LECTURE - APPLIED Regression - MLR Models

Example of Model Buildind

Problem 6.7 - MS

6.6. Clerical staff work hours. In any production process in which one or more workers are engaged in a variety of tasks, the total time spent in production varies as a function of the size of the work pool and the level of output of the various activities. For example, in a large metropolitan department store, the number of hours worked (y)per day by the clerical staff may depend on the following variables:

x_1 = Number of pieces of mail processed (open, sort, etc.)

x_2 = Number of money orders and gift certificates sold

x_3 = Number of window payments (customer charge accounts) transacted

x_4 = Number of change order transactions processed

x_5 = Number of checks cashed

x_6 = Number of pieces of miscellaneous mail processed on an "as available" basis

x_7 = Number of bus tickets sold

Data is in file "CLERICAL.Rdata".

DATA

	OBS	DAY	Y	X1	X2	X3	X4	X5	X6	X7
1	1.00	M	128.50	7781.00	100.00	886.00	235.00	644.00	56.00	737.00
2	2.00	T	113.60	7004.00	110.00	962.00	388.00	589.00	57.00	1029.00
3	3.00	W	146.60	7267.00	61.00	1342.00	398.00	1081.00	59.00	830.00
4	4.00	Th	124.30	2129.00	102.00	1153.00	457.00	891.00	57.00	1468.00
5	5.00	F	100.40	4878.00	45.00	803.00	577.00	537.00	49.00	335.00
6	6.00	S	119.20	3999.00	144.00	1127.00	345.00	563.00	64.00	918.00

PARARMETER ESTIMATES of THE FULL MODEL

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	60.5538	9.4952	6.38	0.0000
X1	0.0013	0.0009	1.47	0.1481
X2	0.0873	0.0483	1.81	0.0774
X3	0.0087	0.0092	0.95	0.3485
X4	-0.0428	0.0173	-2.47	0.0176
X5	0.0468	0.0120	3.91	0.0003
X6	0.2092	0.1302	1.61	0.1153
X7	0.0048	0.0055	0.87	0.3866

Results Forward Selection($\alpha = 0.05$)

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	77.7256	6.9102	11.25	0.0000
X5	0.0583	0.0097	6.00	0.0000
X2	0.1363	0.0454	3.00	0.0043
X4	-0.0347	0.0171	-2.02	0.0486

Results Forward Selection($\alpha = 0.10$)

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	70.4491	7.7242	9.12	0.0000
X5	0.0507	0.0102	4.96	0.0000
X2	0.1021	0.0477	2.14	0.0373
X4	-0.0340	0.0167	-2.04	0.0474
X6	0.2523	0.1317	1.92	0.0615

Backward Selection($\alpha = 0.10$)

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	70.4491	7.7242	9.12	0.0000
X2	0.1021	0.0477	2.14	0.0373
X4	-0.0340	0.0167	-2.04	0.0474
X5	0.0507	0.0102	4.96	0.0000
X6	0.2523	0.1317	1.92	0.0615

Backward Selection($\alpha = 0.15$)

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	68.2744	7.7020	8.86	0.0000
X2	0.0831	0.0482	1.72	0.0916
X3	0.0139	0.0084	1.65	0.1067
X4	-0.0434	0.0174	-2.50	0.0160
X5	0.0447	0.0107	4.18	0.0001
X6	0.2291	0.1301	1.76	0.0849

Using Package - mixlm & leaps

	(Intercept)	X1	X2	X3	X4	X5	X6	X7	SSE	RSQ	adjR2	Cp	BIC
X6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	5406.88	0.56	0.50	6.76	-15.13
X6.1	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	5422.96	0.56	0.50	6.90	-14.98
X7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	5314.50	0.57	0.50	8.00	-12.08
X5	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	5602.49	0.54	0.50	6.38	-17.24
X5.1	1.00	1.00	1.00	0.00	1.00	1.00	1.00	0.00	5621.35	0.54	0.49	6.54	-17.06
X6.2	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	5576.23	0.55	0.49	8.17	-13.53
X5.2	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	5736.11	0.53	0.48	7.49	-16.01
X6.3	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	5626.25	0.54	0.48	8.58	-13.07
X5.3	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	5760.04	0.53	0.48	7.69	-15.80
X4	1.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00	5932.15	0.52	0.48	7.11	-18.22
X5.4	1.00	1.00	0.00	1.00	1.00	1.00	1.00	0.00	5815.62	0.53	0.48	8.15	-15.30
X5.5	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	5830.77	0.53	0.47	8.27	-15.16
X6.4	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	5709.55	0.54	0.47	9.27	-12.30
X4.1	1.00	0.00	0.00	1.00	1.00	1.00	1.00	0.00	5964.02	0.52	0.47	7.38	-17.94
X4.2	1.00	0.00	1.00	1.00	1.00	1.00	0.00	0.00	5980.03	0.51	0.47	7.51	-17.80
X4.3	1.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00	6000.75	0.51	0.47	7.68	-17.62
X5.6	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	5924.96	0.52	0.47	9.05	-14.33
X5.7	1.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	5943.42	0.52	0.46	9.21	-14.17
X5.8	1.00	0.00	1.00	1.00	1.00	1.00	0.00	1.00	5949.36	0.52	0.46	9.26	-14.11
X5.9	1.00	1.00	1.00	0.00	0.00	1.00	1.00	1.00	6052.29	0.51	0.46	10.11	-13.22
X4.4	1.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00	6218.87	0.49	0.45	9.49	-15.76
X4.5	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	6233.04	0.49	0.45	9.60	-15.64
X3	1.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00	6395.31	0.48	0.45	8.95	-18.26
X4.6	1.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	6270.71	0.49	0.45	9.92	-15.33
X6.5	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	6049.20	0.51	0.44	12.08	-9.30
X3.1	1.00	0.00	1.00	0.00	0.00	1.00	1.00	0.00	6455.48	0.48	0.44	9.45	-17.77
X4.7	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	6340.84	0.49	0.44	10.50	-14.75
X4.8	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	6364.19	0.48	0.44	10.69	-14.56
X4.9	1.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	6366.12	0.48	0.44	10.71	-14.54
X3.2	1.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	6511.71	0.47	0.44	9.91	-17.32
X3.3	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	6630.08	0.46	0.43	10.89	-16.38
X3.4	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	6713.73	0.45	0.42	11.58	-15.73
X3.5	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	6758.55	0.45	0.42	11.96	-15.39
X3.6	1.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	6765.28	0.45	0.42	12.01	-15.33
X2	1.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	6941.03	0.44	0.41	11.47	-17.95

Using Package - olsrr

	mindex	n	predictors	rsquare	adjr	predrsq	cp	aic	sbic	sbc	msep	fpe	apc	hsp
5	1	1	X5	0.34	0.33	0.30	18.78	415.86	267.31	421.72	8388.26	167.51	0.71	3.29
66	92	4	X1 X2 X3 X6	0.35	0.30	0.19	24.13	421.36	271.56	433.07	8849.16	186.29	0.79	3.69
86	93	4	X2 X3 X4 X7	0.33	0.27	0.20	26.11	422.89	272.84	434.60	9113.85	191.86	0.81	3.81
67	94	4	X1 X2 X3 X7	0.32	0.26	0.17	27.82	424.18	273.93	435.89	9343.03	196.69	0.83	3.90
76	95	4	X1 X3 X4 X7	0.31	0.25	0.19	28.73	424.85	274.50	436.56	9464.23	199.24	0.84	3.95
70	96	4	X1 X2 X4 X7	0.28	0.22	0.14	31.60	426.93	276.25	438.63	9849.19	207.34	0.88	4.11
64	97	4	X1 X2 X3 X4	0.27	0.21	0.13	32.60	427.62	276.84	439.33	9982.30	210.15	0.89	4.17
69	98	4	X1 X2 X4 X6	0.27	0.20	0.10	32.79	427.76	276.95	439.46	10007.80	210.68	0.89	4.18
114	99	5	X2 X3 X4 X5 X6	0.54	0.50	0.43	6.38	404.92	258.77	418.57	6344.70	135.85	0.57	2.71
105	100	5	X1 X2 X4 X5 X6	0.54	0.49	0.44	6.54	405.09	258.90	418.75	6366.06	136.30	0.58	2.72
99	101	5	X1 X2 X3 X4 X5	0.53	0.48	0.43	7.49	406.14	259.69	419.80	6496.02	139.09	0.59	2.77
106	102	5	X1 X2 X4 X5 X7	0.53	0.48	0.42	7.69	406.36	259.86	420.02	6523.12	139.67	0.59	2.78
109	103	5	X1 X3 X4 X5 X6	0.53	0.48	0.42	8.15	406.86	260.23	420.52	6586.07	141.01	0.60	2.81
118	104	5	X2 X4 X5 X6 X7	0.53	0.47	0.41	8.27	406.99	260.34	420.65	6603.22	141.38	0.60	2.82
119	105	5	X3 X4 X5 X6 X7	0.52	0.47	0.40	9.05	407.83	260.97	421.48	6709.89	143.67	0.61	2.86
113	106	5	X1 X4 X5 X6 X7	0.52	0.46	0.40	9.21	407.99	261.09	421.65	6730.79	144.11	0.61	2.87
115	107	5	X2 X3 X4 X5 X7	0.52	0.46	0.41	9.26	408.04	261.13	421.70	6737.52	144.26	0.61	2.87
108	108	5	X1 X2 X5 X6 X7	0.51	0.46	0.38	10.11	408.93	261.81	422.59	6854.09	146.75	0.62	2.92
102	109	5	X1 X2 X3 X5 X6	0.50	0.44	0.37	11.18	410.03	262.65	423.69	7000.94	149.90	0.63	2.99
117	110	5	X2 X3 X5 X6 X7	0.49	0.43	0.35	12.27	411.13	263.50	424.79	7150.44	153.10	0.65	3.05
110	111	5	X1 X3 X4 X5 X7	0.48	0.43	0.39	12.82	411.67	263.92	425.33	7225.49	154.70	0.65	3.08
103	112	5	X1 X2 X3 X5 X7	0.48	0.42	0.36	13.12	411.97	264.14	425.63	7266.32	155.58	0.66	3.10
112	113	5	X1 X3 X5 X6 X7	0.47	0.42	0.33	13.59	412.43	264.50	426.09	7330.67	156.96	0.66	3.13
116	114	5	X2 X3 X4 X6 X7	0.42	0.35	0.25	19.55	417.91	268.79	431.57	8145.97	174.41	0.74	3.47
111	115	5	X1 X3 X4 X6 X7	0.41	0.35	0.26	19.96	418.26	269.06	431.92	8201.22	175.60	0.74	3.50
104	116	5	X1 X2 X3 X6 X7	0.40	0.33	0.22	21.56	419.64	270.15	433.29	8420.88	180.30	0.76	3.59
107	117	5	X1 X2 X4 X6 X7	0.38	0.31	0.23	23.12	420.94	271.19	434.60	8634.20	184.87	0.78	3.68
100	118	5	X1 X2 X3 X4 X6	0.37	0.31	0.21	23.87	421.55	271.68	435.21	8736.85	187.06	0.79	3.73
101	119	5	X1 X2 X3 X4 X7	0.34	0.26	0.18	27.72	424.59	274.13	438.25	9262.67	198.32	0.84	3.95
120	120	6	X1 X2 X3 X4 X5 X6	0.56	0.50	0.44	6.76	405.07	259.71	420.68	6262.34	136.33	0.58	2.73
124	121	6	X1 X2 X4 X5 X6 X7	0.56	0.50	0.43	6.90	405.22	259.82	420.83	6280.97	136.73	0.58	2.74
126	122	6	X2 X3 X4 X5 X6 X7	0.55	0.49	0.41	8.17	406.67	260.84	422.28	6458.49	140.60	0.59	2.82
121	123	6	X1 X2 X3 X4 X5 X7	0.54	0.48	0.42	8.58	407.14	261.17	422.75	6516.42	141.86	0.60	2.84
125	124	6	X1 X3 X4 X5 X6 X7	0.54	0.47	0.41	9.27	407.90	261.71	423.51	6612.90	143.96	0.61	2.88
123	125	6	X1 X2 X3 X5 X6 X7	0.51	0.44	0.35	12.08	410.90	263.87	426.51	7006.29	152.52	0.64	3.06
122	126	6	X1 X2 X3 X4 X6 X7	0.42	0.34	0.24	21.25	419.65	270.33	435.26	8289.07	180.45	0.76	3.61
127	127	7	X1 X2 X3 X4 X5 X6 X7	0.57	0.50	0.42	8.00	406.17	261.44	423.73	6298.49	139.37	0.59	2.81