Biometry, H24, Test 1

Name: _____ Student number_____

1. (2.5 marks) The Nubian wild ass (Equus africanus africanus) is the nominate subspecies of African wild ass, and one of the ancestors of the domestic donkey, which was domesticated about 6,000 years ago. It is pesumed to be extinct, although a population might be surviving in The Gebel Elba National Park, near the border of Egypt and Sudan.

   According to historical records Nubian wild asses had longer ears than the Somali wild asses or than domestic donkeys. A study of a sample of 8 asses from Gebel Elba produced the following measurements for the lengths of their ears (in mm):

   193 211 217 188 244 236 217 222

   Compute the mean, the standard deviation and the coefficient of variation of length of ears of this sample of Gebel Elba asses.

$$\bar{x} = \frac{1}{8}\left(193 + 211 + 217 + 188 + 244 + 236 + 217 + 222\right) = 216 \text{ mm}$$

$$s^2 = \frac{1}{7}\left[(193 - 216)^2 + (211 - 216)^2 + \ldots + (222 - 216)^2\right] = 365.71$$

$$s = \sqrt{s^2} = 19.12 \text{ mm}$$

$$CV = \frac{s}{\bar{x}} = \frac{19.12}{216} = 0.0885 = 8.85\%$$

2. (2.5 marks) The gorgeous Fennec (Vulpes zerda) foxes of the Sahara also have relatively large ears. Observations from 24 adult Fennec foxes show the following ear lengths (in mm)

9.4 9.6 9.5 9.4 8.9 9.3 9.7 9.5

9.5 9.1 9.9 8.8 8.9 9.2 10.0 9.3

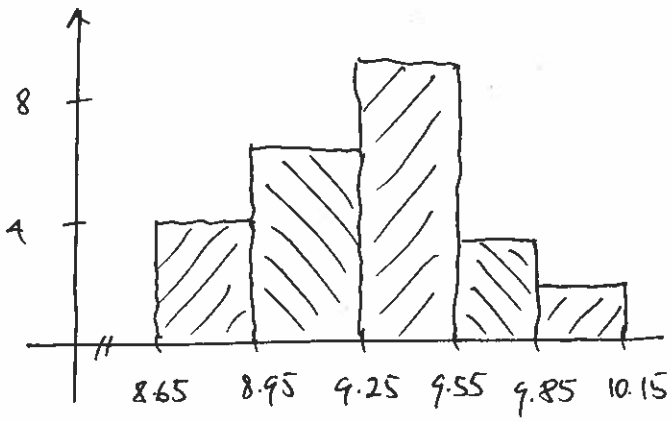
9.4 9.2 9.4 9.0 9.0 8.7 9.6 9.1

Organize the data into a frequency table with five classes. Draw a histogram based on this frequency table.

Range: 8.7 - 10.0

Class width: $\frac{10.0 - 8.7}{5} = 0.26 \rightarrow$ Round to 0.3

Class	Freq.
8.7 - 8.9	4
9.0 - 9.2	6
9.3 - 9.5	9
9.6 - 9.8	3
9.9 - 10.1	2



3. (2.5 marks) The Gabal Elba National Park, declared by Egyptian Prime Minister Ahmed Nazif in 1986, covers some 3,560,000 ha. Afrotropical elements have their northern limits at Gabal Elba, and the dense cover of acacias and other scrubs represents the only natural woodland in Egypt. There is at least one endemic species of plant (Biscutella elbensis), a perennial flowering mustard plant.

   In the last five years the population of Biscutella elbensis in a area of the park has experienced growth of 28%, 40%, 16%, -20% and 40% respectively. If initially there were 50 Biscutella elbensis plants in this area of the park, how many Biscutella elbensis plants were there after one year, after two years, after three years, after four years and after five years (round to integers)? What is the average yearly growth rate over the five years?

$50 \longrightarrow 50 \times 1.28 = 64$

$64 \longrightarrow 64 \times 1.40 = 89.6 \longrightarrow 90$

$90 \longrightarrow 90 \times 1.16 = 104.4 \rightarrow 104$

$104 \longrightarrow 104 \times 0.80 = 83.2 \rightarrow 83$

$83 \rightarrow 83 \times 1.40 = 116.2 \rightarrow 116$

Average growth rate $= \sqrt[5]{(1.28)(1.4)(1.16)(0.8)(1.4)} = 1.184$

$\rightarrow 18.4\%$

4. (2 marks) The olive baboon (Papio anubis), is the most wide-ranging of all baboons being native to 25 countries throughout Africa. Isolated populations are even present in some mountainous regions of the Sahara. The olive baboon lives in groups of 15 to 135, made up of a few males, many females, and their young. A study found the following for the sizes of baboon family groups in the Sahara:

Group size	Frequency
[15, 35)	12
[35, 55)	20
[55, 75)	30
[75, 95)	14
[95, 115)	8
[115, 135)	4

Compute the average family group size for the olive baboons in the Sahara.

$$\bar{x} = \frac{25 \cdot 12 + 45 \cdot 20 + 65 \cdot 30 + 85 \cdot 14 + 105 \cdot 8 + 125 \cdot 4}{12 + 20 + 30 + 14 + 8 + 4}$$

$$\bar{x} = 64.55$$

5. (3.5 marks) The desert hedgehog (Paraechinus aethiopicus) is one of the smallest of hedgehogs. The female desert hedgehog gives birth to up to six young, in a burrow or concealed nest. The quills of the newborn hedgehogs are located just under the skin, to prevent damage to the female during birth. The quills then emerge within a few hours.

   The emergence of the quills for newborn desert hedgehogs from Mauritania, Libya and Egypt was recorded and classified as fast (under 3 hours) and slow (over 3 hours). The data is as follows

Emergenece of quills	Fast	Slow	
Mauritania	41	79	120
Libya	32	66	98
Egypt	34	70	104
	107	215	322

   Consider selecting a random newborn desert hedgehog from one of these three areas. Consider the following events: M = {Mauritania}, Libya = {L}, E = {Egypt}, F = {Fast quill emergence}, S = {Slow quill emergence}. Compute the following probabilities.

   a) $p(S)$, b) $p(M \cup L)$, c) $p(M \cap F)$, d) $p(F \cup E')$, e) $p(S|L)$, f) $p(F|E)$.

   By comparing unconditional with conditional probabilities decide if the speed of emergence of the newborn hedgehog quills depends on the location.

$p(S) = \frac{215}{322} = 0.6677$

$p(M \cup L) = \frac{120+98}{322} = 0.677$

$p(M \cap F) = \frac{41}{322} = 0.1273$

$p(F \cup E') = \frac{41+32+34+79+66}{322} = 0.7826$

$p(S|L) = \frac{66}{98} = 0.6735$

$p(E|F) = \frac{34}{107} = 0.3178$

$p(S) = 0.6677 \neq p(S|L) = 0.6735$

There seems to be a dependency, but it looks very weak.

6. (2.5 marks) Cerastes vipera, common names Sahara sand viper and Avicenna viper, is a viper species endemic to the deserts of North Africa and the Sinai Peninsula. An ancient Egyptian queen has committed suicide by being bitten by such a viper or by using a poisonous hairpin. It is not known for certain which of the two options she used, but based on mentions in ancient stories there is a 0.8 probability she was bitten by a viper and 0.2 probability she used a poisoned hairpin. It is know that a Sahara sand viper is deadly 60% of the time if untreated and that toxins found on poisoned ancient Egyptian haipins are deadly 85% of the time.

   An ancient Egyptian queen used one of these two methods to commit suicide and died. What is the probability she used a poisoned hairpin?

$P(V) = 0.8 \qquad P(H) = 0.2$

$P(D|V) = 0.6 \qquad P(D|H) = 0.85$

$$P(H|D) = \frac{P(H \cap D)}{P(D)} = \frac{P(D|H)P(H)}{P(D|H)P(H) + P(D|V)P(V)}$$

$$P(H|D) = \frac{(0.85)(0.2)}{(0.85)(0.2) + (0.6)(0.8)} = 0.2615$$

7. (2. marks) The desert sparrow (Passer simplex) is a species of bird in the sparrow family Passeridae, found in the Sahara Desert of northern Africa. The desert sparrow is not afraid to come near humans and sometimes builds nests in muddy walls. The Mozabite Berbers build their homes with holes in the walls to welcome these birds, which they call "bar-rode", and if one sings all day in the house, they say this is a sign of good news.

   The probability that the male desert sparrow which lives in the home Lachqar in the Melika oasis will sing in the home on any given day is 0.16. Lachqar is desperate for good news, so he wants to what are the probabilities the sparrow will sing in his home 0, 1, 2, 3, 4 or 5 days out of the next 5 days. Compute these probabilities for him.

Binomial: $p = 0.16 \quad n = 5$

X	0	1	2	3	4	5
$P(x)$	0.4182	0.3983	0.1517	0.0289	0.0028	0.0001

8. (3 marks) Miomantis abyssinica is a species of praying mantis in the family Miomantidae, native to North Africa. It lives in hot and dry conditions, including the Sahara desert. A survey in Mali found the following counts of Miomantis abyssinica in quadrats of 100 m^2 in area:

≤3 Merge

count	0	1	2	3	4
frequency	18	22	13	5	2
P(X)	0.306	0.362	0.214	0.1169	
Predicted Freq.	18.38	21.74	12.87	7.02	

a) Compute the sample mean, the sample variance and the coefficient of dispersion. Does the Poisson distribution look like a good fit for this data?

b) Implement a χ^2-test for the goodness of fit of a Poisson model. Does the model fit?

$$\bar{x} = \frac{18(0) + 22(1) + 13(2) + 5(3) + 2(4)}{18 + 22 + 13 + 5 + 2} = 1.1833$$

$$s^2 = \frac{1}{59}\{(0-1.1833)^2 \times 18 + (1-1.1833)^2 \times 22 + \dots + (4-1.1833)^2 \times 2\}$$

$s^2 = 1.13531$ $\quad CD = \frac{s^2}{\bar{x}} = \frac{1.13531}{1.1833} = 0.9594$ Poisson model could be a fit.

Poisson $\mu \approx \bar{x} = 0.9594$

$$\chi^2 = \frac{(18-18.38)^2}{18.38} + \frac{(22-21.74)^2}{21.74} + \frac{(13-12.87)^2}{12.87} + \frac{(7-7.02)^2}{7.02}$$

$\chi^2 = 0.0121$ with $4-1-1 = 2$ d.f

p-value > 0.99

The data does not at all contradict a Poisson model.