Lab 3 - Mental Rotation

In this experiment, 54 subjects performed a mental rotation task similar to Shepard & Metzler (1971): multiple pairs of 3D objects were presented at four different rotating angles. Data was obtained from Ganis & Kievit (2015).

The goal is to analyze the relationship between subjects' reaction times (dependent variable) and angles (independent variable) both within subjects **[Tasks 1-3]** and across subjects **[Tasks 4-5]**.

Begin your solution as prompted below; everything else was written.

Refer to the lecture slides for the set of functions that you might use for this lab.

This lab must be done **individually**. The required packages have been imported for you below.

In [3]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import pickle
from scipy.stats import linregress
```

Total number of subjects in the experiment that you will analyze.

In [4]:
```
nsubject = 54
```

The four angles (in degrees) at which 3D objects were presented.

In [5]:
```
unique_angles = [0,50,100,150]
```

Create place-holder variable for recording mean response times (see below).

In [11]:
```
rt_matrix = np.zeros((nsubject,4))
std_matrix = np.zeros((nsubject,4)) # place holder for std
```

Create place-holder variable for recording slopes (see below).

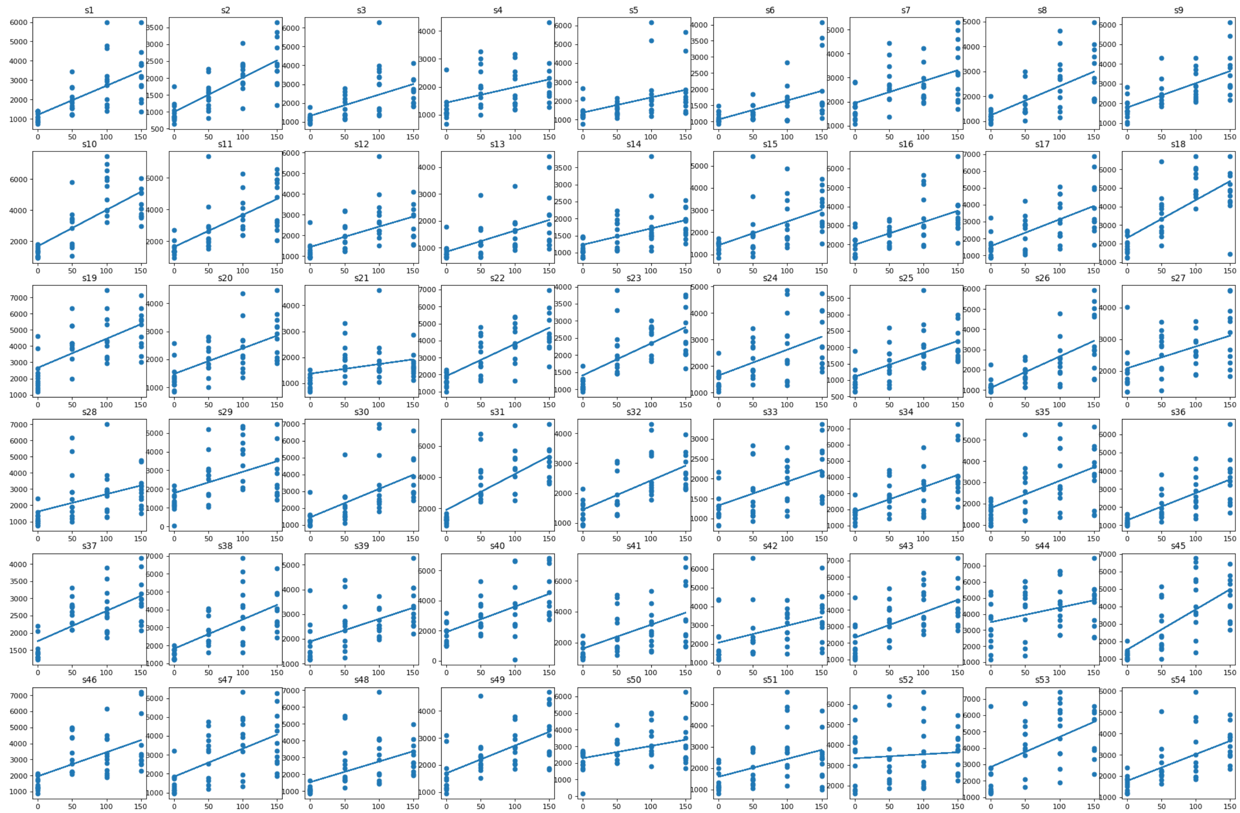
In [22]:
```
slopes = np.zeros(nsubject)
```

Create a meta figure that visualizes results for individual subjects, then begin analysis.

In [26]:
```
fig = plt.figure(figsize=(30, 20), dpi= 80, facecolor='w', edgecolor='
k')

# Loop over the subjects
for s in range(0,nsubject):

    # Specify the file name of the subject in question
    fn_in = 'data-mental-rotation/sub'+str(s+1)

    # Read in experimental data
    with open(fn_in+'.pickle', 'rb') as f:  # Python 3: open(..., 'wb'
)
        stimuli, rt, angle, acc, ind_stimuli = pickle.load(f)

    # Focus on trials where stimulus pair is matched
    inds= np.where(ind_stimuli==0)

    # Record the reaction time (rt) for each trial in a vector
    rt = np.float32(rt[inds])
    # Record the angle of the object pair for each trial in a vector
    angle = np.float32(angle[inds])


    #========== Your solution begins here ==========

    # Task 1: Line fitting [3pts]

    #-------Task 1.1-------
    # Fit a line (linear regression) between reaction time (rt) and an
gle
    # i.e. rt = angle x slope + intercept

    linefit = np.polyfit(angle[np.isfinite(rt)], rt[np.isfinite(rt)],
1)

    #-------Task 1.2-------
    # Record the slope for this subject in place-holder variable "slop
es"

    slope = linefit[0]
```

```
    slopes[s] = slope

    # Create a subplot for this subject
    plt.subplot(6,9,s+1)

    # Task 2: Within-subject visualization [2pts]

    #-------Task 2.1-------
    # Scatter plot reaction times (y-axis) against angles (x-axis)

    plt.scatter(angle[np.isfinite(rt)], rt[np.isfinite(rt)])

    #-------Task 2.2-------
    # Juxtapose the fitted line onto this scatter plot
    intercept = linefit[1]
    plt.plot(angle[np.isfinite(rt)], intercept + slope * angle[np.isfi
nite(rt)], '-')

    # Specify title of the plot by subject index
    plt.title('s'+str(s+1))

    # Task 3: Within-subject statistics [1pt]

    #-------Task 3.1-------
    # Calculate within-subject mean response time across trials, for e
ach angle
    anglecleaned = angle[np.isfinite(rt)]
    rtcleaned = rt[np.isfinite(rt)]
    angle_list = []

    for angle in unique_angles:
        angle_list.append(np.nanmean(rtcleaned[anglecleaned == angle])
)



    #-------Task 3.2-------
    # Record this value in place-holder variable "rt_matrix"

    rt_matrix[s,] = angle_list

    # Calculate response time standard deviation and store in std_matr
ix
    angle_std_list = []
    std = 0
    for angle in unique_angles:
        current_std = np.nanstd(rtcleaned[anglecleaned == angle])
        angle_std_list.append(np.nanstd(rtcleaned[anglecleaned == angl
e]))
        std += current_std
```

```
    avg_std = std/4 # because there are 4 unique angles
    std_matrix[s,] = angle_std_list




plt.show()
```



Task 4: Across-subject visualization [2pts]

Task 4.1: Take the average of mean response times across subjects, for each angle.

In [42]:
```
# Write your code here.

avg_mean_angle_0 = np.mean(rt_matrix[:, [0]])
avg_mean_angle_50 = np.mean(rt_matrix[:, [1]])
avg_mean_angle_100 = np.mean(rt_matrix[:, [2]])
avg_mean_angle_150 = np.mean(rt_matrix[:, [3]])

avg_mean_angle_list = [avg_mean_angle_0, avg_mean_angle_50, avg_mean_a
ngle_100, avg_mean_angle_150]
for i in range(4):
    print("average of mean response time of " + str(unique_angles[i])
+ " degree: " + str(avg_mean_angle_list[i]))
```

```
average of mean response time of 0 degree: 1537.9027755172165
average of mean response time of 50 degree: 2508.8503033673323
average of mean response time of 100 degree: 3120.911496762876
average of mean response time of 150 degree: 3353.570246943721
```

Task 4.2: Take the standard deviation of mean response times across subjects, for each angle.

In [44]:
```
avg_std_angle_0 = np.mean(std_matrix[:, [0]])
avg_std_angle_50 = np.mean(std_matrix[:, [1]])
avg_std_angle_100 = np.mean(std_matrix[:, [2]])
avg_std_angle_150 = np.mean(std_matrix[:, [3]])

std_mean_angle_list = [avg_std_angle_0, avg_std_angle_50, avg_std_angl
e_100, avg_std_angle_150]
for i in range(4):
    print("average of mean response time of " + str(unique_angles[i])
+ " degree: " + str(std_mean_angle_list[i]))
```

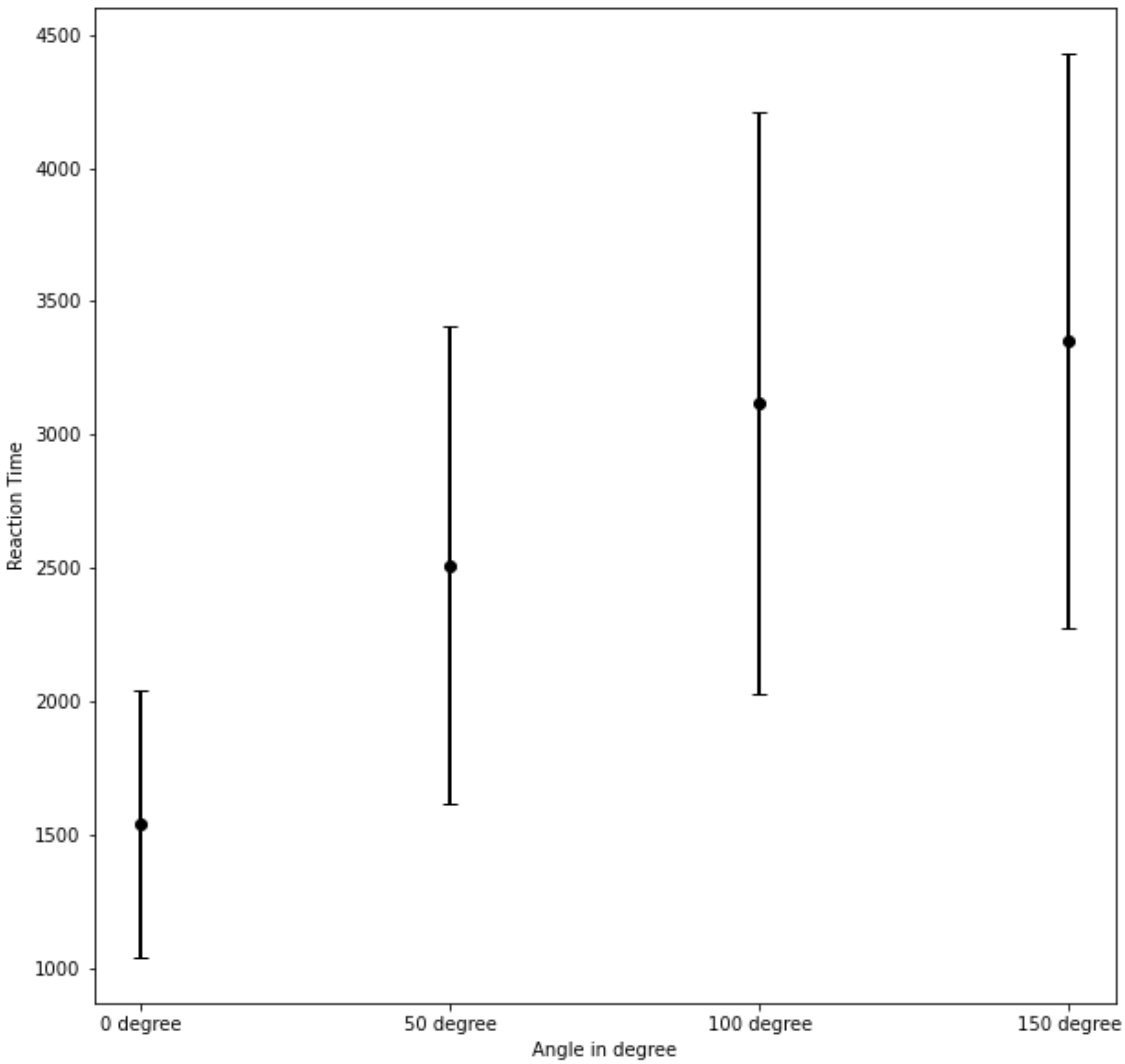
```
average of mean response time of 0 degree: 500.74333247432
average of mean response time of 50 degree: 897.2320579246239
average of mean response time of 100 degree: 1091.7502317075375
average of mean response time of 150 degree: 1077.2051397252965
```

Task 4.3: Plot the average and standard deviation values calculated above, against the four angles.

Task 4.4: Label both axes.

In [52]:
```
# plt.figure()

plt.rcParams['figure.figsize']=(10,10)
plt.errorbar(x =[0,50,100,150] ,y = angle_mean ,yerr= std_mean_angle_l
ist, fmt='o', ecolor='black', color='black', elinewidth=2, capsize=4)
# set xticks
ang_list = []
# making x axis looks nice
for i in range(4):
    ang_list.append(str(str(unique_angles[i]) + " degree"))

plt.xticks(unique_angles, ang_list)
plt.ylabel("Reaction Time")
plt.xlabel("Angle in degree")

# plt.show()
```

```
Out[52]: Text(0.5, 0, 'Angle in degree')
```

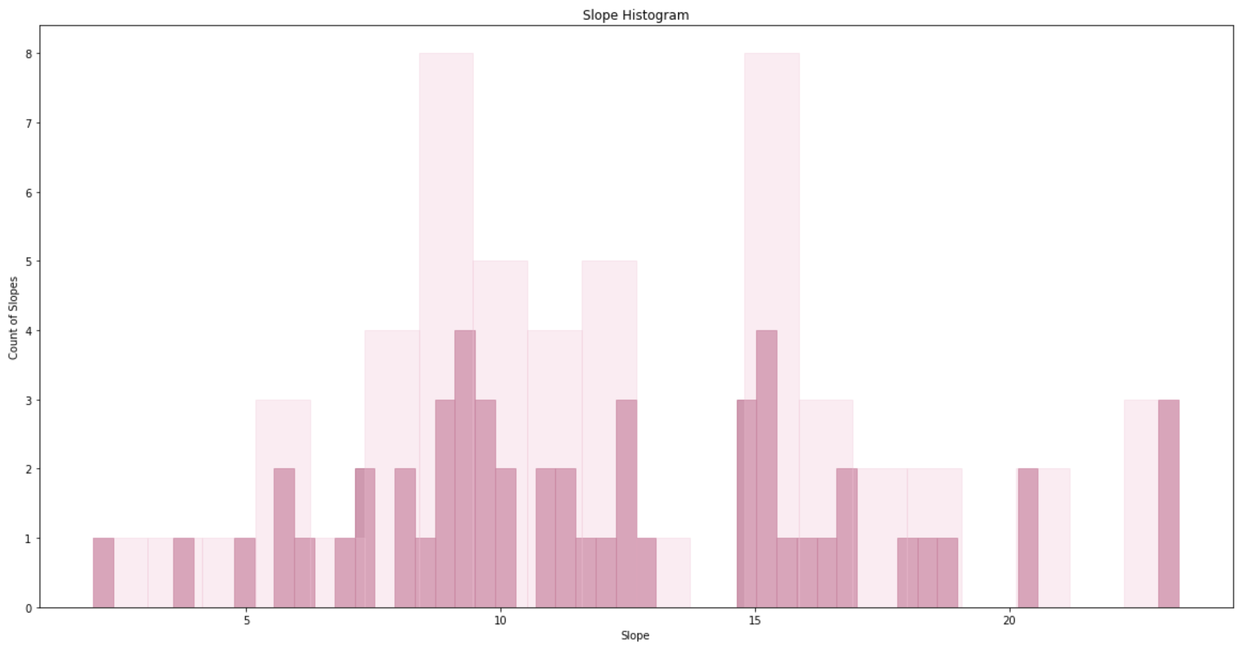


Task 5: Across-subject statistics [2pts]

Task 5.1: Plot a histogram of slopes (across subjects) from the line fits in **Tasks 1.1** and **1.2**.

Task 5.2: Label both axes.

In [74]:
```
# Write your code here.
plt.rcParams['figure.figsize']=(20,10)
plt.hist(slopes, facecolor='#ba6e8d', edgecolor='#ba6e8d', bins= 54, a
lpha=0.7)
# len(np.unique(slopes)) = 54, so all the unique slope value is being
plotted
plt.hist(slopes, facecolor='#f0c2d5', edgecolor='#f0c2d5', bins= 20,al
pha=0.3)
# a rounded version, for overall visualization of slope variation
plt.title("Slope Histogram")
plt.xlabel("Slope")
plt.ylabel("Count of Slopes")
plt.show()
```



Export and submit a **fully executable** Python Jupyter Notebook and a PDF copy of your notebook showing all results. Please follow the usual naming convention for **both** your Jupyter Notebook and PDF files: `lab3_writeup_YourStudentNumber.pdf`

In [ ]:
```

```