Mohamed Khider University of Biskra **Second year license 2025/2026**
Faculty of Natural and Life Sciences and Earth Sciences
Module: Biostatistics

Exam

Exercise 1 (*..pts*) Concentration of hemoglobin (g/dL) measured in 50 blood samples:

Rate of hemoglobin x_i	Frequency n_i	f_i	F_i	$n_i x_i$	$n_i x_i^2$
10	4	.	.	.	.
11	8	.	.	.	.
12	15	.	.	.	.
13	10	.	.	.	.
14	7	.	.	.	.
15	4	.	.	.	.
16	2	.	.	.	.
Total	50	.		.	.

1. Determine the variable studied and its nature.
2. Complete the table.
3. Represent this distribution using the appropriate diagram.
4. Give the cumulative function of frequencies and draw its graph.
5. Determine the following measures: mean, mode, median, variance, standard deviation, Range.

Exercise 2 A sample of 35 children from a given city provided the following heights (in cm):

X	70	85	90	100	105	105	110	120	140	166	75	85	95	100	105	95	100
105	110	120	140	165	75	85	95	100	100	75	85	95	100	100	70	85	105

Note that the true value of σ^2 *is unknown and its corrected estimator is* $\hat{\sigma}_c^2 = 524$.

1. Determine point estimates of the mean and the standard deviation of the children's heights.
2. Based on the sample, can we conclude, at the 5% significance level, that the average height of the children is equal to 100 cm:
   - Formulate the null hypothesis H_0 and the alternative one H_1.
   - Give the statistic of test and her distribution.
   - Calculate the test realization.
   - Find the critical value.
   - What is the decision?

Exercise 3 (*pts*) An agronomist studies the effect of four types of biological fertilizers (Bio1, Bio2, Bio3, Bio4) on the growth of wheat (height in cm). The results for various experimental plots are as follows:

Bio1	Bio2	Bio3	Bio4
42; 45; 48	50; 52; 49; 51	44; 46; 43; 47	38; 40; 41; 39; 42

a) Suppose we want to know if the average yield of Bio1 and the average yield of Bio2 are equal. Then, in this case:

   (a) Which test is appropriate: conformity test, homogeneity test, or ANOVA?

   (b) Formulate the null hypothesis H_0 and the alternative one H_1.

   (c) Give the conditions necessary to perform this test.

   (d) If this conditions is verified, Give the statistic of test.

b) Let us now suppose that we wanted to know whether the four biological fertilizers have the same global effect on wheat growth or not.

   (a) Which test is appropriate: conformity test, homogeneity test, or ANOVA?

   (b) Specify the form of the test to be performed in this case.

   (c) Give the conditions necessary to perform this test.

Exercise 4 (*pts*)
Determine the 6 unknown values (t, y, f) using the appropriate distribution tables:

1. **Student's Distribution:**
   - Let $T \sim t_{14}$. Find t if $P(T \leq t) = 0.975$.
   - Let $T \sim t_{25}$. Find t if $P(T \leq t) = 0.05$.
2. **Chi-Squared Distribution:**
   - Let $Y \sim \chi^2_9$. Find y if $P(Y \leq y) = 0.95$.
   - Let $Y \sim \chi^2_{18}$. Find y if $P(Y > y) = 0.99$.
3. **Fisher Distribution:**
   - Let $F \sim F_{4,12}$. Find f if $P(F \leq f) = 0.95$.
   - Let $F \sim F_{10,5}$. Find f if $P(F \leq f) = 0.99$.

Detailed Solutions: Biostatistics Exam (2025/2026)

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Exercise 01: (08 pts)

1.
   - **Variable:** Concentration of hemoglobin in the blood.
   - **Nature:** Quantitative variable.
2. The Table

x_i	n_i	f_i	F_i	$n_i x_i$	$n_i x_i^2$
10	4	0.08	0.08	40	400
11	8	0.16	0.24	88	968
12	15	0.30	0.54	180	2160
13	10	0.20	0.74	130	1690
14	7	0.14	0.88	98	1372
15	4	0.08	0.96	60	900
16	2	0.04	1.00	32	512
Total	**50**	**1.00**	-	**628**	**8002**

3. Frequency graph.
4. Cumulative frequency graph.
5. The statistical measures
   - **Mean ($\bar{x}$):**
   $$\bar{x} = \frac{\sum n_i x_i}{N} = \frac{628}{50} = 12.56 \text{ g/dL}$$
   - **Mode (M_o):** The value with the highest frequency ($n_i = 15$).
   $$M_o = 12 \text{ g/dL}$$
   - **Median (M_e):** The value where cumulative frequency $F_i \geq 0.5$. $F_i(12) = 0.54$.
   $$M_e = 12 \text{ g/dL}$$
   - **Variance (V):**
   $$V = \left(\frac{\sum n_i x_i^2}{N}\right) - \bar{x}^2 = \frac{8002}{50} - (12.56)^2 = 160.04 - 157.75 = 2.29$$

- **Standard Deviation (σ):**

$$\sigma = \sqrt{V} = \sqrt{2.29} \approx 1.51$$

- **Range:** $x_{max} - x_{min} = 16 - 10 = 6$.

Exercise 02: (05 pts)

1. **Point estimate of the mean height**

$$\bar{x} = \frac{\sum X_i}{n} = 3482/35 \approx 101.6 \text{ cm}$$

2. **Conformity Test**
   Hypotheses: $H_0 : \mu = 100$ vs $H_1 : \mu \neq 100$.

   Test Statistic:
$$U = \frac{\bar{x} - \mu_0}{\sqrt{\hat{\sigma}_c^2/n}} = \frac{101.6 - 100}{\sqrt{524/35}} \approx 0.41$$

   Decision: Critical value (from the normal distribution table) $P(U < u_\alpha) = 1 - \frac{\alpha}{2} = 1 - \frac{0.05}{2} = 0.975$, thus $u_\alpha = 1.96$. Since $0.41 \in]-1.96, 1.96[$, we **fail to reject** H_0. *Conclusion:* We can conclude that the average height is equal to 100 cm at the 5% level.

Exercise 03: (04 pts)

a) Comparison of Bio1 and Bio2

1. **Appropriate test:** Homogeneity test of means.
2. **Hypotheses:** $H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$.
3. **Conditions:**
   (a) Normality
   (b) Independence of samples
   (c) Homogeneity of variances
4. **Statistic:** $t = \frac{\bar{x}_1 - \bar{x}_2}{s_p\sqrt{1/n_1 + 1/n_2}}$.

b) Comparison of four fertilizers

1. **Appropriate test:** ANOVA1 (Analysis of Variance one way).
2. **Form:** $H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$ vs $H_1 : \mu_i \neq \mu_j$.
2. **Conditions:**
   (a) Normality
   (b) Independence of samples
   (c) Homogeneity of variances

Exercise 04: (03 pts)

- **Student** $(n = 14)$**:** $P(T \leq t) = 0.975 \implies t = 2.145$
- **Student** $(n = 25)$**:** $P(T \leq t) = 0.05 \implies t = -1.708$
- **Chi-squared** $(n = 9)$**:** $P(Y \leq y) = 0.95 \implies y = 16.92$
- **Chi-squared** $(n = 18)$**:** $P(Y > y) = 0.99 \implies P(Y \leq y) = 0.01 \implies y = 7.01$
- **Fisher** $(n = 4, m = 12)$**:** $P(F \leq f) = 0.95 \implies f = 3.26$
- **Fisher** $(n = 10, m = 5)$**:** $P(F \leq f) = 0.99 \implies f = 10.05$