MITx CSE.0002x
Introduction to Computational Science and Engineering

Help

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🏠 Course / 3 Finger Exercises (FE) / 3.7 Finger Exercises 4 (FE4)

You are taking "5.2 Exam 2" as a timed exam. Show more

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3.7.2 Finger Exercise: Using the gradient to approximate function changes

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Finger Exercises 4 due Sep 7, 2023 05:00 IST   Completed

MO2.12

As described previously, the gradient of a function can be used to estimate the change of the function for small changes in its inputs (independent variables). Consider a function $f(x_0, x_1)$ of two independent variables (x_0, x_1). Let the gradient of the function at $(x_0^{\text{base}}, x_1^{\text{base}}) = (9, 3)$ be:

$$\nabla f = \left(\frac{\partial f}{\partial x_0}, \frac{\partial f}{\partial x_1} \right) = (-2, 1) \tag{3.33}$$

Then, we can estimate the change in f around the point $(9, 3)$ with Δf which we may view as a function of Δx_0, Δx_1 defined as:
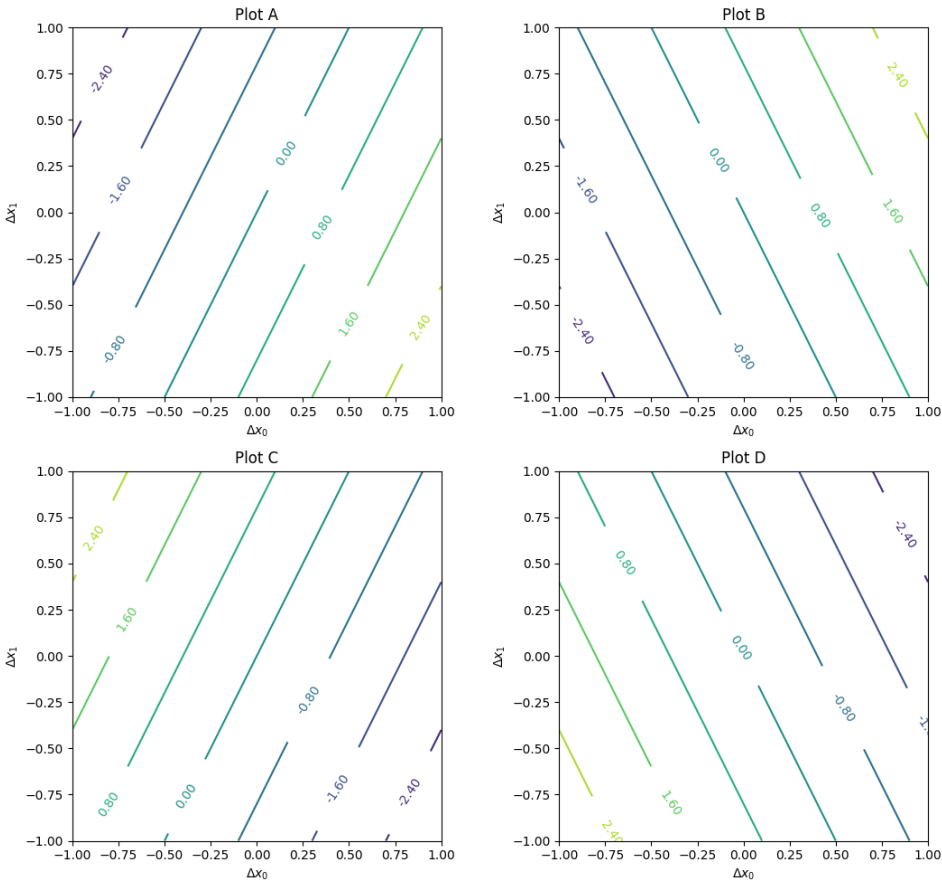
$$\Delta f(\Delta x_0, \Delta x_1) \equiv \nabla f \cdot \Delta \underline{x} \tag{3.3}$$

$$\Delta \underline{x} \equiv (\Delta x_0, \Delta x_1) = (x_0 - 9, x_1 - 3) \tag{3.3}$$

To start, let's consider a plot of $\Delta f(\Delta x_0, \Delta x_1)$. One of the following four plots (Plot A, B, C, or D) is a contour plot of $\Delta f(\Delta x_0, \Delta x_1)$ for this problem. The values of each contour are shown by the labels (as you can see, the contours range from -2.4 to 2.4).

Problem: Find the correct plot

1/1 point (graded)
Which plot shows the correct contours of Δf?

○ Plot A

○ Plot B

⊙ Plot C

○ Plot D

✔

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Problem: Determine change in f from change in x

0/1 point (graded)
Determine Δf for $\Delta \underline{x} = (0.123, 0.789)$. Use three significant digits of precision.

15.543   ✘ Answer: 0.543

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ⓘ Answers are displayed within the problem

Problem: Determine change in f from a new x

1/1 point (graded)
Determine Δf for $(x_0, x_1) = (9.45, 2.88)$. Use three significant digits of precision.

-1.02   ✔ Answer: -1.02

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ⓘ Answers are displayed within the problem

Problem: Find the direction of largest decrease

1/1 point (graded)
From the following values of $(\Delta x_0, \Delta x_1)$, determine which would be estimated (using Δf) to give the largest decrease in f. Select multiple answers if more than one gives the same decrease.

☐ $(\Delta x_0, \Delta x_1) = (1, 0.5)$

☐ $(\Delta x_0, \Delta x_1) = (-1, 0.5)$

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☐ $(\Delta x_0, \Delta x_1) = (-0.5, 1)$

☑ $(\Delta x_0, \Delta x_1) = (-0.5, -1)$

☐ $(\Delta x_0, \Delta x_1) = (0.5, -1)$

✔

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