Data Analysis Project

Name:

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```

In this project, you will be producing a data analysis report. To do so, you will need to explore the dataset using a variety of data analysis methods. Not every distribution and technique is appropriate to every dataset and you will need to make those judgements on an individual basis, though there are several things you should do as part of the project:

- produce a thorough examination of the distributions and scale parameters (e.g. mean and standard deviation)
- explore for correlations between data vectors (basic plots and correlation coefficients) and produce a regression model if applicable
- hypothesis testing an aspect of the data; the testing should have some point you would like to make (e.g., whether a region or data group varies from the global mean)
- use a multidimensional analysis technique to examine similarities/differences between data groups (e.g., rock type, species)

Not every analysis will provide an interesting or useful result, but should be look at as an exploration of the data. You should also give a narrative discussing key observations about your analyses, though an interpretation is not necessary. You will need to interpret the plots and/or results of your analysis in the context of what knowledge is gained through each.

You DO NOT need to interpret the results in terms of a scientific process. For example, if you found a linear relationship between elevation and crustal thickness, you may discuss the significance, but you do not need to discuss the relevance of the relationship to the principles of isostasy.

There are two datasets to choose from:

- Evaristo&McDonnell2017_vegetation&groundwater.xlsx - https://doi.org/10.1038/srep44110 A global database of vegetation type and groundwater observations.
- Kelson_etal2020.xlsx - https://doi.org/10.1016/j.quascirev.2020.106259 A global database of soil and surface isotopes.

A reference for each dataset is also provided in case you have questions about what some of the column abbreviations may be or what the data represent. You will likely find some analyses in these references and it is acceptable to reproduce some of the same analyses, though you should also produce some new/different ones.

Each of these files can be loaded using readtable.m, though some modifications were made so that it could be easily read. As some of these files have multiple tabs, the only tab that is loaded is the first tab unless otherwise specified. In each case, the tab with the relevant data should be the first one. Sometimes MATLAB will change the names of the columns when it imports the data. You can see what the column names are at any time (assuming your table is named data) by typing data.Properties.VariableName (capital letters are important). If you have difficulty loading the data let me know.

I look foward to your analyses.

Analysis

For the final project, I choose "vegetation and groundwater" dataset to analyze

```
addpath 'Final project'\code\;
addpath 'Final project'\data\;
data=readtable("vegetation&groundwater.xlsx")
```

```
Warning: Column headers from the file were modified to make them valid MATLAB
identifiers before creating variable names for the table. The original column headers
are saved in the VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table
variable names.
data = 531×28 table
```

	PAPERYEAR	JOURNALNAME	PAPERTITLE	COUNTRY	SITE	LAT
1	1991	'Nature'	'1991 Dawson and…	'USA'	'SLC UT, US'	40.7667
2	1991	'Nature'	'1991 Dawson and…	'USA'	'SLC UT, US'	40.7667
3	1991	'Nature'	'1991 Dawson and…	'USA'	'SLC UT, US'	40.7667
4	1991	'Nature'	'1991 Smith et al. -…	'USA'	'Sierra Nev…	37.2500
5	1991	'Ecological Applicati…	'1991 Smith et al. -…	'USA'	'Sierra Nev…	37.3500
6	1991	'Ecological Applicati…	'1991 Smith et al. -…	'USA'	'Sierra Nev…	37.2500
7	1992	'Plant, Cell & Enviro…	'1992 Flanagan et …	'USA'	'Sand Dune…	37.0500
8	1992	'Plant, Cell & Enviro…	'1992 Flanagan et …	'USA'	'Sand Dune…	37.0500
9	1992	'Plant, Cell & Enviro…	'1992 Flanagan et …	'USA'	'Sand Dune…	37.0500
10	1992	'Plant, Cell & Enviro…	'1992 Flanagan et …	'USA'	'Sand Dune…	37.0500
11	1992	'Oecologia'	'1992 Ish-Shalom …	'USA'	'Florida Key…	24.6833
12	1992	'Oecologia'	'1992 Ish-Shalom …	'USA'	'Florida Key…	24.7000
13	1992	'Oecologia'	'1992 Ish-Shalom …	'USA'	'Florida Key…	24.6833
14	1992	'Functional Ecology'	'1992 Valentini et a…	'Italy'	'Montalto di…	42.3667

⋮

```
size(data)
```

```
ans = 1×2
   531    28
```

1) Produce a thorough examination of the distributions and scale parameters (e.g. mean and standard deviation)

- **Distribution of locations:**

```
% distribution of locations
number_long = data.LONG;
number_lat = data.LAT;

mean_long = mean(number_long) % calculate mean of longitudes
```

```
mean_long = -21.9932
```

```
long_std = std(number_long)  % calculate standard deviation of longitudes
```

```
long_std = 94.8490
```

```
long_skew = skewness(number_long) % calculate skewness of longitudes
```

```
long_skew = 0.5345
```

```
mean_lat=mean(number_lat)
```

```
mean_lat = 21.8748
```

```
lat_std=std(number_lat)
```

```
lat_std = 24.9995
```

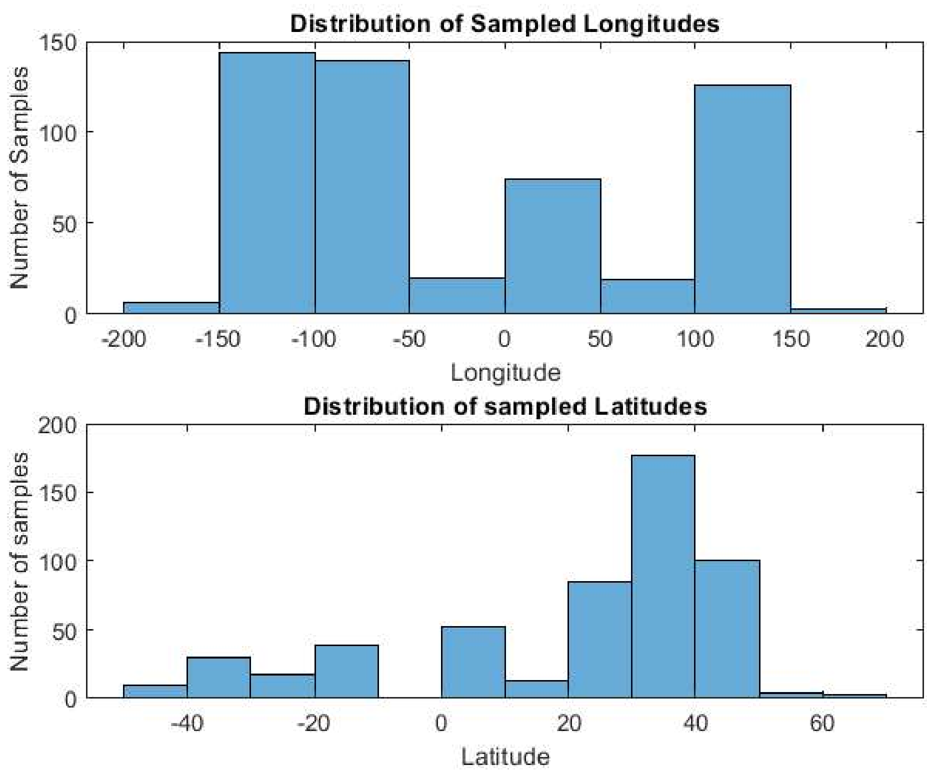
```
lat_skew=skewness(number_lat)
```

```
lat_skew = -1.1465
```

```
figure
subplot(2,1,1)
histogram(data.LONG)
ylabel('Number of Samples');
xlabel('Longitude');
title('Distribution of Sampled Longitudes');

subplot(2,1,2)
histogram(data.LAT)
ylabel('Number of samples');
xlabel('Latitude');
title('Distribution of sampled Latitudes');
histogram(data.LONG)
ylabel('Number of samples');
xlabel('Longitude');
title('Distribution of sampled Longitudes');

subplot(2,1,2)
histogram(data.LAT)
ylabel('Number of samples');
xlabel('Latitude');
title('Distribution of sampled Latitudes');
```



We can in the both Distribution of Longitudes and Latitudes histogram are not normally.

It is clear to see in the Longitude chart that those samples are mostly distributed in the West side rather than East side, and significant represented in the Northern hemisphere as looking at Latitude histogram.

As the skewness is 0.5345, the data are moderately skewed.

And this is the visualization of global distribution:

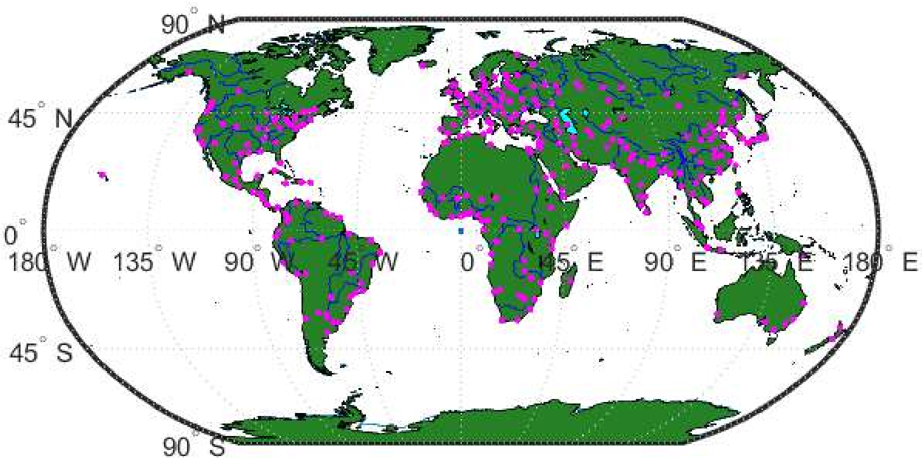
```
figure
worldmap world

load coastlines
[latcells, loncells] = polysplit(coastlat, coastlon);

numel(latcells)
```

```
ans = 241
```

```
plotm(coastlat,coastlon)
geoshow('landareas.shp', 'FaceColor', [0.15 0.5 0.15])
geoshow('worldlakes.shp', 'FaceColor', 'cyan')
geoshow('worldrivers.shp', 'Color', 'blue')
geoshow('worldcities.shp', 'Marker', '.',...
                           'MarkerEdgeColor', 'magenta')
hold on
scatter(data.LONG,data.LAT,30,'.')
hold off
```



- **Distribution of plant species:**

```
plant_species = unique(data.PlantSpecies);
unique(data.PlantSpecies);
Plant_Species=categorical(data.PlantSpecies);
summary(Plant_Species)
```

```
     Abies faxoniana                2
     Abies fraseri                  1
     Acacia erioloba                1
     Acacia tortilis                1
     Acer grandidentatum            2
```

```
Acer negundo                    2
Acer saccharum                  2
Achillea millefolium            1
Alchornea latifolia             1
Alchornea trewioides            1
Alhagi sparsifolia              1
Allocasuarina verticillata      1
Alnus glutinosa                 1
Alnus jorullensis               1
Alseis blackiana                1
```

- **Distribution of plant genus:**

```
plant_genus = unique(data.PlantGenus);
unique(data.PlantGenus);
Plant_Genus=categorical(data.PlantGenus);
summary(Plant_Genus)
```

```
Abies                3
Acacia               2
Acer                 6
Achillea             1
Alchornea            2
Alhagi               1
Allocasuarina        1
Alnus                2
Alseis               1
Ambrosia             1
Amorpha              1
Anacardium           2
Andropogon           1
Annona               1
Apocynum             1
```

From the summary, we can see the largest species are exampled is Pinus sylvestris (7), and the largest plant genus is Quercus (41)

- **Distribution of seed**

```
seeds = unique(data.Seed);
unique(data.Seed);
Seeds=categorical(data.Seed);
summary(Seeds)
```

```
angiosperm      473
gymnosperm       58
```

From the Seeds Summary, it is clear to see angiosperm is moslty presented.

2) Explore for correlations between data vectors (basic plots and correlation coefficients) and produce a regression model if applicable

Pearsons Correliation Coefficient:

```
numerical=data{:,{'LONG','LAT','Mean','DWT_m_','PET','MAP','AET',}};
Anumerical=rmmissing(numerical);
Pearson = corr(Anumerical)
```

```
Pearson = 7×7
```

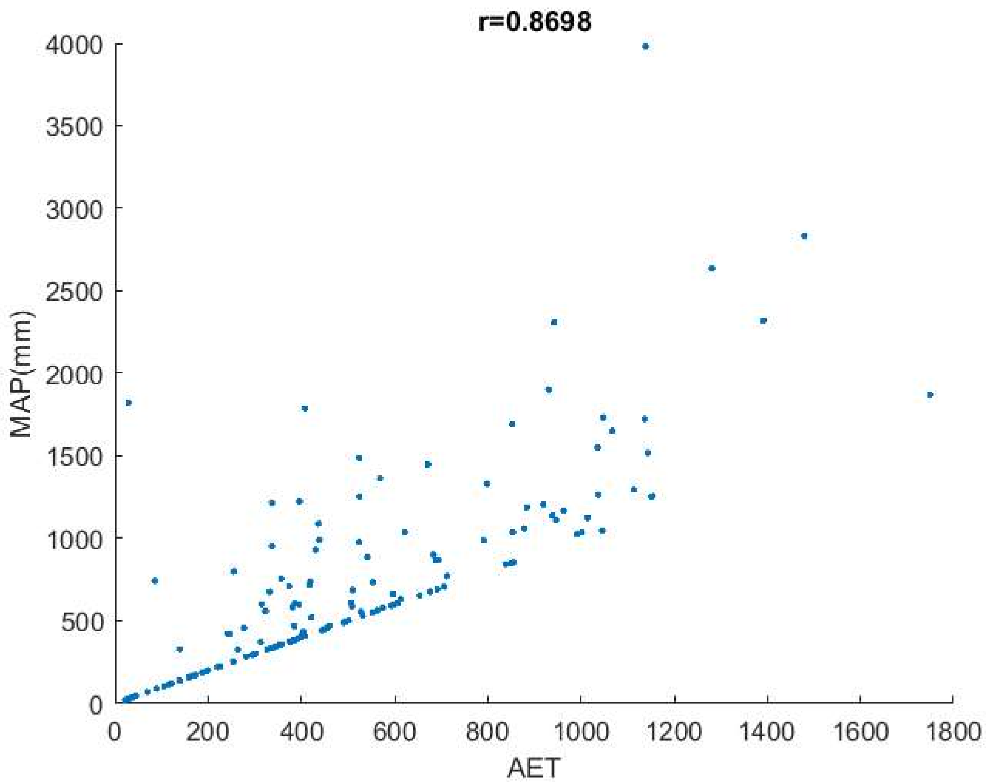
```
    1.0000   -0.7120    0.2409   -0.2505    0.3999    0.3309    0.3094
   -0.7120    1.0000   -0.0181    0.1857   -0.3171   -0.2597   -0.2853
    0.2409   -0.0181    1.0000   -0.0673    0.2302   -0.0753   -0.0031
   -0.2505    0.1857   -0.0673    1.0000    0.1183   -0.1927   -0.2329
    0.3999   -0.3171    0.2302    0.1183    1.0000    0.1595    0.2518
    0.3309   -0.2597   -0.0753   -0.1927    0.1595    1.0000    0.9115
    0.3094   -0.2853   -0.0031   -0.2329    0.2518    0.9115    1.0000
```

Key take-away points from this table are:

- The strongest correlation is between AET and MAP which is 0.9115
- Besides AET and MAP, it seems that the rest of relationships are weak.

These relationships are indicated below:

```
scatter(data.AET,data.MAP,'.')
title('r=0.8698')
xlabel('AET')
ylabel('MAP(mm)')
```



3) Hypothesis testing an aspect of the data; the testing should have some point you would like to make (e.g., whether a region or data group varies from the global mean)

null hypothesis = angiosperms and gynosperms have the different influence of groudwater

alternate hypothesis = angiosperms and gymnosperms have the same influence of groudwater

```
angiosperms = groupfilter(data,'Seed',@(x) all(x == "angiosperm"),'Seed')
```

angiosperms = 473×28 table

	PAPERYEAR	JOURNALNAME	PAPERTITLE	COUNTRY	SITE	LAT
1	1991	'Nature'	'1991 Dawson and…	'USA'	'SLC UT, US'	40.7667
2	1991	'Nature'	'1991 Dawson and…	'USA'	'SLC UT, US'	40.7667
3	1991	'Nature'	'1991 Dawson and…	'USA'	'SLC UT, US'	40.7667
4	1991	'Nature'	'1991 Smith et al. -…	'USA'	'Sierra Nev…	37.2500

	PAPERYEAR	JOURNALNAME	PAPERTITLE	COUNTRY	SITE	LAT
5	1991	'Ecological Applicati…	'1991 Smith et al. -…	'USA'	'Sierra Nev…	37.3500
6	1991	'Ecological Applicati…	'1991 Smith et al. -…	'USA'	'Sierra Nev…	37.2500
7	1992	'Plant, Cell & Enviro…	'1992 Flanagan et …	'USA'	'Sand Dune…	37.0500
8	1992	'Plant, Cell & Enviro…	'1992 Flanagan et …	'USA'	'Sand Dune…	37.0500
9	1992	'Plant, Cell & Enviro…	'1992 Flanagan et …	'USA'	'Sand Dune…	37.0500
10	1992	'Oecologia'	'1992 Ish-Shalom …	'USA'	'Florida Key…	24.6833
11	1992	'Oecologia'	'1992 Ish-Shalom …	'USA'	'Florida Key…	24.7000
12	1992	'Oecologia'	'1992 Ish-Shalom …	'USA'	'Florida Key…	24.6833
13	1992	'Functional Ecology'	'1992 Valentini et a…	'Italy'	'Montalto di…	42.3667
14	1992	'Functional Ecology'	'1992 Valentini et a…	'Italy'	'Montalto di…	42.3667

⋮

```
angio_mag=rmmissing(angiosperms.Mean); % mean of ground water contribute to angiosperms
angio_mean=mean(angio_mag)
```

```
angio_mean = 37.1003
```

```
gymnosperms = groupfilter(data,'Seed',@(x) all(x == "gymnosperm"),'Seed')
```

```
gymnosperms = 58×28 table
```

	PAPERYEAR	JOURNALNAME	PAPERTITLE	COUNTRY	SITE	LAT
1	1992	'Plant, Cell & Enviro…	'1992 Flanagan et …	'USA'	'Sand Dune…	37.0500
2	1992	'Functional Ecology'	'1992 Valentini et a…	'Italy'	'Montalto di…	42.3667
3	1994	'Functional Ecology'	'1994 Donovan an…	'USA'	'Tintic UT, U…	39.9167
4	1994	'Oecologia'	'1994 Evans and E…	'USA'	'Sand Dune…	37.0500
5	1994	'Oecologia'	'1994 Evans and E…	'USA'	'Sand Dune…	37.0500
6	1995	'Canadian Journal o…	'1995 Bishop and …	'Sweden'	'N. Sweden'	64.2333
7	1995	'Canadian Journal o…	'1995 Bishop and …	'Sweden'	'N. Sweden'	64.2333
8	1999	'Oecologia'	'1999 Plamboeck …	'Sweden'	'N. Sweden'	64.2333
9	2001	'Trees'	'2001 Retzlaff et al…	'USA'	'Scotland C…	34.8400
10	2006	'Tree Physiology'	'2006 Fritzsche et …	'Ethiopia'	'Munessa-S…	7.4333
11	2006	'Tree Physiology'	'2006 Fritzsche et …	'Ethiopia'	'Munessa-S…	7.4333
12	2011	'Ecohydrology'	'2011 Xu et al. - W…	'China'	'W. Sichuan…	30.7500
13	2012	'Tree Physiology'	'2012 Andrews et …	'Canada'	'Pincher Cr…	49.6990
14	2012	'Tree Physiology'	'2012 Andrews et …	'Canada'	'Pincher Cr…	49.6990

⋮

```
gymno_mag=rmmissing(gymnosperms.Mean); % mean of ground water contribute to gynosperms
gymno_mean=mean(gymno_mag)
```

```
gymno_mean = 27.9791
```

```
std_angio=std(angio_mag)
```

```
std_angio = 40.3380
```

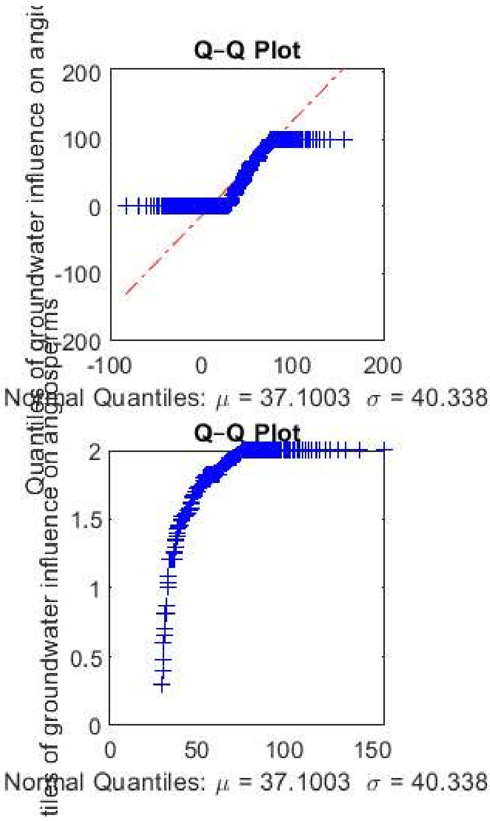
```
std_gymno=std(gymno_mag)
```

```
std_gymno = 37.6278
```

We can see clearly that agiosperms have greater influence by groundwater (mean = 37.1003) then gymnosperms (mean = 27.9791)

```
figure
subplot(2,1,1)
```

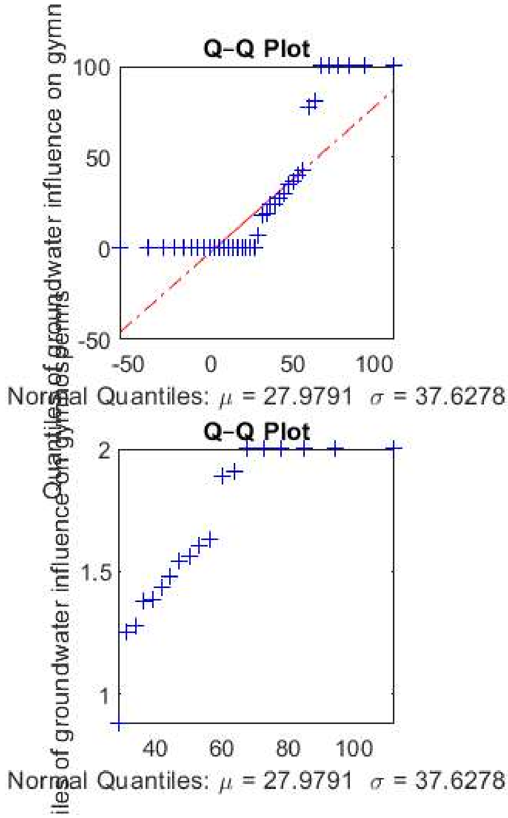
```
h = qqplot(angio_mag,makedist('Normal','mu',angio_mean,'sigma',std_angio));
title('Q-Q Plot')
ylabel('Quantiles of groundwater influence on angiosperms');
xlabel(['Normal Quantiles: \mu = ',num2str(angio_mean),'  \sigma = ',num2str(std_angio)]);
axis square;
set(gca,'Box','on');
subplot(2,1,2)
h = qqplot(log10(angio_mag),makedist('Normal','mu',angio_mean,'sigma',std_angio));
title('Q-Q Plot')
ylabel('Quantiles of groundwater influence on angiosperms');
xlabel(['Normal Quantiles: \mu = ',num2str(angio_mean),'  \sigma = ',num2str(std_angio)]);
axis square;
set(gca,'Box','on');
```



The first plot indicates the middle section is well represented by normal distribution, but the right above and left below show that it is not a well normal distribution.

```
figure
subplot(2,1,1)
h = qqplot(gymno_mag,makedist('Normal','mu',gymno_mean,'sigma',std_gymno));
title('Q-Q Plot')
ylabel('Quantiles of groundwater influence on gymnosperms');
xlabel(['Normal Quantiles: \mu = ',num2str(gymno_mean),'  \sigma = ',num2str(std_gymno)]);
axis square;
set(gca,'Box','on');

subplot(2,1,2)
h = qqplot(log10(gymno_mag),makedist('Normal','mu',gymno_mean,'sigma',std_gymno));
title('Q-Q Plot')
ylabel('Quantiles of groundwater influence on gymnosperms');
xlabel(['Normal Quantiles: \mu = ',num2str(gymno_mean),'  \sigma = ',num2str(std_gymno)]);
axis square;
set(gca,'Box','on');
```



The first plot indicates the middle section is well represented by normal distribution but not better than angiosperms plot. Also, the right above and left below show that it is not a well normal distribution.

As has just been shown, the data for the most part fits normal distribution hence we can use the T test:

```
ttest2(angio_mag,gymno_mag)
```

```
ans = 0
```

T-test = 0 indicates a failure to reject the null hypothesis at the 5%.

It means that angiosperms and gynosperms have the different influence of groudwater

4) Use a multidimensional analysis technique to examine similarities/differences between data groups (e.g., rock type, species)

```
maxAngio=max(angiosperms.Mean)
```

```
maxAngio = 100
```

```
minAngio=min(angiosperms.Mean)
```

```
minAngio = 0
```

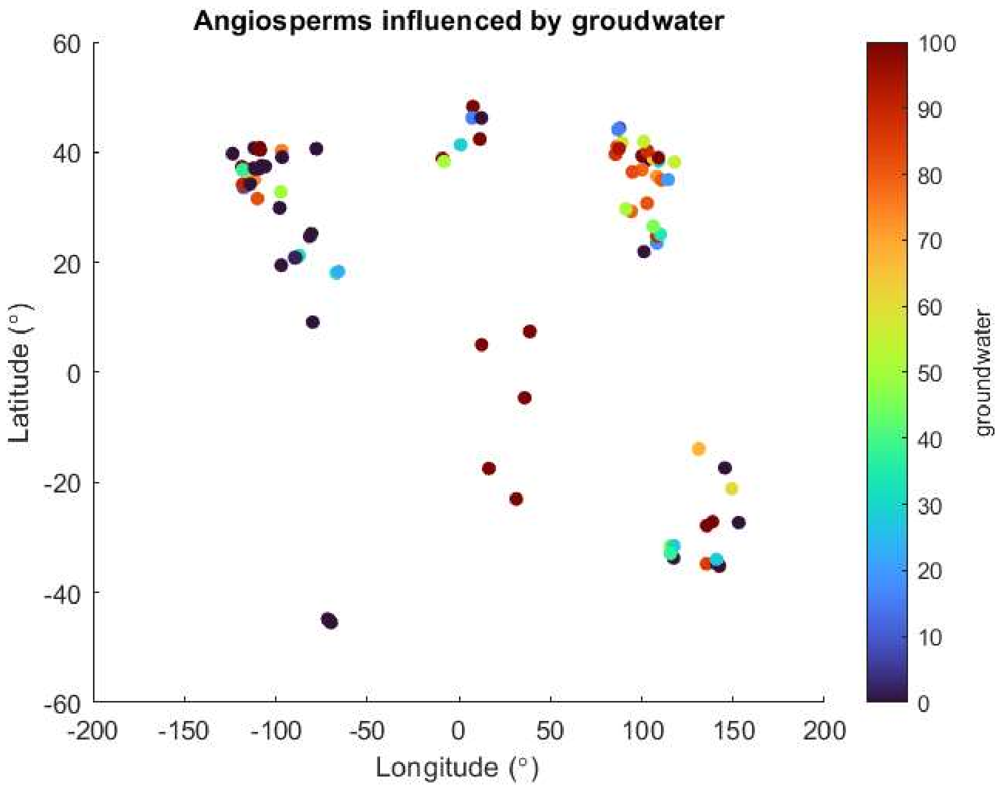
```
x = angiosperms.LONG;
y = angiosperms.LAT;
v = angiosperms.Mean;

figure
hold on;

scatter(x,y,30,v,'filled');
colormap("turbo");
cb = colorbar;
cb.Label.String = 'groundwater';
caxis([minAngio maxAngio]);
xlabel('Longitude (\circ)');
```

```
ylabel('Latitude (\circ)');
hold off;

title('Angiosperms influenced by groudwater');
```




```
maxGymno=max(gymnosperms.Mean)
```

```
maxGymno = 100
```

```
minGymno=min(gymnosperms.Mean)
```

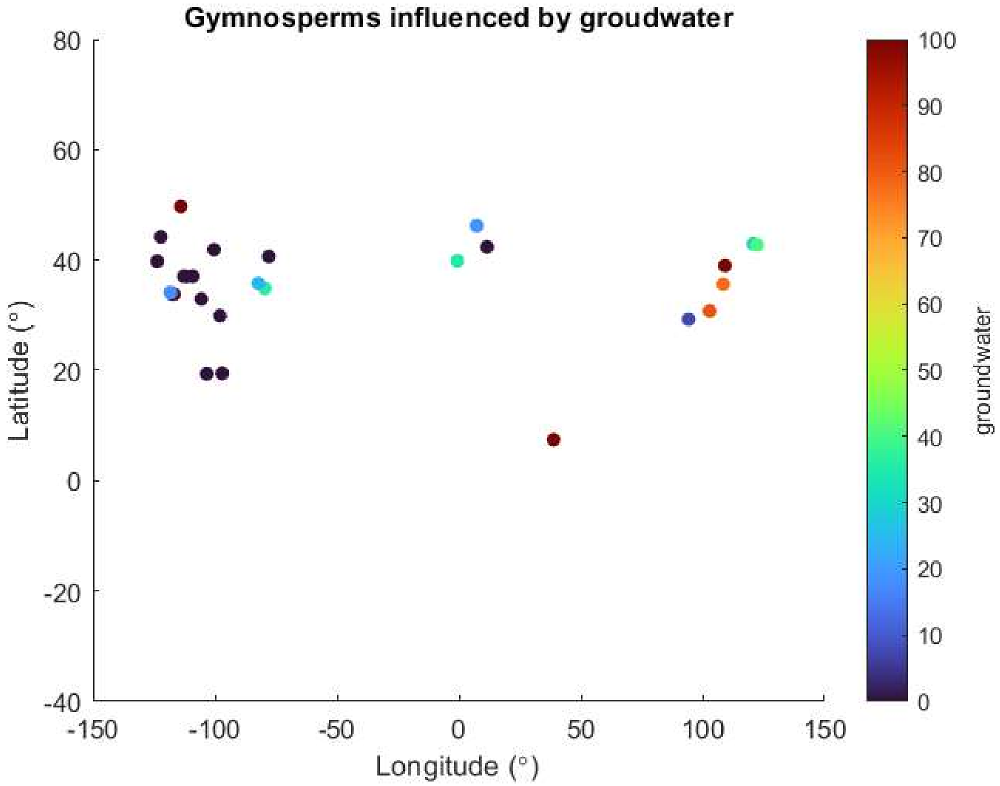
```
minGymno = 0
```

```
x = gymnosperms.LONG;
y = gymnosperms.LAT;
v = gymnosperms.Mean;

figure
hold on;

scatter(x,y,30,v,'filled');
colormap("turbo");
cb = colorbar;
cb.Label.String = 'groundwater';
caxis([minGymno maxGymno]);
xlabel('Longitude (\circ)');
ylabel('Latitude (\circ)');
hold off;

title('Gymnosperms influenced by groudwater');
```



These two map clearly presents three dimensions; latitude, longitude and groundwater influence on angiosperms and gymnosperms.