For questions 1 – 5: When researchers collect a study participant's age, they may record the information in several different ways. For example, the same age information can be recorded as a nominal, ordinal, or ratio variable. Using the clues in the dataset, match the variable with the data type.

Table 1: First 6 Observations of Dataset

AGE1	AGE2	AGE3
Other	72.16	(65,80]
Teen	13.40	(13,20]
Other	34.77	(30,40]
Other	23.15	(20,30]
Other	36.36	(30,40]
Other	11.39	(0,13]

1. *(2 pts)* The variable AGE1 is a _____ variable.

   A. Nominal
   B. Ordinal
   C. Interval
   D. Ratio

2. *(2 pts)* The variable AGE2 is a _____ variable.

   A. Nominal
   B. Ordinal
   C. Interval
   D. Ratio

3. *(2 pts)* The variable AGE3 is a _____ variable.

   A. Nominal
   B. Ordinal
   C. Interval
   D. Ratio

4. *(2 pts)* AGE1 is an example of (mark all that apply)

   A. Categorical Data
   B. Discrete Data
   C. Continuous Data
   D. Binary Data
   E. Longitudinal Data

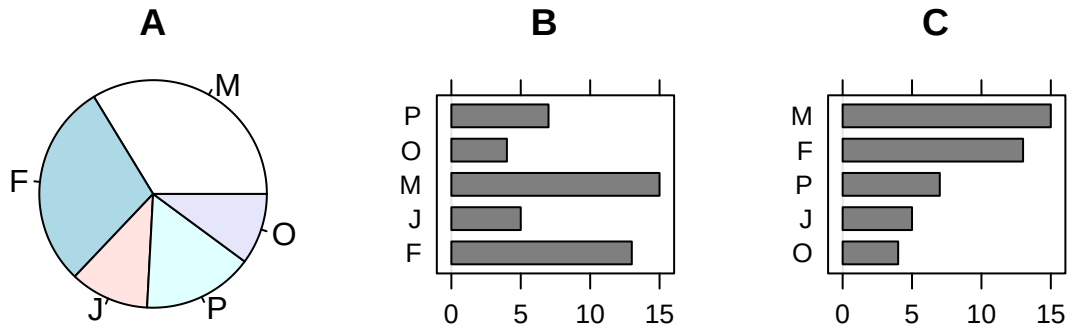
5. *(2 pts)* AGE2 is an example of (mark all that apply)

   A. Categorical Data
   B. Discrete Data
   C. Continuous Data
   D. Binary Data
   E. Longitudinal Data

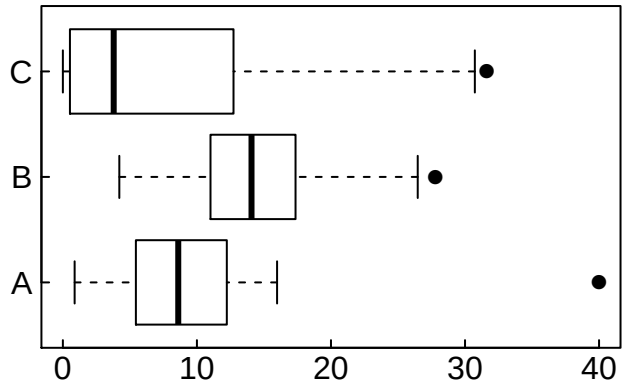
6. *(2 pts)* Calculate Q1 from the following data.

i	1	2	3	4	5	6	7	8	9	10	11
$X_{(i)}$	0.03	0.05	0.05	0.05	0.12	0.19	0.19	0.20	0.26	0.29	0.32

7. *(3 pts)* Rank from best to worse the effectiveness of these 3 displays. (Write your answer as BAC or ABC.)

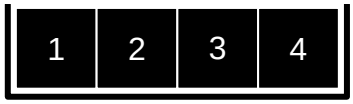


For questions 8 – 12: Boxplots effectively communicate certain properties of the data like center, spread, skew, or the presence of outliers. When boxplots off different populations are placed side by side, the viewer can quickly compare these properties. Consider the following boxplots of AGE from three different populations, labeled A, B, and C.



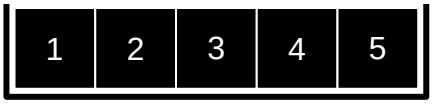
8. *(1 pt)* Which group has the largest Q2?
9. *(1 pt)* Which group has the largest IQR?
10. *(1 pt)* Which group has the largest range (range = max - min)?
11. *(1 pt)* Which group has the skewed age distribution?
12. *(1 pt)* The oldest person of all three groups is how old?

■ **For questions 13 – 15:** Two tickets are drawn at random **WITH** replacement from the following box



13. *(1 pt)* What is the chance that the second ticket is 4?
14. *(1 pt)* What is the chance that the second ticket is 4, given that the first is 2?
15. *(1 pt)* What is the probability that 2 is drawn first and 4 is drawn second?

■ **For questions 16 – 18:** Two tickets are drawn at random **WITHOUT** replacement from the following box



16. *(1 pt)* What is the chance that the second ticket is 4?
17. *(1 pt)* What is the chance that the second ticket is 4, given that the first is 2?
18. *(1 pt)* What is the probability that 2 is drawn first and 4 is drawn second?

19. *(2 pts)* Consider the population below. From each unit we have collected

$A =$ School
$B =$ Sports Preference

		School		
		UNC	DUKE	
Preference	Basketball	9	6	15
	Football	3	2	5
		12	8	20

Calculate $P(A = \text{UNC} \mid B = \text{Basketball})$.

20. *(2 pts)* Enjoy 2 free points.

For questions 21 – 28: Identify the distribution of the random variable in the following examples. Use the following options:

A. Normal
B. Binomial
C. Poisson
D. None of the Above

21. *(1 pt)* Suppose 25% of a population are recessive carriers of a disease. Let X equal the number of students that are recessive carriers in a class of 25 students.

22. *(1 pt)* Suppose a pedestrian injury (from motor vehicle collision) occurs at a particular crosswalk twice a year. Let Y equal the number of pedestrian injuries at the crosswalk each year.

23. *(1 pt)* A local fast food chain is offers a promotion where "1 in 4 orders win". Let W be the number of wins in 20 orders.

24. *(1 pt)* Let W be the weight of a full term male infant. The average weight is 3800 grams, and the standard deviation is 448.

25. *(1 pt)* Let B be a measure of bone density in women ages 65 to 70. The mean is 50 and the standard deviation is 10.

26. *(1 pt)* In a group of 150 women ages 65 to 70, let O be the number of women with bone density less than 40.

27. *(1 pt)* Let C be the number of new cervical cancer cases among 35 year-old women in India for the year 2008.

28. *(1 pt)* Of the 35 year-old women diagnosed with cervical cancer in India in 2008, let L be the number that live at least 5 more years.

29. *(2 pts)* Referring to question 23, what is $P(W = 11)$?

For questions 30 – 34: Select the term that best describes the example or definition. Use the following options.

(A) Single Blind
(B) Double Blind
(C) Triple Blind
(D) Placebo Effect
(E) Experimenter's Bias
(F) Sampling Frame
(G) Probability Sample
(H) Nonresponse Bias
(I) Unit Nonresponse
(J) Item Nonresponse
(K) Convenience Sample
(L) Sampling Bias
(M) Systematic Sampling
(N) Stratified Random Sampling
(O) Clustered Random Sample
(P) Simple Random Sample (SRS)
(Q) Completely Randomized Design
(R) Randomized Block Design
(S) Potential Confounding Variable

30. *(2 pts)* A sample within an elementary school where classrooms are randomly selected and then a random sample of students are surveyed from the selected classrooms.

31. *(2 pts)* A researcher wants to study his community's kidney health. To do so, he performs a systematic survey sample at a fitness club. His sample likely suffers from this bias.

32. *(2 pts)* Because a data collector knows which subjects are in the treatment or placebo group, she is inclined to observe the treatment group more intently.

33. *(2 pts)* A researcher discovers that on average his treatment group is younger than his placebo group. Age, then, is an example of this.

34. *(2 pts)* This type of experimental design can avoid the issues in question 33.

For questions 35 – 37: Suppose X denotes a mother's pre-pregnancy weight in pounds, and Y is the infant's full term birth weight in pounds. Suppose the correlation between X and Y is 0.46.

35. *(1 pt)* How will the correlation change if we scale X to kilograms?

    A. Goes up
    B. Goes down
    C. Stays the same
    D. Cannot say

36. *(1 pt)* How will the correlation change if we scale X to kilograms and scale Y to grams?

    A. Goes up
    B. Goes down
    C. Stays the same
    D. Cannot say

37. *(1 pt)* How will the correlation change if we center both X and Y at 0?

    A. Goes up
    B. Goes down
    C. Stays the same
    D. Cannot say

38. *(3 pts)* Calculate the correlation coefficient of X and Y.

X	Y
-1	1
-2	1
0	2
2	-2

39. *(1 pt)* True or False? A correlation of X and Y close to 0 indicates that X and Y are not associated.

40. *(1 pt)* True or False? A correlation of X and Y close to -1 indicates that X and Y are not associated.

41. *(1 pt)* True or False? A correlation of X and Y close to 1 indicates that X causes Y.

42. *(1 pt)* True or False? Ecological correlations are calculated from individual-level data.

■ In this class we have introduced the concept of population parameters. For example, we have discussed the population mean, μ, for continuous outcomes. And, we've discussed the population proportion, p, for binary outcomes.

There is a family of hypothesis tests dealing with μ, and there is a family of hypothesis tests dealing with p. Within each family, we can consider (a) hypotheses that directly compare 2 populations and (b) hypotheses that deal with a single population.

The table below organizes these 4 types of hypothesis tests. Each cell is labeled.

	μ	p
One Population	A	B
Two Populations	C	D

For problems 43 – 45, read the situation and identify which type of hypothesis test is appropriate.

43. *(1 pt)* A researcher claims that natural childbirth (natural meaning no episiotomy, no epidural, etc.) results in fewer instances of negative health outcomes for the mother.

    To test the hypothesis, suppose the researcher enrolls 100 expectant mothers into a study. 50 mothers are randomly selected for the treatment (natural childbirth) group and the remaining mothers are selected for the control (standard care) group.

    The researcher will record the number of mothers experiencing negative health outcomes in each group.

44. *(1 pt)* A researcher believes a specific antigen is more prevalent among individuals of a remote community than the general populace. In general populations, the prevalence of this antigen is known to be 0.15. To test her hypothesis, the researcher collected 100 independent blood samples from individuals in the remote community. She tested the blood samples for the presence or absence of the antigen.

45. *(1 pt)* The mean birth weight of full term female infants is 3565 grams. A researcher believes female infants with a specific genetic marker are born heavier. Suppose the researcher collects the birth weight of 50 full-term females with the genetic marker and the birth weight 50 full-term females without the genetic marker.

46. *(1 pt)* Which test statistic(s) can apply to cell A? (Mark all that apply.)

    `A.` t-test
    `B.` 2 sample t-test
    `C.` Large sample binomial proportion test
    `D.` 2 Sample binomial proportion test
    `E.` Pearson's χ^2 test
    `F.` ANOVA F test

47. *(1 pt)* Which test statistic(s) can apply to cell B? (Mark all that apply.)

    A. t-test
    B. 2 sample t-test
    C. Large sample binomial proportion test
    D. 2 Sample binomial proportion test
    E. Pearson's χ^2 test
    F. ANOVA F test

48. *(1 pt)* Which test statistic(s) can apply to cell D? (Mark all that apply.)

    A. t-test
    B. 2 sample t-test
    C. Large sample binomial proportion test
    D. 2 Sample binomial proportion test
    E. Pearson's χ^2 test
    F. ANOVA F test

49. *(2 pts)* Return to the situation in question 44. Calculate the value of the appropriate test statistic if the antigen was present in 26 samples.

50. *(2 pts)* Continuing from the previous question, calculate the p-value of the two-sided hypothesis test.

51. *(3 pts)* You are working with a researcher who has collected performance scores from 8 students from class A and 7 students from class B. The researcher would like to compare class A and class B in terms of performance. Which test statistic is appropriate?

    A. Kruskal-Wallis Test
    B. Binomial Proportion Test
    C. Sign Test
    D. t Test
    E. Paired t Test
    F. Wilcoxon-Signed-Rank Test
    G. 2 Sample t Test
    H. Wilcoxon-Rank-Sum Test

52. *(3 pts)* Investigator C. Sandiego wishes to find whether banks of certain countries have more money in their vaults. She inspects the vaults of several banks from several countries. Below are the results (in $ millions).

USA	11, 13, 9
Switzerland	15, 20, 22
Ecuador	4, 1, 2
Mauritius	11, 14, 16.33
Togo	5, 13, 11

    Which test statistic is appropriate?

    A. Kruskal-Wallis Test
    B. Binomial Proportion Test
    C. Sign Test
    D. t Test
    E. Paired t Test
    F. Wilcoxon-Signed-Rank Test
    G. 2 Sample t Test
    H. Wilcoxon-Rank-Sum Test

53. *(3 pts)* The nonparametric equivalent of the one sample t-test is _____ .

    A. Kruskal-Wallis Test
    B. Binomial Proportion Test
    C. Sign Test
    D. ANOVA F Test
    E. Paired t Test
    F. Wilcoxon-Signed-Rank Test
    G. 2 Sample t Test
    H. Wilcoxon-Rank-Sum Test

54. *(1 pt)* Enjoy a point.

55. *(2 pts)* A researcher collects 5 data points — 5.0, 4.1, 3.8, 4.4, 1.5 — in order to calculate a 95% confidence interval for the population mean, μ.

    What is the sample standard error?

56. *(2 pts)* What is the margin of error of the researcher's point estimate? (Margin of error is the confidence interval's half width.)

57. *(3 pts)* The rate of HIV/AIDS infection is at epidemic levels in Zambia, with a hypothesized national prevalence of 17% among adults aged 15-49. Our goal is to create a 95% confidence interval for p with a margin of error of 0.05. Using the hypothesized value of 0.17, what sample size is necessary to achieve this margin of error?

58. *(3 pts)* Continuing with the previous question, if we prefer a 90% confidence interval instead, what would happen to the required sample size n?

    A. Goes up
    B. Goes down
    C. Stays the same
    D. Cannot say

For questions 59 – 62: The model of Mendelian inheritance suggests that certain genetic traits are either dominant or recessive. Because mice have two sets of chromosomes, an individual mouse may be double dominant (DD), double recessive (DR), or heterozygous (H). Heterozygous means one dominant gene and one recessive gene.

If Mendel's model is correct, then two heterozygous parents can expect their offspring to be DD, DR, or H with the following probabilities.

DD	DR	H
.25	.25	.5

A researcher suspects a certain trait follows Mendelian inheritance. To test her theory, she breeds mice known to be heterozygous. The following is the data she observed.

DD	DR	H
19	23	58

Our goal is to investigate the Mendelian inheritance model with a goodness-of-fit test.

59. *(2 pts)* What is the reference distribution of the test statistic.

A. χ^2_1
B. χ^2_2
C. χ^2_3
D. Z
E. t_{99}

60. *(2 pts)* Calculate the value of the test statistic.

61. *(2 pts)* Find the p-value.

A. $0.1 < p$
B. $0.05 < p \leq 0.1$
C. $0.01 < p \leq 0.05$
D. $p \leq 0.01$

62. *(2 pts)* What is test result at an $\alpha = 0.01$ significance level?

A. Fail to reject the null hypothesis
B. Reject the null hypothesis

63. *(2 pts)* True or False? The odds ratio is calculated from r×c contingency tables.

For questions 64 – 69: Investigator C. Sandiego wishes to investigate regional height differences. She collects the height of 15 individuals from 3 regions: Coastal Carolina, Piedmont Carolina, and Appalachian Carolina. She collects data from a total of $15 \times 3 = 45$ individuals. The incomplete ANOVA table follows:

Source	DF	SS	MS	F value
Country	A	254.58	D	E
Residuals	B	C	25.415	

64. *(1 pt)* What is the value in the A cell?

65. *(1 pt)* What is the value in the B cell?

66. *(1 pt)* What is the value in the C cell?

67. *(1 pt)* What is the value in the D cell?

68. *(1 pt)* What is the value in the E cell?

69. *(2 pts)* The p-value of the ANOVA F test is 0.011. At the $\alpha = 0.05$ test level, the data would support which conclusion?

    A. The mean height in each region is the same.
    B. The mean height is different in each region.
    C. There is at least one region that differs from the rest in height.
    D. None of the above.

70. *(2 pts)* You'll recall that an ANOVA analysis is appropriate when we compare the means of several, say k, groups. If we only have 2 groups, the ANOVA analysis is identical to which test?

    A. 2 Sample binomial proportion test
    B. 2 Sample t-test
    C. Pearson's χ^2 test
    D. χ^2 Goodness of fit test.

For question 71 – 75: Consider data on X = log body weight (log kg) and Y = log brain weight (log g) of 25 species of land animals. The possible simple linear regression model is:

$$Y = \beta_0 + \beta_1 X + \epsilon, \qquad \epsilon \sim N(0, \sigma^2).$$

The regression results are posted below.

	Estimate	SE	95% CI	
Intercept	2.15	0.20	1.74	2.57
log(body)	0.75	0.05	0.66	0.85
n = 25, k = 2				
residual sd = 0.73, R-Squared = 0.92				

71. *(1 pt)* What is the estimate of β_0?

72. *(1 pt)* What is the estimate of β_1?

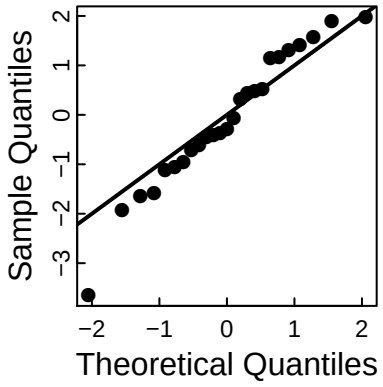
73. *(1 pt)* What is the estimate of σ^2?

74. *(1 pt)* Perform a test of linear association between log body weight and log brain weight at an $\alpha = 0.05$ test level. What do you conclude?

    A. The data suggests log body weight and log brain weight are linearly associated.
    B. The data suggests log body weight and log brain weight are NOT linearly associated.
    D. Neither. Cannot perform a linear association test with a regression model.

75. *(1 pt)* Suppose you know the log body weight of another species is 1. Use the linear regression model to estimate the mean log brain weight of this additional animal.

76. *(2 pts)* The following type of plot is best used for which purpose?



    A. Check the normality of the outliers
    B. Check the normality of the residuals
    C. Investigate heteroskedacity
    D. None of the above

77. *(3 pts)* The issues that may detrimentally affect the validity of a simple linear regression are _____ . (Mark all that apply.)

    A. A strong correlation between X and Y
    B. Outliers
    C. Heteroskedasticity
    D. X is an experimental factor
    E. The errors are normally distributed
    F. None of the above

■ Read the abstract and answer the questions that follow.

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Comparative Effectiveness of Weight-Loss Interventions in Clinical Practice

Lawrence J. Appel, M.D., M.P.H., Jeanne M. Clark, M.D., M.P.H., Hsin-Chieh Yeh, Ph.D., Nae-Yuh Wang, Ph.D., Janelle W. Coughlin, Ph.D., Gail Daumit, M.D., M.H.S., Edgar R. Miller III, M.D., Ph.D., Arlene Dalcin, R.D., Gerald J. Jerome, Ph.D., Steven Geller, M.D., Gary Noronha, M.D., Thomas Pozefsky, M.D., Jeanne Charleston, R.N., Jeffrey B. Reynolds, M.S., Nowella Durkin, Richard R. Rubin, Ph.D., Thomas A. Louis, Ph.D., and Frederick L. Brancati, M.D., M.H.S.

ABSTRACT

BACKGROUND

Obesity and its cardiovascular complications are extremely common medical problems, but evidence on how to accomplish weight loss in clinical practice is sparse.

METHODS

We conducted a randomized, controlled trial to examine the effects of two behavioral weight-loss interventions in 415 obese patients with at least one cardiovascular risk factor. Participants were recruited from six primary care practices; 63.6% were women, 41.0% were black, and the mean age was 54.0 years. One intervention provided patients with weight-loss support remotely — through the telephone, a study-specific Web site, and e-mail. The other intervention provided in-person support during group and individual sessions, along with the three remote means of support. There was also a control group in which weight loss was self-directed. Outcomes were compared between each intervention group and the control group and between the two intervention groups. For both interventions, primary care providers reinforced participation at routinely scheduled visits. The trial duration was 24 months.

RESULTS

At baseline, the mean body-mass index (the weight in kilograms divided by the square of the height in meters) for all participants was 36.6, and the mean weight was 103.8 kg. At 24 months, the mean change in weight from baseline was −0.8 kg in the control group, −4.6 kg in the group receiving remote support only ($P<0.001$ for the comparison with the control group), and −5.1 kg in the group receiving in-person support ($P<0.001$ for the comparison with the control group). The percentage of participants who lost 5% or more of their initial weight was 18.8% in the control group, 38.2% in the group receiving remote support only, and 41.4% in the group receiving in-person support. The change in weight from baseline did not differ significantly between the two intervention groups.

CONCLUSIONS

In two behavioral interventions, one delivered with in-person support and the other delivered remotely, without face-to-face contact between participants and weight-loss coaches, obese patients achieved and sustained clinically significant weight loss over a period of 24 months. (Funded by the National Heart, Lung, and Blood Institute and others; ClinicalTrials.gov number, NCT00783315.)

From the Welch Center for Prevention, Epidemiology, and Clinical Research, Johns Hopkins University (L.J.A., J.M.C., H.-C.Y., N.-Y.W., G.D., E.R.M., F.L.B.); the Divisions of General Internal Medicine (L.J.A., J.M.C., H.-C.Y., N.-Y.W., G.D., E.R.M., A.D., G.J.J., G.N., T.P., J.B.R., N.D., F.L.B.) and Endocrinology (T.P.) and the Departments of Psychiatry and Behavioral Sciences (J.W.C.) and Pediatrics (R.R.R.), Johns Hopkins University School of Medicine; the Departments of Epidemiology (L.J.A., J.M.C., H.-C.Y., J.C., F.L.B.) and Biostatistics (N.-Y.W., T.A.L.), Johns Hopkins Bloomberg School of Public Health; and Johns Hopkins Community Physicians (G.N.) — all in Baltimore; and the Department of Kinesiology, Towson University, Towson (G.J.J.); the Centennial Medical Group, Elkridge (S.G.); and Park Medical Associates, Timonium (T.P.) — all in Maryland. Address reprint requests to Dr. Appel at lappel@jhmi.edu.

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78. *(2 pts)* What is the study design?

    A. Observational survey
    B. Randomized, control trial

79. *(2 pts)* How many treatment groups does the study have?

80. *(2 pts)* What is the primary outcome variable?

    A. Body-Fat Percentage (BFP)
    B. Body-Mass Index (BMI)
    C. Weight
    D. Obesity (Yes/NO)

81. *(3 pts)* What is the central contradiction of public health ethics?

82. *(1 pt)* Ethical standards in public health tend to be _____.

    A. a reaction to cruel or distasteful research of the past