

NYU Center for Data Science: DS-GA 1003
Machine Learning and Computational Statistics (Spring 2018)

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Instructions: Following most lab and lecture sections, we will be providing concept checks for review. Each concept check will:

- List the lab/lecture learning objectives. You will be responsible for mastering these objectives, and demonstrating mastery through homework assignments, exams (midterm and final), and on the final course project.
- Include concept check questions. These questions are intended to reinforce the lab/lectures, and help you master the learning objectives.

You are strongly encourage to complete all concept check questions, and to discuss these (and related) problems on Piazza and at office hours. However, problems marked with a (★) are considered optional.

Week 4 Lab: Concept Check Exercises

Subgradients

1. (★) If $f : \mathbb{R}^n \rightarrow \mathbb{R}$ is convex and differentiable at x , the $\partial f(x) = \{\nabla f(x)\}$.
2. Fix $f : \mathbb{R}^n \rightarrow \mathbb{R}$ and $x \in \mathbb{R}^n$. Then the subdifferential $\partial f(x)$ is a convex set.
3. (a) True or False: A subgradient of $f : \mathbb{R}^n \rightarrow \mathbb{R}$ at x is normal to a hyperplane that globally underestimates the graph of f .
(b) True or False: If $g \in \partial f(x)$ then $-g$ is a descent direction of f .
(c) True or False: For $f : \mathbb{R} \rightarrow \mathbb{R}$, if $1, -1 \in \partial f(x)$ then x is a global minimizer of f .
(d) True or False: Let $f : \mathbb{R}^n \rightarrow \mathbb{R}$ and let $g \in \partial f(x)$. Then $\alpha g \in \partial f(x)$ for all $\alpha \in [0, 1]$.
(e) True or False: If the sublevel sets of a function are convex, then the function is convex.
4. Let $f : \mathbb{R}^2 \rightarrow \mathbb{R}$ be defined by $f(x_1, x_2) = |x_1| + 2|x_2|$. Compute $\partial f(x_1, x_2)$ for each $x_1, x_2 \in \mathbb{R}^2$.