LINEAR ALGEBRA FOR EVERYONE

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Errata in the First Printing

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Those videos (including 18.06SC and 18.065) are also on **www.youtube.com/mitocw**
18.06 Linear Algebra 18.06SC with problem solutions 18.065 Learning from Data

p.9 Section 1.1, Change 'Problems 10-14' to 'Problems 11-14', and shift this line after Problem 10.

p.10 Section 1.1, Problem 23 : Last sentence is 'A typical edge goes to $(1, 0, 1, 0)$.'

p.12 Section 1.2, Line 9, $\theta = 0^\circ$ (degree symbol was missing).

p.14 Caption of Figure 1.8, 'Unit vectors : $\boldsymbol{u} \cdot \boldsymbol{i} = \cos\theta$' ($\boldsymbol{i}$, not $\boldsymbol{U}$).

p.14 Paragraph immediately below Figure 1.8, 'The angle with $\boldsymbol{w}_1 = (1, 3)$ is less than 90° because $\boldsymbol{v} \cdot \boldsymbol{w}_1 = 6$ is positive.' ($\boldsymbol{w}_1$ replaces $\boldsymbol{w}$ twice).

p.15 Section 1.2, Line 6, spelling correction : 'Bunyakowsky' (not 'Buniakowsky').

p.15 Section 1.2, Example 8, '... *geometric mean* $|\boldsymbol{ab}| \leq$ *arithmetic mean*...' (take absolute value of ab).

p.18 Section 1.2, first line, Problems 17-20 (not 25).

p.18 Section 1.2, Problem 17, change the first sentence : 'The vectors $\boldsymbol{v} = (4, 2)$ and $\boldsymbol{w} = (-1, 2)$ are two sides of a right triangle.'

p.18 Section 1.2, Problem 18, last line : 'Use (1) and (2) with...

p.18 Section 1.2, Problem 22, end : '... find $\boldsymbol{u} \cdot \boldsymbol{U}$. (not $\cos\theta$).

p.19 New Problem 24 : Show that the squared diagonal lengths $\|\boldsymbol{v}+\boldsymbol{w}\|^2+\|\boldsymbol{v}-\boldsymbol{w}\|^2$ in a parallelogram add to the sum of the four squared side lengths $2\|\boldsymbol{v}\|^2 + 2\|\boldsymbol{w}\|^2$.

p.22 Section 1.3, Last line : 'The **column space** $\mathbf{C}(A)$ **of** $\boldsymbol{A}$...' (insert '$\mathbf{C}(A)$').

p.23 Section 1.3, below Equation (4) : '... good place to start, because its column space $\mathbf{C}(A_4)$ is the full...' (insert '$\mathbf{C}(A_4)$').

p.24 Section 1.3, Second sentence : 'The last two columns give two more directions in $\mathbf{R}^4$, and *the four columns are independent*.'

p.24 Section 1.3, Line 9, start : Replace $A_2\boldsymbol{x} = \boldsymbol{v}$ with $A_5\boldsymbol{x} = \boldsymbol{v}$.

p.25 Section 1.3, Fourth paragraph : Delete '... so the column rank is 1.' (we have no definition for 'column rank' yet).

p.25 Section 1.3, Fifth paragraph : Delete last sentence 'So the row space is the line through row 2.'

p.26 Section 1.3, First line : Replace 'This chapter introduces. . . ' with 'This section introduces. . . '

p.26 Section 1.3, Problem 2, new second sentence : 'The trivial combination (zero times every column) is not allowed.'

p.28 Section 1.3, Problem 21, modified third sentence, 'Find $\boldsymbol{x} \neq \mathbf{0}$ in $A\boldsymbol{x} = \mathbf{0}$:'

p.28 Section 1.3, Problem 21, second row (modified) in line with matrix A : 'A has only two independent rows'

p.29 Section 1.4, Line 7 after the box : Replace 'm columns and p rows' with 'm rows and p columns'.

p.40 Section 2.1, Remove (repeated) paragraph just after the first enumerated point : 'The best case has a square matrix A $(m = n)$ with independent columns. Then there is one solution $\boldsymbol{x}$ (one combination of the columns of A) for *every* vector $\boldsymbol{b}$.'

p.46 Problem Set 2.1 : First line of Problem 2, 'planes' should actually be 'lines'.

p.203 Line #7 should have x_2 thrice : $(A - \frac{1}{2}I)\boldsymbol{x}_2 = 0$ is $\begin{bmatrix} .3 & .3 \\ .2 & .2 \end{bmatrix} \boldsymbol{x}_2 = \begin{bmatrix} \mathbf{0} \\ \mathbf{0} \end{bmatrix} \dots$

p.286 Paragraph above Equation (2) : 'The key is **composition** : function of function of function. . . We have $L + 1$ layers $\ell = 0, 1, \dots, L$ (layer 0 is input, layer L is output). Composition produces $\boldsymbol{v}_L$ from $\boldsymbol{v}_{L-1}$ and eventually from the input $\boldsymbol{v}_0$:'

p.286 Line below Equation (2) : Ends with '. . . A_1 to A_L and the vectors $\boldsymbol{b}_1$ to $\boldsymbol{b}_{L-1}$.'

p.289 Line 7 : $\mathbf{1}$ Key operation **Composition $\boldsymbol{F(x, v) = F_3(F_2(F_1(v)))}$**

p.289 After Equation (1), fourth line : '$\boldsymbol{x} = (A_1, \boldsymbol{b}_1, \dots, b_{L-1}, A_L)$ in the central. . . '

p.289 Line -2 (second-last line on page) : 'composite function $\boldsymbol{F} = F_L \cdot\cdot (F_2(F_1(\boldsymbol{v})))$ has an important. . . '

p.290 End of line 4, Replace '$A_0\boldsymbol{v}_0 + \boldsymbol{b}_0$' with '$A_1\boldsymbol{v}_0 + \boldsymbol{b}_1$'.

p.290 Line after Equation (3), add parentheses : '... optimizing $\boldsymbol{x} = (A_1, \boldsymbol{b}_1, A_2)$ is...'

p.296 First paragraph (twice) and second paragarph (once) : '$A_1\boldsymbol{v}_1 + \boldsymbol{b}_1$' should be replaced by '$A_2\boldsymbol{v}_1 + \boldsymbol{b}_2$'

p.297 Problem #1, Last sentence : 'Describe the 12 (not 15) linear pieces of $G =$ sum of these four ReLU's.'

p.298 Problem #11 : 'Does learning succeed for $N = 4$ neurons ? What is the count $r(N, 2)$ of flat pieces in $F(\boldsymbol{v})$? The white polygon shows where flat pieces in the graph of $F(\boldsymbol{v})$ change...'

p.302 First paragraph : Variable B is actually variable H (three times).

p.303 Last line : Variable B is actually variable H.

p.314 Second-last paragraph erroneously refers to Figure 8.5, should be Figure 8.9.

p.317 Figure erroneously has '$\mathbf{cos\,(\theta_k)^2}$', should have '$\mathbf{cos^2\,\theta_k}$'.

p.319 Problem #2 : Replace '$P(\boldsymbol{x}_k - \boldsymbol{x}^*)$' with '$(I - P)\,(\boldsymbol{x}_k - \boldsymbol{x}^*)$'

p322 Fifth line : ... p_0 to p_{100} for each score.

p.325 Fifth line below the figure caption, σ^2 :'$\mathbf{N}\,(0, \sigma^2)$'

p.325 Equation #8, σ^2 : '**Normal distribution $\mathbf{N}(\boldsymbol{m},\ \boldsymbol{\sigma^2})$**'

p.327 Last line : Replace '$\boldsymbol{p(x)}$' with '$\mathbf{N(0,\ \sigma^2)}$'

p.329 Example 5, 1 and 2 replaced by 4 and 5 :

Joint probability matrices for Examples 4 and 5

$$\boldsymbol{P_4} = \begin{bmatrix} \frac{1}{4} & \frac{1}{4} \\ \frac{1}{4} & \frac{1}{4} \end{bmatrix} \quad \text{and} \quad \boldsymbol{P_5} = \begin{bmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{2} \end{bmatrix}.$$

p.329 Middle of the page, refers to Example 4 (not Example 1) : Example 4 showed *independent* random variables.

p.330 Line above Equation (15) : 'Therefore the n^2 joint probabilities'...

p.331 Equation (20), remove the '$\sum$' symbol.

p.331 Third line after Equation (20) should refer to Equation (17).