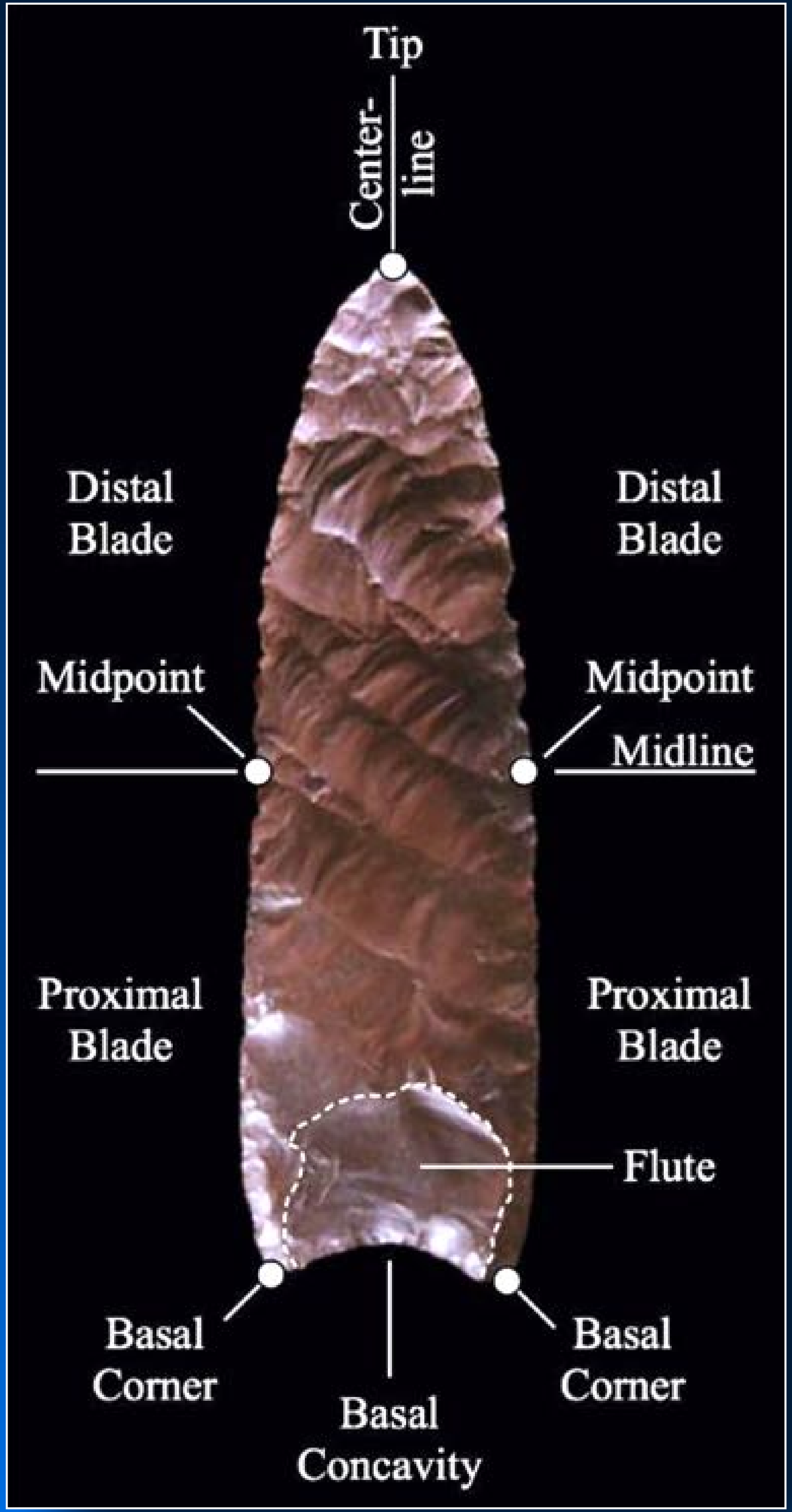
Lab Practical Assignment V

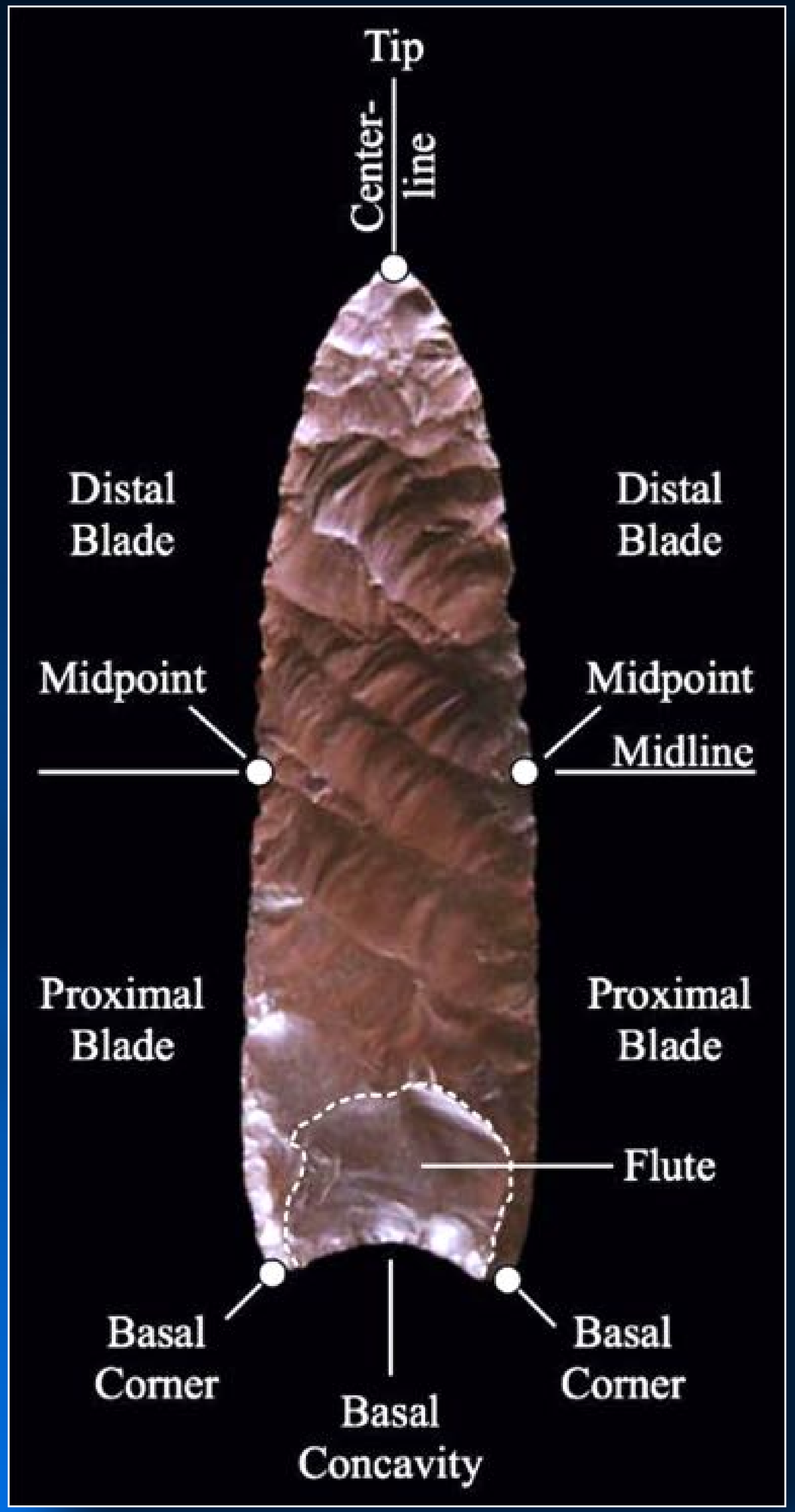
Morphometrics & Spatial Data Analysis




Lab Practical Assignment V

1. The Clovis dataset (Clovis.csv, Clovis.dat) contains a set of outline semilandmarks for 148 Clovis archeological points collected from four regions in the continental United States. In order to understand human cultural development archaeologists often wish to quantify and compare the forms of artifacts fashioned by craftsmen in different geographic regions, especially in those cases where written records are not available. Analysis of the nominal artifacts that define fluted projectile points, such as those characteristic of the North American Clovis culture (ca. 11,600 – 10,800 radiocarbon yrs BP, 13,550 –12,850 calibrated yrs B.P.), represents an interesting case in point. Identified primarily by their production of a distinctively shaped bladed tool, the PaleoIndian cultures that created these artifacts spread across North America in the interval between the retreat of the northern glaciers at the end of the Pleistocene and the start of the Younger Dryas cold interval. Regional variation in the forms and/or shapes of these artifacts (Fig. 2) has been cited as evidence that Clovis people did, and did not vary their design in response to local environmental conditions or situations, including fabrication material availability, prey types, cultural differences, use in ceremonial activities, etc. Analyse the shapes of these Clovis point outlines and address the following questions. (100 points)



Lab Practical Assignment V

1. The Clovis dataset (Clovis.csv, Clovis.dat) contained set of outline semilandmarks for 148 Clovis archeological points collected from four regions in the continental United States. … (100 points)

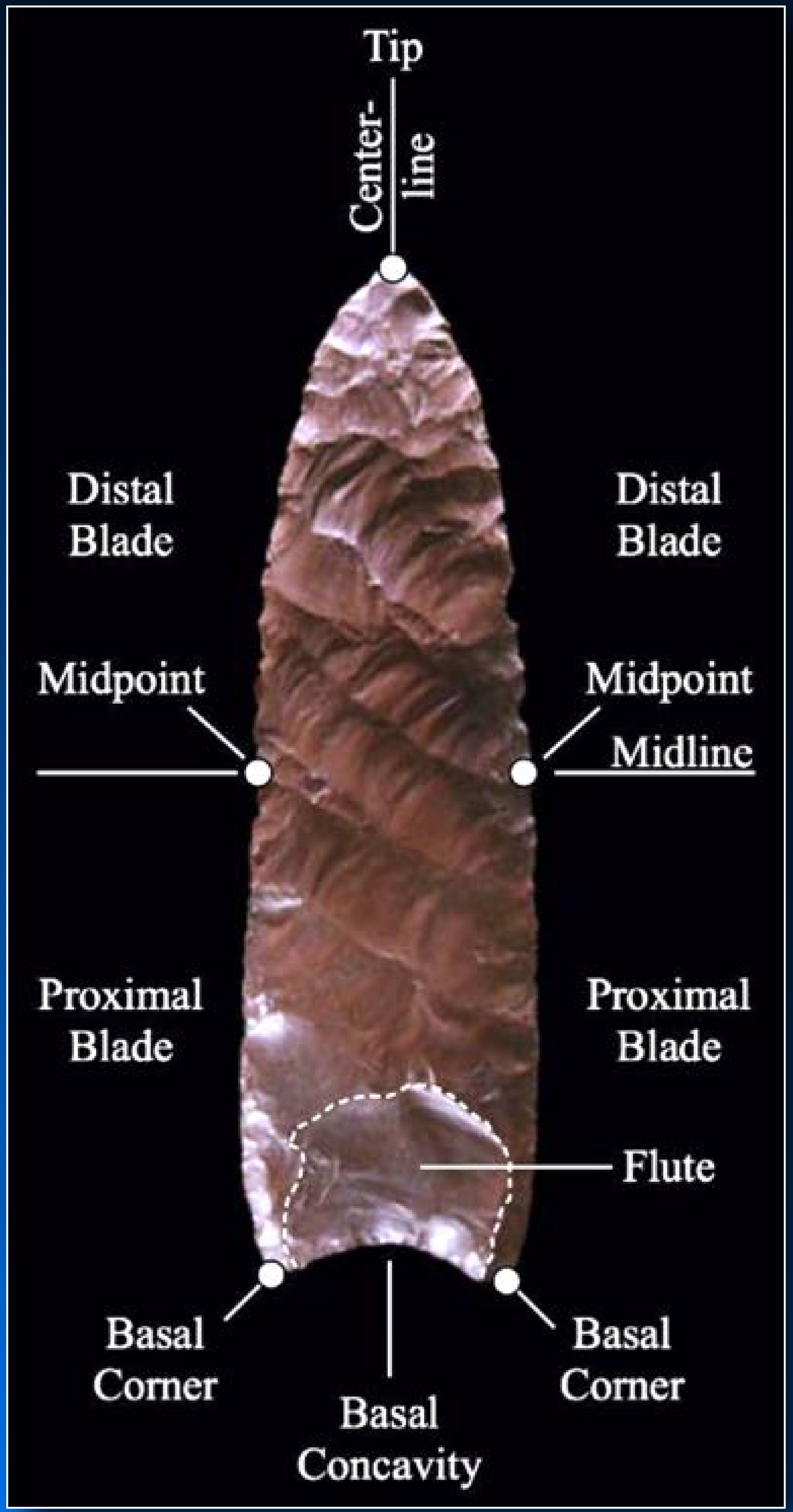
   a. Do these data need to be transformed prior to analysis? (10 points)

   b. Can the dimensionality of these data be reduced without losing potentially important information content? If so, by what means and by how much? Describe the methods and how the data-analysis results that support your (written) interpretation. (20 points)

   c. What are the major directions of shape variation across the pooled sample? Describe the methods and how the data-analysis results that support your (written) interpretation. (20 points)

   d. Do distinctions, in terms of Clovis-point shape variation, exist between the regions from which the samples were collected? Describe the methods and how the data-analysis results that support your (written) interpretation. (30 points)

   e. If any regional distinctions exist, are they significant statistically? Describe the methods and how the data-analysis results that support your (written) interpretation. (20 points)



Lab Practical Assignment V

Clovis Point Outlines

n	Group	*x1*	*y1*	*x2*	*y2*	*x3*	y3	x4	y4	x5	y5
1	Southwest	0.3171	0.0089	0.2705	0.0527	0.2150	0.0845	0.1562	0.1097	0.0936	0.1229
2	Southwest	0.3273	0.0070	0.2846	0.0550	0.2264	0.0827	0.1630	0.0946	0.0992	0.1038
3	Southwest	0.3251	0.0126	0.2768	0.0518	0.2230	0.0831	0.1648	0.1050	0.1028	0.1099
4	Southwest	0.3405	0.0042	0.2864	0.0436	0.2237	0.0675	0.1586	0.0835	0.0931	0.0980
5	Southwest	0.3170	0.0036	0.2779	0.0552	0.2213	0.0866	0.1585	0.1025	0.0952	0.1160
6	Southwest	0.3145	0.0131	0.2666	0.0548	0.2080	0.0790	0.1531	0.1105	0.0910	0.1240
7	Southwest	0.3107	0.0110	0.2691	0.0568	0.2144	0.0859	0.1548	0.1028	0.0940	0.1145
8	Southwest	0.3430	0.0039	0.2886	0.0433	0.2301	0.0762	0.1640	0.0885	0.0979	0.1001
9	Southwest	0.3313	0.0054	0.2844	0.0517	0.2248	0.0799	0.1601	0.0928	0.0954	0.1055
10	Southwest	0.0061	0.2966	0.0417	0.2314	0.0601	0.0601	0.1643	0.0697	0.0969	0.0767

Lab Practical Assignment V

1. Calibrating airborne and satellite remote sensing systems requires extensive "ground truthing" via comparison with features whose local and/or regional distributions are known. As part of a calibration exercise a high-angle arial photograph was taken of a test area in southern Arizona in which the taxonomic identification of each individual plant was known. These plants were classified into two types based on their ecologies: extremely drought-tolerant creosote-type plants (e.g., *Larrea tridentata*, left)) and moderately drought-tolerant brittlebush-type plants (e.g., *Encelia fairnose*, right). The locations of these plants in the test area are given in the Arizona datasets (Arizona.csv, Arizona.dat). Use quadrate analysis to quantify and compare the distributions of these plant types in answering the following questions. (90 points)

   a. Do these data need to be transformed prior to analysis? (10 points)

   b. Use the combined distributions of both plants to define 9 cell, 16 cell and 25 cell quadrate sampling schemes. Show your cell counts. (10 points)

Lab Practical Assignment V

1. Calibrating airborne and satellite remote sensing systems requires extensive “ground truthing” … (90 points)

   c. Test for distributional uniformity for the drought-tolerant creosote-type plants and the brittle-bush plants using each sampling scheme. Show the data-analysis results that support your (written) interpretation. (20 points)

   d. Combine the two datasets and test for distri-butional randomness and clustering for the drought-tolerant creosote-type plants and the brittlebush plants using a 15 x 15 quadrat sampling scheme. Show the distribution map and data-analysis results that support your (written) interpretation. (20 points)

   e. On the basis of the results you obtained in 3c and 3d decide whether the two plant types exhibit similar of different distributions in the test area. Refer to specific data-analysis results that support your (written) interpretation. (30 points)

Lab Practical Assignment V

Arizona Test Site Locations

n	Type	X Axis	Y Axis
1	Creosote-Type	21.97	6.56
2	Creosote-Type	25.59	8.41
3	Creosote-Type	36.90	7.79
4	Creosote-Type	42.01	4.10
5	Creosote-Type	17.91	10.05
6	Creosote-Type	16.42	10.87
7	Creosote-Type	12.37	10.66
9	Creosote-Type	15.14	12.71
10	Creosote-Type	18.98	12.10

n	Type	X Axis	Y Axis
8	Brittlebush Type	13.44	12.30
11	Brittlebush Type	22.82	11.69
26	Brittlebush Type	30.92	14.15
29	Brittlebush Type	37.32	19.27
30	Brittlebush Type	38.82	20.71
31	Brittlebush Type	40.31	20.91
34	Brittlebush Type	43.08	23.78
35	Brittlebush Type	48.84	25.63
36	Brittlebush Type	50.55	26.86

Lab Practical Assignment V

3. At present, over some 190 have been conformed to exist on Earth (see Earth Impact Database). The North American Impact Structures datasets (North American Impact Structures.csv, North American Impact Structures.dat) lists the locations of the 60 impact structures known from North America (the US, Canada and Mexico) along with the 10 suspected structures that remain unconfirmed at this time. Analyze the geographic distribution of these impact known and suspected structures and answer the following questions. (120 points)

   a. Do these data need to be transformed prior to analysis? (10 points)

   b. Are the confirmed impact structures distributed uniformly across North America? Describe the methods and how the data-analysis results that support your (written) interpretation. (20 points)

   c. Do the confirmed impact structures exhibit unusual clustering or dispersion across North America? If so, what might this arise from? Describe the methods and how the data-analysis results that support your (written) interpretation. (30 points)

   d. Are the unconfirmed impact structure positions distributed uniformly within their own spatial field? Describe the methods and show the data-analysis results that support your (written) interpretation. (20 points)

   e. If positions of the unconfirmed structures are combined with the positions of the confirmed impact structures, would this change your answers to 3b and/or 3c? Show the data-analysis results that support your (written) interpretation. (40 points)

Lab Practical Assignment V

North American Impact Database

Name	Location	Diameter (km)	Age (years)	Latitude	Longitude
Brent	Ontario	3.8	396 ± 20	46°5′N	78°29′W
Carswell	Saskatchewan	39	115 ± 10	58°27′N	109°30′W
Charlevoix	Quebec	54	342 ± 15	47°32′N	70°18′W
Couture	Quebec	8	430 ± 25	60°8′N	75°20′W
Deep Bay	Saskatchewan	13	99 ± 4	56°24′N	102°59′W
Eagle Butte	Alberta	10	< 65	49°42′N	110°30′W
Elbow	Saskatchewan	8	395 ± 25	50°59′N	106°43′W
Gow	Saskatchewan	4	< 250	56°27′N	104°29′W
Haughton	Nunavut	23	39	75°23′N	89°40′W

Lab Practical Assignment V

4. The cuticula of many trilobites display numerous tubercles , which are small raised bumps or granular-like protuberances on a structure's surface. In some trilobites these are thought to house specialized organs that allowed the trilobite to sense its local environment. If this hypotheses is correct it would be interesting to know whether the distribution of these tubercles was random, clustered or dispersed. The Tubercles dataset (Tubercles.csv, Tubercles.dat) contains information on the positions of 136 tubercles collected from the left-hand side of the cranidium from a single Paradoxides forchhammeri specimen. Use nearest-neighbor analysis to answer the following questions. (100 points)
    a. Do these data need to be transformed prior to analysis? (10 points)
    b. What is the expected mean nearest neighbor distance for these data based on the naîve estimate and Donnelly's (1978) correction for edge effects? In this calculation use the area and perimeter of the distribution's convex hull as the area estimate. (20 points)
    c. What is the mean nearest neighbor distance for these data? (20 points)
    d. Based on the results you obtained in 4b and 4c, decide whether the tubercles in this specimen display a random, clustered or dispersed distribution. Show the data-analysis results that support your (written) interpretation. (30 points)
    e. Based on the results you obtained in 4d offer explanations for the distribution, and the function, of tubercles under the assumption that they housed some sort of sensory organ. (20 points)

Lab Practical Assignment V

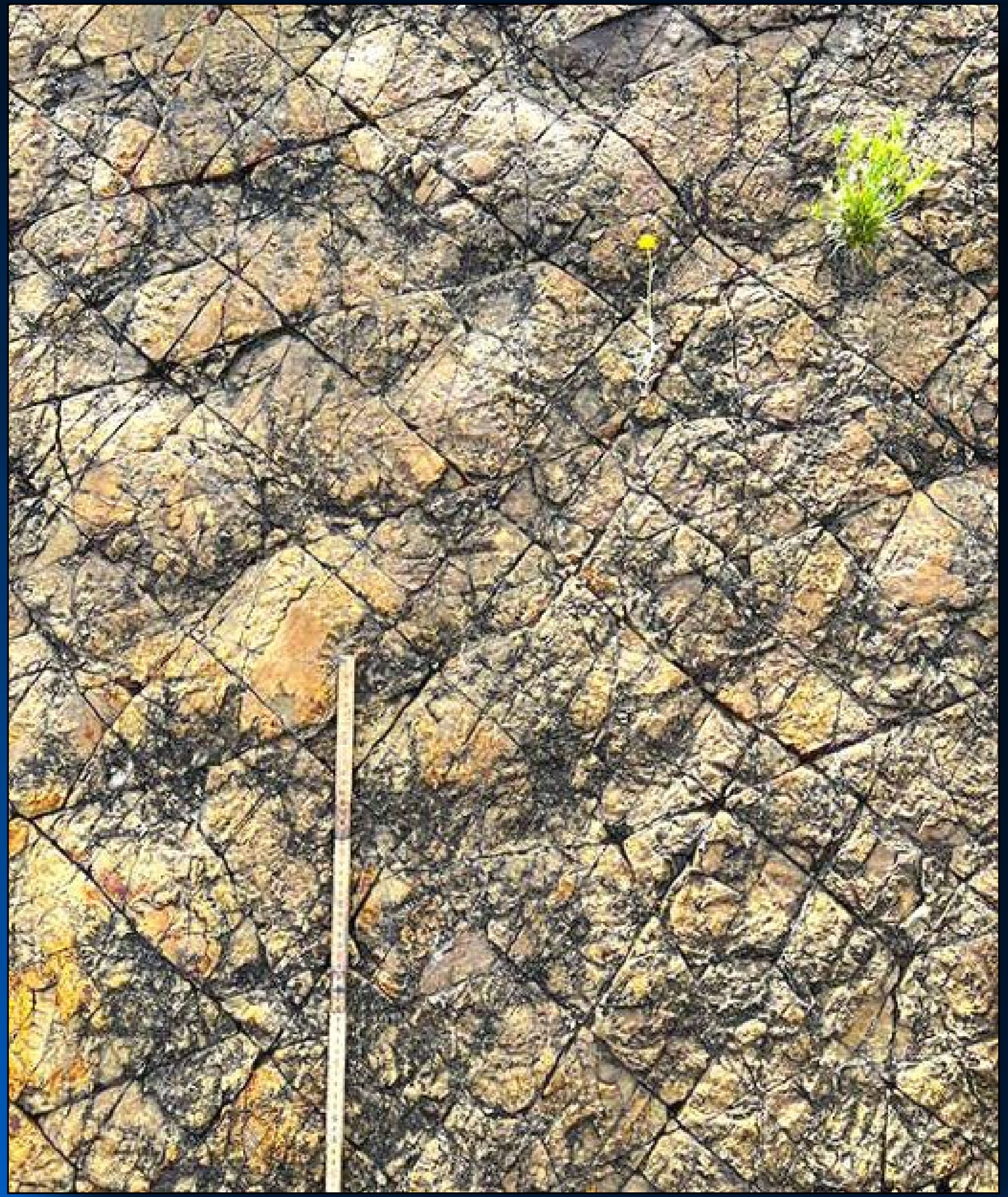
Trilobite Glabellar Tubercles

n	Group	x-Axis (cm)	y-Axis (cm)
1	Paradoxides forchhammeri	0.306	1.932
2	Paradoxides forchhammeri	0.240	1.825
3	Paradoxides forchhammeri	0.404	1.935
4	Paradoxides forchhammeri	0.357	1.798
5	Paradoxides forchhammeri	0.460	1.872
6	Paradoxides forchhammeri	0.568	1.874
7	Paradoxides forchhammeri	0.574	1.754
8	Paradoxides forchhammeri	0.724	1.847
9	Paradoxides forchhammeri	0.808	1.839
10	Paradoxides forchhammeri	0.788	1.681

n	Group	x-Axis (cm)	y-Axis (cm)
11	Paradoxides forchhammeri	0.916	1.694
12	Paradoxides forchhammeri	0.922	1.823
13	Paradoxides forchhammeri	1.061	1.834
14	Paradoxides forchhammeri	1.081	1.632
15	Paradoxides forchhammeri	1.128	1.651
16	Paradoxides forchhammeri	1.148	1.782
17	Paradoxides forchhammeri	1.234	1.842
18	Paradoxides forchhammeri	1.454	1.763
19	Paradoxides forchhammeri	1.348	1.670
20	Paradoxides forchhammeri	1.357	1.593

Lab Practical Assignment V

3. In the development of petroleum reservoirs it is important to understand the direction(s) petroleum resources can be expected to flow. In this context it would be useful to know whether lineaments exposed on the surfaces of reservoir-rock outcrops are indicative of fractures at depth. The three Odessa datasets (Odessa North, Odessa Northwest, Odessa West) contain surface lineament direction measurements for two reservoir rock formations In the Odessa North field independent assessments of the reservoir fracture pattern characterizing the Grayburg Dolomite at depth suggest its fractures exhibit a trend of approx. N 75° E. In the Odessa Northwest field (also the Grayburg Dolomite) at-depth studies suggest fracture trends of N 35° E and N 55° W. The Odessa West field drawn petroleum from the San Andrews Limestone where water flood breakthrough data suggest a channeling trend of N 75° E. The Odessa North, Odessa Northwest and Odessa West datasets each contain surface lineament measurements for outcrops of the reservoir rocks in question. Use these data to perform the following analyses and answer their associated questions. (120 points)



   a. Do these data need to be transformed prior to analysis? (10 points)

   b. Display direction rose charts for the Odessa North, Odessa Northwest and Odessa West datasets. Use these to estimate the mean lineament directions and their associated 95 percent confidence angles. (30 points)

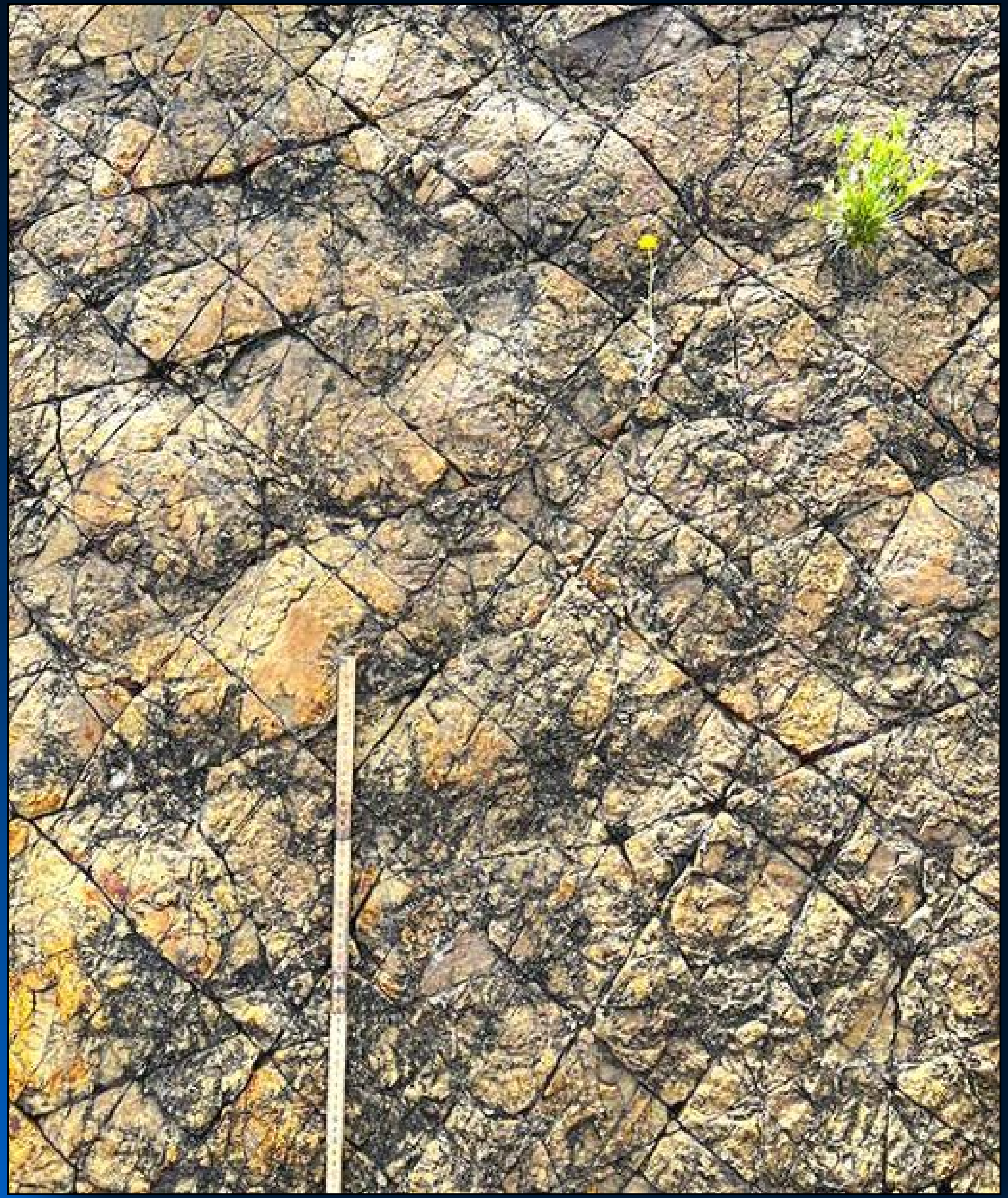
Lab Practical Assignment V

3. In the development of petroleum reservoirs it is important to understand the direction(s) petroleum resources can be expected to flow. … (120 points)

a. On a pairwise basis, do these lineament data all exhibit the same trend directions? Show the data-analysis results that support your (written) interpretation. (30 points)

b. Are each of the lineament datasets consistent with the estimates of at-depth fracture trends for their respective petroleum production fields? Show the data-analysis results that support your (written) interpretation. (30 points)

c. How might any discrepancies between surface lineament trends and at-depth direction flow trends be accounted for? (20 points)



Lab Practical Assignment V

Odessa Direction Data

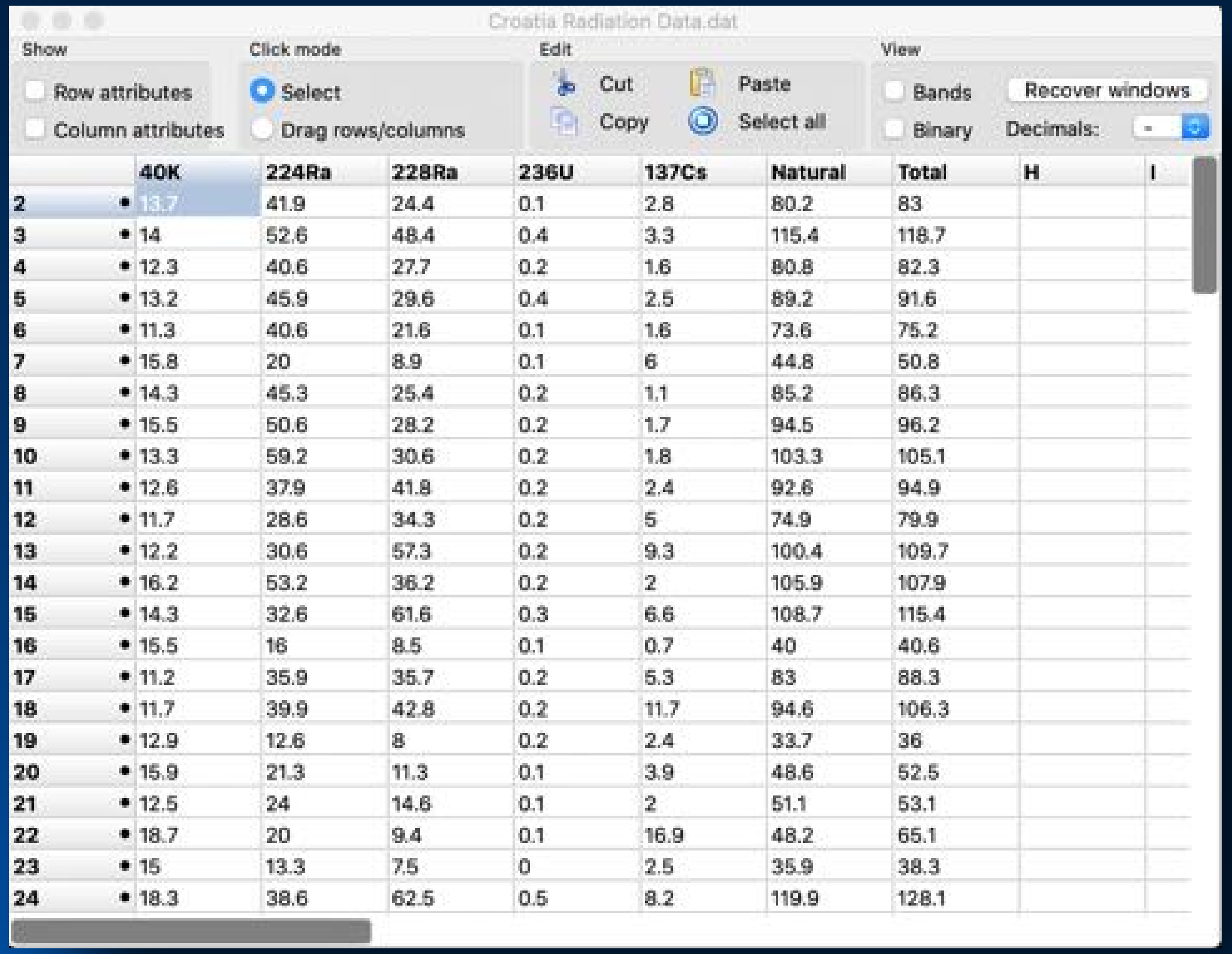
n	Group	Azimuth
1	Odessa North	49.3
2	Odessa North	43.3
3	Odessa North	47.4
4	Odessa North	129.0
5	Odessa North	128.5
6	Odessa North	126.3
7	Odessa North	127.8
8	Odessa North	125.0
9	Odessa North	47.5
10	Odessa North	47.8

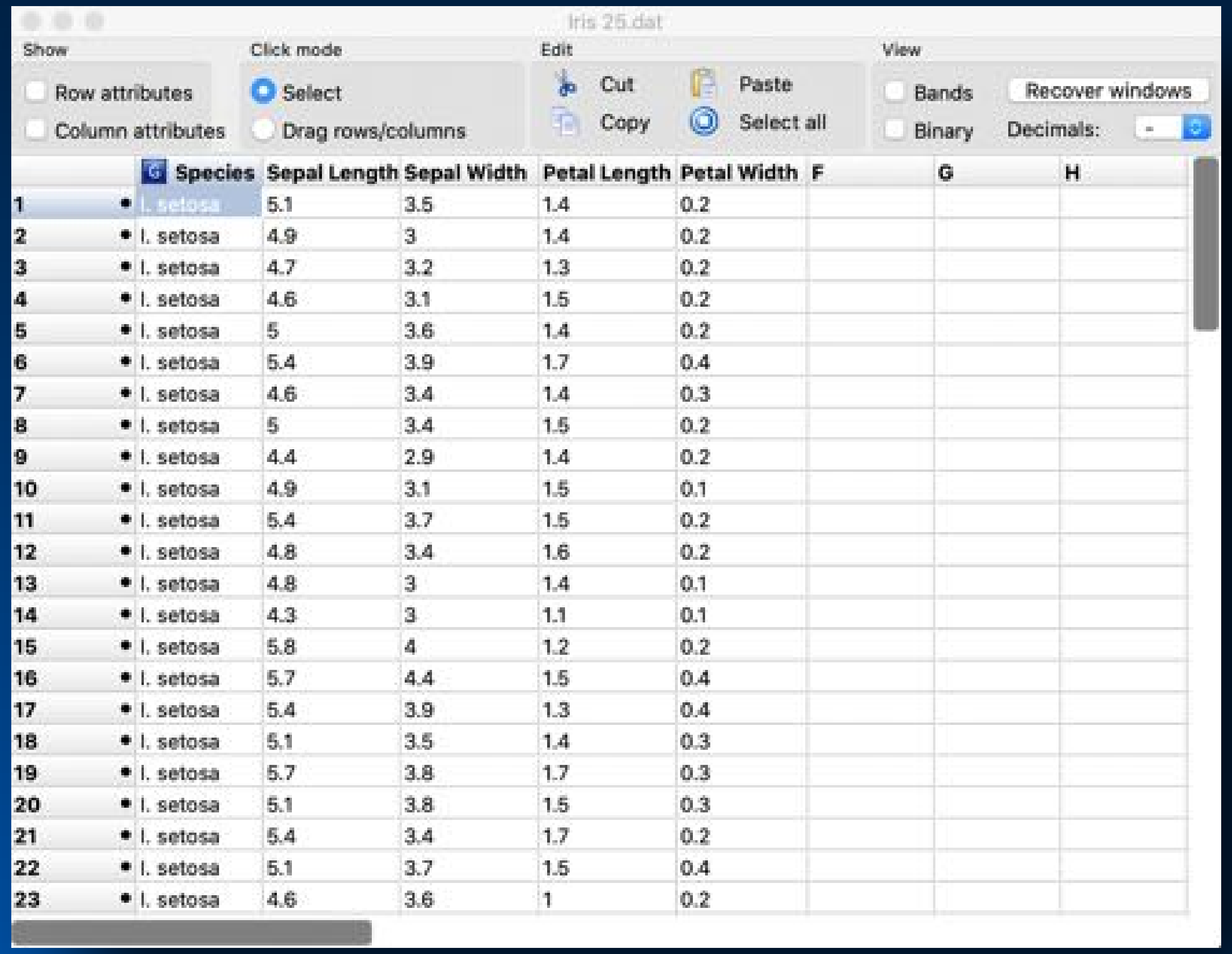
n	Group	Azimuth
1	Odessa Northwest	35.3
2	Odessa Northwest	105.9
3	Odessa Northwest	33.2
4	Odessa Northwest	249.4
5	Odessa Northwest	78.5
6	Odessa Northwest	34.7
7	Odessa Northwest	76.0
8	Odessa Northwest	31.0
9	Odessa Northwest	32.5
10	Odessa Northwest	241.9

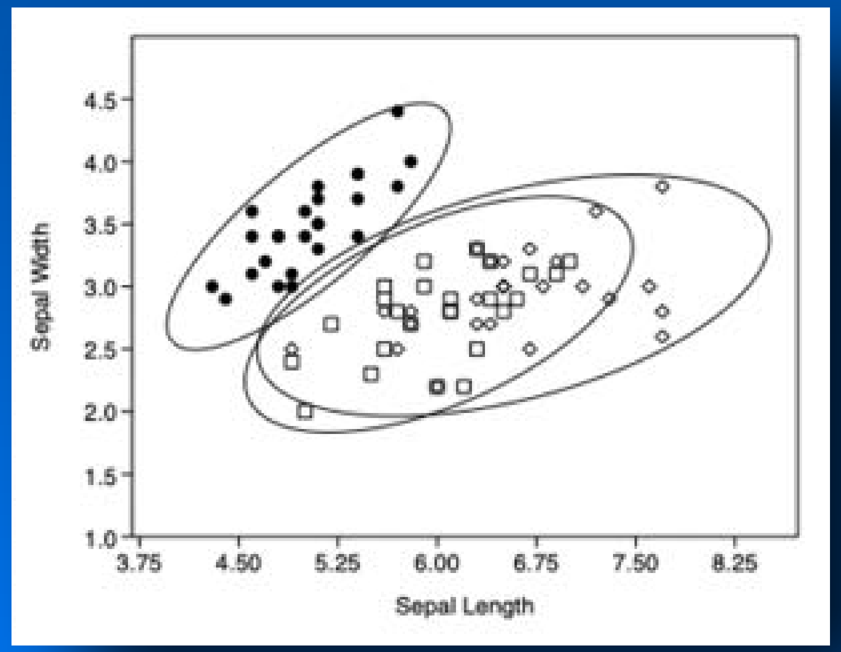
n	Group	Azimuth
1	Odessa West	27.8
2	Odessa West	181.4
3	Odessa West	47.5
4	Odessa West	12.2
5	Odessa West	242.7
6	Odessa West	68.0
7	Odessa West	48.8
8	Odessa West	180.5
9	Odessa West	77.5
10	Odessa West	246.2

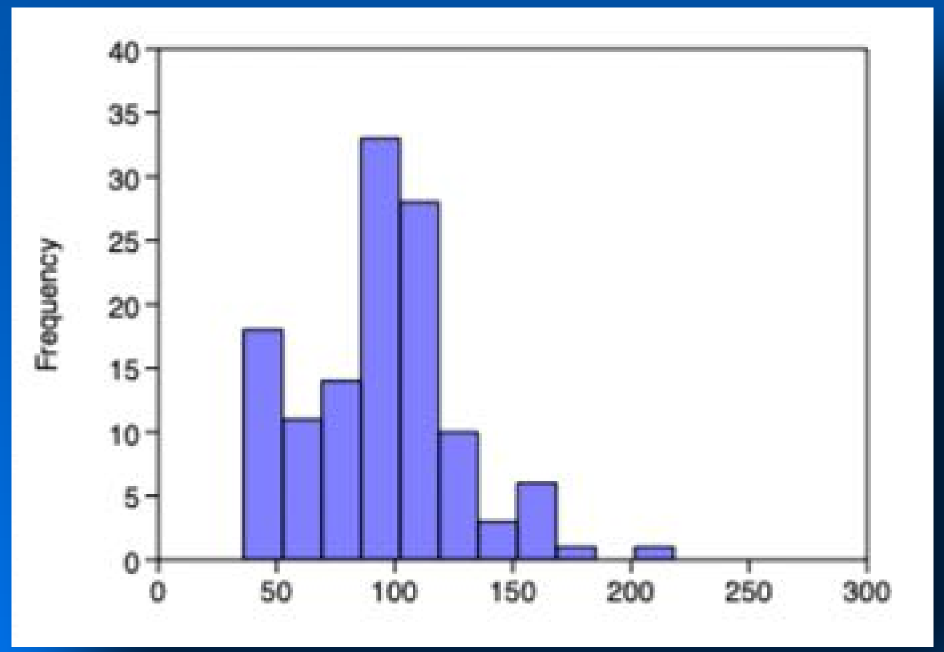
Lab Practical Assignment IV

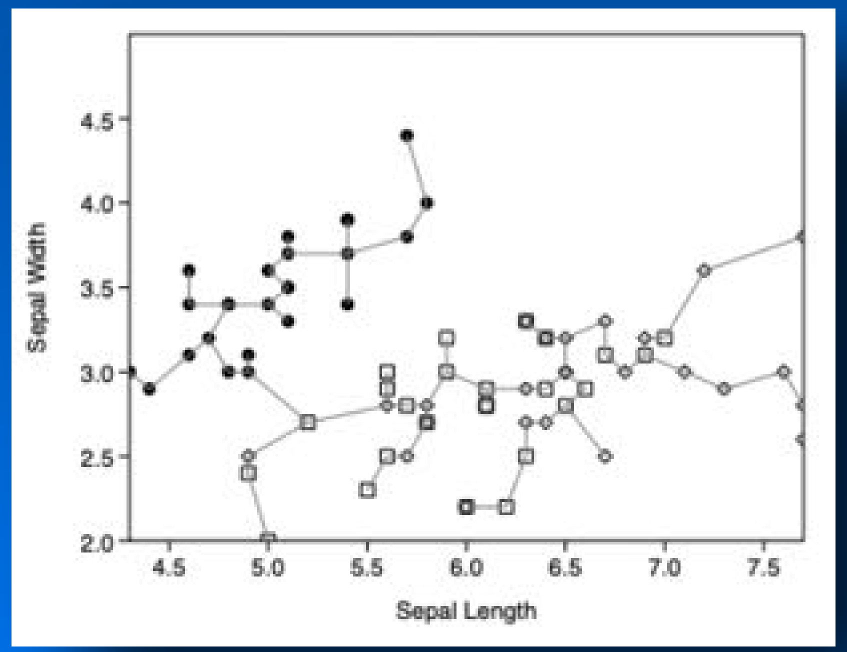
Multivariate Data Analysis, Morphometrics & Diversity











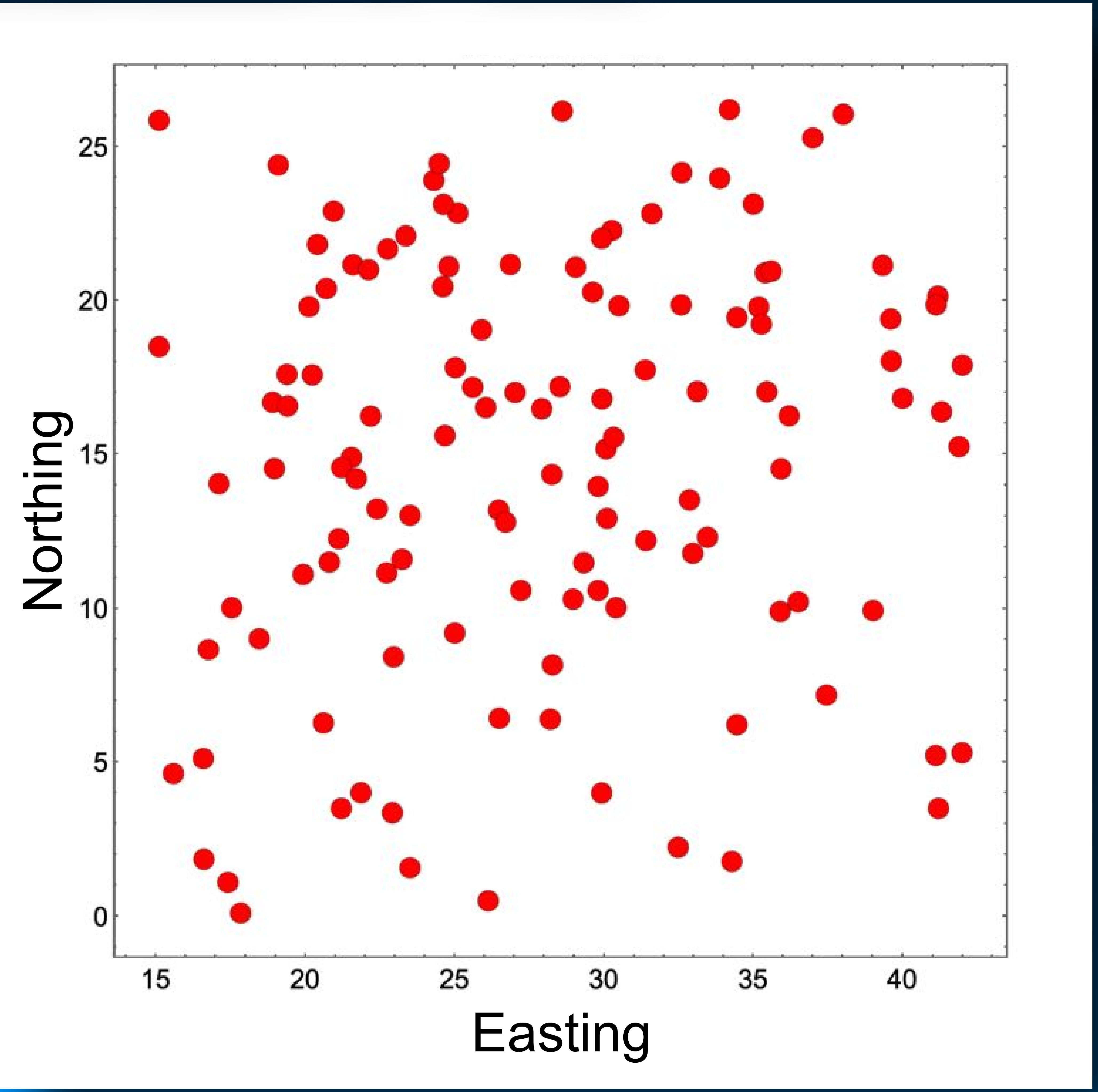
Distribution of Points

Test for Uniform Distribution of Points

Often one of the first questions to be confronted in an earth science context is what sort of spatial distribution the sampled localities in a dataset exhibit.

This is a plot of the locations of 123 wells drilled in the Arbuckle Group in central Kansas.

Do these data exhibit uniform density?



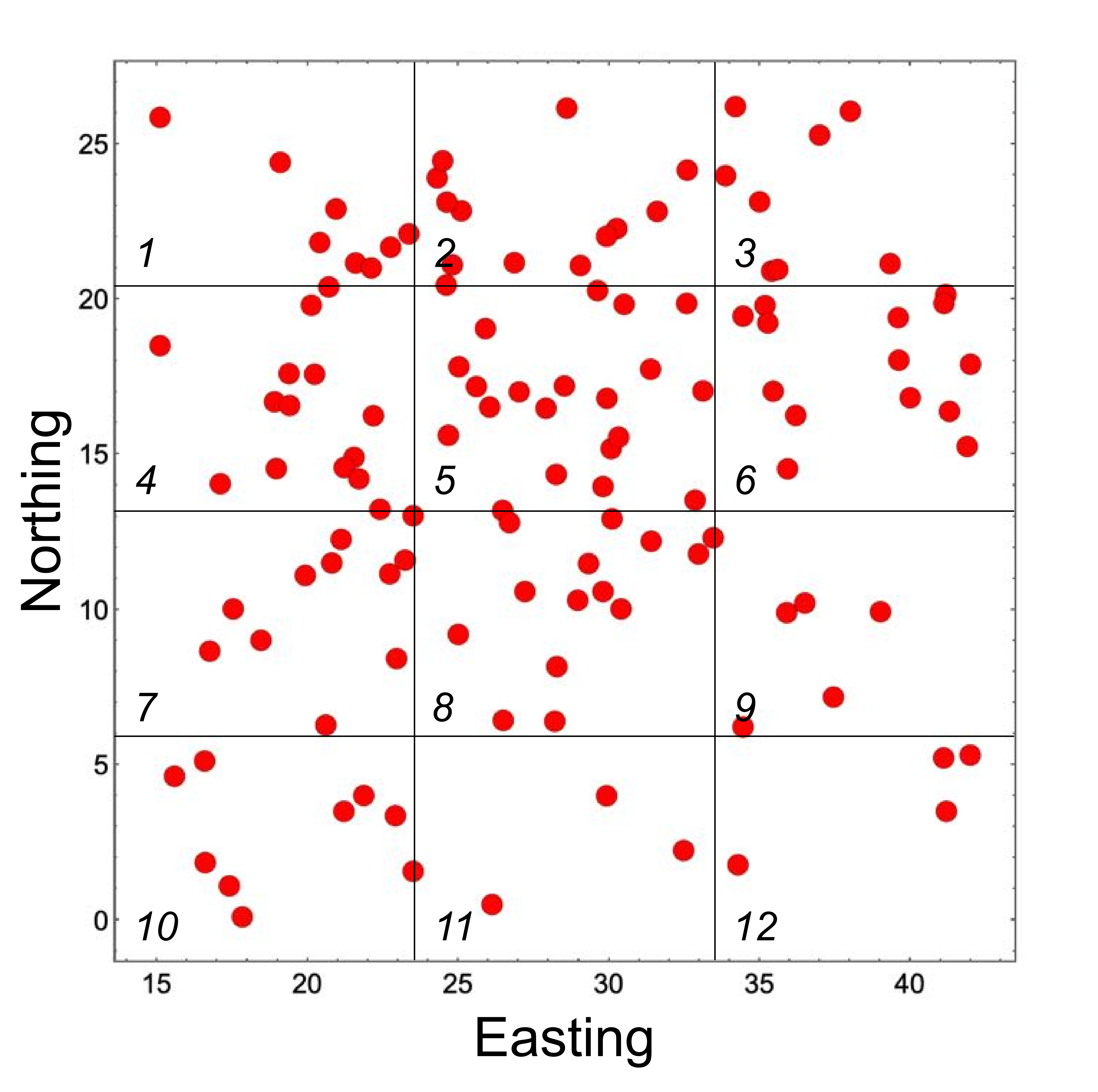
Distribution of Points

Test for Uniform Distribution of Points: Quadrat Analysis

One approach would be to partition the area into a series of equal-size quadrats and count the frequency of wells that fall into each partition.

If the wells are spaced uniformly there should be no statistically significiant difference between the quadrat frequency counts.

Cell	Obs.
1	8
2	13
3	8
4	14
5	20
6	14
7	11
8	14
9	5
10	9
11	3
12	4
Σ	123

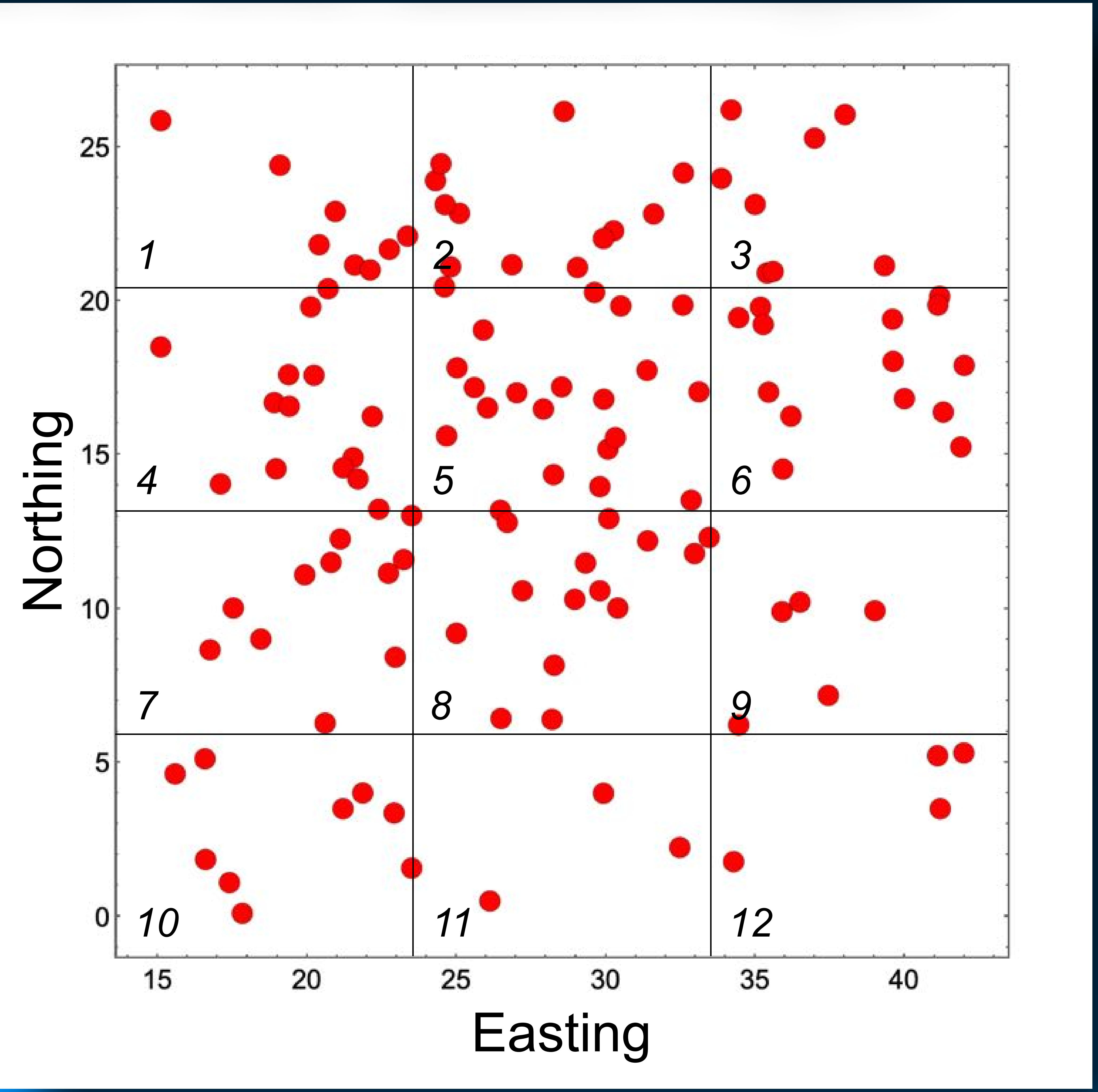


Distribution of Points

Test for Uniform Distribution of Points: Quadrat Analysis

The Chi-Squared (χ^2) Test

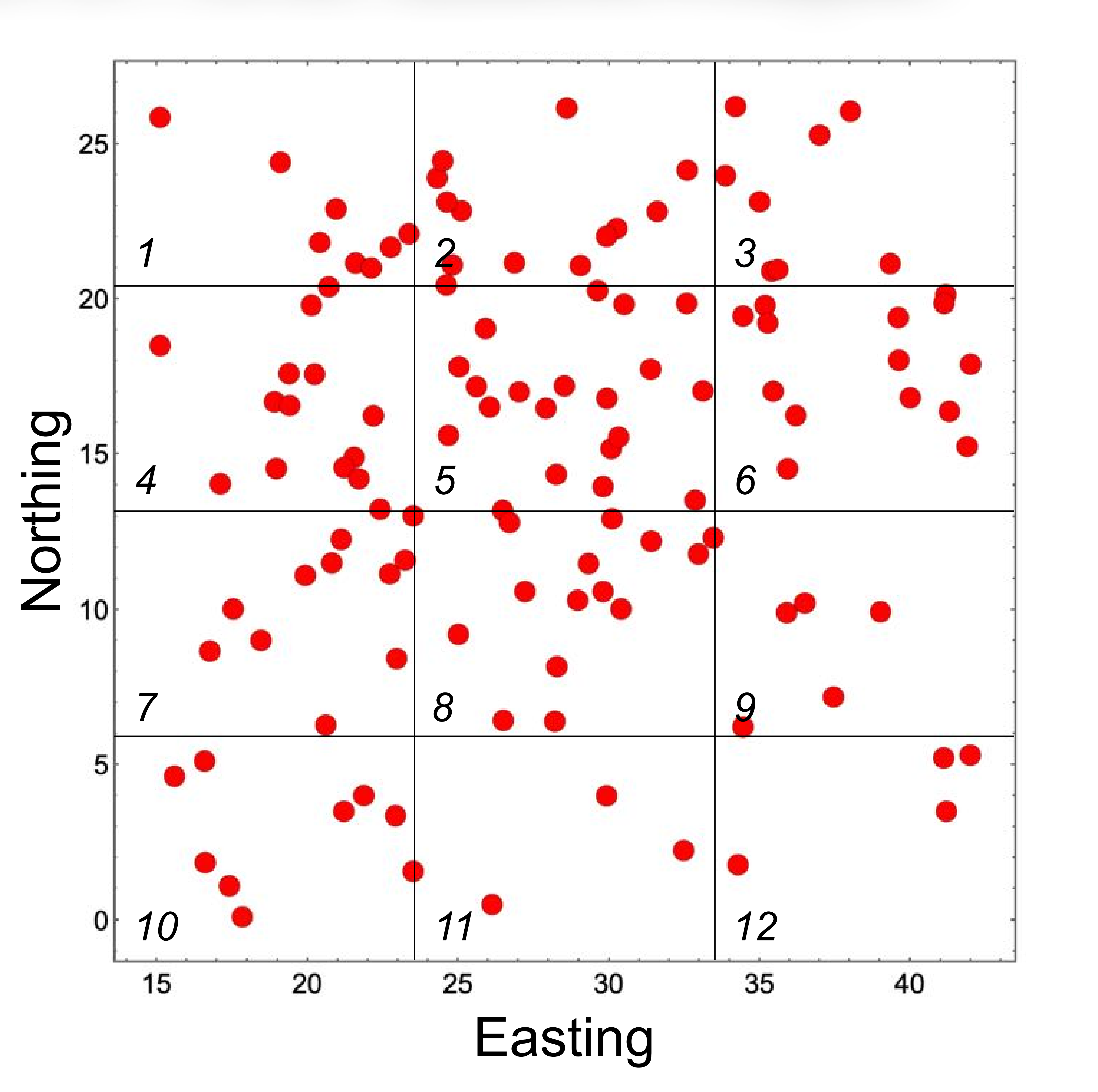
Statistical test to determine if there is a significant difference between observed and expected frequencies in categorical data. The χ^2 statistic can also be used to test for variable independence and whether the data fits a specific distribution (goodness-of-fit test).



Distribution of Points

Test for Uniform Distribution of Points: Quadrat Analysis

Cell	Obs.	Expect.	$(O-E)^2 / E$
1	8	10.25	0.49
2	13	10.25	0.74
3	8	10.25	0.49
4	14	10.25	1.37
5	20	10.25	9.27
6	14	10.25	1.37
7	11	10.25	0.05
8	14	10.25	1.37
9	5	10.25	2.69
10	9	10.25	0.15
11	3	10.25	5.13
12	4	10.25	3.81
Σ	123	123	26.95



Distribution of Points

Test for Uniform Distribution of Points: Quadrat Analysis

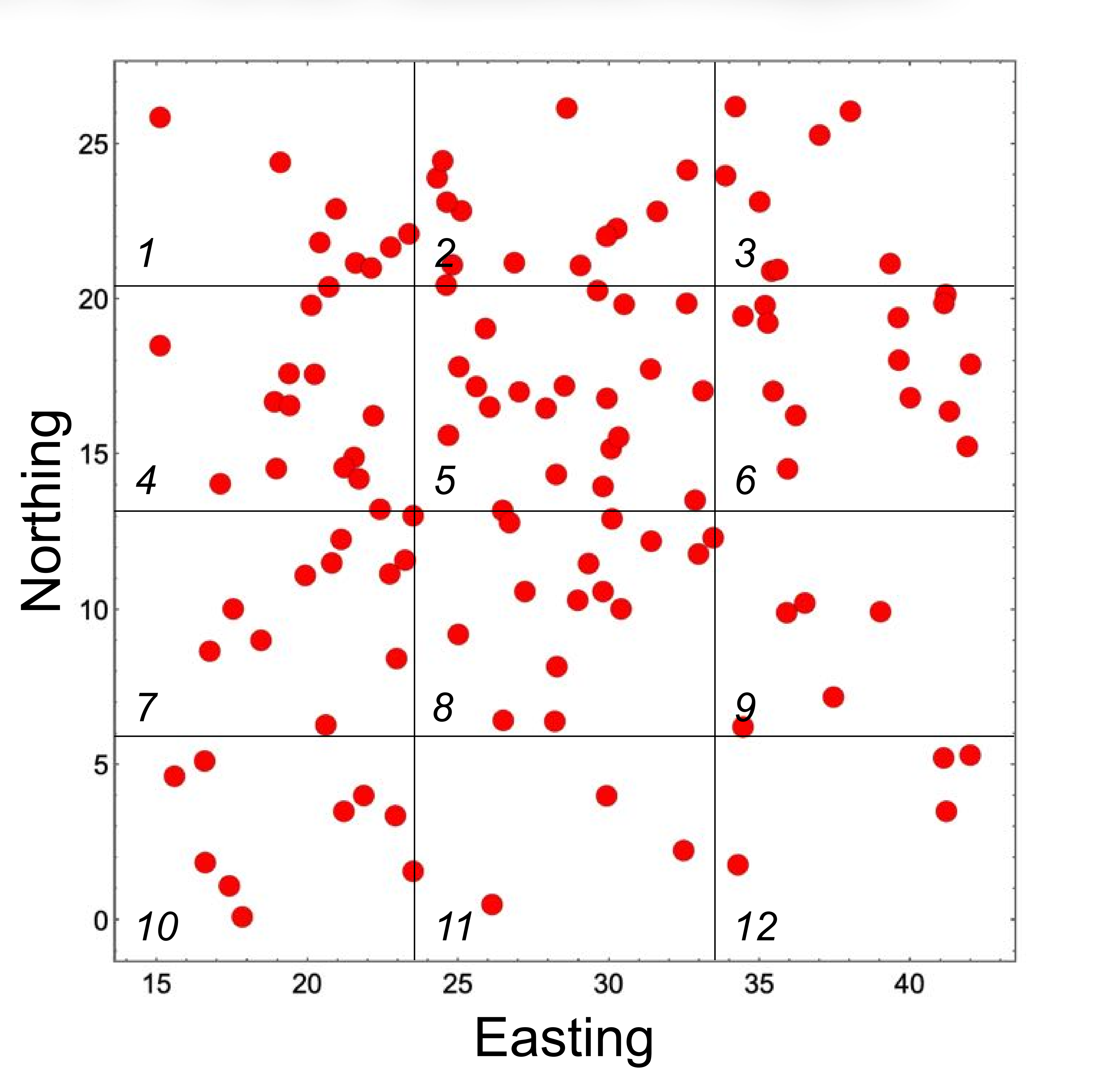
The Chi-Squared (χ^2) Test

$$\chi^2 = \sum_{i=1}^{n} \frac{(Obs. - Exp.)^2}{Exp.}$$

$$\chi^2_{\alpha=0.05,dof=10} = 18.31$$

$$\chi^2_{obs.} = 26.95$$

Reject H_0



Distribution of Points

Test for Uniform & Clustered Distribution of Points

Morissita (I_δ) Test

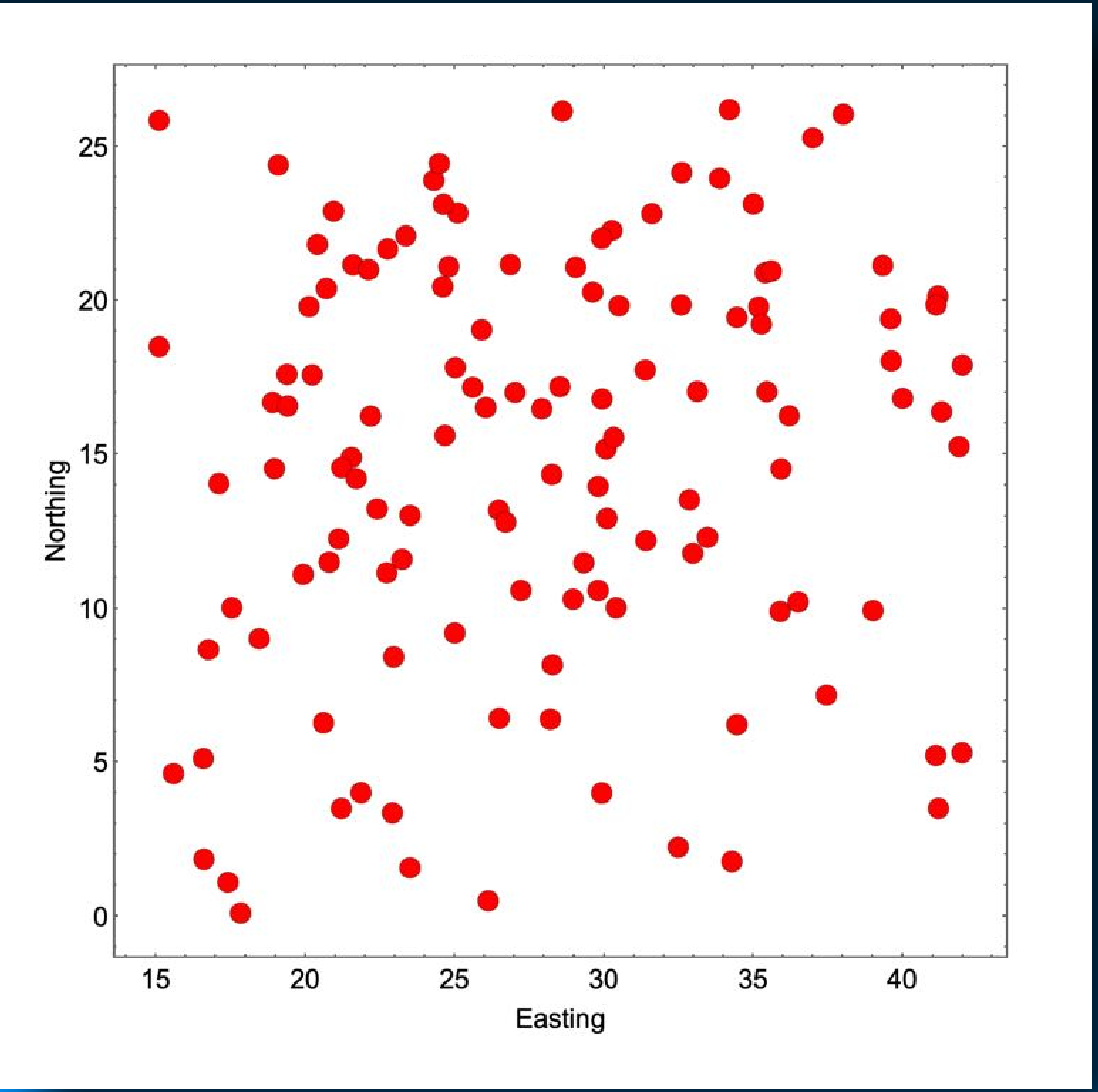
$$I_\delta = n\frac{\sum_{i=1}^{n} x^2 - \sum_{i=n}^{n} x}{(\sum_{i=1}^{n})^2 - \sum_{i=1}^{n} x}$$

I_δ < 1.0 = Overdispersed Distribution

I_δ + 1.0 = Random Distribution

I_δ > 1.0 = Clustered Distribution

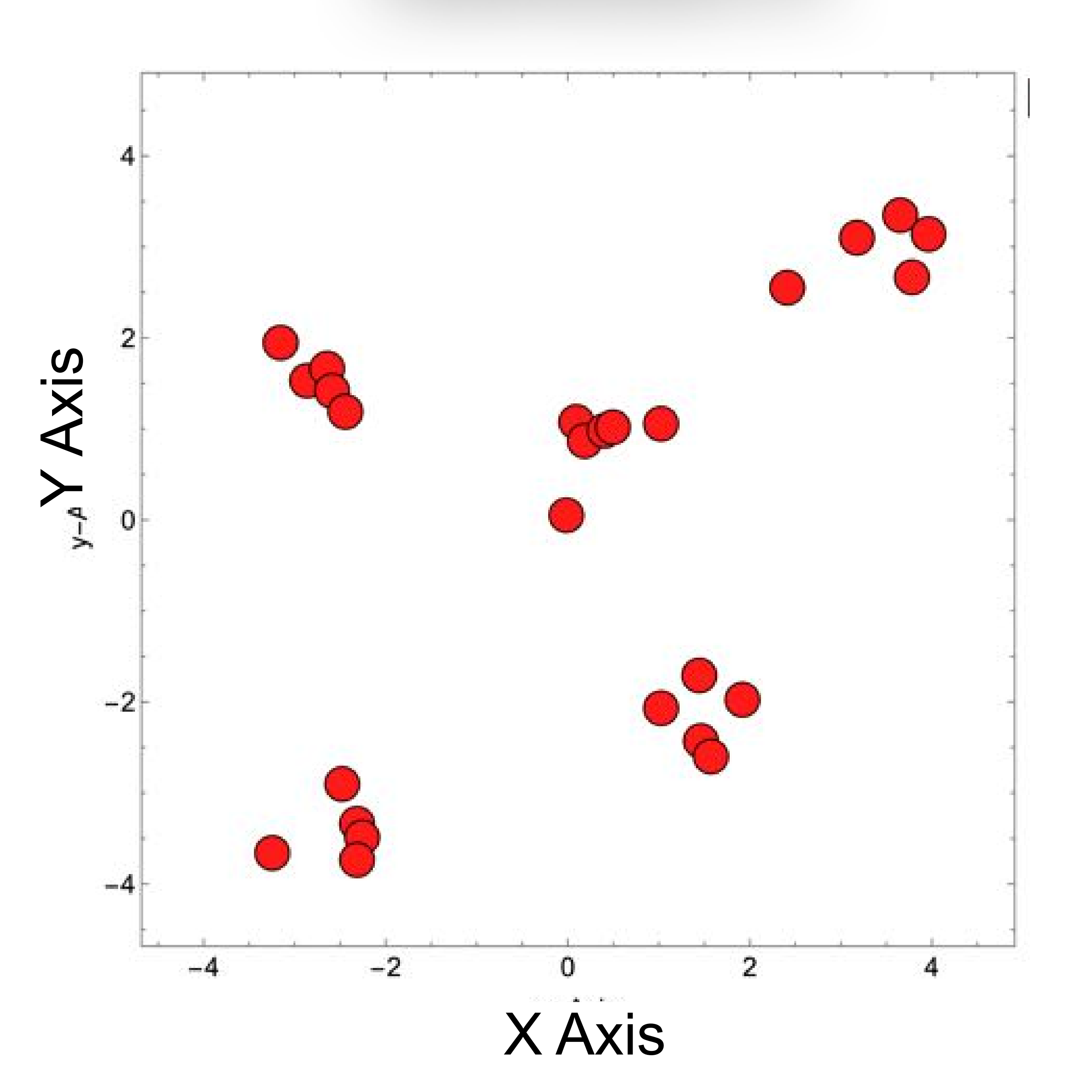
$$F_0 = \frac{I_\delta(\sum_{i=1}^{n} x - 1) + n - \sum_{i=1}^{n} x}{n - 1}$$



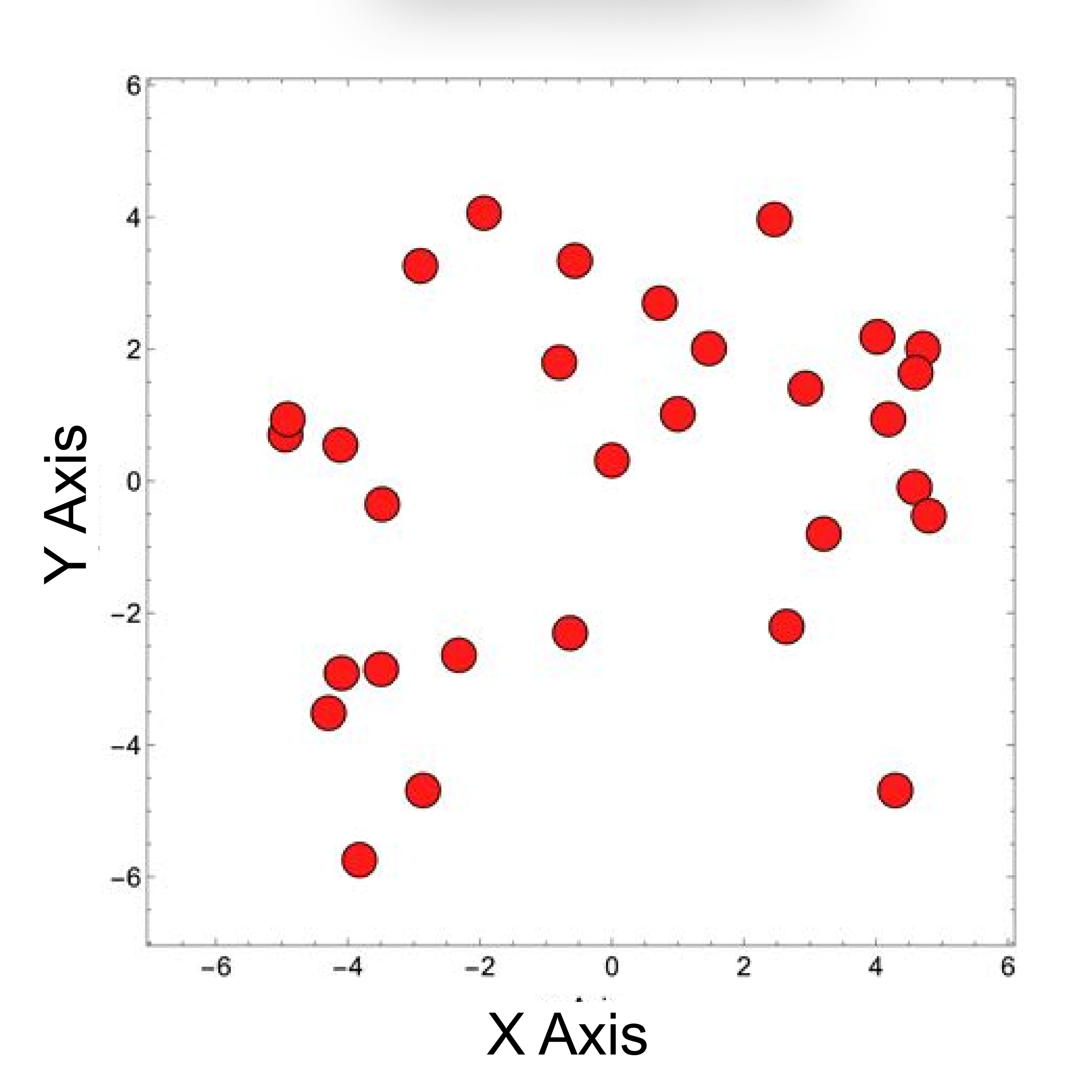
Distribution of Points

Test for a Clustered Distribution of Points: Nearest-Neighbor Analysis

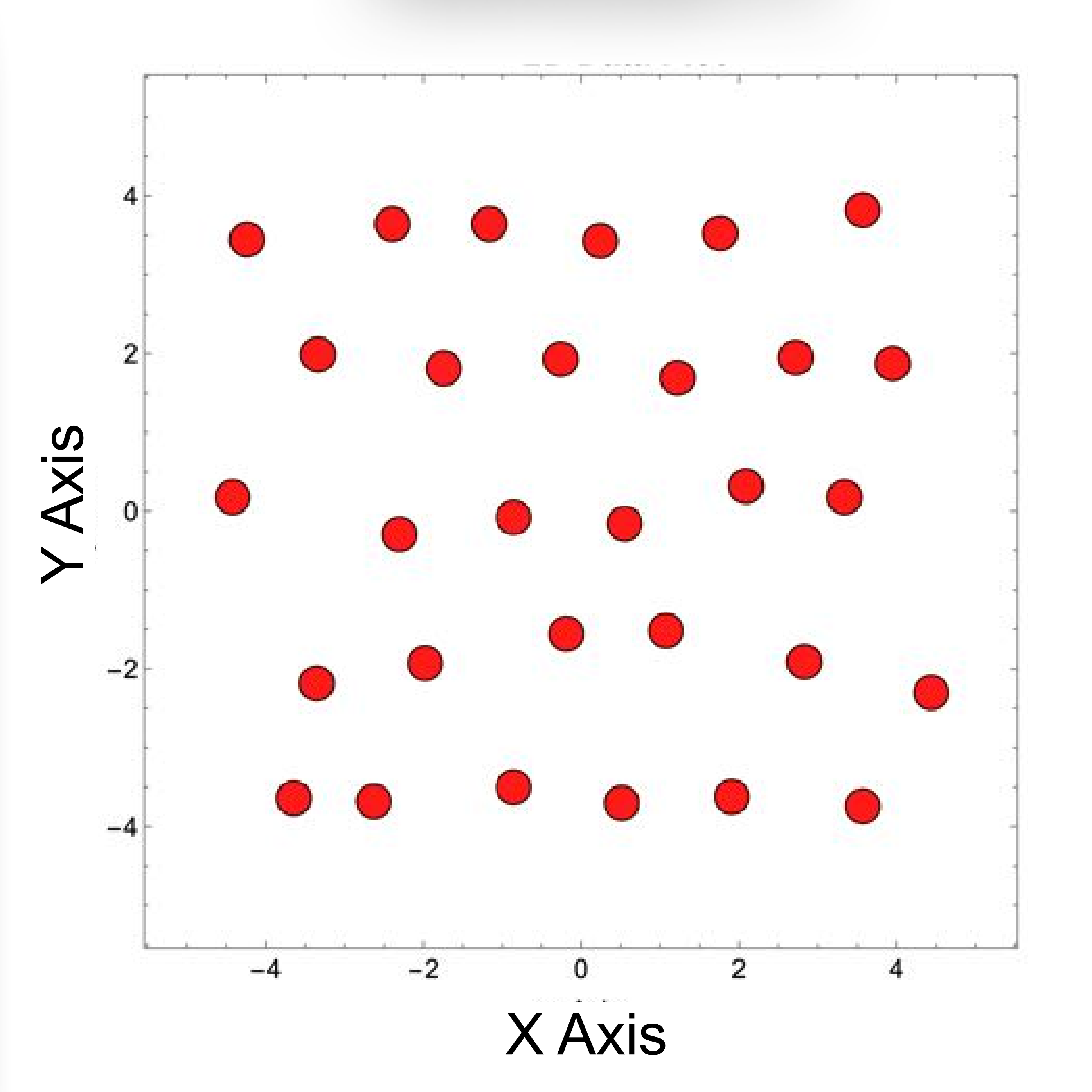
Distribution A



Distribution B



Distribution C

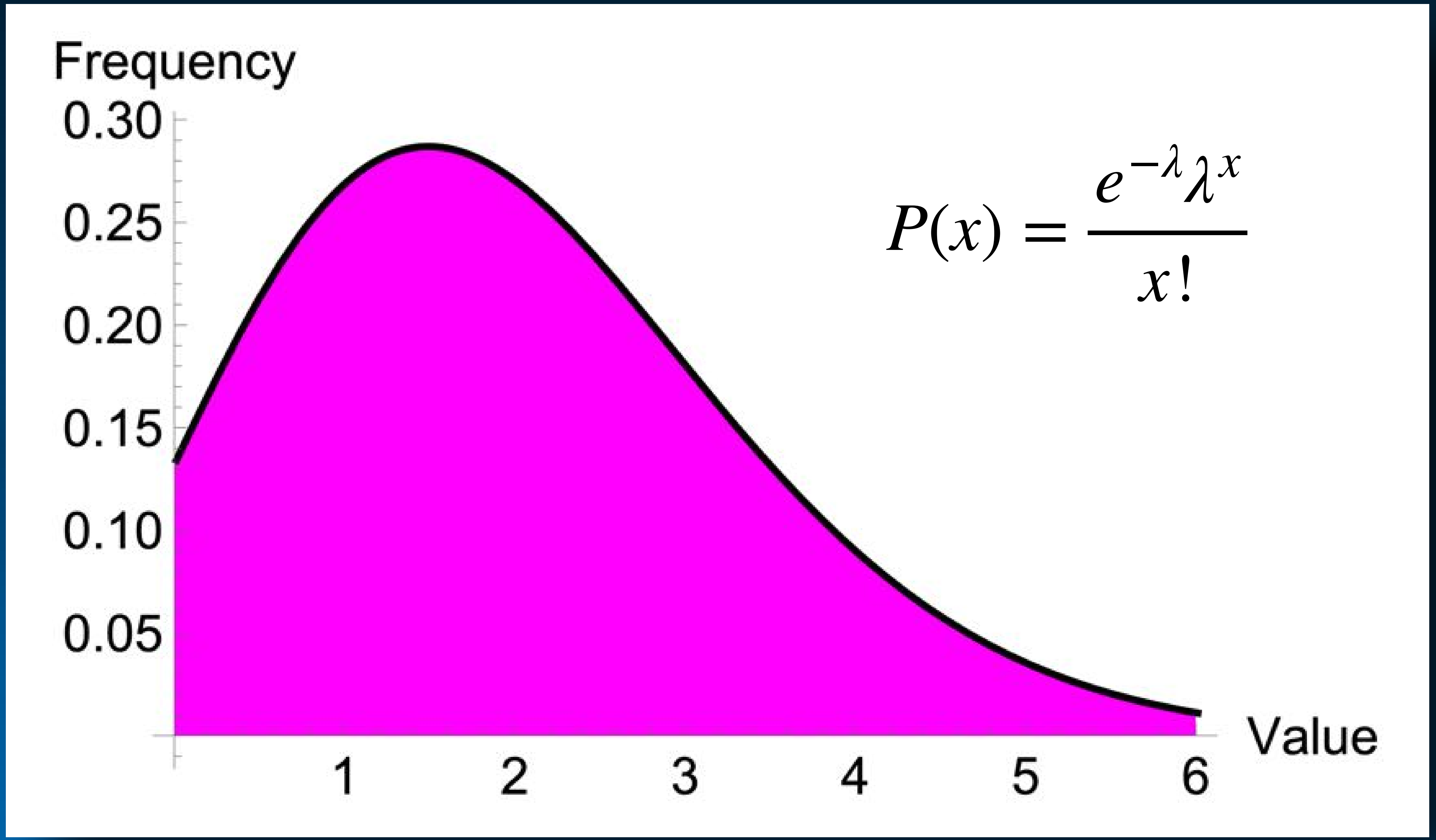


Tests also exist that forego the need to subdivide the space into quadrants. Let’s compare the distributions of these three point sets and ask the question of the extent to which they exhibit clustering.

Distribution of Points

Poisson Distribution

The Poisson distribution tabulates the number of independent events (x) that occur within a fixed interval given an average rate of occurrence (λ). The Poisson distribution is useful for modelling distributions of points in space because it:

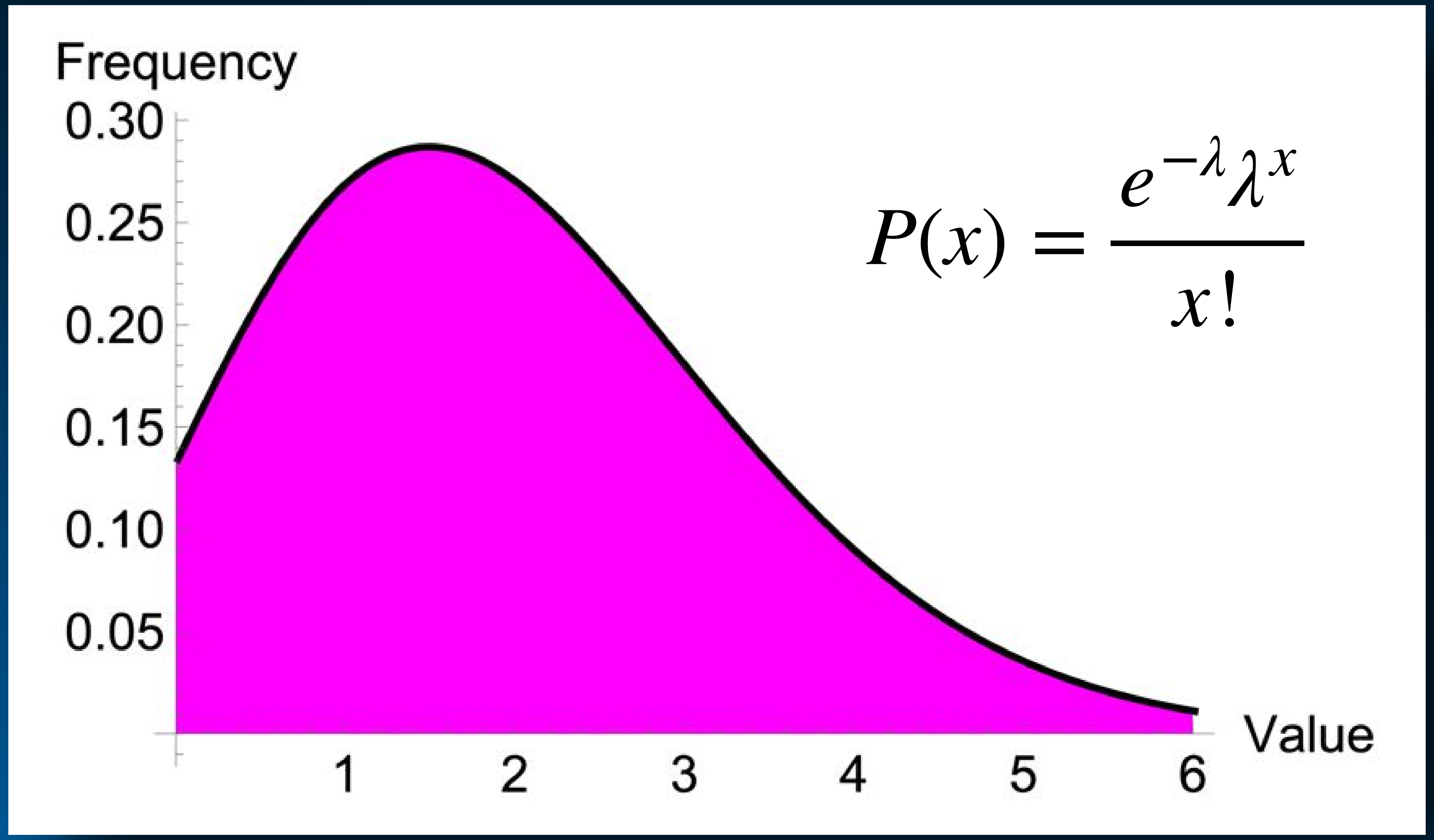


- assumes complete spatial independence (points don't attract or repel);
- places points at a constant rate (achieves homogeneity);
- works best for producing the occurrence of discrete events;
- effectively models the spatial distribution of rare occurrences.

Distribution of Points

Nearest-Neighbor Analysis

The Poisson distribution supports nearest-neighbor analysis because, for any given area (A) and sample size (n) it allows estimation of the mean distance between any point and its nearest neighbor for a random sample.



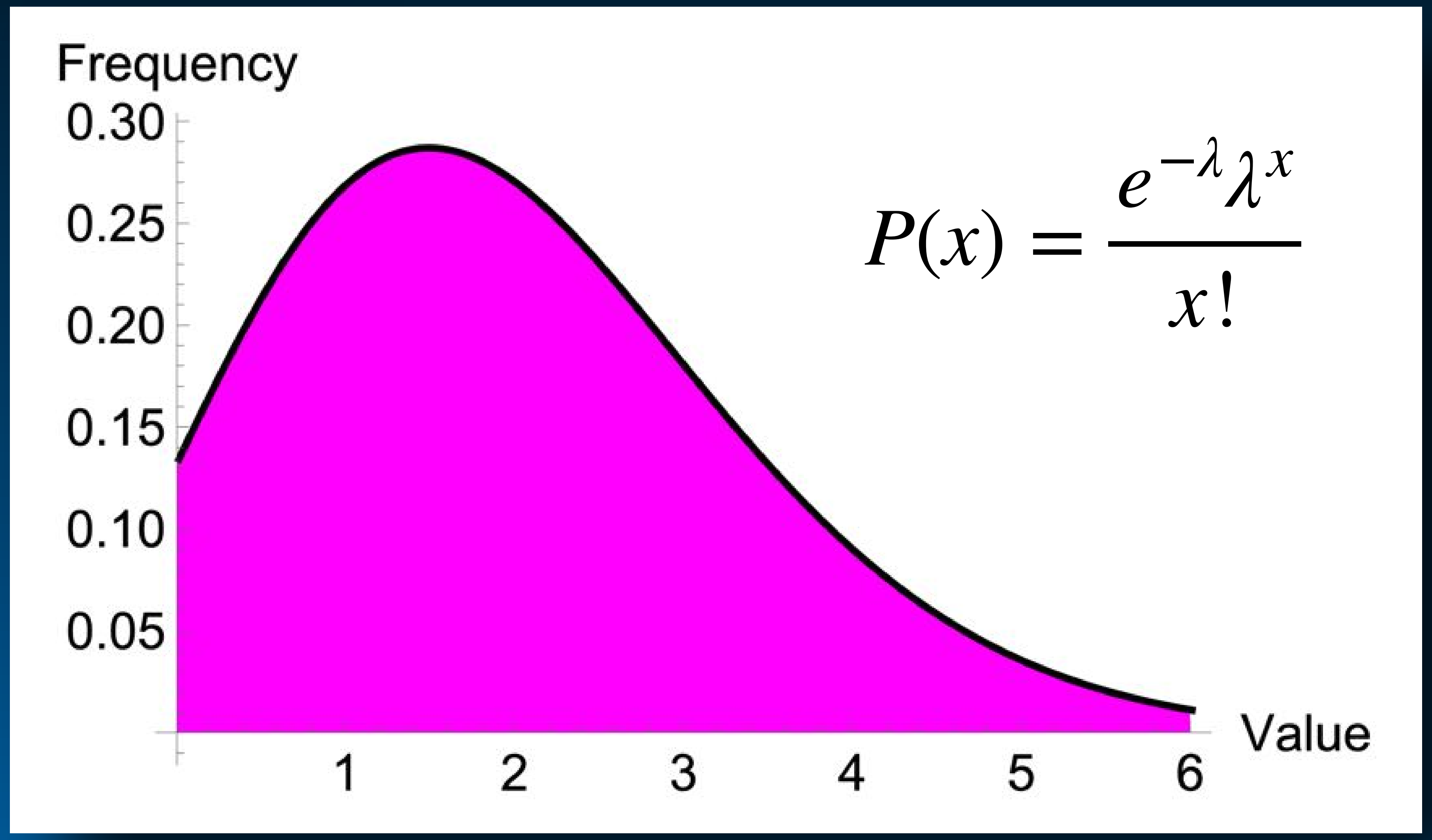
$$\bar{\mu} = \frac{1}{2}\sqrt[2]{\frac{A}{n}} \qquad R = \frac{\bar{d}}{\bar{u}}$$

Once we have this estimate we can easily calculate the mean distance to the nearest neighbor ($\bar{d}$) of all points in any distribution of points (in 2, 3, or m dimensions) and compare that value to this prediction. Clark and Evans (1954) expressed this as a ratio (R).

Distribution of Points

Nearest-Neighbor Analysis

Clark and Evans' R varies between 0.0 (all points coincide) and c. 2.15 (all points spaced regularly in a hexagonal array.



If $R < 0.0$, $\bar{d} < \bar{u}$ ➛ data are clustered.

If $R = 0.0$, $\bar{d} = \bar{u}$ ➛ data are distributed randomly.

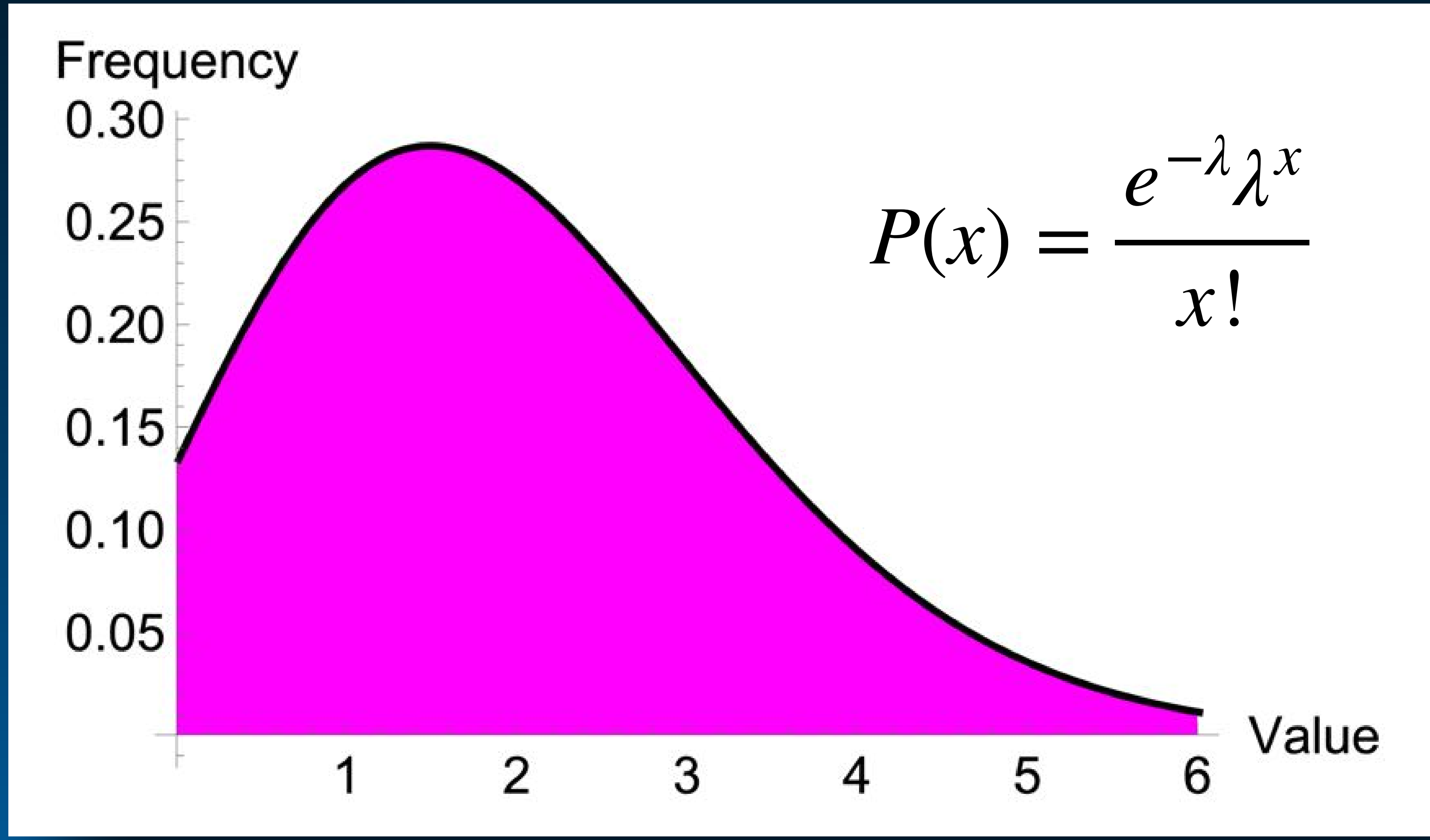
If $R > 0.0$, $\bar{d} > \bar{u}$ ➛ data are dispersed.

Note, this test provides not only a means whereby we can identify when data exhibit a clustered character (as well as providing a definition of what clustered data are), it also provides a means whereby we can identify data that have a non-random dispersed character (as well as providing a definition of what dispersed data are).

Distribution of Points

Nearest-Neighbor Analysis

The Poisson distribution also allows us to turn this relation into a parametric statistical test. To do this we need an estimate of the standard error for the estimate of the mean nearest-neighbor distance (s_e).



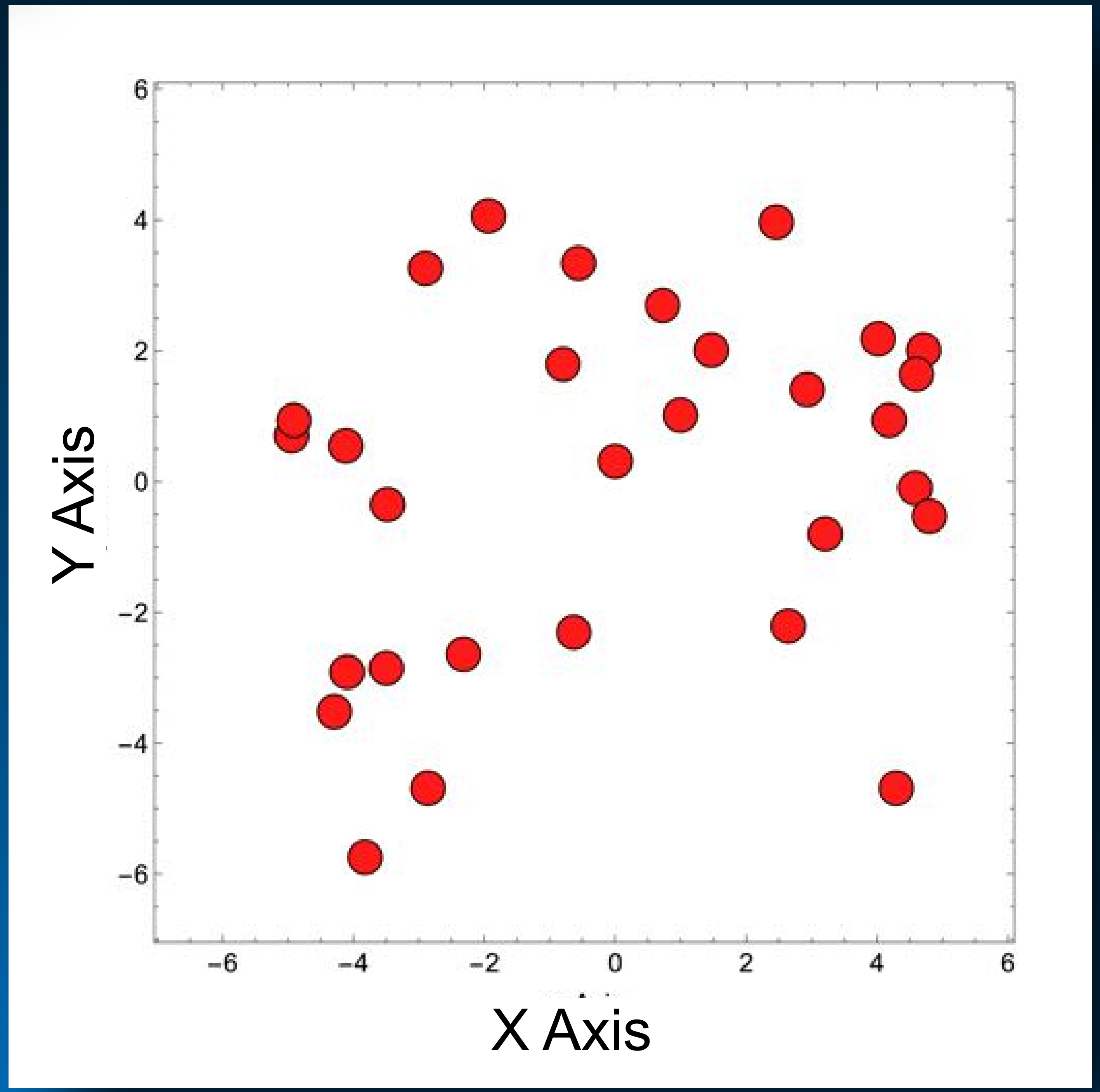
$$s_e = \frac{\sqrt{(4-\pi)A}}{2\sqrt[2]{\pi n}} \qquad R = \frac{\bar{d}}{\bar{u}}$$

Once we have this estimate we can easily calculate the associated probability (p) value via reference to the standardized normal distribution (Z test). Note this test does not assume the data are normally distributed because (i.) $\bar{u}$ is estimated from the Poisson distribution and (ii.) $\bar{d}$ will be distributed normally via the CLT.

Distribution of Points

Nearest-Neighbor Analysis

One widely recognized problem with nearest-neighbor analysis is that points near the edge of the distribution have fewer neighbors than points close to the distribution's center. There are serval potential solutions to this problem, the most commonly implemented of which is a set of correction factors for the estimate of the mean nearest-neighbor distance and its variance (see Donnelly, 1978) based on extensive simulations.



$$\bar{\delta} \approx \frac{1}{2}\sqrt[2]{\frac{A}{n}} + (0.514 + \frac{0.412}{\sqrt[2]{n}})\frac{P}{n}$$

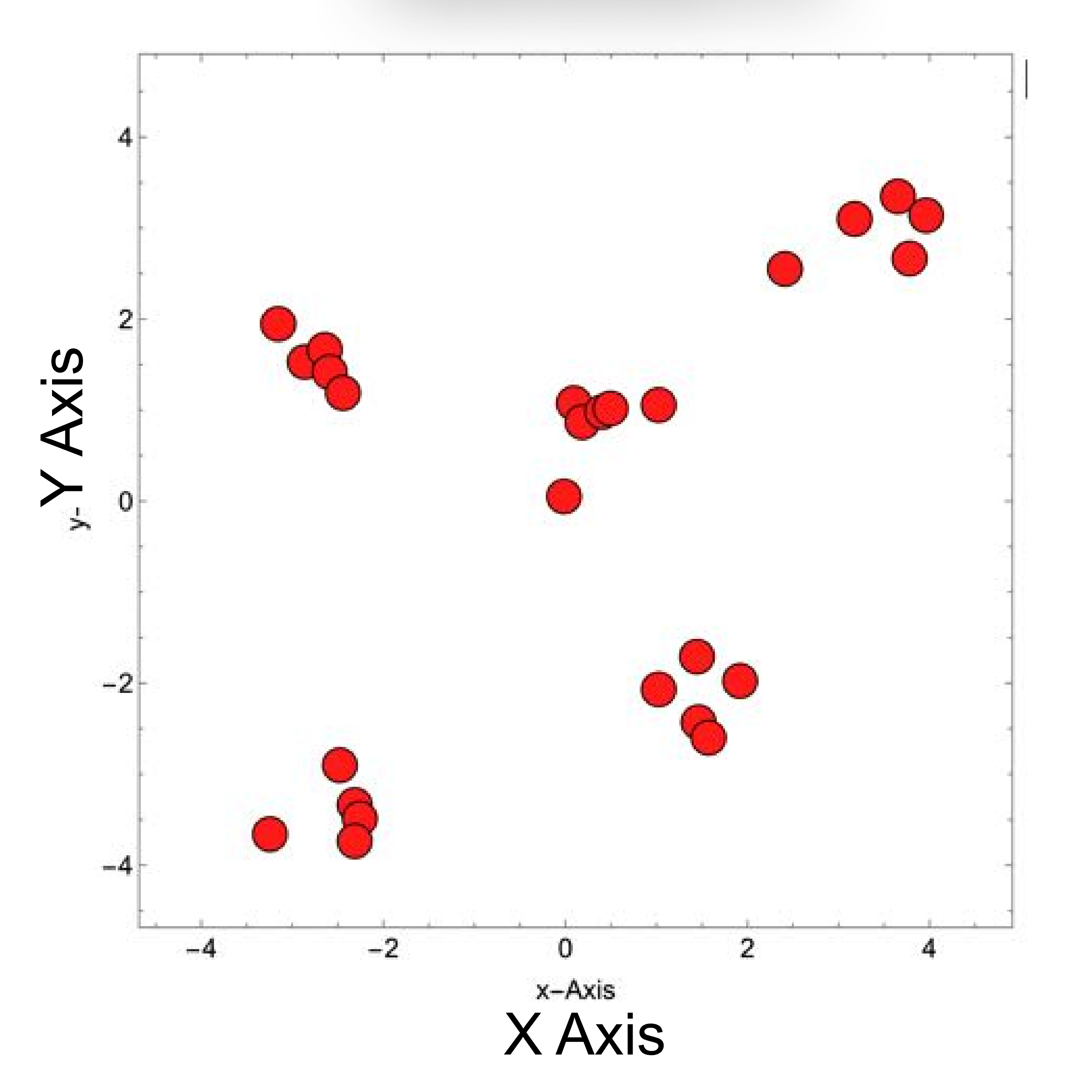
$$s_{\delta}^{2} \approx 0.070\frac{A}{n^{2}} + 0.035P\frac{\sqrt[2]{A}}{n^{\frac{5}{2}}}$$

Note: in both these equations P is the perimeter of the boundary used to estimate A.

Distribution of Points

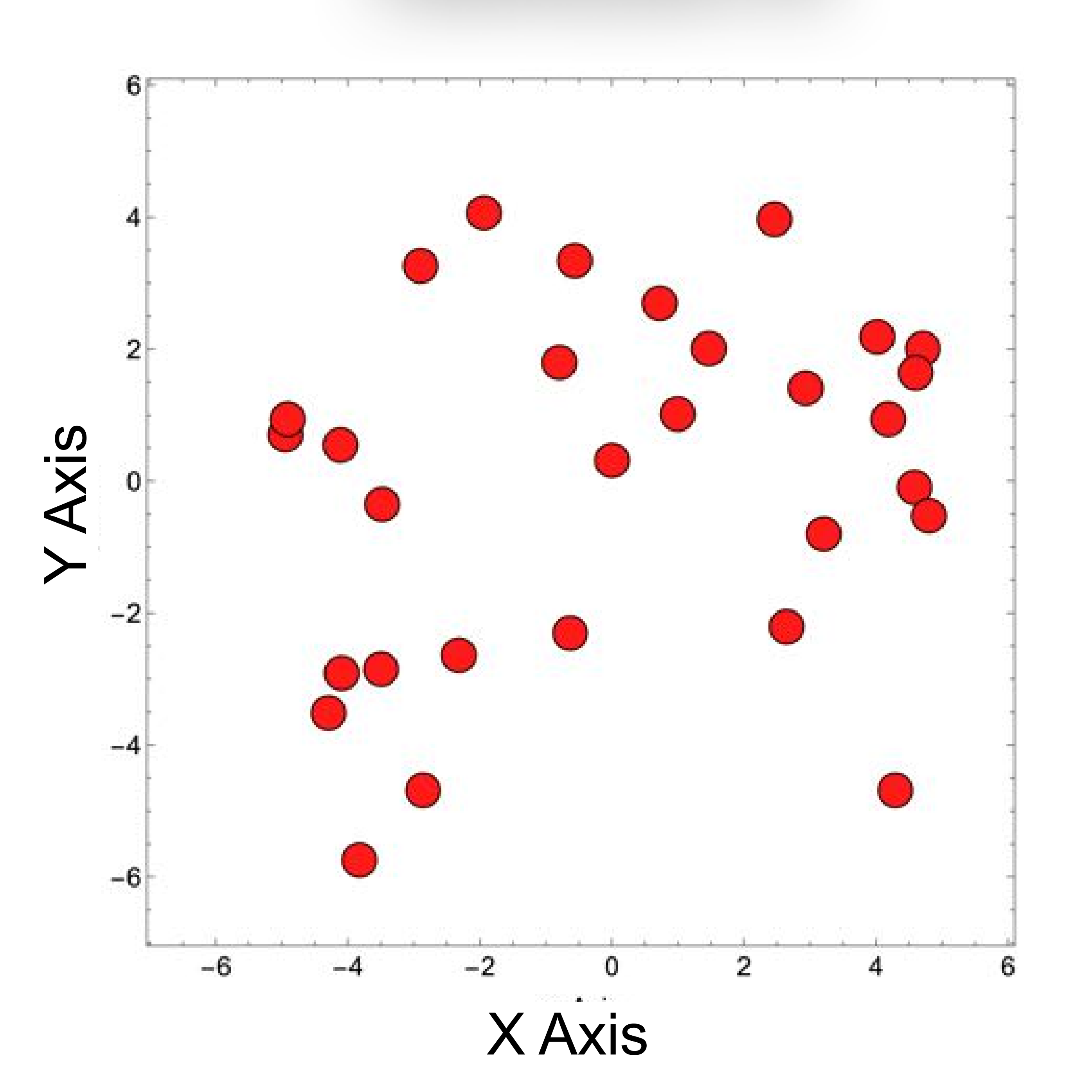
Test for a Clustered Distribution of Points: Nearest-Neighbor Analysis

Distribution A



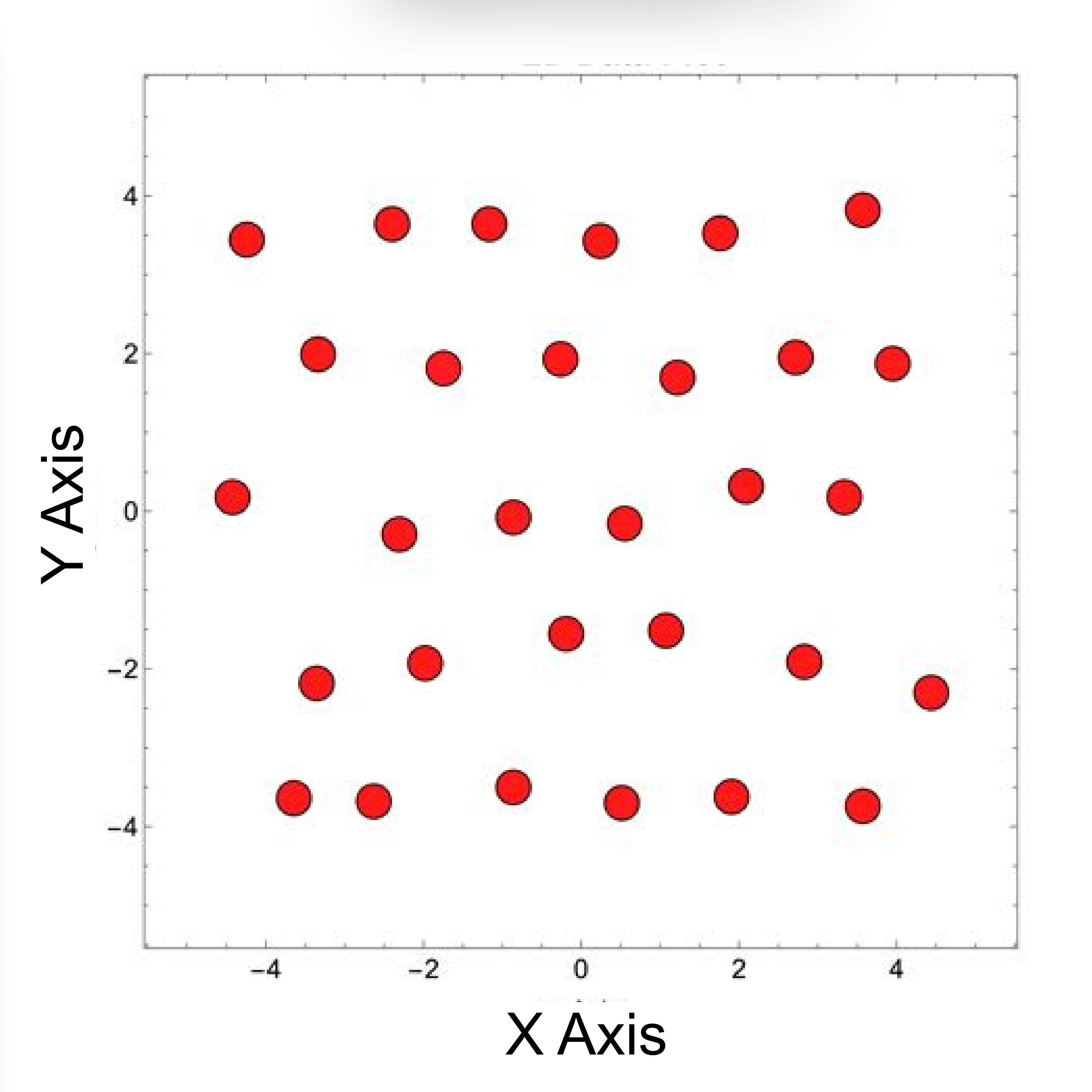
$\bar{u}$ = 0.574 R = 0.691
$\bar{d}$ = 0.397 z = 3.017
a = 0.0013

Distribution B



$\bar{u}$ = 0.811 R = 1.341
$\bar{d}$ = 1.088 z = 3.570
a = 0.0001

Distribution C



$\bar{u}$ = 0.712 R = 2.010
$\bar{d}$ = 1.430 z = 10.581
a = 0.000000000

Analysis of Directional Data

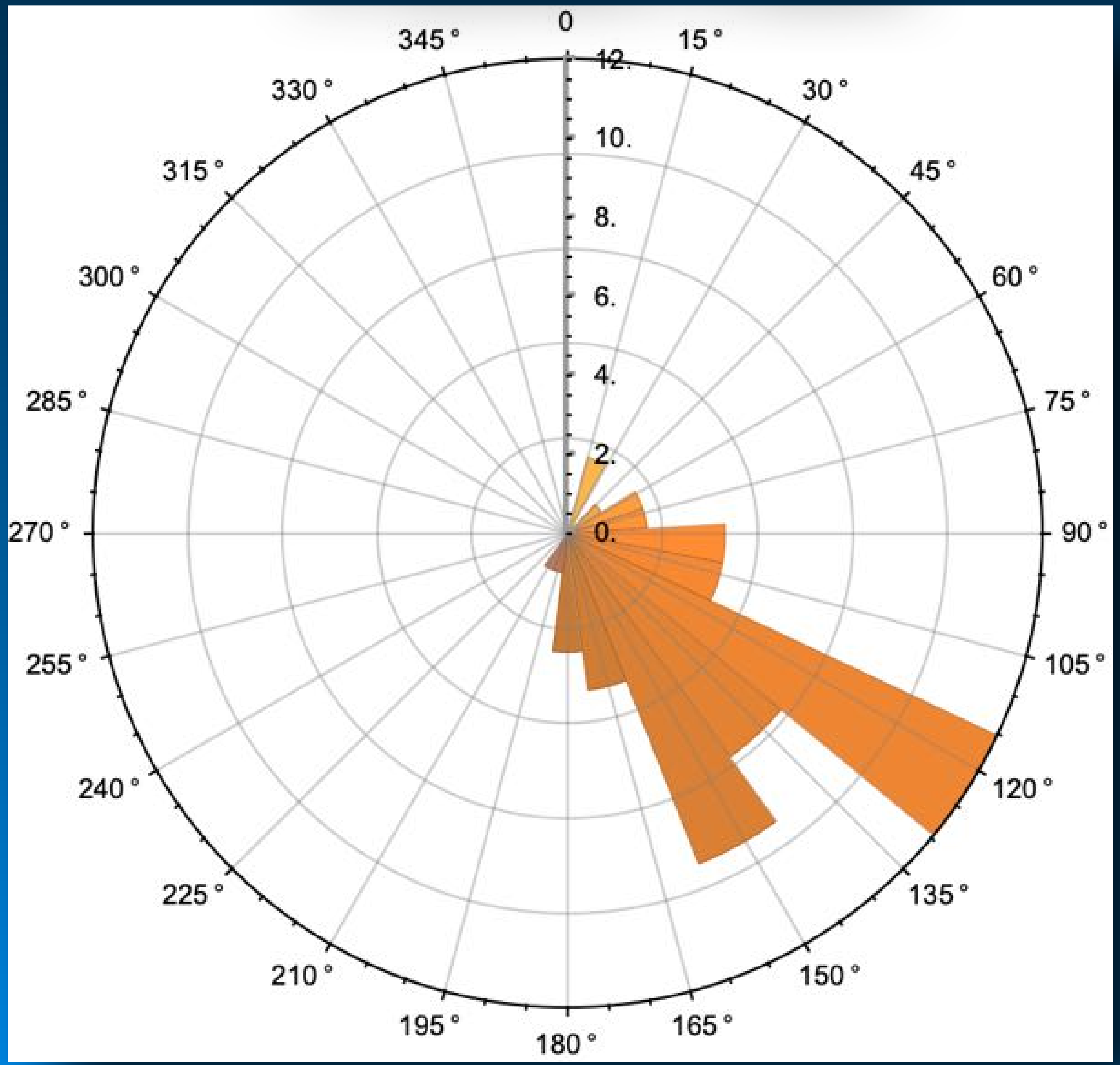
Graphic Presentation of Directional Data

Striation	Angle (°)
1	23
2	27
3	53
4	58
5	64
6	83
7	85
8	88
9	93
10	99
11	100
12	105
13	113
14	113
15	114
16	117
17	121
18	123
19	125
20	126

Striation	Angle (°)
21	129
22	132
23	132
24	132
25	134
26	135
27	137
28	144
29	145
30	145
31	146
32	153
33	155
34	155
35	155
36	157
37	163
38	165
39	171
40	172

Striation	Angle (°)
41	129
42	132
43	132
44	132
45	134
46	135
47	137
48	144
49	145
50	145
51	146

Orientation of Glacial Striations in Southern Finland

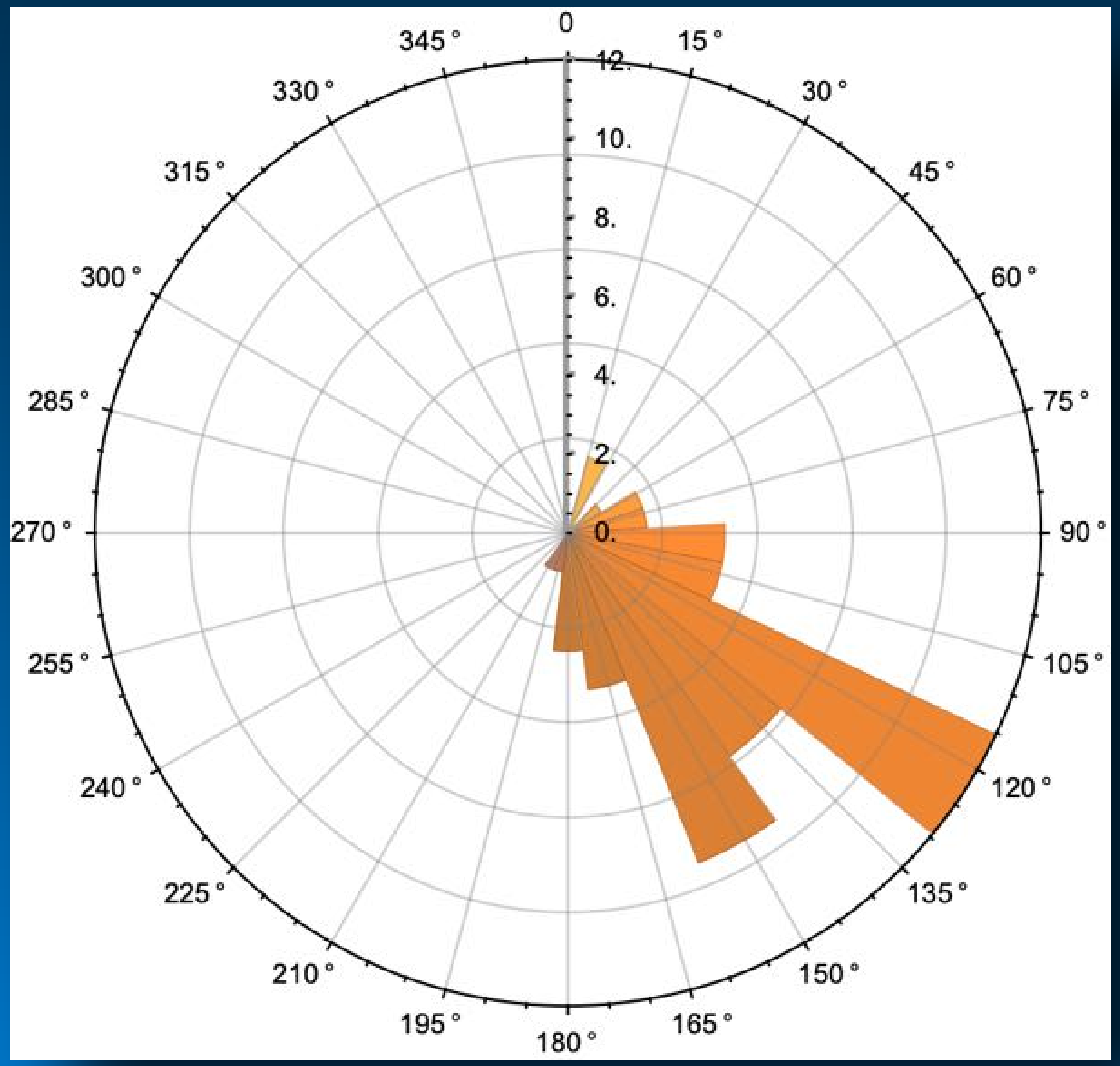


25 Bins

Analysis of Directional Data

Rayleigh's Test for a Preferred Trend

Orientation of Glacial Striations in Southern Finland



$$X_r = \sum_{i=1}^{n} cos\ \theta_i \qquad X_r = -25.7933$$

$$Y_r = \sum_{i=1}^{n} sin\ \theta_i \qquad Y_r = 31.6367$$

$$R = \sqrt[2]{X_r^2 + Y_r^2} \qquad R = 40.8188$$

$$\bar{R} = R/n \qquad \bar{R} = 0.8004$$

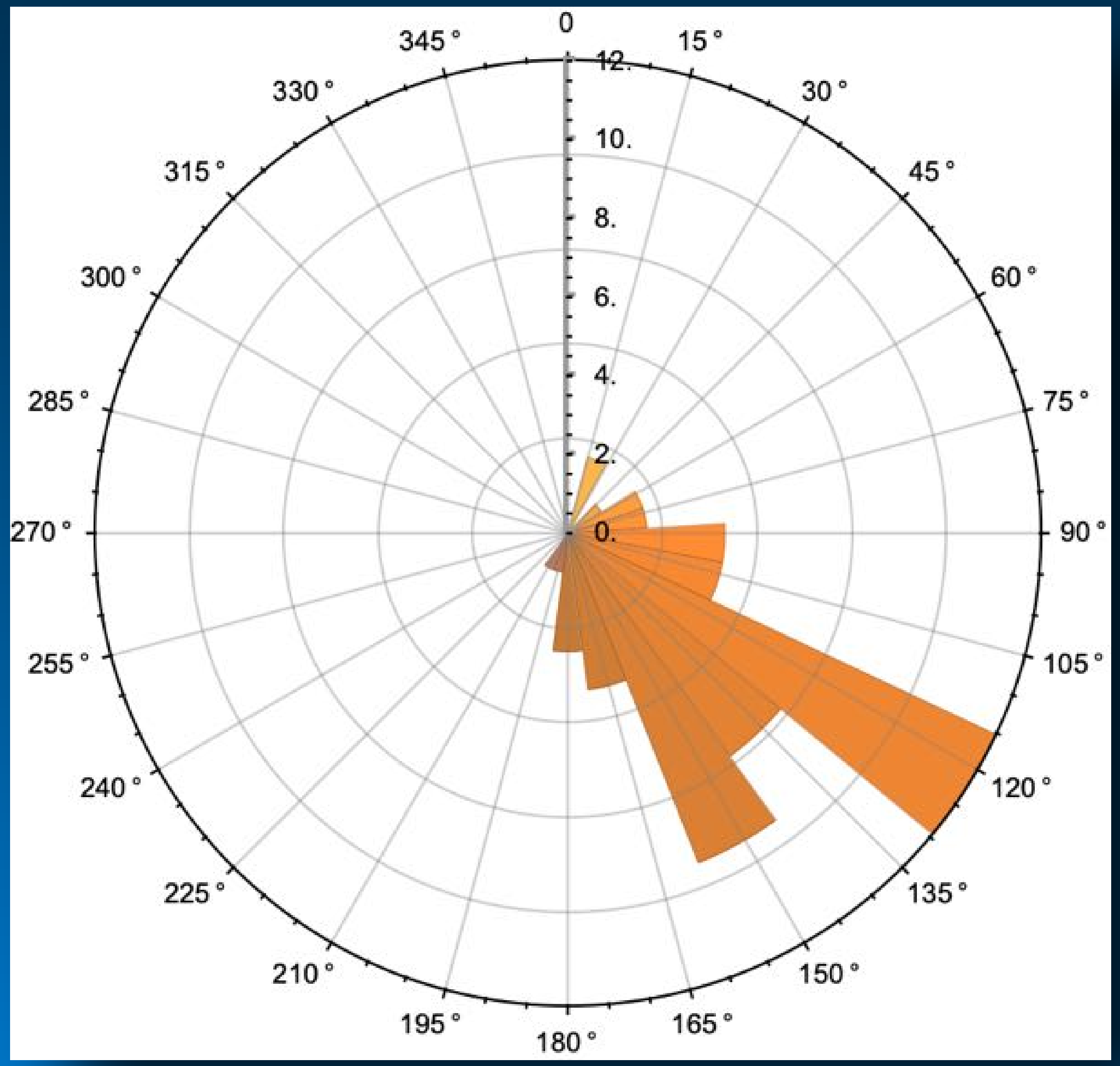
$$\bar{R}_{\alpha=0.05,n=51} = 0.2981$$

Reject H_0 at a = 0.05. The data exhibit a preferred orientation.

Analysis of Directional Data

Rayleigh's Test for Comparison to a Specific Trend

Orientation of Glacial Striations in Southern Finland



This test can be made exact, but this requires the use of extensive charts to enable setting of the correct critical value (Stephens, 1969). An alternative, approximate approach is to calculate the confidence interval on the mean vector direction and use that as a standard to which any specific trend might be compared.

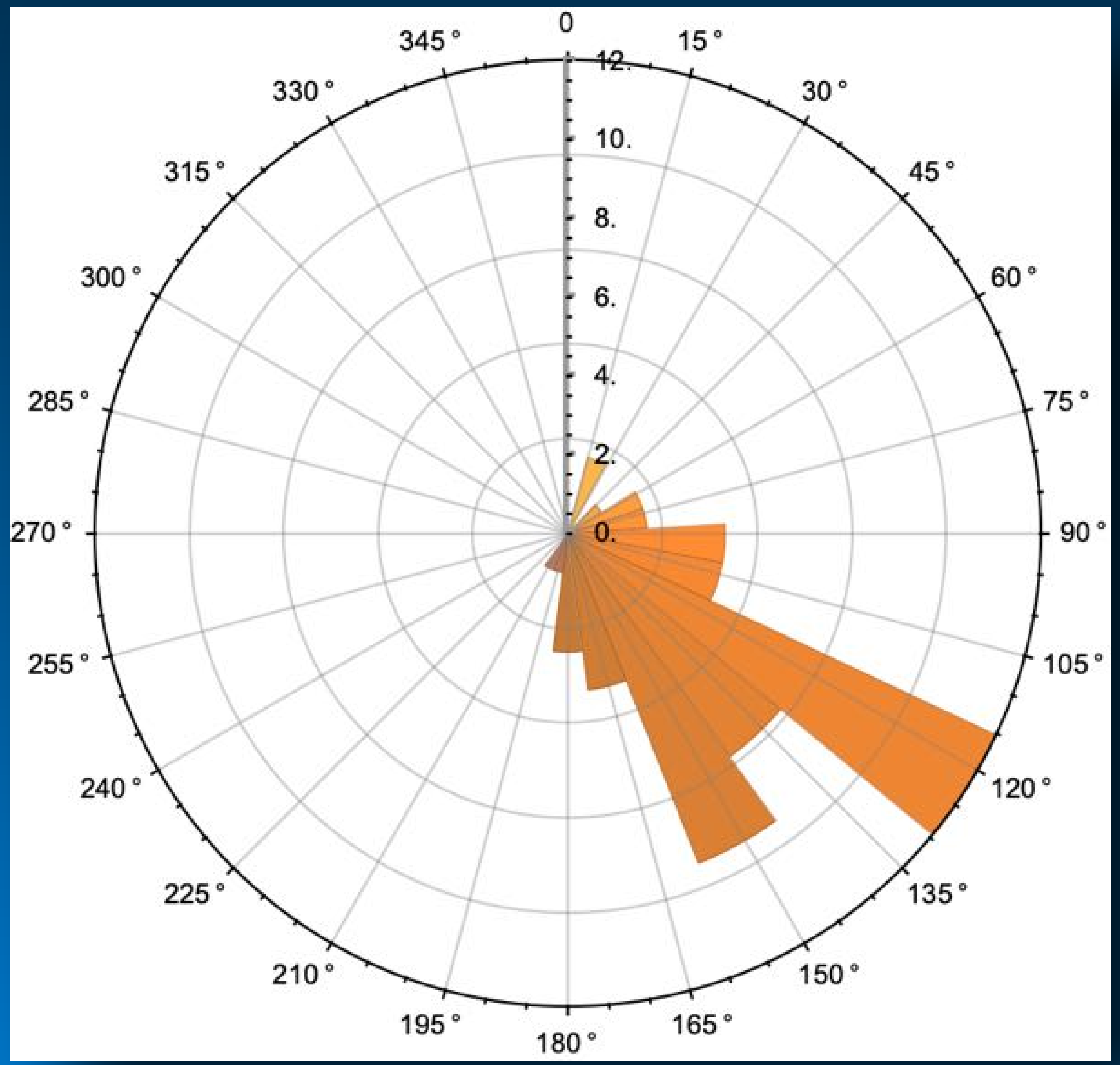
Mean Vector: $\bar{\theta} = tan^{-1}(Y_r/X_r)$

Standard Error: $s_e = \frac{1}{\sqrt[2]{n\bar{R}\kappa}}$

Analysis of Directional Data

Rayleigh's Confidence-Interval Test for Comparison to a Specific Trend

Orientation of Glacial Striations in Southern Finland



$$\bar{\theta} = tan^{-1}(Y_r/X_r)$$

$$\bar{\theta} = 129.19°$$

$$s_e = \frac{1}{\sqrt[2]{n\bar{R}\kappa}}$$

$$s_e = 5.2924°$$

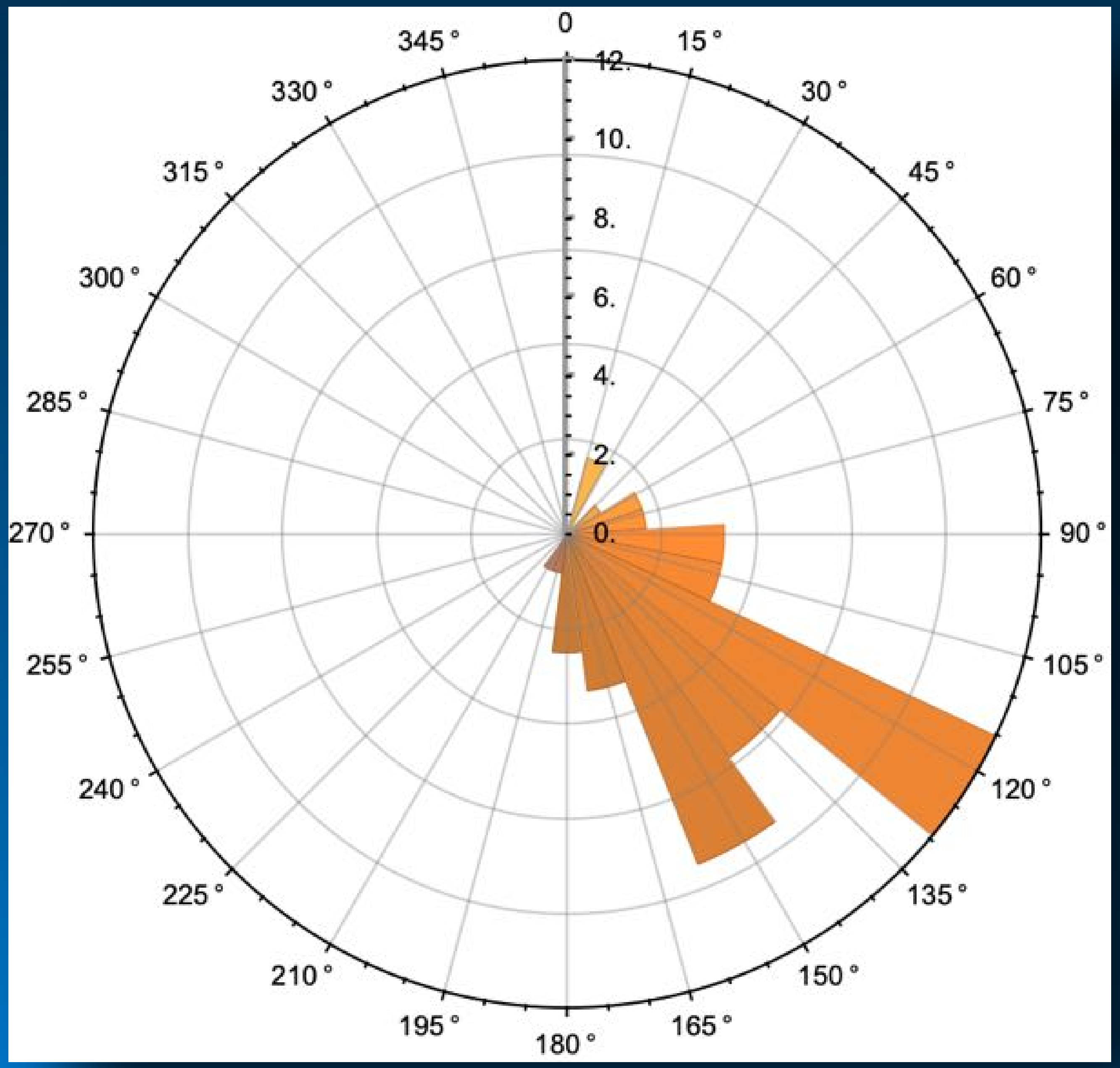
$$CI_{\alpha=0.05} = Z_\alpha s_e$$

$CI_{\alpha=0.05} =$ 123.898° - 134.483°

Analysis of Directional Data

V Test for Comparison to a Specific Trend

Orientation of Glacial Striations in Southern Finland



$$V = \frac{1}{n} \sum_{i=0}^{n} cos(\theta_i - \mu_0)$$

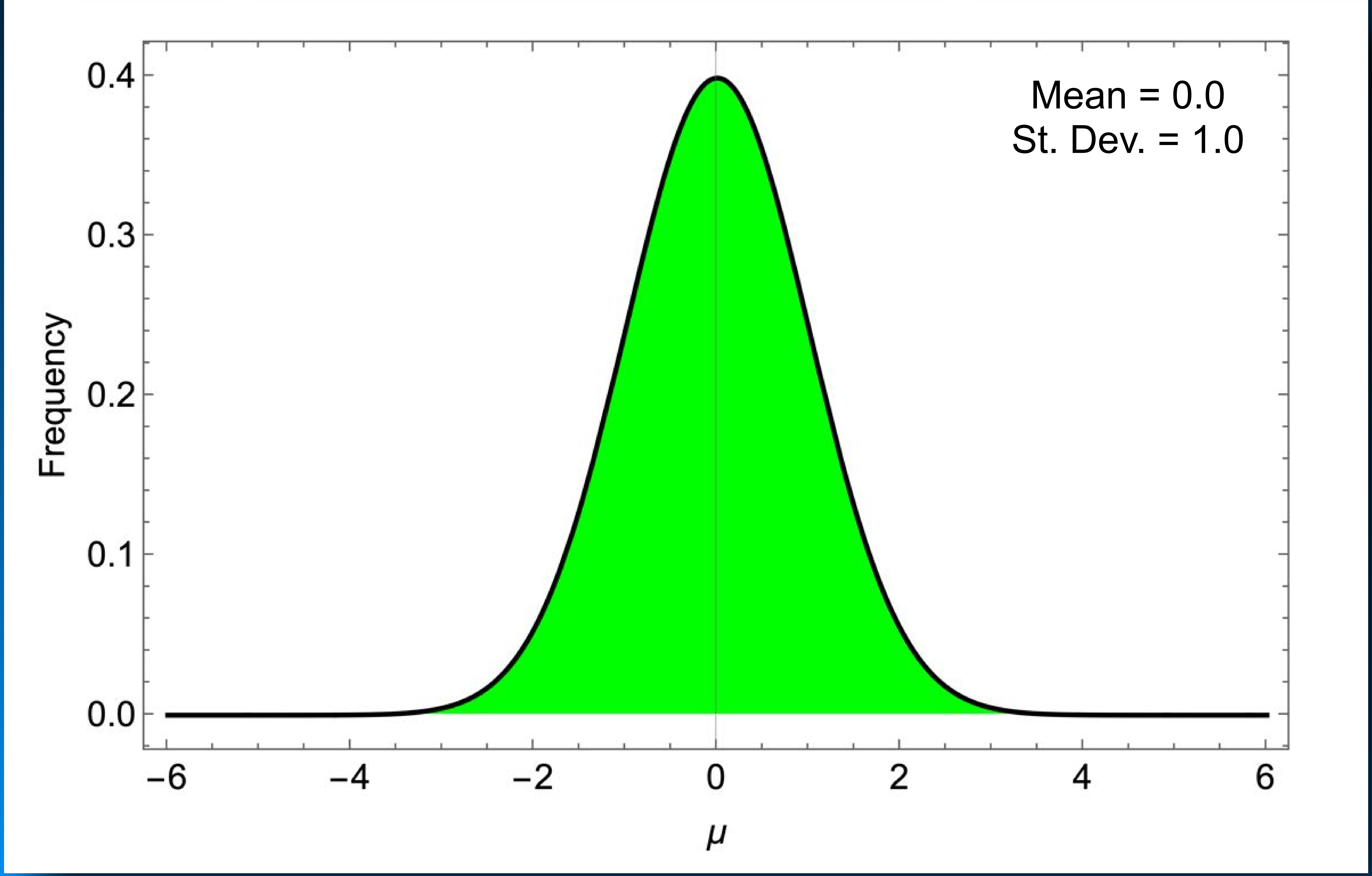
Where: μ_0 - specific trend angle.

$$\bar{R} = \sqrt[2]{(\frac{1}{n} \sum_{i=1}^{n} cos(\theta_i)) + (\frac{1}{n} \sum_{i=1}^{n} sin(\theta_i))}$$

$$u = \bar{R} \cdot \sqrt[2]{2n} \cdot cos(\bar{\theta} - \mu_0)$$

Analysis of Directional Data

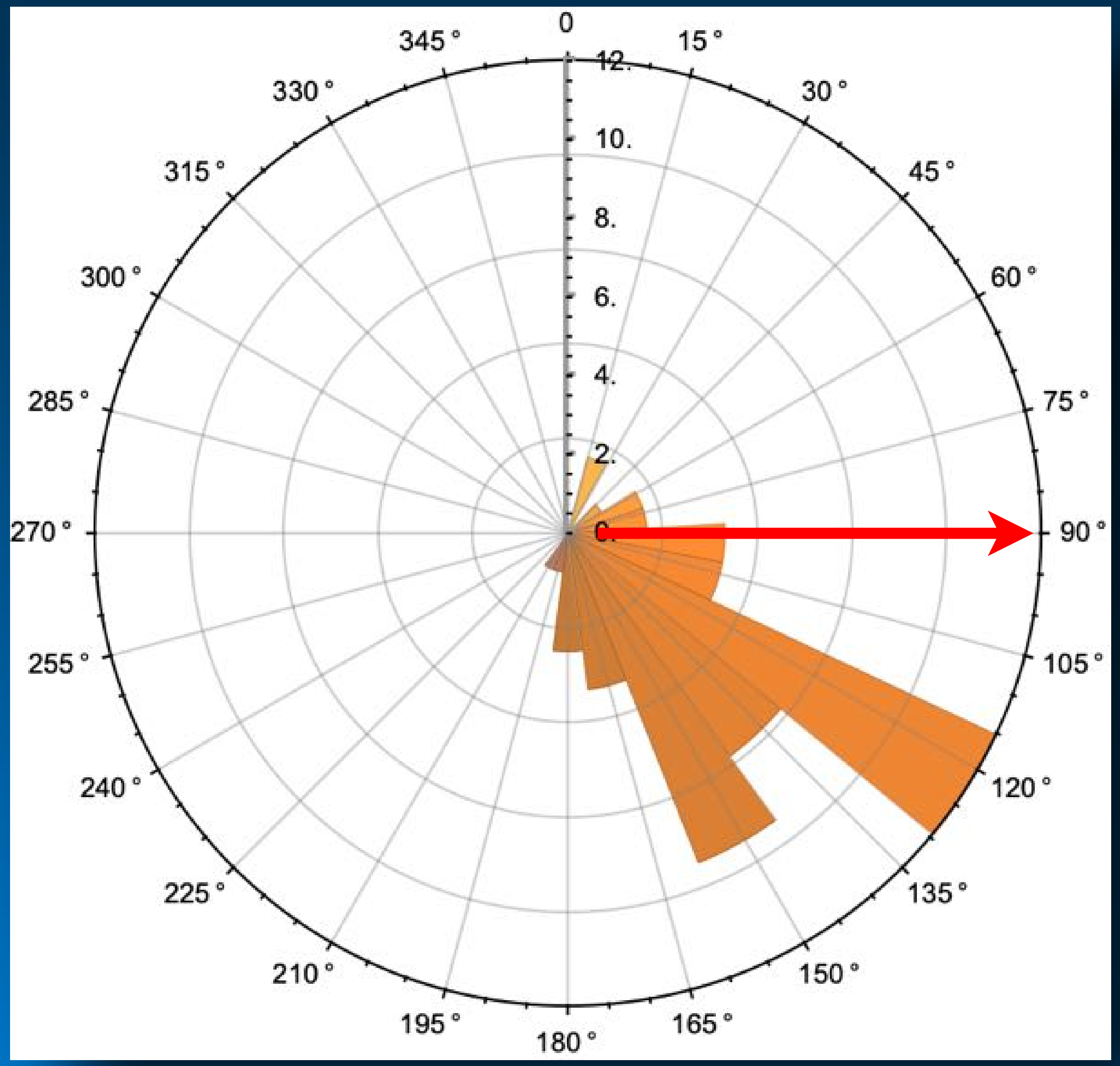
V Test is Referenced to the Standard Normal Distribution



Analysis of Directional Data

V Test for Comparison to a Specific Trend: Example

Orientation of Glacial
Striations in Southern Finland



$$\mu_0 = 90°$$

$$V = \frac{1}{n}\sum_{i=0}^{n} cos(\theta_i - \mu_0)$$

$$V = 0.6203$$

$$\bar{R} = \sqrt[2]{(\frac{1}{n}\sum_{i=1}^{n} cos(\theta_i)) + (\frac{1}{n}\sum_{i=1}^{n} sin(\theta_i))}$$

$$\bar{R} = 0.3385$$

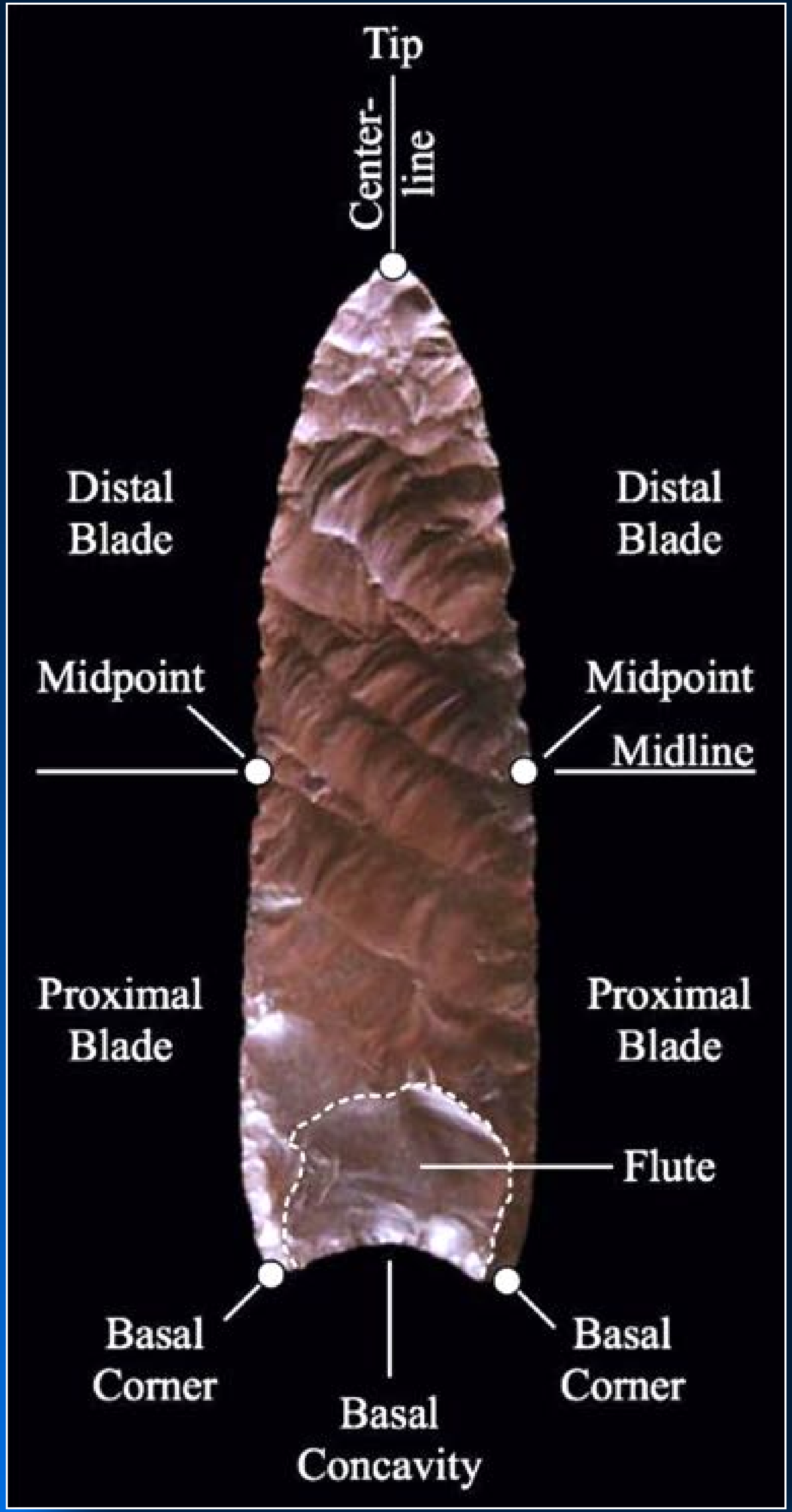
$$u = \bar{R} \cdot \sqrt[2]{2n} \cdot cos(\bar{\theta} - \mu_0)$$

$$u = 2.7761$$

$$\alpha = 0.9967$$

Lab Practical Assignment V

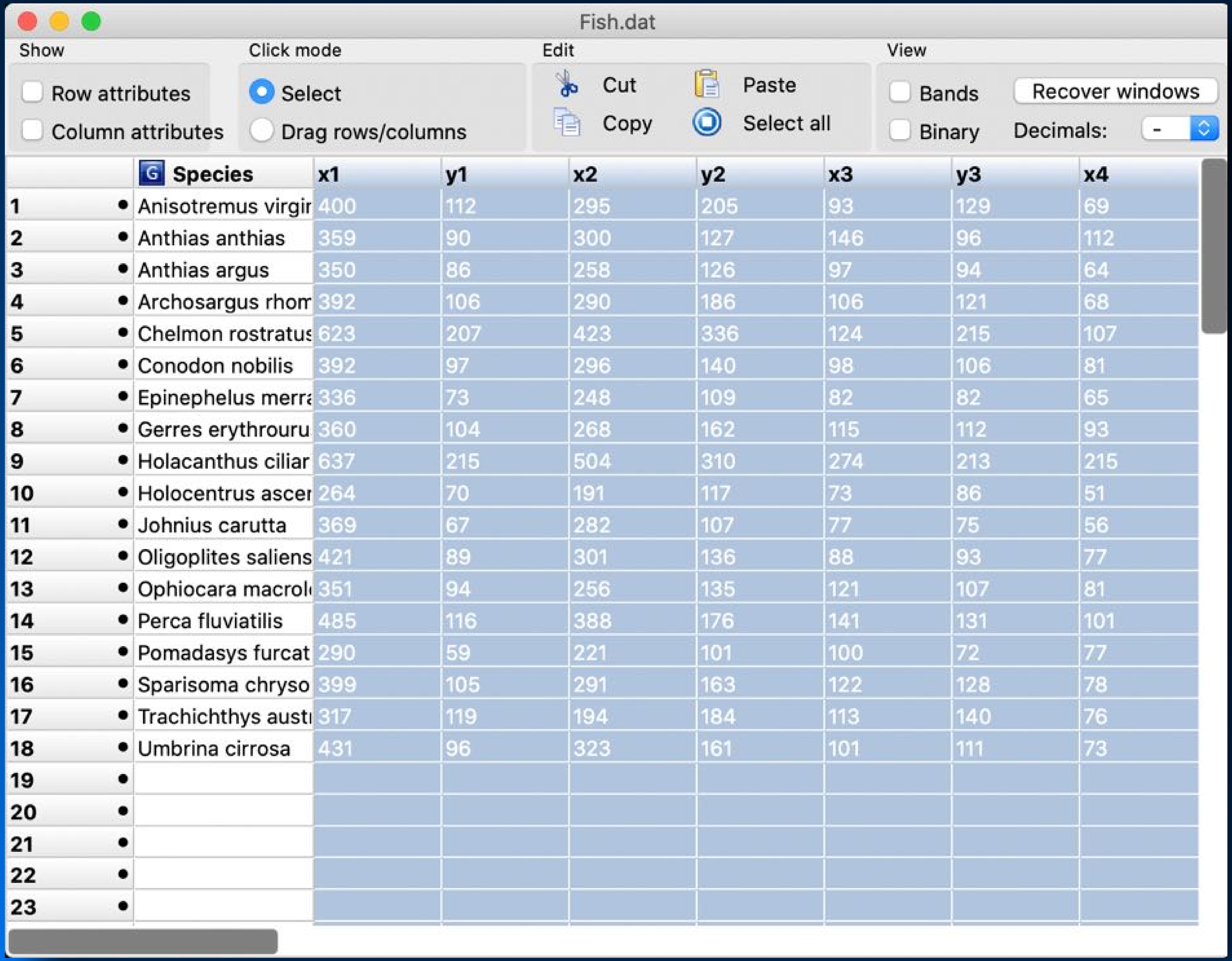
Morphometrics & Spatial Data Analysis



Lab Practical Assignment V

Lab Practical Assignment IV

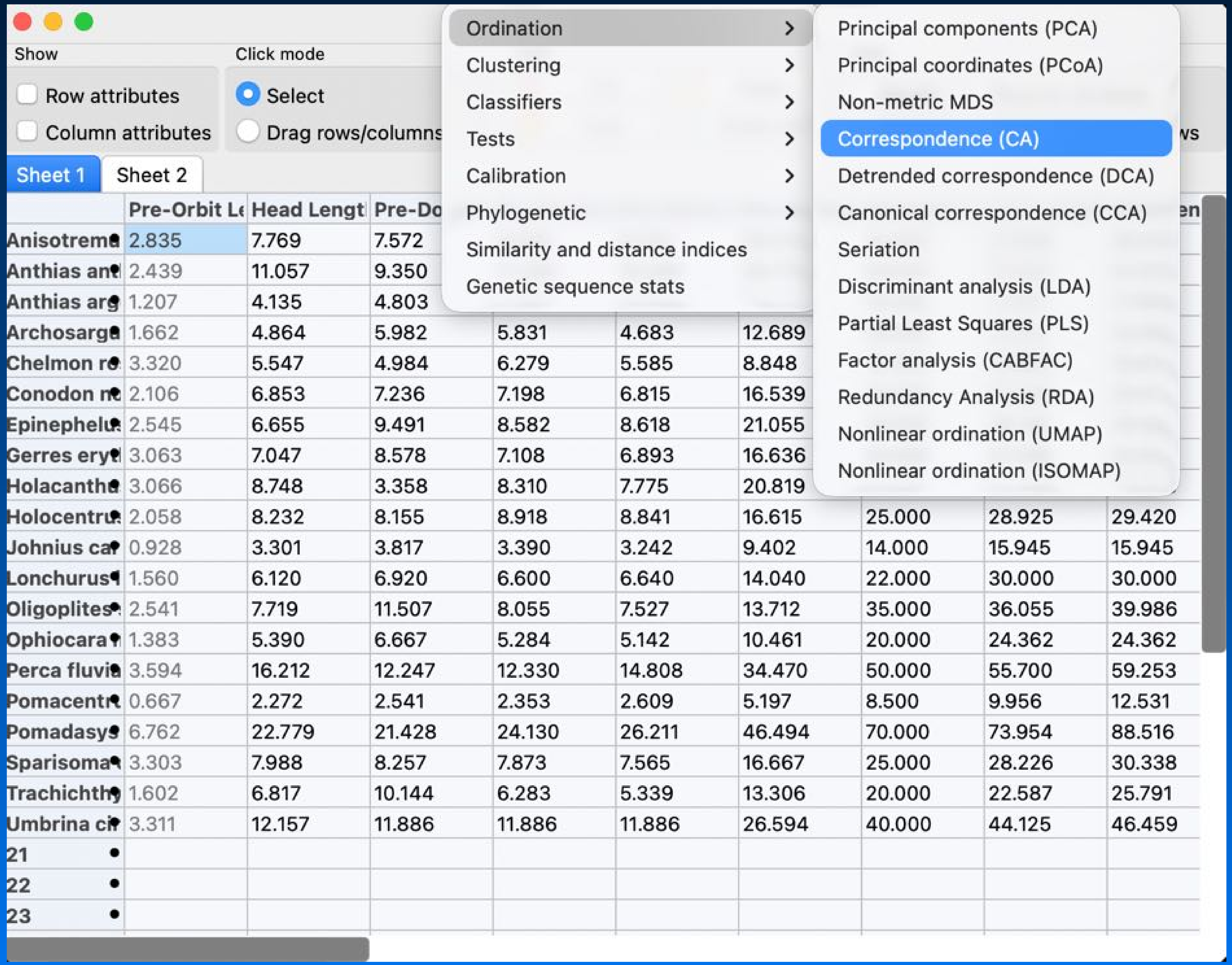
Correspondence Analysis (CA) in PAST



	Species	x1	y1	x2	y2	x3	y3	x4
1	Anisotremus virgir	400	112	295	205	93	129	69
2	Anthias anthias	359	90	300	127	146	96	112
3	Anthias argus	350	86	258	126	97	94	64
4	Archosargus rhom	392	106	290	186	106	121	68
5	Chelmon rostratus	623	207	423	336	124	215	107
6	Conodon nobilis	392	97	296	140	98	106	81
7	Epinephelus merra	336	73	248	109	82	82	65
8	Gerres erythrouru	360	104	268	162	115	112	93
9	Holacanthus ciliar	637	215	504	310	274	213	215
10	Holocentrus ascer	264	70	191	117	73	86	51
11	Johnius carutta	369	67	282	107	77	75	56
12	Oligoplites saliens	421	89	301	136	88	93	77
13	Ophiocara macrol	351	94	256	135	121	107	81
14	Perca fluviatilis	485	116	388	176	141	131	101
15	Pomadasys furcat	290	59	221	101	100	72	77
16	Sparisoma chryso	399	105	291	163	122	128	78
17	Trachichthys austi	317	119	194	184	113	140	76
18	Umbrina cirrosa	431	96	323	161	101	111	73
19								
20								
21								
22								
23								

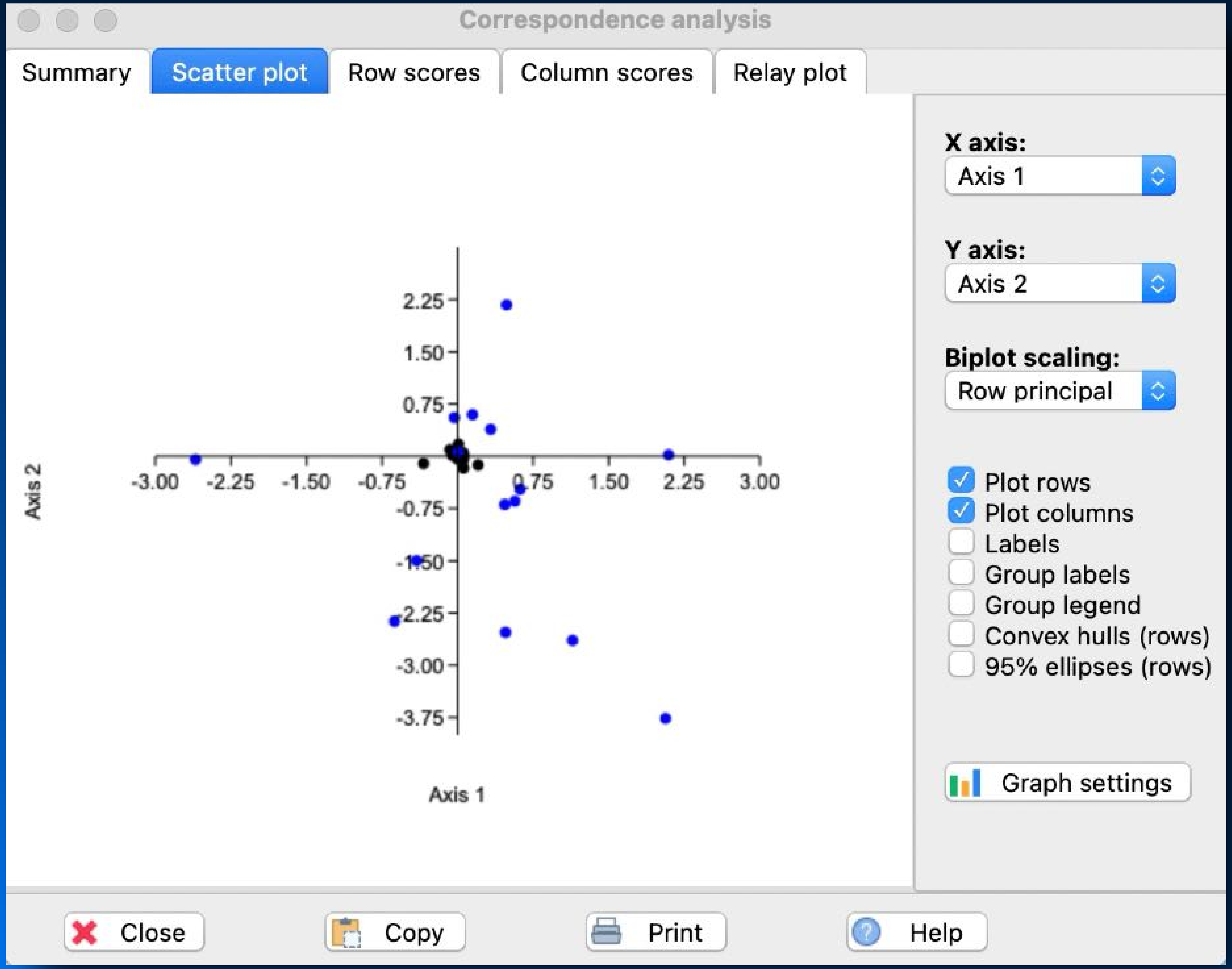
Lab Practical Assignment IV

Correspondence Analysis (CA) in PAST



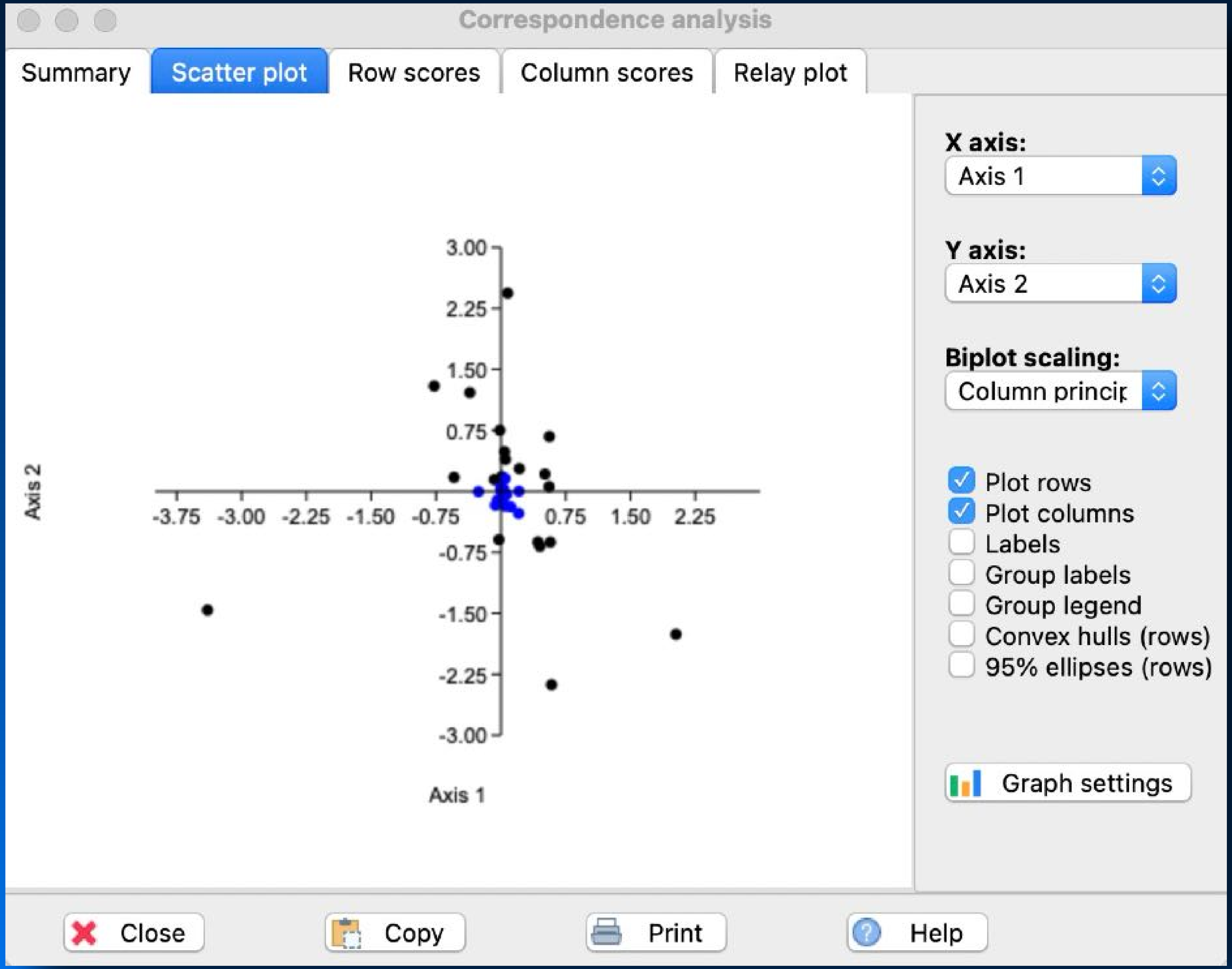
Lab Practical Assignment IV

Correspondence Analysis (CA) in PAST



Lab Practical Assignment IV

Correspondence Analysis (CA) in PAST



Lab Practical Assignment IV

Correspondence Analysis (CA) in PAST

Correspondence analysis

Summary | Scatter plot | Row scores | Column scores | Relay plot

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7
Anisotremu	0.428941	-0.623339	-1.18863	-0.691429	0.0640283	0.123041	0.206876
Anthias antl	-0.772099	1.29508	0.0745189	-0.763146	-0.555875	0.963312	-1.29872
Anthias arg	0.214153	0.277894	0.532644	0.290636	0.0946202	-0.85502	0.74243
Archosargu	-0.0231584	-0.594056	0.713386	-0.336355	0.744103	-0.852494	0.958767
Chelmon ro:	0.585829	-2.37852	-2.44617	1.2247	2.22573	0.71357	-0.08096
Conodon nc	-0.0750732	0.144131	0.322876	1.18735	0.0227208	-1.01525	-0.59383
Epinephelu:	-0.0120463	0.750241	-0.185678	1.28241	0.644586	-2.37598	-0.77855
Gerres erytl	0.558052	0.0571966	-0.938088	-1.23159	0.955982	-0.0587613	0.168408
Holacanthu:	-3.39368	-1.4601	0.14124	-0.769842	0.0770166	-0.254558	0.167149
Holocentru:	0.509518	0.211664	-1.05658	-0.513393	-0.650864	0.170772	-0.05765
Johnius car	-0.359458	1.2136	0.362347	1.21756	0.275235	-2.23329	-0.54889
Lonchurus l	0.0781638	2.43765	-1.51518	-1.20932	0.607941	0.0184996	-0.24819
Oligoplites :	0.0415191	0.486424	2.00956	0.842686	2.39464	1.37649	-0.38717
Ophiocara n	0.561366	0.673332	1.57496	-0.333736	0.233144	1.53931	2.40185
Perca fluvia	0.010096	0.180316	0.530167	0.679371	-1.47605	-0.35476	1.48998
Pomacentru	-0.541987	0.171298	0.831647	-0.591197	0.314744	0.866411	-1.51888
Pomadasys	0.451729	-0.676219	-0.0171987	0.92956	-1.19529	0.909109	-1.07592
Sparisoma (	0.57168	-0.625106	-0.775374	0.57192	0.601923	0.303605	1.14385
Trachichthy	2.02615	-1.75782	1.92227	-2.77288	-0.184818	-1.53884	-1.12847

Close | Copy | Print | Help

Lab Practical Assignment IV

Correspondence Analysis (CA) in PAST

Correspondence analysis

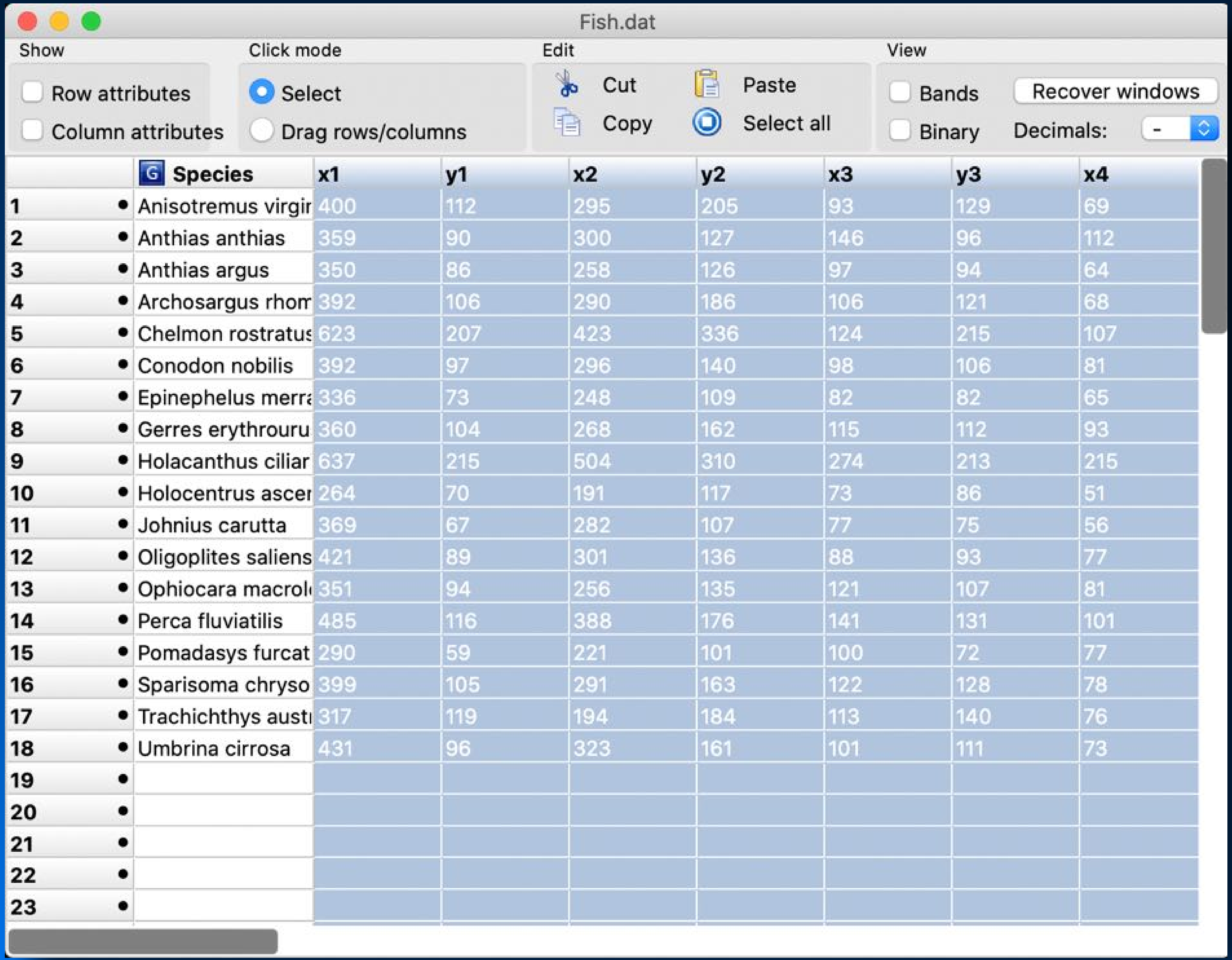
Summary | Scatter plot | Row scores | Column scores | Relay plot

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7
Pre-Orbit Le	0.0474775	-0.182296	-0.156216	0.0742287	0.123059	0.0293501	0.0221414
Head Lengt	0.0466845	-0.0500687	-0.0244075	0.00938765	-0.0569188	0.0288396	0.0239833
Pre-Dorsal	0.208871	0.00123279	0.0562029	-0.0129859	0.0696972	-0.0204981	-0.0173962
Pre-Pectora	0.0567217	-0.0465127	-0.0600497	0.0259171	-0.0042464	0.0201656	-0.0285902
Pre-Pelvic L	0.0618946	-0.0341045	-0.0666588	0.0607289	-0.0621742	0.0341176	-0.0176317
Pre-Anal Le	0.00066602	0.00364572	-0.0260186	0.0167667	-0.0617167	-0.062964	0.00833159
Standard Le	0.0326823	0.0279091	0.02848	0.033805	0.0147693	0.00134247	0.00913006
Fork Length	-0.0032994	0.0400337	0.0110395	0.0090198	0.0199935	-0.0190263	0.0202197
Total Lengt	0.0146826	0.0430804	0.0262531	-0.0032032	-0.0043100	0.023796	-0.023757
Snout Leng	0.113773	-0.190597	-0.113549	0.0285136	0.0661375	0.0054673	0.00477027
Eye Diamet	0.205812	-0.271462	0.127121	-0.18161	-0.107625	-0.0536325	-0.111289
Pectoral Fin	0.048535	0.156604	-0.118454	-0.176557	0.00016446	0.0228703	0.0183163
Dorsal Fin L	-0.259323	-0.0035478	-0.0055230	0.0030982	0.0151355	0.00194268	-0.0199572
Peduncle Le	-0.0405785	-0.108016	0.141516	-0.0232726	-0.0844916	0.107742	0.0975062
Body Depth	-0.0626009	-0.170866	0.0243383	-0.0887391	0.025862	-0.0152384	0.0157711

Close | Copy | Print | Help

Lab Practical Assignment IV

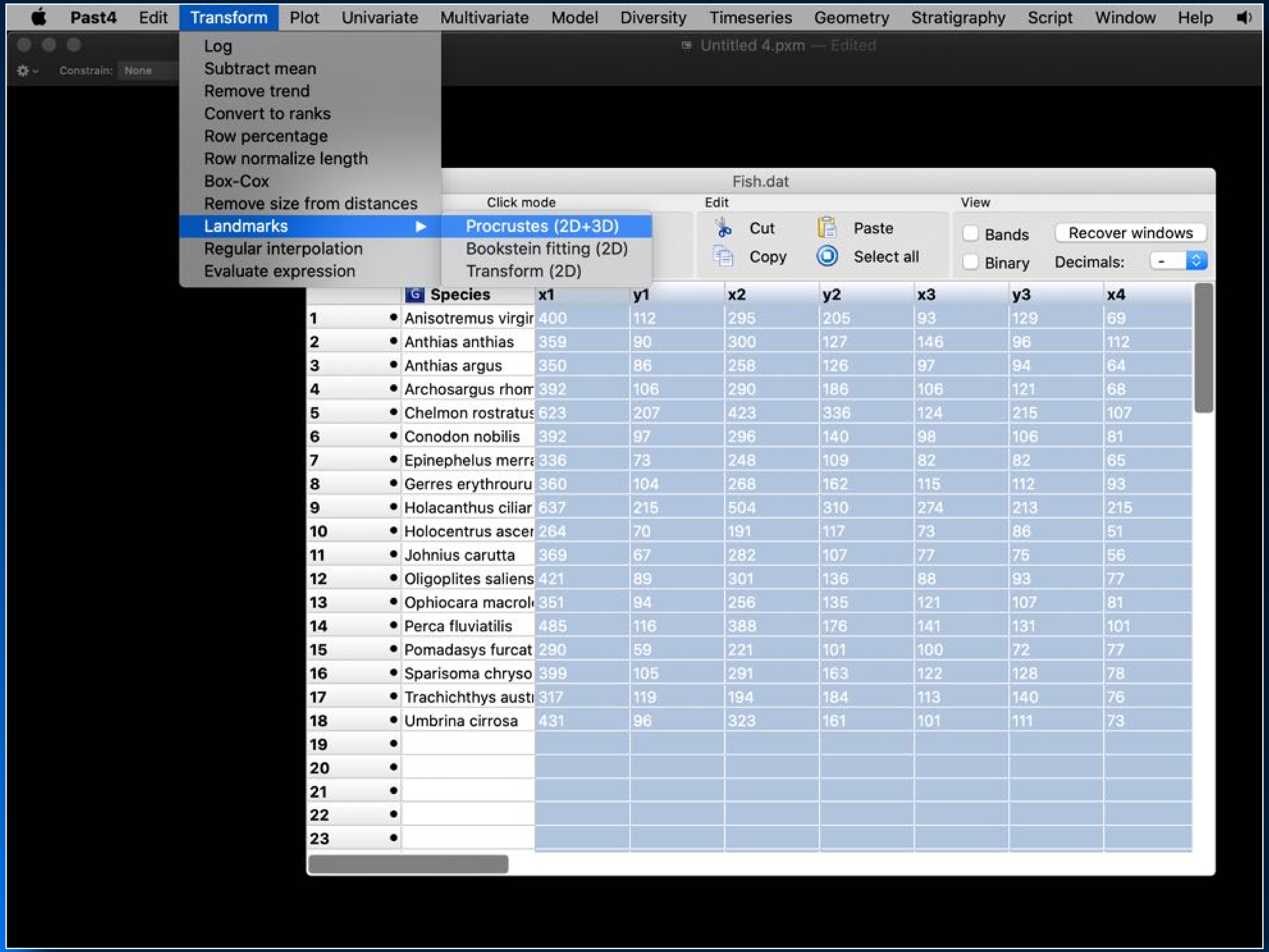
Geometric Morphometrics (GM) in PAST



	Species	x1	y1	x2	y2	x3	y3	x4
1	Anisotremus virgir	400	112	295	205	93	129	69
2	Anthias anthias	359	90	300	127	146	96	112
3	Anthias argus	350	86	258	126	97	94	64
4	Archosargus rhom	392	106	290	186	106	121	68
5	Chelmon rostratus	623	207	423	336	124	215	107
6	Conodon nobilis	392	97	296	140	98	106	81
7	Epinephelus merra	336	73	248	109	82	82	65
8	Gerres erythrouru	360	104	268	162	115	112	93
9	Holacanthus ciliar	637	215	504	310	274	213	215
10	Holocentrus ascer	264	70	191	117	73	86	51
11	Johnius carutta	369	67	282	107	77	75	56
12	Oligoplites saliens	421	89	301	136	88	93	77
13	Ophiocara macrol	351	94	256	135	121	107	81
14	Perca fluviatilis	485	116	388	176	141	131	101
15	Pomadasys furcat	290	59	221	101	100	72	77
16	Sparisoma chryso	399	105	291	163	122	128	78
17	Trachichthys austr	317	119	194	184	113	140	76
18	Umbrina cirrosa	431	96	323	161	101	111	73
19								
20								
21								
22								
23								

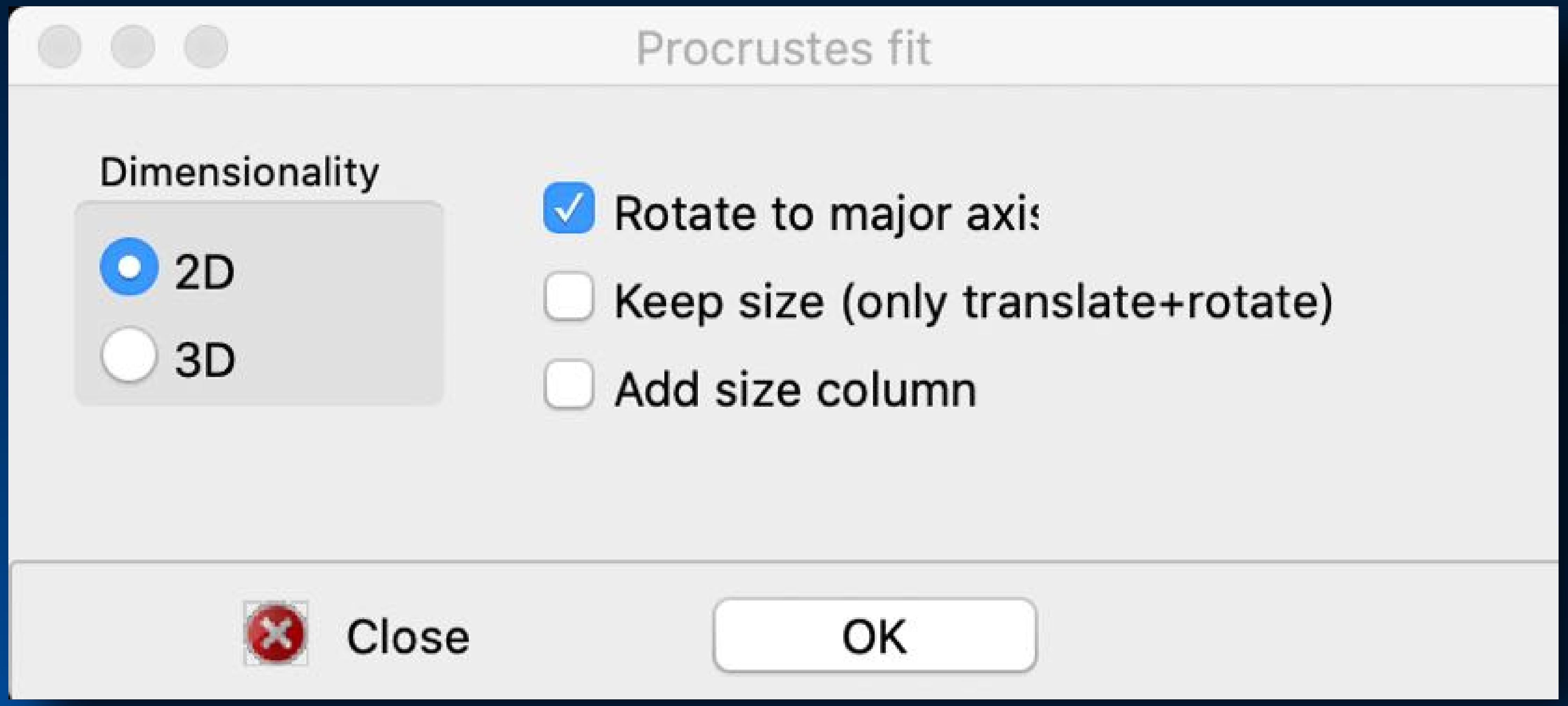
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



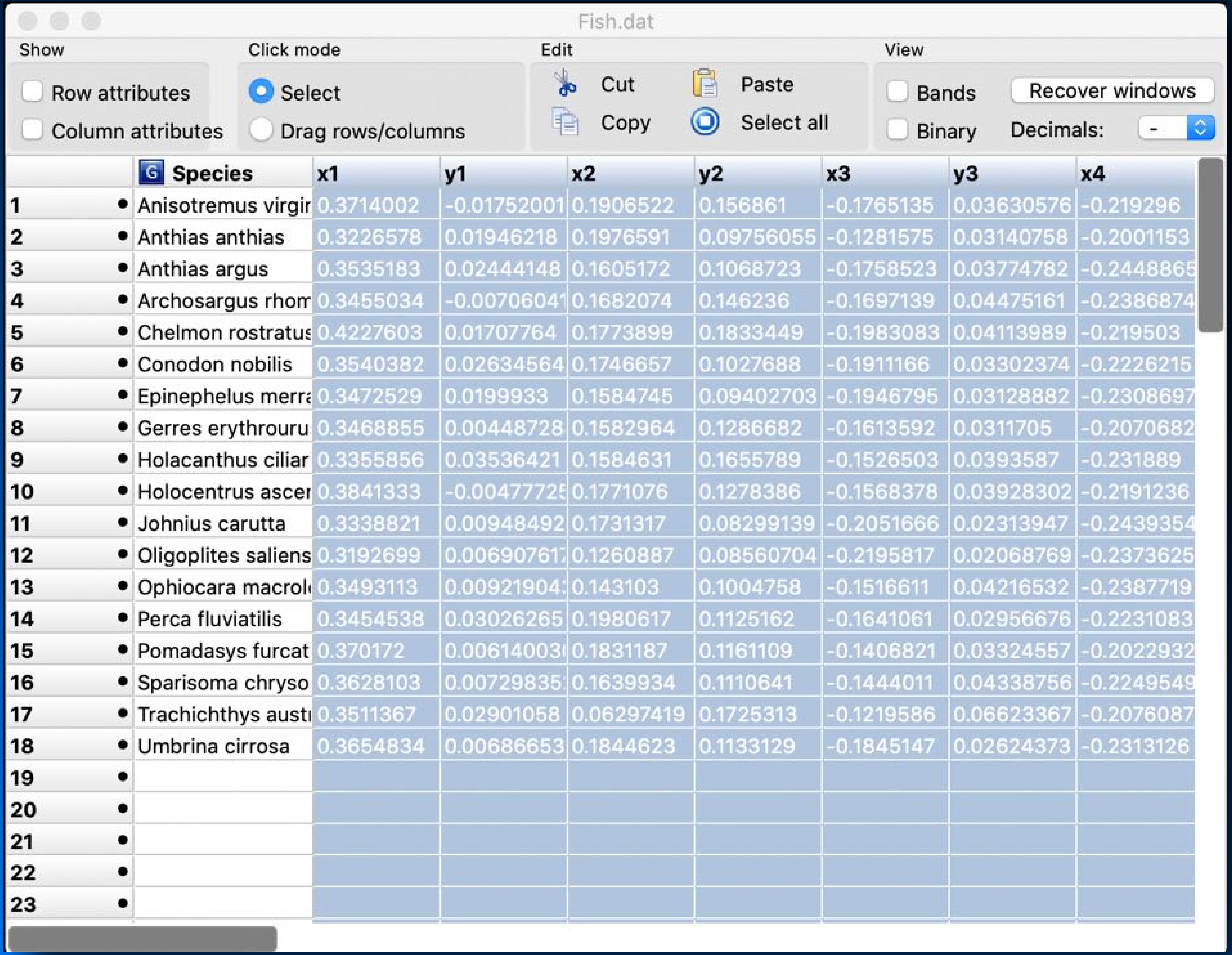
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



Lab Practical Assignment IV

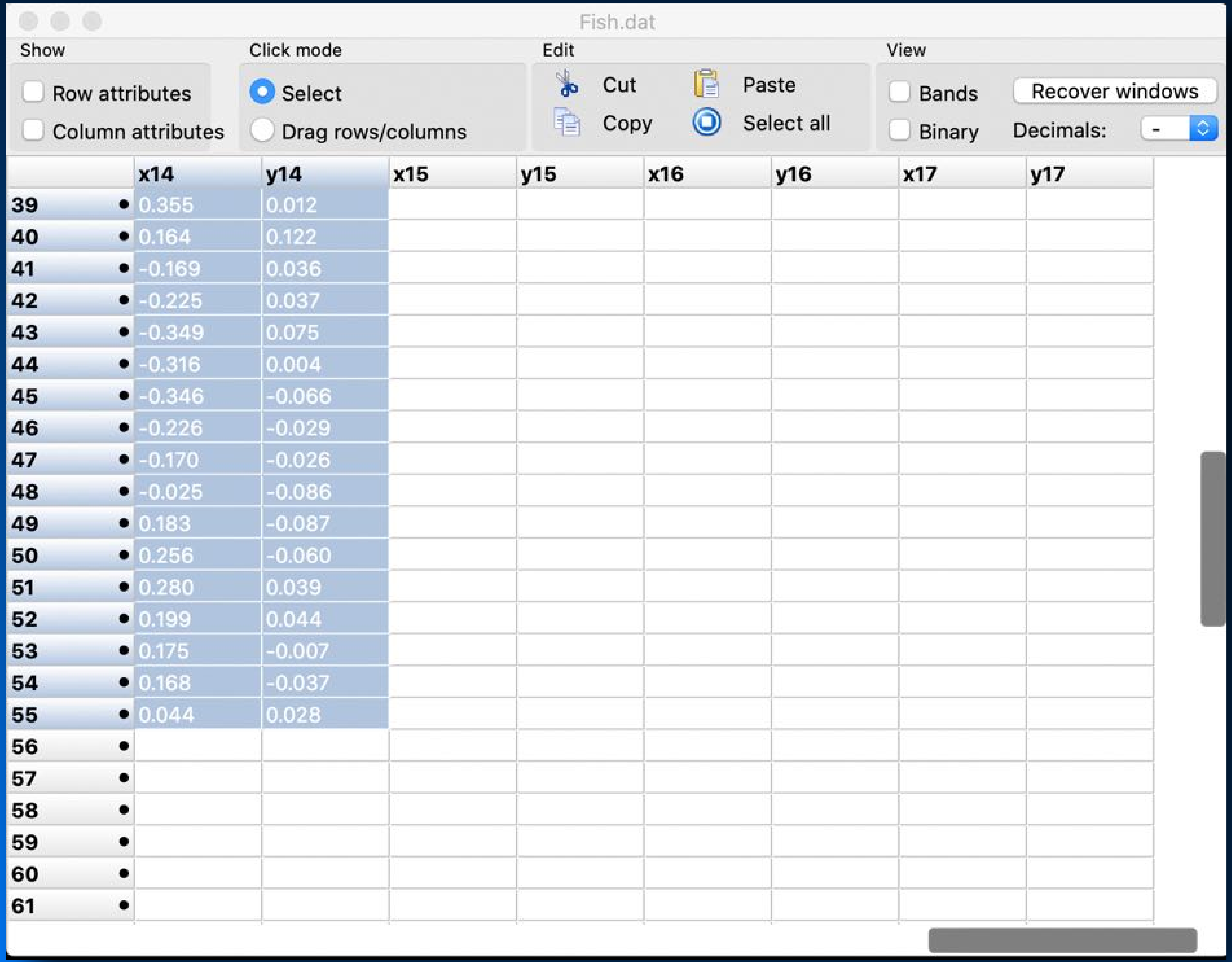
Geometric Morphometrics (GM) in PAST



	Species	x1	y1	x2	y2	x3	y3	x4
1	Anisotremus virgir	0.3714002	-0.01752001	0.1906522	0.156861	-0.1765135	0.03630576	-0.219296
2	Anthias anthias	0.3226578	0.01946218	0.1976591	0.09756055	-0.1281575	0.03140758	-0.2001153
3	Anthias argus	0.3535183	0.02444148	0.1605172	0.1068723	-0.1758523	0.03774782	-0.2448865
4	Archosargus rhor	0.3455034	-0.00706041	0.1682074	0.146236	-0.1697139	0.04475161	-0.2386874
5	Chelmon rostratus	0.4227603	0.01707764	0.1773899	0.1833449	-0.1983083	0.04113989	-0.219503
6	Conodon nobilis	0.3540382	0.02634564	0.1746657	0.1027688	-0.1911166	0.03302374	-0.2226215
7	Epinephelus merra	0.3472529	0.0199933	0.1584745	0.09402703	-0.1946795	0.03128882	-0.2308697
8	Gerres erythrouru	0.3468855	0.00448728	0.1582964	0.1286682	-0.1613592	0.0311705	-0.2070682
9	Holacanthus ciliar	0.3355856	0.03536421	0.1584631	0.1655789	-0.1526503	0.0393587	-0.231889
10	Holocentrus ascer	0.3841333	-0.0047772	0.1771076	0.1278386	-0.1568378	0.03928302	-0.2191236
11	Johnius carutta	0.3338821	0.00948492	0.1731317	0.08299139	-0.2051666	0.02313947	-0.2439354
12	Oligoplites saliens	0.3192699	0.0069076	0.1260887	0.08560704	-0.2195817	0.02068769	-0.2373625
13	Ophiocara macrol	0.3493113	0.0092190	0.143103	0.1004758	-0.1516611	0.04216532	-0.2387719
14	Perca fluviatilis	0.3454538	0.03026265	0.1980617	0.1125162	-0.1641061	0.02956676	-0.2231083
15	Pomadasys furcat	0.370172	0.0061400	0.1831187	0.1161109	-0.1406821	0.03324557	-0.2022932
16	Sparisoma chryso	0.3628103	0.0072983	0.1639934	0.1110641	-0.1444011	0.04338756	-0.2249549
17	Trachichthys austr	0.3511367	0.02901058	0.06297419	0.1725313	-0.1219586	0.06623367	-0.2076087
18	Umbrina cirrosa	0.3654834	0.00686653	0.1844623	0.1133129	-0.1845147	0.02624373	-0.2313126
19								
20								
21								
22								
23								

Lab Practical Assignment IV

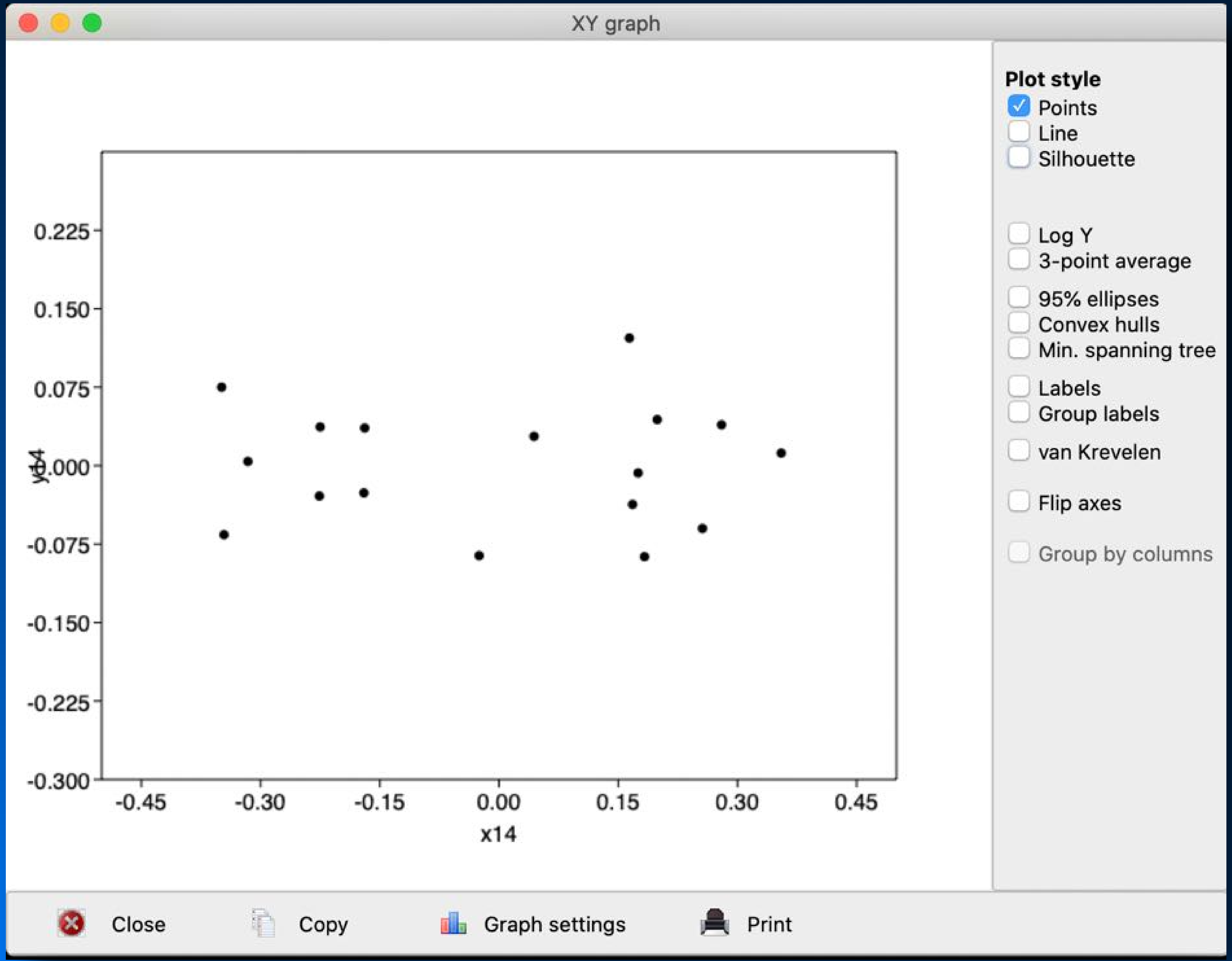
Geometric Morphometrics (GM) in PAST



	x14	y14	x15	y15	x16	y16	x17	y17
39 •	0.355	0.012						
40 •	0.164	0.122						
41 •	-0.169	0.036						
42 •	-0.225	0.037						
43 •	-0.349	0.075						
44 •	-0.316	0.004						
45 •	-0.346	-0.066						
46 •	-0.226	-0.029						
47 •	-0.170	-0.026						
48 •	-0.025	-0.086						
49 •	0.183	-0.087						
50 •	0.256	-0.060						
51 •	0.280	0.039						
52 •	0.199	0.044						
53 •	0.175	-0.007						
54 •	0.168	-0.037						
55 •	0.044	0.028						
56 •								
57 •								
58 •								
59 •								
60 •								
61 •								

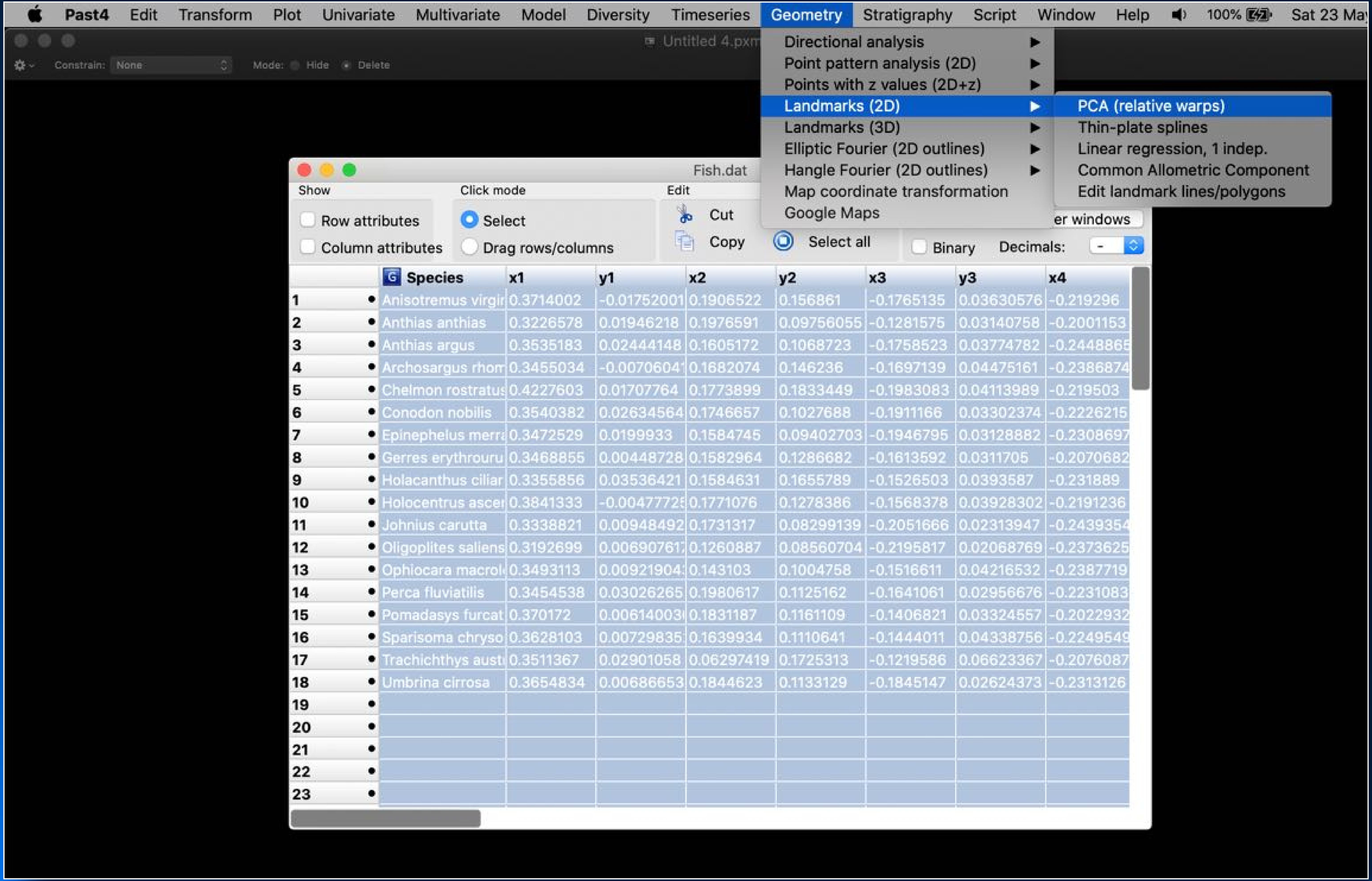
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



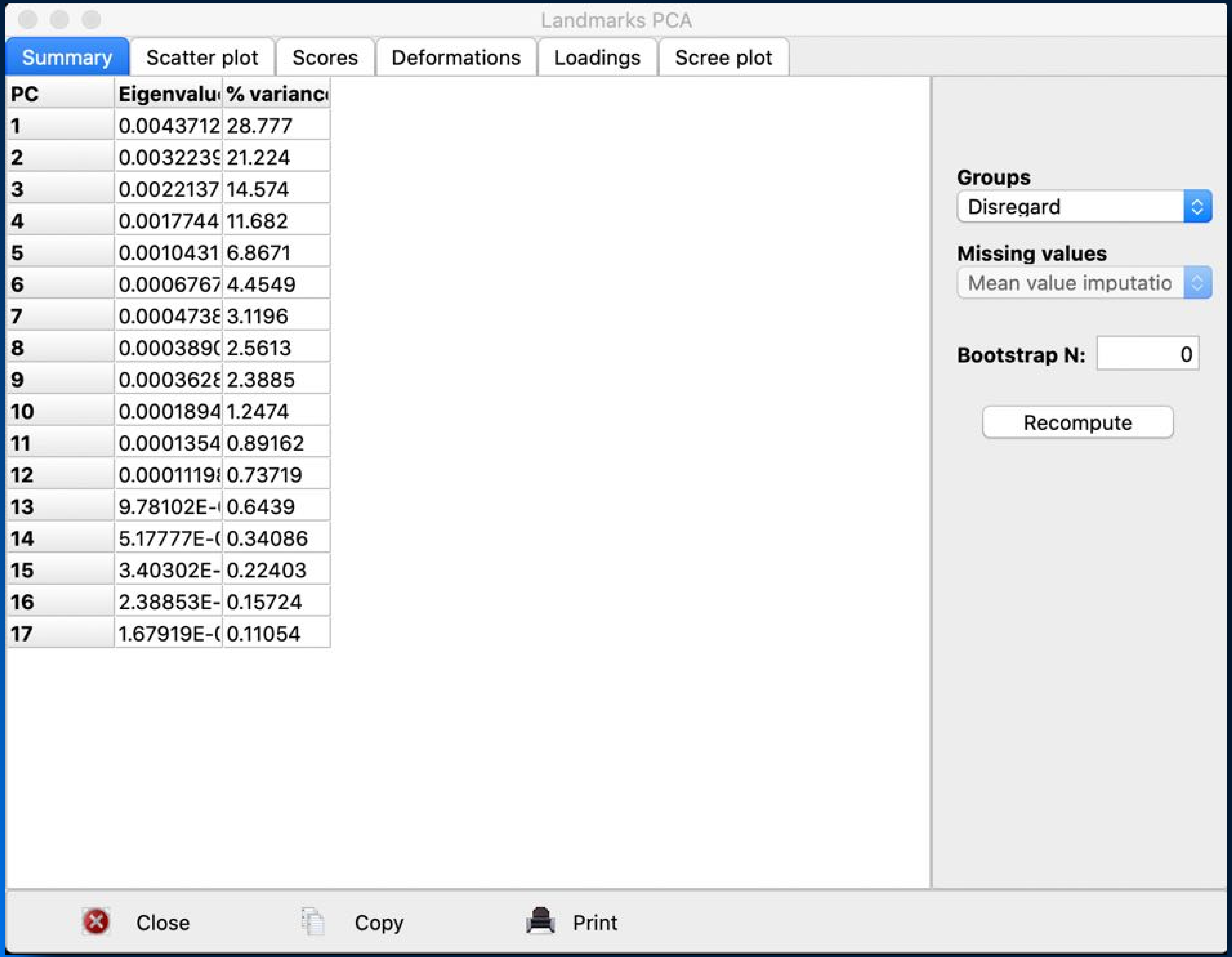
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



Lab Practical Assignment IV

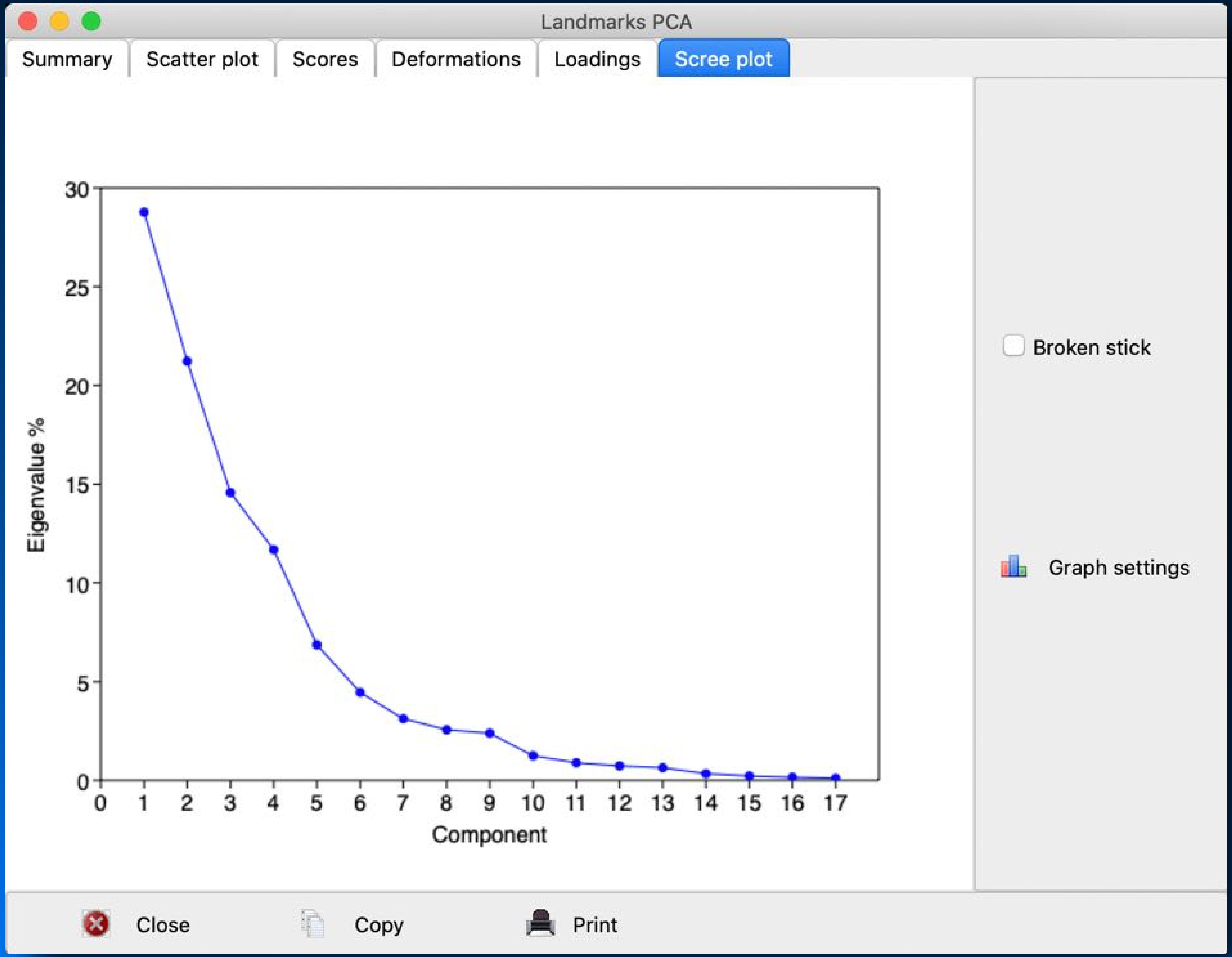
Geometric Morphometrics (GM) in PAST



PC	Eigenvalu	% varianc
1	0.0043712	28.777
2	0.0032239	21.224
3	0.0022137	14.574
4	0.0017744	11.682
5	0.0010431	6.8671
6	0.0006767	4.4549
7	0.0004738	3.1196
8	0.0003890	2.5613
9	0.0003628	2.3885
10	0.0001894	1.2474
11	0.0001354	0.89162
12	0.0001119	0.73719
13	9.78102E-	0.6439
14	5.17777E-	0.34086
15	3.40302E-	0.22403
16	2.38853E-	0.15724
17	1.67919E-	0.11054

Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST

Landmarks PCA

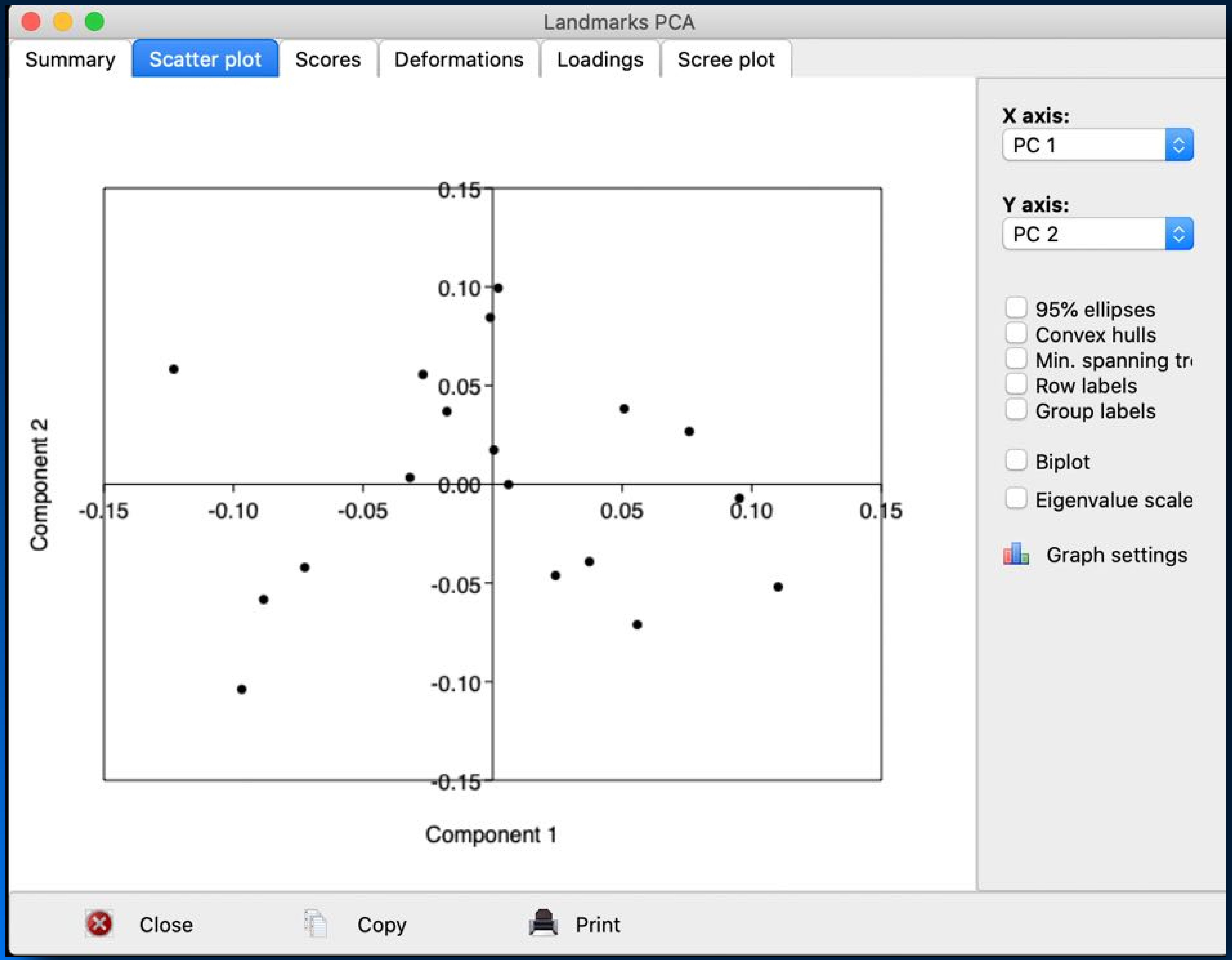
Summary | Scatter plot | Scores | Deformations | Loadings | Scree plot

	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9
1	-0.026866	0.055598	0.064949	0.034384	-0.0052946	-0.038127	0.024969	0.0044809	-0.0028
2	-0.096798	-0.10391	0.014196	0.002074	0.0099012	0.023677	-0.01501	-0.047535	-0.0049
3	0.075882	0.026719	0.0025628	-0.0218	0.013279	0.0038961	-0.0087203	-0.0042867	-0.0004
4	0.00046148	0.017351	-0.0026588	-0.027496	-0.0096916	-0.013857	0.027016	-0.0060346	-0.0004
5	0.0021173	0.099357	-0.015516	0.071542	-0.070375	0.01795	-0.01992	-0.010401	-0.0270
6	0.037309	-0.039206	0.00029195	-0.017909	-0.026682	-0.0059226	-0.009217	0.01259	-0.0029
7	0.095227	-0.0070486	0.0080838	-0.042492	-0.0084688	-0.001915	-0.039572	-0.0048142	0.01398
8	-0.072476	-0.042134	0.0023352	0.0043647	0.0010973	-0.044499	0.0098308	-0.019652	-0.0003
9	-0.0010021	0.084432	-0.025135	-0.061329	-0.021528	0.033059	0.031023	-0.023742	0.0367
10	-0.017634	0.036834	0.074168	0.04124	0.028255	-0.0025066	-0.032101	0.0052659	0.01786
11	0.11017	-0.051959	0.011192	-0.026966	-4.3234E-05	-0.020161	-0.006372	0.010329	0.00126
12	0.055808	-0.071131	-0.1166	0.084449	-0.0093282	-0.011623	0.014538	0.0033672	0.01742
13	0.050784	0.038244	-0.020593	0.036904	0.092095	0.038505	0.011856	-0.0025093	-0.0174
14	0.024266	-0.046282	0.017214	-0.045933	-0.01877	0.018353	0.015427	0.0034881	-0.0470
15	-0.088379	-0.058395	0.026723	0.013353	-0.022848	0.051104	0.0015778	0.0434	0.01980
16	-0.031932	0.0033687	0.010114	-0.017149	0.015153	-0.0091573	0.023813	0.025731	-0.0087
17	-0.12306	0.058297	-0.097009	-0.05136	0.024113	-0.023517	-0.032447	0.016925	-0.0077
18	0.0061146	-0.00013142	0.045686	0.024124	0.0091374	-0.015259	0.003307	-0.0066036	0.01308

Close | Copy | Print

Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST

Landmarks PCA

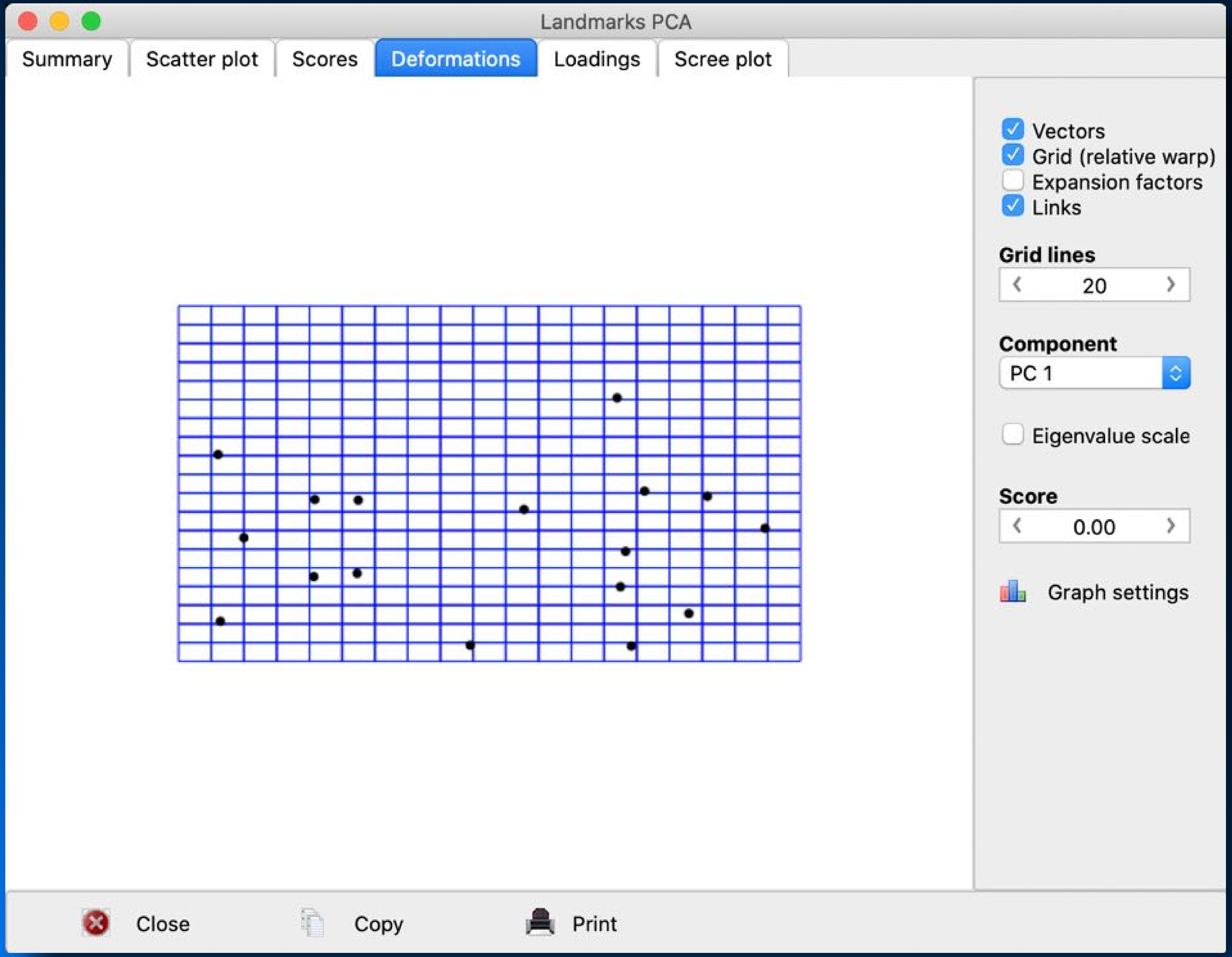
Summary | Scatter plot | Scores | Deformations | **Loadings** | Scree plot

	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9
x1	-0.051878	0.24533	0.19567	0.22017	-0.22647	0.060788	-0.27682	0.32297	-0.2
y1	0.01903	3.6792E-05	-0.12594	-0.18021	-0.075472	0.21856	-0.16535	-0.12962	-0.1
x2	0.072325	-0.1458	0.52673	0.098044	-0.30949	0.26532	0.31696	-0.30757	-0.1
y2	-0.22396	0.41307	-0.039758	-0.024722	-0.31301	-0.082983	0.08642	-0.11684	-0.1
x3	-0.31448	0.034169	0.047283	-0.22532	0.33423	0.30317	0.0080109	-0.011405	-0.0
y3	-0.07501	0.11316	-0.053376	-0.070381	0.073915	-0.0010597	-0.080432	0.082845	-0.0
x4	-0.18233	-0.04974	0.037345	0.017543	-0.074772	0.036204	-0.16065	-0.0029835	-0.0
y4	-0.061423	0.1469	-0.064126	-0.057168	0.12965	-0.047305	0.024969	-0.014099	-0.0
x5	0.32526	0.32679	0.027132	0.011879	0.0039667	0.011311	0.10147	-0.037506	0.00
y5	-0.21677	0.022459	-0.12687	-0.040685	0.0070389	0.38458	0.17193	0.022077	0.19
x6	-0.38838	-0.30899	-0.05965	0.049521	-0.38226	-0.37412	0.079226	0.051364	0.10
y6	0.0075227	0.024421	-0.061813	-0.030648	-0.012194	-0.0076015	0.13408	-0.080005	-0.0
x7	0.37603	0.39107	0.010097	-0.010071	0.011978	0.0016313	-0.096007	0.031928	0.08
y7	0.20235	-0.016093	-0.0024302	-0.022977	-0.043551	-0.26252	-0.082326	-0.12071	-0.3
x8	-0.17314	-0.056002	0.034868	0.076455	-0.11563	0.014281	-0.28457	0.026265	0.05
y8	0.045274	-0.048046	-0.087346	0.071526	-0.11557	-0.014548	-0.21082	-0.030634	0.23
x9	-0.28829	0.045191	0.027333	-0.14176	0.27675	0.14742	-0.1139	-0.10894	-0.0
y9	0.046799	-0.035472	-0.11734	0.063339	-0.11269	-0.009626	-0.14077	0.0053558	0.24
x10	-0.028914	0.00033638	-0.46692	0.72951	0.13845	0.10452	0.099983	-0.053188	-0.11
y10	0.11678	-0.29743	0.14021	0.017291	0.15237	-0.11111	-0.371	0.21064	-0.1
x11	0.023804	0.0090602	-0.24665	-0.14582	0.13741	-0.24439	-0.061083	-0.26974	0.00
y11	0.17812	-0.30658	0.092541	0.054315	0.039894	0.16517	-0.085667	-0.022317	0.05
x12	-0.02522	0.14629	0.09445	-0.19982	-0.034535	-0.16868	0.091622	0.24691	0.35
y12	0.14337	-0.11337	-0.0048105	-0.032384	-0.15883	0.19782	-0.035824	-0.039814	0.11

Close | Copy | Print

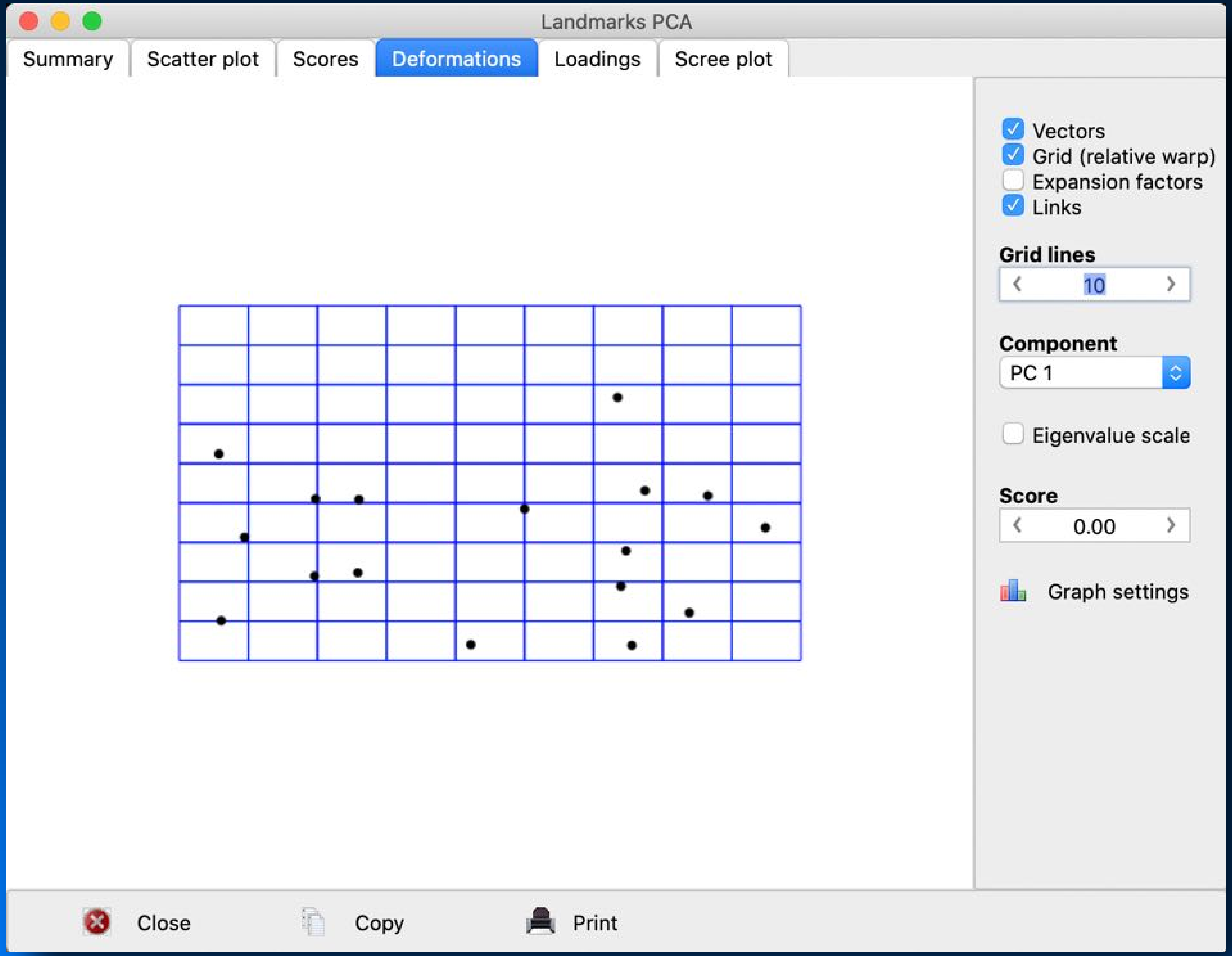
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



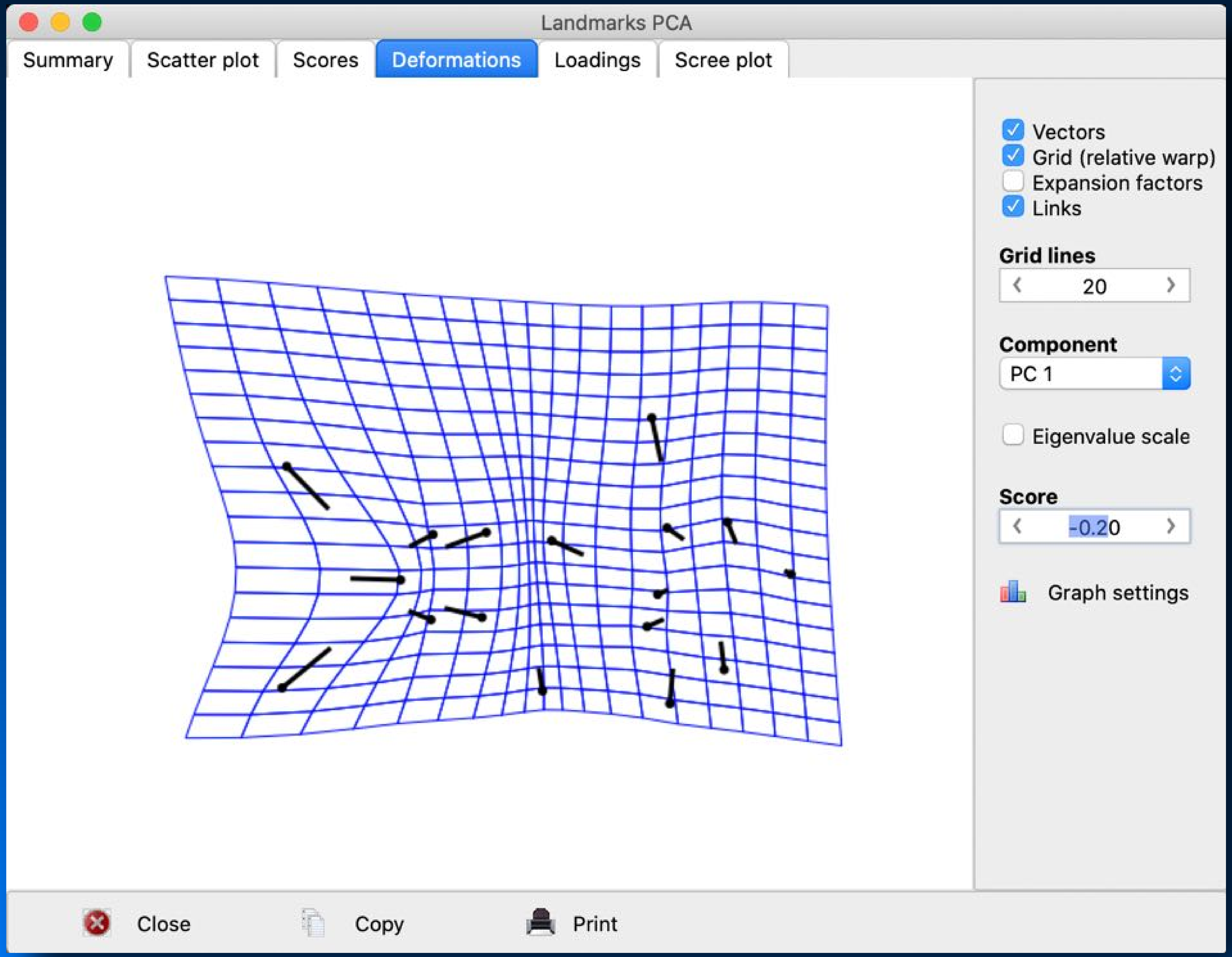
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



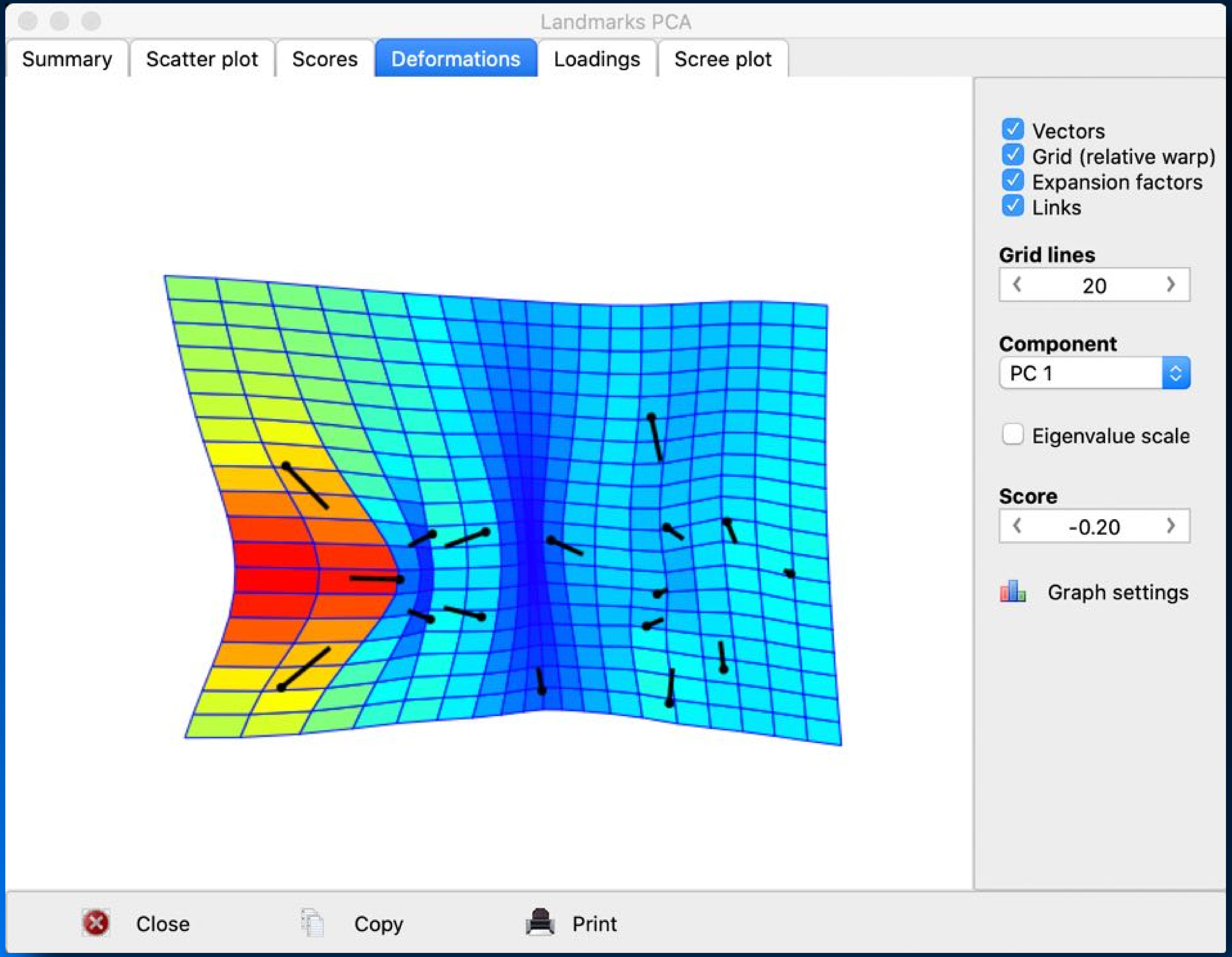
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



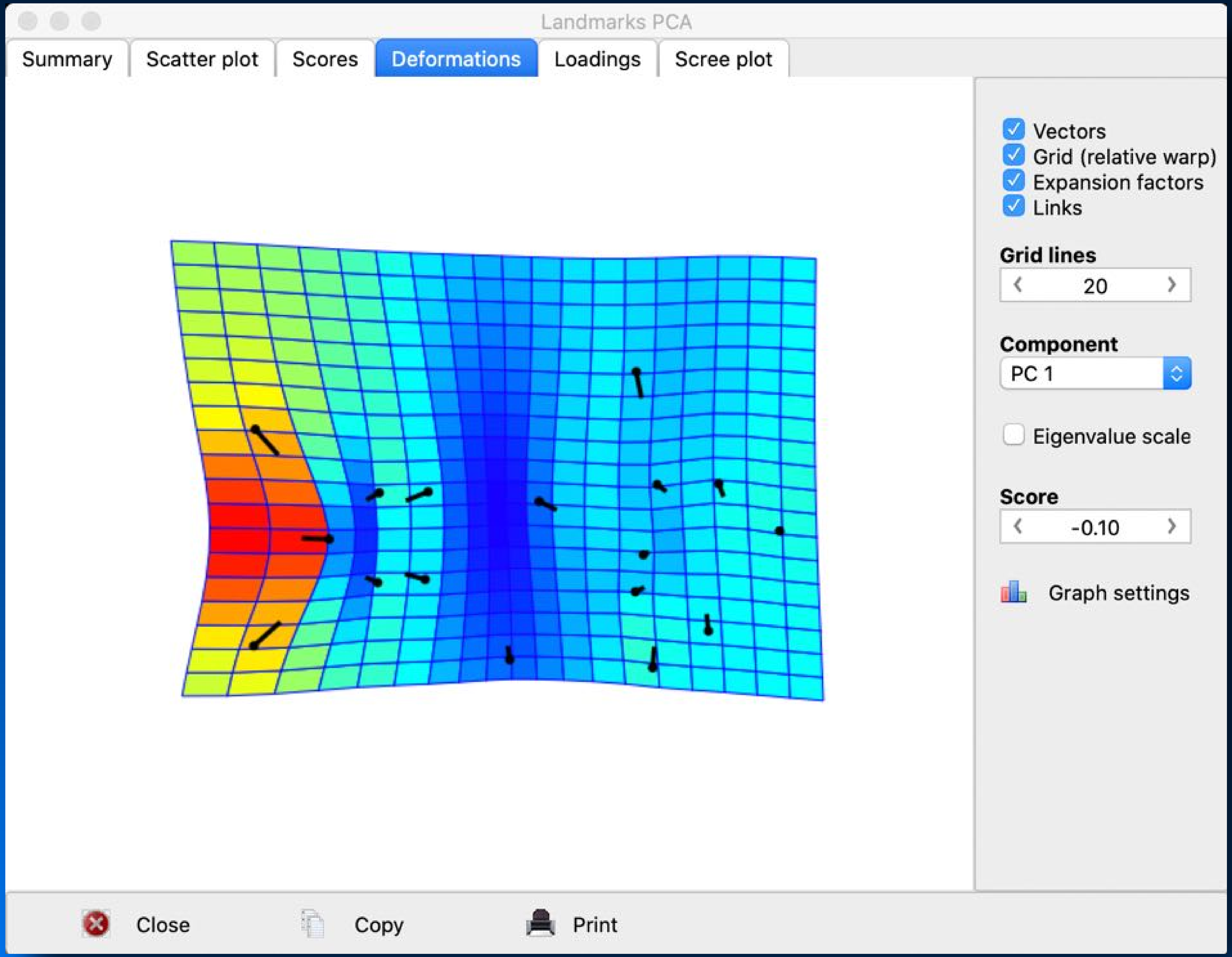
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



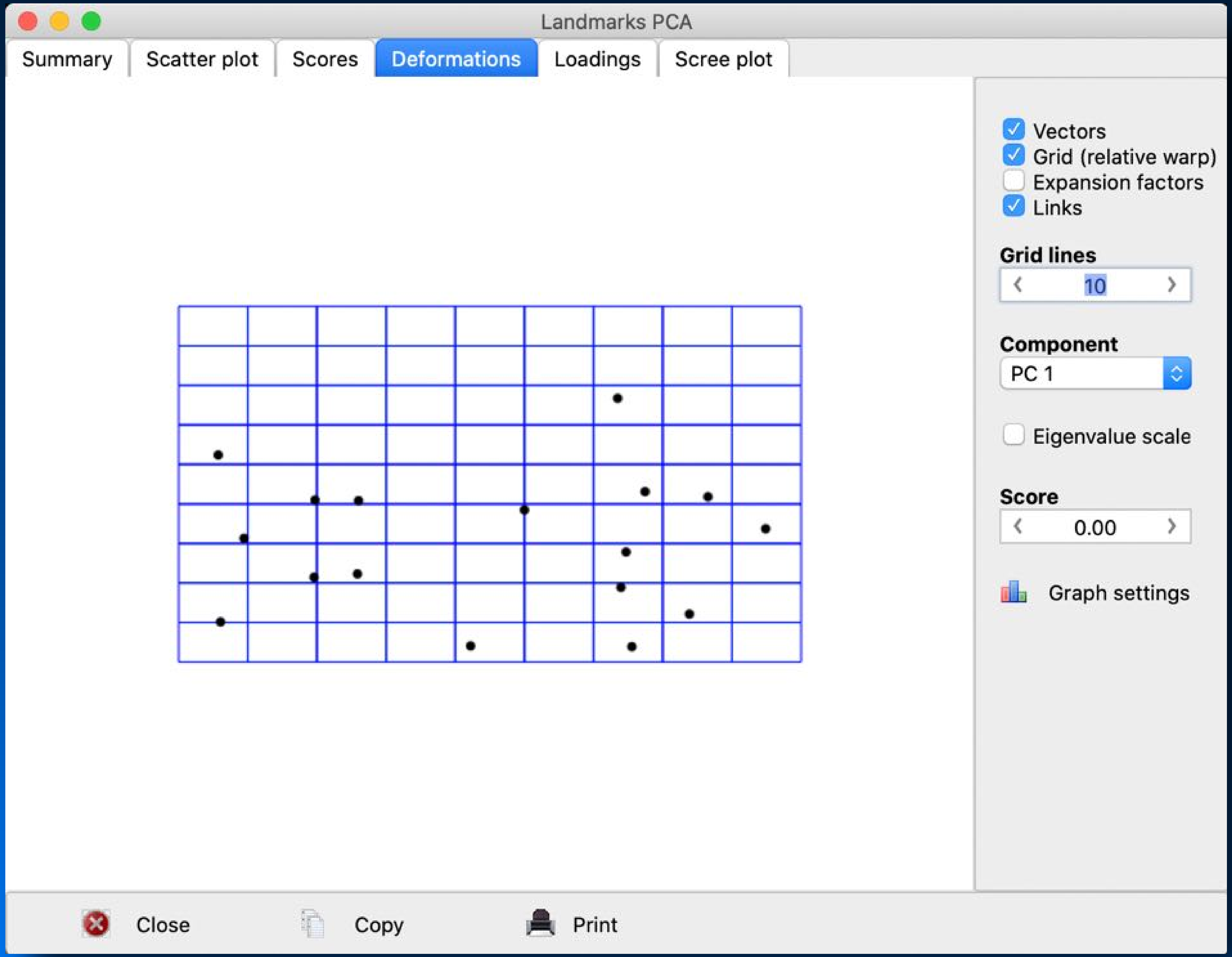
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



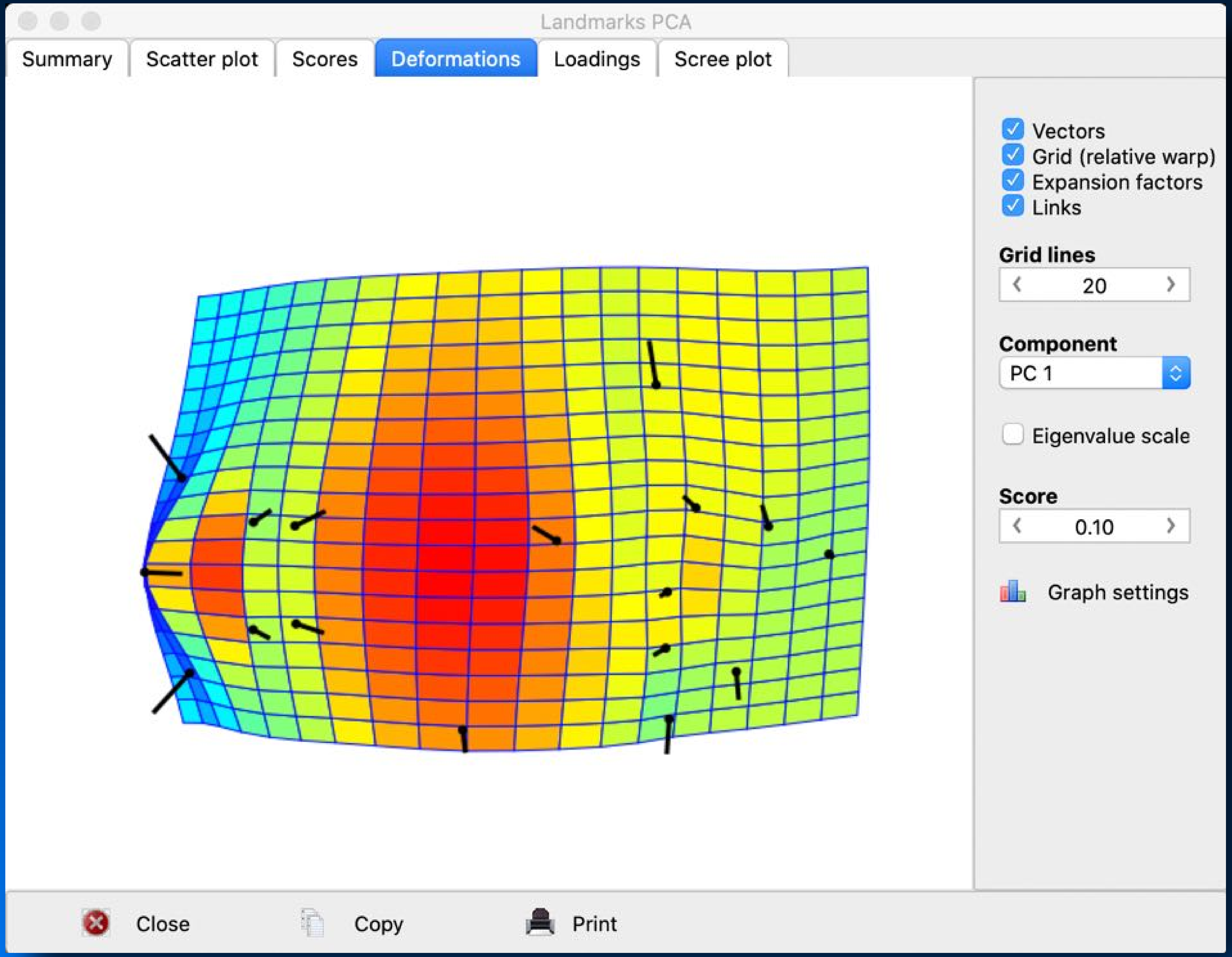
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



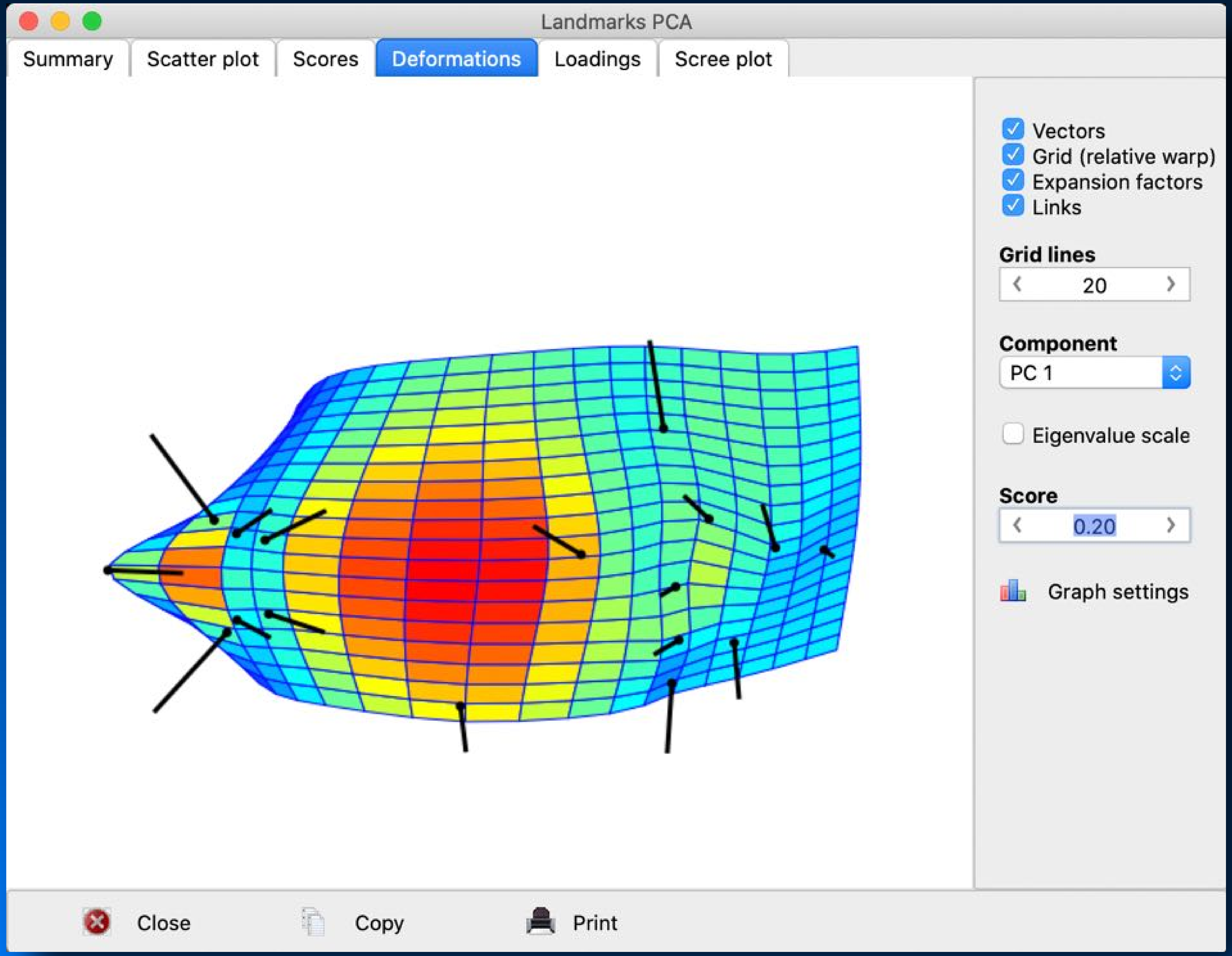
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



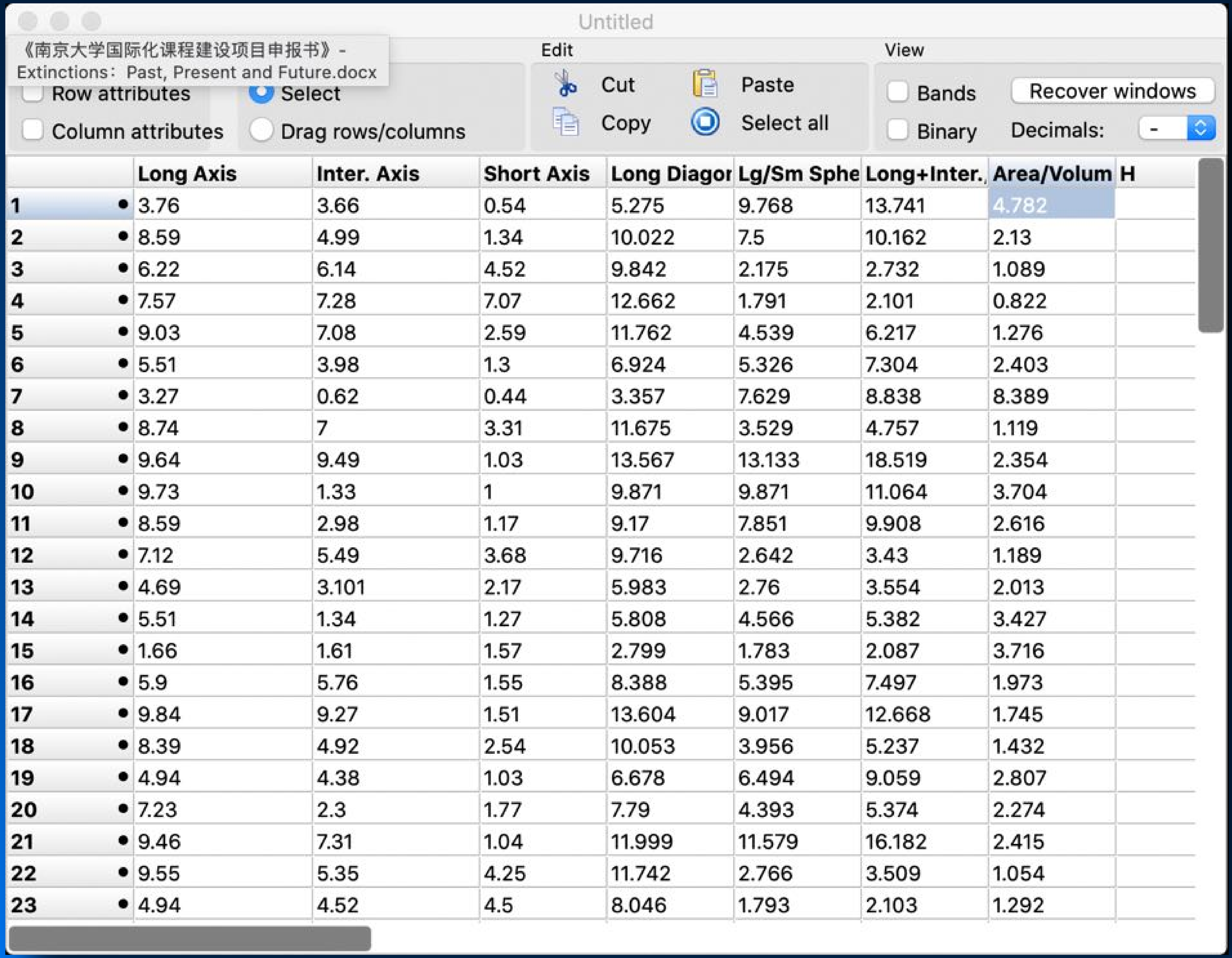
Lab Practical Assignment IV

Geometric Morphometrics (GM) in PAST



Lab Practical Assignment IV

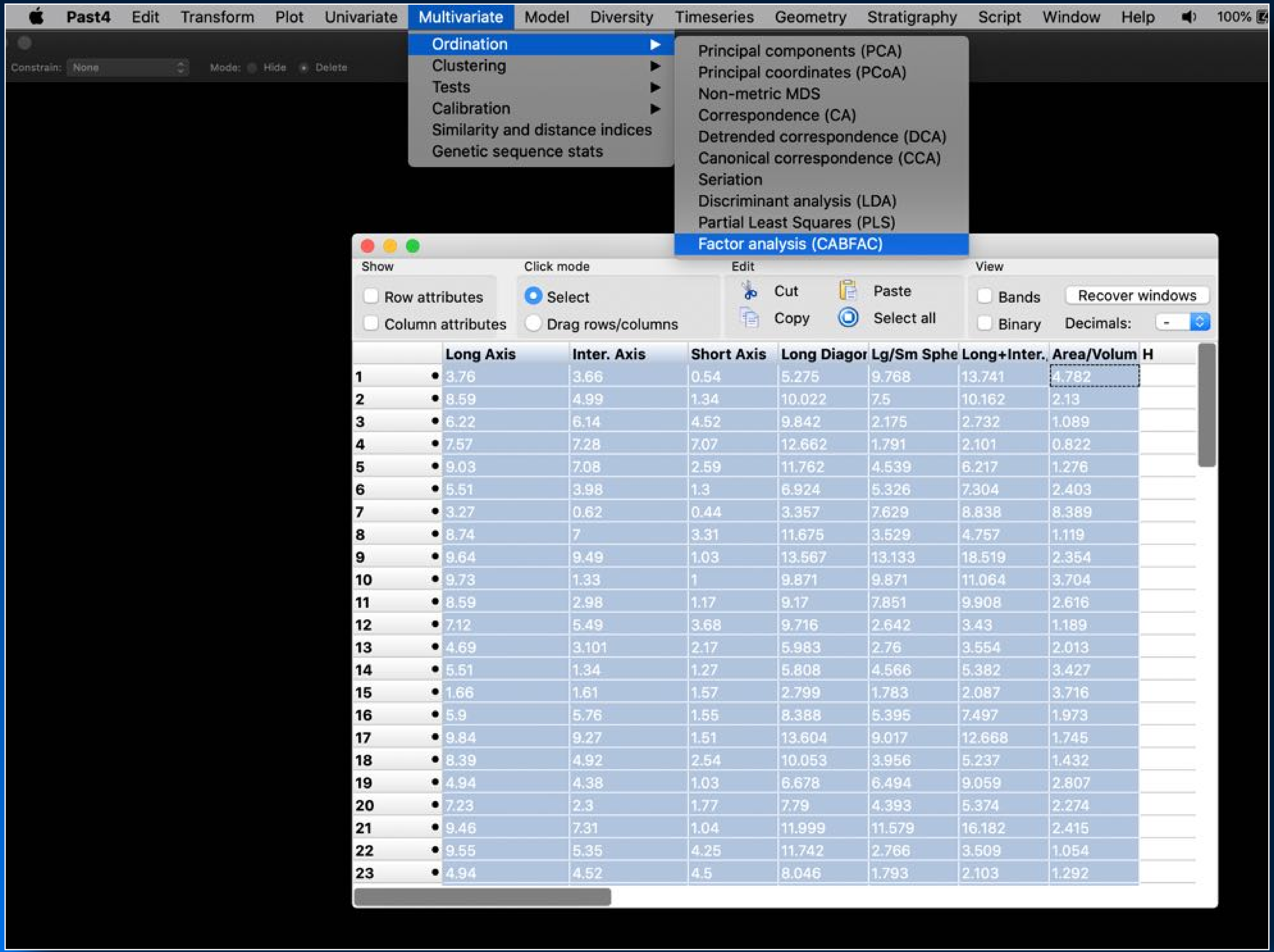
Factor Analysis (Q-Mode) in PAST



	Long Axis	Inter. Axis	Short Axis	Long Diagor	Lg/Sm Sphe	Long+Inter.	Area/Volum	H
1 •	3.76	3.66	0.54	5.275	9.768	13.741	4.782	
2 •	8.59	4.99	1.34	10.022	7.5	10.162	2.13	
3 •	6.22	6.14	4.52	9.842	2.175	2.732	1.089	
4 •	7.57	7.28	7.07	12.662	1.791	2.101	0.822	
5 •	9.03	7.08	2.59	11.762	4.539	6.217	1.276	
6 •	5.51	3.98	1.3	6.924	5.326	7.304	2.403	
7 •	3.27	0.62	0.44	3.357	7.629	8.838	8.389	
8 •	8.74	7	3.31	11.675	3.529	4.757	1.119	
9 •	9.64	9.49	1.03	13.567	13.133	18.519	2.354	
10 •	9.73	1.33	1	9.871	9.871	11.064	3.704	
11 •	8.59	2.98	1.17	9.17	7.851	9.908	2.616	
12 •	7.12	5.49	3.68	9.716	2.642	3.43	1.189	
13 •	4.69	3.101	2.17	5.983	2.76	3.554	2.013	
14 •	5.51	1.34	1.27	5.808	4.566	5.382	3.427	
15 •	1.66	1.61	1.57	2.799	1.783	2.087	3.716	
16 •	5.9	5.76	1.55	8.388	5.395	7.497	1.973	
17 •	9.84	9.27	1.51	13.604	9.017	12.668	1.745	
18 •	8.39	4.92	2.54	10.053	3.956	5.237	1.432	
19 •	4.94	4.38	1.03	6.678	6.494	9.059	2.807	
20 •	7.23	2.3	1.77	7.79	4.393	5.374	2.274	
21 •	9.46	7.31	1.04	11.999	11.579	16.182	2.415	
22 •	9.55	5.35	4.25	11.742	2.766	3.509	1.054	
23 •	4.94	4.52	4.5	8.046	1.793	2.103	1.292	

Lab Practical Assignment IV

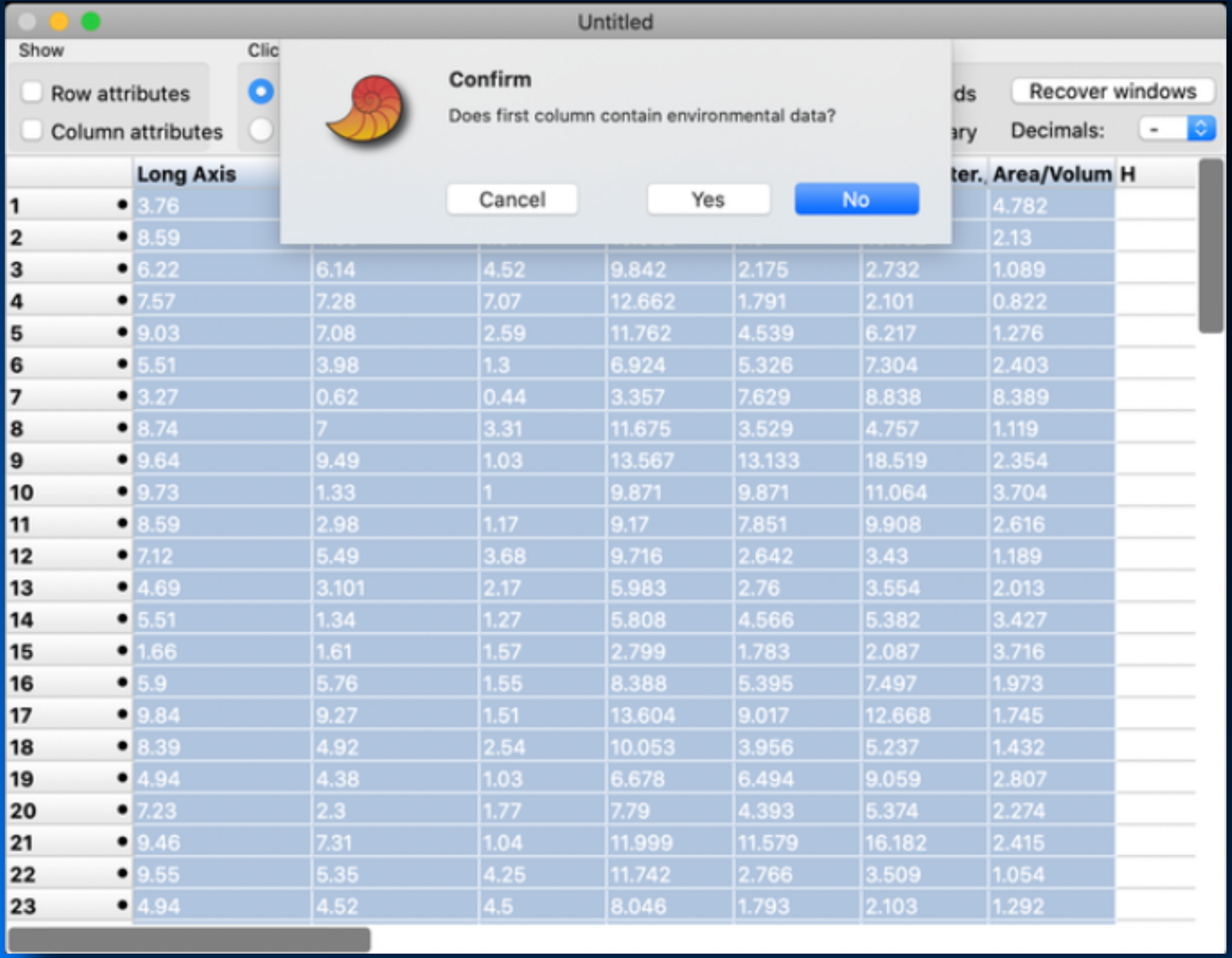
Factor Analysis (Q-Mode) in PAST



	Long Axis	Inter. Axis	Short Axis	Long Diagor	Lg/Sm Sphe	Long+Inter.	Area/Volum	H
1	3.76	3.66	0.54	5.275	9.768	13.741	4.782	
2	8.59	4.99	1.34	10.022	7.5	10.162	2.13	
3	6.22	6.14	4.52	9.842	2.175	2.732	1.089	
4	7.57	7.28	7.07	12.662	1.791	2.101	0.822	
5	9.03	7.08	2.59	11.762	4.539	6.217	1.276	
6	5.51	3.98	1.3	6.924	5.326	7.304	2.403	
7	3.27	0.62	0.44	3.357	7.629	8.838	8.389	
8	8.74	7	3.31	11.675	3.529	4.757	1.119	
9	9.64	9.49	1.03	13.567	13.133	18.519	2.354	
10	9.73	1.33	1	9.871	9.871	11.064	3.704	
11	8.59	2.98	1.17	9.17	7.851	9.908	2.616	
12	7.12	5.49	3.68	9.716	2.642	3.43	1.189	
13	4.69	3.101	2.17	5.983	2.76	3.554	2.013	
14	5.51	1.34	1.27	5.808	4.566	5.382	3.427	
15	1.66	1.61	1.57	2.799	1.783	2.087	3.716	
16	5.9	5.76	1.55	8.388	5.395	7.497	1.973	
17	9.84	9.27	1.51	13.604	9.017	12.668	1.745	
18	8.39	4.92	2.54	10.053	3.956	5.237	1.432	
19	4.94	4.38	1.03	6.678	6.494	9.059	2.807	
20	7.23	2.3	1.77	7.79	4.393	5.374	2.274	
21	9.46	7.31	1.04	11.999	11.579	16.182	2.415	
22	9.55	5.35	4.25	11.742	2.766	3.509	1.054	
23	4.94	4.52	4.5	8.046	1.793	2.103	1.292	

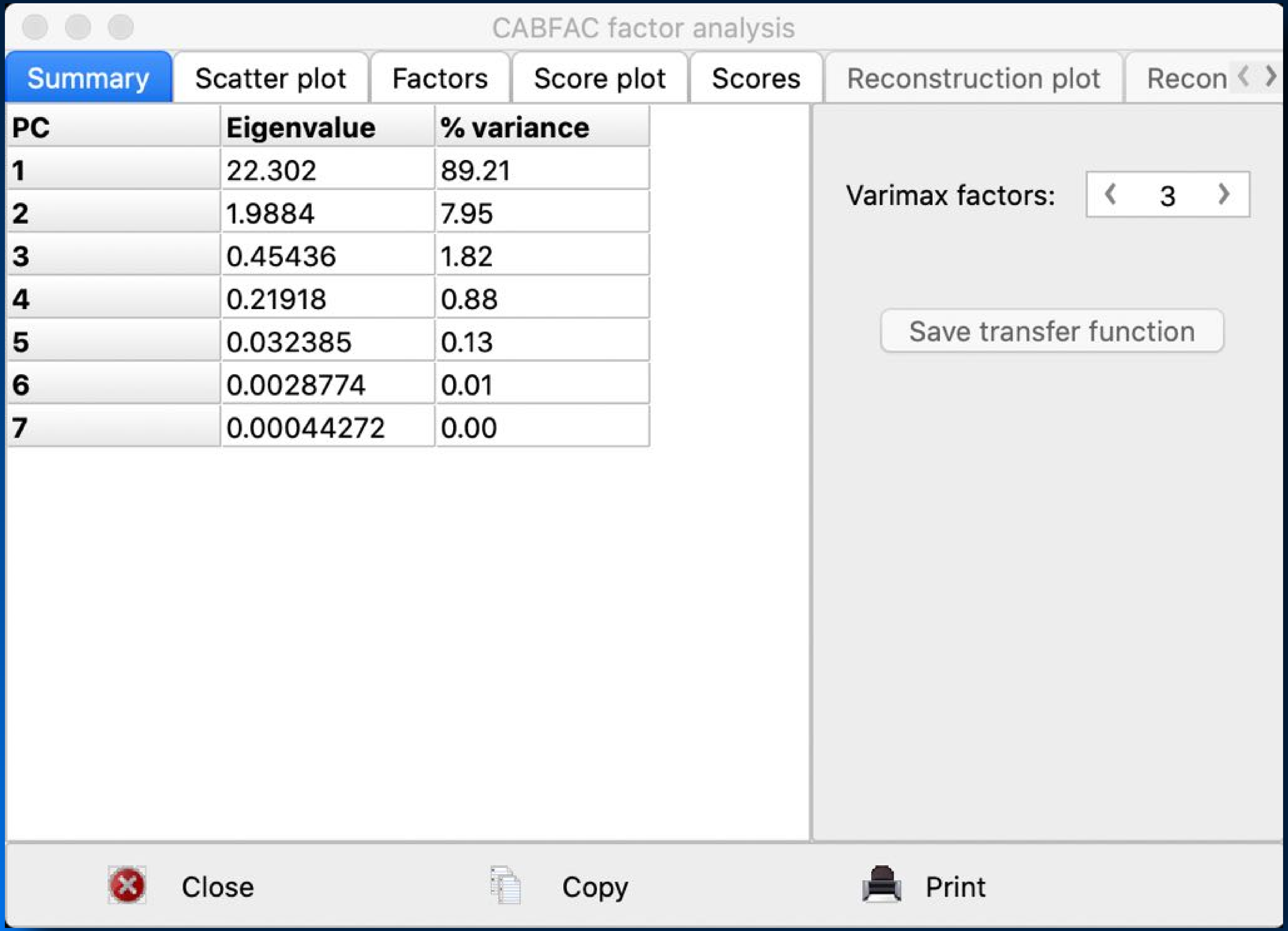
Lab Practical Assignment IV

Factor Analysis (Q-Mode) in PAST



Lab Practical Assignment IV

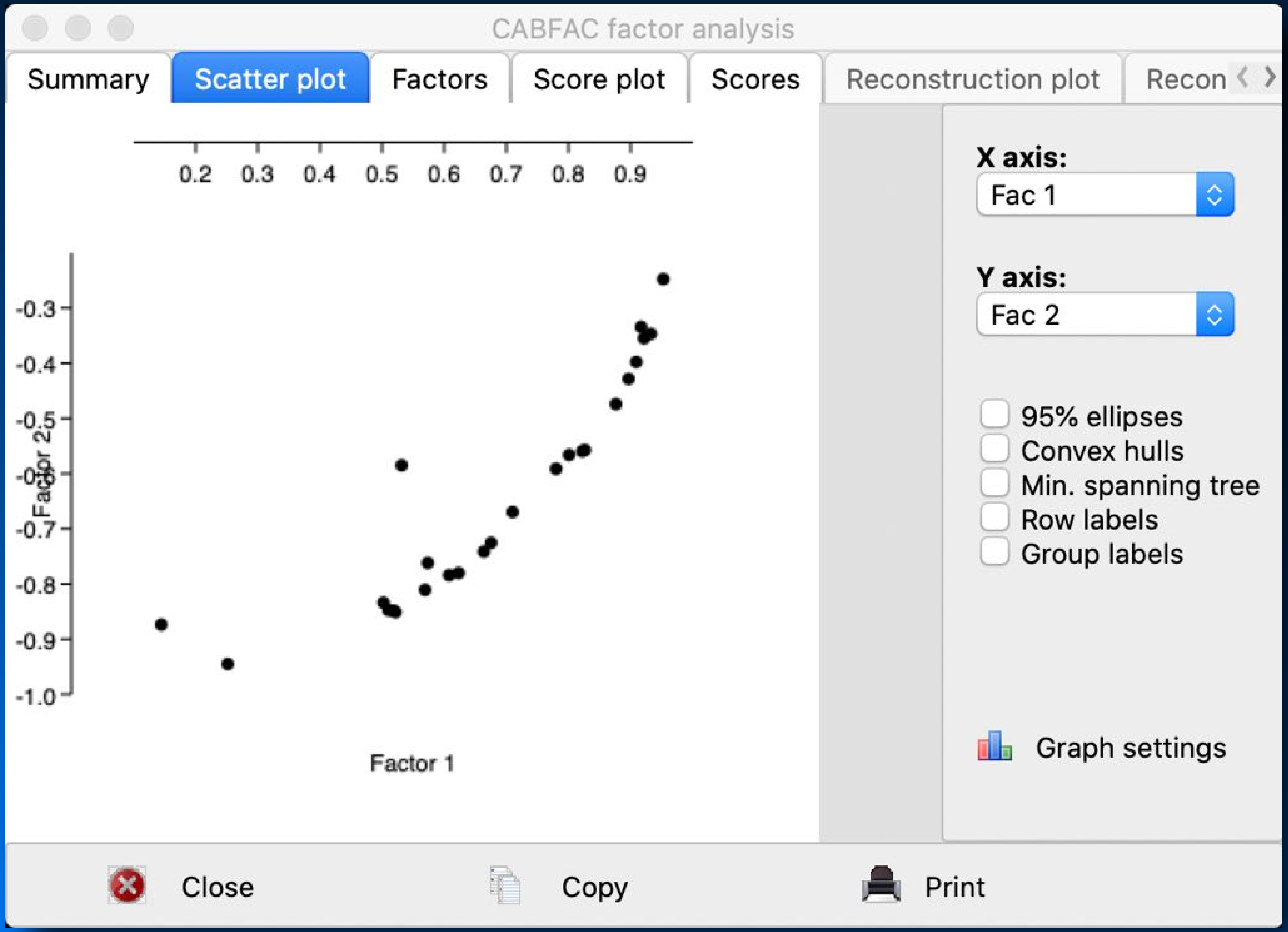
Factor Analysis (Q-Mode) in PAST



PC	Eigenvalue	% variance
1	22.302	89.21
2	1.9884	7.95
3	0.45436	1.82
4	0.21918	0.88
5	0.032385	0.13
6	0.0028774	0.01
7	0.00044272	0.00

Lab Practical Assignment IV

Factor Analysis (Q-Mode) in PAST



Lab Practical Assignment IV

Factor Analysis (Q-Mode) in PAST

Lab Practical Assignment IV

Factor Analysis (Q-Mode) in PAST

Lab Practical Assignment IV

Factor Analysis (Q-Mode) in PAST

CABFAC factor analysis

Summary | Scatter plot | **Factors** | Score plot | Scores | Reconstruction plot | Recon

	Factor 1	Factor 2	Factor 3
1	0.25166	-0.94507	0.15775
2	0.62315	-0.78003	0.052032
3	0.92145	-0.35465	0.12875
4	0.9525	-0.2476	0.13774
5	0.82637	-0.55727	0.047103
6	0.60796	-0.78393	0.11991
7	0.14461	-0.87368	0.46354
8	0.8762	-0.4742	0.064172
9	0.5177	-0.84818	-0.00032143
10	0.50215	-0.83378	0.12374
11	0.56908	-0.81055	0.085776
12	0.89672	-0.42828	0.10997
13	0.78002	-0.59128	0.20412
14	0.57347	-0.76178	0.25946
15	0.53135	-0.58507	0.60377
16	0.67547	-0.72527	0.077413

Close Copy Print

Lab Practical Assignment IV

Factor Analysis (Q-Mode) in PAST

CABFAC factor analysis

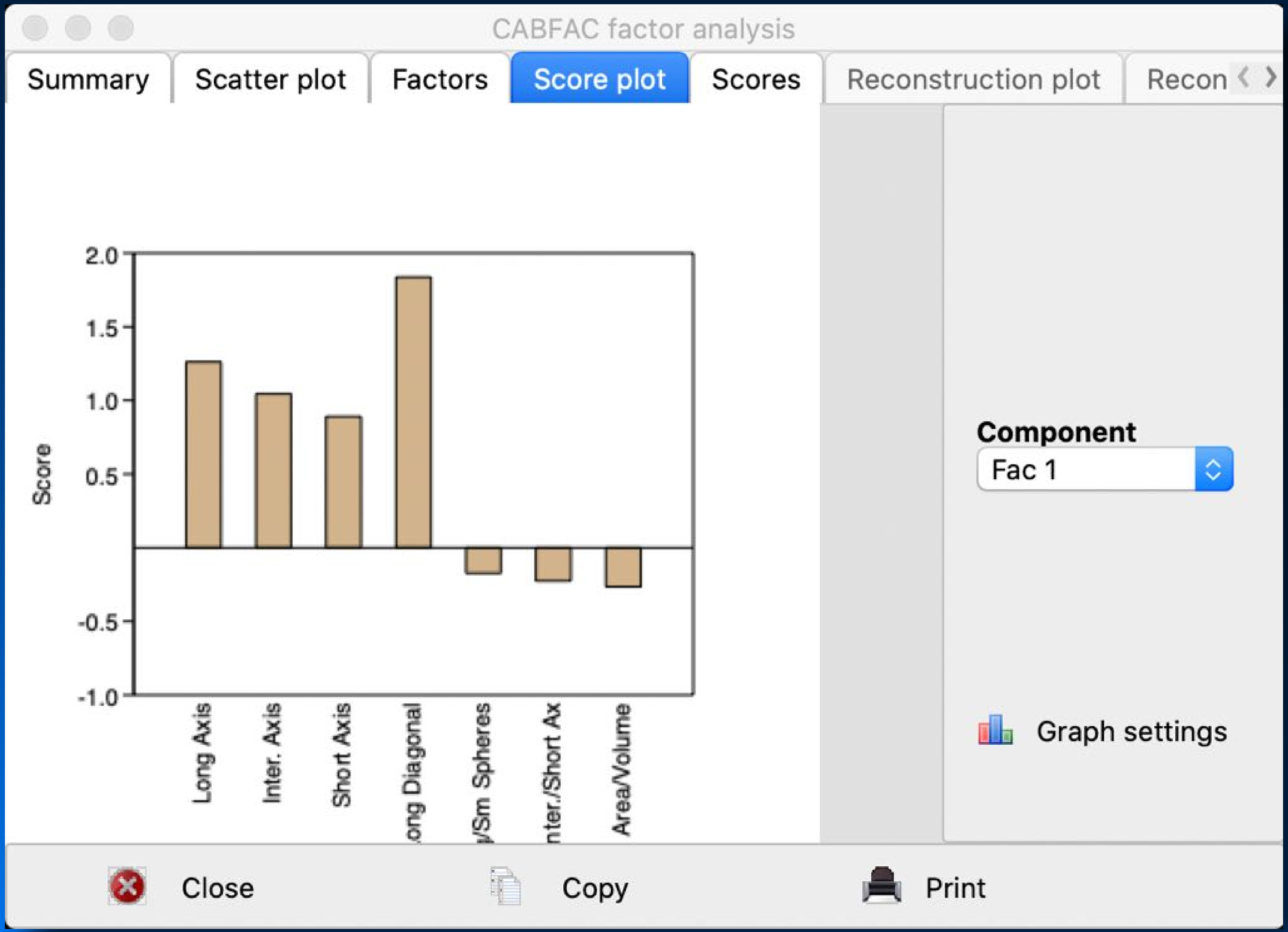
Summary | Scatter plot | Factors | Score plot | **Scores** | Reconstruction plot | Recon

	Factor 1	Factor 2	Factor 3
Long Axis	1.2614	-0.46931	-0.14766
Inter. Axis	1.0446	-0.11176	-0.23943
Short Axis	0.89014	0.51091	0.92102
Long Diagor	1.8369	-0.30847	0.11411
Lg/Sm Sphe	-0.17366	-1.479	0.086597
Long+Inter.,	-0.22492	-2.0119	-0.30829
Area/Volum	-0.26524	-0.41938	2.4407

Close | Copy | Print

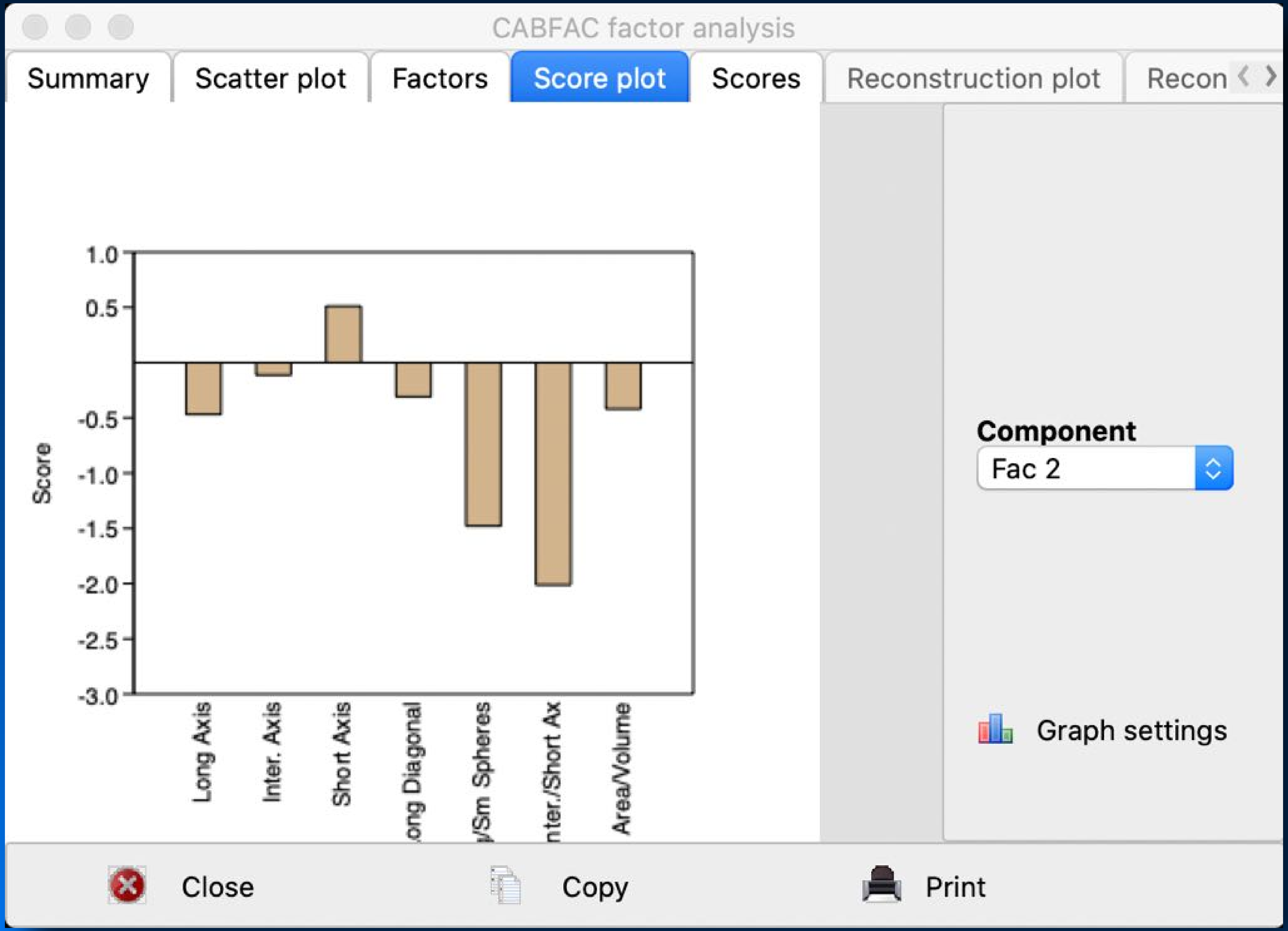
Lab Practical Assignment IV

Factor Analysis (Q-Mode) in PAST



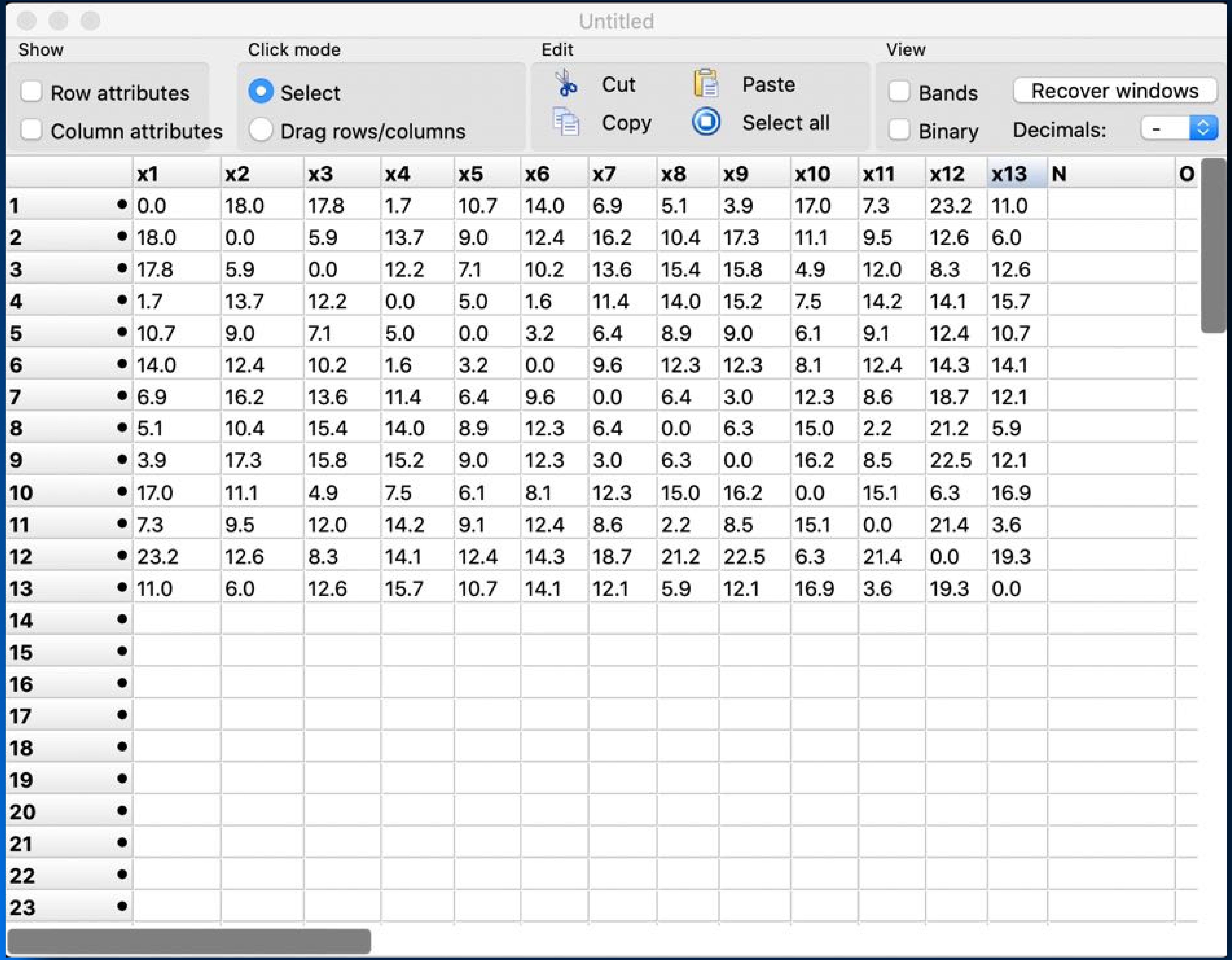
Lab Practical Assignment IV

Factor Analysis (Q-Mode) in PAST



Lab Practical Assignment IV

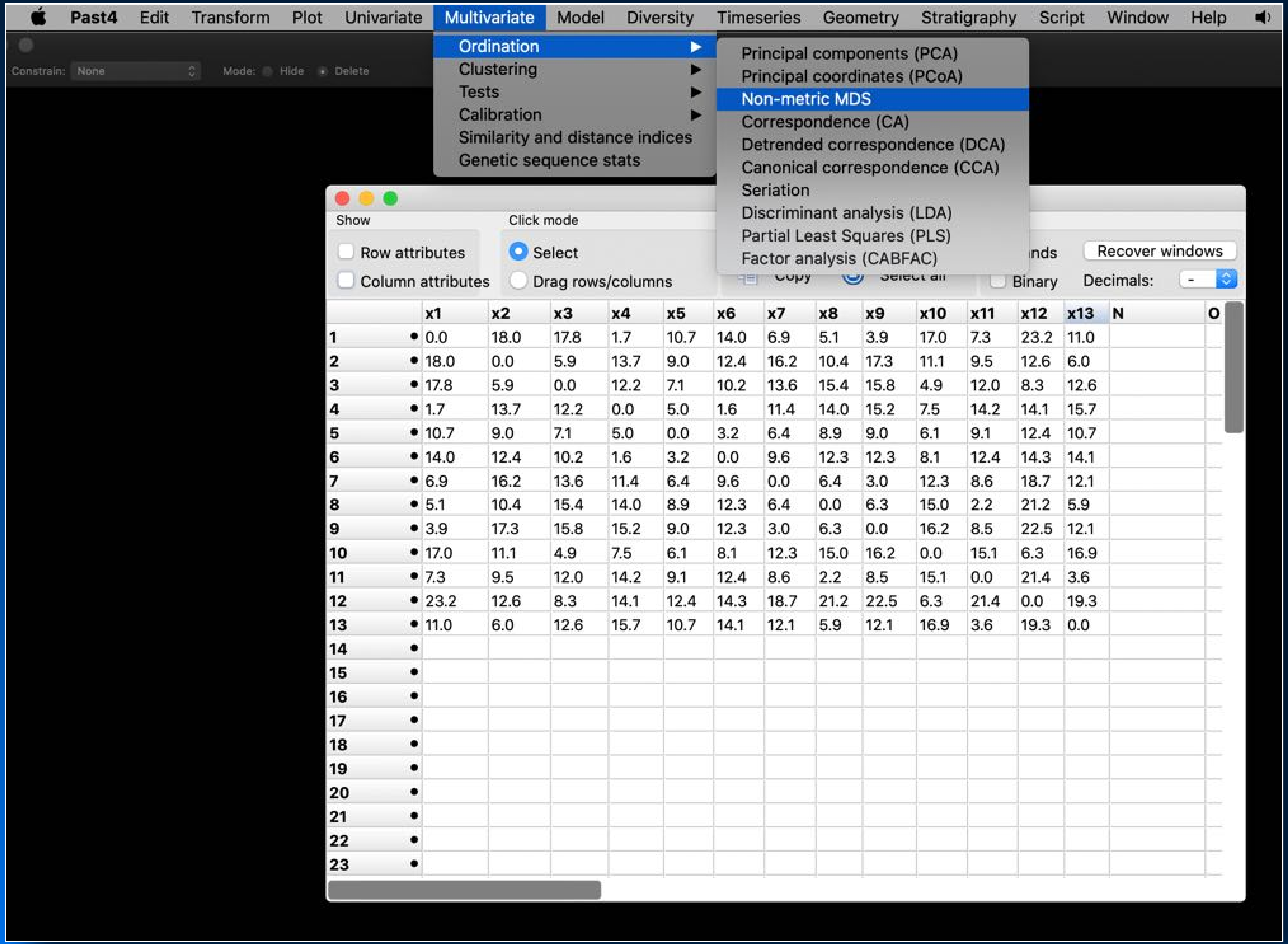
Factor Analysis (Q-Mode) in PAST



	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13
1	0.0	18.0	17.8	1.7	10.7	14.0	6.9	5.1	3.9	17.0	7.3	23.2	11.0
2	18.0	0.0	5.9	13.7	9.0	12.4	16.2	10.4	17.3	11.1	9.5	12.6	6.0
3	17.8	5.9	0.0	12.2	7.1	10.2	13.6	15.4	15.8	4.9	12.0	8.3	12.6
4	1.7	13.7	12.2	0.0	5.0	1.6	11.4	14.0	15.2	7.5	14.2	14.1	15.7
5	10.7	9.0	7.1	5.0	0.0	3.2	6.4	8.9	9.0	6.1	9.1	12.4	10.7
6	14.0	12.4	10.2	1.6	3.2	0.0	9.6	12.3	12.3	8.1	12.4	14.3	14.1
7	6.9	16.2	13.6	11.4	6.4	9.6	0.0	6.4	3.0	12.3	8.6	18.7	12.1
8	5.1	10.4	15.4	14.0	8.9	12.3	6.4	0.0	6.3	15.0	2.2	21.2	5.9
9	3.9	17.3	15.8	15.2	9.0	12.3	3.0	6.3	0.0	16.2	8.5	22.5	12.1
10	17.0	11.1	4.9	7.5	6.1	8.1	12.3	15.0	16.2	0.0	15.1	6.3	16.9
11	7.3	9.5	12.0	14.2	9.1	12.4	8.6	2.2	8.5	15.1	0.0	21.4	3.6
12	23.2	12.6	8.3	14.1	12.4	14.3	18.7	21.2	22.5	6.3	21.4	0.0	19.3
13	11.0	6.0	12.6	15.7	10.7	14.1	12.1	5.9	12.1	16.9	3.6	19.3	0.0

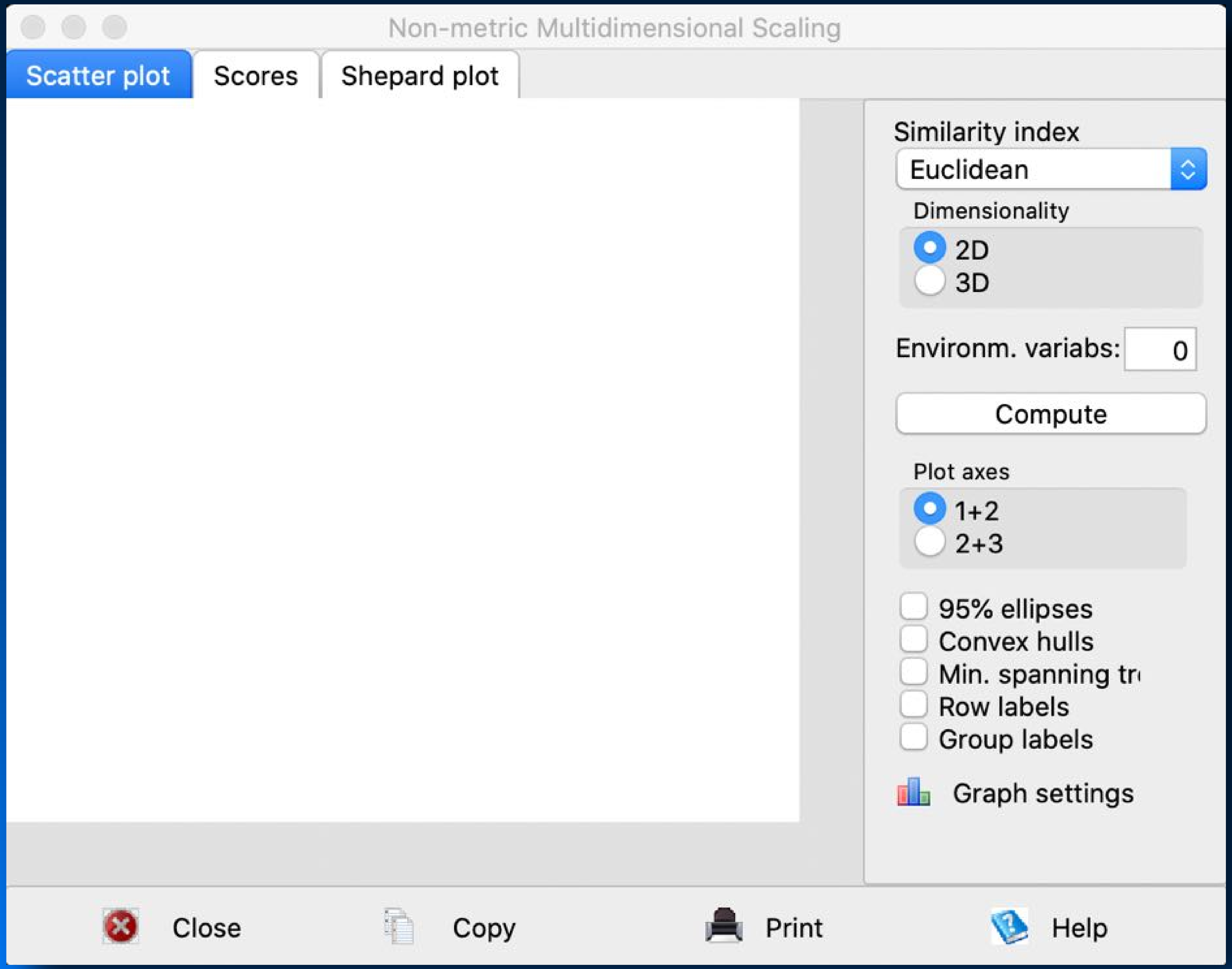
Lab Practical Assignment IV

Multidimensional Scaling (MDS) in PAST



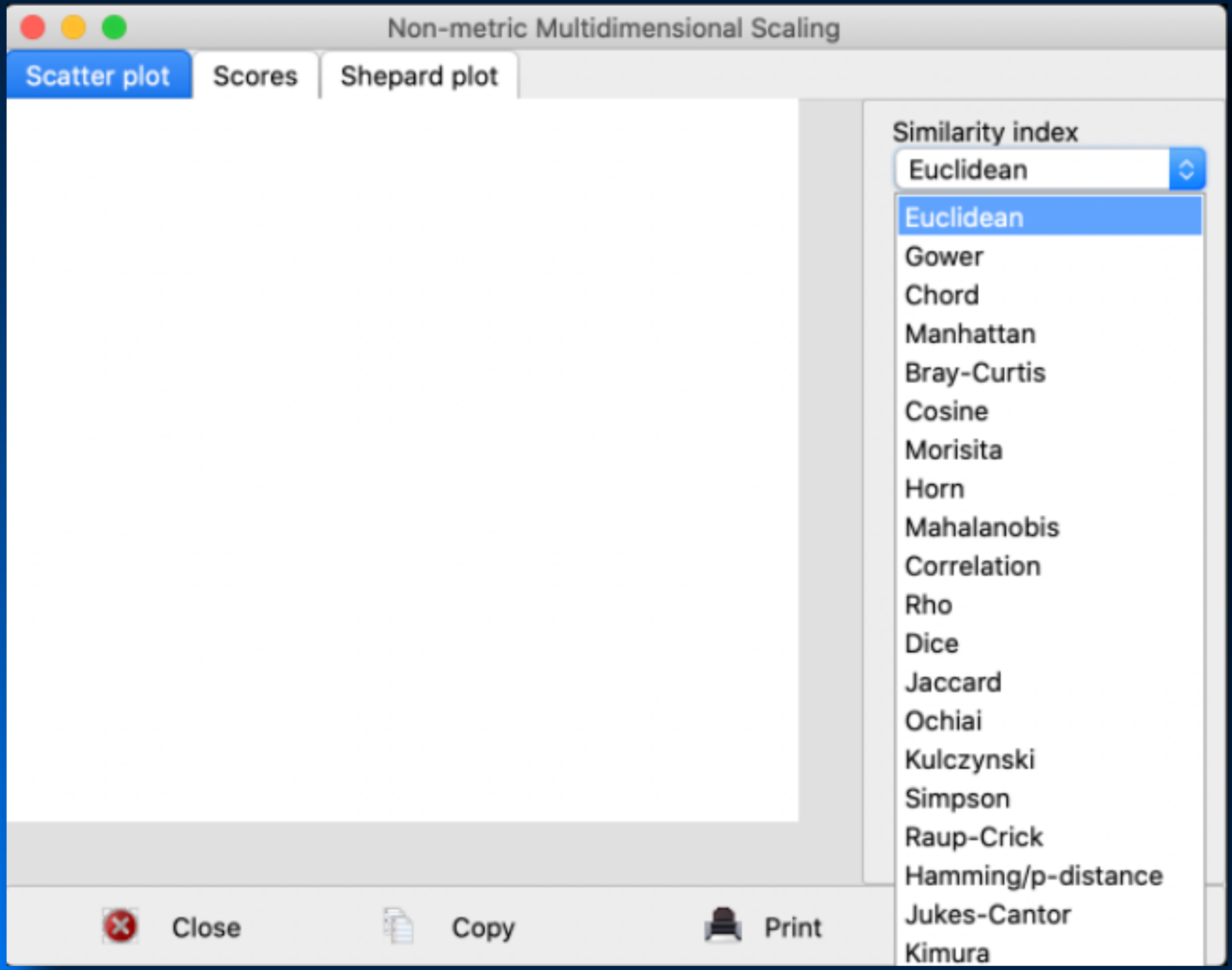
Lab Practical Assignment IV

Multidimensional Scaling (MDS) in PAST



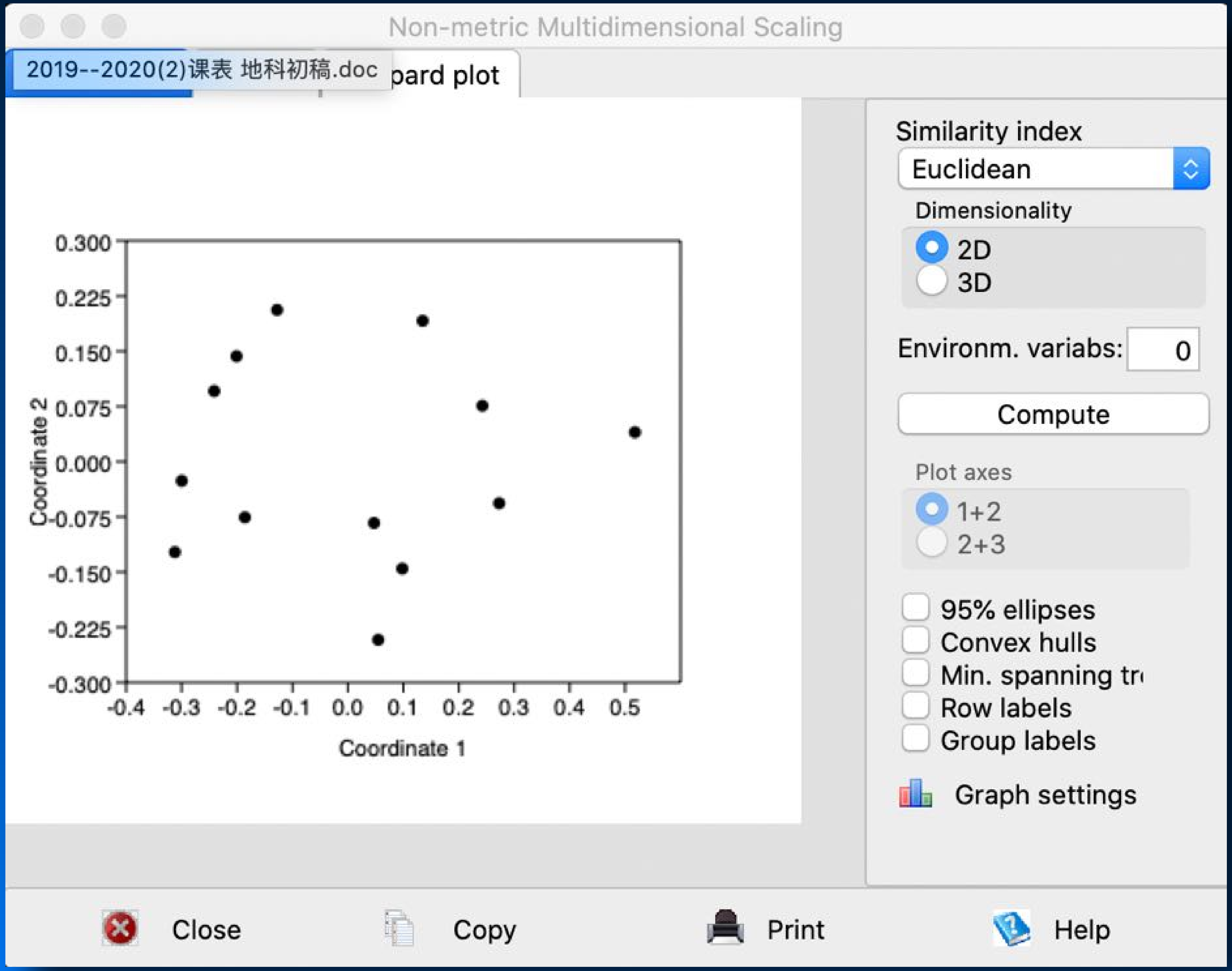
Lab Practical Assignment IV

Multidimensional Scaling (MDS) in PAST



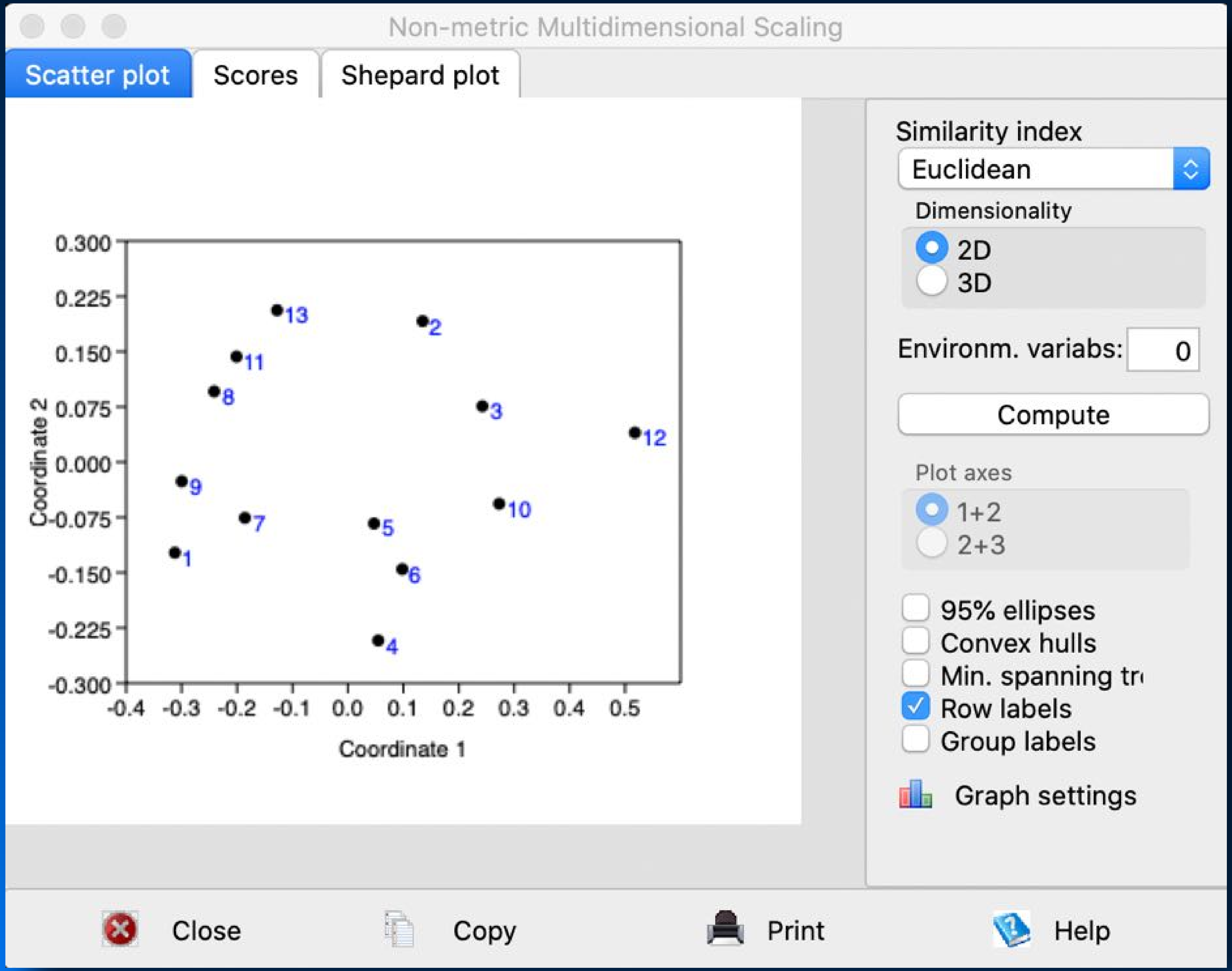
Lab Practical Assignment IV

Multidimensional Scaling (MDS) in PAST



Lab Practical Assignment IV

Multidimensional Scaling (MDS) in PAST



Lab Practical Assignment IV

Multidimensional Scaling (MDS) in PAST

Non-metric Multidimensional Scaling

Scatter plot | Scores | Shepard plot

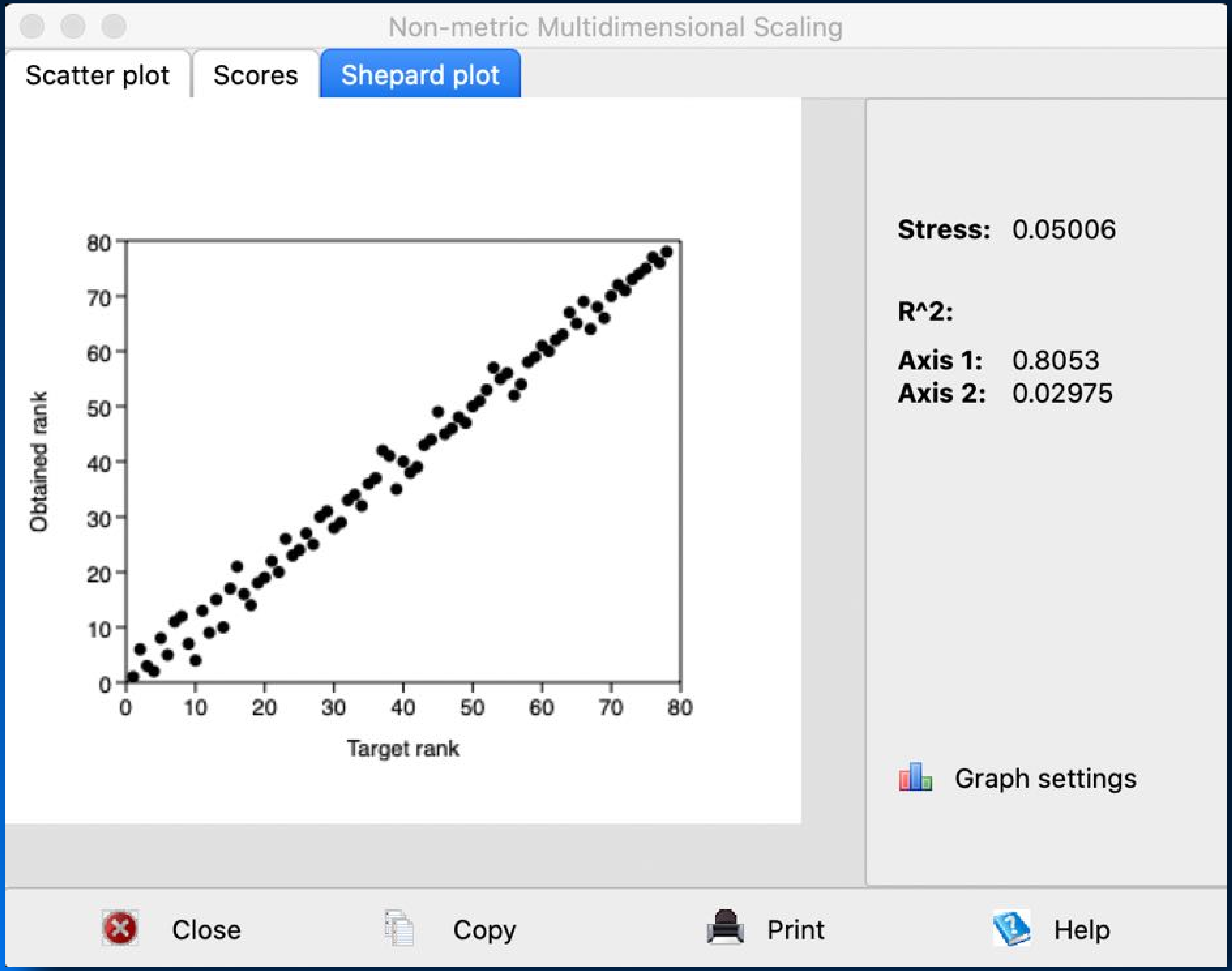
Scores

Name	Axis 1	Axis 2
1	-0.31217	-0.12294
2	0.13479	0.1913
3	0.24249	0.075833
4	0.054699	-0.24206
5	0.047125	-0.083326
6	0.09814	-0.14534
7	-0.18584	-0.075679
8	-0.24124	0.095846
9	-0.29972	-0.026118
10	0.27278	-0.056515
11	-0.20098	0.14311
12	0.51776	0.039838
13	-0.12784	0.20605

Close Copy Print Help

Lab Practical Assignment IV

Multidimensional Scaling (MDS) in PAST



Lab Practical Assignment IV

Multivariate Data Analysis, Morphometrics & Diversity