(4)

CTL 741 Applied Research Design and Analysis in Education
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Fall 2008
Homework # 7 – cep741.homework.practical.runs.doc

Paragraph summary, problem #1

An engineer monitoring defective units on a manufacturing line recorded a series of failures and successes. A runs test was performed to identify periodic runs that might not be visible in the control charts. A z-score of 2.83 was obtained, which is significant beyond the .01 level of 2.56. This means that there might be some systematic problem on the manufacturing line.

H/W #7 (Sudi Balimuttajjo)

Hand Calculation:

(#1)

Ho: The sequence of failures and successes is random

Ha: The sequence is not random but is systematic

$N = 50$

$m = S = 30$

$n = f = 20$

$r = 35$

Since $m > 20$, we use the z-score, where

$$Z = \frac{r + h - \frac{2mn}{N} - 1}{\sqrt{\frac{2mn(2mn-N)}{N^2(N-1)}}}$$

$h = +.5$ for $r < \frac{2mn}{N} + 1$

$h = -.5$ for $r > \frac{2mn}{N} + 1$

$$\frac{2mn}{N} + 1 = \frac{2 \times 30 \times 20}{50} + 1 = 25$$

$r = 35 > 25 \quad \therefore h = -.5$

So

$$Z = \frac{34.5 - 25}{\sqrt{\frac{2 \times 30 \times 20(2 \times 30 \times 20 - 50)}{50 \times 50 \times 49}}} = \frac{9.5}{3.3564} = 2.8304$$

Since $Z = 2.8304$ is greater than the critical z-score at at the .01 level of 2.58, the test is significant. We reject the null hypothesis and conclude that the sequence is probably not random but systematic.

#1

```
GET
  FILE='\\unrnas\users\sudib\Desktop\Fall 2008\CEP 741\HW\HW#7.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
NPAR TESTS
  /RUNS(2)=qn1values
  /STATISTICS  DESCRIPTIVES QUARTILES
  /MISSING ANALYSIS.
```

NPar Tests

[DataSet1] \\unrnas\users\sudib\Desktop\Fall 2008\CEP 741\HW\HW#7.sav

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
qn1values	50	1.8000	.98974	1.00	3.00

Descriptive Statistics

	Percentiles		
	25th	50th (Median)	75th
qn1values	1.0000	1.0000	3.0000

Runs Test

	qn1values
Test Value[a]	2.0000
Total Cases	50
Number of Runs	35
Z	2.979
Asymp. Sig. (2-tailed)	.003

a. User-specified.

Paragraph summary, problem #2

After observing the pass/fail statistics of applicants for admission, an EEO auditor suspects that non-minority candidates were favored because the sequence of passes and failures does not look random. To ascertain the truth, a runs test is performed on the pass/fail distribution of a one year period. The result is not significant, suggesting that the frequency of passes and failures is probably random.

HW-7 (Sudi Balimuttajjo)

Hand Calculation:

(#2)

H_0: The sequence is random

H_a: The sequence is not random

$N = 24$

$m = p = 16$

$n = f = 8$

Obtain score $r_o = 13$.

- Since m' and n are less than 20, use the critical r - tables.
- The critical values of r are 6 and 17.

Since $r_o = 13$ is not equal nor less than 6 and not equal nor greater than 17 (i.e $r_o \neq 6$ and $r_o \neq 17$). We <u>fail to reject</u> the null hypothesis. So, the frequency of passes and failures is probably random.

#2

```
NPAR TESTS
  /RUNS(2)=qn2values
  /STATISTICS  DESCRIPTIVES QUARTILES
  /MISSING ANALYSIS.
```

NPar Tests

[DataSet1] \\unrnas\users\sudib\Desktop\Fall 2008\CEP 741\HW\HW#7.sav

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
qn2values	24	1.6667	.96309	1.00	3.00

Descriptive Statistics

	Percentiles		
	25th	50th (Median)	75th
qn2values	1.0000	1.0000	3.0000

Runs Test

	qn2values
Test Value[a]	2.0000
Total Cases	24
Number of Runs	13
Z	.394
Asymp. Sig. (2-tailed)	.694

a. User-specified.

Paragraph summary, problem #3

The tolerance levels of precision tools in a factory are worrying the owner. He would like to know if the rates at which deviations from the accepted tolerances occur are as random as they should be. A runs test is performed on 34 units. The result of a z-score of -2.219 is found to be significant at the .05 level of -1.96. This suggests that the error rates are probably not random.

H/W 7 (Sudi Balimuttegjb)
Hand Calculation

(#3)

H_0: The error rates are random

H_a: The error rates are not random

$N = 34$

$m = 23$

$n = 10$

$r = 9$

Since $m > 20$, we use the Z-score, i.e

$$Z = \frac{r + h - \frac{2mn}{N} - 1}{\sqrt{\frac{2mn(2mn-N)}{N^2(N-1)}}}$$

where $h = -.5$ if $r > \frac{2mn}{N} + 1$

$h = +.5$ if $r < \frac{2mn}{N} + 1$

$$\frac{2mn}{N} + 1 = \frac{2 \times 23 \times 10}{34} + 1 = 14.53$$

$r = 9 < 14.53$, so $h = +.5$

$$Z = \frac{9.5 - 14.53}{\sqrt{\frac{2 \times 23 \times 10(2 \times 23 \times 10 - 34)}{34 \times 34 \times 33}}} = \frac{-5.03}{2.2665} = -2.219$$

$Z = -2.219$ is significant at the .05 level of -1.96. We <u>reject the null</u> and conclude that the error rates are not random.

7-3

```
NPAR TESTS
  /RUNS(2)=qn3values
  /STATISTICS  DESCRIPTIVES QUARTILES
  /MISSING ANALYSIS.
```

NPar Tests

[DataSet1] \\unrnas\users\sudib\Desktop\Fall 2008\CEP 741\HW\HW#7.sav

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
qn3values	33	1.6061	.93339	1.00	3.00

Descriptive Statistics

	Percentiles		
	25th	50th (Median)	75th
qn3values	1.0000	1.0000	3.0000

Runs Test

	qn3values
Test Value[a]	2.0000
Total Cases	33
Number of Runs	9
Z	-2.291
Asymp. Sig. (2-tailed)	.022

a. User-specified.

Paragraph summary, problem #4

My friend wants to confirm whether the random number generator of a computer produces genuine random numbers. A runs test is performed on a sequence of 40 random numbers produced by his computer. The outcome at the .05 level is not significant, suggesting that the numbers are probably not random.

H/W 7 (Sudi Balimuttajjo)

Hand Calculation

(#4)

H_0: The numbers are random

H_a: The numbers are not random

$N = 39$

$m = 20$

$n = 19$

$r_0 = 24$

- Since $m = 20$ and $n < 19$, we use the critical r-tables.
- The critical r-values are 13 and 27.
- Since $r_0 = 24$ is not less than nor equal to 13, and not equal nor greater than 27. The result is not significant. We fail to reject the null hypothesis and conclude that the numbers are probably random.

#4

```
NPAR TESTS
  /RUNS(2)=qn4values
  /STATISTICS  DESCRIPTIVES QUARTILES
  /MISSING ANALYSIS.
```

NPar Tests

[DataSet1] \\unrnas\users\sudib\Desktop\Fall 2008\CEP 741\HW\HW#7.sav

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
qn4values	39	2.0256	1.01274	1.00	3.00

Descriptive Statistics

	Percentiles		
	25th	50th (Median)	75th
qn4values	1.0000	3.0000	3.0000

Runs Test

	qn4values
Test Value[a]	2.0000
Total Cases	39
Number of Runs	24
Z	.978
Asymp. Sig. (2-tailed)	.328

a. User-specified.

Paragraph summary, problem #5

As a bank CEO, I am interested in the stability of the Canadian dollar against the US dollar. I monitor the strength through end of the day fluctuations recorded over a specific period. To assess whether the fluctuations of the month of September, 1998 exhibit some pattern, a runs test is performed. The results obtained were significant, implying that the fluctuations were not random but instead follow some pattern.

H/W 7 (Sudi Balimuttajjo)

Hand Calculation

(X 5.) H_0: Fluctuations in the Canadian dollar are random.

H_a: Fluctuations are not random

$N = 30$

$m = UP = 17$

$n = DOWN = 13$

$r_0 = 8$

- Since $m, n < 20$, we use the critical r-tables.
- The critical values are 10 and 22.
- The obtained r-value, $r_0 = 8$ less than the critical r of 10 at .05 level. This is a significant result and so we reject the null. Therefore, the fluctuations are probably not random but instead follow some pattern

#5

```
NPAR TESTS
  /RUNS(2)=qn5values
  /STATISTICS  DESCRIPTIVES QUARTILES
  /MISSING ANALYSIS.
```

NPar Tests

[DataSet1] \\unrnas\users\sudib\Desktop\Fall 2008\CEP 741\HW\HW#7.sav

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
qn5values	30	2.1333	1.00801	1.00	3.00

Descriptive Statistics

	Percentiles		
	25th	50th (Median)	75th
qn5values	1.0000	3.0000	3.0000

Runs Test

	qn5values
Test Value[a]	2.0000
Total Cases	30
Number of Runs	8
Z	-2.738
Asymp. Sig. (2-tailed)	.006

a. User-specified.

Paragraph summary, problem #6

Economist Paul M. Sommers of Middlebury College, Vermont tested whether Mack McGwire hit home runs at random or in streaks. McGwire hit home runs in 58 games out of 162 in 1998. A runs test performed on the sequence of home runs/ no home runs was not significant. McGwire was found to hit home runs at rather at random.

H/W 7 (Sudi Balimuttajjo)

Hand calculation

(#6)

H_0: McGwire hits homeruns randomly

H_a: McGwire hits homeruns in streaks

$N = 162$

m = homeruns = 58

n = no homeruns = 104

$r = 73$

- Since $m, n > 20$, we calculate the Z-score

$$Z = \frac{r + h - \frac{2mn}{N} - 1}{\sqrt{\frac{2mn(2mn-N)}{N^2(N-1)}}}$$

$h = +.5$ if $r < \frac{2mn}{N} + 1$

$h = -.5$ if $r > \frac{2mn}{N} + 1$

$$\frac{2mn}{N} + 1 = \frac{2 \times 58 \times 104}{162} + 1 = \frac{12,064}{162} + 1 = 75.469$$

$r = 73 < 75.469$, so, $h = +.5$

$$Z = \frac{73.5 - 75.469}{\sqrt{\frac{2 \times 58 \times 104 \times 11,902}{162 \times 162 \times 161}}} = \frac{-1.969}{5.8295} = -0.3378$$

$Z = -0.3378$ is not significant at the .05 level of -1.96. We fail to reject the null and conclude that Mark McGwire hits homeruns at random.

#6

```
NPAR TESTS
  /RUNS(2)=qn6values
  /STATISTICS  DESCRIPTIVES QUARTILES
  /MISSING ANALYSIS.
```

NPar Tests

[DataSet1] \\unrnas\users\sudib\Desktop\Fall 2008\CEP 741\HW\HW#7.sav

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
qn6values	162	1.7160	.96181	1.00	3.00

Descriptive Statistics

	Percentiles		
	25th	50th (Median)	75th
qn6values	1.0000	1.0000	3.0000

Runs Test

	qn6values
Test Value[a]	2.0000
Total Cases	162
Number of Runs	73
Z	-.424
Asymp. Sig. (2-tailed)	.672

a. User-specified.

Paragraph summary, problem #7

To confirm whether Kobe Byrant's shots are random or in streaks, a runs test was carried out on the shooting success/failure sequence of his field goal shots for the 1st game of the western conference finals between Los Angeles and San Antonio on May 19, 2001. The test was not significant. So, unlike what the announcers claimed, Kobe's shooting is probably random.

H/W 7 (Sneha Balimuttaji)

Hand Calculation:

(#7)

H_0: Kobe Byrant shoots at random

H_a: Kobe Byrant shoots in streaks

$N = 37$

$m = O = 18$

$n = X = 19$

$r = 19$

- Since m and n are both less than 20, we use the critical r-values tables. The Critical values of r are 13 and 26.
- Since $r = 19$ is not equal nor less than 13 and not equal nor greater than 26, the result is <u>not significant</u> at $\alpha = .05$. We fail to reject the null and suggest that Kobe's shooting is probably random.

```
NPAR TESTS
  /RUNS(2)=qn7values
  /STATISTICS  DESCRIPTIVES QUARTILES
  /MISSING ANALYSIS.
```

NPar Tests

[DataSet1] \\unrnas\users\sudib\Desktop\Fall 2008\CEP 741\HW\HW#7.sav

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
qn7values	37	1.9730	1.01342	1.00	3.00

Descriptive Statistics

	Percentiles		
	25th	50th (Median)	75th
qn7values	1.0000	1.0000	3.0000

Runs Test

	qn7values
Test Value[a]	2.0000
Total Cases	37
Number of Runs	19
Z	.000
Asymp. Sig. (2-tailed)	1.000

a. User-specified.