1 Sparse Example 1 — A Convex Sparse Example

$$
\begin{aligned}
\min_{x\in\mathbb{R}^n} \quad & \frac{a}{4}\sum_{i=1}^{n}(x_i-1)^4 && (1)\\
\text{s.t.} \quad & 4ax_1 + 2ax_2 = 10a && (2)\\
& 5a \le 2ax_1 + ax_3 && (3)\\
& a \le 2ax_1 + 0.5ax_i \le 2an && (4)\\
& x_1 \text{ free}, && (5)\\
& 0.0 \le x_2, && (6)\\
& 1.5 \le x_3 \le 10 && (7)\\
& 0.5 \le x_i,\ \forall i = 4, ..., n && (8)
\end{aligned}
$$

Here $n \geq 3$ and $a > 0$ are parameters that can be modified via Ex6 driver's command arguments. Their default values are $n = 3$ and $a = 1.0$.

The analytical optimal solution is $x_1 = 1.75$, $x_2 = x_3 = 1.5$, and $x_i = 1$ for $i \in \{4, 5, \ldots, n\}$. The objective value is 0.110352. The file nlpSparse_EX1_driver.cpp provides more details about how to use HiOp to solve instances of this example/test problem.

2 Sparse Example 2 — A Nonconvex Sparse Example

$$
\begin{aligned}
\min_{x\in\mathbb{R}^n} \quad & -\frac{a}{4}\sum_{i=1}^{n}(x_i-1)^4 + 0.5\sum_{i=1}^{n}x_i^2 && (9)\\
\text{s.t.} \quad & 4x_1 + 2x_2 = 10 && (10)\\
& 4x_1 + 2x_2 = 10 && (11)\\
& 5 \le 2x_1 + x_3 && (12)\\
& 4x_1 + 2x_3 \le 19 && (13)\\
& 1 \le 2x_1 + 0.5x_i \le 2n && (14)\\
& x_1 \text{ free}, && (15)\\
& 0.0 \le x_2, && (16)\\
& 1.5 \le x_3 \le 10 && (17)\\
& 0.5 \le x_i,\ \forall i = 4, ..., n && (18)
\end{aligned}
$$

Here $n \geq 3$ and $a > 0$ are parameters which can be tuned via Ex6 driver's command arguments. Their default values are $n = 3$ and $a = 0.1$. Note that the equality constraints (10) and (11) are duplicate. This is done on purpose to make the constraint Jacobian matrix rank deficient and to stress test HiOp on this numerically difficult, nonconvex problem. The file nlpSparse_EX2_driver.cpp provides more details about how to use HiOp in various configurations to solve instances of this example/test problem.