when $c' \neq c$

$$\frac{\partial^2 l(w)}{\partial w_c \partial w_{c'}} = \left\{ \sum_{j=1}^{n} x_j \left[I(y_j = c) - P(y_j = c \mid x_j, w) \right] \right\}'$$

$$= \sum_{j=1}^{n} x_j \left[I(y_j = c) - \frac{e^{w_c^T x_j}}{\sum_{c=1}^{C} e^{w_c^T x_j}} \right]'$$

$$= \sum_{j=1}^{n} x_j (x_j)^T \cdot \frac{e^{w_c^T x_j} \cdot e^{w_{c'}^T x_j}}{\left(\sum_{c=1}^{C} e^{w_c^T x_j} \right)^2}$$

$$= \sum_{j=1}^{n} P(y_j = c \mid x_j, w) \cdot P(y_j = c' \mid x_j, w) \, x_j (x_j)^T$$