

Practice Problems

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The Importance of Practice

“...the most important role that innate factors play may be in a person's willingness to engage in sustained training.”

There have now been many studies of elite performers--concert violinists, chess grandmasters, professional ice-skaters, mathematicians, and so forth--and the biggest difference researchers find between them and lesser performers is the amount of deliberate practice they've accumulated. Indeed, the most important talent may be the talent for practice itself. K. Anders Ericsson, a cognitive psychologist and expert on performance, notes that the most important role that innate factors play may be in a person's willingness to engage in sustained training. He has found, for example, that top performers dislike practicing just as much as others do. But, more than others, they have the will to keep at it anyway. - Atul Gawande, *The Learning Curve*

The number in parentheses following each question refers to the number of the answer on the [answer sheet](#).

1. Use the following data on limb length (cm) in deer to test the hypothesis that forelimb length and hindlimb length differ in individual deer. (1)

deer no.	1	2	3	4	5	6	7	8	9	10
forelimb	142	140	144	144	142	146	149	150	142	148
hindlimb	138	136	147	139	143	141	143	145	136	146

2. Use the data below to determine if the performance of three different olfactory behaviors (types A, B, and C), which bulls typically exhibit on approaching a female, is related to the reproductive stage of the female. (2)

		Behavior of bull		
		A	B	C
Female	conceptive	29	48	27
	nonconceptive	32	68	9

3. Nineteen pigs were assigned at random to one of four experimental groups. Each group was fed a different diet. Use the following data on pig weights (kg) to test the hypothesis that pig weights were the same on all diets. (3)

feed 1	feed 2	feed 3	feed 4
60.8	68.7	102.6	87.9
57.0	67.7	102.1	84.2
65.0	74.0	100.2	83.1
58.6	66.3	96.5	85.7
61.7	69.8		90.3

4. Because of its association with a variety of serious disorders, caffeine is a closely monitored food additive. The following table shows the caffeine content (grams per 100 grams of dry matter) in 12 brands of instant coffee, 8 spray-dried and 4 freeze-dried. Test for a difference in the mean caffeine content of spray-dried and freeze-dried instant coffee. (4)

<u>Spray-dried</u>		<u>Freeze-dried</u>
4.8	4.6	3.7
4.0	3.3	3.4
3.8	3.7	2.8
4.3	3.9	3.9

5. As female alligator snapping turtles grow, they gain weight faster than they gain length. From the data given below, construct a regression model which predicts the weight (g) of a snapper from a given length (mm). To maximize the usefulness of the model, a r^2 of at least 98% is required. Models with r^2 less than 98% are acceptable but result in less than full credit. Use your equation to predict the weight of a snapper with a length of 200 mm. (5)

<u>PL(mm)</u>	<u>WGT (g)</u>	<u>PL(mm)</u>	<u>WGT(g)</u>
70	98	200	2110
225	2843	32	9.5
134	572	175	1203
93	204	118	477
55	35	122	518
161	1075	74	98
255	4139	44	23

6. Use the following data on heights of plants grown with two different fertilizers to test the hypothesis that the “newer” fertilizer enhances growth better than the “present” fertilizer. (6)

present: 48.2, 54.6, 58.3, 47.8, 51.4, 52.0, 55.2, 49.1, 49.9, 52.6
 newer: 52.3, 57.4, 55.6, 53.2, 61.3, 58.0, 59.8, 54.8

7. Knowing that the diameter of branches selected by an arboreal snake was a function of body weight, an ecologist wanted to predict perch size by simply measuring body length. In order to do this, he had to know the relationship between body length and body weight. He measured body lengths (mm) and weights (g) of 10 snakes: (7)

length - 140, 220, 280, 340, 380, 420, 440, 462, 480, 501
 weight - 2.5, 5.7, 9.3, 17.5, 22.3, 28.5, 31.8, 39.5, 45.5, 52.0

Regress weight on length. Is the relationship between body length and weight good enough that you would feel comfortable in predicting weight from length? Is there something that could be done to improve the predictability? Do it. Predict the weight of a 470 mm snake from the equations produced by both the raw and transformed data.

8. A senior USDA epidemiologist was assigned the task of determining whether race and/or geographic origin affected susceptibility of humans to viral hiniditrus (HIDS). As background information, the epidemiologist used the following data collected by the California state government on the population composition of San Francisco in 2000: 385,728 citizens reported their race and/or geographic origin as White, 60,515 Black, 3,458 Indian, 239,565 Asian, 3,844 Hawaiian, and 50,368 “other.” In 2001-02, the epidemiologist’s team collected data on over 4000 HIDS victims in San Francisco according to their race and/or geographic origin. Specifically, there were 2213 victims who classified themselves as White, 373 Black, 29 Indian, 1327 Asian, 26 Hawaiian, and 259 “other.” According to these data, do race and/or ethnic origin affect susceptibility to HIDS? (8)
9. Use the following data on ranked scores on a keyboarding skills test to test the hypothesis that high school training improves keyboarding skills of college students. (9)

with training: 44, 48, 36, 32, 51, 45, 54, 56
 without training: 32, 40, 44, 44, 34, 30, 26

10. Use the following data on number of terrestrial invertebrate species occurring in limestone caves of various sizes (km^2) in the Greenbriar Valley of West Virginia to construct a species-area curve (log-log regression of no. species [S] on cave area [A]). Using your model, predict the number of species expected in a cave encompassing an area of 275 km^2 . (10)

cave area	50	90	250	350	400
no. species	2	4	11	8	12

11. Use the following data on rank of earlobe “droop” in 12 students to test the hypothesis that “droop” of males does not differ from females. (11)

males: 1, 2, 4, 5, 7, 9, 10
 females: 3, 6, 8, 11, 12

12. Use the data in GINMOVE.SYD to test the hypothesis that there is a relationship between sex of turtle and habitat preference. (12)
13. The Mars Candy Co. claimed that 30% of peanut M&Ms are brown, 20% yellow, 20% red, 10% orange, 10% green and 10% blue. A sample one pound bag of M&Ms had 173 browns, 133 yellows, 84 reds, 43 oranges, 34 greens, and 39 blues. Use the sample to test the validity of the company’s claim. (13)
14. Ten colonies of juvenile hamsters were established with densities of animals ranging from one to five animals per square meter. After one week, three animals were randomly selected from each colony and their serum corticosterone was measured. Is corticosterone a function of density? (14)

density:	1	1	2	2	3	3	4	4	5	5
corticosterone:	3.2	2.8	8.5	10.2	27.5	34.0	97.2	120.0	330.0	285.0

15. The data below are the observed number of sparrow nests in forty 8000 square meter plots and the expected number of nests assuming that nests were distributed randomly (i.e., fit a Poisson distribution). Test the hypothesis that nests are randomly distributed. (15)

no. nests	observed no. plots
0	9
1	22
2	6
3	2
4	1
5	0

16. Use the following data on number of ladybird beetles collected from sunflowers throughout the year to test the hypothesis that sex ratio of beetles is unrelated to season. (16)

Sex	Spring	Summer	Fall	Winter
male	163	135	71	43
female	86	77	40	38

17. An ecologist studying the distribution of two species of grasses noticed that seeds of the more widespread species usually dispersed further than the local species. Since it was known in other species that lightweight seeds dispersed more easily by wind than did heavier seeds, he measured seed weights of the species. The data (in grams) are:

Widespread species - .047, .034, .052, .044, .042, .049, .038, .037, .050, .044
 Local species - .054, .032, .042, .034, .057, .046, .048, .038, .062, .032

Was there any evidence for attributing differences in dispersal ability to weight of seeds? (17)

18. An avian ecologist was interested in possible competition between two closely-related, sympatric, seed-eating birds. He offered seeds of various sizes in artificial feeding stations to the birds in their natural habitat. Answer the questions using the results below: (18)

variable	no. cases	mean	standard deviation	
sp 1	15	3.09	0.308	$t = -2.18, P < 0.05$
sp 2	15	3.31	0.242	$F = 1.63, P > 0.30$

- a. Do the two species differ in the average size of seeds eaten? (a) yes; (b) no; (c) cannot determine with results provided
- b. Do the two species differ in the variation of seed sizes eaten? (a) yes; (b) no; (c) cannot determine with results provided
19. White-throated sparrows occur in two distinct color morphs, referred to as brown and white. It was suspected that females select mates of the opposite morph (i.e., white females select brown males and vice versa). This phenomenon is known as negative assortive mating. In 49 mated pairs, the color combinations were as below. Do the results support the assumption that negative assortive mating occurs in this species? (19)

		Males	
		white	brown
Females	white	7	23
	brown	14	5

20. Use the following data on clutch size to test the hypothesis that variability in clutch size differs between zoo-bred and wild-bred mallard ducks. (20)

zoo: 10, 11, 12, 11, 10, 11, 11
 wild: 9, 8, 11, 12, 10, 13, 11, 10, 10

21. To investigate whether rats could differentiate between fresh and spoiled food, a behavioral psychologist randomly assigned 6 male and 6 female rats to two levels of food quality. She then measured food consumed over one week. The variables were food consumption (g/d), food quality (fresh lard =1; rancid lard =2), and sex (male=1; female=2). The data are shown below. Is there a sex or food quality effect? Prepare an interaction plot and explain how it relates to the ANOVA output. (21)

Food consumption	Food quality	Sex	Food consumption	Food quality	Sex
709	1	1	657	1	2
592	2	1	508	2	2
679	1	1	594	1	2
538	2	1	505	2	2
699	1	1	677	1	2
476	2	1	539	2	2

22. Fifteen tobacco plants of the same age and genetic strain were randomly assigned to three groups of five plants each. One group was untreated, one was infected with tobacco mosaic virus (TMV), and one was infected with tobacco ringspot virus (TRSV). After one week, the activity of o-diphenol oxidase activity was determined in each plant. Does infection by either virus affect the activity of this enzyme? (22)

control: 1.47, 1.62, 1.06, 0.89, 1.67
 TMV-infected: 2.44, 2.31, 1.98, 2.76, 2.39
 TRSV-infected: 2.87, 3.05, 2.36, 3.21, 3.00

23. Tomato plants of the same genetic strain and age were subjected to a temperature of 45°C for three hours. Such treatment reduces the plants' ability to photosynthesize. One plant from the group was randomly selected each day for 10 consecutive days and its rate of photosynthesis ($\mu\text{M CO}_2/\text{g}/\text{sec}$) was determined. Use the data below to determine if the plants recover from this temperature stress, and if so, write an equation to describe the rate of recovery. (23)

days posttreatment: 0 1 2 3 4 5 6 7 8 9
 photosynthetic rate: 15.0 17.5 16.5 19.0 22.0 24.0 22.5 26.5 25.0 30.0

24. Use the following data on clutch size to test the hypothesis that variability in clutch size differs between captive and wild ducks. (24)

captive: 10, 11, 12, 11, 10, 11, 11
 wild: 9, 8, 11, 12, 10, 13, 11, 10, 10

25. A random sample of female mosquito fish was collected. Their total length (mm) and the number of embryos that each contained were determined. Is there an association between body length and number of embryos? (25)

fish no: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 body length: 30 28 43 39 37 37 37 37 39 36 33 35 38 39 30 32 33 34 30 34 33 32
 no. embryos: 19 8 59 56 23 27 26 52 59 31 19 50 53 22 9 35 17 39 25 38 19 17

26. A herpetologist observed that growth rate in snapping turtles seemed to decline with size and age. He was interested in predicting precisely growth rates so that he could assign ages to turtles of a given size. He captured 10 female turtles, measured shell lengths, marked each individually, released and recaptured them at various times thereafter. The data are (growth rates in mm/month; length in mm):

Length - 180, 60, 75, 92, 140, 115, 101, 152, 164, 129
 GR - 1.0, 10.9, 8.0, 7.3, 2.1, 3.7, 5.2, 1.8, 1.4, 2.8

Is there a functional relationship between growth rate and size (age)? Predict the growth rate of a 134 mm turtle. (26)

27. An evolutionary biologist sampled road warblers from three localities in North America: Eastern, Western, and the intermountain region. Ten randomly selected individuals were classified by sex and locality and their bill lengths were measured. Does bill length differ between the sexes or localities? Proceed as if the assumptions have been met. Prepare an interaction plot and explain how it relates to the ANOVA output. (27)

Females			Males		
Eastern	Western	Intermtn	Eastern	Western	Intermtn
50.1	53.4	54.0	46.5	57.5	49.1
52.8	55.2	49.1	44.4	59.3	51.8
50.8	51.0	60.5	42.0	62.4	55.3
58.8	59.3	57.8	51.1	61.1	43.6
59.7	61.5	48.7	45.8	59.9	50.1
49.0	61.2	57.0	46.3	55.6	51.0
58.8	57.8	61.1	41.8	56.8	49.0
62.2	50.1	62.8	52.0	59.2	48.8
57.8	56.0	59.8	46.5	50.4	52.0
61.2	56.5	60.3	39.0	47.8	43.0

28. The following data are serum cholesterol concentration (mg/100 ml) and arterial calcium deposition (mg/100 g dry weight of tissue) in 11 chimpanzees. Is there a relationship between cholesterol and calcium deposition? (28)

cholesterol 59 52 42 59 24 24 40 32 63 57 36
 calcium 298 303 233 287 236 245 265 233 286 290 264

29. A mammalogist was interested in possible ontogenetic changes in the food niche of otters. One aspect of her research involved the relationship of prey size and predator size. She collected data on 10 otters as follows (in g):

Otter wgt. - 1500, 500, 750, 1000, 620, 1100, 1450, 520, 800, 880
 Prey wgt. - 128, 190, 75, 125, 47, 203, 92, 80, 111, 27

Is there a relationship between predator size and prey size? What would you predict the average prey weight would be of a 1200 g otter? (29)

30. An ecologist studied the local movements (home ranges) of softshell turtles in a river. He needed to know if length of home range differed between adult males and females. He equipped 20 turtles (10 males, 10 females) with radiotransmitters and over a 4 month period relocated each turtle an average of 84 times. Lengths of home ranges (in meters) of the individual turtles were:

Males - 300, 450, 475, 440, 725, 515, 530, 541, 590, 340
 Females - 1200, 2150, 1480, 998, 1080, 1220, 540, 675, 800, 1350

Does home range size differ between the sexes? (30)

31. A particular disease functioned as an important density regulatory mechanism in a population of soil nematodes. Evidence suggested that the disease resulted from an unknown mineral deficiency or imbalance. Because nematodes gain nutrients from ingesting soil, a particularly confident agricultural ecologist strongly argued that nematode abundance could be predicted if the abundance of certain minerals were known. Before this prediction could be made, however, it was necessary to determine the relationship between the occurrence of the disease and various soil minerals. The ecologist sampled nematode abundance and various mineral levels at all localities where the disease was known to occur. His data follow:

nem. density- 324, 244, 987, 766, 111, 345, 278, 097, 447, 747
 magnesium- 9.2, 9.4, 7.4, 6.8, 6.6, 7.1, 4.6, 5.5, 7.7, 9.3
 iron- 22, 13, 14, 102, 88, 68, 14, 31, 101, 34
 potassium- 1.2, 0.3, 0.4, 0.6, 1.0, 0.4, 0.3, 0.8, 0.8, 0.7
 chromium- 0.1, 0.2, 0.1, 0.2, 0.3, 0.1, 0.1, 0.3, 0.2, 0.2
 sodium- 34, 67, 33, 45, 29, 12, 57, 27, 19, 29

What was the relationship of the abundance of each of the five minerals to the density of nematodes? (31)

32. Using the following data on serum cholesterol concentration (mg/100 ml) in male and female turtles to test the hypothesis that sex does not affect cholesterol levels. (32)

males: 220.1, 218.6, 229.6, 228.8, 222.0, 224.1, 226.5
 females: 223.4, 221.5, 230.2, 224.3, 223.8, 230.8

33. Use the data in GINMOVE.SYD to test the hypothesis that male and female turtles move different distances each day. (33)

34. Use the following data on frequency of parasitic "g" infection in three species of hatchery trout to test the hypothesis that infection with parasite "g" is independent of trout species. (34)

	Sp. 1	Sp. 2	Sp. 3
with parasite "g"	18	10	13
without parasite "g"	6	15	12

35. Crop yields were measured in each of nine experimental plots over two successive years, one using "old" fertilizer and one using "new" fertilizer. Use the following data to test the research hypothesis that the new fertilizer produced greater yields. (35)

plot	1	2	3	4	5	6	7	8	9
old fertilizer	1920	2020	2060	1960	1960	2140	1980	1940	1790
new fertilizer	2250	2410	2260	2200	2360	2320	2240	2300	2090

36. Use the following data on human sex ratio in 6115 sibships of 12 to test the null hypothesis that the sample data fit a binomial distribution. (36)

no. males	no. females	Obs. no.	Exp. no.	
12	0	7	1.493	pool
11	1	45	17.915	
10	2	181	98.533	
9	3	478	328.442	
8	4	829	738.995	
7	5	1112	1182.393	
6	6	1343	1379.458	
5	7	1033	1182.393	
4	8	670	738.995	
3	9	286	328.442	
2	10	104	98.533	pool
1	11	24	17.915	
0	12	3	1.493	
		6115	6115	

37. Use the data in HOGNOSE.SYS to test the hypothesis that active (act\$=act) male resident snakes (status\$=res) move greater distances each day than do active female residents. (37)
38. After calibration in the laboratory, temperature-sensitive radiotransmitters were implanted into the body cavities of softshell turtles (*Trionyx*) living in a creek. Use the following data to determine the functional relationship between \log_{10} pulse interval (msec) and transmitter temperature ($^{\circ}\text{C}$). Use reverse prediction to estimate the body temperature of a basking turtle which transmits at a pulse interval of 1337 msec. (38)

pulse interval	1024	1234	1475	1725	2067	2567	3205
temperature	35.2	29.9	24.9	20.0	15.5	9.0	1.8

39. Algae cells were incubated in a culture medium containing different concentrations ($\mu\text{g/g}$) of dilithium chloride. After a period of incubation, the concentration of dilithium in the algae cells was determined. Was cellular concentration a function of medium concentration? Predict the cellular concentration of cells incubated in a medium concentration of 14.5 ($\mu\text{g/g}$). (39)

medium:	0	1	2	5	10	20
cells:	0	9	21	47	105	213

40. Use the following data on two types of air pollutants (nitrogen oxides, hydrocarbons) measured over 11 days on the same sample taken each day to test the hypothesis that the two pollutants were present in the same concentration. (40)

day	1	2	3	4	5	6	7	8	9	10	11
nit. oxides	104	116	84	77	61	84	81	72	61	97	84
hydro	108	118	89	71	66	83	88	76	68	96	81

41. Determine if the conclusion in the following newspaper article is warranted. *Study: Calcium and Vitamin D Supplements Help Prevent Fractures (Associated Press - National Bureau)*. Calcium and vitamin D supple-

ments can cut in half older people's risk of broken bones, a study found. Those taking supplements slowed their bone turnover — the rate at which bone tissue breaks down and rebuilds — and maintained or slightly increased their bone density, according to the study by Tufts University researchers. Aging is often accompanied by osteoporosis, in which bones become extremely fragile. Osteoporosis and fractures resulting from it cost the U.S. health care system an estimated \$10 billion or more a year. Other studies also have shown that calcium supplements — with or without vitamin D, which is known to help the gut absorb calcium — can slow bone loss. However, the study by Dr Beth Dawson-Hughes and other Tufts researchers went further and found that when people taking the supplements fell, they were only half as likely to break a bone as people who were not taking supplements. The study, published in today's New England Journal of Medicine, looked at 389 men and women age 65 or older who were fairly healthy and living at home. The average subject was getting about 700 milligrams a day of calcium and about 200 international units of vitamin D through diet. For three years, half of them took daily supplements containing 500 milligrams of calcium citrate and 700 international units of vitamin D. The rest were given placebos, or dummy supplements. During that period, 37 people suffered fractures: 11 of 187 in the group taking supplements, or 6 percent, compared with 26 of 202 in the placebo group, or 13 percent. Each group reported about an equal number of falls. Because the difference in bone density between the two groups was modest, the researchers said the protective effect of the supplements may have been due to the slower rate of bone turnover. The study adds to evidence that calcium supplements can help prevent broken bones in elderly people at little cost and with few side effects, Dr. Richard L Prince, of the University of Western Australia, said in an accompanying editorial. (41)

42. Density of voles (a common kind of "field" mouse) is commonly believed to be more abundant in grassland habitats which have been burned every 4-5 years compared to those grassland habitats which have never been burned. To test this assumption, a population ecologist determined population density of voles in 10 burned and 10 unburned habitats throughout the species range. The data are:

	<u>Density (no./ha)</u>
burned	348, 244, 198, 321, 276, 239, 287, 311, 302, 271
unburned	167, 231, 098, 177, 216, 179, 195, 154, 163, 134

Is there a difference in mean density between the habitats? Is the variance in density in one habitat greater than that in the other habitat? (42)

43. Use the data below on number of maple seedlings in 100 1m x 1m quadrats to test the hypothesis that seedlings are randomly distributed among quadrats as predicted by the expected Poisson frequencies. (43)

<u>Seedlings/ quadrat</u>	<u>observed</u>
0	35
1	28
2	15
3	10
4	7
5	5
6	0

44. An ornithologist was interested in whether red-eyed vireos preferred certain kinds of microhabitats in which to nest. The first question that came to his mind was: Do vireos prefer one kind of tree over another? Ninety nests were located in the following kinds of trees (39 in oaks, 16 in hickories, 6 in maples, 5 in willow, and 24 in "other"). It was also determined that oaks constituted 41.0% of the vegetation of the study area, hickories 12.0%, maples 9.5%, willow 9.0%, and "other" 28.5%). Did the vireos prefer to nest in one tree over another? (44)
45. A mammalogist wanted to know if a certain species of pocket gopher preferred certain soil types over others. To examine the question, he set out a large grid of gopher traps in a heterogeneous environment and trapped 327 gophers over seven months. Soil types (A-E) are indicated for each cell in the grid. Each cell contained one trap. The number of gophers captured in each soil type was A=148, B=61, C=13, D=85, E=20. The research question is, "Did the gophers discriminate among soils?" (45)

B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
D	D	A	A	A	A	A	A	A	A	A	A	C	C	C
D	D	D	D	A	A	A	A	A	A	A	A	A	C	C
D	D	A	D	D	A	A	A	A	D	A	A	A	A	C
D	D	A	A	D	D	D	A	A	D	A	A	A	A	C
A	A	A	A	A	D	D	D	D	D	A	A	A	A	A
A	A	A	A	A	A	D	D	D	D	A	A	A	A	A
E	E	E	A	A	A	A	D	D	D	A	A	A	D	D
E	E	E	E	E	E	E	E	D	D	D	A	A	A	D

- a. What is the null hypothesis? (a) $H_0: \mu = \mu$; (b) $H_0: \rho = 0$; (c) $H_0: O = E$; (d) $H_0: \sigma^2 = \sigma^2$
 b. What is the value of the test statistic? (a) $\chi^2 = 184.0$; (b) $\chi^2 = 2.3$; (c) $\chi^2 = 365.2$; (d) $\chi^2 = 18.7$
 c. What is the probability? (a) $P < 0.01$; (b) $P < 0.05$; (c) $P > 0.05$; (d) $P > 0.100$; (e) $P > 0.90$
 d. Should the null hypothesis be rejected? (a) yes; (b) no; (c) cannot determine with the results provided
 e. What is the biological conclusion? (a) gophers discriminate among soils; (b) gophers do not discriminate among soils; (c) cannot determine with the results provided.

46. Using the following data on wing lengths of sparrows (*Passer*) of various ages to compute a regression equation which predicts wing length of a bird of known age. Graph the data and fit a least-squares regression line. Use inverse prediction to estimate the age of a sparrow with a wing length of 4.5 cm. (46)

age (days)	3	4	5	6	8	9	10	11	12	14	15	16	17
wing length (cm)	1.4	1.5	2.2	2.4	3.1	3.2	3.2	3.9	4.1	4.7	4.5	5.2	5.0

47. The following data were obtained from F_2 crosses between progeny of yellow-green and chlorophyll-deficient strains of lettuce. Test the fit of these data to the expected 3:1 (yellow-green: chlorophyll-deficient) phenotypic ratio. (47)

no. yellow-green = 1016
 no. chlorophyll-deficient = 351

48. Use the following data on human blood-clotting times (min.) of individuals given one of two different drugs to test the hypothesis that drug B induces clotting at a faster rate. (48)

Drug B: 8.8, 8.4, 7.9, 8.7, 9.1, 9.6
 Drug G: 9.9, 9.0, 11.1, 9.6, 8.7, 10.4, 9.5

49. An evolutionary ecologist observed an apparent seasonal change in the phenotypic frequency in a population of a beetle species. The change appeared to be correlated with a change in abundance of a major predator (a mantid). Was the predator responsible for the seasonal phenotypic changes in the beetle because of selective predation on one of the phenotypes? The first step in solving this problem was to determine if, in fact, the phenotypic frequencies did change. Therefore, the ecologist made large collections at periodic times throughout the year. The data were as follows:

	Number of specimens collected in		
	<u>Mid spring</u>	<u>Mid summer</u>	<u>Mid fall</u>
Red beetles	1057	999	355
Black beetles	1094	1847	712
Mottled beetles	1005	1698	731

From previous work, it was known that beetles were born in early spring with equal phenotypic frequencies. How did the frequencies in midspring and midsummer compare with newborn samples? What do these results suggest biologically? (49)

50. Orcas occur in two distinct color morphs, referred to as Bblack and Bwhite. A marine biologist hypothesized that female Orcas selected mates of the opposite background color (i.e., Bwhite females select Bblack males and vice versa). In 490 mated pairs of Orcas, Bwhite males mated with Bwhite females in 14% of cases, Bwhite males mated with Bblack females in 47% of cases, Bblack males mated with Bwhite females in 29% of cases, and Bblack males mated with Bblack females in 10% of cases. Do these results support the biologist's hypothesis? (50)
51. A field biologist was interested in the habitats selected by an arboreal (tree-dwelling) snake. The first question that came to mind was: Do snakes prefer one kind of tree over another? The biologist selected a study area and collected 90 snakes (39 in alder, 16 in ironwood, 6 in oak, 5 in willow, and 24 in "other"). He also determined that alder constituted 41.0% of the vegetation of the study area, ironwood 12.0%, oak 9.5%, willow 9.0%, and "other" 28.5%. Did the snakes prefer one tree over another? (51)
52. The weight (g), length (mm), and width (mm) of 11 randomly selected killdeer eggs were measured. Is there a correlation between weight and width? (52)

bird no:	1	2	3	4	5	6	7	8	9	10	11
weight:	13	13	12	13.5	15.5	15	16	14	14	15	12
width:	26.4	26.5	26.4	27.1	28.3	28	28.4	27.2	27.7	27.6	26.7
length:	36.7	36.5	34.3	37.1	38.1	37.2	39.0	37.5	36.7	38.3	36.0

53. In a study tracking the DARE drug education program to graduation, 141 out of 288 high school students exposed to the DARE (drug education) had used marijuana, and 181 out of 335 students not exposed to the DARE program had used marijuana. Test for evidence that the rate of marijuana use is affected by exposure to the DARE program. (53)
54. In a study of snake hibernation, fifteen pythons of similar size and age were randomly assigned to three groups. One group was treated with drug A, one group with drug B, and the third group was not treated. Their systolic blood pressure (mmHg) was measured 24 hours after administration of the treatments. Does either drug affect blood pressure? Does any one have a greater or lesser effect than the other? (54)

control: 130, 135, 132, 128, 130
 drug A: 118, 120, 125, 119, 121
 drug B: 105, 110, 98, 106, 105

55. A mammalogist measured activity levels of voles by installing electronic treadles in vole runways. Each time a vole crossed a treadle, an electronic signal was sent to a computer-controlled data logger. Activity levels (events/hour) were found to vary greatly; therefore the mammalogist measured other variables, including ambient temperature (C), light intensity (foot-candles), wind speed (km/hour), and time of day (24 hour) in order to determine their effects on activity. Answer the questions using the results provided. (55)
- a. Which independent variable had the largest effect on activity? (a) temperature; (b) time; (c) light; (d) wind; (e) activity
- b. Which independent variable had the least effect on activity? (a) temperature; (b) time; (c) light; (d) wind; (e) activity
- c. Which independent variable(s) had no significant effect on activity? (a) temperature; (b) time; (c) light; (d) wind; (e) activity

Matrix of Pearson Correlation Coefficients
 (ns = $P > 0.05$; * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$)

	activity	temp	time	light	wind
activity	1.000	-.433	-.951	-.606	-.886
temp	-.433	1.000	.578	.402	.755
time	-.951	.578	1.000	.477	.913
light	-.606	.402	.477	1.000	.886
wind	-.886	.755	.913	.886	1.000

	***	*		ns	***
light	-.606	.402	.477	1.000	.567
	*	ns	ns		*
wind	-.886	.755	.913	.567	1.000
	***	**	***	*	

56. The major prey items of humpback chubs are benthic (bottom-dwelling) macroinvertebrates. Because many such macroinvertebrates are extremely habitat-specific, a thorough knowledge of diet can give a clue as to where the chubs forage. Use the data below on proportion of crayfish in the diet of chubs to determine if there is a difference in diet among adult males (ADM), subadult females (SADF), and adult females (ADF). Caution: what are the variables? (56)

sex	age class	prop. crayfish	sex	age class	prop. crayfish
male	adult	0.42	female	subadult	0.44
male	adult	0.32	male	adult	0.29
female	adult	0.75	female	adult	0.67
female	subadult	0.49	female	subadult	0.39
female	adult	0.74	male	adult	0.38
male	adult	0.24	female	adult	0.89
male	adult	0.45	female	adult	0.82
female	adult	0.42	female	subadult	0.31
female	subadult	0.55	male	adult	0.37
male	adult	0.53	female	subadult	0.77
female	adult	0.29	female	adult	0.48
female	adult	0.28	male	adult	0.90
male	adult	0.28	male	adult	0.21
male	adult	0.83	female	subadult	0.68
female	subadult	0.39	female	adult	0.39

57. Use the following data on strontium concentrations (mg/ml) in five different bodies of water to test the hypothesis that strontium levels do not differ among localities. Assuming you find significance, which means do you think are different from other means? (57)

Grayson's Pond	Beaver Lake	Angler's Cove	Appletree Lake	Rock River
28.2	39.6	46.3	41.0	56.3
33.2	40.8	42.1	44.1	54.1
36.4	37.9	43.5	46.4	59.4
34.6	37.1	48.8	40.2	62.7
29.1	43.6	43.7	38.6	60.0
31.0	42.4	40.1	36.3	57.3

58. The data below represent water bath calibrations for a miniature temperature-sensitive radiotracer which was subsequently implanted into the body cavity of a hibernating softshell turtle. Construct a regression model that predicts pulse interval (PI) from water bath temperature (C), and then use inverse prediction to determine the turtle's body temperature from a pulse interval of 1250 msec. Because pulse rates are often curvilinearly related to temperature, a semi-log transformation is usually in order. (58)

temp:	35.1	29.9	24.9	20.0	15.6	8.9	1.8
PI:	936	1158	1412	1728	2052	2612	3285

59. A game manager was concerned about the declining population of wood ducks on her management area. She made the observation that males appeared to be more abundant than females. Since these animals are monogamous, she reasoned that perhaps an imbalanced sex ratio contributed to the decline. She surveyed the wood duck population over a one-year period and collected these data:

Number of adult males - 82
Number of adult females - 54

It is known that the sex ratio at birth (primary sex ratio) is 1:1. Is the adult sex ratio (secondary sex ratio) also 1:1? (59)

60. Test whether the observed data are randomly distributed (60)

Results - number of maple seedlings in 100 quadrats.

No. of plants	Obs freq.	Exp freq.	(O-E) ² /E
0	35	24.4	4.605
1	28	34.4	1.191
2	15	24.3	3.559
3	10	11.4	0.172
4	7	4.0	+ 9.335 (pooled)
5	5 = 12	1.1 = 5.1	
Total	100	99.6	18.86

61. It is thought that endotherms from northern areas have shorter appendages than endotherms from southern areas. Test this hypothesis using the following data on wing lengths (mm) of house sparrows. (61)

northern: 120, 113, 125, 118, 116, 114, 119

southern: 116, 117, 121, 114, 116, 118, 123, 120

62. Ten randomly selected soil samples were analyzed for krypton content ($\mu\text{g}/\text{kg}$ soil) using an old, expensive, but very reliable and accurate method. The samples were also analyzed with a newer, less expensive, and faster method, but one that yields relative ranking results rather than absolute values. A strong correlation between the results of the two methods would indicate that the new method is also accurate to the extent of its rank output. Is it? (62)

old: 26 30 20 35 40 25 33 50 65 60

new: 3 4 1 6 7 2 5 8 10 9

63. Dimetrodons always have litters consisting of four young. Based on the theory of sex determination in mammals, calculate the expected frequencies for the number of males in 247 litters of four siblings each. (63)

No. of males	Obs freq.
0	7
1	24
2	93
3	99
4	24

64. Using the following data on volume (cubic microns) of avian erythrocytes taken from normal (diploid) and intersex (triploid) individuals, test the hypothesis that ploidy does not affect erythrocyte size. (64)

diploid: 248, 236, 269, 254, 249, 251, 260, 245, 239, 255

triploid: 380, 391, 377, 392, 398, 374

65. A physiological ecologist was interested in the thermal ecology of a species of whiptail lizard. As a preliminary investigation, he measured body temperatures (T_b) of 10 lizards. At the same time with each lizard he measured air temperature (T_a), soil surface temperature (T_s), and solar radiation (R_a). The data are:

T_b - 40.0, 29.8, 38.6, 41.2, 42.0, 37.4, 30.6, 34.5, 40.8, 36.2

T_a - 27.2, 28.2, 36.7, 38.0, 34.8, 37.2, 27.5, 29.9, 37.2, 30.2

T_s - 45.1, 29.1, 39.2, 45.8, 39.2, 38.9, 35.0, 44.0, 47.5, 37.7

R_a - 94.7, 84.9, 92.3, 95.9, 96.0, 91.5, 85.8, 89.9, 93.9, 91.4

Is there a relationship between T_b and the other variables? Which variable is the most important in determining body temperatures of lizards? (65)

66. The age, systolic blood pressure, and diastolic blood pressure for a random sample of people were determined. Is age correlated with systolic pressure? Is age correlated with diastolic pressure? If both systolic and diastolic pressure are correlated with age, which is the stronger correlation? (66)

individual:	1	2	3	4	5	6	7	8	9	10	11	12
age:	22	20	7	10	30	21	35	38	10	22	15	46
systolic:	114	118	94	94	118	140	118	120	100	125	108	130
diastolic:	74	68	54	48	64	70	78	80	40	90	58	90

67. Use the data in HOGNOSE.SYD to test the hypothesis that there is no relationship between the sex of active (act\$=act) snakes and their use of grass and leaf litter groundcover types. (67)
68. An old article in the *Chicago Daily News* summarized the results of a three-year Canadian study that concluded that regular use of ibuprofen relieved symptoms of joint pain due to inflammation. A sample of 630 patients were included in an experiment in which they were randomly assigned to one of three treatments with equal numbers in each treatment. The treatments were: ibuprofen, synthetic ibuprofen, and a placebo control. Those who reported relief included 57% of the ibuprofen group, 50% of the synthetic ibuprofen group, and 37% of the placebo group. Do your results support the conclusions of the article? (68)
69. A researcher wanted to know whether the drug Retilan, therapy, or both can change a group of hyperactive boys' out-of-seat behavior. The researcher randomly assigns the boys to six different groups with three levels of Retalin dosage and two types of therapy. The data are shown with the variables being number of out-of-seat behaviors, type of therapy (B=behavioral, C=cognitive), and Retilan dosage (low, medium, high). Prepare an interaction plot and explain how it relates to the ANOVA output. (69)

54 B low	53 B high	54 C medium
56 B low	55 B high	57 C medium
53 B low	56 B high	58 C medium
57 B low	52 B high	56 C medium
55 B low	54 B high	53 C medium
51 B medium	52 C low	58 C high
56 B medium	50 C low	57 C high
53 B medium	53 C low	55 C high
55 B medium	51 C low	61 C high
55 B medium	54 C low	59 C high

70. Twenty-four freshwater clams were randomly assigned to four groups of six each. One group was placed in deionized water, one group was placed in a solution of 0.5 mM sodium sulfate, and one group was placed in a solution of 0.74 mM sodium chloride. At the end of a specified time period, blood potassium levels ($\mu\text{M K}^+$) were determined. Did treatment affect blood potassium levels? (70)

pond water: 0.518, 0.523, 0.495, 0.502, 0.525, 0.490
 deionized water: 0.318, 0.342, 0.301, 0.390, 0.327, 0.320
 sodium sulfate: 0.393, 0.415, 0.351, 0.390, 0.385, 0.397
 sodium chloride: 0.383, 0.405, 0.398, 0.352, 0.381, 0.407

71. In a three-year mark-recapture study of softshell turtles in the Kansas River, Plummer (1977) captured 1029 turtles 1535 times. Was the chance of being recaptured randomly determined?

No. times turtle was recaptured	Observed
0	1045
1	307

2	11
3	50
4	9
5	4
6	3
7	2
8	0
9	2