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2. Exploration of critical points

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Practice

Critical points 1

1.0/1 point (graded)
Consider the function

$$f(x,y) = x^2 + y^2 - x^2y^2. \tag{4.38}$$

The partial derivatives of f are

$$f_x(x,y) = 2x - 2xy^2 \tag{4.39}$$
$$f_y(x,y) = 2y - 2x^2y. \tag{4.40}$$

Find the critical point(s) of $f(x,y)$. (Enter ordered pairs in parentheses, e.g. (x, y). If there is more than one point, separate with semicolons, e.g. (a, b); (c, d). You may type e for Euler's number, and pi for the mathematical constant π.)

Critical points of $f(x,y)$: (0,0);(1,1);(1,-1);(-1,1);(-1,-1) ✔ **Answer:** (0,0);(1,1);(-1,1);(1,-1);(-1,-1)

Solution:

We have

$$f_x(x,y) = 2x - 2xy^2 = 2x(1-y^2) \tag{4.41}$$
$$f_y(x,y) = 2y - 2x^2y = 2y(1-x^2). \tag{4.42}$$

For a point to be a critical point, both equations must equal 0 simultaneously. We know $f_x = 0$ when $x = 0$. Plugging this into the equation for f_y gives

$$f_y(0,y) = 2y(1-0) = 2y. \tag{4.43}$$

So we need $y = 0$. Therefore, one of the critical points is $(0,0)$.

We also see that $f_x = 0$ when $y = \pm 1$. Plugging $y = 1$ into the equation for f_y gives

$$f_y(x,1) = 2(1-x^2) \tag{4.44}$$

which will equal zero when $x = \pm 1$. So two more critical points are $(1,1)$ and $(-1,1)$.

Plugging $y = -1$ into the equation for f_y gives

$$f_y(x,-1) = -2(1-x^2) \tag{4.45}$$

which will equal zero when $x = \pm 1$. Therefore, two more critical points are given by $(1,-1)$ and $(-1,-1)$.

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Answers are displayed within the problem

Critical points 2

1.0/1 point (graded)

Find the critical points of

$$g(x,y) = -xye^{-(x^2+y^2)/8}. \tag{4.46}$$

(Enter ordered pairs in parentheses, e.g. (x, y). If there is more than one point, separate with semicolons, e.g. (a, b); (c, d). You may type e for Euler's number, and pi for the mathematical constant π.)

Critical points of $g(x,y)$: (0,0);(2,2);(2,-2);(-2,2);(-2,-2) ✔ **Answer:** (0,0);(2,2);(-2,2);(2,-2);(-2,-2)

Solution:

Using the product rule and chain rule, we have

$$g_x(x,y) = -ye^{(-x^2-y^2)/8} + x^2y/4e^{(-x^2-y^2)/8} = ye^{(-x^2-y^2)/8}\left(x^2/4-1\right) \tag{4.47}$$

$$g_y(x,y) = -xe^{(-x^2-y^2)/8} + xy^2/4e^{(-x^2-y^2)/8} = xe^{(-x^2-y^2)/8}\left(y^2/4-1\right). \tag{4.48}$$

These equations are simultaneously zero when:

- $x = 0$ and $y = 0$
- $x^2/4 - 1 = 0$ and $y^2/4 - 1 = 0$ which gives $x = \pm 2$ and $y = \pm 2$.

This leads to the following five critical points:

$$(0,0), (2,2), (-2,2), (2,-2), (-2,-2) \tag{4.49}$$

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2. Exploration of critical points

Topic: Unit 3: Optimization / 2. Exploration of critical points

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- Can we say the infinite is a critical point? — 3
- STAFF: Possible error in critical points 2 answer — My answer got (0.2/1). I think it's highly likely the grader is incorrect here. Thanks. — 9
- Error in both answers? — The first question did not accept (-1,-1) as an answer so I got (0.8/1) which is not confirmed by the answer that accepts (-1,-1) as a v... — 5
- [staff] typo in Critical points 2 solution

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[typo] function name

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