quadratic_bilevel

For decision variables $x \in \mathbb{R}^{n_x}$ and $y \in \mathbb{R}^{n_y}$ and the quadratic bilevel program has the form

$$
\begin{aligned}
\underset{x\in\mathbb{R}^{n_x}, y\in\mathbb{R}^{n_y}}{\text{minimise}} \quad & \frac{1}{2}x^\top P_{\text{up}} x + \frac{1}{2}y^\top Q_{\text{up}} y + x^\top R_{\text{up}} y + c_{\text{up}}{}^\top x + d_{\text{up}}{}^\top y \\
\text{subject to} \quad & A_{\text{up}} x + B_{\text{up}} y \geq r_{\text{up}} \\
& \bar{x} \leq x \leq \underline{x} \\
& y \in \underset{y\in\mathbb{R}^{n_y}}{\arg\min} \begin{cases} \frac{1}{2}x^\top P_{\text{lo}} x + \frac{1}{2}y^\top Q_{\text{lo}} y + \frac{1}{2}y^\top R_{\text{lo}} y + c_{\text{lo}}{}^\top x + d_{\text{lo}}{}^\top y \\ A_{\text{lo}} x + B_{\text{lo}} y \geq r_{\text{lo}} \\ \bar{y} \leq y \leq \underline{y} \end{cases}
\end{aligned}
$$

where the program is parametrised by

Parameter	variable name	dimension
A_{up}	`A_upper`	$\in \mathbb{R}^{n_G \times n_x}$
B_{up}	`B_upper`	$\in \mathbb{R}^{n_G \times n_y}$
c_{up}	`c_upper`	$\in \mathbb{R}^{n_x}$
d_{up}	`d_upper`	$\in \mathbb{R}^{n_y}$
P_{up}	`P_upper`	$\in \mathbb{R}^{n_x \times n_x}$
Q_{up}	`Q_upper`	$\in \mathbb{R}^{n_y \times n_y}$
R_{up}	`R_upper`	$\in \mathbb{R}^{n_x \times n_y}$
r_{up}	`rhs_upper`	$\in \mathbb{R}^{n_G}$
A_{lo}	`A_lower`	$\in \mathbb{R}^{n_g \times n_x}$
B_{lo}	`B_lower`	$\in \mathbb{R}^{n_g \times n_y}$
c_{lo}	`c_lower`	$\in \mathbb{R}^{n_x}$
d_{lo}	`d_lower`	$\in \mathbb{R}^{n_y}$
P_{lo}	`P_lower`	$\in \mathbb{R}^{n_x \times n_x}$
Q_{lo}	`Q_lower`	$\in \mathbb{R}^{n_y \times n_y}$
R_{lo}	`R_lower`	$\in \mathbb{R}^{n_x \times n_y}$
r_{lo}	`rhs_lower`	$\in \mathbb{R}^{n_g}$
$\bar{x}, \underline{x}$	`x_bounds`	$\in \mathbb{R}^{n_x}$
$\bar{y}, \underline{y}$	`y_bounds`	$\in \mathbb{R}^{n_y}$

We provide a range of data files to parameterise this problem. They are listed here with citations to the paper of origin.

- aiyoshi_shimizu_1984_ex2 [1, page 1114]
- an_et_al_2009 [5, page 332]
- bard_1988_ex1 [3, page 18]
- bard_1988_ex2 [3, page 23]
- bard_1991_ex1
- bard_book_1998 [2, page 326, Example 8.3.2]

- calamai_vicente_1994a [4, page 105]
- calamai_vicente_1994b [4, page 115]
- calamai_vicente_1994c [4, page 116]

References

[1] E. Aiyoshi and K. Shimizu. A solution method for the static constrained stackelberg problem via penalty method. *IEEE Transactions on Automatic Control*, 29(12):1111–1114, 1984.

[2] Jonathan Bard. *Practical Bilevel Optimization: Algorithms And Applications*, volume 30. Springer Science & Business Media, 09 1998.

[3] Jonathan F. Bard. Convex two-level optimization. *Mathmatical Programming*, 40(1–3):15–27, January 1988.

[4] Paul H. Calamai and Luis N. Vicente. Generating quadratic bilevel programming test problems. *ACM Trans. Math. Softw.*, 20(1):103–119, March 1994.

[5] Le Thi Hoai An, Pham Dinh Tao, Nam Nguyen Canh, and Nguyen Thoai. Dc programming techniques for solving a class of nonlinear bilevel programs. *Journal of Global Optimization*, 44(3):313–337, July 2009.