

## Practical 2: solutions

### Jumping Rivers

In this question, we are going to use a `for` statement to loop over a large data set and construct some scatter plots. To generate the data, run the following piece of code

```
import jupyterprogramming

exper = jupyterprogramming.datasets.experiment.load_data()

# change the column names
exper.columns = ["measure", "time", "treat"]
```

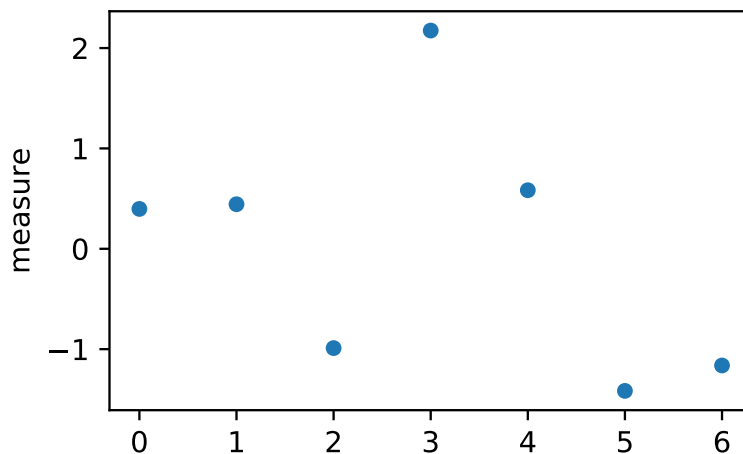
The data frame `exper` represents an experiment, where we have ten treatments:  $A, B, \dots, J$  and measurements at some time points. We want to create a scatter plot of measurement against time, for each treatment type.

2. First we create a scatter plot of one treatment:

```
group = exper[exper.treat == "A"]

import matplotlib.pyplot as plt

group.plot.scatter(x = "time", y = "measure")
```



3. To generate a scatter-plot for each treatment, we need to iterate over the different treatment types:

```
for i in exper.treat.unique():
    group = exper[exper.treat == i]
```

```
group.plot.scatter(x = "time", y = "measure")
plt.show()
input("Hit enter for next plot")
```

- What does `exper.treat.unique()` give?

```
print('It gives all the unique treatments.')
```

```
## It gives all the unique treatments.
```

- In the for loop, what variable is changing? What are its possible values?

```
print('The treat variable is changing. \
It goes through the different treatments.')
```

```
## The treat variable is changing. It goes through the different treatments.
```

- What does the `input()` function do?

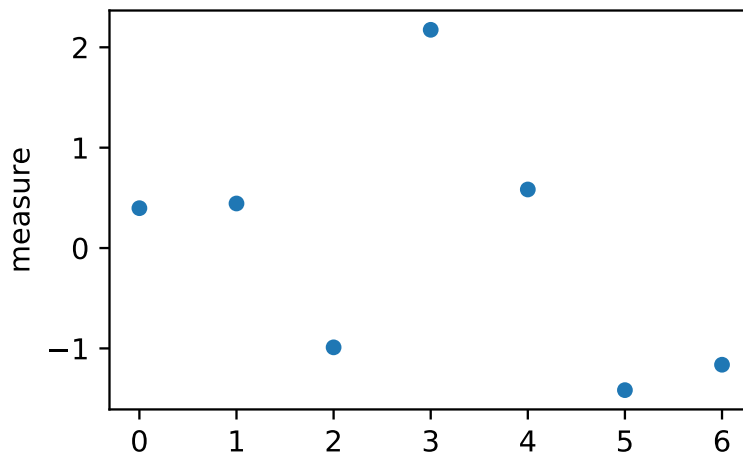
```
print(' It halts execution, waits for user input')
```

```
## It halts execution, waits for user input
```

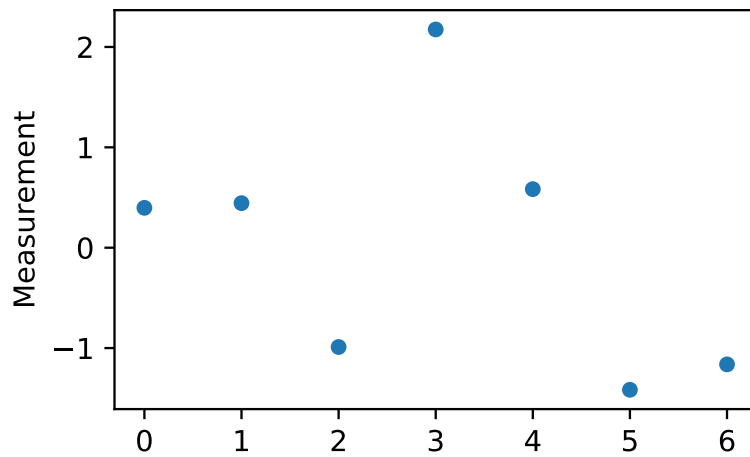
### Questions

1. The default axis labels aren't great. So we can change the  $x$ -axis label using `plt.xlabel()`:

```
group.plot.scatter(x = "time", y = "measure")
plt.xlabel("Time")
```



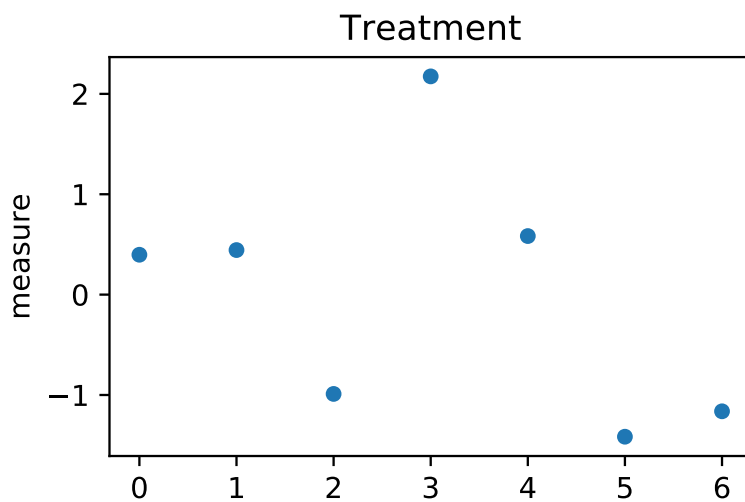
```
group.plot.scatter(x = "time", y = "measure")
plt.xlabel("Time")
plt.ylabel("Measurement")
```



Use the `ylab` argument to alter the  $y$ -axis label.

2. To add a title to a plot we use the `plt.title()` argument, viz:

```
group.plot.scatter(x = "time", y = "measure")
plt.title("Treatment")
```



3. We can concatenate strings/characters using `+`,

```
"Treatment "+"A"
```

```
## 'Treatment A'
```

Rather than have a static title, make the title of each plot display the treatment type.

```
group.plot.scatter(x = "time", y = "measure")
plt.xlabel("Time")
```

```
plt.ylabel("Measurement")
plt.title("Treatment "+ i)
plt.show()
```

4. The y-axis range should really be the same in all graphics. Add a `ylim` argument to fix the range.

**Hint:** Work out the range before the `for` loop.

```
ymin = exper.measure.min()
ymax = exper.measure.max()

group.plot.scatter(x = "time", y = "measure")
plt.xlabel("Time")
plt.ylabel("Measurement")
plt.title("Treatment "+i)
plt.ylim([ymin, ymax])
plt.show()
```

5. At each iteration, use the `print()` function to print the average measurement level across all time points.

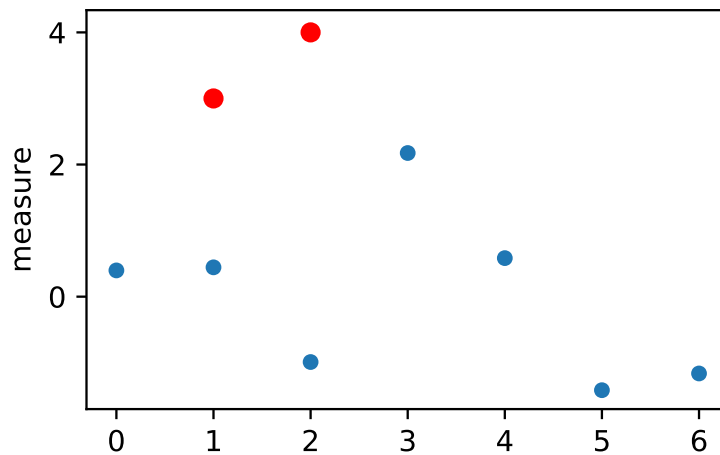
**Hint:** You will have to convert the mean to a string, to do this use the `str()` function.

```
##Within the for loop have the line
print("The mean is "+str(group.measure.mean()))
```

6. On each graph, highlight any observations with a blue point if they are larger than the mean + standard deviations or less than the mean - standard deviations. Store your graph as a variable, then use the `.scatter()` method to plot additional points.

**Hint:** You don't need `if` statements here. Just subset your data frame and pass this new data frame to the `points` function. For example, to highlight the points (1,2) and (3, 4) we use the command:

```
p = group.plot.scatter(x = "time", y = "measure")
p.scatter([1,2],[3,4], color = "red")
```



```
p = group.plot.scatter(x = "time", y = "measure")
plt.xlabel("Time")
plt.ylabel("Measurement")
plt.title("Treatment "+i)
plt.ylim([ymin, ymax])

## calculate outliers
measures = group.measure
upper_lim = np.mean(measures) + np.std(measures)
lower_lim = np.mean(measures) - np.std(measures)
outliers = group[(group.measure < lower_lim) | (group.measure > upper_lim)]

# add additional outlier points to the plot
p.scatter(outliers.time, outliers.measure, color = "red")
```

7.. Put your code, i.e. the for loop and plotting commands, in a function which takes the data frame as an argument.

```
## FULL SOLUTION
def viewgraphs(exper):
    ymin = exper.measure.min()
    ymax = exper.measure.max()
    for i in exper.treat.unique():
        group = exper[exper.treat == i]
        p = group.plot.scatter(x = "time", y = "measure")
        plt.xlabel("Time")
        plt.ylabel("Measurement")
        plt.title("Treatment "+i)
        plt.ylim([ymin, ymax])
```

```
measures = group.measure
upper_lim = np.mean(measures) + np.std(measures)
lower_lim = np.mean(measures) - np.std(measures)
outliers = group[(group.measure < lower_lim) | (group.measure > upper_lim)]

p.scatter(outliers.time, outliers.measure, color = "red")
input("Hit enter for next plot")
plt.show()
```