

Contents

Preface	xv
1. Introduction	1
1.1. C C & I, 1	
1.1.1 Construction, 1	
1.1.2 Characterization, 2	
1.1.3 Inference, 3	
1.2. Illustrations, 4	
1.2.1 Residuals versus fitted values, 4	
1.2.2 Residuals versus the predictors, 6	
1.2.3 Residuals versus the response, 7	
1.3. On things to come, 9	
1.4. Notational conventions, 10	
Problems, 13	
2. Introduction to 2D Scatterplots	14
2.1. Response plots in simple regression, 14	
2.2. New Zealand horse mussels, 15	
2.3. Transforming y via inverse response plots, 20	
2.3.1 Response transformations, 21	
2.3.2 Response transformations: Mussel data, 24	
2.4. Danish twins, 25	
2.5. Scatterplot matrices, 29	
2.5.1 Construction, 29	
2.5.2 Example, 31	

2.6.	Regression graphics in the 1920s, 32	
2.6.1	Ezekiel's successive approximations, 32	
2.6.2	Bean's graphic method, 34	
2.7.	Discussion, 37	
	Problems, 38	
3.	Constructing 3D Scatterplots	40
3.1.	Getting an impression of 3D, 40	
3.2.	Depth cuing, 42	
3.3.	Scaling, 43	
3.4.	Orthogonalization, 44	
	Problems, 46	
4.	Interpreting 3D Scatterplots	47
4.1.	Haystacks, 47	
4.2.	Structural dimensionality, 49	
4.2.1	One predictor, 49	
4.2.2	Two predictors, 50	
4.2.3	Many predictors, 51	
4.3.	One-dimensional structure, 51	
4.4.	Two-dimensional structure, 55	
4.4.1	Removing linear trends, 55	
4.4.2	Identifying semiparametric regression functions, 56	
4.5.	Assessing structural dimensionality, 58	
4.5.1	A visual metaphor for structural dimension, 59	
4.5.2	A first method for deciding $d = 1$ or 2, 59	
4.5.3	Natural rubber, 61	
4.6.	Assessment methods, 63	
4.6.1	Using independence, 64	
4.6.2	Using uncorrelated 2D views, 65	
4.6.3	Uncorrelated 2D views: Haystack data, 67	
4.6.4	Intraslice residuals, 69	
4.6.5	Intraslice orthogonalization, 71	
4.6.6	Mussels again, 72	
4.6.7	Discussion, 73	
	Problems, 74	

5. Binary Response Variables	78
5.1. One predictor, 78	
5.2. Two predictors, 79	
5.2.1 Checking 0D structure, 82	
5.2.2 Checking 1D structure, 82	
5.2.3 Comparison with previous checking methods, 84	
5.2.4 Exploiting the binary response, 85	
5.3. Illustrations, 86	
5.3.1 Australian Institute of Sport, 86	
5.3.2 Kyphosis data, 89	
5.4. Three predictors, 91	
5.4.1 Checking 1D structure, 91	
5.4.2 Kyphosis data again, 93	
5.5. Visualizing a logistic model, 94	
5.5.1 Conditionally normal predictors, 95	
5.5.2 Other predictor distributions, 98	
Problems, 99	
6. Dimension-Reduction Subspaces	101
6.1. Overview, 101	
6.2. Dimension-reduction subspaces, 103	
6.3. Central subspaces, 105	
6.4. Guaranteeing $\mathcal{S}_{y x}$ by constraining ..., 108	
6.4.1 ... the distribution of x , 108	
6.4.2 ... the distribution of $y x$, 111	
6.5. Importance of central subspaces, 112	
6.6. h -Level response plots, 114	
Problems, 117	
7. Graphical Regression	120
7.1. Introduction to graphical regression, 120	
7.2. Capturing $\mathcal{S}_{y x_1}$, 124	
7.2.1 Example: Linear regression, 125	
7.2.2 Example: $\mathcal{S}_{y x_1} = \mathcal{S}(\eta_1)$, but $\mathcal{S}_{y x_2} \neq \mathcal{S}(\eta_2)$, 126	
7.3. Forcing $\mathcal{S}_{y x_1} \subset \mathcal{S}(\eta_1)$, 127	
7.3.1 Location regressions for the predictors, 128	
7.3.2 Elliptically contoured distributions, 129	
7.3.3 Elliptically contoured predictors, 131	

7.4.	Improving resolution,	134
7.5.	Forcing $\mathcal{S}_{y x_1} = \mathcal{S}(\eta_1)$,	137
7.5.1	Example: x_1 independent of x_2 , but $\mathcal{S}_{y x_1} \neq \mathcal{S}(\eta_1)$,	137
7.5.2	Conditions for $\mathcal{S}_{y x_1} = \mathcal{S}(\eta_1)$,	137
7.5.3	Marginal consistency assumption,	139
7.6.	Visual fitting with h -level response plots,	140
	Problems,	142
8.	Getting Numerical Help	143
8.1.	Fitting with linear kernels,	143
8.1.1	Isomerization data,	145
8.1.2	Using the Li–Duan Proposition,	146
8.2.	Quadratic kernels,	147
8.3.	The predictor distribution,	150
8.4.	Reweighting for elliptical contours,	153
8.4.1	Voronoi weights,	154
8.4.2	Target distribution,	155
8.4.3	Modifying the predictors,	156
	Problems,	158
9.	Graphical Regression Studies	159
9.1.	Naphthalene data,	159
9.1.1	Naphthoquinone, Y_N ,	161
9.1.2	Phthalic anhydride, Y_p ,	170
9.2.	Wheat protein,	175
9.3.	Reaction yield,	179
9.4.	Discussion,	184
	Problems,	184
10.	Inverse Regression Graphics	187
10.1.	Inverse regression function,	187
10.1.1	Mean checking condition,	191
10.1.2	Mean checking condition: Wheat protein,	193
10.1.3	Mean checking condition: Mussel data,	194
10.2.	Inverse variance function,	196
10.2.1	Variance checking condition,	199
10.2.2	Variance checking condition: Ethanol data,	200
	Problems,	201

11. Sliced Inverse Regression	203
11.1. Inverse regression subspace, 203	
11.2. SIR, 204	
11.3. Asymptotic distribution of $\hat{\Lambda}_d$, 206	
11.3.1 Overview, 206	
11.3.2 The general case, 208	
11.3.3 Distribution of $\hat{\Lambda}_d$ with constraints, 210	
11.4. SIR: Mussel data, 213	
11.5. Minneapolis schools, 216	
11.6. Discussion, 220	
Problems, 222	
12. Principal Hessian Directions	224
12.1. Incorporating residuals, 225	
12.2. Connecting $\mathcal{S}_{e z}$ and \mathcal{S}_{ezz} when ..., 227	
12.2.1 ... $E(z \rho^T z) = P_\rho z$, 227	
12.2.2 ... $E(z \rho^T z) = P_\rho z$ and $\text{Var}(z \rho^T z) = Q_\rho$, 230	
12.2.3 ... z is normally distributed, 231	
12.3. Estimation and testing, 231	
12.3.1 Asymptotic distribution of $\hat{\Delta}_\kappa$, 232	
12.3.2 An algorithm for inference on κ , 235	
12.3.3 Asymptotic distribution of $\hat{\Delta}_\kappa$ with constraints, 236	
12.3.4 Testing e independent of z , 238	
12.4. pHd: Reaction yield, 238	
12.4.1 OLS and SIR, 239	
12.4.2 pHd test results, 240	
12.4.3 Subtracting β , 241	
12.4.4 Using stronger assumptions, 243	
12.5. pHd: Mussel data, 243	
12.5.1 pHd test results, 244	
12.5.2 Simulating the response, 246	
12.5.3 Using Voronoi weights, 246	
12.6. pHd: Haystacks, 248	
12.7. Discussion, 249	
12.7.1 pHd with the response, 249	
12.7.2 Additional developments, 250	
Problems, 251	

13. Studying Predictor Effects	254
13.1. Introduction to net-effect plots, 254	
13.1.1 Natural rubber: Net-effect plots, 255	
13.1.2 Joint normality, 256	
13.1.3 Slicing, 257	
13.1.4 Reducing brushing dimensions, 259	
13.2. Distributional indices, 259	
13.2.1 Example, 260	
13.2.2 Location dependence, 262	
13.2.3 Post-model net-effect plots, 264	
13.2.4 Bivariate SIR, 265	
13.3. Global net-effect plots, 266	
13.3.1 Tar, 268	
13.3.2 Minneapolis schools again, 269	
Problems, 270	
14. Predictor Transformations	272
14.1. CERES plots, 273	
14.1.1 Motivation, 273	
14.1.2 Estimating α_1 , 274	
14.1.3 Example, 276	
14.2. CERES plots when $E(x_1 x_2)$ is ..., 279	
14.2.1 ... Constant, 279	
14.2.2 ... Linear in x_2 , 280	
14.2.3 ... Quadratic in x_2 , 281	
14.3. CERES plots in practice, 283	
14.3.1 Highly dependent predictors, 284	
14.3.2 Using many CERES plots, 285	
14.3.3 Transforming more than one predictor, 289	
14.4. Big Mac data, 290	
14.5. Added-variable plots, 294	
14.6. Environmental contamination, 296	
14.6.1 Assessing relative importance, 297	
14.6.2 Data analysis, 298	
Problems, 302	

15. Graphics for Model Assessment	303
15.1. Residual plots, 304	
15.1.1 Rationale, 304	
15.1.2 Isomerization data, 305	
15.1.3 Using residuals in graphical regression, 306	
15.1.4 pHd, 309	
15.1.5 Residual plots: Kyphosis data, 309	
15.1.6 Interpreting residual plots, 312	
15.2. Assessing model adequacy, 313	
15.2.1 Marginal regression functions ... , 314	
15.2.2 Marginal variance functions ... , 316	
15.2.3 Marginal model plots, 317	
15.2.4 Isomerization data again, 319	
15.2.5 Reaction yield data, 322	
15.2.6 Tomato tops, 322	
15.2.7 Marginal model plots: Kyphosis data, 325	
Problems, 327	
Bibliography	329
Author Index	339
Subject Index	343