#Chopsticks!

A few researchers set out to determine the optimal length of chopsticks for children and adults. They came up with a measure of how effective a pair of chopsticks performed, called the "Food Pinching Performance." The "Food Pinching Performance" was determined by counting the number of peanuts picked and placed in a cup (PPPC).

An investigation for determining the optimum length of chopsticks.

Link to Abstract and Paper (http://www.ncbi.nlm.nih.gov/pubmed/15676839)
the abstract below was adapted from the link

Chopsticks are one of the most simple and popular hand tools ever invented by humans, but have not previously been investigated by ergonomists (https://www.google.com/search?q=ergonomists). Two laboratory studies were conducted in this research, using a randomised complete block design (http://dawg.utk.edu/glossary/whatis_rcbd.htm), to evaluate the effects of the length of the chopsticks on the food-serving performance of adults and children. Thirty-one male junior college students and 21 primary school pupils served as subjects for the experiment to test chopsticks lengths of 180, 210, 240, 270, 300, and 330 mm. The results showed that the food-pinching performance was significantly affected by the length of the chopsticks, and that chopsticks of about 240 and 180 mm long were optimal for adults and pupils, respectively. Based on these findings, the researchers suggested that families with children should provide both 240 and 180 mm long chopsticks. In addition, restaurants could provide 210 mm long chopsticks, considering the trade-offs between ergonomics and cost.

For the rest of this project, answer all questions based only on the part of the experiment analyzing the thirty-one adult male college students.

Download the data set for the adults (https://www.udacity.com/api/nodes/4576183932/supplemental_media/chopstick-effectivenesscsv/download), then answer the following questions based on the abstract and the data set.

If you double click on this cell, you will see the text change so that all of the formatting is removed. This allows you to edit this block of text. This block of text is written using Markdown (http://daringfireball.net/projects/markdown/syntax), which is a way to format text using headers, links, italics, and many other options. You will learn more about Markdown later in the Nanodegree Program. Hit shift + enter or shift + return to show the formatted text.

1. What is the independent variable in the experiment?

You can either double click on this cell to add your answer in this cell, or use the plus sign in the toolbar (Insert cell below) to add your answer in a new cell.

The independent variable in this experiment is the "Chopstick.Length"

2. What is the dependent variable in the experiment?

The dependent variable (or the outcome) of the experiment is the "Food.Pinching.Efficiency" of the chopsticks

3. How is the dependent variable operationally defined?

The dependent variable which is the "Food.Pinching.Efficiency" of the chopsticks is operationally defined as follows: The percentage of peanuts picked and placed in a cup (PPPC) by a pair of chopsticks. (Percentage of The number of peanuts succesfully placed out of the total number of peanuts provided)

4. Based on the description of the experiment and the data set, list at least two variables that you know were controlled.

Think about the participants who generated the data and what they have in common. You don't need to guess any variables or read the full paper to determine these variables. (For example, it seems plausible that the material of the chopsticks was held constant, but this is not stated in the abstract or data description.)

Some of the controlled variables in this experiment are:
(1) The subjects - Same subjects are tested on all the different lengths of chopsticks
(2) The Gender of the participants - All the participants are male
(3) The material and Grip of the chopsticks - All the chopsticks given to participants is of the same type to maintain unbiased testability
(4) The age group of the participants - Since all the adult participants of part 1 of the experiment belonged to junior colleges, they are more likely to be in a fixed age group.

One great advantage of ipython notebooks is that you can document your data analysis using code, add comments to the code, or even add blocks of text using Markdown. These notebooks allow you to collaborate with others and share your work. For now, let's see some code for doing statistics.

In [2]:
```
import pandas as pd

# pandas is a software library for data manipulation and analysis
# We commonly use shorter nicknames for certain packages. Pandas is often
# hit shift + enter to run this cell or block of code
```

In [3]:
```
path = r'~/R Prog/chopstick-effectiveness.csv'
# Change the path to the location where the chopstick-effectiveness.csv f
# If you get an error when running this block of code, be sure the chopst

dataFrame = pd.read_csv(path)
dataFrame
```

Out[3]:

	Food.Pinching.Efficiency	Individual	Chopstick.Length
0	19.55	1	180
1	27.24	2	180
2	28.76	3	180
3	31.19	4	180
4	21.91	5	180
5	27.62	6	180
6	29.46	7	180
7	26.35	8	180
8	26.69	9	180
9	30.22	10	180
10	27.81	11	180
11	23.46	12	180
12	23.64	13	180
13	27.85	14	180
14	20.62	15	180
15	25.35	16	180
16	28.00	17	180
17	23.49	18	180
18	27.77	19	180
19	18.48	20	180

20	23.01	21	180
21	22.66	22	180
22	23.24	23	180
23	22.82	24	180
24	17.94	25	180
25	26.67	26	180
26	28.98	27	180
27	21.48	28	180
28	14.47	29	180
29	28.29	30	180
...	...	...	...
156	26.18	2	330
157	25.93	3	330
158	28.61	4	330
159	20.54	5	330
160	26.44	6	330
161	29.36	7	330
162	19.77	8	330
163	31.69	9	330
164	24.64	10	330
165	22.09	11	330
166	23.42	12	330
167	28.63	13	330
168	26.30	14	330
169	22.89	15	330
170	22.68	16	330
171	30.92	17	330
172	20.74	18	330
173	27.24	19	330

174	17.12	20	330
175	23.63	21	330
176	20.91	22	330
177	23.49	23	330
178	24.86	24	330
179	16.28	25	330
180	21.52	26	330
181	27.22	27	330
182	17.41	28	330
183	16.42	29	330
184	28.22	30	330
185	27.52	31	330

186 rows × 3 columns

Let's do a basic statistical calculation on the data using code! Run the block of code below to calculate the average "Food Pinching Efficiency" for all 31 participants and all chopstick lengths.

In [4]:
```
dataFrame['Food.Pinching.Efficiency'].mean()
```

Out[4]:
```
25.00559139784947
```

This number is helpful, but the number doesn't let us know which of the chopstick lengths performed best for the thirty-one male junior college students. Let's break down the data by chopstick length. The next block of code will generate the average "Food Pinching Effeciency" for each chopstick length. Run the block of code below.

In [5]:
```
meansByChopstickLength = dataFrame.groupby('Chopstick.Length')['Food.Pinc
meansByChopstickLength

# reset_index() changes Chopstick.Length from an index to column. Instead
```

Out[5]:

	Chopstick.Length	Food.Pinching.Efficiency
0	180	24.935161
1	210	25.483871
2	240	26.322903
3	270	24.323871
4	300	24.968065
5	330	23.999677

5. Which chopstick length performed the best for the group of thirty-one male junior college students?

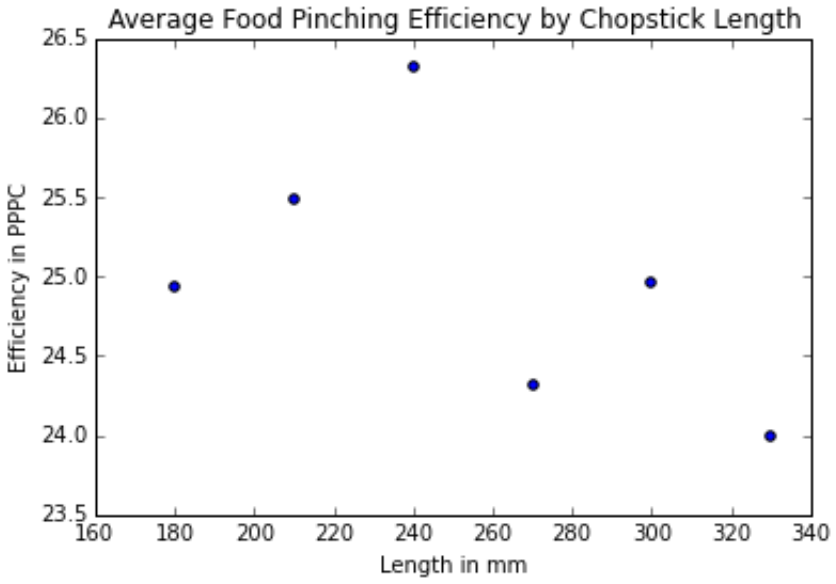
chopstick length of 240 mm performed the best with
Food.Pinching.Efficiency averaging to 26.322903

In [6]:
```
# Causes plots to display within the notebook rather than in a new window
%pylab inline

import matplotlib.pyplot as plt

plt.scatter(x=meansByChopstickLength['Chopstick.Length'], y=meansByChopst
            # title="")
plt.xlabel("Length in mm")
plt.ylabel("Efficiency in PPPC")
plt.title("Average Food Pinching Efficiency by Chopstick Length")
plt.show()
```

```
Populating the interactive namespace from numpy and matplotlib
```



6. Based on the scatterplot created from the code above, interpret the relationship you see. What do you notice?

From the scatterplot the "Efficiency in PPPC" seems to increase as the chopstick.length increases up to a certain extent and then, beyond the optimum length, the efficiency seems to follow a down hill. There is clearly a parabolic relation bettween the Efficiency and the Length. This relation clearly shows a single most optimal efficiency giving the corresponding optimal length value.

In the abstract the researchers stated that their results showed food-pinching performance was significantly affected by the length of the chopsticks, and that chopsticks of about 240 mm long were optimal for adults.

7a. Based on the data you have analyzed, do you agree with the claim?

Yes. Based on the data set, it seems reasonable to conclude that 240mm

is the optimal length of chopsticks for adults

7b. Why?

The efficiency clearly tends uphill till the length reaches 240mm and then tends downhill beyong 240mm. The efficiency at 240mm stands out as the peak of the parabolic relation and can be considered as the optimal data as per the test data of the experiment.