Tentamentsskrivning i Statistisk slutledning MVE155/MSG200, 7.5 hp.

Tid: tisdagen den 15 mars, 2016 kl 14.00-18.00
Examinator och jour: Serik Sagitov, tel. 772-5351, mob. 0736 907 613, rum H3026 i MV-huset.
Hjälpmedel: Chalmersgodkänd räknare, **egen** formelsamling (fyra A4 sidor)
CTH: för "3" fordras 12 poäng, för "4" - 18 poäng, för "5" - 24 poäng.
GU: för "G" fordras 12 poäng, för "VG" - 20 poäng.
Inclusive eventuella bonuspoäng.

Partial answers and solutions are also welcome. Good luck!

1. (5 points) For each of nine horses, a veterinary anatomist measured the density of nerve cells at specified sites in the intestine:

Animal	Site I	Site II
1	50.6	38.0
2	39.2	18.6
3	35.2	23.2
4	17.0	19.0
5	11.2	6.6
6	14.2	16.4
7	24.2	14.4
8	37.4	37.6
9	35.2	24.4

The null hypothesis of interest is that in the population of all horses there is no difference between the two sites.

(a) Which of the two non-parametric tests is appropriate here: the rank-sum test or the signed-rank test? Explain your choice.

(b) On the basis of the data, would you reject the null-hypothesis? Use one of the tests named in the item (a).

(c) Explain the following extract from the course text book:

> More precisely, with the signed rank test, H_0 states that the distribution of the differences is symmetric about zero. This will be true if the members of pairs of experimental units are assigned randomly to treatment and control conditions, and the treatment has no effect at all.

2. (5 points) Suppose that grades of 10 students on a midterm and a final exams have a correlation coefficient of 0.5 and both exams have an average score of 75 and a standard deviation of 10.

(a) Sketch a scatterplot illustrating performance on two exams for this group of 10 students.

(b) If Carl's score on the midterm is 90, what would you predict his score on the final to be? How uncertain is this prediction?

(c) If Maria scored 80 on the final, what would you guess that her score on the midterm was?

(d) Exactly what assumptions do you make to make your calculations in (b) and (c)?

3. (5 points) The gamma distribution Gamma(α, λ) is a conjugate prior for the Poisson data distribution with a parameter θ. If x is a single observed value randomly sampled from the Poisson

distribution, then the parameters (α', λ') for the posterior gamma distribution of θ are found by the following updating rule:
- the shape parameter $\alpha' = \alpha + x$,
- the scale parameter $\lambda' = \lambda + 1$.

(a) Find $\hat{\theta}_{\text{PME}}$, the posteriori mean estimate for the θ, under the exponential prior with parameter 1, given the following iid sample values from the Poisson(θ) population distribution

$$x_1 = 2, \quad x_2 = 0, \quad x_3 = 2, \quad x_4 = 5.$$

(b) What is the updating rule for an arbitrary sample size n? Compare the value of $\hat{\theta}_{\text{PME}}$ with the maximum likelihood estimator $\hat{\theta}_{\text{MLE}}$ as $n \to \infty$. Your conclusions?

4. (5 points) Extracorporeal membrane oxygenation (ECMO) is a potentially life-saving procedure that is used to treat newborn babies who suffer from severe respiratory failure. An experiment was conducted in which 29 babies were treated with ECMO and 10 babies were treated with conventional medical therapy (CMT). In the ECMO group only 1 patient died, while in the CMT group 4 patients died.

(a) Suggest a statistical model and compute the likelihood function for the data as a function of two parameters: p - the probability to die under the ECMO treatment and q - the probability to die under the CMT treatment.

(b) Write down a relevant pair of statistical hypotheses in the parametric form. Perform the exact Fisher test.

5. (5 points) Suppose that we have an iid sample of size 100 from the normal distribution with mean μ and standard deviation $\sigma = 10$. For $H_0 : \mu = 0$ and $H_1 : \mu \neq 0$ we use the absolute value of the sample mean $T = |\bar{X}|$ as the test statistic. Denote by V the P-value of the test.

(a) Show that $V = 2(1 - \Phi(T_{\text{obs}}))$, where T_{obs} is the observed value of the test statistic and $\Phi(x)$ is the standard normal distribution function. Plot the null distribution curve for $\bar{X}$ and graphically illustrate this formula.

(b) In what sense the P-value V is a random variable? Using (a) show that

$$P(V \leq 0.05) = P(\bar{X} < -1.96) + P(\bar{X} > 1.96).$$

(c) Suppose that the true value of the population mean is $\mu = 4$. Using (b) show that $P(V \leq 0.05) \approx 0.975$. Illustrate by drawing the density curve for the true distribution of $\bar{X}$.

(d) Comment on the result (c) in the light of the statement: "P values, the 'gold standard' of statistical validity, are not as reliable as many scientists assume".

6. (5 points) A population with mean μ consists of three subpopulations with means μ_1, μ_2, μ_3 and the same variance σ^2. Three independent iid samples, each of size $n = 13$, from the three subpopulation distributions gave the following sample means and standard deviations:

	Sample 1	Sample 2	Sample 3
Mean	6.3	5.6	6.0
SD	2.14	2.47	3.27

(a) Compute a stratified sample mean, assuming that the three subpopulation sizes have the ratios $N_1 : N_2 : N_3 = 0.3 : 0.2 : 0.5$. Prove that this is an unbiased estimate for the population mean μ.

(b) Assume that all three subpopulation distributions are normal. Write down simultaneous confidence intervals for the three differences $\mu_1 - \mu_2$, $\mu_1 - \mu_3$, and $\mu_2 - \mu_3$.

(c) Would you reject the null hypothesis of equality $\mu_1 = \mu_2 = \mu_3$ in this case?

Statistical tables

a. $\alpha = .025$ one-tailed; $\alpha = .05$ two-tailed

n_2 \ n_1	3		4		5		6		7		8		9		10	
	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U
3	5	16	6	18	6	21	7	23	7	26	8	28	8	31	9	33
4	6	18	11	25	12	28	12	32	13	35	14	38	15	41	16	44
5	6	21	12	28	18	37	19	41	20	45	21	49	22	53	24	56
6	7	23	12	32	19	41	26	52	28	56	29	61	31	65	32	70
7	7	26	13	35	20	45	28	56	37	68	39	73	41	78	43	83
8	8	28	14	38	21	49	29	61	39	73	49	87	51	93	54	98
9	8	31	15	41	22	53	31	65	41	78	51	93	63	108	66	114
10	9	33	16	44	24	56	32	70	43	83	54	98	66	114	79	131

b. $\alpha = .05$ one-tailed; $\alpha = .10$ two-tailed

n_2 \ n_1	3		4		5		6		7		8		9		10	
	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U	T_L	T_U
3	6	15	7	17	7	20	8	22	9	24	9	27	10	29	11	31
4	7	17	12	24	13	27	14	30	15	33	16	36	17	39	18	42
5	7	20	13	27	19	36	20	40	22	43	24	46	25	50	26	54
6	8	22	14	30	20	40	28	50	30	54	32	58	33	63	35	67
7	9	24	15	33	22	43	30	54	39	66	41	71	43	76	46	80
8	9	27	16	36	24	46	32	58	41	71	52	84	54	90	57	95
9	10	29	17	39	25	50	33	63	43	76	54	90	66	105	69	111
10	11	31	18	42	26	54	35	67	46	80	57	95	69	111	83	127

Figure 1: Critical values for the rank-sum test.

One-Sided	Two-Sided	$n = 5$	$n = 6$	$n = 7$	$n = 8$	$n = 9$
$p = .1$	$p = .2$	2	3	5	8	10
$p = .05$	$p = .1$	0	2	3	5	8
$p = .025$	$p = .05$		0	2	3	5
$p = .01$	$p = .02$			0	1	3
$p = .005$	$p = .01$				0	1
$p = .0025$	$p = .005$					0
$p = .001$	$p = .002$					
One-Sided	**Two-Sided**	$n = 15$	$n = 16$	$n = 17$	$n = 18$	$n = 19$
$p = .1$	$p = .2$	36	42	48	55	62
$p = .05$	$p = .1$	30	35	41	47	53
$p = .025$	$p = .05$	25	29	34	40	46
$p = .01$	$p = .02$	19	23	27	32	37
$p = .005$	$p = .01$	15	19	23	27	32
$p = .0025$	$p = .005$	12	15	19	23	27
$p = .001$	$p = .002$	8	11	14	18	21
One-Sided	**Two-Sided**	$n = 25$	$n = 26$	$n = 27$	$n = 28$	$n = 29$
$p = .1$	$p = .2$	113	124	134	145	157
$p = .05$	$p = .1$	100	110	119	130	140
$p = .025$	$p = .05$	89	98	107	116	126
$p = .01$	$p = .02$	76	84	92	101	110
$p = .005$	$p = .01$	68	75	83	91	100
$p = .0025$	$p = .005$	60	67	74	82	90
$p = .001$	$p = .002$	51	58	64	71	79
One-Sided	**Two-Sided**	$n = 35$	$n = 36$	$n = 37$	$n = 38$	$n = 39$
$p = .1$	$p = .2$	235	250	265	281	297
$p = .05$	$p = .1$	213	227	241	256	271
$p = .025$	$p = .05$	195	208	221	235	249
$p = .01$	$p = .02$	173	185	198	211	224
$p = .005$	$p = .01$	159	171	182	194	207
$p = .0025$	$p = .005$	146	157	168	180	192
$p = .001$	$p = .002$	131	141	151	162	173

Figure 2: Critical values for the signed-rank test.

Standard normal curve areas

z	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Figure 3: Standard normal distribution

df/α =	**.40**	**.25**	**.10**	**.05**	**.025**	**.01**	**.005**	**.001**	**.0005**
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657	318.309	636.619
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.260	0.697	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.259	0.695	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.259	0.694	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.258	0.692	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.258	0.691	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.258	0.690	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.257	0.689	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.257	0.688	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.257	0.688	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.257	0.687	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.257	0.686	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.256	0.686	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.256	0.685	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.256	0.685	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.256	0.684	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.256	0.684	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.256	0.684	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.256	0.683	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.256	0.683	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.256	0.683	1.310	1.697	2.042	2.457	2.750	3.385	3.646
35	0.255	0.682	1.306	1.690	2.030	2.438	2.724	3.340	3.591
40	0.255	0.681	1.303	1.684	2.021	2.423	2.704	3.307	3.551
50	0.255	0.679	1.299	1.676	2.009	2.403	2.678	3.261	3.496
60	0.254	0.679	1.296	1.671	2.000	2.390	2.660	3.232	3.460
120	0.254	0.677	1.289	1.658	1.980	2.358	2.617	3.160	3.373
inf.	0.253	0.674	1.282	1.645	1.960	2.326	2.576	3.090	3.291

Figure 4: Critical values for the t-distribution

NUMERICAL ANSWERS

1a. This is an example of a paired sample, therefore the signed-rank test is appropriate for testing the null hypothesis of no difference.

1b. We use the signed-rank test. The observed test statistics are $W_+ = 39$ and $W_- = 6$.

Animal	Site I	Site II	Difference	Signed rank
1	50.6	38.0	12.6	8
2	39.2	18.6	20.6	9
3	35.2	23.2	12.0	7
4	17.0	19.0	-2.0	-2
5	11.2	6.6	4.6	4
6	14.2	16.4	-2.2	-3
7	24.2	14.4	9.8	5
8	37.4	37.6	-0.2	-1
9	35.2	24.4	10.8	6

According to Figure 2, the two-sided P-value is larger than 5% because the smaller test statistic $W_- = 6$ is larger than the critical value 5 for $n = 9$. Therefore, we do not reject the null hypothesis of equality in favour of the two-sided alternative.

1c. The extract from the course text book reminds that the null hypothesis for the signed rank test, beside equality of two population distributions, assumes a symmetric distribution for the differences. It also explains why such an assumption is reasonable.

2b. The fitted regression line for the final score y as a function of the midterm score x is $y = 37.5 + 0.5x$. Given $x = 90$ we get a point prediction $y = 82.5$. The estimate of σ^2 is

$$s^2 = \frac{n-1}{n-2} s_y^2 (1 - r^2) = 84.4.$$

Thus the 95% prediction interval for Carl's final score is

$$82.5 \pm t_8(0.025) s \sqrt{1 + \frac{1}{9} + \frac{1}{8}\left(\frac{15}{10}\right)^2} = 82.5 \pm 24.6.$$

2c. The fitted regression line for the midterm score x as a function of the final score y is $x = 37.5 + 0.5y$. Given $y = 80$ we get a point prediction $x = 77.5$.

3a. The exponential prior with parameter 1 is Gamma$(1, 1)$. Applying the updating rule four times:

$$(1, 1) \to (3, 2) \to (3, 3) \to (5, 4) \to (10, 5),$$

we find the posterior distribution to be Gamma$(10, 5)$. Therefore, $\hat{\theta}_{\text{PME}} = 10/5 = 2$.

3b. The general updating rule for an arbitrary sample $(x_1, \ldots, x_n$ becomes
- the shape parameter $\alpha' = \alpha + n\bar{x}$,
- the scale parameter $\lambda' = \lambda + n$.

We have $\hat{\theta}_{\text{PME}} = \frac{\alpha + n\bar{x}}{\lambda + n}$. Comparing this to the maximum likelihood estimator $\hat{\theta}_{\text{MLE}} = \bar{x}$, we see that

$$\hat{\theta}_{\text{PME}} - \hat{\theta}_{\text{MLE}} = \frac{\alpha + n\bar{x}}{\lambda + n} - \bar{x} = \frac{\alpha - \lambda\bar{x}}{\lambda + n} \to 0,$$

as $n \to \infty$. This means that the role of the prior is less important with large sample sizes.

4a. We have two independent samples from two distributions: one with parameter p, and the other with parameter q. Using $\mathrm{Bin}(29, p)$ and $\mathrm{Bin}(10, q)$ we compute the likelihood function as

$$L(p,q) = \binom{29}{1} p(1-p)^{28} \binom{10}{4} q^4 (1-q)^6.$$

4b. We test $H_0 : p = q$ against $H_1 : p \neq q$ using the exact Fisher test.

	ECMO	CMT	Total
Died	1	4	5
Alive	28	6	34
Total	29	10	39

The count $Y = 1$ is our observed test statistics whose null distribution is $\mathrm{Hg}(39, 29, \frac{5}{39})$. The one-sided P-value is

$$P(Y=0) + P(Y=1) = \frac{\binom{5}{0}\binom{34}{29}}{\binom{39}{29}} + \frac{\binom{5}{1}\binom{34}{28}}{\binom{39}{29}} = \frac{34!29!10!}{5!29!39!} + \frac{5 \cdot 34!29!10!}{6!28!39!}$$
$$= \frac{10 \cdot 9 \cdot 8 \cdot 7 \cdot 6}{39 \cdot 38 \cdot 37 \cdot 36 \cdot 35} + \frac{10 \cdot 9 \cdot 8 \cdot 7 \cdot 5 \cdot 29}{39 \cdot 38 \cdot 37 \cdot 36 \cdot 35} = \frac{10 \cdot 9 \cdot 8 \cdot 7 \cdot (6 + 5 \cdot 29)}{39 \cdot 38 \cdot 37 \cdot 36 \cdot 35} = 0.011.$$

The two-sided P-value becomes 2% and we can reject the null hypothesis.

5a. The null distribution of $|\bar{X}|$ is standard normal. The P-value of the test is the probability under the null distribution that $|\bar{X}| > T_{\mathrm{obs}}$. Thus

$$V = P_{H_0}(|\bar{X}| > T_{\mathrm{obs}}) = 2(1 - \Phi(T_{\mathrm{obs}})).$$

5b. Different samples will give different observed values $T_{\mathrm{obs}} = |\bar{X}_{\mathrm{obs}}|$, in this sense the P-value $V = 2(1 - \Phi(T_{\mathrm{obs}}))$ is a random variable. We have

$$P(V \leq 0.05) = P(1 - \Phi(|\bar{X}_{\mathrm{obs}}|) \leq 0.025) = P(\Phi(|\bar{X}|) \geq 0.975) = P(|\bar{X}| > 1.96).$$

5c. If the true value of the population mean is $\mu = 4$, then $\bar{X}$ has distribution $\mathrm{N}(4, 1)$. Using (b) we find

$$P(V \leq 0.05) \approx P(\bar{X} > 2) = 1 - \Phi(2 - 4) = \Phi(2) \approx 0.975.$$

5d. We see from 5c that even with such a big separation between the null-hypothesis and the true parameter values, there is a probability of 2.5% that the P-value will exceed 5%. One has to be aware of this variability while interpreting the P-value produced by your statistical analysis.

6a. Stratified sample mean $\bar{X}_s = 0.3 \cdot 6.3 + 0.2 \cdot 5.6 + 0.5 \cdot 6.0 = 6.01$.

6b. We are in the one-way Anova setting with $I = 3$ and $J = 13$. The 95% Bonferroni simultaneous confidence intervals for the three differences $\mu_1 - \mu_2$, $\mu_1 - \mu_3$, and $\mu_2 - \mu_3$ are computed as

$$\bar{X}_u - \bar{X}_v \pm t_{36}(0.05/6) s_p \sqrt{2/13},$$

with the pooled sample variance given by

$$s_p^2 = \frac{12 \cdot s_1^2 + 12 \cdot s_2^2 + 12 \cdot s_3^2}{36} = \frac{2.14^2 + 2.47^2 + 3.27^2}{3} = 2.67^2.$$

This yields

$$\bar{X}_u - \bar{X}_v \pm 2.5 \cdot 2.67 \cdot 0.39 = \bar{X}_u - \bar{X}_v \pm 2.62.$$

6c. We would not reject the null hypothesis of equality $\mu_1 = \mu_2 = \mu_3$, since for all three pairwise differences the confidence intervals contain zero:

$$0.7 \pm 2.62, \quad 0.3 \pm 2.62, \quad 0.4 \pm 2.62.$$