Manual of ReSNA Plugins

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1 Which problem do you want to solve?

ReSNA Plugin solves (or tries to solve) many kinds of problems by using ReSNA solver and SOCCP reformulation technique. Please choose a suitable ReSNA Plugin corresponding to the problem you want to solve. Note that, for any ReSNA Plugin, `ReSNA.m` must be put in the same folder.

Optimization problems (1.1 − 1.6) **Sorry! Those plugins 1.1 − 1.6 are not completed yet. Please solve the KKT system by the complementarity problem plugins 1.7 − 1.14.**

1.1 Linear/Quadratic Program (type 1)

`LPQP_ReSNA1.m` solves (finds the KKT point of) the Quadratic Program (QP) expressed as follows:

$$\begin{aligned} \underset{x\in\mathbb{R}^n}{\text{Minimize}} \quad & \tfrac{1}{2}x^\top Qx + r^\top x \\ \text{subject to} \quad & x \geq 0,\ Cx + d = 0, \end{aligned} \tag{1.1}$$

where $Q \in \mathbb{R}^{n\times n}$, $r \in \mathbb{R}^n$, $C \in \mathbb{R}^{l\times n}$ and $d \in \mathbb{R}^l$ are given matrices and vectors. When $Q = 0$, (1.1) is a Linear Program (LP). For the detailed usage of this plugin, see `manual_LPQP_ReSNA1.pdf`.

1.2 Linear/Quadratic Program (type 2)

`LPQP_ReSNA2.m` solves (finds the KKT point of) the Quadratic Program (QP) expressed as follows:

$$\begin{aligned} \underset{x\in\mathbb{R}^n}{\text{Minimize}} \quad & \tfrac{1}{2}x^\top Qx + r^\top x \\ \text{subject to} \quad & Ax + b \geq 0,\ Cx + d = 0, \end{aligned} \tag{1.2}$$

where $Q \in \mathbb{R}^{n\times n}$, $r \in \mathbb{R}^n$, $A \in \mathbb{R}^{m\times n}$, $b \in \mathbb{R}^m$, $C \in \mathbb{R}^{l\times n}$ and $d \in \mathbb{R}^l$ are given matrices and vectors. When $Q = 0$, (1.2) is a Linear Program (LP). For the detailed usage of this plugin, see `manual_LPQP_ReSNA2.pdf`.

1.3 Nonlinear Program

`NLP_ReSNA.m` solves (finds the KKT point of) the Nonlinear Program (NLP) expressed as follows:

$$\begin{aligned} \underset{x\in\mathbb{R}^n}{\text{Minimize}} \quad & \theta(x) \\ \text{subject to} \quad & G(x) \geq 0,\ H(x) = 0, \end{aligned} \tag{1.3}$$

where $\theta : \mathbb{R}^n \to \mathbb{R}$, $G : \mathbb{R}^n \to \mathbb{R}^m$ and $H : \mathbb{R}^n \to \mathbb{R}^l$ are given continuously differentiable functions. For the detailed usage of this plugin, see `manual_NLP_ReSNA.pdf`.

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1.4 Linear/Quadratic Second-Order Cone Program (type 1)

LQSOCP_ReSNA1.m solves (finds the KKT point of) the Quadratic Second-Order Cone Program (QSOCP) expressed as follows:

$$\begin{aligned} \underset{x\in\mathbb{R}^n}{\text{Minimize}} \quad & \tfrac{1}{2}x^\top Qx + r^\top x \\ \text{subject to} \quad & x \in \mathcal{K},\ Cx + d = 0, \end{aligned} \tag{1.4}$$

where $Q \in \mathbb{R}^{n\times n}$, $r \in \mathbb{R}^n$, $C \in \mathbb{R}^{l\times n}$ and $d \in \mathbb{R}^l$ are given matrices and vectors, and $\mathcal{K}$ is a Cartesian product of several second-order cones (SOCs). When $Q = 0$, (1.4) is a Linear Second-Order Cone Program (LSOCP). For the detailed usage of this plugin, see manual_LQSOCP_ReSNA1.pdf.

1.5 Linear/Quadratic Second-Order Cone Program (type 2)

LQSOCP_ReSNA2.m solves (finds the KKT point of) the Quadratic Second-Order Cone Program (QSOCP) expressed as follows:

$$\begin{aligned} \underset{x\in\mathbb{R}^n}{\text{Minimize}} \quad & \tfrac{1}{2}x^\top Qx + r^\top x \\ \text{subject to} \quad & Ax + b \in \mathcal{K},\ Cx + d = 0, \end{aligned} \tag{1.5}$$

where $Q \in \mathbb{R}^{n\times n}$, $r \in \mathbb{R}^n$, $A \in \mathbb{R}^{m\times n}$, $b \in \mathbb{R}^m$, $C \in \mathbb{R}^{l\times n}$ and $d \in \mathbb{R}^l$ are given matrices and vectors, and $\mathcal{K}$ is a Cartesian product of several second-order cones (SOCs). When $Q = 0$, (1.5) is a Linear Second-Order Cone Program (LSOCP). For the detailed usage of this plugin, see manual_LQSOCP_ReSNA2.pdf.

1.6 Nonlinear Second-Order Cone Program

NSOCP_ReSNA.m solves (finds the KKT point of) the Nonlinear Second-Order Cone Program (NSOCP) expressed as follows:

$$\begin{aligned} \underset{x\in\mathbb{R}^n}{\text{Minimize}} \quad & \theta(x) \\ \text{subject to} \quad & G(x) \in \mathcal{K},\ H(x) = 0, \end{aligned} \tag{1.6}$$

where $\theta : \mathbb{R}^n \to \mathbb{R}$, $G : \mathbb{R}^n \to \mathbb{R}^m$ and $H : \mathbb{R}^n \to \mathbb{R}^l$ are given continuously differentiable functions, and $\mathcal{K}$ is a Cartesian product of several second-order cones (SOCs). For the detailed usage of this plugin, see manual_NLP_ReSNA.pdf.

Complementarity problems (1.7 – 1.14)

1.7 Linear Complementarity Problem

LCP_ReSNA.m solves the Linear Complementarity Problem (LCP) expressed as follows:

$$\begin{aligned} \text{Find} \quad & (x, y) \in \mathbb{R}^n \times \mathbb{R}^n \\ \text{such that} \quad & x \geq 0,\ y \geq 0,\ x^\top y = 0, \\ & y = Mx + q, \end{aligned} \tag{1.7}$$

where $M \in \mathbb{R}^{n\times n}$ and $q \in \mathbb{R}^n$ are given matrix and vector, respectively. For the detailed usage of this plugin, see manual_LCP_ReSNA.pdf.

1.8 Mixed Linear Complementarity Problem

MLCP_ReSNA.m solves the Mixed Linear Complementarity Problem (MLCP) expressed as follows:

$$\begin{aligned} \text{Find} \quad & (x,y,p) \in \mathbb{R}^n \times \mathbb{R}^n \times \mathbb{R}^l \\ \text{such that} \quad & x \geq 0,\ y \geq 0,\ x^\top y = 0, \\ & y = M_{11}x + M_{12}p + q_1,\ \ M_{21}x + M_{22}p + q_2 = 0, \end{aligned} \tag{1.8}$$

where $M_{11} \in \mathbb{R}^{n\times n}$, $M_{12} \in \mathbb{R}^{n\times l}$, $M_{21} \in \mathbb{R}^{l\times n}$, $M_{22} \in \mathbb{R}^{l\times l}$, $q_1 \in \mathbb{R}^n$ and $q_2 \in \mathbb{R}^l$ are given matrices and vectors. For the detailed usage of this plugin, see manual_MLCP_ReSNA.pdf.

1.9 Nonlinear Complementarity Problem

NCP_ReSNA.m solves the Nonlinear Complementarity Problem (NCP) expressed as follows:

$$\begin{aligned} \text{Find} \quad & (x,y) \in \mathbb{R}^n \times \mathbb{R}^n \\ \text{such that} \quad & x \geq 0,\ y \geq 0,\ x^\top y = 0, \\ & y = F(x), \end{aligned} \tag{1.9}$$

where $F : \mathbb{R}^n \to \mathbb{R}^n$ is a given continuously differentiable function. For the detailed usage of this plugin, see manual_NCP_ReSNA.pdf.

1.10 Mixed Nonlinear Complementarity Problem

MNCP_ReSNA.m solves the Mixed Nonlinear Complementarity Problem (MNCP) expressed as follows:

$$\begin{aligned} \text{Find} \quad & (x,y,p) \in \mathbb{R}^n \times \mathbb{R}^n \times \mathbb{R}^l \\ \text{such that} \quad & x \geq 0,\ y \geq 0,\ x^\top y = 0, \\ & y = F_1(x,p),\ \ F_2(x,p) = 0, \end{aligned} \tag{1.10}$$

where $F_1 : \mathbb{R}^n \times \mathbb{R}^l \to \mathbb{R}^n$ and $F_2 : \mathbb{R}^n \times \mathbb{R}^l \to \mathbb{R}^l$ are given continuously differentiable functions. For the detailed usage of this plugin, see manual_MNCP_ReSNA.pdf.

1.11 Linear Second-Order Cone Complementarity Problem

LSOCCP_ReSNA.m solves the Linear Second-Order Cone Complementarity Problem (LSOCCP) expressed as follows:

$$\begin{aligned} \text{Find} \quad & (x,y) \in \mathbb{R}^n \times \mathbb{R}^n \\ \text{such that} \quad & x \in \mathcal{K},\ y \in \mathcal{K},\ x^\top y = 0, \\ & y = Mx + q, \end{aligned} \tag{1.11}$$

where $M \in \mathbb{R}^{n\times n}$ and $q \in \mathbb{R}^n$ are given matrix and vector, respectively, and $\mathcal{K}$ is a Cartesian product of several second-order cones (SOCs). For the detailed usage of this plugin, see manual_LSOCCP_ReSNA.pdf.

1.12 Mixed Linear Second-Order Cone Complementarity Problem

MLSOCCP_ReSNA.m solves the Mixed Linear Second-Order Cone Complementarity Problem (MLSOCCP) expressed as follows:

$$\begin{aligned} \text{Find} \quad & (x,y,p) \in \mathbb{R}^n \times \mathbb{R}^n \times \mathbb{R}^l \\ \text{such that} \quad & x \in \mathcal{K},\ y \in \mathcal{K},\ x^\top y = 0, \\ & y = M_{11}x + M_{12}p + q_1,\ \ M_{21}x + M_{22}p + q_2 = 0, \end{aligned} \tag{1.12}$$

where $M_{11} \in \mathbb{R}^{n\times n}$, $M_{12} \in \mathbb{R}^{n\times l}$, $M_{21} \in \mathbb{R}^{l\times n}$, $M_{22} \in \mathbb{R}^{l\times l}$, $q_1 \in \mathbb{R}^n$ and $q_2 \in \mathbb{R}^l$ are given matrices and vectors, and $\mathcal{K}$ is a Cartesian product of several second-order cones (SOCs). For the detailed usage of this plugin, see manual_MLSOCCP_ReSNA.pdf.

1.13 Nonlinear Second-Order Cone Complementarity Problem

`NSOCCP_ReSNA.m` solves the Nonlinear Second-Order Cone Complementarity Problem (NSOCCP) expressed as follows:

$$\begin{aligned} \text{Find} \quad & (x, y) \in \mathbb{R}^n \times \mathbb{R}^n \\ \text{such that} \quad & x \in \mathcal{K},\ y \in \mathcal{K},\ x^\top y = 0, \\ & y = F(x), \end{aligned} \tag{1.13}$$

where $F : \mathbb{R}^n \to \mathbb{R}^n$ is a given continuously differentiable function, and $\mathcal{K}$ is a Cartesian product of several second-order cones (SOCs). For the detailed usage of this plugin, see `manual_NSOCCP_ReSNA.pdf`.

1.14 Mixed Nonlinear Second-Order Cone Complementarity Problem

To solve Mixed Nonlinear Second-Order Cone Complementarity Problem (MNSOCCP), use `ReSNA.m` directly. For the detailed usage of `ReSNA.m`, see `manual_ReSNA.pdf`.

Equation (1.15)

1.15 Nonlinear Equation

`NEQ_ReSNA.m` solves the Nonlinear Equation expressed as follows:

$$\begin{aligned} \text{Find} \quad & (x, y) \in \mathbb{R}^n \times \mathbb{R}^n \\ \text{such that} \quad & y = F(x), \end{aligned}$$

where $F : \mathbb{R}^n \to \mathbb{R}^n$ is a given continuously differentiable function. For the detailed usage of this plugin, see `manual_NEQ_ReSNA.pdf`.