

An Explanation Module for Deep Neural Networks Facing Multivariate Time Series Classification

● Introduction

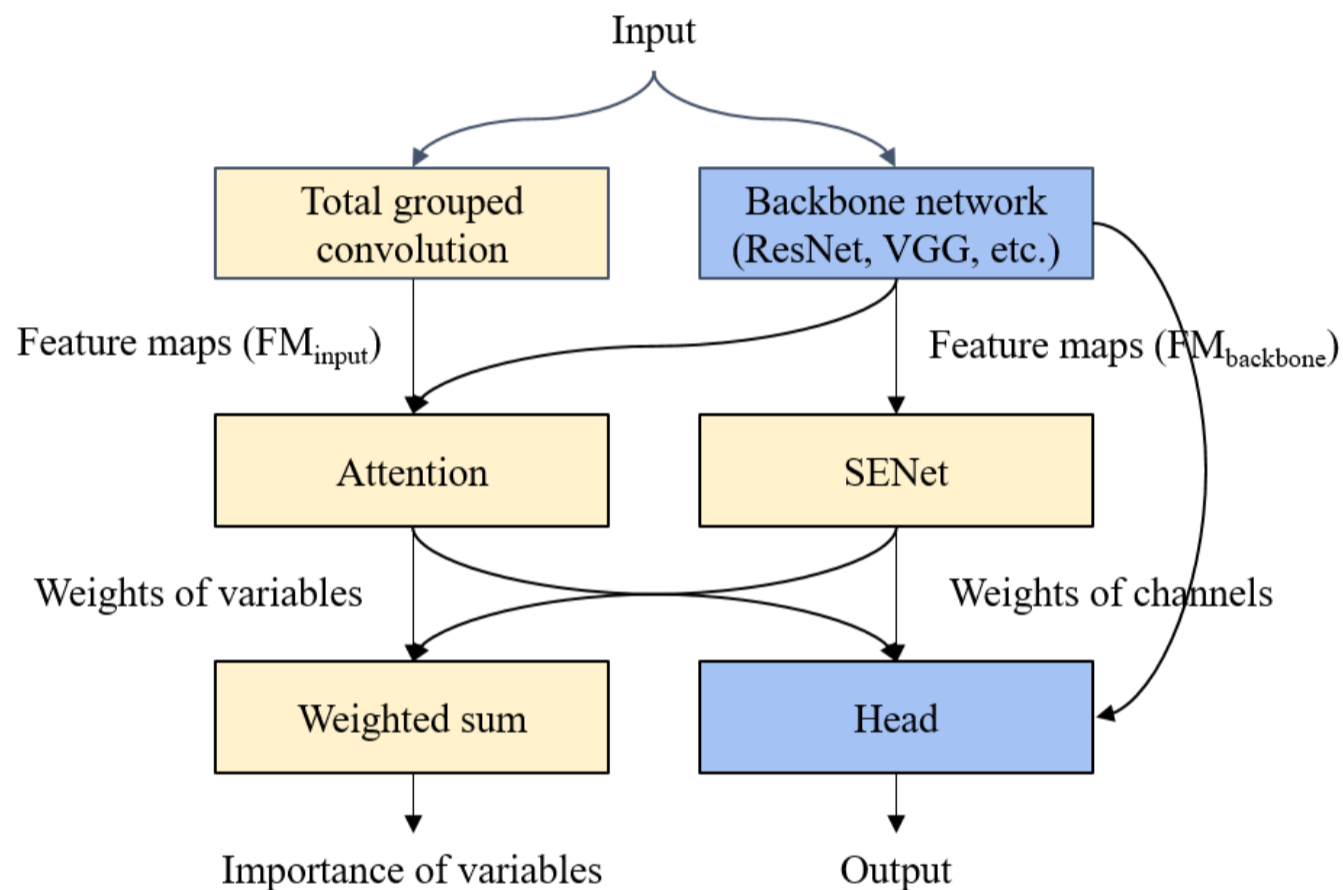
Applications of multivariate time series classification is universal: weather forecasting, activity recognition, etc. Deep learning methods are popular, but its black-box characteristics makes it difficult to explain the classification process.

● Limitations

For deep learning methods, to figure out the importance of the variables during multivariate time series classification, the limitations are:

1. Need to re-design the whole architecture
2. The application domain is limited

● Our methods



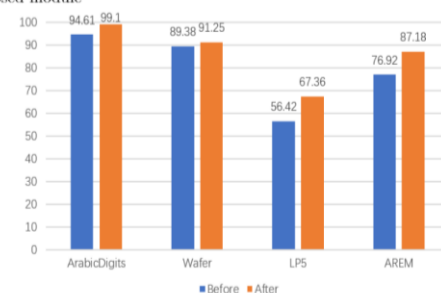
1. Use total grouped convolution layer to obtain the feature map of each variable (FM_{input}).
2. Use attention layer to obtain the importance (weights) of FM_{input} regarding to each channel of $FM_{backbone}$.
3. Use SENet to obtain the importance (weights) of the channels of $FM_{backbone}$.
4. Use Weighted Sum to obtain the final results.

● Experimental Results

Table 1. Experimental results on Wafer dataset

Accuracy (sd) (w/o noise)	99.87% (0.68%)					
Variable id	1	2	3	4	5	6
Importance of variables	0.101	0.129	0.158	0.261	0.276	0.075
Accuracy (%) (w/ noise)	99.01	96.38	96.38	96.38	94.38	99.75
Standard Deviation (w/noise)	0.05	0.39	0.38	0.42	0.76	0.04
Accuracy change ($\Delta\%$)	0.86	3.49	3.49	3.49	4.9	0.12

Fig. 1. Accuracy comparison between the original model and the model combined with our proposed module



We firstly train the model on the original dataset, then we select a specific class, and we sample the noise data from Gaussian distribution and add to the variables separately and we test the model using this class of time series sequences again. If the variable is important, then the accuracy will change dramatically after adding the noise to the variable and vice versa.

Our module performs well on all the selected four datasets (see the left table, more results can be seen in the paper). And it improves the classification accuracy (see the right figure).

● Future Plan

1. Explore the importance of the variable as well as the time period to figure out the local importance for classification.
2. Make it practicable for time series forecasting.