UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester kedua

Sidang 1990/91

April 1991

MKT261 - Kaedah Statistik Gunaan

Masa: [3 jam]

Jawab **SEMUA** soalan. Semua soalan mesti dijawab dalam Bahasa Malaysia. Satu set lampiran dikepilkan.

1. (a) Dalam suatu ujian untuk membandingkan lajunya dua jenis komputer dengan saiz yang sama, lapan buah program besar yang ditulis dalam FORTRAN dilarikan pada kedua-dua komputer. Kemudian amaun masa CPU dalam minit diukurkan.

Output daripada SPSS ditunjukkan di bawah.

Independent samples of KOMPUTER Jenis Komputer

Group 1: KOMPUTER EQ 1 Group 2: KOMPUTER EQ 2

t-test for: MASA masa CPU

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	8	50.8750	28.588	10.107
Group 2	8	54.1250	31.110	10.999

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.18	.829	-.22	14	.831	-.22	13.90	.831

Huraikan kesimpulan anda. Gunakan $\alpha = .05$. Berikan anggapan-anggapan yang diperlu bagi prosedur yang digunakan.

(b) Rekabentuk segiempat sama Latin digunakan untuk mengkaji sama ada tayar yang dikeluarkan oleh empat pengeluar berbeza akan menghasilkan kecekapan petrol yang berbeza secara bererti bagi lori perdagangan. Empat buah lori digunakan bagi ujian ini dan setiap jenis tayar diuji pada setiap lori. Juga, ujian-ujian ini perlu dijalankan selama empat hari. Setiap jenis tayar diuji pada setiap hari program ujian itu. Rekabentuk yang digunakan ditunjuk di bawah:

		Hari			
		4	3	1	2
Lori	3	Tayar 4	Tayar 2	Tayar 1	Tayar 3
	4	Tayar 2	Tayar 1	Tayar 3	Tayar 4
	2	Tayar 1	Tayar 3	Tayar 4	Tayar 2
	1	Tayar 3	Tayar 4	Tayar 2	Tayar 1

Output SPSS bagi data diperolehi ditunjukkan di bawah:

A N A L Y S I S O F V A R I A N C E

CEKAP kecekapan (batu/gelen)
BY LORI
HARI
JENIS jenis tayar

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	1.638	9	.182	11.765	.004
LORI	.068	3	.023	1.458	.317
HARI	.263	3	.088	5.668	.035
JENIS	1.307	3	.436	28.169	.001
Explained	1.638	9	.182	11.765	.004
Residual	.093	6	.015		
Total	1.731	15	.115		

Huraikan kesimpulan-kesimpulan yang boleh diperolehi daripada kajian ini. Gunakan $\alpha = .05$.
Nyatakan anggapan-anggapan yang telah anda gunakan.

(c) Seorang penyelidik telah mengkaji hubungan di antara struktur laporan lelaki/perempuan di dalam tempat perkejaan dan paras kepuashatian pekerja dalam kerja mereka.

Prosedur CROSSTABS dari SPSS telah digunakan untuk memproses data diperolehi. Output didapati diberikan di bawah:

Crosstabulation: PARAS paras kepuashatian
By HUBUNGAN penyelia/pekerja

Count HUBUNGAN->Tot Pct	perempuan/lelak 1.00	perempuan/peremp 2.00	lelaki/lelaki 3.00	lelaki/perempuan 4.00	Row Total
PARAS 1.00 puashati	20 4.4	25 5.6	50 11.1	75 16.7	170 37.8
2.00 tiada pendapat	40 8.9	50 11.1	50 11.1	40 8.9	180 40.0
3.00 tak puashati	30 6.7	45 10.0	10 2.2	15 3.3	100 22.2
Column Total	90 20.0	120 26.7	110 24.4	130 28.9	450 100.0

Chi-Square	D.F.	Significance	Min E.F.	Cells with E.F.< 5
67.18016	6	.0000	0.000	None

Number of Missing Observations = 0

Berikan kesimpulan-kesimpulan anda. Gunakan $\alpha = .05$.

(d). Pengurus jualan bagi sebuah syarikat yang menjual "soybeans" terbungkus melalui sebuah rangkaian supermarket yang mempunyai stor-stor di seluruh Malaysia berminat mengkaji hubungan di antara harga runcit barangan itu dan periklanan pada jualan runcit. Untuk mengkaji isu ini, pengurus tersebut merekod jualan y (dalam ribu unit), purata harga unit x1 per bungkus, dan peratusan x2 dari jumlah perbelanjaan yang diperuntukkan kepada periklanan bagi tahun yang lalu dalam setiap dari n = 25 rantau jualan.

Suatu program regresi SPSS telah digunakan untuk menyuaikan model peringkat dua

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_1^2 + \beta_4 x_2^2 + \beta_5 x_1 x_2 + \varepsilon$$

kepada data. Sebahagian output yang diperolehi ditunjuk di

bawah:

VARIABLE	MEAN	STANDARD DEVIATION
1 (Y)	30.6519	7.9602
2 (X1)	.3604	.0357
3 (X2)	6.3600	1.7049
4 (X1)SQ.	.1311	.0251
5 (X2)SQ.	43.2400	22.5153
6 (X1)(X2)	2.2840	.6285

MULTIPLE R	.8396
R SQUARE	.7049
STD. ERROR	4.8598

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	5	1072.065	214.413	9.080
RESIDUAL	19	448.678	23.615	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
(CONSTANT)	134.0799			
X1	-628.4045	667.1304	-2.8183	-.9412
X2	2.4161	7.5804	.5175	.3187
X1SQ.	841.6853	907.5220	2.6540	.9275
X2SQ.	.2286	.3071	.6466	.7444
(X1)(X2)	-5.4993	21.9262	-.4342	-.2508

Huraikan kesimpulan-kesimpulan anda. Gunakan $\alpha = .05$ (jika diperlukan).

(e) Suatu program regresi SPSS digunakan untuk menyuaikan model peringkat satu

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon$$

kepada data dari (d) di atas. Sebahagian daripada output ditunjuk di bawah:

MULTIPLE R .8281
R SQUARE .6857
STD. ERROR 4.6604

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	2	1042.917	521.458	24.009
RESIDUAL	22	447.826	21.719	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
(CONSTANT)	35.6170			
X1	-72.8205	26.8613	-.3271	-2.7110
X2	3.3458	.5635	.7166	5.9375

Ujikan sama ada model peringkat kedua yang disuaikan dalam (d) memberi suatu kemajuan apabila dipertimbangkan dengan model peringkat pertama. Iaitu, bagi model peringkat kedua dari (d), uji hipotesis

$$H_0: \beta_3 = \beta_4 = \beta_5 = 0.$$

Gunakan $\alpha = .05$. (100/100)

2. Persatuan Pengguna Pulau Pinang menguji masa hayat lima jenama pita pencetak komputer dot-matriks dengan menggunakan sebuah pencetak. Hasil-hasil didapati ditunjukkan di bawah:

Jenama	Masa hayat (jam)				Jumlah
A	20.5	17.7	20.0	19.2	77.4
B	24.0	26.2	21.2	26.1	97.5
C	27.4	35.2	31.2	28.2	122.0
D	17.1	18.1	18.5	16.7	70.4
E	36.5	33.9	26.9	27.0	124.3

$$\Sigma\Sigma y_{ij}^2 = 12{,}829.98$$

(a) Dapatkan jadual analisis varians bagi masalah ini.

(b) Adakah terdapat perbezaan yang bererti di antara lima jenama pita yang dikaji? Gunakan $\alpha = .05$.
Nyatakan semua anggapan yang anda telah gunakan.

(c) Andaikan sebelum eksperimen tersebut dijalankan, kita telah merancang untuk membandingkan pita Jenama A (yang kini digunakan) dengan pita-pita yang lain.
Binakan suatu set kontras ortogon yang membolehkan kita menjalankan perbandingan yang dikehendaki.
Adakah terdapat kontras yang bererti? Gunakan $\alpha = .05$.

(100/100)

3. Seorang ahli agronomi ingin membandingkan kekesanan lima punca nitrogen pada hasil bahan kering dari tanaman barli yang digunakan sebagai tanaman untuk makanan lembu dan kuda. Lima punca itu bersama dengan kawalan (tiada nitrogen) adalah:

1. $(NH_4)_2SO_4$
2. NH_4NO_3
3. $CO(NH_2)_2$
4. $Ca(NO_3)_2$
5. $NaNO_3$
6. Kawalan

Supaya hasil didapati boleh digunakan untuk berbagai keadaan tanah, dia memutus untuk menjalankan eksperimennya pada empat jenis tanah berbeza. Bagi rekabentuknya, beliau telah memilih suatu rekabentuk blok rawakan dengan jenis tanah sebagai faktor pemblokan. Beliau menempatkan enam plot pada setiap dari empat jenis tanah itu, kemudian mengumpukkan secara rawak rawatan-rawatan itu kepada plot-plot bagi setiap jenis tanah. Apabila masak dia menuai hasil setiap plot and menyukatkan bahan kering makanan yang diperolehi. Hasil-hasil didapati (dalam kilogram per plot) ditunjukkan di bawah:

	Jenis Tanah				
Rawatan	I	II	III	IV	Jumlah
1	32.1	35.6	41.9	35.4	145.0
2	30.1	31.5	37.1	30.8	129.5
3	25.4	27.4	33.8	31.1	117.7
4	24.1	33.0	35.6	31.4	124.1
5	26.1	31.0	33.8	31.9	122.8
6	23.2	24.8	26.7	26.7	101.4
Jumlah	161.0	183.3	208.9	187.3	740.5

$$\Sigma\Sigma Y_{ij}^2 = 23,339.87$$

(a) Binakan suatu jadual analisis varians.

(b) Adakah terdapat perbezaan di antara enam rawatan yang dikaji? Gunakan $\alpha = .05$.
Nyatakan semua anggapan yang telah anda menggunakan.

(c) Jika terdapat hasil yang bererti dalam (b), gunakan ujian Duncan dengan $\alpha = .05$ untuk memperolehi rawatan-rawatan yang berbeza secara bererti.

(d) Dapatkan selang keyakinan 95% bagi perbezaan min untuk rawatan 1 dan rawatan 3.

(e) Dapatkan selang keyakinan 95% bagi min untuk rawatan 6.

(100/100)

4. (a) Huraikan secara ringkas rekabentuk-rekabentuk berikut:

(i) Rekabentuk blok rawakan

(ii) Rekabentuk segiempat sama Latin

(iii) Rekabentuk faktorial.

(b) Untuk menguji secara serentak kesan pada ukuran batu (mileage) daripada tiga campuran petrol dan dua buah karburetor, seorang penyiasat memutus untuk menjalankan suatu eksperimen faktorial dengan tiga pereplikaan. Berdasarkan suatu rekabentuk begitu, 18 buah kereta dipilih secara rawak bagi enam gabungan rawatan itu, dan data diperolehi (dalam batu per galen) diberikan di bawah.

	Campuran Petrol		
Karburetor	1	2	3
1	18.4	18.7	20.6
	19.0	17.9	20.0
	18.6	18.0	20.7
2	20.1	21.0	22.4
	21.2	20.8	22.4
	20.2	20.5	21.8

(i) Adakah wujud tindakan bersaling yang bererti? Tunjukkan secara bergraf dan kemudian gunakan suatu ujian keertian. Gunakan $\alpha = .05$.

(ii) Adakah wujud perbezaan yang bererti diantara campuran petrol? Di antara karburetor-karburetor? Gunakan $\alpha = .05$.

(iii) Nyatakan sebarang anggapan yang anda telah menggunakan.

Perhatian: Jumlah nilai didalam setiap sel ditunjukkan di bawah.

	Campuran Petrol			
Karburetor	1	2	3	Jumlah
1	56.0	54.6	61.3	171.9
2	61.5	62.3	66.6	190.4
Jumlah	117.5	116.9	127.9	362.3

$$\Sigma\Sigma\Sigma y_{ijk}^2 = 7326.61$$

(100/100)

5(a). Banyak komponen mesin sentiasa mengalami paras desakan yang berubah. Bagi komponen-komponen begitu, kegagalan kerapkali disebabkan pemuatan yang diulangi pada paras desakan yang lebih rendah daripada titik kegagalan. Had kecekalan (endurance limit) suatu bahan adalah titik sedemikian hingga jika paras desakan adalah rendah daripada titik itu suatu komponen akan tahan secara tak tentu tanpa kesan buruk daripada sebarang jenis desakan.

Data berikut berkenaan dengan had kecekalan (dalam psi), y bagi besi waja relatif kepada kekuatan tensil (dalam psi), x di mana x adalah pembolehubah tak bersandar. Data itu diperolehi daripada suatu ujian khas yang menentukan had kecekalan.

x	y		
80	30.3	31.2	31.0
100	37.0	37.8	36.7
120	43.2	44.5	44.6
140	50.4	51.5	50.5
160	55.4	56.0	55.0
180	60.4	61.6	61.1
200	63.2	64.6	63.7

$\Sigma x_i = 2,940$ $\Sigma y_i = 1,029.7$

$\Sigma x_i^2 = 445,200$ $\Sigma y_i^2 = 53,206.75$

$\Sigma x_i y_i = 153,644$ $n = 21$

(i) Plot data itu pada suatu gambarajah sebaran.

(ii) Dapatkan garis regresi linear mudah yang mengkaitkan y dengan x dan plot garis regresi itu pada gambarajah sebaran dari (i).

(iii) Ujikan sama ada model regresi linear mudah di atas bererti atau tidak. Gunakan $\alpha = .05$.

(iv) Anggarkan min had kecekalan bagi besi waja apabila kekuatan tensil adalah 150 psi, dengan menggunakan suatu selang keyakinan 95%.

(v) Nyatakan semua anggapan yang anda telah gunakan.

(b) Bagi data dari (a), penyiasat bagi eksperimen ini berpendapat bahawa mungkin kesan kekuatan tensil pada had kecekalan tak linear. Jadi, beliau telah menggunakan prosedur SPSS, ONEWAY dengan option POLYNOMIAL dengan darjah empat. Output didapati ditunjukkan di bawah:

- - - - - - - - - - O N E W A Y - - - - - - - - - -

Variable Y endurance limit

By Variable X tensile strength

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	6	2711.8333	451.9722	1195.3925	.0000
Linear Term	1	2678.1011	2678.1011	7083.1389	.0000
Deviation from Linear	5	33.7323	6.7465	17.8433	.0000
Quad. Term	1	29.1448	29.1448	77.0832	.0000
Deviation from Quad.	4	4.5875	1.1469	3.0333	.0538

Cubic Term	1	2.4939	2.4939	6.5959 .0223
Deviation from Cubic	3	2.0936	.6979	1.8457 .1852
Quartic Term	1	.0182	.0182	.0481 .8295
Deviation from Quartic	2	2.0754	1.0377	2.7445 .0987
Within Groups	14	5.2933	.3781	
Total	20	2717.1267		

Huraikan kesimpulan-kesimpulan penyiasat itu. Gunakan $\alpha = .05$.

Dapatkan persamaan polinomial terbaik yang mengkaitkan y dengan x.

(c) Berikan faedah-faedah polinomial ortogon apabila dibandingkan dengan polinomial biasa.

(100/100)

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BERBAGAI RUMUS (Tatatanda seperti di dalam nota kuliah)

1. Dua sampel tak bersandar ($n_1 < 25$ atau $n_2 < 25$)

$$s_p^2 = \frac{\sum_i (x_i - \bar{x})^2 + \sum_j (y_j - \bar{y})^2}{n_1 + n_2 - 2}$$

$$= \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

2. Sampel berpasangan

$$s_d^2 = \frac{\sum_i (d_i - \bar{d})^2}{n - 1}$$

$$= \frac{\sum_i d_i^2 - \frac{(\sum d_i)^2}{n}}{n - 1}$$

3. Analisis varian satu hala

$$SST = \sum_i \sum_j y_{ij}^2 - \frac{y_{..}^2}{N}$$

$$SSA = \sum_i \frac{y_{i.}^2}{n_i} - \frac{y_{..}^2}{N}$$

$$SSE = SST - SSA$$

Bagi sebarang kontras $L = \sum_i c_i y_{i.}$,

$$SSL = (\sum_i c_i y_{i.})^2 / (n \sum_i c_i^2)$$

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4. Rekabentuk blok rawakan

$$SST = \sum_i \sum_j y_{ij}^2 - \frac{y_{..}^2}{N}$$

$$SSA = \sum_i \frac{y_{i.}^2}{b} - \frac{y_{..}^2}{N}$$

$$SSB = \sum_j \frac{y_{.j}^2}{a} - \frac{y_{..}^2}{N}$$

$$SSE = SST - SSA - SSB$$

5. Rekabentuk segiempat sama Latin

$$SST = \sum_i \sum_j y_{ijk}^2 - \frac{y_{...}^2}{N}$$

$$SSR = \sum_i \frac{y_{i..}^2}{P} - \frac{y_{...}^2}{N}$$

$$SSC = \sum_k \frac{y_{..k}^2}{P} - \frac{y_{...}^2}{N}$$

$$SSA = \sum_j \frac{y_{.j.}^2}{P} - \frac{y_{...}^2}{N}$$

$$SSE = SST - SSR - SSC - SSA$$

6. Rekabentuk faktorial (dua faktor)

$$SST = \sum_i \sum_j \sum_k y_{ijk}^2 - \frac{y_{...}^2}{N}$$

$$SSA = \sum_i \frac{y_{i..}^2}{bn} - \frac{y_{...}^2}{N}$$

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$$SSB = \sum_j \frac{y_{.j.}^2}{an} - \frac{y_{...}^2}{N}$$

$$SS_{\text{sub-jumlah}} = \sum_i \sum_j \frac{y_{ij.}^2}{n} - \frac{y_{...}^2}{N}$$

$$SSAB = SS_{\text{sub-jumlah}} - SSA - SSB$$

$$SSE = SST - SS_{\text{sub-jumlah}}$$

7. Korelasi dan regresi linear mudah

$$r^2 = \frac{\left(\sum_i x_i y_i - (\sum_i x_i)(\sum_i y_i)/n\right)^2}{[\sum_i x_i^2 - (\sum_i x_i)^2/n][\sum_i y_i^2 - (\sum_i y_i)^2/n]}$$

$$\hat{\beta}_1 = \frac{\sum_i x_i y_i - (\sum_i x_i)(\sum_i y_i)/n}{\sum_i x_i^2 - (\sum_i x_i)^2/n}$$

$$\hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}$$

$$SSE = S_{yy} - \hat{\beta}_1^2 S_{xx}$$

$$= S_{yy} - \hat{\beta}_1 S_{xy}$$

$$S_{Y \cdot X}^2 = \frac{SSE}{n-2}$$

Anggaran ralat piawai bagi $\hat{\beta}_0$ ialah

$$\sqrt{MSE\left(\frac{1}{n} + \frac{\bar{x}^2}{S_{xx}}\right)}$$

Anggaran ralat piawai bagi $\hat{\beta}_1$ ialah

$$\sqrt{MSE/S_{xx}}$$

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Selang peramalan $100(1 - \alpha)\%$ pada $x = x_0$:

$$\hat{y} \pm t_{\alpha/2} \sqrt{MSE\left(1 + \frac{1}{n} + \frac{(x_0 - \bar{x})^2}{S_{xx}}\right)}$$

Selang keyakinan $100(1 - \alpha)\%$ pada $x = x_0$ bagi $\mu_{Y \cdot X_0}$ ialah

$$\hat{y} \pm t_{\alpha/2} \sqrt{MSE\left(\frac{1}{n} + \frac{(x_0 - \bar{x})^2}{S_{xx}}\right)}$$

8. **Regresi linear berganda**

$$\underset{\sim}{y} = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix}, \quad \underset{\sim}{x} = \begin{pmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1k} \\ 1 & x_{21} & x_{22} & \cdots & x_{2k} \\ \vdots & \vdots & \vdots & & \vdots \\ 1 & x_{n1} & x_{n2} & \cdots & x_{nk} \end{pmatrix}$$

$$\underset{\sim}{\beta} = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{pmatrix}, \quad \underset{\sim}{\varepsilon} = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix}$$

$$\hat{\underset{\sim}{\beta}} = (\underset{\sim}{X}'\underset{\sim}{X})^{-1}\underset{\sim}{X}'\underset{\sim}{y}$$

$$SSE = \underset{\sim}{y}'\underset{\sim}{y} - \hat{\underset{\sim}{\beta}}'\underset{\sim}{X}'\underset{\sim}{y}$$

$$SSR = \hat{\underset{\sim}{\beta}}'\underset{\sim}{X}'\underset{\sim}{y} - (\Sigma y_i)^2/n$$

$$r^2_{12.3} = \frac{(r_{12} - r_{13}\, r_{23})^2}{(1 - r^2_{13})(1 - r^2_{23})}$$

$$MSE = \frac{SSE}{n-p}, \quad p = k+1 .$$

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9. Polinomial ortogon

$$P_0(x) = 1$$

$$P_1(x) = \lambda_1 \left[\frac{x-\bar{x}}{d}\right]$$

$$P_2(x) = \lambda_2 \left[\left(\frac{x-\bar{x}}{d}\right)^2 - \left(\frac{n^2-1}{12}\right)\right]$$

$$P_3(x) = \lambda_3 \left[\left(\frac{x-\bar{x}}{d}\right)^3 - \left(\frac{x-\bar{x}}{d}\right)\left(\frac{3n^2-7}{20}\right)\right]$$

$$P_4(x) = \lambda_4 \left[\left(\frac{x-\bar{x}}{d}\right)^4 - \left(\frac{x-\bar{x}}{d}\right)^2\left(\frac{3n^2-13}{14}\right) + \frac{3(n^2-1)(n^2-9)}{560}\right]$$

$$\hat{\alpha}_j = \frac{\sum_{i=1}^{n} P_j(x_i)y_i}{\sum_{i=1}^{n} P_j^2(x_i)}, \quad j = 0, 1, \ldots, k$$

$$SSR(\alpha_j) = \hat{\alpha}_j \sum_{i=1}^{n} P_j(x_i)y_i$$

$$SSE(k) = S_{yy} - \sum_{j=1}^{k} \hat{\alpha}_j \left[\sum_{i=1}^{n} P_j(x_i)y_i\right]$$

10. Pemilihan pembolehubah dan pembangunan model dalam regresi

$$R_p^2 = \frac{SSR(p)}{S_{yy}} = 1 - \frac{SSE(p)}{S_{yy}}$$

$$\overline{R_p^2} = 1 - \left(\frac{n-1}{n-p}\right)(1 - R_p^2)$$

$$MSE(p) = \frac{SSE(p)}{n-p}$$

$C_p = \frac{SSE(p)}{\hat{\sigma}^2} - (n-2p)$, di mana $\hat{\sigma}^2$ adalah suatu anggaran σ^2 .

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VII. Significant Ranges for Duncan's Multiple Range Test[a]

$r_{01}(p, f)$

	p											
f	2	3	4	5	6	7	8	9	10	20	50	100
1	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
3	8.26	8.5	8.6	8.7	8.8	8.9	8.9	9.0	9.0	9.3	9.3	9.3
4	6.51	6.8	6.9	7.0	7.1	7.1	7.2	7.2	7.3	7.5	7.5	7.5
5	5.70	5.96	6.11	6.18	6.26	6.33	6.40	6.44	6.5	6.8	6.8	6.8
6	5.24	5.51	5.65	5.73	5.81	5.88	5.95	6.00	6.0	6.3	6.3	6.3
7	4.95	5.22	5.37	5.45	5.53	5.61	5.69	5.73	5.8	6.0	6.0	6.0
8	4.74	5.00	5.14	5.23	5.32	5.40	5.47	5.51	5.5	5.8	5.8	5.8
9	4.60	4.86	4.99	5.08	5.17	5.25	5.32	5.36	5.4	5.7	5.7	5.7
10	4.48	4.73	4.88	4.96	5.06	5.13	5.20	5.24	5.28	5.55	5.55	5.55
11	4.39	4.63	4.77	4.86	4.94	5.01	5.06	5.12	5.15	5.39	5.39	5.39
12	4.32	4.55	4.68	4.76	4.84	4.92	4.96	5.02	5.07	5.26	5.26	5.26
13	4.26	4.48	4.62	4.69	4.74	4.84	4.88	4.94	4.98	5.15	5.15	5.15
14	4.21	4.42	4.55	4.63	4.70	4.78	4.83	4.87	4.91	5.07	5.07	5.07
15	4.17	4.37	4.50	4.58	4.64	4.72	4.77	4.81	4.84	5.00	5.00	5.00
16	4.13	4.34	4.45	4.54	4.60	4.67	4.72	4.76	4.79	4.94	4.94	4.94
17	4.10	4.30	4.41	4.50	4.56	4.63	4.68	4.73	4.75	4.89	4.89	4.89
18	4.07	4.27	4.38	4.46	4.53	4.59	4.64	4.68	4.71	4.85	4.85	4.85
19	4.05	4.24	4.35	4.43	4.50	4.56	4.61	4.64	4.67	4.82	4.82	4.82
20	4.02	4.22	4.33	4.40	4.47	4.53	4.58	4.61	4.65	4.79	4.79	4.79
30	3.89	4.06	4.16	4.22	4.32	4.36	4.41	4.45	4.48	4.65	4.71	4.71
40	3.82	3.99	4.10	4.17	4.24	4.30	4.34	4.37	4.41	4.59	4.69	4.69
60	3.76	3.92	4.03	4.12	4.17	4.23	4.27	4.31	4.34	4.53	4.66	4.66
100	3.71	3.86	3.98	4.06	4.11	4.17	4.21	4.25	4.29	4.48	4.64	4.65
∞	3.64	3.80	3.90	3.98	4.04	4.09	4.14	4.17	4.20	4.41	4.60	4.68

f = degrees of freedom.

[a] Reproduced with permission from "Multiple Range and Multiple F Tests," by D. B. Duncan, *Biometrics*, Vol. 1, No. 1, pp. 1–42, 1955

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VII. Significant Ranges for Duncan's Multiple Range Test (*continued*)

$r_{05}(p, f)$

	p											
f	2	3	4	5	6	7	8	9	10	20	50	100
1	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
2	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09
3	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
4	3.93	4.01	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02
5	3.64	3.74	3.79	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
6	3.46	3.58	3.64	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68
7	3.35	3.47	3.54	3.58	3.60	3.61	3.61	3.61	3.61	3.61	3.61	3.61
8	3.26	3.39	3.47	3.52	3.55	3.56	3.56	3.56	3.56	3.56	3.56	3.56
9	3.20	3.34	3.41	3.47	3.50	3.52	3.52	3.52	3.52	3.52	3.52	3.52
10	3.15	3.30	3.37	3.43	3.46	3.47	3.47	3.47	3.47	3.48	3.48	3.48
11	3.11	3.27	3.35	3.39	3.43	3.44	3.45	3.46	3.46	3.48	3.48	3.48
12	3.08	3.23	3.33	3.36	3.40	3.42	3.44	3.44	3.46	3.48	3.48	3.48
13	3.06	3.21	3.30	3.35	3.38	3.41	3.42	3.44	3.45	3.47	3.47	3.47
14	3.03	3.18	3.27	3.33	3.37	3.39	3.41	3.42	3.44	3.47	3.47	3.47
15	3.01	3.16	3.25	3.31	3.36	3.38	3.40	3.42	3.43	3.47	3.47	3.47
16	3.00	3.15	3.23	3.30	3.34	3.37	3.39	3.41	3.43	3.47	3.47	3.47
17	2.98	3.13	3.22	3.28	3.33	3.36	3.38	3.40	3.42	3.47	3.47	3.47
18	2.97	3.12	3.21	3.27	3.32	3.35	3.37	3.39	3.41	3.47	3.47	3.47
19	2.96	3.11	3.19	3.26	3.31	3.35	3.37	3.39	3.41	3.47	3.47	3.47
20	2.95	3.10	3.18	3.25	3.30	3.34	3.36	3.38	3.40	3.47	3.47	3.47
30	2.89	3.04	3.12	3.20	3.25	3.29	3.32	3.35	3.37	3.47	3.47	3.47
40	2.86	3.01	3.10	3.17	3.22	3.27	3.30	3.33	3.35	3.47	3.47	3.47
60	2.83	2.98	3.08	3.14	3.20	3.24	3.28	3.31	3.33	3.47	3.48	3.48
100	2.80	2.95	3.05	3.12	3.18	3.22	3.26	3.29	3.32	3.47	3.53	3.53
∞	2.77	2.92	3.02	3.09	3.15	3.19	3.23	3.26	3.29	3.47	3.61	3.67

f = degrees of freedom.

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TABLE III (MKT261)

Transformation of r to Z $\left(\text{i.e., } Z = \frac{1}{2} \log_e \frac{1+r}{1-r}\right)$

r	Z	r	Z	r	Z
.00	.000				
.01	.010	.36	.377	.71	.887
.02	.020	.37	.388	.72	.908
.03	.030	.38	.400	.73	.929
.04	.040	.39	.412	.74	.950
.05	.050	.40	.424	.75	.973
.06	.060	.41	.436	.76	.996
.07	.070	.42	.448	.77	1.020
.08	.080	.43	.460	.78	1.045
.09	.090	.44	.472	.79	1.071
.10	.100	.45	.485	.80	1.099
.11	.110	.46	.497	.81	1.127
.12	.121	.47	.510	.82	1.157
.13	.131	.48	.523	.83	1.188
.14	.141	.49	.536	.84	1.221
.15	.151	.50	.549	.85	1.256
.16	.161	.51	.563	.86	1.293
.17	.172	.52	.576	.87	1.333
.18	.182	.53	.590	.88	1.376
.19	.192	.54	.604	.89	1.422
.20	.203	.55	.618	.90	1.472
.21	.213	.56	.633	.91	1.528
.22	.224	.57	.648	.92	1.589
.23	.234	.58	.662	.93	1.658
.24	.245	.59	.678	.94	1.738
.25	.255	.60	.693	.95	1.832
.26	.266	.61	.709	.96	1.946
.27	.277	.62	.725	.97	2.092
.28	.288	.63	.741	.98	2.298
.29	.299	.64	.758	.99	2.647
.30	.310	.65	.775		
.31	.321	.66	.793		
.32	.332	.67	.811		
.33	.343	.68	.829		
.34	.354	.69	.848		
.35	.365	.70	.867		

Table III is abridged from Table VII of Fisher and Yates: *Statistical Tables for Biological, Agricultural, and Medical Research*, published by Oliver and Boyd Limited, Edinburgh, by permission of the authors and publishers.

X. Coefficients of Orthogonal Polynomials[a]

	$n = 3$		$n = 4$			$n = 5$				$n = 6$					$n = 7$					
X_j	P_1	P_2	P_1	P_2	P_3	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4	P_5	P_1	P_2	P_3	P_4	P_5	P_6
1	−1	1	−3	1	−1	−2	2	−1	1	−5	5	−5	1	−1	−3	5	−1	3	−1	1
2	0	−2	−1	−1	3	−1	−1	2	−4	−3	−1	7	−3	5	−2	0	1	−7	4	−6
3	1	1	1	−1	−3	0	−2	0	6	−1	−4	4	2	−10	−1	−3	1	1	−5	15
4			3	1	1	1	−1	−2	−4	1	−4	−4	2	10	0	−4	0	6	0	−20
5						2	2	1	1	3	−1	−7	−3	−5	1	−3	−1	1	5	15
6										5	5	5	1	1	2	0	−1	−7	−4	−6
7															3	5	1	3	1	1
$\sum_{j=1}^{n} \{P_i(X_j)\}^2$	2	6	20	4	20	10	14	10	70	70	84	180	28	252	28	84	6	154	84	924
λ	1	3	8	1	$\frac{10}{3}$	1	1	$\frac{5}{6}$	$\frac{35}{12}$	2	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{7}{12}$	$\frac{21}{10}$	1	1	$\frac{1}{6}$	$\frac{7}{12}$	$\frac{7}{20}$	$\frac{77}{60}$

	$n = 8$						$n = 9$						$n = 10$					
X_j	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P_2	P_3	P_4	P_5	P_6
1	−7	7	−7	7	−7	1	−4	28	−14	14	−4	4	−9	6	−42	18	−6	3
2	−5	1	5	−13	23	−5	−3	7	7	−21	11	−17	−7	2	14	−22	14	−11
3	−3	−3	7	−3	−17	9	−2	−8	13	−11	−4	22	−5	−1	35	−17	−1	10
4	−1	−5	3	9	−15	−5	−1	−17	9	9	−9	1	−3	−3	31	3	−11	6
5	1	−5	−3	9	15	−5	0	−20	0	18	0	−20	−1	−4	12	18	−6	−8
6	3	−3	−7	−3	17	9	1	−17	−9	9	9	1	1	−4	−12	18	6	−8
7	5	1	−5	−13	−23	−5	2	−8	−13	−11	4	22	3	−3	−31	3	11	6
8	7	7	7	7	7	1	3	7	−7	−21	−11	−17	5	−1	−35	−17	1	10
9							4	28	14	14	4	4	7	2	−14	−22	−14	−11
10													9	6	42	18	6	3
$\sum_{j=1}^{n} \{P_i(X_j)\}^2$	168	168	264	616	2184	264	60	2772	990	2002	468	1980	330	132	8580	2860	780	660
λ	2	1	$\frac{2}{3}$	$\frac{7}{12}$	$\frac{7}{10}$	$\frac{11}{60}$	1	3	$\frac{5}{6}$	$\frac{7}{12}$	$\frac{3}{20}$	$\frac{11}{60}$	2	$\frac{1}{2}$	$\frac{5}{3}$	$\frac{5}{12}$	$\frac{1}{10}$	$\frac{11}{240}$

[a] Adapted with permission from *Biometrika Tables For Statisticians*, Vol. 1, 3rd edition by E. S. Pearson and H. O. Hartley, Cambridge University Press, Cambridge, 1966.

SPSS/PC+™ Reference Card

This card provides a convenient reference to the SPSS/PC+™ System for the IBM PC/XT and PC/AT. Command diagrams appear in alphabetical order and are constructed according to the following conventions.

Square brackets enclose optional specifications not necessary to the correct completion of the command. **Braces** enclose alternative specifications. One of these specifications must be entered in order to complete the command. The brackets and braces themselves are not part of the specification.

Ellipses indicate that an element may be repeated.

Uppercase elements must be entered as they appear in the diagrams.

Lowercase elements describe information to be filled in by the user, such as the word "varlist" to indicate a list of user-specified variables.

Boldface elements are defaults. Two asterisks (**) indicate that a specification is a default when its associated subcommand is not specified.

AGGREGATE

```
AGGREGATE OUTFILE={'filename'}
                  {*        }
  [/PRESORTED]
   /BREAK=varlist [{(A)}] [varlist [{(A)}]] ...
                  {(D)}           {(D)}
  [/MISSING=COLUMNWISE]
   /aggvar ['label'] aggvar ['label'] ...
        =function(varlist[,arguments])
  [/aggvar ...]
```

ANOVA

```
ANOVA [VARIABLES=] varlist BY varlist(min,max) [WITH varlist]
      [/VARIABLES=] varlist ...]
      [/OPTIONS=option numbers]
      [/STATISTICS={statistic numbers}]
                   {ALL              }
```

Options:

1 Include user-missing values
2 Suppress labels
3 Suppress all interaction terms
4 Suppress three-way terms
5 Suppress four-way terms
6 Suppress five-way terms
7 Covariates with main effects
8 Covariates after main effects
9 Regression approach
10 Hierarchical approach
11 Narrow format

Statistics:

1 MCA table
2 Unstandardized regression coefficients for covariates
3 Display cell means and counts

BEGIN DATA—END DATA

```
BEGIN DATA
lines of data
END DATA
```

COMMENT

```
* text
```

COMPUTE

```
COMPUTE target variable=expression
```

Arithmetic Operators:

\+ Addition
\- Subtraction
* Multiplication
/ Division
** Exponentiation

Numeric Functions:

ABS	Absolute value	RND	Round
TRUNC	Truncate	MOD10	Modulus
SQRT	Square root	EXP	Exponential
LG10	Base 10 logarithm	LN	Natural logarithm
SIN	Sine	COS	Cosine
ATAN	Arctangent		

Missing-Value Functions:

VALUE Treat user missing as valid
SYSMIS Return 1 if system-missing
MISSING Return 1 if missing

Cross-case Function:

LAG Lag

Random-Number Functions:

UNIFORM Uniform pseudo-random number
NORMAL Normal pseudo-random number

Date Function:

YRMODA Date function

CORRELATION

```
CORRELATION [VARIABLES=] {varlist} [WITH varlist] [/varlist ...]
                         {ALL    }
            [/OPTIONS=option numbers]
            [/STATISTICS={statistic numbers}]
                         {ALL              }
```

Options:

1 Include user missing values
2 Exclude missing values pairwise
3 Two-tailed probability
4 Write count and correlation matrix
5 Display count and probability

Statistics:

1 Univariate mean, standard deviation, and count
2 Cross-product deviations and covariance

COUNT

```
COUNT varname=varlist (value list) varlist (value list)
      [/varname=...]
```

Keywords available for numeric value lists:

LO LOWEST HI HIGHEST THRU SYSMIS MISSING

CROSSTABS

```
CROSSTABS [TABLES=] {varlist} BY varlist [BY...]
                    {ALL    }
          [/[TABLES=] varlist...]
          [/OPTIONS=option numbers]
          [/STATISTICS={statistic numbers}]
                       {ALL              }
```

Options:

1 Include user missing values
2 Suppress all labels
3 Display row percentages
4 Display column percentages
5 Display two-way table total percentages
6 Suppress value labels
8 Order rows by descending value
12 Suppress tables
13 Suppress cell counts
14 Display expected frequencies
15 Display chi-square residuals
16 Display standardized chi-square residuals
17 Display adjusted standardized chi-square residuals
18 Display all cell information
19 Suppress values

Statistics:

1 Chi-square
2 Phi for 2 × 2 tables, Cramér's V for larger tables
3 Contingency coefficient
4 Lambda
5 Uncertainty coefficient
6 Kendall's tau-b
7 Kendall's tau-c
8 Gamma
9 Somers' d
10 Eta
11 Pearson's r

DATA LIST: Fixed Format

```
DATA LIST [FILE='filename'] [FIXED] [TABLE]
 /varlist columns [{(0)}] [varlist columns ...] [/ ...] [/ ...]
                  {(n)}
                  {(A)}
```

Format	*Meaning*
(n)	Implied decimal places for numeric variables
(A)	String variable

DATA LIST: Freefield Format

```
DATA LIST [FILE='filename'] FREE
      /variable [({A })] varlist
                 {Aw}
```

Format	*Meaning*
(Aw)	String of width w

DATA LIST: Matrix Materials

```
DATA LIST [FILE='filename'] MATRIX [{FIXED}] /varlist
                                   {FREE }
```

DESCRIPTIVES

```
DESCRIPTIVES [VARIABLES=] {varlist}
                          {ALL    }
             [/OPTIONS=option numbers]
             [/STATISTICS={statistic numbers}]
                          {ALL              }
```

Options:

1 Include user missing values
2 Suppress variable labels
3 Save Z scores on active file
5 Exclude missing values listwise
6 Serial format
7 Narrow format
8 Suppress variable names

Statistics:

1 Mean
2 Standard error of mean
5 Standard deviation
6 Variance
7 Kurtosis
8 Skewness
9 Range
10 Minimum
11 Maximum
12 Sum
13 Mean, standard deviation, minimum, and maximum

DISPLAY

```
DISPLAY [{varlist}]
         {ALL    }
```

EXECUTE

```
EXECUTE {path\filename{.ext}} ['parameters']
        {DOS          {.BAT}
```

EXPORT

```
EXPORT OUTFILE='filename' [/KEEP={ALL    }] [/DROP=varlist]
                                 {varlist}
     [/RENAME=(old varlist=new varlist)...] [/MAP]
     [/DIGITS=number]
```

FINISH

```
FINISH
```

FORMATS

```
FORMATS variable (format) [variable ...]
```

Format	*Meaning*
Fw.d	Numeric of width w and d decimal places
COMMAw.d	Numeric with commas and decimal places
DOLLARw.d	Numeric with dollar sign, commas, and decimal places

FREQUENCIES

```
FREQUENCIES [VARIABLES=]{varlist}
                        {ALL    }
[/FORMAT={(CONDENSE)}] [{NOTABLE }] [NOLABELS]
         {(ONEPAGE )}  {LIMIT(n)}
         [{(DVALUE)}] [DOUBLE] [NEWPAGE]]
          {(AFREQ  )}
          {(DFREQ  )}
[/MISSING=INCLUDE]
[/BARCHART=[MINIMUM(n)] [MAXIMUM(n)] [{FREQ(n)   }]]
                                      {PERCENT(n)}
[/HISTOGRAM=[MINIMUM(n)] [MAXIMUM(n)] [{FREQ(n)   }]]
                                       {PERCENT(n)}
           [{(NONORMAL)}] [INCREMENT(n)]]
            {(NORMAL  )}
[/HBAR=same keywords as HISTOGRAM]
[/NTILES=n]  [/PERCENTILES=value list]
[/STATISTICS={(DEFAULT)  [MEAN] [STDDEV] [MINIMUM] [MAXIMUM]
             {(SEMEAN) [VARIANCE] [SKEWNESS] [SESKEW] [RANGE] [MODE]
             {(KURTOSIS) [SEKURT] [MEDIAN] [SUM] [ALL] [NONE]]
```

GET

```
GET [FILE={('SPSS.SYS'**)}] [/DROP=varlist]
          {('filename'  )}
```

HELP

```
HELP [ALL] [TOPICS] [NEWS]
     [command] [subcommand] [topic]
```

IF

```
IF (logical expression) target variable=assignment expression
```

Relational Operators:

EQ or =	Equal to	NE or ~= or <>	Not equal to
LT or <	Less than	LE or <=	Less than or equal to
GT or >	Greater than	GE or >=	Greater than or equal to

Logical Operators:

AND or & OR or | NOT or ~

Missing-Value Functions:

SYSMIS	Returns 1 (true) if value is system-missing
MISSING	Returns 1 (true) if value is system- or user-missing
VALUE	Returns the value itself, ignoring user-missing flags

IMPORT

```
IMPORT FILE='filename' [/KEEP={ALL    }] [/DROP=varlist]
                              {varlist}
     [/RENAME=(old varlist=new varlist)...] [/MAP]
```

INCLUDE

```
{INCLUDE 'filename'}
{@filename         }
```

JOIN

```
[JOIN] {MATCH}
       {ADD  }
  /{FILE }=*{file specification}
   {TABLE}  {*                 }
 [/KEEP=varlist ] [/DROP=varlist ]
 [/RENAME (old varlist=new varlist) [(old varlist=...)]]
  /FILE=...
    ...
 [/FILE=...  ]
    ...
 [/MAP] [/BY=varlist]
```

LIST

```
LIST [[VARIABLES=]{ALL**  }]
                  {varlist}
  [/CASES=[FROM {1**}] [TO {eof**}] [BY {1**}] ]
                {n   }     {n    }       {n  }
  [/FORMAT={(UNNUMBERED**)}] [{WRAP**}] [WEIGHT] ]
           {(NUMBERED    )}  {(SINGLE)}
```

MEANS

```
MEANS [TABLES=] {varlist} BY varlist [BY varlist ...]
                {ALL    }
                {/varlist...}
     [/OPTIONS=option numbers]
     [/STATISTICS={statistic numbers}]
                  {ALL              }
```

Options:

1 Include user-missing values	8 Suppress value labels
2 Exclude cases with user-missing dependent values	9 Suppress independent variable names
3 Suppress all labels	10 Suppress independent variable values
5 Suppress group counts	11 Suppress group means
6 Display group sums	12 Display group variances
7 Suppress group standard deviations	

Statistics:

1 One-way analysis of variance
2 Test of linearity

MISSING VALUE

```
MISSING VALUE  {varlist}(({value})) [[/]varlist ...]
               {ALL    }
```

N

```
N n [ESTIMATED]
```

NPAR TESTS

```
NPAR TESTS  [CHISQUARE=varlist [(lo,hi)]]
   [/EXPECTED={EQUAL**      }]
              {f1,f2, ...fn}
   [/K-S ({UNIFORM [,lo,hi]})=varlist]
          {NORMAL [,m,sd]  }
          {POISSON [,m]    }
   [/RUNS ({MEAN  })=varlist]
          {MEDIAN }
          {MODE   }
          {value  }
   [/BINOMIAL [({.5})]=varlist ({value1,value2})]
              {p   }           {value          }
   [/MCNEMAR=varlist] [WITH varlist]
   [/SIGN=varlist] [WITH varlist]
   [/WILCOXON=varlist] [WITH varlist ]
   [/COCHRAN=varlist]
   [/FRIEDMAN=varlist]
   [/KENDALL=varlist]
   [/MEDIAN [(value)]=varlist BY var (value1,value2)]
   [/M-W=varlist BY var (value1,value2)]
   [/K-S=varlist BY var (value1,value2)]
   [/W-W=varlist BY var (value1,value2)]
   [/MOSES[(n)]=varlist BY var (value1,value2)]
   [/K-W=varlist BY var (value1,value2)]
   [/OPTIONS=option numbers]
   [/STATISTICS=statistic numbers]
```

Options:

1 Include user-missing values	3 Sequential pairing of variables for two related samples
2 Exclude missing values listwise	4 Random sampling

Statistics:

1 Mean, maximum, minimum, standard deviation, and count
2 Quartiles and count

ONEWAY

```
ONEWAY [VARIABLES=]varlist BY varname(min,max)
   [/POLYNOMIAL=n]
   [/CONTRAST=coefficient list] [/CONTRAST=...]
   [/RANGES={(SNK          )}] [RANGES=...]
            {(TUKEY        )}
            {(HTUKEY       )}
            {(ranges values)}
            {(LSD          )}  [({.05  })]
            {(DUNCAN       )}   {alpha}
            {(MODLSD       )}
            {(SCHEFFE      )}
   [/OPTIONS=option numbers]
   [/STATISTICS={statistic numbers}]
                {ALL              }
```

Options:

1 Include user-missing values	7 Read matrix of counts, means, and standard deviations
2 Exclude missing values listwise	8 Read matrix of counts, means, pooled variance, and degrees of freedom
3 Suppress variable labels	10 Harmonic mean of all group sizes as sample sizes in range tests
4 Write matrix of counts, means, and standard deviations	
6 Use value labels as group labels	

Statistics:

1 Group descriptive statistics
2 Fixed- and random-effects statistics
3 Homogeneity of variance tests

PLOT

```
PLOT [MISSING=[{PLOTWISE**} ] [INCLUDE]]
             {LISTWISE  }
  [/HSIZE={38**}] [/VSIZE={16**}]
          {n   }         {n   }
  [/CUTPOINT={EVERY({1**})}]
             {      {n  }}
             {value list }
  [/SYMBOLS={ALPHANUMERIC**                    }]
            {NUMERIC                           }
            {'symbols'[,'overplot symbols']    }
            {X'hexsymbs'[,'overplot hexsymbs'] }
  [/HORIZONTAL=['title'] [STANDARDIZE] [REFERENCE(vector)]]
                {MIN(min)} [MAX(max)]
                {UNIFORM}
  [/VERTICAL=['title'] [STANDARDIZE] [REFERENCE(vector)]]
              {MIN(min)} [MAX(max)]
              {UNIFORM}
  [/FORMAT={DEFAULT**          }]
           {CONTOUR[({10})]    }
           {       {n  }       }
           {OVERLAY            }
           {REGRESSION         }
  [/TITLE='title']
  /PLOT={varlist} [WITH varlist [(PAIR)] [BY varname] [.varlist...]]
        {ALL    }
  [/PLOT=...]
```

PROCESS IF

```
PROCESS IF [(]variable (relational operator) value[)]
```

Relational Operators:

EQ or = NE or ~= or <>
LT or < LE or <=
GT or > GE or >=

RECODE

Numeric Recodes:

```
RECODE varlist (value list=value)...(value list=value)

       [/varlist...]
```

Input keywords available for numeric recodes are:

LO LOWEST HI HIGHEST THRU MISSING SYSMIS ELSE

Output keywords available for numeric recodes are:

SYSMIS

String Recodes:

```
RECODE varlist ('string',['string'...]='string')

       [varlist...]
```

Input keywords available for string recodes are:

ELSE

REGRESSION

```
REGRESSION VARIABLES={varlist }
                     {ALL    }
                     {(COLLECT)}
  [/STATISTICS={DEFAULTS**} [R] [COEFF] [ANOVA] [OUTS]
               {ZPP       } [CHA] [CI] [F] [BCOV] [SES] [TOL]
               {COND      } [XTX] [HISTORY] [END] [LINE] [ALL]]
  [/CRITERIA=[DEFAULTS**] [TOLERANCE({0.01 })] [MAXSTEPS({2v})]
                                     {value}            {n }
             [{PIN({0.05 })}]     [{POUT({0.1 })}]
              {    {value}  }      {     {value} }
              {FIN({3.84  })}      {POUT({2.71 })}
              {    {value}  }      {     {value} }
  [/{NOORIGIN**}]
    {ORIGIN    }
  /DEPENDENT=varlist
  /[METHOD=]{STEPWISE [=varlist]    } [/METHOD=...]
            {FORWARD [=varlist]     }
            {BACKWARD [=varlist]    }
            {ENTER [=varlist]       }
            {REMOVE=varlist         }
            {TEST=(varlist) (varlist)}
  [/DESCRIPTIVES={DEFAULTS} [MEAN] [STDDEV] [CORR]
                 {VARIANCE} [XPROD] [SIG] [N] [BADCORR]
                 {COV     } [ALL]   [NONE**]]
  [/SELECT={ALL**                  }]
           {varname relation value }
  [/MISSING={LISTWISE**      } [INCLUDE]]
            {PAIRWISE        }
            {MEANSUBSTITUTION}
  [/WIDTH={value on SET**}]
          {n             }
```

REGRESSION: Matrix Materials

```
REGRESSION [READ=[DEFAULTS] [MEAN] [STDDEV]
                 [VARIANCE] [{CORR}] [N]]
                            {COV }
  [/WRITE=[DEFAULTS] [MEAN] [STDDEV]
          [VARIANCE] [CORR] [COV]
          [N] [NONE**]]
  /VARIABLES=varlist/DEPENDENT=varlist/METHOD=method
```

REGRESSION: Residuals

```
REGRESSION  VARIABLES=varlist/ DEPENDENT=varname/ METHOD=method

  [/RESIDUALS=[DEFAULTS] [DURBIN]
       [OUTLIERS({ZRESID    })] [ID (varname)]
                 {tempvarlist}
       [NORMPROB({ZRESID    })] [HISTOGRAM({ZRESID    })]
                 {tempvarlist}             {tempvarlist}
       [SIZE({SMALL})] [{SEPARATE}]]
             {LARGE}   {POOLED  }
  [/CASEWISE=[DEFAULTS] [{OUTLIERS({3    })}]]
                         {       {value}  }
                         {ALL             }
            [PLOT({ZRESID  })] [{DEPENDENT PRED RESID}]]
                  {tempvar }   {tempvarlist           }
  [/SCATTERPLOT=(varname,*tempvarname)... [SIZE({SMALL})]]
                                               {LARGE}
  [/PARTIALPLOT=[{ALL                  }] [SIZE({SMALL})]]
                 {varname,varname,...  }        {LARGE}
  [/SAVE=tempvar(newname) [tempvar(newname)... ]]
```

Temporary residual variables are:

```
PRED AIMPRED SRESID MAHAL RESID ZPRED SDRESID
COOK DRESID ZRESID SEPRED LEVER
```

REPORT

```
REPORT
 [FORMAT=[TSPACE({1})] [CHDSPACE({1})]
                 {n}             {n}
       [BRKSPACE({1})] [FTSPACE({1})]
                 {n}             {n}
       [LENGTH({SET length})] [MARGINS({SET width})]
               {n,n         }          {n,n      }
       [{NOLIST  }] [SUMSPACE({1})]
        {LIST[(n)]}           {n}
       [MISSING {' '}]]
                {'c'}

[/STRING=stringname ([varname] [(width)] [(BLANK)]
         ['string']...)[stringname...]]

/VARIABLES={var          } [({VALUE})] ['col head'] [(width)]
           {var TO var   }  {LABEL }
                            {DUMMY }

          [(OFFSET({0})]] [var...]
                   {n}

[/MISSING={VAR                }]
          {NONE               }
          {LIST(varlist{1})   }
                       {n}

[/TITLE='line1' 'line2'...] [/FOOTNOTE='line1' 'line2'...]
          or                                  or

{/LTITLE='line1' 'line2'...} {/LFOOTNOTE='line1' 'line2'...}
{/CTITLE='line1' 'line2'...} {/CFOOTNOTE='line1' 'line2'...}
{/RTITLE='line1' 'line2'...} {/RFOOTNOTE='line1' 'line2'...}
/BREAK=varlist [({VALUE})] ['col head'] [(width)]
                {LABEL }

       [OFFSET({0})] [({NOTOTAL})]
                {n}  {{TOTAL  }}
       [({NONAME})] [({SKIP({1})})]
         {NAME   }          {n}
                    {PAGE  }
```

or

```
/BREAK=(NOBREAK) ((width)] [(OFFSET({0}))][(SKIP({1}))]
                            {n}           {n}

[/SUMMARY=function...['summary title'][(break col #)]

          [SKIP({0})]]
                {n}
```

or

```
[/SUMMARY=PREVIOUS[(n)]]
```

where function is

```
aggregate [(varname[(d)][({PLAIN  })] [varname...])]
                         {DOLLAR }
                         {COMMA  }
```

or

```
composite(agg(varname)...)[(report col[(d)][({PLAIN  })])]
                                            {DOLLAR }
                                            {COMMA  }
```

Aggregate Functions:

VALIDN	VARIANCE	PCGT(n)
SUM	KURTOSIS	PCLT(n)
MIN	SKEWNESS	PCIN(min,max)
MAX	MEDIAN(min,max)	ADDFRQ(min,max)
MEAN	MODE(min,max)	RELFRQ(min,max)
STDEV		

Composite Functions

DIVIDE(agg(varname) agg(varname) [factor])
PCT(agg(varname) agg(varname))
SUBTRACT(agg(varname) agg(varname))
ADD(agg(varname) agg(varname) ...)
GREAT(agg(varname) agg(varname) ...)
LEAST(agg(varname) agg(varname) ...)
AVERAGE(agg(varname) agg(varname) ...)
MULTIPLY(agg(varname) agg(varname) ...)

REVIEW

```
REVIEW [{LOG      }]
       {LISTING  }
       {BOTH     }
       {'filename' ['filename']}
```

SAMPLE

```
SAMPLE {sampling fraction          }
       {sample size FROM file size}
```

SAVE

```
SAVE [OUTFILE={SPSS.SYS**}] [/DROP=varlist]
              {'filename'}

 [/{COMPRESSED  }]
   {UNCOMPRESSED}
   {QUICK       }
```

SELECT IF

```
SELECT IF  (logical expression)
```

Relational Operators:

EQ or =	Equal to	NE or ~= or <>	Not equal to
LT or <	Less than	LE or <=	Less than or equal to
GT or >	Greater than	GE or >=	Greater than or equal to

Logical Operators:

AND or & OR or | NOT or ~

Missing-Value Functions:

SYSMIS	Returns 1 (true) if value is system-missing
MISSING	Returns 1 (true) if value is system- or user-missing
VALUE	Returns the value itself, ignoring user-missing flags

SET

```
SET [SCREEN={ON }]/  [PRINTER={OFF}]/  [LISTING={SPSS.LIS  }]/
           {OFF}             {ON }             {ON       }
                                               {OFF      }
                                               {'filename'}

    [LENGTH={24}]/  [WIDTH={79     }]/  [EJECT={OFF}]/
           {n  }          {132    }            {ON }
                          {n      }
                          {NARROW }
                          {WIDE   }

    [LOG={SPSS.LOG }]/  [RESULTS={'SPSS.PRC'}]/
         {ON       }             {'filename'}
         {OFF      }
         {'filename'}

    [HISTOGRAM={'■'   }]/  [BLOCK={'■'   }]/
               {'char'}           {'char'}

    [BOXSTRING={'-|+++++++++'}]/  [PTRANSLATE={ON }]/
               {'11 char'    }                {OFF}
               {'3 char'     }

    [INCLUDE={ON }]/  [ECHO={OFF}]/
             {OFF}          {ON }

    [PROMPT={'SPSS/PC:'}]/  [CPROMPT={'      :'}]/  [MORE={ON }]/
            {'string'  }             {'string'  }         {OFF}

    [ENDCMD={'.'   }]/  [NULLINE={ON }]/  [BEEP={ON }]/
            {'char'}             {OFF}            {OFF}

    [COLOR={(7,1,1)  }]/  [RCOLOR={(1,2,4)  }]/
           {ON       }             {(a,b[,c])}
           {OFF      }
           {(a,b[,c])}

    [COMPRESS={OFF}]/  [WORKDEV=device]/
              {ON }

    [BLANKS={' '     }]/  [SEED={RANDOM}]/
            {real num}          {number}
```

When SCREEN is OFF, the following defaults are in effect.

```
LENGTH=59  EJECT=ON
BOXSTRING='-|+++++++++'  HISTOGRAM='X'  BLOCK='X'
```

SHOW

```
SHOW
```

SORT

```
SORT CASES [BY] varlist [({A})] [varlist...]
                          {D}
```

SPSS MANAGER

```
SPSS MANAGER [{REMOVE  =procedure-name [.procedure-name...] }
             {INSTALL =procedure-name [.procedure-name...] }
             {STATUS  [=procedure-name [.procedure-name...]]}
           [/{CONFIRM  }]
             {NOCONFIRM}
           [/FROM={'device or path specification'}]
                  {'A:'                          }
```

SUBTITLE

```
SUBTITLE [{'}] text [{'}]
         {"}        {"}
```

TITLE

```
TITLE [{'}] text [{'}]
      {"}        {"}
```

T-TEST

Independent Samples:

```
T-TEST GROUPS=varname [({1,2       })] /VARIABLES=varlist
                       {value     }
                       {value,value}
      [/OPTIONS=option numbers]
```

Paired Samples:

```
T-TEST PAIRS=varlist [WITH varlist] [/{PAIRS=} varlist ...]
      [/OPTIONS=option numbers]
```

Options:

1 Include user-missing values
2 Exclude missing values listwise
3 Suppress variable labels
5 Special pairing for WITH

VALUE LABELS

```
VALUE LABELS  varlist value 'label' value 'label' ...
             [/varlist ...]
```

VARIABLE LABELS

```
VARIABLE LABELS  varlist 'label' [[/]varname ...]
```

WEIGHT

```
WEIGHT  {BY varname}
        {OFF       }
```

WRITE

```
WRITE [VARIABLES={ALL**  }]
                 {varlist}
  [/CASES=[FROM {1**}] [TO {eof**}]
                {n  }      {n  }
          [BY {1**}]]
              {n  }
  [/FORMAT=[{UNNUMBERED**}] [{WRAP**}] [WEIGHT]]
            {NUMBERED    }   {SINGLE}
```

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Table VI VALUES OF THE EXPONENTIAL FUNCTION $e^{-\lambda}$

λ	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.00	1.000	0.990	0.980	0.970	0.961	0.951	0.942	0.932	0.923	0.914
0.10	0.905	0.896	0.887	0.878	0.869	0.861	0.852	0.844	0.835	0.827
0.20	0.819	0.811	0.803	0.795	0.787	0.779	0.771	0.763	0.756	0.748
0.30	0.741	0.733	0.726	0.719	0.712	0.705	0.698	0.691	0.684	0.677
0.40	0.670	0.664	0.657	0.651	0.644	0.638	0.631	0.625	0.619	0.613
0.50	0.607	0.600	0.595	0.589	0.583	0.577	0.571	0.566	0.560	0.554
0.60	0.549	0.543	0.538	0.533	0.527	0.522	0.517	0.512	0.507	0.502
0.70	0.497	0.492	0.487	0.482	0.477	0.472	0.468	0.463	0.458	0.454
0.80	0.449	0.445	0.440	0.436	0.432	0.427	0.423	0.419	0.415	0.411
0.90	0.407	0.403	0.399	0.395	0.391	0.387	0.383	0.379	0.375	0.372
1.00	0.368	0.364	0.361	0.357	0.353	0.350	0.346	0.343	0.340	0.336
1.10	0.333	0.330	0.326	0.323	0.320	0.317	0.313	0.310	0.307	0.304
1.20	0.301	0.298	0.295	0.292	0.289	0.287	0.284	0.281	0.278	0.275
1.30	0.273	0.270	0.267	0.264	0.262	0.259	0.257	0.254	0.252	0.249
1.40	0.247	0.244	0.242	0.239	0.237	0.235	0.232	0.230	0.228	0.225
1.50	0.223	0.221	0.219	0.217	0.214	0.212	0.210	0.208	0.206	0.204
1.60	0.202	0.200	0.198	0.196	0.194	0.192	0.190	0.188	0.186	0.185
1.70	0.183	0.181	0.179	0.177	0.176	0.174	0.172	0.170	0.169	0.167
1.80	0.165	0.164	0.162	0.160	0.159	0.157	0.156	0.154	0.153	0.151
1.90	0.150	0.148	0.147	0.145	0.144	0.142	0.141	0.139	0.138	0.137
2.00	0.135	0.134	0.133	0.131	0.130	0.129	0.127	0.126	0.125	0.124
2.10	0.122	0.121	0.120	0.119	0.118	0.116	0.115	0.114	0.113	0.112
2.20	0.111	0.110	0.109	0.108	0.106	0.105	0.104	0.103	0.102	0.101
2.30	0.100	0.0992	0.0983	0.0973	0.0963	0.0953	0.0944	0.0935	0.0926	0.0916
2.40	0.0907	0.0898	0.0889	0.0880	0.0872	0.0863	0.0854	0.0846	0.0837	0.0829
2.50	0.0821	0.0813	0.0805	0.0797	0.0789	0.0781	0.0773	0.0765	0.0758	0.0750
2.60	0.0743	0.0735	0.0728	0.0721	0.0714	0.0707	0.0699	0.0693	0.0686	0.0679
2.70	0.0672	0.0665	0.0659	0.0652	0.0646	0.0639	0.0633	0.0627	0.0620	0.0614
2.80	0.0608	0.0602	0.0596	0.0590	0.0584	0.0578	0.0573	0.0567	0.0561	0.0556
2.90	0.0550	0.0545	0.0539	0.0534	0.0529	0.0523	0.0518	0.0513	0.0508	0.0503

From Avram Goldstein, *Biostatistics*. New York: Macmillan, 1964. Reprinted by permission.