# Multi 13.6 Notes

## Omkar Tasgaonkar

## December 25, 2024

## Contents

0.1 0.2	The Directional Derivative:				3
List	of Figures				
1	A graph $z = f(x, y)$ represents the hill				2
2	A graph $z = f(x, y)$ represents the hill Rotation of theta				2
3	The Gradient, max growth				3

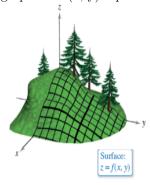
### 0.1 The Directional Derivative:

The directional derivative tells us the slope in a direction:

$$\frac{\partial f}{\partial x} = slope \ in \ x - dir \tag{1}$$

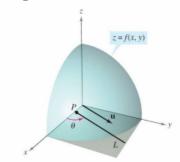
$$\frac{\partial f}{\partial y} = slope \ in \ y - dir \tag{2}$$

Figure 1: A graph z = f(x, y) represents the hill



We want to find the slope in a certain direction, a rotation of theta in cylindrical

Figure 2: Rotation of theta

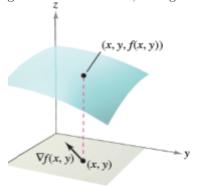


So our direction vector u Therefore our directional derivative is the dot product of two vectors, now which vectors?

#### 0.2 The Gradient

The gradient tells us the biggest derivative vector at a certain point in the graph!

Figure 3: The Gradient, max growth



$$\nabla f(x,y) = \frac{\partial f}{\partial x}\vec{i} + \frac{\partial f}{\partial y}\vec{j} \tag{3}$$

So now, if we rotate this gradient by an angle theta, then we can say that the gradient is a subset of rotated gradients Or that  $\nabla$  f(x, y)  $\in$  G where G is the superset

For the final step, the directional derivative must be a scalar quantity as it is a slope, so:

Directional derivative = 
$$\nabla f(x, y) \cdot u$$
 (4)

Whereby u is the direction vector for angle  $\theta$ 

### 0.2.1 Using $\nabla$ f(x, y) to find Directional Derivative

Find the directional derivative of  $f(x,y)=3x^2-2y^2at(-3/4,0)$  in the direction of:  $3/4\vec{i}+\vec{j}$ 

$$\nabla f(x,y) = 6x\vec{i} - 4y\vec{j} \tag{5}$$

$$u = 3/5\vec{i} + 4/5\vec{j} \tag{6}$$

$$\nabla f(-3/4,0) \cdot u = -9/2\vec{i} \cdot (3/5\vec{i} + 4/5\vec{j}) \tag{7}$$

So the directional derivative or dot product for this question evaluates to: -27/10