Capstone Project 1: MuscleHub AB Test

Step 1: Get started with SQL

Like most businesses, Janet keeps her data in a SQL database. Normally, you'd download the data from her database to a csv file, and then load it into a Jupyter Notebook using Pandas.

For this project, you'll have to access SQL in a slightly different way. You'll be using a special Codecademy library that lets you type SQL queries directly into this Jupyter notebook. You'll have pass each SQL query as an argument to a function called `sql_query`. Each query will return a Pandas DataFrame. Here's an example:

In [1]:
```
# This import only needs to happen once, at the beginning of the notebook
from codecademySQL import sql_query
```

In [2]:
```
# Here's an example of a query that just displays some data
sql_query('''
SELECT *
FROM visits
LIMIT 5
''')
```

Out[2]:

	index	first_name	last_name	email	gender	visit_date
0	0	Karen	Manning	Karen.Manning@gmail.com	female	5-1-17
1	1	Annette	Boone	AB9982@gmail.com	female	5-1-17
2	2	Salvador	Merritt	SalvadorMerritt12@outlook.com	male	5-1-17
3	3	Martha	Maxwell	Martha.Maxwell@gmail.com	female	5-1-17
4	4	Andre	Mayer	AndreMayer90@gmail.com	male	5-1-17

In [3]:
```
# Here's an example where we save the data to a DataFrame
df = sql_query('''
SELECT *
FROM applications
LIMIT 5
''')
```

Step 2: Get your dataset

Let's get started!

Janet of MuscleHub has a SQLite database, which contains several tables that will be helpful to you in this investigation:

- `visits` contains information about potential gym customers who have visited MuscleHub
- `fitness_tests` contains information about potential customers in "Group A", who were given a fitness test
- `applications` contains information about any potential customers (both "Group A" and "Group B") who filled out an application. Not everyone in `visits` will have filled out an application.
- `purchases` contains information about customers who purchased a membership to MuscleHub.

Use the space below to examine each table.

In [4]:
```
# Examine visits here
sql_query('''
SELECT *
FROM visits
LIMIT 5
''')
```

Out[4]:

	index	first_name	last_name	email	gender	visit_date
0	0	Karen	Manning	Karen.Manning@gmail.com	female	5-1-17
1	1	Annette	Boone	AB9982@gmail.com	female	5-1-17
2	2	Salvador	Merritt	SalvadorMerritt12@outlook.com	male	5-1-17
3	3	Martha	Maxwell	Martha.Maxwell@gmail.com	female	5-1-17
4	4	Andre	Mayer	AndreMayer90@gmail.com	male	5-1-17

In [5]:
```
# Examine fitness_tests here
sql_query('''
SELECT *
FROM fitness_tests
LIMIT 5
''')
```

Out[5]:

	index	first_name	last_name	email	gender	fitness_test_date
0	0	Kim	Walter	KimWalter58@gmail.com	female	2017-07-03
1	1	Tom	Webster	TW3857@gmail.com	male	2017-07-02
2	2	Marcus	Bauer	Marcus.Bauer@gmail.com	male	2017-07-01
3	3	Roberta	Best	RB6305@hotmail.com	female	2017-07-02
4	4	Carrie	Francis	CF1896@hotmail.com	female	2017-07-05

In [6]:
```
# Examine applications here
sql_query('''
SELECT *
FROM applications
LIMIT 5
''')
```

Out[6]:

	index	first_name	last_name	email	gender	application_date
0	0	Roy	Abbott	RoyAbbott32@gmail.com	male	2017-08-12
1	1	Agnes	Acevedo	AgnesAcevedo1@gmail.com	female	2017-09-29
2	2	Roberta	Acevedo	RA8063@gmail.com	female	2017-09-15
3	3	Darren	Acosta	DAcosta1996@hotmail.com	male	2017-07-26
4	4	Vernon	Acosta	VAcosta1975@gmail.com	male	2017-07-14

In [7]:
```
# Examine purchases here
sql_query('''
SELECT *
FROM purchases
LIMIT 5
''')
```

Out[7]:

	index	first_name	last_name	email	gender	purchase_date
0	0	Roy	Abbott	RoyAbbott32@gmail.com	male	2017-08-18
1	1	Roberta	Acevedo	RA8063@gmail.com	female	2017-09-16
2	2	Vernon	Acosta	VAcosta1975@gmail.com	male	2017-07-20
3	3	Darren	Acosta	DAcosta1996@hotmail.com	male	2017-07-27
4	4	Dawn	Adkins	Dawn.Adkins@gmail.com	female	2017-08-24

We'd like to download a giant DataFrame containing all of this data. You'll need to write a query that does the following things:

1. Not all visits in `visits` occurred during the A/B test. You'll only want to pull data where `visit_date` is on or after `7-1-17`.
2. You'll want to perform a series of `LEFT JOIN` commands to combine the four tables that we care about. You'll need to perform the joins on `first_name`, `last_name`, and `email`. Pull the following columns:

- `visits.first_name`
- `visits.last_name`
- `visits.gender`
- `visits.email`
- `visits.visit_date`
- `fitness_tests.fitness_test_date`
- `applications.application_date`
- `purchases.purchase_date`

Save the result of this query to a variable called `df`.

Hint: your result should have 5004 rows. Does it?

In [8]:
```
df = sql_query('''
SELECT visits.first_name,
       visits.last_name,
       visits.visit_date,
       fitness_tests.fitness_test_date,
       applications.application_date,
       purchases.purchase_date
FROM visits
LEFT JOIN fitness_tests
    ON fitness_tests.first_name = visits.first_name
    AND fitness_tests.last_name = visits.last_name
    AND fitness_tests.email = visits.email
LEFT JOIN applications
    ON applications.first_name = visits.first_name
    AND applications.last_name = visits.last_name
    AND applications.email = visits.email
LEFT JOIN purchases
    ON purchases.first_name = visits.first_name
    AND purchases.last_name = visits.last_name
    AND purchases.email = visits.email
WHERE visits.visit_date >= '7-1-17'
''')
print df.head()
len(df)
```

```
  first_name last_name visit_date fitness_test_date application_date  \
0        Kim    Walter     7-1-17        2017-07-03             None
1        Tom   Webster     7-1-17        2017-07-02             None
2     Edward     Bowen     7-1-17              None       2017-07-04
3     Marcus     Bauer     7-1-17        2017-07-01       2017-07-03
4    Roberta      Best     7-1-17        2017-07-02             None

  purchase_date
0          None
1          None
2    2017-07-04
3    2017-07-05
4          None
```

Out[8]:
```
5004
```

Step 3: Investigate the A and B groups

We have some data to work with! Import the following modules so that we can start doing analysis:

- `import pandas as pd`
- `from matplotlib import pyplot as plt`

In [9]:
```
import pandas as pd
from matplotlib import pyplot as plt
```

We're going to add some columns to `df` to help us with our analysis.

Start by adding a column called `ab_test_group`. It should be `A` if `fitness_test_date` is not `None`, and `B` if `fitness_test_date` is `None`.

```
In [10]: df['ab_test_group'] = df.fitness_test_date.apply(lambda x:
                                                  'A' if pd.notnull(x) else 'B')
```

Let's do a quick sanity check that Janet split her visitors such that about half are in A and half are in B.

Start by using `groupby` to count how many users are in each `ab_test_group`. Save the results to `ab_counts`.

```
In [11]: ab_counts = df.groupby('ab_test_group').first_name.count().reset_index()
         ab_counts
```

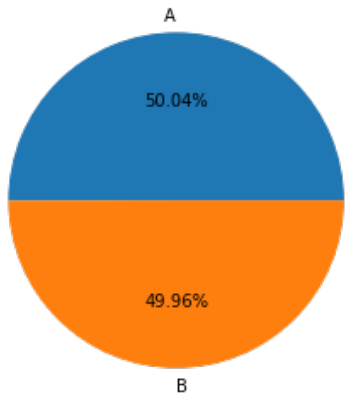
Out[11]:

	ab_test_group	first_name
0	A	2504
1	B	2500

We'll want to include this information in our presentation. Let's create a pie cart using `plt.pie`. Make sure to include:

- Use `plt.axis('equal')` so that your pie chart looks nice
- Add a legend labeling `A` and `B`
- Use `autopct` to label the percentage of each group
- Save your figure as `ab_test_pie_chart.png`

```
In [12]: plt.pie(ab_counts.first_name.values, labels=['A', 'B'], autopct='%0.2f%%')
         plt.axis('equal')
         plt.show()
         plt.savefig('ab_test_pie_chart.png')
```



```
<Figure size 432x288 with 0 Axes>
```

Step 4: Who picks up an application?

Recall that the sign-up process for MuscleHub has several steps:

1. Take a fitness test with a personal trainer (only Group A)
2. Fill out an application for the gym
3. Send in their payment for their first month's membership

Let's examine how many people make it to Step 2, filling out an application.

Start by creating a new column in `df` called `is_application` which is `Application` if `application_date` is not `None` and `No Application`, otherwise.

In [13]:
```
df['is_application'] = df.application_date.apply(lambda x: 'Application' if pd.not
null(x) else 'No Application')
```

Now, using `groupby`, count how many people from Group A and Group B either do or don't pick up an application. You'll want to group by `ab_test_group` and `is_application`. Save this new DataFrame as `app_counts`

In [14]:
```
app_counts = df.groupby(['ab_test_group', 'is_application']).first_name.count().re
set_index()
app_counts
```

Out[14]:

	ab_test_group	is_application	first_name
0	A	Application	250
1	A	No Application	2254
2	B	Application	325
3	B	No Application	2175

We're going to want to calculate the percent of people in each group who complete an application. It's going to be much easier to do this if we pivot `app_counts` such that:

- The `index` is `ab_test_group`
- The `columns` are `is_application` Perform this pivot and save it to the variable `app_pivot`. Remember to call `reset_index()` at the end of the pivot!

In [15]:
```
app_pivot = app_counts.pivot(columns='is_application', index='ab_test_group', valu
es='first_name').reset_index()
app_pivot
```

Out[15]:

is_application	ab_test_group	Application	No Application
0	A	250	2254
1	B	325	2175

Define a new column called `Total`, which is the sum of `Application` and `No Application`.

```
In [16]: app_pivot['Total']=app_pivot['Application'] + app_pivot['No Application']
         app_pivot
```

Out[16]:

is_application	ab_test_group	Application	No Application	Total
0	A	250	2254	2504
1	B	325	2175	2500

Calculate another column called `Percent with Application`, which is equal to `Application` divided by `Total`.

```
In [17]: app_pivot['Percent with Application']= app_pivot.Application/app_pivot.Total
         app_pivot
```

Out[17]:

is_application	ab_test_group	Application	No Application	Total	Percent with Application
0	A	250	2254	2504	0.09984
1	B	325	2175	2500	0.13000

It looks like more people from Group B turned in an application. Why might that be?

We need to know if this difference is statistically significant.

Choose a hypothesis tests, import it from `scipy` and perform it. Be sure to note the p-value. Is this result significant?

```
In [18]: from scipy.stats import chi2_contingency

         contingency = [[250, 2254], [325, 2175]]
         chi2_contingency(contingency)
```

```
Out[18]: (10.893961295282612,
          0.0009647827600722304,
          1,
          array([[ 287.72981615, 2216.27018385],
                 [ 287.27018385, 2212.72981615]]))
```

Step 4: Who purchases a membership?

Of those who picked up an application, how many purchased a membership?

Let's begin by adding a column to `df` called `is_member` which is `Member` if `purchase_date` is not `None`, and `Not Member` otherwise.

```
In [19]: df['is_member']=df.purchase_date.apply(lambda x: 'Member' if pd.notnull(x) else 'N
         ot Member')
         print df.head()
```

```
  first_name last_name visit_date fitness_test_date application_date  \
0        Kim    Walter     7-1-17        2017-07-03             None
1        Tom   Webster     7-1-17        2017-07-02             None
2     Edward     Bowen     7-1-17              None       2017-07-04
3     Marcus     Bauer     7-1-17        2017-07-01       2017-07-03
4    Roberta      Best     7-1-17        2017-07-02             None

  purchase_date ab_test_group  is_application   is_member
0          None             A  No Application  Not Member
1          None             A  No Application  Not Member
2    2017-07-04             B     Application      Member
3    2017-07-05             A     Application      Member
4          None             A  No Application  Not Member
```

Now, let's create a DataFrame called `just_apps` the contains only people who picked up an application.

```
In [20]: just_apps=df[df.is_application == 'Application']
         print just_apps.head()
```

```
   first_name last_name visit_date fitness_test_date application_date  \
2      Edward     Bowen     7-1-17              None       2017-07-04
3      Marcus     Bauer     7-1-17        2017-07-01       2017-07-03
9    Salvador  Cardenas     7-1-17        2017-07-07       2017-07-06
11    Valerie     Munoz     7-1-17        2017-07-03       2017-07-05
35    Michael     Burks     7-1-17              None       2017-07-07

   purchase_date ab_test_group is_application   is_member
2     2017-07-04             B    Application      Member
3     2017-07-05             A    Application      Member
9           None             A    Application  Not Member
11    2017-07-06             A    Application      Member
35    2017-07-13             B    Application      Member
```

Great! Now, let's do a `groupby` to find out how many people in `just_apps` are and aren't members from each group. Follow the same process that we did in Step 4, including pivoting the data. You should end up with a DataFrame that looks like this:

is_member	ab_test_group	Member	Not Member	Total	Percent Purchase
0	A	?	?	?	?
1	B	?	?	?	?

Save your final DataFrame as `member_pivot`.

In [21]:
```
member_count = just_apps.groupby(['ab_test_group', 'is_member'])\
                   .first_name.count().reset_index()
member_pivot = member_count.pivot(columns='is_member',
                                  index='ab_test_group',
                                  values='first_name')\
                           .reset_index()

member_pivot['Total'] = member_pivot.Member + member_pivot['Not Member']
member_pivot['Percent Purchase'] = member_pivot.Member / member_pivot.Total
member_pivot
```

Out[21]:

is_member	ab_test_group	Member	Not Member	Total	Percent Purchase
0	A	200	50	250	0.800000
1	B	250	75	325	0.769231

It looks like people who took the fitness test were more likely to purchase a membership **if** they picked up an application. Why might that be?

Just like before, we need to know if this difference is statistically significant. Choose a hypothesis tests, import it from `scipy` and perform it. Be sure to note the p-value. Is this result significant?

In [22]:
```
contingency = [[200, 50], [250, 75]]
chi2_contingency(contingency)
```

Out[22]:
```
(0.615869230769231,
 0.43258646051083327,
 1,
 array([[195.65217391,  54.34782609],
        [254.34782609,  70.65217391]]))
```

Previously, we looked at what percent of people **who picked up applications** purchased memberships. What we really care about is what percentage of **all visitors** purchased memberships. Return to `df` and do a `groupby` to find out how many people in `df` are and aren't members from each group. Follow the same process that we did in Step 4, including pivoting the data. You should end up with a DataFrame that looks like this:

is_member	ab_test_group	Member	Not Member	Total	Percent Purchase
0	A	?	?	?	?
1	B	?	?	?	?

Save your final DataFrame as `final_member_pivot`.

In [23]:
```
df_groupby=df.groupby(['ab_test_group','is_member']).first_name.count().reset_inde
x()
final_member_pivot=df_groupby.pivot(columns='is_member',index='ab_test_group',valu
es='first_name')\
                                                          .reset_index()
final_member_pivot['Total']=final_member_pivot.Member + final_member_pivot['Not Me
mber']
final_member_pivot['Percent Purchase']=final_member_pivot.Member/final_member_pivo
t.Total
final_member_pivot
```

Out[23]:

is_member	ab_test_group	Member	Not Member	Total	Percent Purchase
0	A	200	2304	2504	0.079872
1	B	250	2250	2500	0.100000

Previously, when we only considered people who had **already picked up an application**, we saw that there was no significant difference in membership between Group A and Group B.

Now, when we consider all people who **visit MuscleHub**, we see that there might be a significant different in memberships between Group A and Group B. Perform a significance test and check.

In [24]:
```
contingency = [[200, 2304], [250, 2250]]
chi2_contingency(contingency)
```

Out[24]:
```
(5.949182292591156,
 0.014724114645783203,
 1,
 array([[ 225.17985612, 2278.82014388],
        [ 224.82014388, 2275.17985612]]))
```

Step 5: Summarize the acquisition funel with a chart

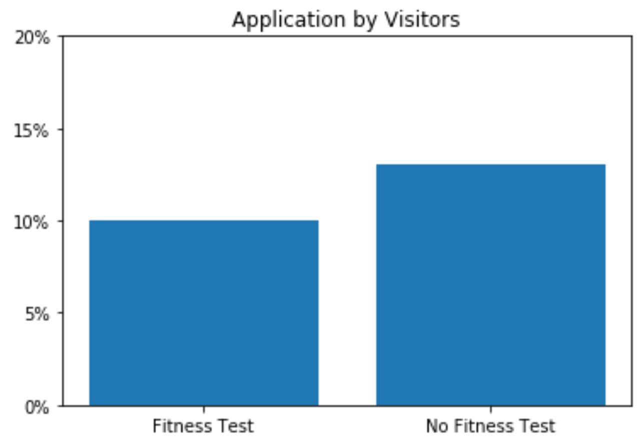
We'd like to make a bar chart for Janet that shows the difference between Group A (people who were given the fitness test) and Group B (people who were not given the fitness test) at each state of the process:

- Percent of visitors who apply
- Percent of applicants who purchase a membership
- Percent of visitors who purchase a membership

Create one plot for **each** of the three sets of percentages that you calculated in `app_pivot`, `member_pivot` and `final_member_pivot`. Each plot should:

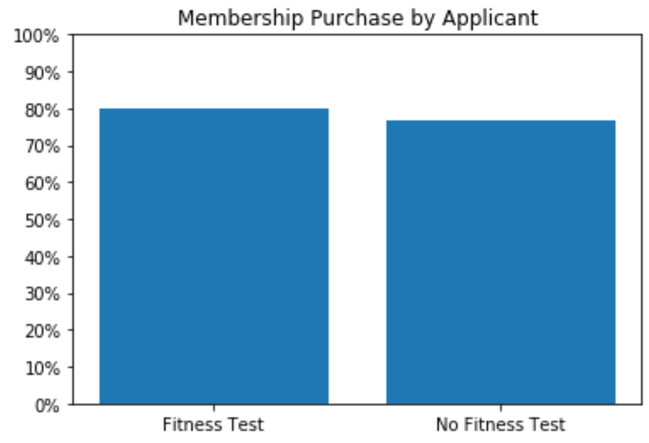
- Label the two bars as `Fitness Test` and `No Fitness Test`
- Make sure that the y-axis ticks are expressed as percents (i.e., `5%`)
- Have a title

In [31]:
```
# Percent of Visitors who Apply
ax = plt.subplot()
plt.bar(range(len(app_pivot)),
       app_pivot['Percent with Application'].values)
ax.set_xticks(range(len(app_pivot)))
ax.set_xticklabels(['Fitness Test', 'No Fitness Test'])
ax.set_yticks([0, 0.05, 0.10, 0.15, 0.20])
ax.set_yticklabels(['0%', '5%', '10%', '15%', '20%'])
ax.set_title('Application by Visitors')
plt.show()
plt.savefig('percent_visitors_apply.png')
```



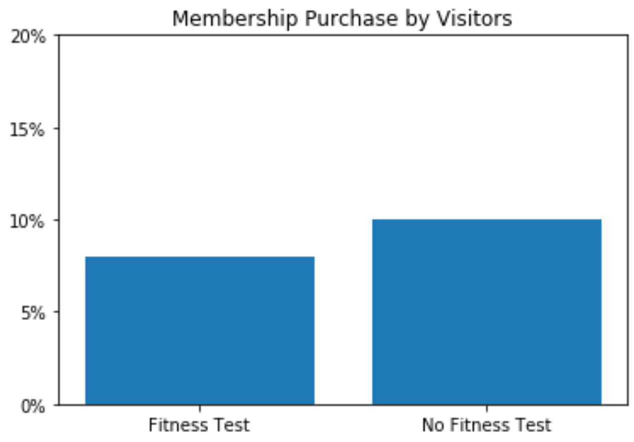
```
<Figure size 432x288 with 0 Axes>
```

In [28]:
```
# Percent of Applicants who Purchase
ax = plt.subplot()
plt.bar(range(len(member_pivot)),
       member_pivot['Percent Purchase'].values)
ax.set_xticks(range(len(app_pivot)))
ax.set_xticklabels(['Fitness Test', 'No Fitness Test'])
ax.set_yticks([0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1])
ax.set_yticklabels(['0%', '10%', '20%', '30%', '40%', '50%', '60%', '70%', '80%',
'90%', '100%'])
ax.set_title('Membership Purchase by Applicant')
plt.show()
plt.savefig('percent_apply_purchase.png')
```



```
<Figure size 432x288 with 0 Axes>
```

In [29]:
```
# Percent of Visitors who Purchase
ax = plt.subplot()
plt.bar(range(len(final_member_pivot)),
       final_member_pivot['Percent Purchase'].values)
ax.set_xticks(range(len(app_pivot)))
ax.set_xticklabels(['Fitness Test', 'No Fitness Test'])
ax.set_yticks([0, 0.05, 0.10, 0.15, 0.20])
ax.set_yticklabels(['0%', '5%', '10%', '15%', '20%'])
ax.set_title('Membership Purchase by Visitors')
plt.show()
plt.savefig('percent_visitors_purchase.png')
```



```
<Figure size 432x288 with 0 Axes>
```