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Correction to "Bayesian Model Averaging: A Tutorial"

A printing malfunction caused all minus signs and some left parentheses to be omitted from the paper "Bayesian Model Averaging: A Tutorial" by Jennifer A. Hoeting, David Madigan, Adrian E. Raftery and Chris T. Volinsky in the November 1999 issue of *Statistical Science* (volume 14, pages 382-417). These errors occurred after the proof stage and were not the fault of the authors. Corrections to the paper are listed below. A corrected version of the paper is also available at http://www.stat.washington.edu/www/research/online/hoeting1999.pdf. Please cite this article as follows: Hoeting, J. A., Madigan, D., Raftery, A. E. and Volinsky, C. T. (1999) "Bayesian Model Averaging: A Tutorial (with discussion)" *Statistical Science* **14**:4, 382–417. Corrected version available at http://www.stat.washington.edu/www/research/online/hoeting1999.pdf.

p. 383, last display of second column: replace the formula for $\mathrm{Var}[\Delta|D]$ by

$$\mathrm{Var}[\Delta|D] = \sum_{k=0}^{K} (\mathrm{Var}[\Delta|D, M_k] + \hat{\Delta}_k^2)\ \mathrm{pr}(M_k|D) - E[\Delta|D]^2,$$

p. 385, 24 lines from top of first column: replace

"$O_L = O_R{}^1$" by "$O_L = O_R^{-1}$"

p. 386, last display of second column: replace by

$$Y^{(\rho)} = \begin{cases} \dfrac{y^\rho - 1}{\rho}, & \rho \neq 0, \\ \log(y), & \rho = 0. \end{cases}$$

p. 386, 11 lines from bottom of second column: replace

"(1, 0, 0.5" by "(−1, 0, 0.5"

p. 387, first column: equation (8) should read

$$\varepsilon \sim \begin{cases} N(0, \sigma^2), & \text{w.p. } (1-\pi), \\ N(0, K^2\sigma^2), & \text{w.p. } \pi. \end{cases} \tag{8}$$

p. 387, last line of second column: "$O(n\ ^1)$" should be "$O(n^{-1})$."

p. 388, first column: equation (11) should read

$$2\log B_{10} \approx \chi^2 + (E_1 - E_0). \tag{11}$$

p. 388, sentence that follows equation (11) should read:

"In (11), $\chi^2 = 2\{\ell_1(\hat{\beta}_1) - \ell_0(\hat{\beta}_0)\}$"

p. 388, second display in first column should read:

$$E_k = 2\lambda_k(\hat{\beta}_k) + \lambda_k'(\hat{\beta}_k)^T(F_k + G_k)^{-1} \cdot \{2 - F_k(F_k + G_k)^{-1}\}\ \lambda_k'(\hat{\beta}_k) - \log|F_k + G_k| + p_k\ \log(2\pi)$$

p. 388, 2 lines under second display in first column: replace

"$G_k = W_k{}^1$" by "$G_k = W_k^{-1}$"

p. 388, 6 lines under second display in first column: replace

"$O(n\ ^{1/2})$" by "$O(n^{-1/2})$"

p. 388, 9 lines under second display in first column: replace

"$O(n\ ^1)$" by "$O(n^{-1})$"

p. 388, equation (13): this equation should read

$$\log\ \mathrm{pr}(D|M_k) \approx \log\ \mathrm{pr}(D|\hat{\beta}_k, M_k) - d_k\ \log n, \tag{13}$$

p. 390, equation (16): this equation should read

$$\mathrm{pr}(M_i) = \prod_{j=1}^{p} \pi_j^{\delta_{ij}}\ (1-\pi_j)^{1-\delta_{ij}}\ , \tag{16}$$

p. 390, equation (17): this equation should read

$$-\sum_{d \in D^T} \log \mathrm{pr}\left(d \mid M, D^B\right), \tag{17}$$

p. 390, equation (18): this equation should read

$$-\sum_{d \in D^T} \log \left\{ \sum_{M \in \mathscr{M}} \mathrm{pr}\left(d \mid M, D^B\right) \mathrm{pr}\left(M \mid D^B\right) \right\}. \tag{18}$$

p. 392, table 1: this table should read

TABLE 1
PBC example: summary statistics and BMA estimates

Variable	Range	Mean	Mean $\beta \mid D$	SD $\beta \mid D$	$P(\beta \neq 0 \mid D)$
Bilirubin (log)	−1.20–3.33	0.60	0.784	0.129	100
Albumen (log)	0.67–1.54	1.25	−2.799	0.796	100
Age (years)	26–78	49.80	0.032	0.010	100
Edema	0 = no edema	$n = 263$	0.736	0.432	84
	0.5 = edema but no diuretics	$n = 29$			
	1 = edema despite diuretics	$n = 20$			
Prothrombin time	2.20–2.84	2.37	2.456	1.644	78
Urine copper (log)	1.39–6.38	4.27	0.249	0.195	72
Histologic stage	1–4	3.05	0.096	0.158	34
SGOT	3.27–6.13	4.71	0.103	0.231	22
Platelets	62–563	262.30	−0.000	0.000	5
Sex	0 = male	0.88	−0.014	0.088	4
Hepatomegaly	1 = present	0.51	0.006	0.051	3
Alkaline phosphates	5.67–9.54	7.27	−0.003	0.028	3
Ascites	1 = present	0.08	0.003	0.047	2
Treatment (DPCA)	1 = DPCA	0.49	0.002	0.028	2
Spiders	1 = present	0.29	0.000	0.027	2
Time observed (days)	41–4556	2001			
Status	0 = censored 1 = died	0.40			

p. 392, table 2: this table should read

TABLE 2
PBC example: results for the full data set[1]

Model no.	Age	Edema	Bili	Albu	UCopp	SGOT	Prothromb	Hist	PMP	Log lik
1	•	•	•	•	•		•		0.17	−174.4
2	•	•	•	•	•		•	•	0.07	−172.6
3	•	•	•	•	•			•	0.07	−172.5
4	•		•	•	•		•		0.06	−172.2
5[2]	•	•	•	•			•		0.05	−172.0
6	•	•	•	•	•				0.05	−172.0
7	•	•	•	•	•	•	•		0.04	−171.7
8	•	•	•	•		•	•		0.04	−171.4
9	•	•	•	•		•	•	•	0.04	−171.3
10	•	•	•	•	•	•	•	•	0.03	−170.9
$\Pr_{MA}[\beta_i \neq 0]$	1.00	0.84	1.00	1.00	0.72	0.22	0.78	0.34		

[1] PMP denotes the posterior model probability. Only the 10 models with the highest PMP values are shown.
[2] Model selected by FH.

p. 395, table 7: this table should read

TABLE 7
Body fat example: least squares regression results from the full model[1]

Predictor		Coef	Std error	*t*-statistic	*p*-value
Intercept		−17.80	20.60	−0.86	0.39
X_1	age	0.06	0.03	1.89	0.06
X_2	weight	−0.09	0.06	−1.50	0.14
X_3	height	−0.04	0.17	−0.23	0.82
X_4	neck	−0.43	0.22	−1.96	0.05
X_5	chest	−0.02	0.10	−0.19	0.85
X_6	abdomen	0.89	0.08	10.62	<0.01
X_7	hip	−0.20	0.14	−1.44	0.15
X_8	thigh	0.24	0.14	1.74	0.08
X_9	knee	−0.02	0.23	−0.09	0.93
X_{10}	ankle	0.17	0.21	0.81	0.42
X_{11}	biceps	0.16	0.16	0.98	0.33
X_{12}	forearm	0.43	0.18	2.32	0.02
X_{13}	wrist	−1.47	0.50	−2.97	<0.01

[1]Residual standard error = 4, $R^2 = 0.75$, $N = 251$, F-statistic = 53.62 on 13 and 237 df, p-value <0.0001.

p. 396, table 8: this table should read

TABLE 8
Body fat example: comparison of BMA results to model selected using standard model selection methods[1]

Predictor		Bayesian model averaging: Mean $\beta \mid D$	Bayesian model averaging: SD $\beta \mid D$	Bayesian model averaging: $P(\beta \neq 0 \mid D)$	Stepwise model *p*-value
X_6	abdomen	1.2687	0.08	100	<0.01
X_2	weight	−0.4642	0.15	97	0.03
X_{13}	wrist	−0.0924	0.08	62	<0.01
X_{12}	forearm	0.0390	0.06	35	0.01
X_4	neck	−0.0231	0.06	19	0.05
X_{11}	biceps	0.0179	0.05	17	
X_8	thigh	0.0176	0.05	15	0.02
X_7	hip	−0.0196	0.07	13	0.12
X_5	chest	0.0004	0.02	6	
X_1	age	0.0029	0.02	5	0.05
X_9	knee	0.0020	0.02	5	
X_3	height	−0.0015	0.01	4	
X_{10}	ankle	0.0011	0.01	4	

[1]Stepwise, minimum Mallow's C_p, and maximum adjusted R^2 all selected the same model. The predictors are sorted by $P(\beta_i \neq 0 \mid D)$ which is expressed as a percentage. The results given here are based on standardized data (columns have means equal to 0 and variances equal to 1).

p. 412, last line of second column: replace

"$\sigma^{\,d}$" by "σ^{-d}"

p. 414, display near bottom of second column: replace by

$$\beta_1 = \tfrac{1}{2}\left(\bar{Y}_{21}^{\text{new}} - \bar{Y}_{11}^{\text{new}}\right) + \tfrac{1}{2}\left(\bar{Y}_{22}^{\text{new}} - \bar{Y}_{12}^{\text{new}}\right) + O_p\left(n_{\text{new}}^{-\frac{1}{2}}\right),$$