

## Objective of Assignment

The objective of this assignment is to learn how to use the sparse nonlinear programming problem (NLP) solver SNOPT. SNOPT solves NLPs of the following form:

$$\min f(\mathbf{z})$$

subject to the algebraic constraints

$$\begin{aligned} \mathbf{a}_{\min} &\leq \mathbf{A}\mathbf{z} \leq \mathbf{a}_{\max} \\ \mathbf{g}_{\min} &\leq \mathbf{g}(\mathbf{z}) \leq \mathbf{g}_{\max} \end{aligned}$$

In this assignment you will solve three NLPs using SNOPT. For reference, the SNOPT user's guide can be found on the web. The SNOPT mex files for use in the course can be found by clicking [here](#). All of the information on how to use SNOPT is included in the user's guide, and an example of using SNOPT is included in the zip file.

### Question 1

Solve the following NLP using SNOPT. Let  $\mathbf{z} = (z_1, z_2, z_3, z_4, z_5)$ . Maximize

$$f(\mathbf{z}) = (z_1 - z_2)^2 + (z_2 + z_3 - 2)^2 + (z_4 - 1)^2 + (z_5 - 1)^2$$

subject to the bounds

$$\begin{aligned} z_1 + 3z_2 &= 4 \\ z_3 + z_4 - 2z_5 &= 0 \\ z_2 - z_5 &= 0 \end{aligned}$$

### Question 2

Solve the following NLP using SNOPT. Let  $\mathbf{z} = (z_1, z_2, z_3, z_4, z_5)$ . Minimize

$$f(\mathbf{z}) = (z_1 - z_2)^2 + (z_2 - z_3)^3 + (z_3 - z_4)^4 + (z_4 - z_5)^4$$

subject to

$$\begin{aligned} z_3 + z_4 + z_5 &\geq 3 \\ z_1 + z_2^2 + z_3^3 &= 3 \\ z_1 + z_2 &\geq 1 \\ z_2 - z_3^2 + z_4 &= 1 \\ z_1 z_5 &= 1 \end{aligned}$$

### Question 3

Solve the following NLP using SNOPT. Let  $\mathbf{z} = (z_1, z_2, z_3, z_4, z_5, z_6, z_7, z_8, z_9)$ . Maximize

$$f(\mathbf{z}) = z_2 z_6 - z_1 z_7 + z_3 z_7 + z_5 z_8 - z_4 z_9 - z_3 z_8$$

subject to the bounds

$$\begin{aligned}
 z_1 &\geq 0 \\
 z_3 &\geq -1 \\
 z_3 &\leq +1 \\
 z_5 &\geq 0 \\
 z_6 &\geq 0 \\
 z_7 &\geq 0 \\
 z_8 &\leq 0 \\
 z_9 &\leq 0
 \end{aligned}$$

and the constraints

$$\begin{aligned}
 z_1^2 + z_6^2 &\leq 1 \\
 (z_2 - z_1)^2 + (z_7 - z_6)^2 &\leq 1 \\
 (z_3 - z_1)^2 + z_6^2 &\leq 1 \\
 (z_1 - z_4)^2 + (z_6 - z_8)^2 &\leq 1 \\
 (z_1 - z_5)^2 + (z_6 - z_9)^2 &\leq 1 \\
 z_2^2 + z_7^2 &\leq 1 \\
 (z_3 - z_2)^2 + z_7^2 &\leq 1 \\
 (z_4 - z_2)^2 + (z_8 - z_7)^2 &\leq 1 \\
 (z_2 - z_5)^2 + (z_7 - z_9)^2 &\leq 1 \\
 (z_4 - z_3)^2 + z_8^2 &\leq 1 \\
 (z_5 - z_3)^2 + z_9^2 &\leq 1 \\
 z_4^2 + z_8^2 &\leq 1 \\
 (z_4 - z_5)^2 + (z_9 - z_8)^2 &\leq 1 \\
 z_5^2 + z_9^2 &\leq 1 \\
 -z_1 + z_2 &\geq 0 \\
 -z_2 + z_3 &\geq 0 \\
 z_3 - z_4 &\geq 0 \\
 z_4 - z_5 &\geq 0
 \end{aligned}$$