magmaOffenburg: Predicting Kick Length using Echo State Networks

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Abstract

In addition to improve kick reliability, this paper describes an approach to predict the kick distance just before the actual kick is performed. If an unfavorable situation is detected, the kick is not performed and a new approach to the ball is done saving time. The prediction is done using Echo State Networks and compared to a classical approach using regressions trees. Results show that the combination of the two approaches delivers best results.

1 Echo State Networks

Echo State networks (ESN) are recurrent neural networks with a sparsly connected set of neurons called dynamic reservoir and an optional layer of output neurons fully connected to the reservoir. Connections among reservoir neurons are random and never change. An example network is shown in Figure 1.

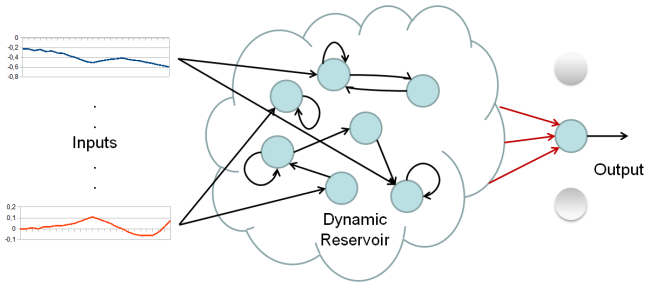

Figure 1: Echo State Network

The network used to predict kick length had 6 input neurons, sparsly (0.25) connected to the reservoir of 100 neurons, sparsly (0.004) connected among themselves and fully connected to the single output neuron. Inputs to ESNs where time series of roughly 25 cycles of the below mentioned attributes while the regression trees only used the last cycle's values. Training of the ESN is performed by mapping the reservoir neurons activity to the desired output using the weight's to the output. In case of linear regression, this can be done for all input-output patterns at once (in two lines of Matlab code).

2 Data

For our training the kick distance of 559 left leg kicks have been recorded. The distribution is shown in Figure 2. Attributes contained x and y deviation of the torso's z-vector (upX, upY), the torso-relative ball position (ballX, ballY) and the change of upX and upY. The decision is taken at the time when the left leg had reached its backmost position.

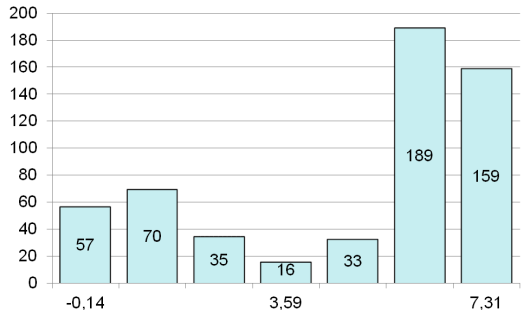

Figure 2: Distribution of kick distance for 559 kicks

3 Results

Application of regression trees to the data resulted in a root mean square error (RMSE) of 1,50. ESN results show an RMSE of 1,67, worse than regression trees. In this domain, the strength of ESN's to accept time series as inputs did not produce better results. However, using both together taking the average of both predictions resulted in the best result of RMSE 1,31. An individual comparison of the predictions for the first 45 kicks is shown in Figure 3.

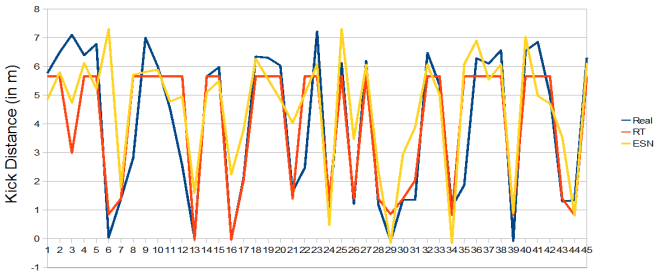

Figure 3: Prediction of Regression Tree and ESN for 45 kicks