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1. (2 marks) Build a (supervised) neural network to classify the wines (Supervised neural network = multilayer perceptron = MLP in the jargon.)

   Because of the time required, use only 5-fold cross validation. Report briefly on the performance of this technique, including computational time required.

   Neural networks often perform better when their inputs are normalized, often to the interval [0,1] or [-1,+1]. Try using the Normalizer node to see if this helps.

   Answer:

Unnormalized data

A Supervised Neural Network (SNN) with 4 nodes in the hidden layer ($\sqrt{13 \text{ attributes}} \approx 4$) was built, as seen in Figure 1.

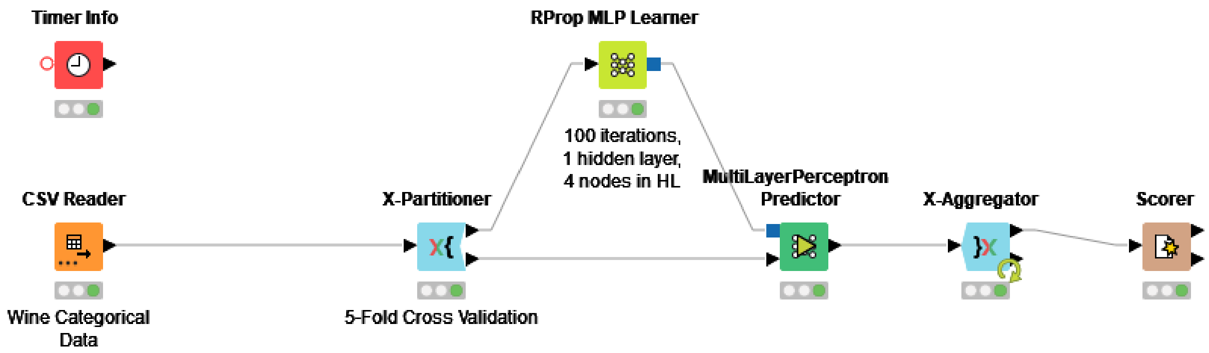
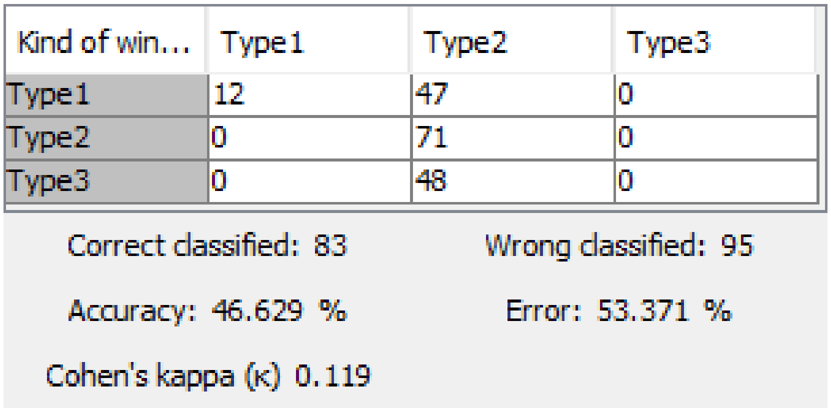


Figure 1: KNIME workflow of a SNN for unnormalized data

Based on the confusion matrix for the SNN shown in Figure 2, the accuracy of ∼47 % leaves a lot of room for improvement.



Kind of win...	Type1	Type2	Type3
Type1	12	47	0
Type2	0	71	0
Type3	0	48	0

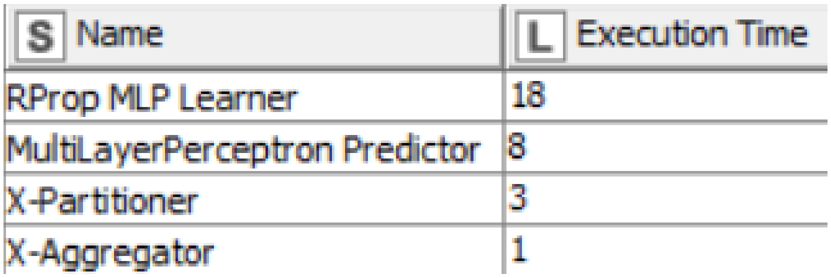
Correct classified: 83 Wrong classified: 95

Accuracy: 46.629 % Error: 53.371 %

Cohen's kappa (κ) 0.119

Figure 2: Confusion matrix of the SNN with unnormalized data

Timing wise, the SNN with unnormalized data took ~30 ms to compute, as seen in Figure 3.



S Name	L Execution Time
RProp MLP Learner	18
MultiLayerPerceptron Predictor	8
X-Partitioner	3
X-Aggregator	1

Figure 3: Timer information for SNN with unnormalized data

Normalized data

Normalized to $[0, 1]$

I used the Normalizer node to normalize the data to the interval [0,1].

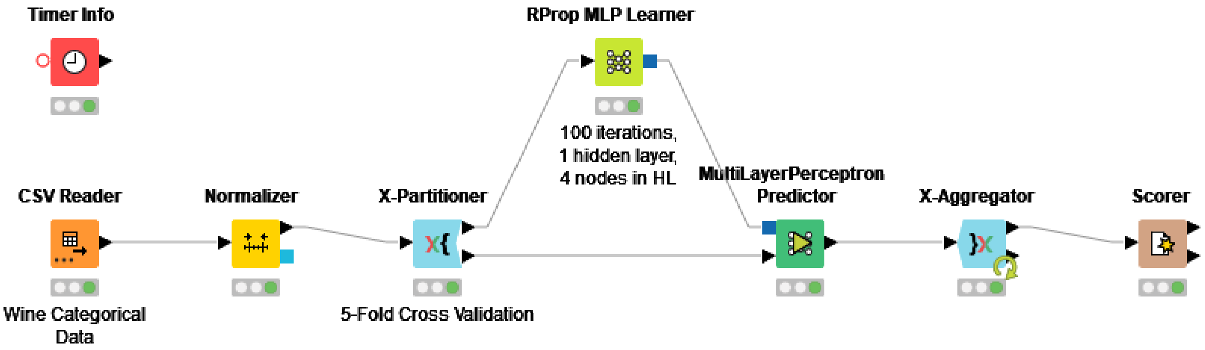
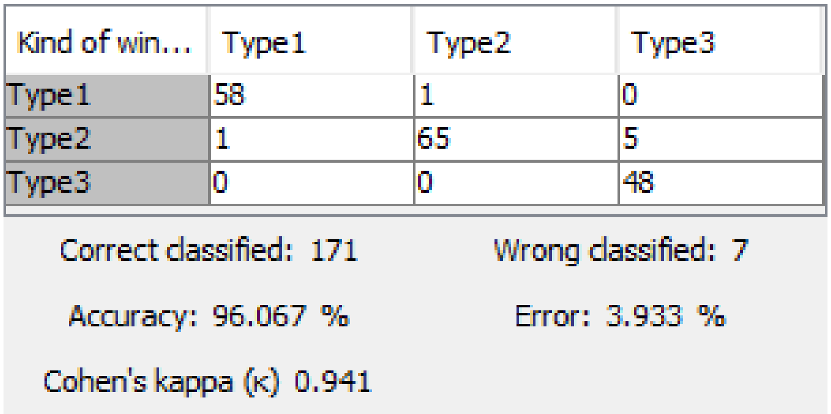


Figure 4: KNIME workflow of a SNN for normalized data

From the confusion matrix for the SNN shown in Figure 5, the accuracy of ∼96 % is a great 39 % increase compared to using unnormalized data.



Kind of win...	Type1	Type2	Type3
Type1	58	1	0
Type2	1	65	5
Type3	0	0	48

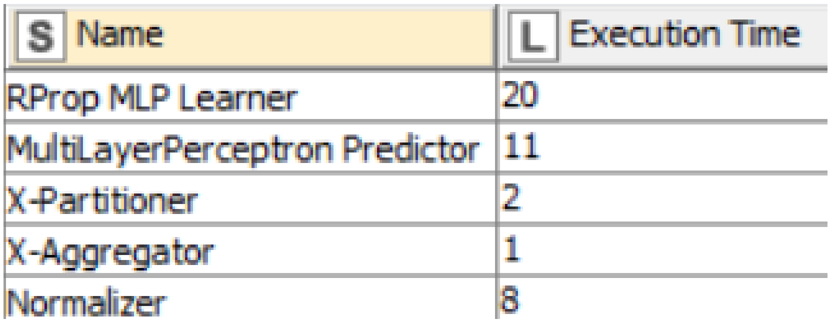
Correct classified: 171 Wrong classified: 7

Accuracy: 96.067 % Error: 3.933 %

Cohen's kappa (κ) 0.941

Figure 5: Confusion matrix of the SNN with data normalized to $[0, 1]$

From Figure 6, it can be seen that the SNN took ∼42 ms to compute, which seems like an acceptable increase in execution time for the significant increase in prediction accuracy.

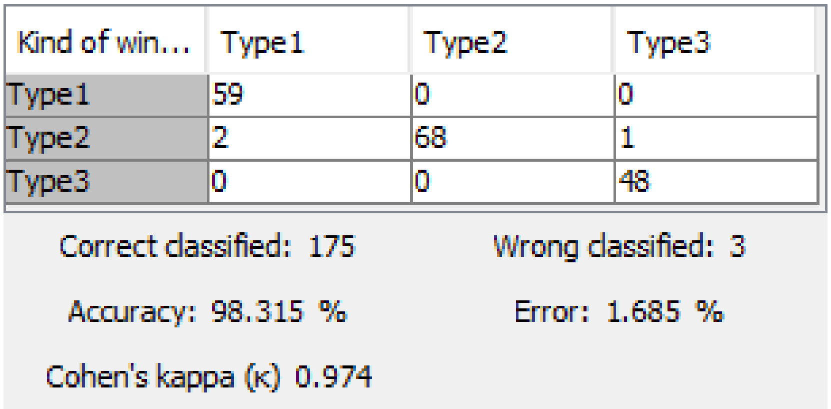


S Name	L Execution Time
RProp MLP Learner	20
MultiLayerPerceptron Predictor	11
X-Partitioner	2
X-Aggregator	1
Normalizer	8

Figure 6: Timer information for SNN with data normalized to $[0, 1]$

Normalized to $[-1, 1]$

From the confusion matrix for the SNN shown in Figure 7, the accuracy of $\sim$98 % is even better than the $\sim$96 % accuracy obtained from normalizing to the interval $[0, 1]$.



Kind of win...	Type1	Type2	Type3
Type1	59	0	0
Type2	2	68	1
Type3	0	0	48

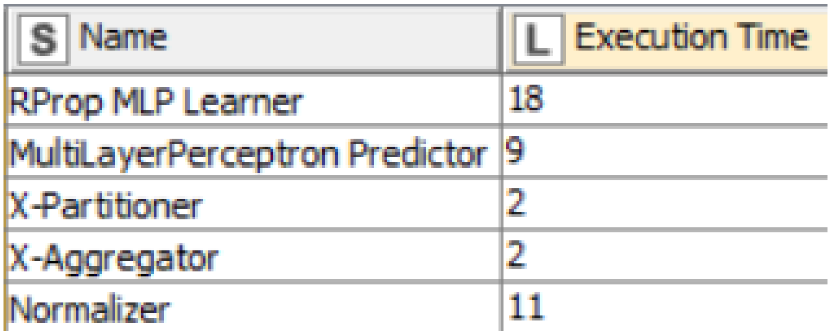
Correct classified: 175 Wrong classified: 3

Accuracy: 98.315 % Error: 1.685 %

Cohen's kappa (κ) 0.974

Figure 7: Confusion matrix of the SNN with data normalized to $[-1, 1]$

From Figure 8, it can be seen that the SNN took $\sim$44 ms to compute, which also seems like an acceptable increase in execution time for the significant increase in prediction accuracy.



S Name	L Execution Time
RProp MLP Learner	18
MultiLayerPerceptron Predictor	9
X-Partitioner	2
X-Aggregator	2
Normalizer	11

Figure 8: Timer information for SNN with data normalized to $[-1, 1]$