

NJU Final Examination
Statistics and Data Analysis in the Earth Sciences
Spring 2026

True-False Questions

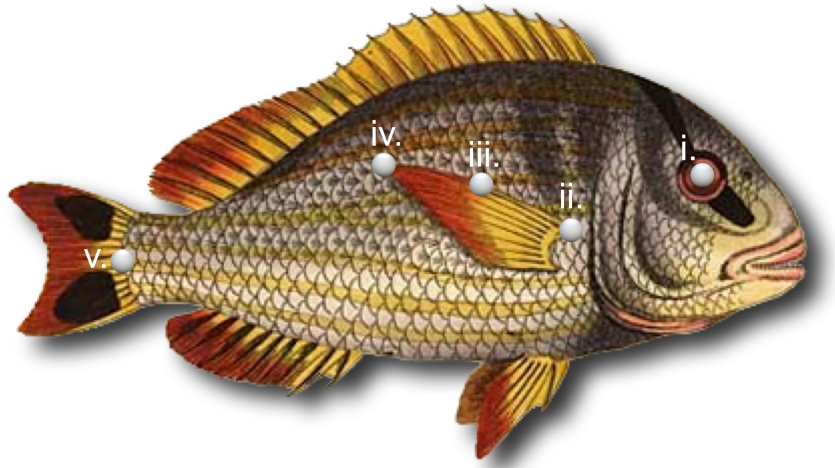
1. An isotropic shape transformation is one in which the sides of a form that are parallel to one another in their original position remain parallel after the transformation has been completed. **T**
2. Isochrony refers to the state of two or more stratigraphic events having occurred at the same point in relative time. **T**
3. Under Shaw's graphic correlation analysis the stratigraphic ranges of event pairs can be extended based on information supplied via comparison of stratigraphic successions, but never shortened. **T**
4. In biodiversity analysis coverage is a measure of the proportion of total taxa, observations or measurements (N) a subsample of size m is likely to contain (on average). **T**
5. Procrustes alignment is used to remove position, scaling and shape differences from landmark datasets. **F**
6. Shape change is a localized metric increase or decrease in the dimensions of an organ or body. **T**
7. A thin plate spline can be used to express shape change as a deformation of a rectilinear grid using the metaphor of the amount of energy it takes to bend a hypothetical metal plate (closely-spaced bends require more energy than broad bends). **T**
8. Changes in the slope of a line of correlation (LOC) between two stratigraphic successions mark the presence of depositional hiatuses. **F**
9. Procrustes alignment minimizes the sum of deviations of corresponding landmark locations across a dataset. **F**
10. A multi-valued, closed-form outline is one in which any radius vector drawn from the outline's centroid crosses its boundary one or more times. **F**
11. The Poisson distribution is useful for determining whether a set of points is spaced uniformly. **F**
12. Linear distance data incorporate shape-based geometry into morphometric data analyses. **F**
13. Semilandmarks should be used whenever the form changes of interest are located on an object's periphery. **F**
14. At any moment the taxic richness of a given locality represents a dynamic balance between competing positive and negative influencing factors. **T**
15. Hay's probabilistic stratigraphy is based on the inference of stratigraphic superposition relations between co-occurring stratigraphic events. **F**
16. Alpha (α) diversity is the total number of different taxa, or observations of interest, that occur at a particular area or locality at a particular time. **T**
17. A truly random distribution of points can contain no spatial clusters. **F**
18. Semilandmarks are a special form of Type 3 landmarks. **T**
19. In spatial data analysis a set of polygons are regarded as being a type of raster data. **T**
20. Allometry is the study of the influence of ontogeny on body form and function. **F**
21. Diversity can be represented by the count of the number of different objects and/or observations of interest in an assemblage. **F**
22. Boundary curves specified by a series of mathematical point locations represent a form of spatial vector data. **T**

23. In biodiversity studies gamma (γ) diversity is the total taxic composition/diversity within a large geographic region, habitat or ecosystem. **T**
24. A fractal is any geometric line, surface or high-dimensional figure that exhibits a significant amount of complexity. **F**
25. Stratigraphy is the branch of geology that deals with the formation, composition, sequence, and correlation of stratified rocks. **T**

Matching Questions

26. Match the landmarks.

- a. Type 1
- b. Type 2
- c. Type 3
- d. Semilandmark

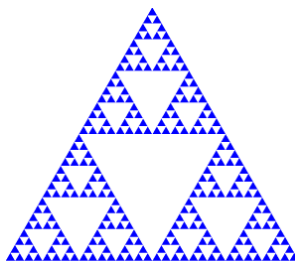


27. Match the following biodiversity level concepts to their definitions.

- | | |
|-------------------------|---|
| a. Community/Assemblage | i. The environment in which a species lives. |
| b. Ecosystem | ii. All populations that do, or can, interbreed and produce viable offspring. |
| c. Habitat | iii. A group of interbreeding individuals living in the same environment. |
| d. Population | iv. A group of populations living and interacting in the same environment. |
| e. Species | v. A group of communities/assemblages and their abiotic environment. |

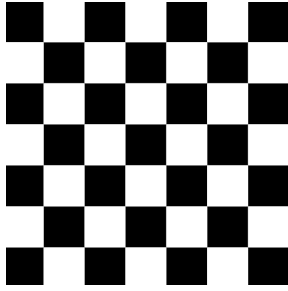
28. Identify which of the following diagrams has a fractional dimension.

a.

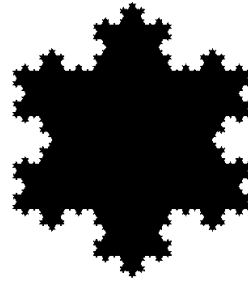


- i. Fractional dimension
- ii. Non-fractional dimension

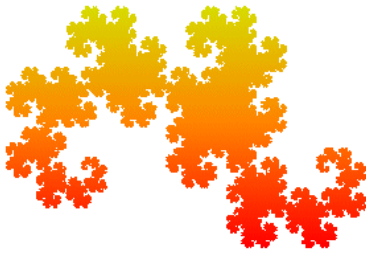
b.



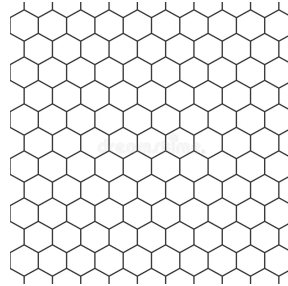
c.



d.



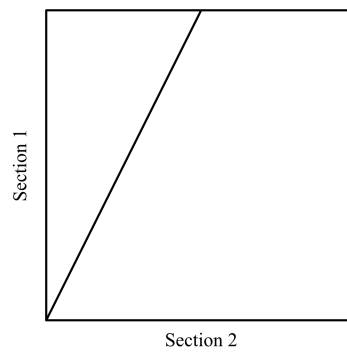
e.



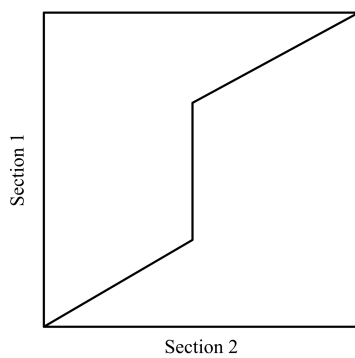
29. Match the graphic correlation diagrams (right) to their correct interpretations (left).

- a. Line of correlation
- b. Hiatus in Section 1
- c. Hiatus in Section 2
- d. Relatively reduced rock accumulation in Section 1
- e. Relatively reduced rock accumulation in Section 2

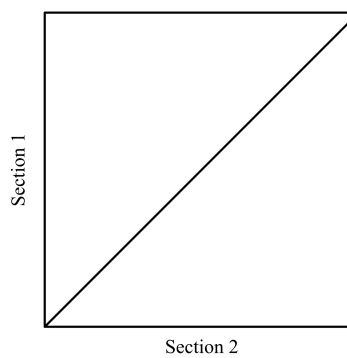
i.



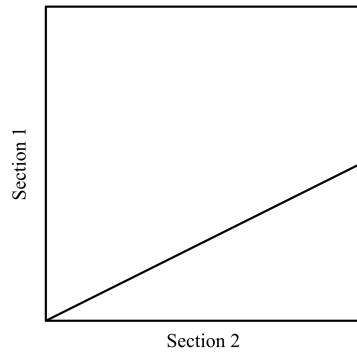
ii.



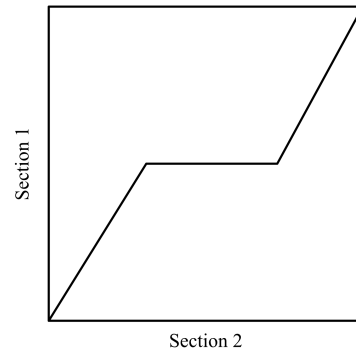
iii.



iv.



v.



30. Identify which of the following foraminifera have single-valued, and which have multi-valued outlines.

a.



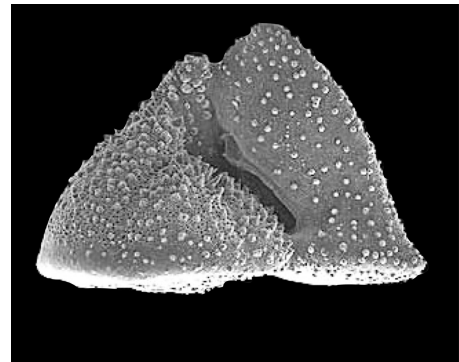
i. Single-valued outline

ii. Multi-valued outline

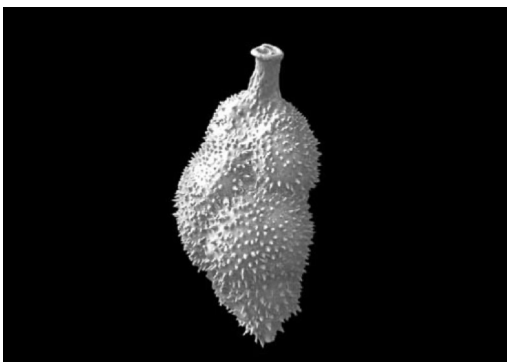
b.



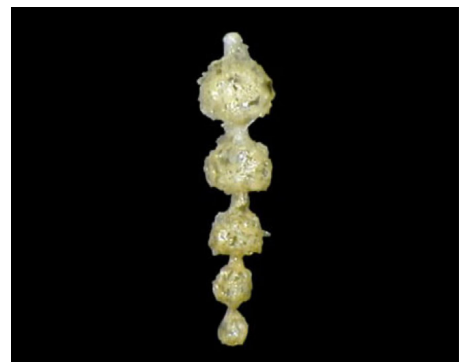
c.



d.



e.



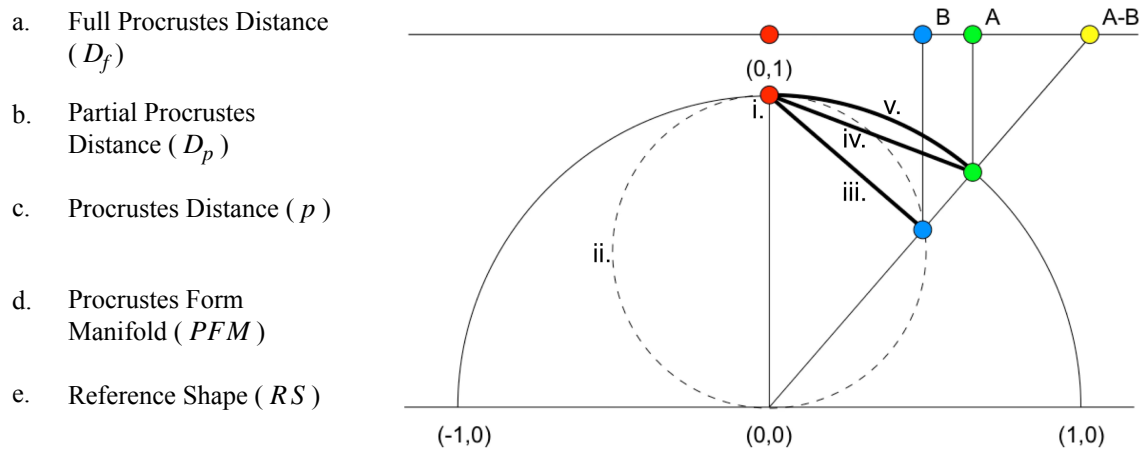
31. Match the following biodiversity trend/rule concepts to their definitions.

a. Cope's Rule

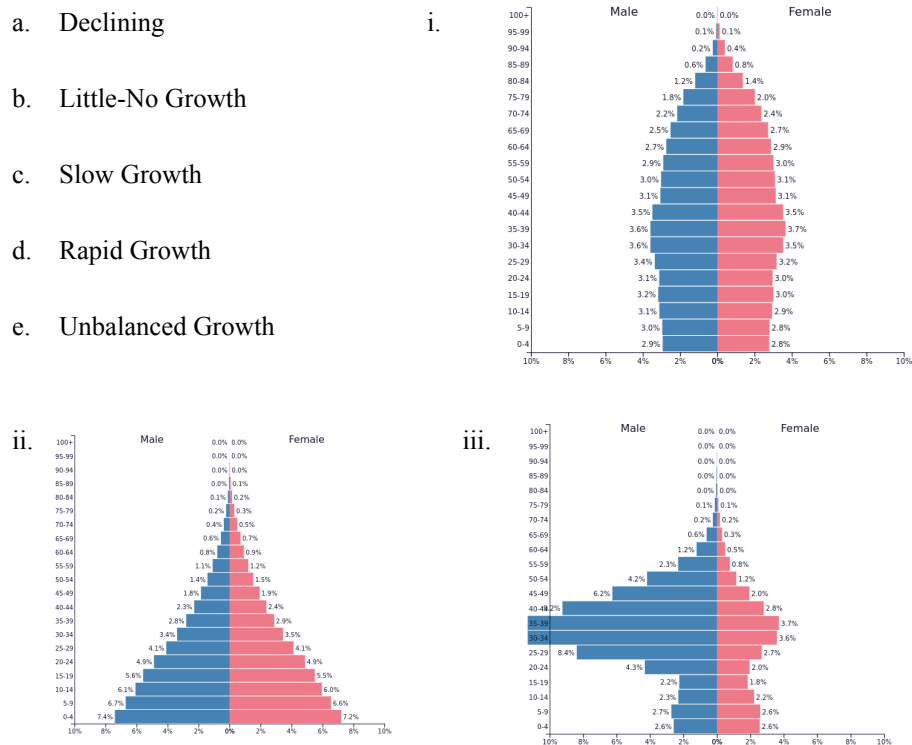
i. Two species that compete for the same resource cannot co-exist at constant abundance ratios; there is always a winner.

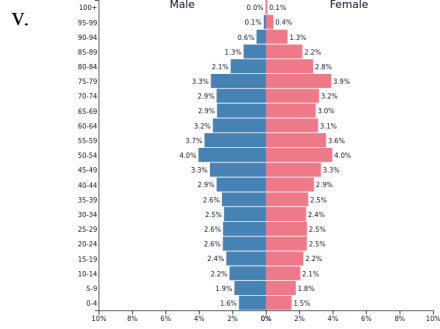
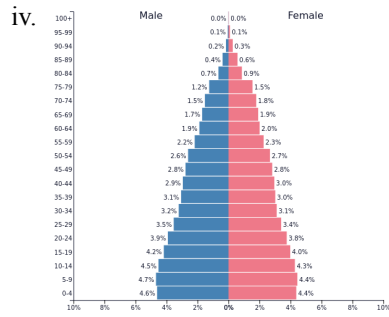
- b. Gause's Law ii. Within species of endotherms heavily pigmented forms tend to be found in more humid environments.
- c. Golger's Rule iii. in aquatic species an inverse relation exists between water temperature and eristic characters (e.g., fin rays, vertebrae, scale numbers).
- d. Jordan's Rule iv. Within lineages body parts tend to become reduced in number and specialized in function.
- e. Williston's Law v. Within animal lineages body size tends to increase over time.

32. Match the aspects of a Procrustes shape projection onto a linear tangent plane to their correct names.



33. Match the following population pyramids (right) to the correct growth predictions (left).

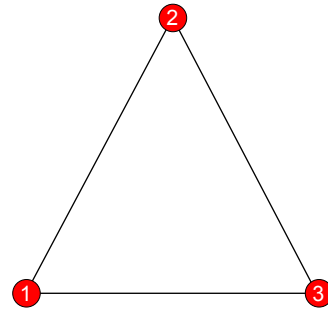




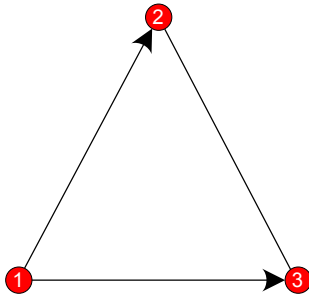
34. Match the graphs (right) to their correct types (left).

- Circle Graph
- Circuit Graph
- Directed Graph
- Semi-directed Graph
- Undirected Graph

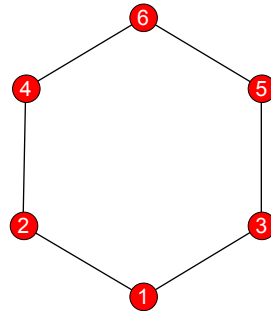
i.



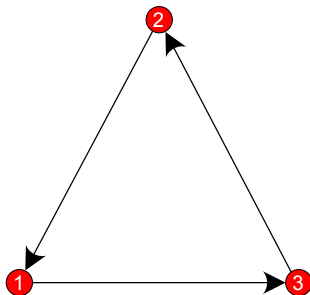
ii.



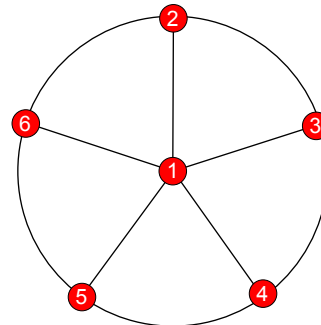
iii.



iv.

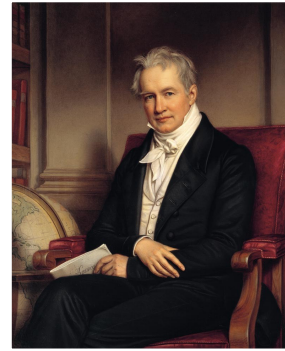


v.

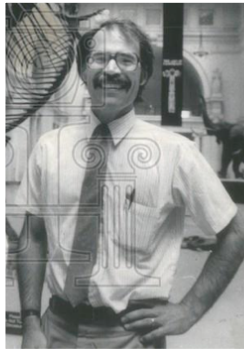


35. Match the portraits/photos (right) of these scientists to their contributions to the study of biodiversity..

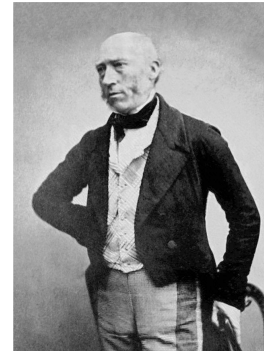
- a. First to estimate of Phanerozoic taxic richness variation.
- b. Discovered relation between species richness and availability of food resource.
- c. Discovered latitudinal diversity gradient.
- d. Identified the three great Phanerozoic evolutionary faunas.
- e. Revived interest in the study of mass extinctions.



ii.



iii.



iv.



v.



Multiple-Choice Questions

36. Identify the options available in the stratigraphic constrained optimization method's simulated-annealing search algorithm for controlling the optimization search. (Choose all that apply)
- a. **Initial temperature**
 - b. **Number of cooling steps**
 - c. Number of stratigraphic successions
 - d. **Cooling ratio**
 - e. All of the above
37. Identify the advantages of quantitative stratigraphy. (Choose all that apply)
- a. **Data-driven**
 - b. **Supports use different data-analysis approaches**
 - c. **Reproducible results**
 - d. **Flexible (through use of alternative settings)**
 - e. **Supports integration of different data types**

38. Identify the statistical distribution that was first used to estimate stratigraphic confidence intervals.
- Dirichlet distribution
 - Exponential distribution**
 - Normal distribution
 - Poisson distribution
 - None of the above.
39. Identify the characteristics of radial Fourier analysis as a means of means of representing patterns of size and/or shape variation. (Choose all that apply)
- Boundary outlines are sampled as a function of the lengths of a series of equiangular radius vectors originating from the outline's centroid.**
 - Can be used to quantify the forms of open or closed curves.
 - Can be used to analyze both single-valued and multi-valued outline shapes.
 - All of the above.
 - None of the above.
40. Identify the characteristics of eigenshape analysis as a means of means of representing patterns of size and/or shape variation. (Choose all that apply)
- Boundary outlines are sampled either as sets of (scaled or unscaled) x, y coordinate values or via reference to a geometric shape function (e.g., Zhan & Roskies Shape Function).
 - Can be used to quantify the forms of open or closed curves.
 - Can be used to analyze both single-valued and multi-valued outline shapes.
 - All of the above.**
 - None of the above.
41. Identify the statement(s) that best define morphometric form change. (Choose all that apply)
- A generalized metric increase or decrease in all dimensions of a body or organ.
 - A localized metric increase or decrease in some part of a body or organ.
 - The sum total of size and shape changes across all parts of a body or organ.**
 - All of the above.
 - None of the above.
42. Identify the statements that are true of the concept of a morphometric landmark. (Choose all that apply)
- The coordinate point location of some meaningful structure.**
 - A coordinate point location whose position can be defined precisely via reference to tissue types, extremal aspects of bodies or curves, and/or the positions of other landmarks.**
 - A coordinate point location anywhere on the bodies of biological individuals.
 - A coordinate point location that can be found across all objects in a sample.**
 - All of the above.
43. Identify the quantitative stratigraphy methods that focus on specification of the most commonly observed order of stratigraphic events. (Choose all that apply)
- Graphic Correlation
 - Probabilistic Stratigraphy**
 - Ranking and Scaling**
 - Stratigraphic Constrained Optimization
 - Unitary Associations**
44. Identify the mathematical concept of diversity. (Choose all that apply)
- Mean abundance
 - Mean rarity**
 - Mean species richness
 - Proportion of common taxa
 - All of the above.

45. Based on the stratigraphic data shown to the right, identify the probability of the purple triangle event occurring stratigraphically above the blue square event.

- 0.25
- 0.57**
- 0.63
- 0.86
- None of the above.

46. Identify the factors that contribute to diachrony in stratigraphic events across different stratigraphic sections and/or cores. (Choose all that apply)

- Erosion
- Variable preservation potential
- Variable abundances/concentrations in sediments
- Environmental exclusion
- All of the above.**

47. Identify the difficulties often encountered when attempting to interpret results of a fractal analysis. (Choose all that apply)

- Different fractal patterns can have the same fractal dimension.**
- Analysis is quite computation intensive
- Fractal dimensions describe one aspect of a morphological pattern, but not the geometry as a whole**
- All of the above.
- None of the above.

48. Identify geochronometric dating methods. (Choose all that apply)

- Cosmogenic nucleotide dating**
- Dendrochronologic dating**
- Estimated Earth history cooling rates
- Radioisotopic dating**
- Varve dating**

49. Identify the various modes of isotropic (uniform) geometric transformation. (Choose all that apply)

- Compression/Dilation**
- Scaling**
- Shear**
- Square-to-Kite
- Rotation**

50. Identify the advantages of using vector data in a spatial data analysis. (Choose all that apply)

- A wide array of data structures can be described and represented efficiently as set of mathematical coordinate points or vertices.**
- Each vertex is associated with metadata that gives the geometric structure its meaning.
- The vertex-defined geometric features can be associated with multiple information attributes.**
- Calculations based on even large, multilayered, vector datasets and are very quick and efficient
- All of the above.

51. The taxic richness of a stratigraphic sample represents a dynamic balance between which factors. (Choose all that apply)

- Variation in local extinction rates (extirpation)**
- Variation in local emigration rates**
- Variation in local immigration rates**
- Variation in local abundance
- All of the above.

Sample	I	II	III	IV	V	VI	VII	VIII	IX
8					●				
7				●	●				●
6				●	▲	●			●
5				■	■	●	●		●
4	●		●	▲	■	■	●	▲	▲
3	■		■	■	■	●	■	●	▲
2	■	●	▲	■	■	▲	■	●	■
1	■	●	■	■	■	■	■	■	■

52. Identify the causes and problem(s) that result from the Pinocchio Effect. (Choose all that apply)
- One or more landmarks are missing in one or more objects in a sample.
 - One, or a small number of landmarks exhibit large displacements in their positions relative to other landmarks across a sample**
 - Variation exists in the precision with which all landmarks can be located across a sample.
 - All of the above.
 - None of the above.
53. Identify the methods use to estimate the dimensionality of a fractal pattern. (Choose all that apply)
- Student's *t*-test
 - Normality test
 - Cluster analysis
 - Regression analysis**
 - Multidimensional scaling
54. Identify the feature(s) that are true of all shapes defined by landmark configurations. (Choose all that apply)
- All configurations of landmarks of constant root centroid size and common centroid location are geometrically constrained to lie on the surface of a hyperdimensional mathematical manifold.**
 - The dimensionality of this manifold will be equivalent to the number of vertices used to represent the shapes under consideration.
 - The radius of this manifold is determined by the root centroid size value.**
 - Landmark configurations of different sizes (= form configurations) will be located along radii projecting from the hyperdimensional manifold's centroid through the configuration's position.**
 - All of the above.
55. Identify the spatial biodiversity rules/trends. (Choose all that apply)
- Alan's Rule**
 - Bergmann's Rule**
 - Dollo's Law
 - Hennig's Rule
 - Latitudinal "Diversity" Gradient**
56. Identify the steps used to compare the vector (*x* and *y*) directional trends of differently sized samples statistically. (Choose all that are correct)
- Sum the directional vector values
 - Calculate the resultant**
 - Calculate the mean resultant length**
 - Compare c to the Rayleigh distribution's critical value**
 - All of the above
57. Identify the statistical distributions used to test directional hypotheses. (Choose all that apply)
- Chi-Square Distribution
 - Standard Normal Distribution**
 - Rayleigh Distribution**
 - von Mises Distribution**
 - All of the above.
58. Identify the statements that are true of the Mosiman-Gould model of allometry. (Choose all that apply)
- Size represents the dominant contributor to variation and covariance structure.
 - Shape is quantified as a vector of ratios (= perpendicular to the vector of isometry).**
 - Size and shape can be separated cleanly as a result of definitional differences.**
 - Shape can be represented as a vector, or space, oriented perpendicular to the allometric size vector(s).
 - Size represents a factor that can influence the expression of shape.**
59. For a linear distance dataset consisting of 30 objects and 15 variables, what would be the PCA loading value of the eigenvector that expresses pure isometry?
- 0.067
 - 0.182

- c. **0.258**
 - d. 0.333
 - e. None of the above.
60. Identify the characteristics of a fractal pattern. (Choose all that apply)
- a. Complexity
 - b. **Fractional dimension**
 - c. **Infinite perimeter**
 - d. **Self-similarity**
 - e. All of the above.
 - f. None of the above.
61. Identify the types of stratigraphic unit boundaries that have chronostratigraphic significance. (Choose all that apply)
- a. Lithostratigraphy units
 - b. Biostratigraphic units
 - c. Magnetostratigraphic units
 - d. Chemo-isotopic stratigraphic units
 - e. **None of the above.**
62. Identify the variables that are consistent with the concept of size in a morphometric analysis. (Choose all that apply)
- a. **Area**
 - b. **Perimeter**
 - c. **Root centroid size (of a set of landmarks)**
 - d. **Weight or mass**
 - e. None of the above.
63. Identify the characteristics of elliptical Fourier analysis as a means of representing patterns of size and/or shape variation. (Choose all that apply)
- a. **Boundary outlines are sampled as functions of the x and y (and z) coordinate series of an outline (or surface) separately.**
 - b. Was developed originally to quantify the forms of open or closed curves.
 - c. **Can be used to analyze both single-valued and multi-valued outline shapes.**
 - d. All of the above.
 - e. None of the above.
64. Identify the factors that are standardized during the calculation of Bookstein shape coordinates. (Choose all that apply)
- a. Position
 - b. Rotation
 - c. Scale
 - d. **All of the above.**
 - e. None of the above.
65. How many linear distances are defined by 6 landmarks?
- a. 6
 - b. 12
 - c. 13
 - d. **15**
 - e. 18
66. Identify the attributes and uses of a directional rose diagram. (Choose all that apply)
- a. **Similar in concept to a histogram**
 - b. Used to undertake statistical tests of directional hypotheses
 - c. **Able to display trends and patterns of variation in directional data**
 - d. All of the above.
 - e. None of the above.

67. Identify the statistical tests that can be performed on point distributions. (Choose all that apply)
- Test for uniform point distribution**
 - Test for clustered point distribution**
 - Test for maximum/minimum point distribution
 - Test of random point distribution**
 - All of the above.
68. Identify the considerations involved in specification of a reference shape on which to base a geometric morphometric analysis. (Choose all that apply)
- Location of the reference shape on the surface of the Procrustes shape half-sphere controls the location of the linear tangent plane used for projection of shape-configurations into a linear ordination space.
 - Location of the reference shape within the spatial domain of the sampled shapes reduces the distortion of geometric relations among the sampled shapes.
 - Researchers are free to select reference shapes according to the needs of their particular investigation.
 - All of the above.**
 - None of the above.
69. Identify the set of mathematical methods that have been used in attempts to express shape change in the manner of a deformation akin to that proposed originally by D'Arcy Wentworth Thompson (Choose all that apply)
- Biorthogonal Grids**
 - Path Analysis
 - Thin Plate Splines**
 - Singular Value Decomposition
 - Trend Surface Analysis**
70. Identify the conditions consistent with the employment of landmarks as a means of representing patterns of size and/or shape variation. (Choose all that apply)
- When each object in the sample is composed of multiple parts the relative locations of which can be represented adequately by a single point.**
 - When each object can be oriented in a consistent direction across the sample.
 - When the positions of all landmarks can be located on all individuals within the sample.**
 - All of the above.
 - None of the above.
71. Identify the uses of the collector's curve. (Choose all that apply)
- Estimating a taxon's relative abundance
 - Comparing taxic richnesses between samples of different sizes
 - Evaluating adequacy of biodiversity sample-collection program
 - All of the above.**
 - None of the above.
72. Identify the conditions consistent with the employment of semilandmarks as a means of representing patterns of size and/or shape variation. (Choose all that apply)
- When the targets of a particular investigation include sets of continuously curving structures whose forms cannot be represented accurately by a small number of manually placed landmarks.
 - When a complex morphology lacks an adequate number of definable landmark locations to represent the form or shape at a level of detail required to reach the goal(s) of an investigation
 - When there is a need to incorporate assessments of both the point locations structures and curved structural elements in the context of an analysis.
 - All of the above.**
 - None of the above.
73. Identify the sources of gaps in the occurrence of stratigraphic datum levels. (Choose all that apply)
- Environmental exclusion**
 - Mis-identification**
 - Sampling issues: collection of samples from discrete horizons**
 - Variable abundance**
 - Variable preservation potential**

74. Identify different examples of raster spatial data. (Choose all that apply)
- a. **Aerial Photographs**
 - b. **Digital Climate Model**
 - c. **Digital Elevation Models**
 - d. **Digital Land-Use Models**
 - e. **Satellite Images**
75. Identify the variables necessary to calculate Strauss and Sadler's Dirichlet distribution-based stratigraphic confidence interval. (Choose all that apply)
- a. Mean gap between event occurrences
 - b. **Number of event occurrences**
 - c. Euler's constant (e)
 - d. **Length/time interval of the event's stratigraphic range**
 - e. All of the above.