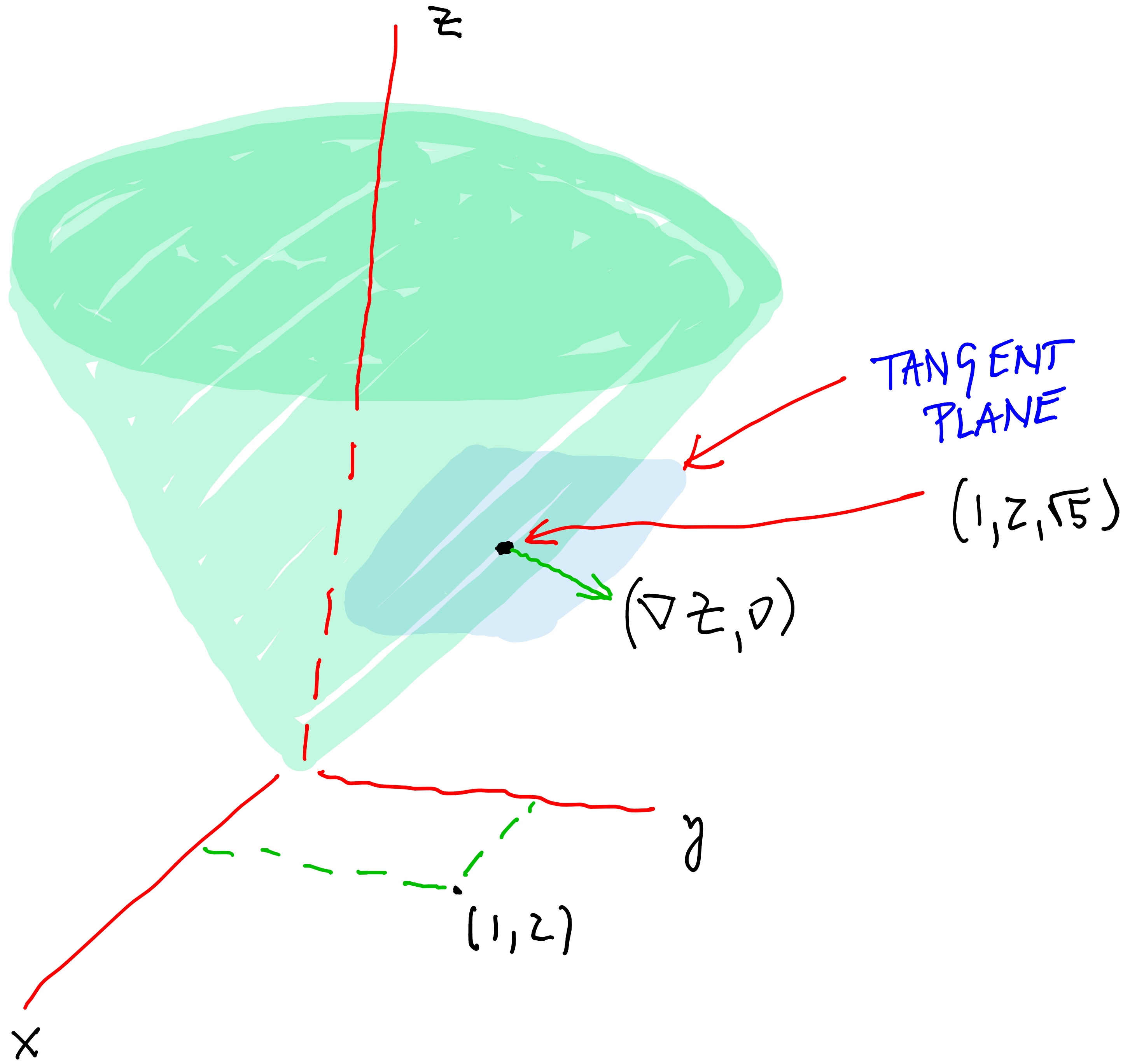
1.) $z = \sqrt{x^2 + y^2}$



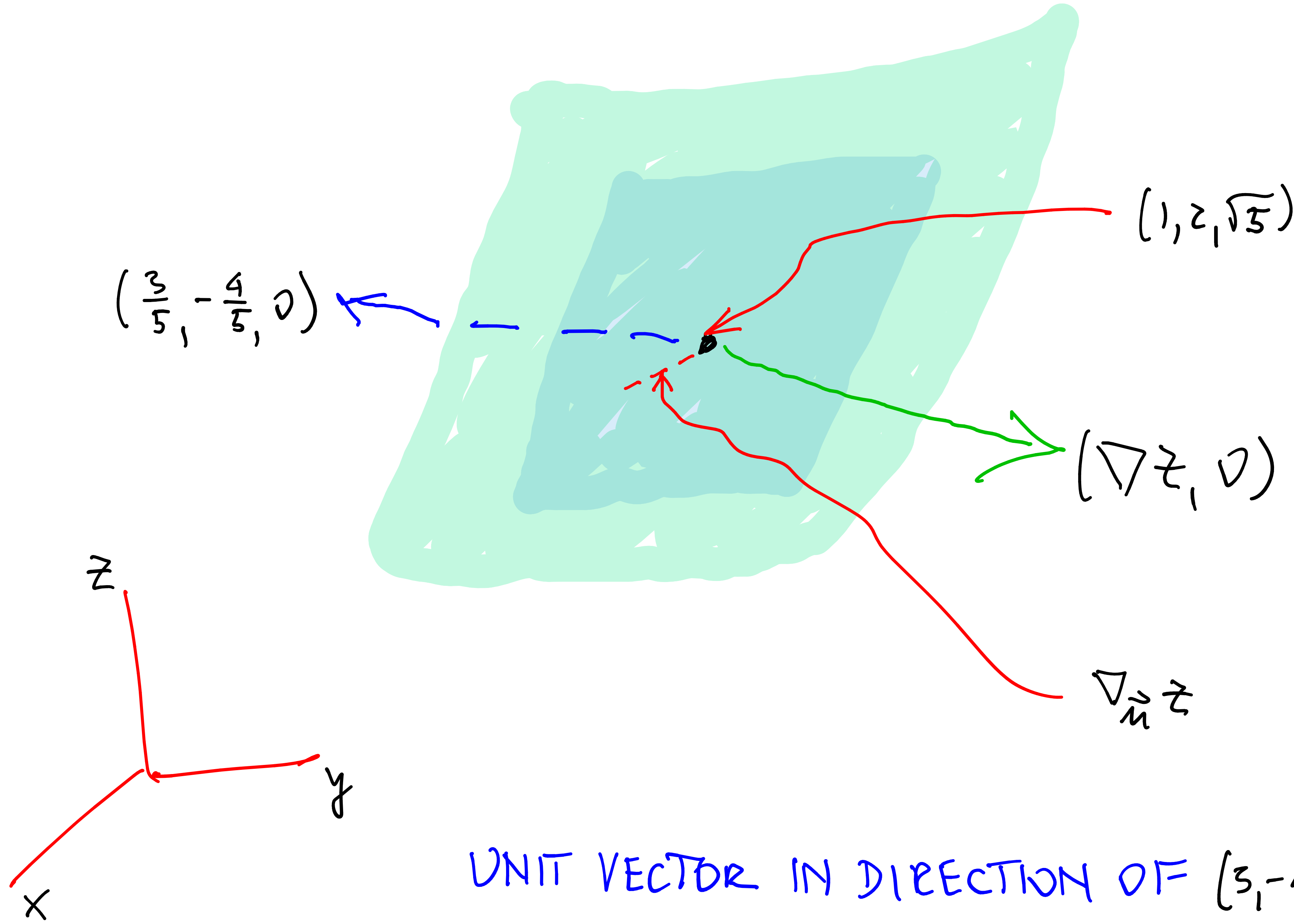
$$z_x = \frac{x}{\sqrt{x^2+y^2}} \qquad z_y = \frac{y}{\sqrt{x^2+y^2}}$$

$$P = (1,2) \; : \quad z = \sqrt{5} \;, \quad z_x = \frac{1}{\sqrt{5}} \;, \quad z_y = \frac{2}{\sqrt{5}}$$

TANGENT PLANE: $z = \sqrt{5} + \frac{1}{\sqrt{5}}(x-1) + \frac{2}{\sqrt{5}}(y-2)$

$$x - 1 + 2y - 4 + 5 = \sqrt{5}\, z$$

$$x + 2y - \sqrt{5}\, z = 0$$



UNIT VECTOR IN DIRECTION OF $(3,-4)$

$$\vec{u} = \left(\frac{3}{5}, -\frac{4}{5}\right)$$

$$D_{\vec{u}} z(1,2) = \vec{u} \cdot \nabla z(1,2) = \left(\frac{3}{5}, -\frac{4}{5}\right) \cdot \left(\frac{1}{\sqrt{5}}, \frac{2}{\sqrt{5}}\right) =$$

$$= \frac{1}{5\sqrt{5}}(3-8) = -\frac{1}{\sqrt{5}}$$

NONE OF THESE OBJECTS EXIST AT $(0,0)$ B/C

z HAS A CORNER THERE.

2.) $z = f(x,y)$, $x = r\cos\theta$, $y = r\sin\theta$

$$z_r = z_x\cos\theta + z_y\sin\theta$$
$$z_\theta = -z_x r\sin\theta + z_y r\cos\theta$$

$$r z_r\cos\theta - z_\theta\sin\theta = r z_x$$

$$r z_r\sin\theta + z_\theta\cos\theta = r z_y$$

$$z_x = z_r\cos\theta - z_\theta\frac{\sin\theta}{r}$$

$$z_y = z_r\sin\theta + z_\theta\frac{\cos\theta}{r}$$

$$x z_x + y z_y = r\cos\theta\left(z_r\cos\theta - z_\theta\frac{\sin\theta}{r}\right) +$$

$$+ r\sin\theta\left(z_r\sin\theta + z_\theta\frac{\cos\theta}{r}\right) =$$

$$= r z_r$$