

**EXAM IN HMET4100, 22 JANUARY 2020:
SUGGESTED SOLUTIONS AND COMMENTS**

VERSION INTENDED FOR CANDIDATES

Knut R. Wangen

k.r.wangen@medisin.uio.no

February 11, 2020

INTRODUCTION

The exam was arranged digitally on the Inspera platform and consisted of 9 questions. Four of the questions were multiple choice questions where the candidates should choose one out of a set of alternative answers. The remaining questions were in “essay” format and the answers had to be written as text.

The maximum score for each question was 10 points and the minimum was 0 points. In total, the maximum score was 90 points.

The following relation between grades (A-F) and points [0-90] was used: A: [81-90], B: [71-80], C: [55-70], D: [41-54], E: [30-40], F: [0-29].

After the grades are published, the candidates will receive an e-mail with their individual scores, and the present suggested solution that explains the general principles for how scores and grades were awarded. A candidate’s detailed scores on the exam questions and the general suggested solution are together considered as the formal explanation of the grade, and no further formal explanations will be given.

Appeal against grades. Appeals against grades must be submitted following the procedure described on the course web-page (that is, not submitted to the course coordinator).

Informal feedback. Candidates who wish to receive additional feedback may ask the course coordinator for an informal talk (phone call or personal meeting). The candidates must then email the course coordinator 2-3 suggested times. These suggested times should be within normal office hours (0900h-1700h), with at least two workdays notice, and within the period 17–29 February 2020.

SUGGESTED SOLUTIONS

QUESTION 1

Correct answer: $P(Z < -0.57) \approx \underline{\underline{0.284}}$

QUESTION 2

$$(\hat{p}_x - \hat{p}_y) \pm Z_{\alpha/2} \sqrt{\frac{\hat{p}_x(1 - \hat{p}_x)}{n_x} + \frac{\hat{p}_y(1 - \hat{p}_y)}{n_y}}$$

$$(0.33 - 0.37) \pm 1.96 \sqrt{\frac{0.33(1 - 0.33)}{410} + \frac{0.37(1 - 0.37)}{370}}$$

Correct answer: $(-0.107, 0.027)$

QUESTION 3

The observed test statistic is $(n - 1)s^2/\sigma_0^2 = (26 - 1)125.2/90 = 34.778$.

Correct answer: The critical value is $\chi_{25,0.05}^2 = 37.652$, and they should NOT REJECT the null hypothesis

QUESTION 4

We have $S = 10$ people with a positive difference. From the binomial distribution with $n = 13$ and $p = 0.5$, a one-sided p-value would be $P(X \geq 10) = 0.046$. The two-sided p-value is $2 \cdot 0.046 = \underline{\underline{0.092}}$.

QUESTION 5

$$P(9 \leq X \leq 16) = P(X \leq 16) - P(X \leq 8) = 0.8987 - 0.1550 = 0.7437$$

QUESTION 6

$$P(X > 35) = P\left(\frac{X - 65 \cdot 0.45}{\sqrt{65 \cdot 0.45(1 - 0.45)}} > \frac{35 - 65 \cdot 0.45}{\sqrt{65 \cdot 0.45(1 - 0.45)}}\right)$$

$$= P(Z > 1.43) = 1 - P(Z < 1.43) = 0.0764$$

QUESTION 7

The null hypothesis is that the differences are centered at zero. It is appropriate to use a two-sided alternative hypothesis because the researchers want to "assess whether the drug has any effect", that is, the new drug can tend to increase or decrease the level of the biomarker. The two-sided alternative hypothesis is that the differences are not centered at zero. If the new drug has a positive (negative) effect on the biomarker, we would expect that the differences (After-Before) would be centered at some positive (negative) value.

The observed test statistic is $T_{obs} = \min(T+, T-) = \min(74, 17) = 17$. Table 10 presents critical values for one sided hypothesis. We choose the value for $n = 13$ and $\alpha = 0.025$, because we have a two-sided test and a 5% significance level. Thus, the critical value is 18, and we should reject the

null hypothesis because $T_{obs} = 17 \leq 18$. This results suggests that the new drug has an effect on the level of the biomarker.

QUESTION 8

The null hypothesis is that the population means are equal ($\mu_1 = \mu_2 = \mu_3$) while the alternative hypothesis is that at least one mean is not equal the others.

The observed test statistic is

$$F_{obs} = \frac{MSG}{MSW} = \frac{9.37516511}{1.68628086} = 5.560.$$

The critical value, $F_{2,44,\alpha}$, is not tabulated so we have to use $F_{2,40,\alpha}$ and $F_{2,60,\alpha}$ as approximations. At the 5% significance level, $F_{2,40,0.05} = 3.232$ and $F_{2,60,0.05} = 3.150$, while at the 1% significance level, $F_{2,40,0.01} = 5.179$ and $F_{2,60,0.01} = 4.977$. We should clearly reject the null hypothesis both at the 5% and the 1% significance level.

QUESTION 9

a) Assuming that the population is normally distributed with an unknown variance, the confidence interval becomes:

$$\begin{aligned} \bar{x} \pm t_{12,0.025} \cdot \frac{s}{\sqrt{n}} \\ 9.808756 \pm 2.179 \cdot \frac{1.493731}{\sqrt{13}} \\ \underline{(8.91, 10.71)}. \end{aligned}$$

b) The conclusion from the ANOVA test in Question 8 was that the null hypothesis should be rejected at the 1% significance level, that is, we concluded that the group means are significantly different. The ANOVA test used all available information simultaneously and is in that sense a better test than comparing the confidence intervals for individual means.

The ANOVA test conclusion (not all three means are equal) cannot be used to infer that the confidence intervals for individual means do not overlap.