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HIPA Interlock Forecasting Overview

March 2, 2021

Overview

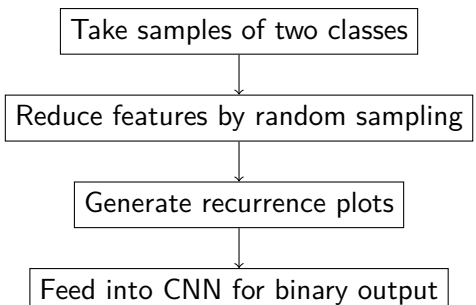
- RPCNN model
  - Submitted paper
  - Improved results
  - Next steps
- Survival model
  - Current result
  - Next steps

RPCNN model – Submitted paper

- Recurrence Plot Convolutional Neural Network (RPCNN) model
- Paper submitted to MDPI Special Issue "Machine Learning and Accelerator Technology"
- Preprint: https://arxiv.org/abs/2102.00786

RPCNN model – Submitted paper

Transfer "time windows" of channels into recurrence plots, then use CNN for binary classification.



RPCNN model – Submitted paper

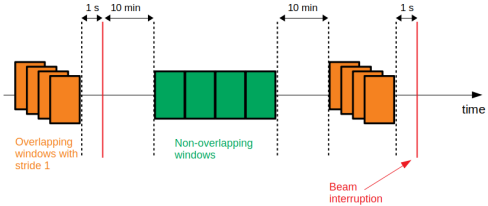


Figure: Take samples of two classes

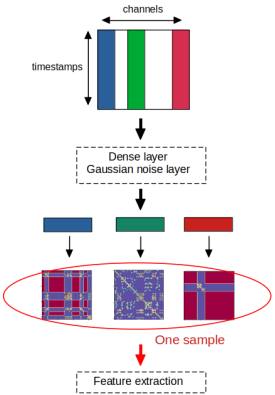


Figure: Generate recurrence plots

RPCNN model – Submitted paper

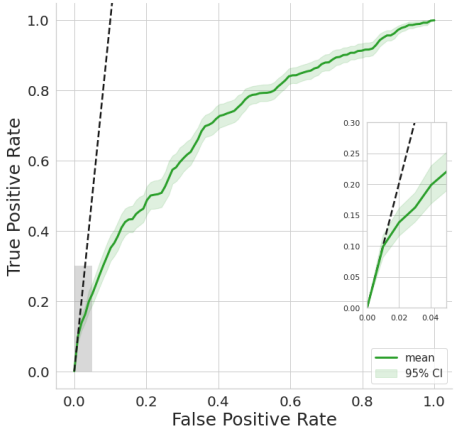


Figure: ROC curve of the RPCNN best model, with CI calculated on 20 different validation sets.

Model	TP	FP	TN	FN	TPR	TNR
RPCNN best	40	75	44035	775	4.9%	99.8%

Model	Beam time saved[s/interlock]	AUC
RPCNN best	0.5 ± 0.2	0.71 ± 0.01

RPCNN model – Submitted paper

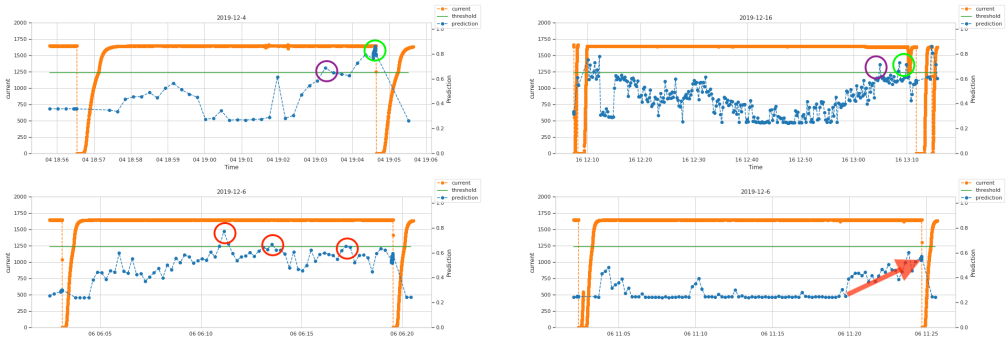


Figure: Screenshots from mimicked live predictions over the validation data. Blue line: prediction value from the model; Orange line: beam current where a drop to zero indicates an interlock; Green line: binary classification threshold.

RPCNN model – Improved results

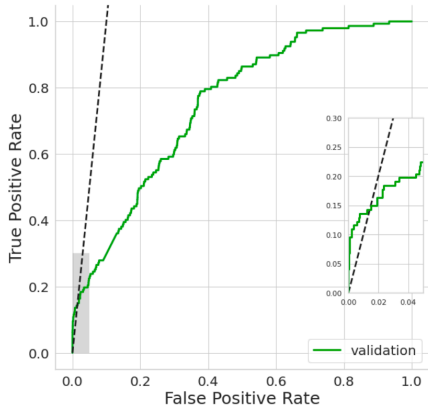


Figure: ROC curve of the improved RPCNN model.

- **Remove unclear samples**: Remove all interlock samples with prediction value < 0.5 in the training set
- **Avoid duplicated FP**: Ignore the next 10 samples after a FP sample
- **Make TP resembles reality**: An interlock is counted as a TP as long as there's one positive sample inside 1 min before

Model	Beam time saved[s/interlock]	AUC
RPCNN best	1.5	0.76

RPCNN model – Next steps

- Different initialization of the model would lead to rather divergent results → train with more data; adaptive learning
- Revise the definition of TP, FP and the beam time saved metric
- Test in real-time experiments

Survival model – Current result

- **Seq2One**: sliding time series of N timesteps → Weibull parameters of the last 1 timestep (better performance)
- **Seq2Seq**: sliding time series of N timesteps → Weibull parameters of N timesteps (worse performance)
- **Pretrain** method: feed the data closer to interlocks more times into the network

Survival model – Current result

- Alarm only at 0.2-0.4 s before interlock
- Several early alarms need investigation

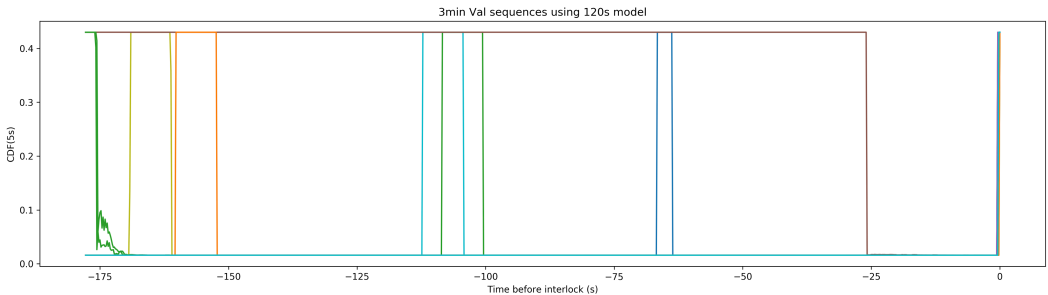


Figure: Validation results of the survival model 3 min before interlock.

Survival model – Next steps

- Get Insights from the RPCNN model
  - Use the subset of features in RPCNN
  - Use recurrence plots as input
- Summary statistics?
- (Open for suggestions)

Thanks to

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