

Instructions

You should submit a carefully written report addressing the problems given below. You are encouraged to discuss ideas with others for this project. If you do work with others, you must still write your report independently.

Use the writing conventions given in *Some notes on writing in mathematics*. You should include enough detail so that a reader can follow your reasoning and reconstruct your work. You should not show every algebraic or arithmetic step. All graphs should be done carefully on graph paper or using appropriate technology.

For this project, you can do either one of the two problems.

The project is due in class on Wednesday, November 1.

1. Applications that involve partial derivatives

Find and describe a real-world application that involves, in some essential way, rates of change in a function of more than one variable. Mathematically, this means partial derivatives, but the source of your application need not mention partial derivatives explicitly. You should find an application outside of mathematics and different from the examples used in our course (class or text). It might be useful to think about science or social science courses that you have taken or are taking. The function you use can be given by data, graph, or formula. Rates of change should have an essential role in the analysis of the phenomenon or situation. That is, rates of change should give some insight on or understanding of the thing under study. In your report you should

- give enough background on the real-world setting so that the situation is understandable to a peer in this class who is unfamiliar with the topic;
- clearly describe the real-world interpretation of the function used in modeling the situation, including the real-world meaning of the input variables, the output variable, and their relationship;
- clearly describe the role played by rates of change in the analysis of the phenomenon or situation; and
- give proper references to any sources you use for your report.

Your goal is to look at how the ideas of calculus show up outside of mathematics and to write coherently about this. Look for something that is interesting to you.

2. Paths of steepest ascent

Given a function $f : \mathbb{R}^n \rightarrow \mathbb{R}$, a path of steepest ascent is a curve that at each point is tangent to the direction in which the function has the greatest rate of change.

For each of the following, find the path of steepest ascent for the given function starting at the given point. If you can, give the exact path of steepest ascent. Otherwise, give an approximation of the path.

(a) $f(x, y) = x^2 - y^2$ starting at $(0.2, -2)$

(b) $f(x, y) = (x + y)e^{-x^2 - y^2}$ starting at $(-0.9, 0)$