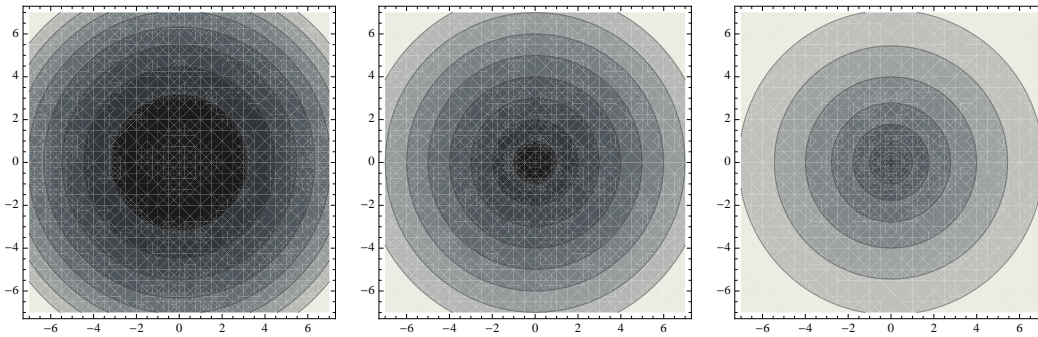


1. Three contour plots are shown. The rings represent the values $z = 1, 2, \dots, 7$. In the graphs, the dark colors represent low values of z and the light colors represent high values of z .



- (a) Which is the graph of $z = \sqrt{x^2 + y^2}$? Explain.
 (b) Explain why the graphs do not show the contours of $z = 4 - x^2 - y^2$.
 (c) Explain why the graphs do not show the graphs of $z = x^2 - y^2$.
2. Sketch the graph of the surface described by the parametric equations $x = u \cos v, y = u \sin v, z = u^2$ on the interval $0 \leq u \leq 2, 0 \leq v \leq 2\pi$.
3. Sketch the graph of the portion of the plane described by the parametric equations $x = u \cos v, y = u \sin v, z = 0$ on the interval $1 \leq u \leq 2, 0 \leq v \leq 2\pi$.
4. Find the equation of the tangent plane to $f(x, y) = x^2 + y^2 + 2$ at $(x, y) = (1, 2)$.
5. Compute the directional derivative of $f(x, y) = \sqrt{x^2 + y^2}$ at $(3, -4)$ in the direction of $\vec{u} = \langle -2, -1 \rangle$.
6. Explain why the maximum value of the directional derivative is in the direction of ∇f .
7. Use the following chart to estimate $\nabla f(8, 6)$

$\begin{matrix} & x \\ y & \end{matrix}$	2	5	8	11	14
-9	2.4	2.1	0.8	0.5	1.0
-4	2.6	2.3	1.4	1.0	1.2
1	2.7	2.4	2.1	1.6	1.2
6	2.9	2.5	2.6	2.2	1.8
11	3.1	2.7	3.0	2.9	2.7

8. Use the above chart and the total differential to estimate $f(7, 0)$
9. To determine the height of a tower, the angle of elevation to the top of the tower was measured from a point 100 feet $\pm \frac{1}{2}$ foot from the base. The angle was measured as 30° , with a possible error of 1° . Assuming that the ground is horizontal, use the total differential to approximate the maximum error in determining the height of the tower.
10. A least squares model is derived from the equation

$$f(a, b) = \sum_{i=1}^n (y_i - ax_i - bx_i^2)^2$$

Set up, but do not solve the least squares equations that will determine the values of a and b .

11. Given $f(x, y) = x^3 - 3x^2 - 6xy - y^2$, determine the critical points and their types. You do not have to find the z values of the points.