

## Supplementary Material

### Slip Detection on Simple Set

A total of 495 training runs were executed over all three neural networks (MLP, SNN, and 3D-CNN). Each ANN achieved validation accuracy exceeding 95% with optimal parameter settings, with the 3D-CNN reaching 99.59% accuracy. The results are reported in Tab. 2.

The MLP parameter sweep achieved its best performance with 98% validation accuracy and 0.003 cross-entropy loss, using the RMSProp optimizer, a learning rate of 0.003, and a batch size of 128. Accuracies showed distinct clustering around either 90% or 50%. Poor results tended to occur with combinations of smaller batch sizes and higher learning rates. RMSProp and Adam optimizers showed comparable performance. For high-accuracy runs, loss values ranged from 0.0007 to 0.1.

The SNN's best configuration achieved 96% validation accuracy with a spike loss of 178, using the RMSProp optimizer, a learning rate of 0.011, and a batch size of 512. Training showed robust performance with accuracies consistently near or above 90% across all parameter combinations. Loss values varied widely, with some runs around 280 and others below 60 or even 20.

The 3D-CNN achieved its peak performance with 99.59% validation accuracy and 0.0035 cross-entropy loss, using the RMSProp optimizer, a learning rate of 0.002, and a batch size of 16. Accuracies clustered either above 80-90% or around 50%. High accuracies were predominantly achieved with small batch sizes (8 to 32) and learning rates below 0.020. Loss values stayed under 0.045, with high-accuracy runs typically below 0.01.