National Research Tomsk State University

Лаборатория анализа данных физики высоких энергий Томского государственного университета

Measurement of differential cross-sections of a single top quark produced in association with a W boson with ATLAS at $\sqrt{s} = 13$ TeV

Progress Report

Neda Firoz

Goal: separate **tW (top+anti-top)** from **$t\bar{t}$** in the **1j1b dilepton** region

•**Inputs (9 variables used):**
bdt_centrality_ll_recalc_NOSYS,
bdt_delta_pT_ll_MET_recalc_NOSYS,
bdt_delta_pT_llb_MET_recalc_NOSYS,
bdt_eta_llMetB_recalc_NOSYS,
bdt_m_l1b_recalc_NOSYS,
bdt_m_l2b_recalc_NOSYS,
bdt_pT_llMetB_recalc_NOSYS,
bdt_pT_llb_recalc_NOSYS,
bdt_sum_ET_recalc_NOSYS.

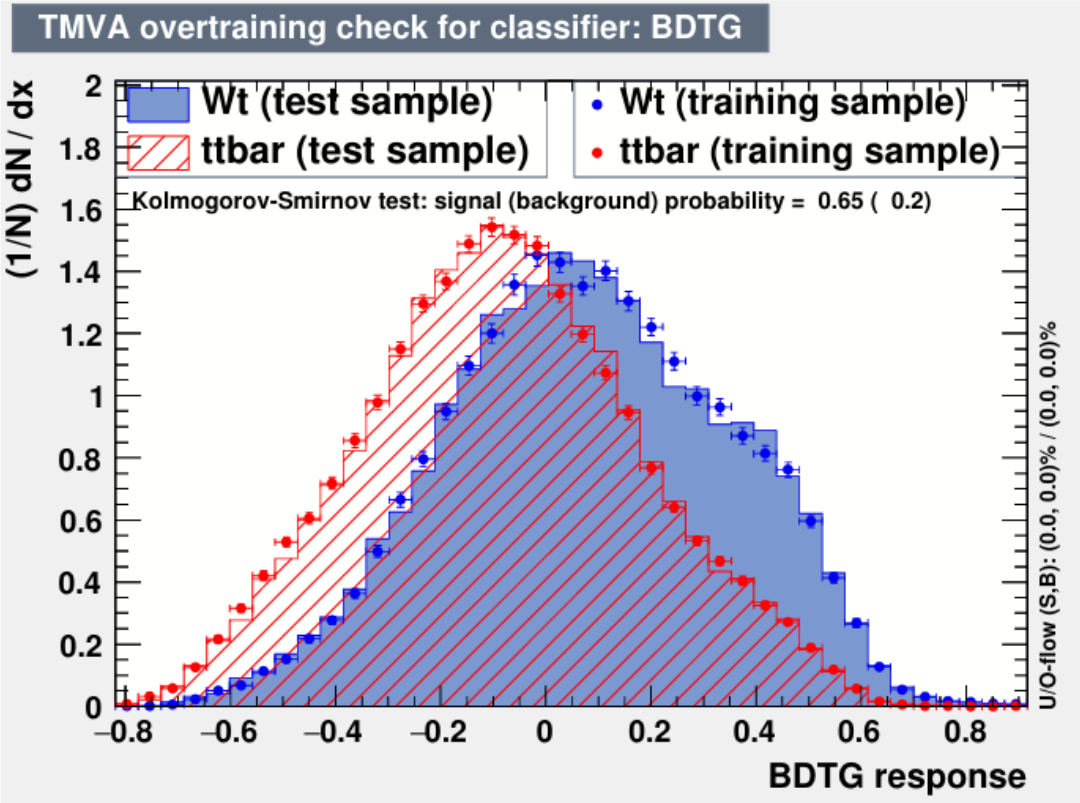
•**Samples / tree:** all files' tree name is analysis

Signal: tW (top) + $\bar{t}$W (anti-top)
Background: $t\bar{t}$ (non-all-had)

•**Event weights:** auto-resolved to weight_mc_NOSYS * weight_pileup_NOSYS * globalTriggerEffSF_NOSYS.

•**Bad values:** any variable ≤ **−990** or non-finite is masked per event.

Article's Report on BDT



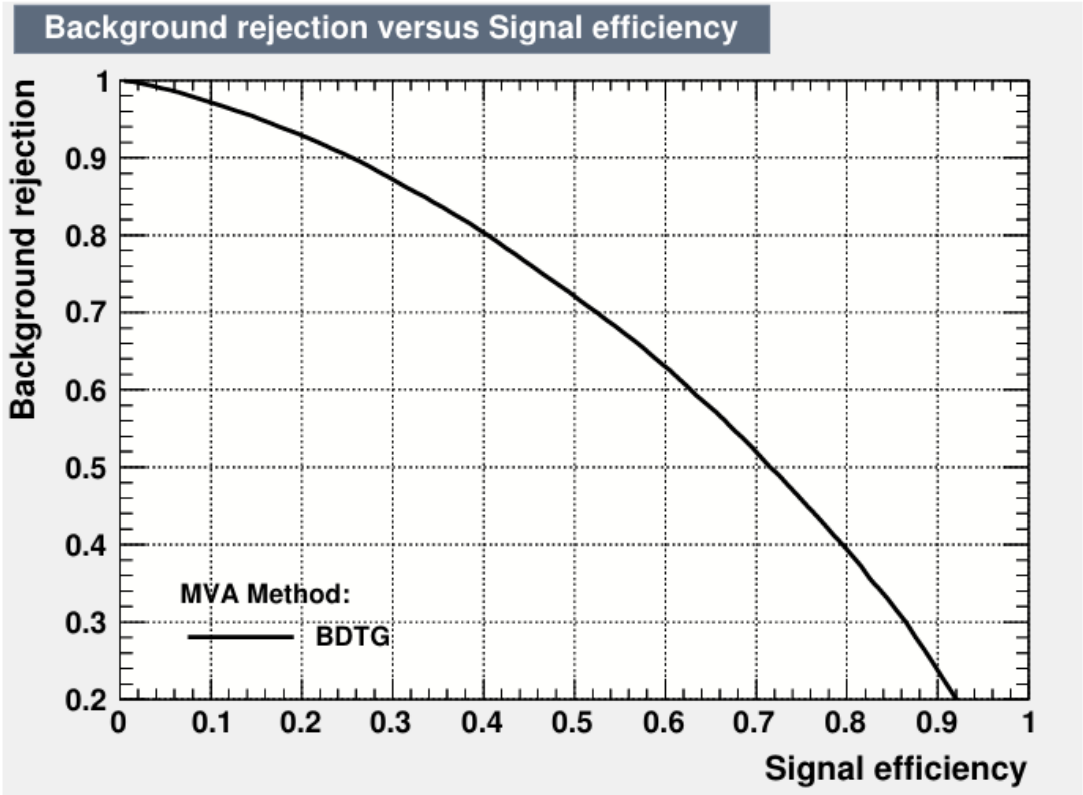


Figure 9: Comparison of test/training sample distributions and background rejection factor versus signal efficiency.

RESULTS on NEW DATA after some hyperparameters optimization and k-fold 20.01.2026

K-fold Validation (TMVA)

Classes / raw events added

Signal: 48,776

Background: 266,006

After != -999 preselection, TMVA reports:

Signal passed: 12,492

Background passed: 75,074

Train/Test trees :

TrainTree = 61,297,

TestTree = 26,269

Model comparison (ROC integral on test sample)

Ranked by TMVA

1.BDTG: 0.665

2.ANN: 0.661

3.BDT: 0.660

4.KNN: 0.648

5.Fisher: 0.632

6.Likelihood: 0.629

Best AUC/ROC integral ≈ 0.665 with BDTG

Preliminary result set-TMVA

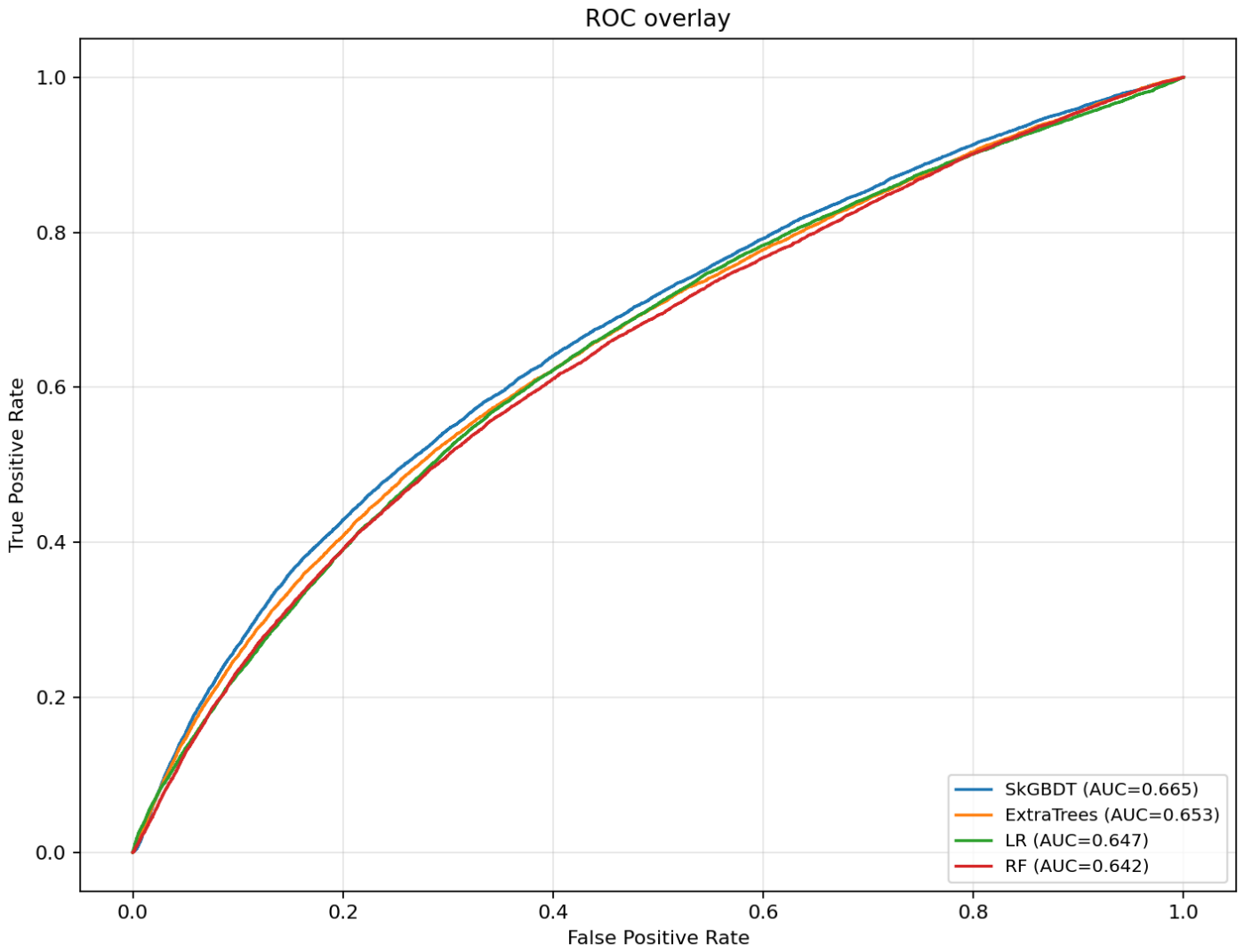
Method	B = 0.01	B = 0.10	B = 0.30
BDTG	0.041 (**0.047**)	0.272 (**0.268**)	0.541 (**0.541**)
ANN	0.041 (**0.048**)	0.272 (**0.267**)	0.539 (**0.535**)
BDT	0.045 (**0.049**)	0.261 (**0.262**)	0.538 (**0.539**)
KNN	0.038 (**0.042**)	0.249 (**0.254**)	0.527 (**0.528**)
Fisher	0.033 (**0.034**)	0.214 (**0.202**)	0.482 (**0.478**)
Likelihood	0.022 (**0.023**)	0.208 (**0.207**)	0.489 (**0.489**)

- Table shows the signal efficiency at fixed background efficiencies of 1%, 10%, and 30%.
- Boosted decision trees (BDTG and BDT) consistently achieve the highest signal efficiency across all operating points.
- The agreement between training and test efficiencies indicates no significant overtraining, particularly for BDTG and BDT.”

Preliminary result set for K-fold Validation in Python

Model	AUC_mean	AUC_std	kfold	n_events	n_valid_folds
SketchboostGBDT	0.665143	0.005386	5	87566	5
ExtraTrees	0.652857	0.004632	5	87566	5
LR	0.647498	0.004209	5	87566	5
RF	0.641839	0.003821	5	87566	5

K-fold on Python Trial 1

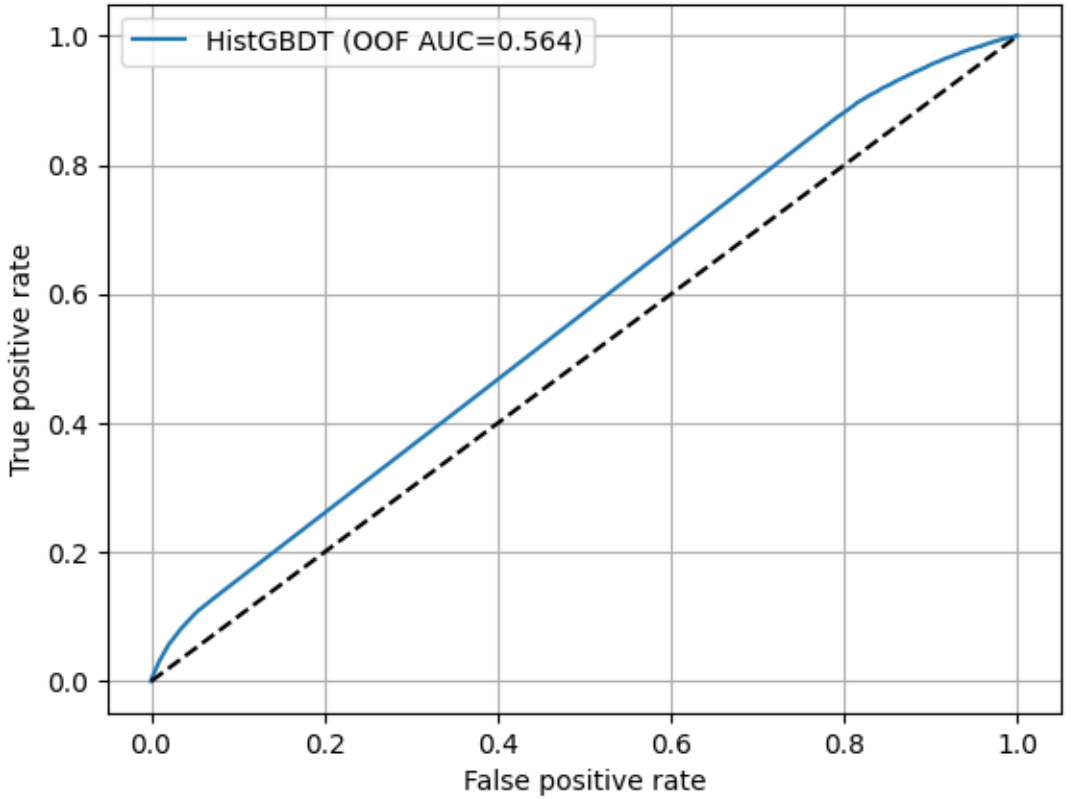


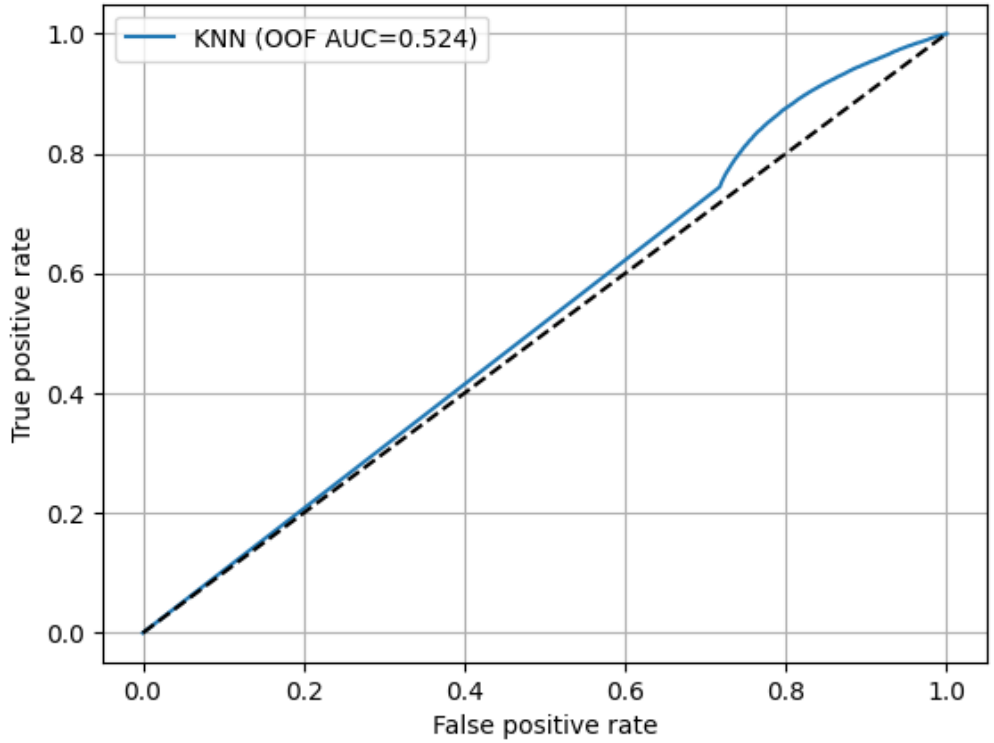
Performance of ML Algorithms using K-fold on Python Trial 2

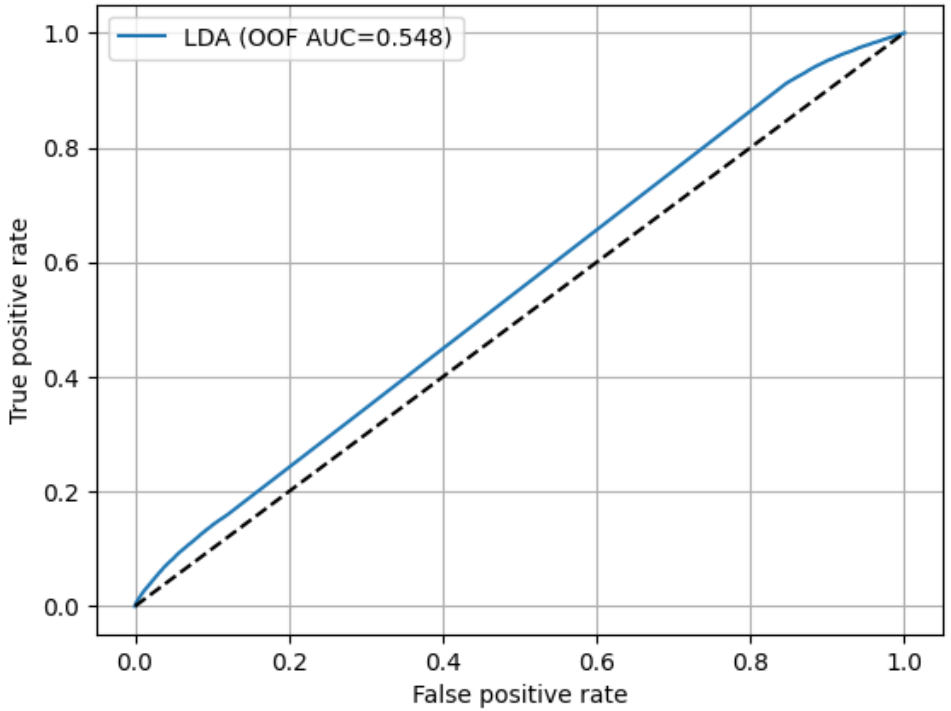
20.01.2026

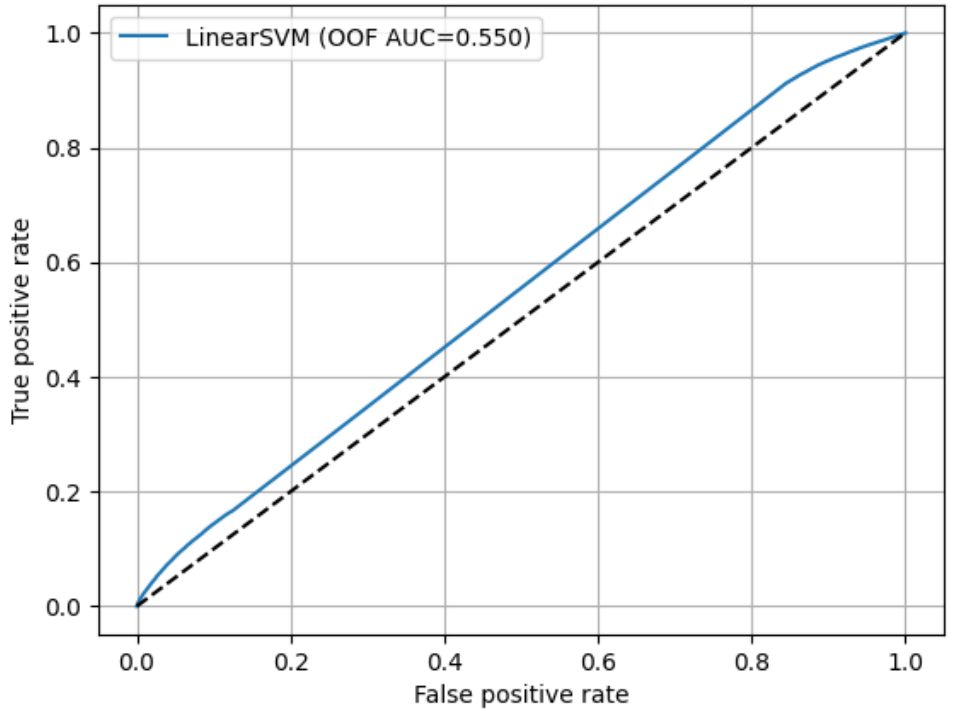
MODEL	AUC_CV_MEAN	AUC_Out of folds	BEST_PARAMS	WALLTIME_SEC
HistGBDT Histogram-based Gradient Boosting Classification	0.563974	0.56373	{'clf__min_samples_leaf': 20, 'clf__max_iter': 200, 'clf__max_depth': 3, 'clf__learning_rate': 0.1}	214.5186
RandomForest	0.56308	0.562716	{'clf__n_estimators': 300, 'clf__min_samples_leaf': 20, 'clf__max_features': 'sqrt', 'clf__max_depth': 8}	7295.539
MLP	0.561451	0.560534	{'clf__learning_rate_init': 0.003, 'clf__hidden_layer_sizes': (9, 4), 'clf__alpha': 0.01}	430.036
Logistic	0.55165	0.551344	{'clf__C': 0.1}	10.49122
Linear_SVM	0.549941	0.549682	{'clf__C': 10.0}	10.71546
LDA	0.547915	0.547607	{'clf__solver': 'svd'}	6.273678
NaiveBayes	0.54654	0.546426	{}	3.780756
KNN	0.523907	0.523906	{'clf__n_neighbors': 100, 'clf__weights': 'distance'}	7526.95

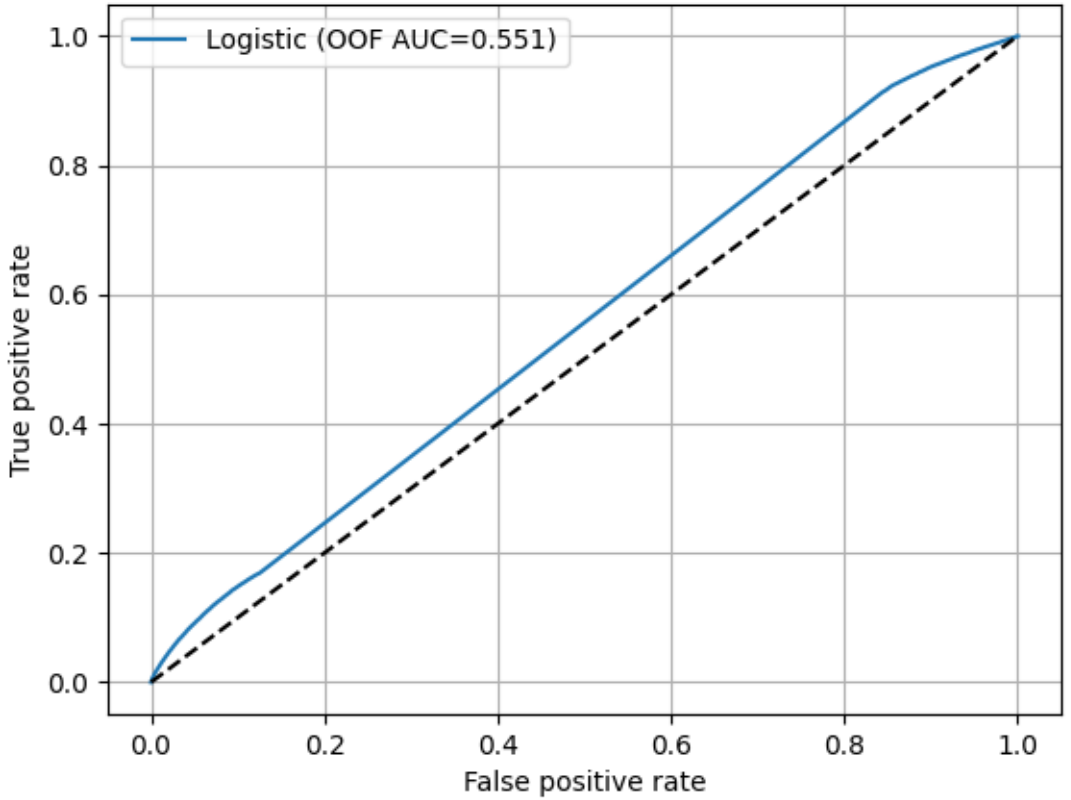
20.01.2026

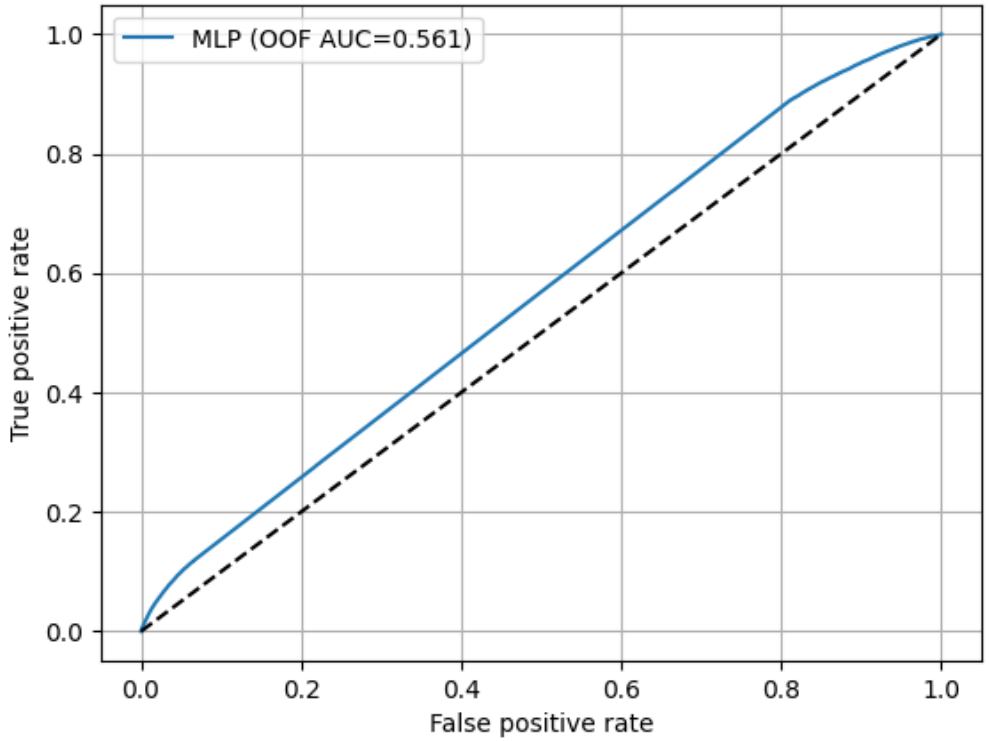

HistGBDT (OOF AUC=0.564)
True positive rate
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0

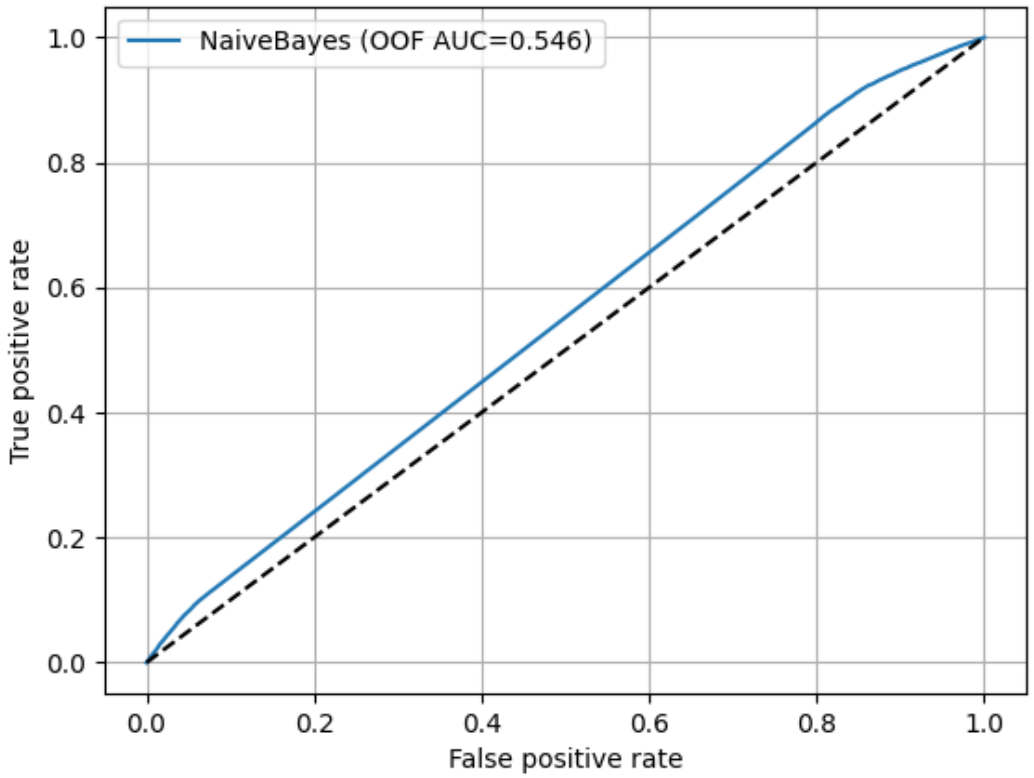

KNN (OOF AUC=0.524)
True positive rate
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0

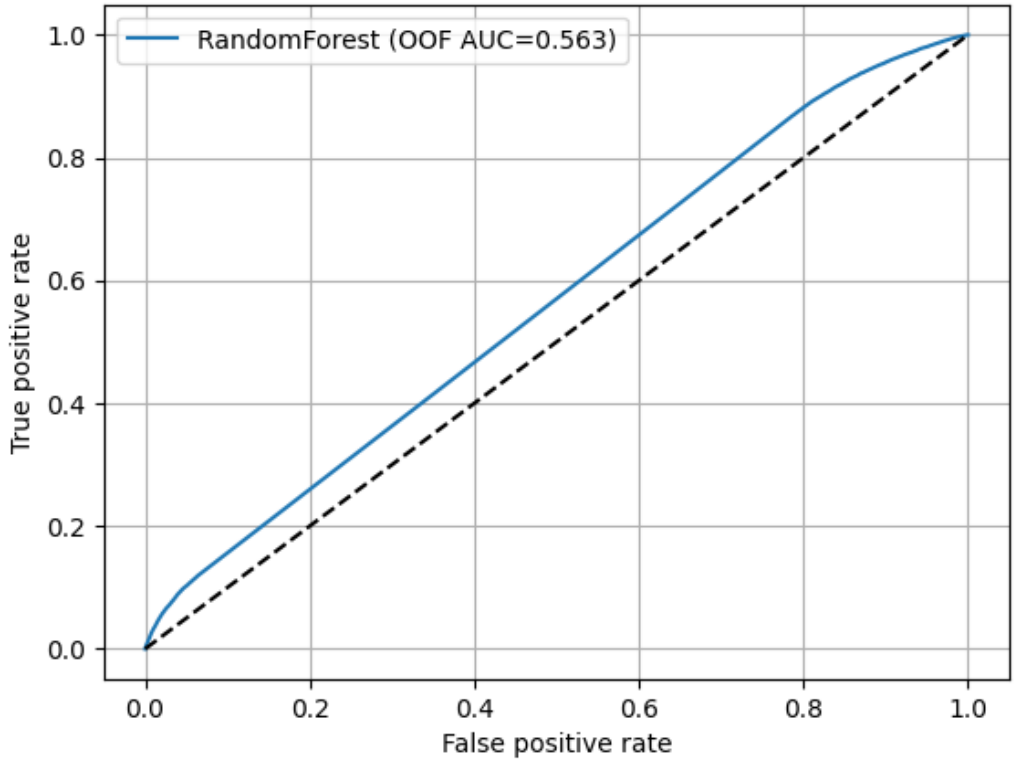

LDA (OOF AUC=0.548)
True positive rate
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0


LinearSVM (OOF AUC=0.550)
True positive rate
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0


Logistic (OOF AUC=0.551)
True positive rate
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0


MLP (OOF AUC=0.561)
True positive rate
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0


NaiveBayes (OOF AUC=0.546)
True positive rate
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0


RandomForest (OOF AUC=0.563)
True positive rate
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0

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Thank you for your attention!!!