2.

Forward:

$s_1 = \omega_1 x \quad , s_2 = \omega_2 x$

$z_1 = \max(0, s_1) \quad , z_2 = \max(0, s_2)$

$a_1 = z_1 \cdot u_{1,1} + z_2 \cdot u_{2,1} \quad , a_2 = z_1 \cdot u_{1,2} + z_2 \cdot u_{2,2}$

$f_j = \dfrac{e^{a_j}}{e^{a_1} + e^{a_2}}$ for $j = 1,2$

$L = \frac{1}{2}\left[(f_1 - y_1)^2 + (f_2 - y_2)^2\right]$

Let $e_j = f_j - y_j$

Backward:

1)
$$\frac{\partial L}{\partial f_j} = e_j$$

2)

softmax Jacobian: $\dfrac{\partial f_i}{\partial a_j} = f_i\,(\delta_{ij} - f_j)$

so vector form with $f = [f_1, f_2]^T$, $e = [e_1, e_2]^T$:

$$g_a = \frac{\partial L}{\partial a} = (\mathrm{diag}(f) - f f^T)\, e$$

For 2 classes:

$$g_{a_1} = e_1 f_1(1-f_1) - e_2 f_1 f_2$$
$$g_{a_2} = e_2 f_2(1-f_2) - e_1 f_1 f_2$$

3)

$$\boxed{\frac{\partial L}{\partial v_{k,j}} = z_k g_{a_j}}$$

$$\frac{\partial L}{\partial v_{1,1}} = z_1 g_{a_1} \qquad \frac{\partial L}{\partial v_{1,2}} = z_1 g_{a_2}$$

$$\frac{\partial L}{\partial v_{2,1}} = z_2 g_{a_1} \qquad \frac{\partial L}{\partial v_{2,2}} = z_2 g_{a_2}$$

4)

$$\frac{\partial L}{\partial z_k} = v_{k,1} g_{a_1} + v_{k,2} g_{a_2}$$

5)

ReLU: $1[z_k > 0]$. $\frac{\partial s_k}{\partial w_k} = x$

$$\frac{\partial L}{\partial w_k} = (v_{k,1} g_{a_1} + v_{k,2} g_{a_2}) 1[w_k x > 0] x$$

So: $$\frac{\partial L}{\partial w_1} = (v_{1,1} g_{a_1} + v_{1,2} g_{a_2}) 1[w_1 x > 0] x$$

$$\frac{\partial L}{\partial w_2} = (v_{2,1} g_{a_1} + v_{2,2} g_{a_2}) 1[w_2 x > 0] x$$