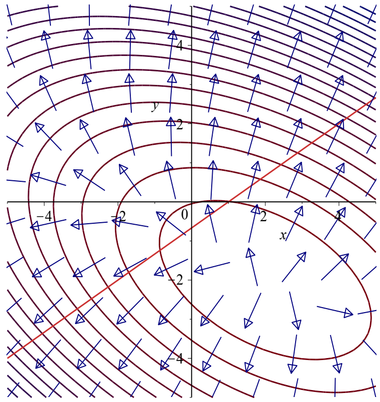

Figure 49.4: The level curves of $J(x,y) = \frac{3}{2}x^2 + 2xy + 3y^2 - 2x + 8y$ and the red search line with direction $\nabla J(-2,-2) = (-12,-8)$

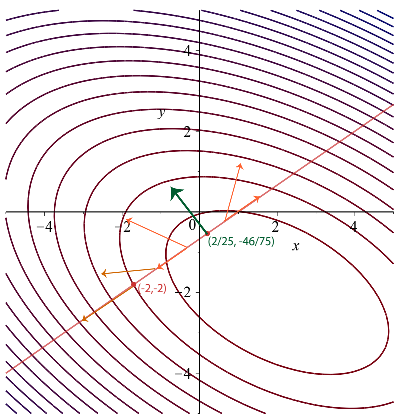

Figure 49.5: Let $u_k = (-2,-2)$. When traversing along the red search line, we look for the green perpendicular gradient vector. This gradient vector, which occurs at $u_{k+1} = (2/25, -46/75)$, provides a minimal ρ_k, since it has no nonzero projection on the search line.

In particular, we find that

$$\rho_k = \frac{\|w_k\|^2}{\langle Aw_k, w_k\rangle} = \frac{13}{75}.$$

This in turn gives us the new point

$$u_{k+1} = u_k - \frac{13}{75}w_k = (-2,-2) - \frac{13}{75}(-12,-8) = \left(\frac{2}{25}, -\frac{46}{75}\right),$$

and we continue the procedure by searching along the gradient direction $\nabla J(2/25, -46/75) = (-224/75, 112/25)$. Observe that $u_{k+1} = (\frac{2}{25}, -\frac{46}{75})$ has a gradient vector which is perpendicular to the search line with direction vector $w_k = \nabla J(-2,-2) = (-12\;-8)$; see Figure