J8: TangPlane
Desmos graph: https://www.desmos.com/3d/zs3ehoduav
Surface S: $z = f(x, y) = 1 + x^2 - y^2$, with $P_0 = (x_0, y_0) = (1, 1)$ in the domain of f

Step 1: The point $P_0 = (x_0, y_0, z_0)$ on the surface S
$P_0 = (x_0, y_0, z_0) = (1, 1, 1)$
($z_0 = f(1, 1) = 1 + 1^2 - 1^2 = 1$)

Step 2: Space curve with $y = y_0 = 1$
$r_X(t) = \langle t, 1, t^2 \rangle$
($r_X(t) = \langle t, 1, f(t, 1) \rangle = \langle t, 1, 1 + t^2 - 1 \rangle$)

Step 3: Tangent vector at $t = x_0 = 1$
($r_X'(t) = \langle 1, 0, 2t \rangle$)
$r_X'(1) = \langle 1, 0, 2 \rangle$

Step 4: Space curve with $x = x_0 = 1$
$r_Y(t) = \langle 1, t, 2 - t^2 \rangle$
($r_Y(t) = \langle 1, t, f(1, t) \rangle = \langle 1, t, 1 + 1^2 - t^2 \rangle$)

Step 5: Tangent vector at $t = y_0 = 1$
($r_Y'(t) = \langle 0, 1, -2t \rangle$)
$r_Y'(1) = \langle 0, 1, -2 \rangle$

Step 6: Cross product
($f_x = 2x$ and $f_Y = -2y$, so $f_x(1, 1) = 2$ and $f_Y(1, 1) = -2$)
$(r_X'(1) \times r_Y'(1) = \langle 1, 0, 2 \rangle \times \langle 0, 1, -2 \rangle = \langle 0 \cdot (-2) - 2 \cdot 1, -(1 \cdot (-2) - 2 \cdot 0), 1 \cdot 1 - 0 \cdot 0 \rangle)$
$n = \langle -2, 2, 1 \rangle$

Step 7: Equation of the tangent plane
($n \cdot \langle x - 1, y - 1, z - 1 \rangle = 0$, so $z = f(1, 1) + f_x(1, 1)(x - 1) + f_Y(1, 1)(y - 1)$)
$z = 1 + 2(x - 1) - 2(y - 1)$

Step 8: Normal line (through the point (1, 1, 1) in the direction of n)
$\langle x, y, z \rangle = \langle 1, 1, 1 \rangle + t\langle -2, 2, 1 \rangle$, that is $x = 1 - 2t$, $y = 1 + 2t$, $z = 1 + t$

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