Errata for "Nonlinear Programming: Concepts, Algorithms and Applications to Chemical Engineering"

- p. 28, line 11: change "$f(x) = x^4 cos(1/x)$" to "$f(x) = x^4(2 + cos(1/x))$"
- pp. 27-30, various places: change "$p^T \nabla^2 f(x^* + \tau p)^T p < 0$" to "$p^T \nabla^2 f(x^* + \tau p)p < 0$" and "$p^T \nabla^2 f(x^* + tp)^T p < 0$" to "$p^T \nabla^2 f(x^* + tp)p < 0$"
- p. 29, line 26: change "$\frac{t^2}{2} p^T \nabla^2 f(x + \tau p)^T p < 0$" to "$\frac{t^2}{2} p^T \nabla^2 f(x^* + \tau p)p < 0$"
- p. 35, lines 22, 24: change "$\nabla^2 f(x^k + t(x^k - x^*))$" to "$\nabla^2 f(x^k + t(x^* - x^k))$"
- p. 45, change Equation (3.23) to: $u^k = \frac{B^k s^k}{[(s^k)^T B^k s^k]^{1/2}}$, and $v^k = \frac{y^k}{((y^k)^T s^k)^{1/2}}$.
- p. 48, line 13: change "if $(1 - \eta) > \zeta$" to "if $(1 - \eta) < \zeta$"
- p. 49, line -3: change "$\kappa(B^k))$" to "$\kappa(B^k)$"
- p. 64, last three lines: change "g" to "g_i"
- p. 71, First line of Equation (4.12) should read: $p^T \nabla_{xx} L(x^*, u^*, v^*)p \geq 0$,
- p. 72, Equation (4.24) should read: $= \begin{bmatrix} 2 + \frac{1}{(x_1^*)^2} & 1 - u^* \\ 1 - u^* & 3 + \frac{1}{(x_2^*)^2} \end{bmatrix} = \begin{bmatrix} 2.5 & 0.068 \\ 0.068 & 3.125 \end{bmatrix}$
- p. 78, line 9: change to "$h_i(x^k) = t^k \nabla h_i(x^*)^T d = 0$"
- p. 80, line 23: change to "We now assume that $d^T \nabla_{xx} L(x^*, u^*, v^*)d < 0$"
- p. 83, Equation (4.66) should read: $= \begin{bmatrix} 2 + \frac{1}{(x_1^*)^2} & 1 - u^* \\ 1 - u^* & 3 + \frac{1}{(x_2^*)^2} \end{bmatrix} = \begin{bmatrix} 2.3093 & 0.4315 \\ 0.4315 & 3.2021 \end{bmatrix}$
- p. 83, last line, change to $(Q^N)^T \nabla_{xx} L(x^*, u^*, v^*) Q^N = 2.4272$
- p. 86, in (4.75), change "min" to "max"
- p. 92, in (5.2), change "$\nabla h(x^*)^T v^*$" to "$\nabla h(x^*) v^*$."
- p. 93, line 18: change $\|\nabla L(x^k, v^k)\| > \epsilon_2$ to $max(\|\nabla L(x^k, v^k)\|, \|h(x^k)\|) > \epsilon_2$.
- p. 93, line 19: change "Evaluate $\nabla f(x^k)$" to "Evaluate $h(x^k)$, $\nabla f(x^k)$"
- pp. 104-109: change d_x to d_x^k in (5.41)-(5.43) and (5.51), (5.53), (5.54).
- p. 108: change "x^{k+2}" to "$x^k + d_x^k + d_x^{k+1}$" in (5.52).
- p. 110, line 16: change "trail point" to "trial point"
- p. 116, in (5.70) and after (5.72), change "$(Z^k)^T f(x^k)$" to "$(Z^k)^T \nabla f(x^k)$"
- p. 118, line 19: change to "The Hessian $W(x, v)$ or its approximation"
- p. 129, change $\bar{d}$ to $\bar{d}_x$ in (5.111).
- p. 140, line 19; p. 178, line 25: change $[0, 0.1]$ to $[0, 0.1, 0, 0]^T$

- p. 140, line 30; p. 178, line 25: change $[0, 0]$ to $[0, 0, 0, 0]^T$
- p. 158, second part of (6.65) should read "$\liminf_{k\to\infty} \|\nabla\varphi_\mu(x^k) + \nabla c(x^k)v^k\| = 0.$"
- p. 160, line 6: change to "$\varphi_\mu(x)$ is bounded below and x is bounded above and below."
- p. 160, line 14: change to "boundedness assumption for φ_μ and x,"
- p. 166, Equation (6.81) should read: $\epsilon^k = \min[\|z^k - \mathcal{P}(z^k - \nabla f(z^k))\|, \min_i(z_{U,(i)} - z_{L,(i)})/2]$
- p. 189, lines 27-28, change to:

  $$g(x^0) = \nabla f(x^0) + \frac{1}{2}\Delta(\epsilon + 1/\epsilon))[1\ 1]^T = (2\epsilon\beta + \Delta(\epsilon + 1/\epsilon)/2)[1\ 1]^T$$

  where second term is the truncation error from the perturbation $\Delta^{1/2}$...
- p. 216, line 16: replace "(8.5g)" by "(8.5d)-(8.5g)"
- p. 222: in (8.8) change $\left[\frac{\partial f}{\partial z}\lambda - \frac{d\lambda}{dt} + \frac{\partial g_E}{\partial z}\nu_E + \frac{\partial g_I}{\partial z}\nu_I\right]^T \delta z(t)$ to $\left[\frac{\partial f}{\partial z}\lambda + \frac{d\lambda}{dt} + \frac{\partial g_E}{\partial z}\nu_E + \frac{\partial g_I}{\partial z}\nu_I\right]^T \delta z(t)$
- p. 225, line 1: change $k = k_{20}/k_{10}$ to $k = k_{20}/(k_{10}^\beta)$
- pp. 235-236: replace (8.39h), (8.40e) and (8.41e) by $1 = \sum_{i=1}^{NC} x_i$
- p. 236, line 23: replace $\sum_{i=1}^{NC}(K_i(T, P) - 1)\frac{dx_i}{dt} = 0$ by $\sum_{i=1}^{NC} \frac{dx_i}{dt} = 0$.
- p. 236, line 25, p. 237 (8.41f): replace by $\sum_{i=1}^{NC}[F(t)(z_i(t) - x_i(t)) - V(t)(y_i(t) - x_i(t))]/M(t) = 0$
- p. 238, change second line of (8.44) to
  "$= \lambda_1 z_2(t) + \lambda_2 u(t) + 1 + \nu_I u(t) + \nu_U(u(t) - u_U) + \nu_L(u_L - u(t))$"
- p. 242, change line 4 to: $-k_3 b(t_f) = H(0) = J(0)u(0) - \lambda_2 k_3 b(0) = J(0)u(0) < 0$
- p. 243, line 15: change "for $k_1 = 1$," to "for $a_0 = 1$, $k_1 = 1$,"
- p. 261: line 19: change equation $\nabla_p \Psi^T = \frac{\partial \Psi}{\partial z}^T S(t_f) + \frac{\partial \psi}{\partial \mathbf{p}}^T$
  to $\nabla_p \Psi = S(t_f)^T \frac{\partial \Psi}{\partial z} + R(t_f)^T \frac{\partial \Psi}{\partial y} + \frac{\partial \Psi}{\partial p}$
- p. 263: in (9.26) change $\left[\frac{\partial f}{\partial z}\lambda - \frac{d\lambda}{dt} + \frac{\partial g}{\partial z}\nu\right]^T \delta z(t)$ to $\left[\frac{\partial f}{\partial z}\lambda + \frac{d\lambda}{dt} + \frac{\partial g}{\partial z}\nu\right]^T \delta z(t)$
- p. 268: Modify equation (9.42) and above "rewritten as:

  $$\frac{d\psi}{dp^l} = \frac{\partial \psi}{\partial p^l} + \int_{t_{l-1}}^{t_l} \left[\frac{\partial f}{\partial p^l}\lambda + \frac{\partial g}{\partial p^l}\nu\right] dt.''$$

  to: "rewritten for the objective function φ as:

  $$\frac{d\varphi}{dp^l} = \frac{\partial \varphi}{\partial p^l} + \int_{t_{l-1}}^{t_l} \left[\frac{\partial f}{\partial p^l}\lambda + \frac{\partial g}{\partial p^l}\nu\right] dt.''$$

- p. 268: Add $h_l \geq 0$ to end of (9.43e)

- p. 270: above (9.47), change: "The corresponding integrals for the decision variables, are given by" to "The corresponding integrals for the derivatives of the objective function ($\varphi = -b(N_T)$), with respect to decision variables, are given by"
- From last paragraph on p. 289 to (10.6), change to: "Equivalently, the *time derivative* of the state in element i can be represented as a Lagrange polynomial with K interpolation points, i.e.,

$$\frac{dz^K(t)}{d\tau} = \sum_{j=1}^{K} \bar{\ell}_j(\tau)\dot{z}_{ij},$$

where $\dot{z}_{ij}$ represents $\frac{dz^K(t_{ij})}{d\tau}$ and $\bar{\ell}_j(\tau) = \prod_{k=1,\neq j}^{K} \frac{(\tau-\tau_k)}{(\tau_j-\tau_k)}$. For element i this leads to the *Runge-Kutta* basis representation for the differential state:

$$z^K(t) = z_{i-1} + h_i \sum_{j=1}^{K} \Omega_j(\tau)\dot{z}_{ij} \qquad (10.5)$$

where z_{i-1} is a coefficient that represents the differential state at the beginning of element i and $\Omega_j(\tau)$ is a polynomial of order K, satisfying

$$\Omega_j(\tau) = \int_0^{\tau} \bar{\ell}_j(\tau')d\tau', \quad t \in [t_{i-1}, t_i], \quad \tau \in [0, 1].$$

To determine the polynomial coefficients that approximate the solution of the DAE, we substitute the polynomial into (10.2) and enforce the resulting algebraic equations at the interpolation points τ_k. This leads to the following *collocation equations*:

$$\frac{dz^K(t_{ik})}{dt} = f(z^K(t_{ik}), t_{ik}),\ k = 1, \ldots, K, \qquad (10.6)$$

- p. 291-292, change (10.13) to $P_K^{(\alpha,\beta)} = \sum_{j=0}^{K}(\tau-1)^j\gamma_j$ with $\gamma_j = \frac{(\alpha+K)!(\alpha+\beta+K+j)!}{(\alpha+j)!(\alpha+\beta+K)!(K-j)!j!}$, $j = 0, \ldots K$.
- p. 296, lines 11, 12: change "$T(t)$" to "$T_i(t)$"
- p. 296, line -4: change "is obtained automatically, as algebraic variables are implicit functions of continuous differential variables." to "can be determined directly from the continuous differential variables at t_i."
- p. 297, lines 6,7 and in (10.21b): change "t_{nc}" to "$t_{i,nc}$"
- p. 342, change (11.41a), (11.41b) from:

$$\bar{G}_i^{ig}(T,P) + RT\ ln(f_i^L) + \left\{\sum_{i=1}^{NC}(l_i\frac{\partial \bar{G}_i^L}{\partial l_i} + v_i\frac{\partial \bar{G}_i^V}{\partial l_i})\right\} - \alpha_L - \gamma_i = 0$$
$$\bar{G}_i^{ig}(T,P) + RT\ ln(f_i^V) + \left\{\sum_{i=1}^{NC}(l_i\frac{\partial \bar{G}_i^L}{\partial v_i} + v_i\frac{\partial \bar{G}_i^V}{\partial v_i})\right\} - \alpha_V - \gamma_i = 0$$

to

$$\bar{G}_i^{ig}(T,P) + RT\ ln(f_i^L) + \left\{\sum_{j=1}^{NC}(l_j\frac{\partial \bar{G}_j^L}{\partial l_i} + v_j\frac{\partial \bar{G}_j^V}{\partial l_i})\right\} - \alpha_L - \gamma_i = 0$$
$$\bar{G}_i^{ig}(T,P) + RT\ ln(f_i^V) + \left\{\sum_{j=1}^{NC}(l_j\frac{\partial \bar{G}_j^L}{\partial v_i} + v_j\frac{\partial \bar{G}_j^V}{\partial v_i})\right\} - \alpha_V - \gamma_i = 0$$

- p. 342, in (11.42b) change $\beta = 1 - s_L + s_V$ to $-s_L \leq \beta - 1 \leq s_V$.

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