Errata

Geophysical Inverse Theory: Discrete Inverse Theeory, MATLAB Edition

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Page xxv, about line 12
Type: Typo in text
Replace **NM** with **MN**

MN

$K \times M$, the product $\mathbf{P} = \mathbf{NM}$ is an $N \times M$ matrix defined according to the rule

Page xxvi, line 15
Type: Typo in text
Replace **NM** with **MN**

MN

a. Matrix multiplication, $\mathbf{P} = \mathbf{NM}$, has a useful interpretation in terms of dot prod-

Page 37, Caption of Figure 2.17
Type: Incorrect *MatLab* script number in caption
Replace 14 with 15

FIGURE 2.17 Histograms (blue curves) of 5000 realizations of a random variable d for the probability density function (red curves) $p(d) = ½c\exp(-|d|/c)$ with $c = 2$. (A) Realizations computed by transforming data drawn from a uniform distribution and (B) realizations computed using the Metropolis-Hastings algorithm. *MatLab* script gda02_14.

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Page 37, Problem 2.2
Type: Typo in text
Replace e^2 with d^2

d^2

2.2. Suppose d is a Gaussian random variable with zero mean and unit variance. What is the probability density function of $E = e^2$? Hint: Since the sign of d gets lost when it is squared, you can assume that $p(d)$ is one-sided, that is, defined for only $d \geq 0$ and with twice the amplitude of the usual Gaussian.

Page 86, First two paragraphs of Section 4.14

Type: Wrong words, "row" and "rows" should be "column" and "columns" in several places

Replace as indicated

4.12 TECHNIQUES FOR COMPUTING RESOLUTION

In very large problems, the model resolution matrix **R** can be cumbersome to compute, owing to its large $M \times M$ size and non-sparse character. Furthermore, time is rarely available for examining all of its rows in detail. Plots of just a few rows, corresponding to model parameters located at strategically chosen points within the model volume, are usually sufficient.

Suppose that we call the *k*th row of **R** the vector $\mathbf{r}^{(k)T}$. Then the identity $\mathbf{R} = \mathbf{RI}$ can be rewritten as

$$R_{ik} = \sum_{j=1}^{M} R_{ij}\delta_{jk} \rightarrow r_i^{(k)} = \sum_{j=1}^{N} R_{ij} m_j^{(k)} \quad \text{with} \quad m_j^{(k)} = \delta_{jk} \tag{4.40}$$

Here we have identified the *k*th column of **I** as "model parameter" vector $m_j^{(k)}$ that is zero except for its *k*th element, which is unity. Recalling that $\mathbf{R} = \mathbf{G}^{-g}\mathbf{G}$, we can write

$$\mathbf{r}^{(k)} = \mathbf{Rm}^{(k)} = \mathbf{G}^{-g}\mathbf{Gm}^{(k)} = \mathbf{G}^{-g}\mathbf{d}^{(k)} \quad \text{with} \quad \mathbf{d}^{(k)} = \mathbf{Gm}^{(k)} \tag{4.41}$$

Thus, the *k*th row of the model resolution matrix solves the inverse problem for synthetic data $\mathbf{d}^{(k)}$ corresponding to a specific model parameter vector $\mathbf{m}^{(k)}$, one that is zero except for its *k*th element, which is unity (that is, a unit spike at row *k*). This suggests a procedure for calculating the resolution: construct the desired $\mathbf{m}^{(k)}$, solve the forward problem to generate $\mathbf{d}^{(k)}$, solve the inverse problem, and then interpret the result as the *k*th row of the resolution matrix (Figure 4.9A, B).

Page 86, First paragraph of Section 4.12

Type: Vector should not be transformed

Delete superscript T as indicated

within the model volume, are usually sufficient.

Suppose that we call the *k*th row of **R** the vector $\mathbf{r}^{(k)T}$. Then the identity $\mathbf{R} = \mathbf{RI}$ can be rewritten as

Page 87, Caption of Figure 4.9
Type: Wrong words, "row" should be "column" in several places
Replace as indicated

FIGURE 4.9 Resolution of an acoustic tomography problem solved with the minimum length method. The physical model space is a 20×20 grid of pixels on an (x,y) grid. Data are measured only along rows and columns, as in Figure 1.2. (Top row) One ~~row~~ column of the resolution matrix, for a model parameter near the center of the (x,y) grid, calculated using two methods, (A) by computing the complete matrix **R** and extracting one ~~row~~ column and (B) by calculating the ~~row~~ column separately. (Botton row) Checkerboard resolution test showing (C) true checkerboard and (D) reconstructed checkerboard. *MatLab* scripts gda04_07 and gda04_08.

Author's Note The resolution matrix **R** for weighted damped least squares (eqn 3.45), is symmetric, so the distinction between its rows and columns *is not* important. In the Backus-Gilbert case, **R** is not symmetric, so the distinction between rows and columns *is* important.

A row of **R** is interpreted as follows: Row k gives the weights of all the true model parameters that contribute to observed model parameter k.

A column of R is interpreted as follows: Column k gives the pattern of estimated model parameters that would be observed if the true model parameters were all zero, except for the k-th.

Thus, when one asks, "How would a true model that contained only a spike spread out to become a blurry set of estimated model parameters?", one needs a column of R.

Page 91, Equation 5.23

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In second equation, delete first occurrence of m_1

$$\frac{\partial L}{\partial m_1} = 0 = \frac{1}{2}\sigma^{-2} 2 m_1 \sum_{i=1}^{N} (d_i^{\text{obs}} - m_1) \tag{5.3}$$

Page 103, Equation 5.23

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Replace *A* with *g*

$$p_{\mathrm{A}}(\mathbf{m}, \mathbf{d}) = \delta(\mathbf{G}\mathbf{m} - \mathbf{d}) \tag{5.23}$$

g

Page 114, Problem 5.5
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Replace 5.55 with 5.17

5.4 This problem builds upon Problem 5.3. Suppose that you are fitting a cubic polynomial to data, $d_i = m_1 + m_2 z_i + m_3 z_i^2 + m_4 z_i^3$, but have *a priori* information that $m_1 = 2m_2 = 4m_3 = 8m_4$. Write a *MatLab* script to solve this problem using Equation (5.55). Use a range of values for the variance σ_m^2 of the *a*

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Page 114, Problem 5.7

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Replace 5.5 with 5.6

MatLab's rpdf() function.

5.7 This problem expands upon Problem 5.5. Suppose that the random numbers

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Page 219, Equation 11.50
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Replace -∞ *with* +∞ in top limit of integral

$$\mathcal{L}^{\dagger} d(x) = -a \frac{\mathrm{d}}{\mathrm{d}x} d(x) + b \int_{x}^{+\infty} d(x') \mathrm{d}x' \qquad (11.50)$$

Page 219, Equation 11.51
Type: Typo in equation
Replace -∞ *with* +∞ in top limit of integral

$$\left.\frac{\delta E}{\delta m}\right|_{\mathbf{m}^{(0)}} = 2a\frac{\mathrm{d}}{\mathrm{d}x}[d^{\mathrm{obs}}(x) - d^{(0)}(x)] - 2b\int_{x}^{+\infty}[d^{\mathrm{obs}}(x') - d^{(0)}(x')]\,\mathrm{d}x' \quad (11.51)$$