2 Artificial Intelligence II (SBH)

You have been given a set $\mathbf{s}$ containing m labelled training examples for a binary classification problem. The ith example is $(\mathbf{x}_i, y_i)$. Approximately 10% of the training examples are labelled $+1$ and the remainder -1. You wish to use $\mathbf{s}$ to train a classifier $h(\mathbf{x}; \mathbf{w}, p)$, where $\mathbf{w}$ is a set of weights and p is a hyperparameter. Your colleague advises you to ignore p and simply set it to 1, and then to use some algorithm to choose $\mathbf{w}$ to minimize the quantity

$$E(\mathbf{w}) = \sum_{i=1}^{m} I(h(\mathbf{x}_i; \mathbf{w}, 1) \neq y_i)$$

where I is the indicator function $I(x) = 1$ if x is true and $I(x) = 0$ otherwise. Your colleague also suggests that the value of $E(\mathbf{w})$ that results should be used as an assessment of your classifier's performance.

(a) Identify *three* errors in your colleague's advice, in each case explaining why it is erroneous. [6 marks]

(b) Suggest a more appropriate way of training and assessing the classifier. In your answer you should address each of the three reasons given in Part (a) and provide an alternative approach, defining in full any new concepts that you introduce. [6 marks]

(c) In addition, identify one further way in which your colleague's suggested procedure is deficient. How would you correct this? [2 marks]

(d) A second colleague points out that rather than choosing a specific $\mathbf{w}$ you should consider a fully Bayesian approach, taking all possible values for $\mathbf{w}$ into account by computing $\Pr(y = +1|\mathbf{x})$. Give *two* reasons why this approach might be preferred, and *two* reasons why it might not, explaining your answer in each case. [6 marks]