Assignment 1

Q1

Kolmogorov (1957) stated that any continuous function defined on an n-dimensional cube can be represented by sums and superpositions of continuous functions of one variable. Later, Hecht-Nielsen (1987) used this theorem and stated that continuous function can be represented by one hidden layer with 2n+1 neurons, n = number of input nodes. But this suits only for sigmoidal kind of activation functions. Later, Kurkova (1992) suggested using two hidden layers when using regular activation functions to compensate for lost efficiency.

In 1997, Tamura and Tateishi developed a method to fix hidden neurons with negligible error based on Akaike's information criteria. They have defined the number of hidden neurons in a three layer network as N-1 and N/2+3 for four-layer networks. N is defined as input target relation.

Sun, Jianye in 2012 defined hidden neurons using the sequential orthogonal approach (SOA). In this method. Hidden neurons are added one by one. They have defined a term, $N_{h.}$ It takes a value between input neurons and output neurons. The value of N_h will be sequentially increased until the error is sufficiently small.

Q2

Machine Learning Model 1

Input Layer = 13 neurons
1st Hidden Layer = 8 neurons
2nd Hidden Layer = 4 neurons
Output Layer = 1 neuron
Activation Function = Rectified Linear Unit
Loss Function = binary_crossentropy

Fold1 F1-Score : 0.80
Fold2 F1-Score : 0.87
Fold3 F1-Score : 0.85
Fold4 F1-Score : 0.89
Fold5 F1-Score : 0.65

Mean F1-Score: 0.812
Mean squared error regression loss: 0.3893486971690928

Machine Learning Model 2

Input Layer = 13 neurons
1st Hidden Layer = 27 neurons
Output Layer = 1 neuron
Activation Function = sigmoid
Loss Function = binary_crossentropy

Fold1 F1-Score : 0.84
Fold2 F1-Score : 0.88
Fold3 F1-Score : 0.82
Fold4 F1-Score : 0.88
Fold5 F1-Score : 0.84

Mean F1-Score: 0.852
Mean squared error regression loss: 0.3399642628816323
Cross-entropy loss: 0.4074338646381005

Machine Learning Model 3

Input Layer = 13 neurons
1st Hidden Layer = 8 neurons
2nd Hidden Layer = 4 neurons
Output Layer = 1 neuron
Activation Function = sigmoid
Loss Function = binary_crossentropy
Use callbacks in during training

Fold1 F1-Score : 0.81
Fold2 F1-Score : 0.71
Fold3 F1-Score : 0.82
Fold4 F1-Score : 0.71
Fold5 F1-Score : 0.83

Mean F1-Score: 0.776

Machine Learning Model 3 gave the best performance.

Q3

Machine Learning Model 2 has been defined according to Kolmogorov's method and created the model with one hidden layer containing 27(2n+1:n = number of input nodes) neurons. And results are agreed with the literature review findings.

Q4

Machine Learning Model 3 after the L1 and L2 regularization.

Fold1 F1-Score : 0.83
Fold2 F1-Score : 0.86
Fold3 F1-Score : 0.82
Fold4 F1-Score : 0.84
Fold5 F1-Score : 0.88

Mean F1-Score: 0.846

Regularization has decreased the machine learning model performance.