main__":
    """:arg
    """
    (df_t1, df_t2, df_t3, df_t4, df_clean, df_control, df_treat
     , t_value, p_two, degree_free, t_stat, p_value, upper_bound, lower_bound) = main()

    print('OVER')
```

```
************************************************** Start import data ******************
*******************************
We have 172 data points are outliers
Before 1069597, After 1066230
For df_control, its normal distribution test is ShapiroResult(statistic=0.99359279870986
94, pvalue=0.7472291588783264)
For df_treat, its normal distribution test is ShapiroResult(statistic=0.870302498340606
7, pvalue=3.8012573644330416e-10)
Distribution of control group
P-value 1.0 > 0.050000000000000044
Accept H0 (control and treatment dont have siginificent differnet) hypothesis
Reject H1 (control and treatment have siginificent different) hypothesis
OVER
```

```
D:\ProgramData\Anaconda3\envs\08_web_mining\lib\site-packages\seaborn\distributions.py:2
```

```
551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```



In [ ]:

9.Test Code

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In [25]:

```
df_t3.shape
```

Out[25]: (1190093, 3)

In [27]:

```
df_t3.describe()
```

Out[27]:

	uid	active_mins
count	1.190093e+06	1.190093e+06
mean	2.420589e+04	3.220315e+01
std	1.417999e+04	1.181531e+03
min	0.000000e+00	1.000000e+00
25%	1.197500e+04	2.000000e+00
50%	2.393200e+04	4.000000e+00
75%	3.619600e+04	1.400000e+01
max	4.999900e+04	9.999900e+04

In [28]:

```
df_t3
```

Out[28]:

	uid	dt	active_mins

	uid	dt	active_mins
0	0	2018-09-24	3.0
1	0	2018-11-08	4.0
2	0	2018-11-24	3.0
3	0	2018-11-28	6.0
4	0	2018-12-02	6.0
...	...	...	...
1190088	49999	2018-09-15	5.0
1190089	49999	2018-09-26	8.0
1190090	49999	2018-10-20	29.0
1190091	49999	2018-12-14	3.0
1190092	49999	2019-01-28	32.0

1190093 rows × 3 columns

In [ ]:

In [ ]:

In [23]:
```
upper_bound
```
Out[23]:
```
-4.509893654334767
```
In [24]:
```
lower_bound
```
Out[24]:
```
-3.665273229338887
```
In [8]:
```
df_control
```
Out[8]:
```
0      19.893420
1      20.235027
2      20.529420
3      19.662953
4      20.119112
         ...
145    19.716245
146    18.977998
147    19.840566
148    19.897338
149    19.860828
Length: 150, dtype: float64
```
In [10]:
```
df_control.describe()
```

Out[10]:
```
count    150.000000
mean      19.323468
std        0.646480
min       17.732331
25%       18.895117
50%       19.278251
75%       19.836096
max       21.135562
dtype: float64
```

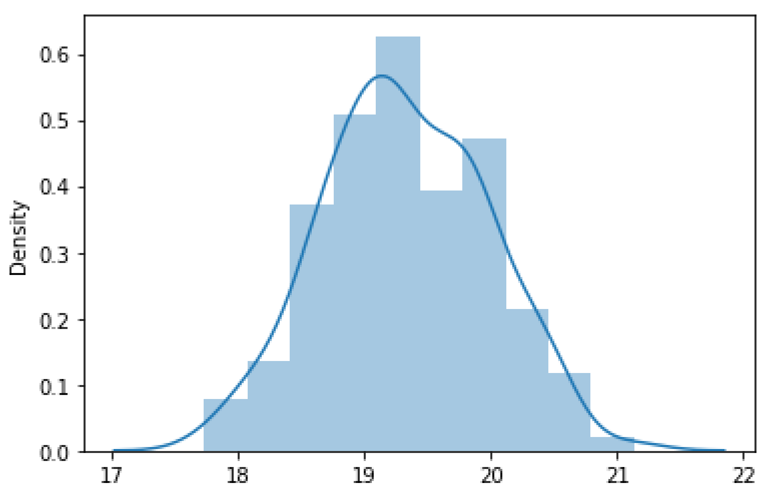
In [11]:
```
df_treat.describe()
```

Out[11]:
```
count    150.000000
mean      23.411051
std        3.057468
min       18.758485
25%       21.385178
50%       22.300901
75%       24.437592
max       32.389844
dtype: float64
```

In [13]:
```
sns.distplot(df_control)
```

```
D:\ProgramData\Anaconda3\envs\08_web_mining\lib\site-packages\seaborn\distributions.py:2
551: FutureWarning: `distplot` is a deprecated function and will be removed in a future
version. Please adapt your code to use either `displot` (a figure-level function with si
milar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

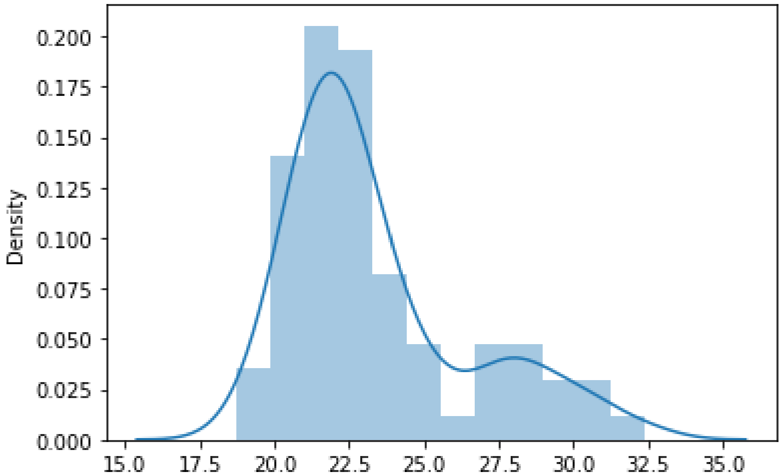
Out[13]: <AxesSubplot:ylabel='Density'>



In [12]:
```
sns.distplot(df_treat)
```

```
D:\ProgramData\Anaconda3\envs\08_web_mining\lib\site-packages\seaborn\distributions.py:2
551: FutureWarning: `distplot` is a deprecated function and will be removed in a future
version. Please adapt your code to use either `displot` (a figure-level function with si
milar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[12]: <AxesSubplot:ylabel='Density'>



In [9]:
```
df_treat
```

Out[9]:
```
0      28.474670
1      27.436468
2      27.181484
3      26.838880
4      27.444191
         ...
145    21.384615
146    21.485224
147    22.237192
148    21.462128
149    22.929389
Length: 150, dtype: float64
```

In [7]:
```
t_value, p_two, degree_free
```

Out[7]:
```
(-16.019643876306674, 1.0, 162.29643381428605)
```

In [ ]:

In [ ]:

In [ ]:

In [295…
```
stats.t.ppf(q=0.975, df=25)
```

Out[295…
```
2.059538552753294
```

In [297…
```
stats.t.ppf(q=0.95, df=200)
```

Out[297…
```
1.652508100910269
```

In [255…
```
# caculate confidence internal right_tail =0.025 two_tail=0.05
t_ci = 1.971
```

```
# sample number
control_num = df_21.shape[0]
treat_num = df_22.shape[0]
```

In [256…

```
control_num
```

Out[256…

```
150
```

In [257…

```
control_std = df_21.std()
treat_std = df_22.std()
se = np.sqrt( np.square(control_std)/control_num + np.square(treat_std)/treat_num)

sample_mean = df_21.mean() -  df_22.mean()
sample_mean

upper_bound = sample_mean - t_ci * se
lower_bound = sample_mean + t_ci * se
```

In [258…

```
upper_bound, lower_bound
```

Out[258…

```
(-0.03298816640548901, -0.022860283394956115)
```

In [ ]:

In [ ]:

In [133…

```
# caculate confidence internal right_tail =0.025 two_tail=0.05
t_ci = 1.971
# sample number
control_num = df_control.shape[0]
treat_num = df_treat.shape[0]
```

In [134…

```
control_std = df_control['active_mins'].std()
```

In [135…

```
treat_std = df_treat['active_mins'].std()
```

In [136…

```
se = np.sqrt( np.square(control_std)/control_num + np.square(treat_std)/treat_num)
```

In [141…

```
df_control['active_mins'].mean(), df_treat['active_mins'].mean()
```

Out[141…

```
(458.2211623246493, 458.4024761077324)
```

In [137…

```
sample_mean = df_control['active_mins'].mean() -  df_treat['active_mins'].mean()
sample_mean
```

Out[137…
```
-0.1813137830831124
```

In [138…
```
upper_bound = sample_mean - t_ci * se
lower_bound = sample_mean + t_ci * se
```

In [139…
```
upper_bound
```

Out[139…
```
-38.591763263087756
```

In [140…
```
lower_bound
```

Out[140…
```
38.22913569692153
```

In [ ]:
```

```

In [210…
```
# caculate confidence internal right_tail =0.025 two_tail=0.05
t_ci = 1.971
t_ci = 2.60
# sample number
control_num = df_control.shape[0]/4
treat_num = df_treat.shape[0]
print(control_num, treat_num)

control_std = (df_control['active_mins']/4).std()
treat_std = df_treat['active_mins'].std()

se = np.sqrt( np.square(control_std)/control_num + np.square(treat_std)/treat_num)

(df_control['active_mins']/4).mean(), df_treat['active_mins'].mean()

sample_mean = (df_control['active_mins']/4).mean() -  df_treat['active_mins'].mean()
sample_mean

upper_bound = sample_mean - t_ci * se
lower_bound = sample_mean + t_ci * se

upper_bound
lower_bound
```

```
37.5 150
```

Out[210…
```
2021.5178573516198
```

In [211…
```
upper_bound
```

Out[211…
```
-1138.0278573516218
```

In [212…
```
1639.3343468615546
```

Out[212…
```
1639.3343468615546
```

In [205…
```
(df_control['active_mins']/4).mean()
```
Out[205… 28581.545

In [206…
```
df_treat['active_mins'].mean()
```
Out[206… 28139.8

In [213…
```
se
```
Out[213… 607.6049451352387

In [214…
```
control_std
```
Out[214… 2650.8065794906283

In [215…
```
(df_control['active_mins']/4).std()
```
Out[215… 2650.8065794906283

In [216…
```
(df_control['active_mins']).std()
```
Out[216… 10603.226317962513

In [118…
```
t_value, p_two, degree_free
```
Out[118… (-0.009303964709989936, 0.9925767506273644, 13920.469441655145)

In [ ]:
```

```

In [ ]:
```

```

In [573…
```
df_treat.shape
```
Out[573… (9208, 2)

In [20]:
```
p_value
```
Out[20]: 3.0324185230356597e-35

In [19]:
```
stats.ttest_ind_from_stats(mean1=df_control.mean()
                           , std1=df_control.std()
                           , nobs1=150
                           , mean2=df_treat.mean()
                           , std2=df_treat.std()
```

```
                              , nobs2=150
                              , equal_var=False)
```

Out[19]: Ttest_indResult(statistic=-16.019643876306688, pvalue=3.03241852303566e-35)

In [15]:

```
import numpy as np
from scipy.stats import ttest_ind
from scipy.stats import t
import pandas as pd

def welch_ttest(x1, x2,alternative):

    n1 = x1.size
    n2 = x2.size
    m1 = np.mean(x1)
    m2 = np.mean(x2)

    v1 = np.var(x1, ddof=1)
    v2 = np.var(x2, ddof=1)

    pooled_se = np.sqrt(v1 / n1 + v2 / n2)
    delta = m1-m2

    tstat = delta /  pooled_se
    df = (v1 / n1 + v2 / n2)**2 / (v1**2 / (n1**2 * (n1 - 1)) + v2**2 / (n2**2 * (n2 -

    # two side t-test
    p = 2 * t.cdf(-abs(tstat), df)

    # upper and lower bounds
    lb = delta - t.ppf(0.975,df)*pooled_se
    ub = delta + t.ppf(0.975,df)*pooled_se

    return pd.DataFrame(np.array([tstat,df,p,delta,lb,ub]).reshape(1,-1),
                         columns=['T statistic','df','pvalue 2 sided','Difference in me
```

In [16]:

```
welch_ttest(df_control,df_treat,"equal")
```

Out[16]:

	T statistic	df	pvalue 2 sided	Difference in mean	lb	ub
0	-16.019644	162.296434	3.032419e-35	-4.087583	-4.591446	-3.583721

In [17]:

```
upper_bound
```

Out[17]: -4.509893654334767

In [18]:

```
lower_bound
```

Out[18]: -3.665273229338887

In [ ]:

In [487…
```
stats.kstest(df_61['active_mins'], 'norm')
```

Out[487…
```
KstestResult(statistic=0.9616591299099563, pvalue=0.0)
```

In [492…
```
df_52.head(2)
```

Out[492…

	uid	dt	active_mins
533200	23941	2019-02-20	1.0
264373	11922	2019-04-09	1.0

In [493…
```
df_62 = df_52.groupby(['dt'], as_index=False)['active_mins'].sum()
```

In [494…
```
stats.kstest(df_62['active_mins'], 'norm')
```

Out[494…
```
KstestResult(statistic=1.0, pvalue=0.0)
```

In [331…
```
st.kstest(df_42, 'norm')
```

Out[331…
```
KstestResult(statistic=0.8678963361749233, pvalue=0.0)
```

In [134…
```
st.shapiro(dist_10)
```

Out[134…
```
ShapiroResult(statistic=0.9979808926582336, pvalue=0.2747354805469513)
```

In [129…
```
st.shapiro(df_11)
```

Out[129…
```
ShapiroResult(statistic=0.0052002668380737305, pvalue=0.0)
```

In [ ]:

In [ ]:

In [ ]: