Due Time: 12:00pm, Thursday February 7, 2019 Submit to Gradescope

The homework is about convex functions. For the 7 exercises, the first three exercises cover the definition (3.2, 3.13, 3.14); the fourth verifies the convexity of a set of functions (3.16); the fifth practices the operation of pointwise maximum and supremum (3.21); and the last two work on the conjugate function (3.36, 3.40). For the assignment, we first practice the derivation of the gradient and Hessian matrix. We then work on a conjugate function with mathematical tools. The seven exercises worth 1 point each and are graded by completion. The first assignments worth 6 points each and the second worth 7 points.

I Exercises from textbook Chapter Three: 3.2, 3.13, 3.14, 3.16, 3.21, 3.36, 3.40

II Assignments

II.1 [Derivatives] Show the first and second order derivatives of function,

\[ f(x) = \frac{2x_1^3}{x_2} + x_2^2 + x_1x_3, \quad x \in \mathbb{R}^3_+ \]

Is function \( f \) convex? Show your explanation.

II.2 [Conjugate Function] Derive the conjugate function \( f^*(y) \) of the following function,

\[ f(x) = (x_1 - 1)^2 + (x_2 - 3)^2, \quad x \in \mathbb{R}^2 \]

What does the curve of \( f^*(y) \) look like? Try to plot the figure with mathematical tools.