

COMP9444 Neural Networks and Deep Learning

Quiz 2 (Probability and Backprop Variations)

This is an optional quiz to test your understanding of the material from Week 2.

1. Write the formula for a Gaussian distribution with mean μ and standard deviation σ .

$$P(x) = \exp(-(x-\mu)^2/2\sigma^2) / (\sqrt{2\pi}\sigma)$$

2. Write the formula for Bayes' Rule, in terms of a cause A and an effect B.

$$P(A|B) = P(B|A)P(A) / P(B)$$

3. Write the formula for the Entropy $H(p)$ of a continuous probability distribution $p()$

$$H(p) = \int_{\theta} p(\theta) (-\log p(\theta)) d\theta$$

4. Write the formula for the Kullback-Leibler Divergence $D_{KL}(p \parallel q)$ between two continuous probability distributions $p()$ and $q()$.

$$D_{KL}(p \parallel q) = \int_{\theta} p(\theta) (\log p(\theta) - \log q(\theta)) d\theta$$

5. Write the formulas for these Loss functions: Squared Error, Cross Entropy, Weight Decay.
(remember to define any variables you use)

Assume z_i is the actual output, t_i is the target output and w_j are the weights.

$$\text{Squared Error: } E = \frac{1}{2} \sum_i (z_i - t_i)^2$$

$$\text{Cross Entropy: } E = \sum_i (-t_i \log(z_i) - (1 - t_i) \log(1 - z_i))$$

$$\text{Weight Decay: } E = \frac{1}{2} \sum_j w_j^2$$

6. In the context of Supervised Learning, explain the difference between Maximum Likelihood estimation and Bayesian Inference.

In Maximum Likelihood estimation, the hypothesis $h \in H$ is chosen which maximizes the conditional probability $P(D | h)$ of the observed data D , conditioned on h . In Bayesian Inference, the hypothesis $h \in H$ is chosen which maximizes $P(D | h)P(h)$, where $P(h)$ is the prior probability of h .

7. Briefly explain the concept of Momentum, as an enhancement for Gradient Descent.

A running average of the differentials for each weight is maintained and used to update the weights as follows:

$$\delta w = \alpha \delta w - \eta dE/dw$$

$$w = w + \delta w$$

The constant α with $0 \leq \alpha < 1$ is called the momentum.

