

1. DERIVATIVES OF MULTI-VARIABLE FUNCTIONS, I

1.1. **Partial Derivatives+ Linear Approximation.** Compute the partial derivatives of $x^2 - y^2$ at the point $(1, 1)$. Use these derivatives to estimate the value of the function at the value $(1.5, 1.5)$.

1.2. **Partial Derivatives + Linear Approximation II.** Consider the function $\frac{xy}{\sqrt{x^2+y^2}}$. Compute the partial derivatives in both the x and y directions at 0 . Estimate the value of the function at the point $(1, 1)$. Why is this such a bad estimate? (You may want to draw a contour plot to help understand why this estimate is so bad!)

1.3. **Limits.** Show that these functions are either continuous, or not continuous

$$\frac{x + y}{x^2 + y^2}$$

$$\frac{x + y}{\sqrt{x^2 + y^2}}$$

$$\frac{\sin x + \sin y}{x + y}$$