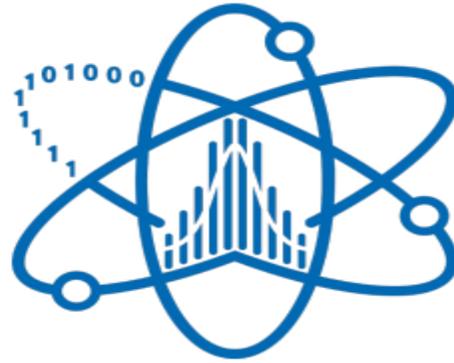




National Research
**Tomsk
State
University**



**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_1l_recalc_NOSYS,
bdt_delta_pT_1l_MET_recalc_NOSYS,
S,
bdt_delta_pT_1lb_MET_recalc_NOSYS,
YS,
bdt_eta_1lMetB_recalc_NOSYS,
bdt_m_11b_recalc_NOSYS,
bdt_m_12b_recalc_NOSYS,
bdt_pT_1lMetB_recalc_NOSYS,
bdt_pT_1lb_recalc_NOSYS,
bdt_sum_ET_recalc_NOSYS.

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

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

Background: $t\bar{t}$ (non-all-had)

•**Event weights:** auto-resolved to
 $\text{weight_mc_NOSYS} * \text{weight_pileup_NOSYS}$
 $* \text{globalTriggerEffSF_NOSYS}$.

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

Article's Report on BDT

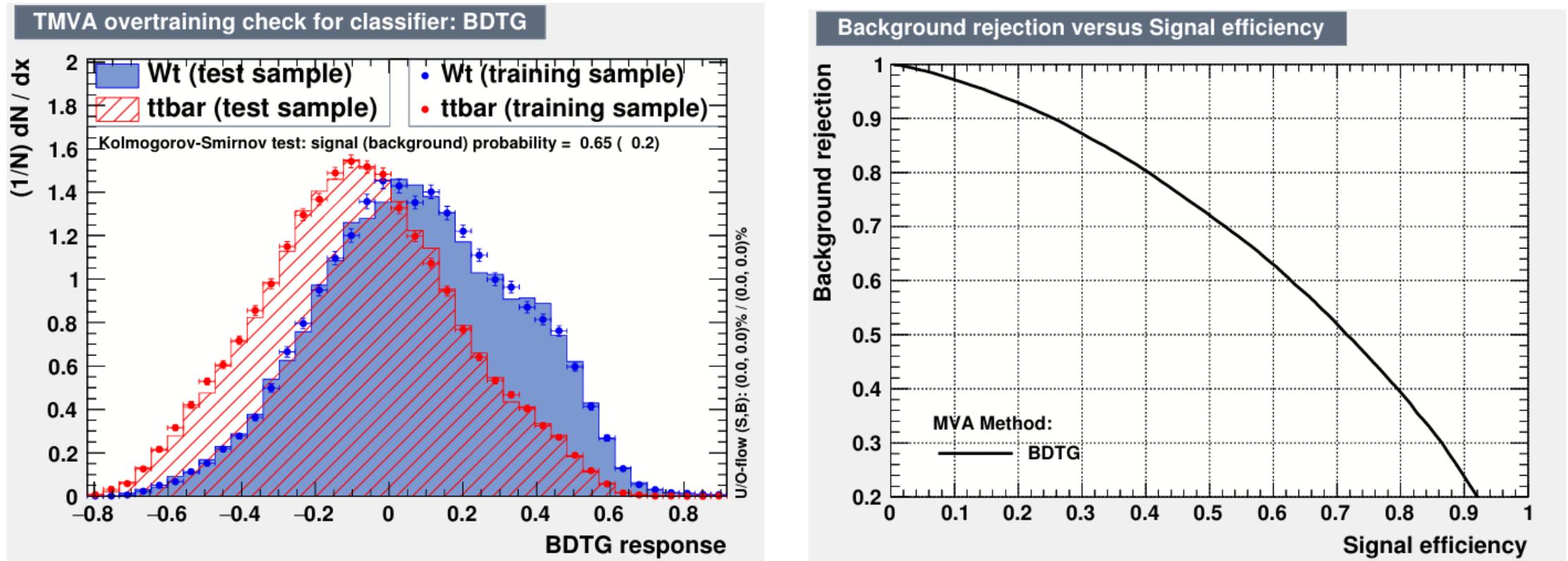


Figure 9: Comparison of test/training sample distributions and background rejection factor versus signal efficiency.

R caret package
Results
03.03.2026

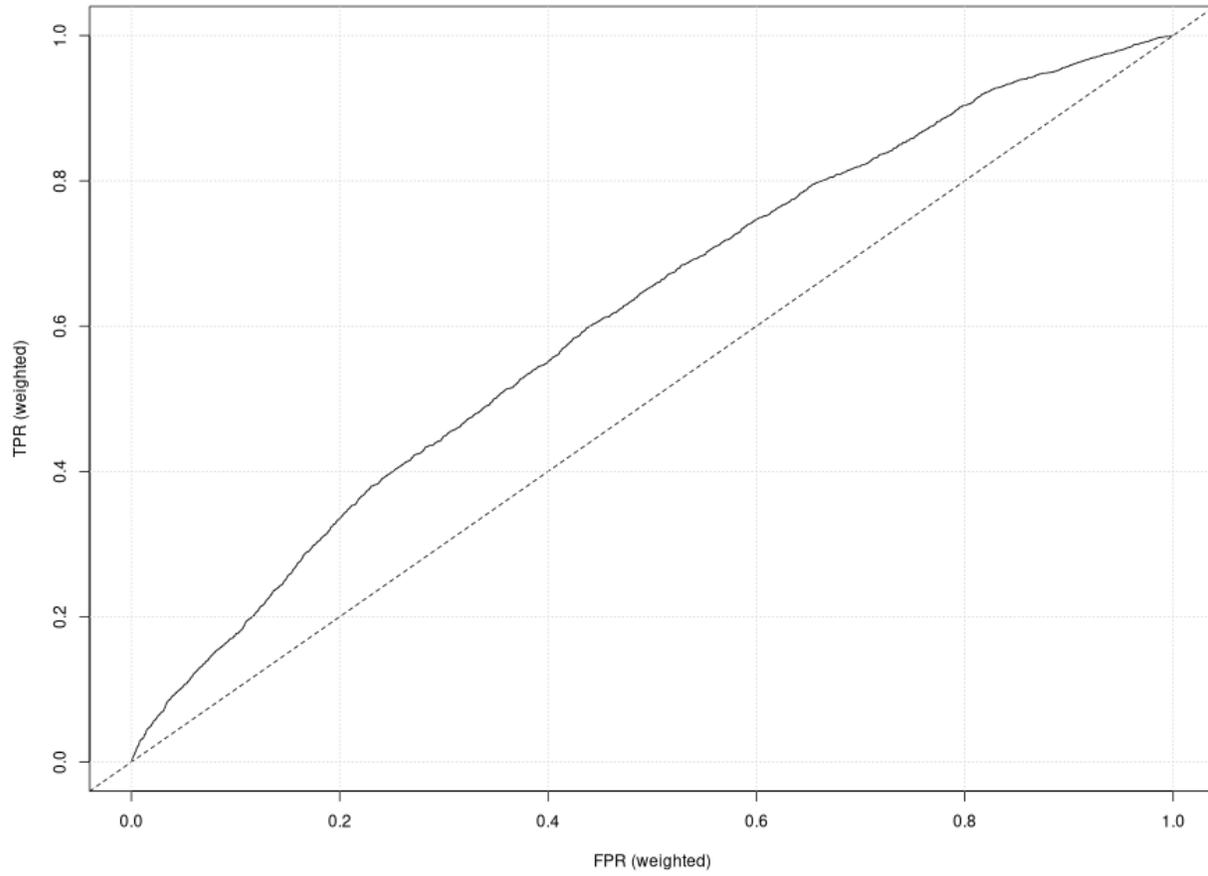
Algorithm	AUC	ROC points	Best thr (S/B)	Max S/B	S @ max S/B	B @ max S/B	Best thr (S/sqrtB)	Max S/sqrt(B)	S @ max S/sqrt(B)	B @ max S/sqrt(B)	Best tune
cforest	0.675663	19117	0.54	7	14	2	0.12	25.88987	2538	9610	mtry=3
ctree	0.672587	19117	0.39	0.563636	31	55	0.11	25.39264	2514	9802	mincriterion=0.99
bam	0.671219	19117	0.63	1.818182	20	11	0.14	25.6132	2097	6703	select=False, method=GCV.Cp
bagFDAG CV	0.669963	19117	0.89	5	5	1	0.09	25.42132	2826	12358	degree=1
gamLoess	0.66925	19117	0.73	6	6	1	0.12	25.63108	2413	8863	span=0.5, degree=1.0
gam	0.669083	19117	0.7	1.833333	11	6	0.11	25.59314	2562	10021	select=True, method=GCV.Cp
blackboost	0.66872	19117	0.58	5	10	2	0.12	25.62615	2638	10597	mstop=50, maxdepth=1
gamboost	0.665027	19117	0.5	2.2	11	5	0.14	25.51987	2364	8581	mstop=50, prune=no

ada	0.663635	19117	0.36	1.625	13	8	0.13	25.64766	2329	8246	iter=50.0, maxdepth=1.0, nu=0.1
earth	0.662981	19117	0.45	1.222222	22	18	0	24.76434	3131	15985	nprune=2, degree=1
fda	0.660232	19117	0.57	5	5	1	0	24.76434	3131	15985	degree=1, nprune=2
ctree2	0.658263	19117	0.14	0.450163	1102	2448	0	24.76434	3131	15985	maxdepth=1.0, mincriterion=0.99
bagFDA	0.656723	19117	0.56	2.5	5	2	0	24.76434	3131	15985	degree=1, nprune=2
gamSpline	0.643669	19117	0.56	3	3	1	0.14	25.32078	2536	10031	df=1
dnn	0.612235	19117	0.38	0.723077	47	65	0.32	24.91682	3093	15409	layer1=1, layer2=0, layer3=0, hidden_dropout=0, visible_dropout=0
evtree	0.610648	19117	0.74	1.5	6	4	0	24.76434	3131	15985	alpha=1
C5.0Rules	0.602376	19117	0.51	1.375	11	8	0	24.76434	3131	15985	parameter=none

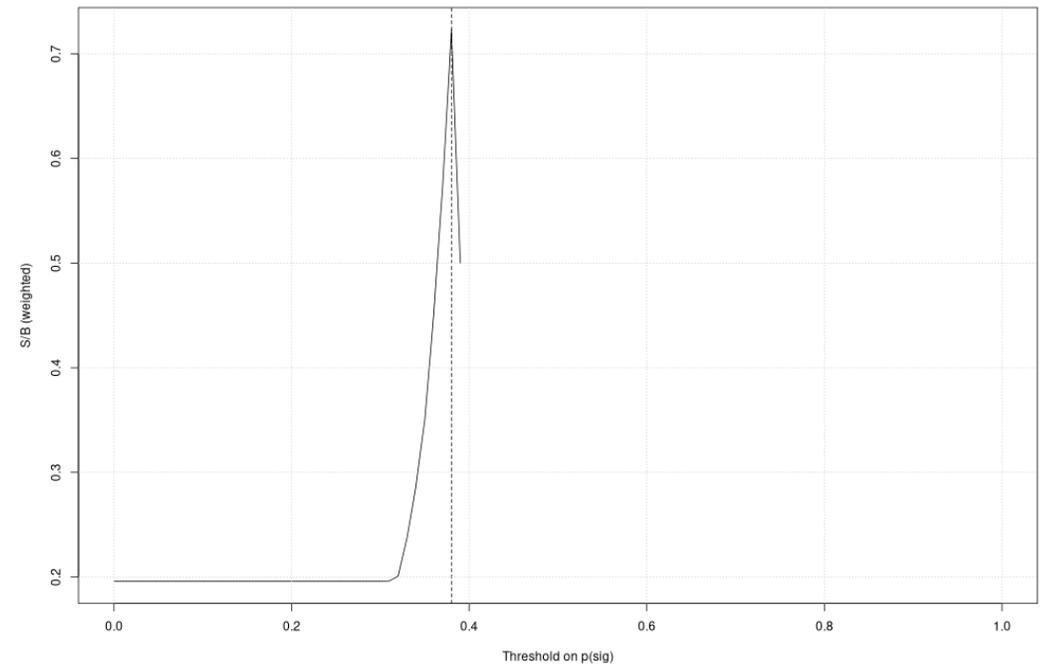
avNNet	0.600064	19117	0	0.195871	3131	15985	0	24.76434	3131	15985	size=1, decay=0, bag=False
C5.0Tree	0.599872	19117	0	0.195871	3131	15985	0	24.76434	3131	15985	parameter =none
C5.0	0.408428	19117	0	0.195871	3131	15985	0	24.76434	3131	15985	trials=1, model=rul es, winnow=T rue
bagEarth	0.382079	19117	0	0.195871	3131	15985	0	24.76434	3131	15985	nprune=2, degree=1
bagEarthG CV	0.330993	19117	0	0.195871	3131	15985	0	24.76434	3131	15985	degree=1

Algorithm	status	used_weights_in_training	caret_best_unweighted_ROC	weighted_auc_cv	weighted_acc_cv	cpu_user	cpu_sys	elapsed	thr_opt_SB	max_SB	max_Ssqr_tB
avNNet	OK	TRUE	1	0.681463	0.836211	128.52	0.931	129.934	0	0.195871	24.76434
ranger	OK	TRUE	0.670751	0.668745	0.837571	1452.967	17.773	774.24	0.61	3	25.57607
nnet	OK	TRUE	0.676684	0.654188	0.836681	46.175	0.82	47.142	0.6	5	24.96918
dnn	OK	TRUE	0.639349	0.637748	0.836211	2091.6	16.937	793.387	0.4	0.692308	25.14228
gbm	SKIP_MISSING_PACKS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
glmnet	SKIP_MISSING_PACKS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
xgbLinear	FAIL_TRAIN	TRUE	NA	NA	NA	413070.7	4853.356	12823.75	NA	NA	NA
xgbTree	FAIL_TRAIN	TRUE	NA	NA	NA	350173.4	4873.833	11055.15	NA	NA	NA

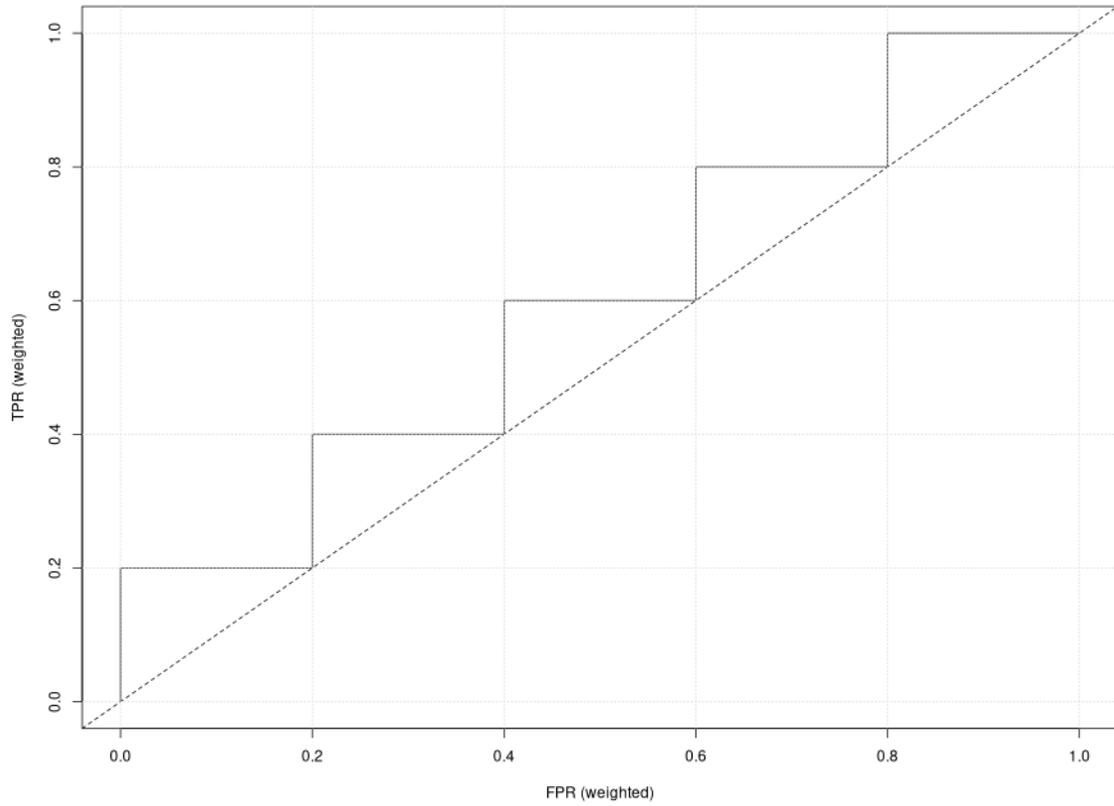
Weighted ROC: dnn AUC=0.61223



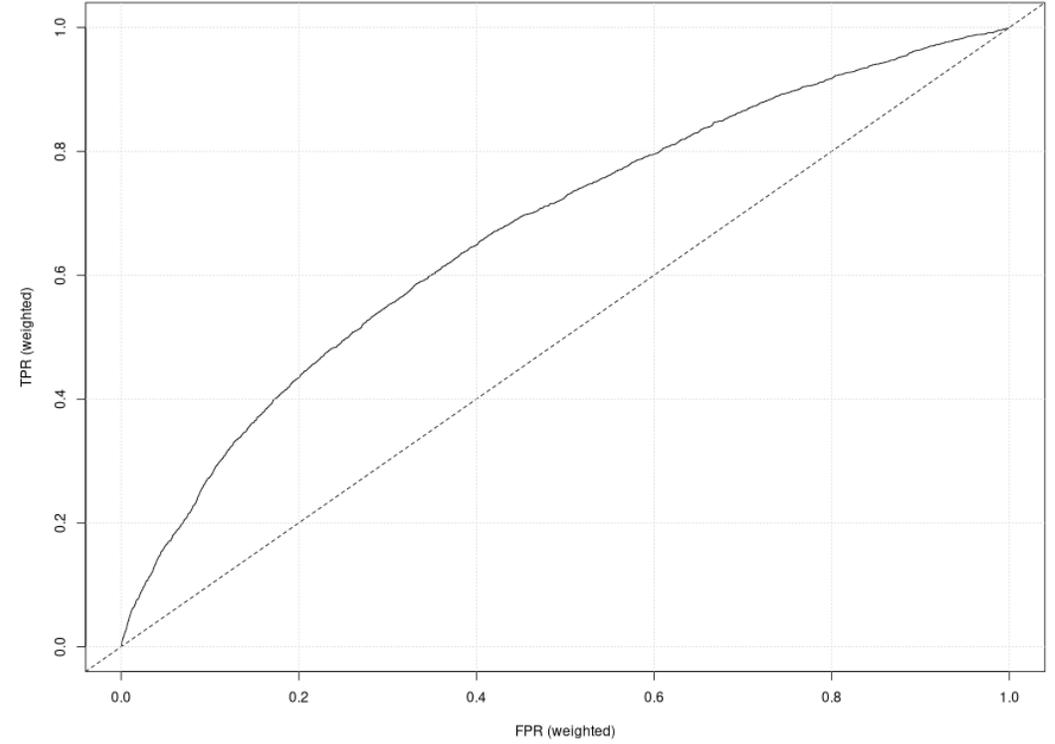
S/B vs threshold: dnn



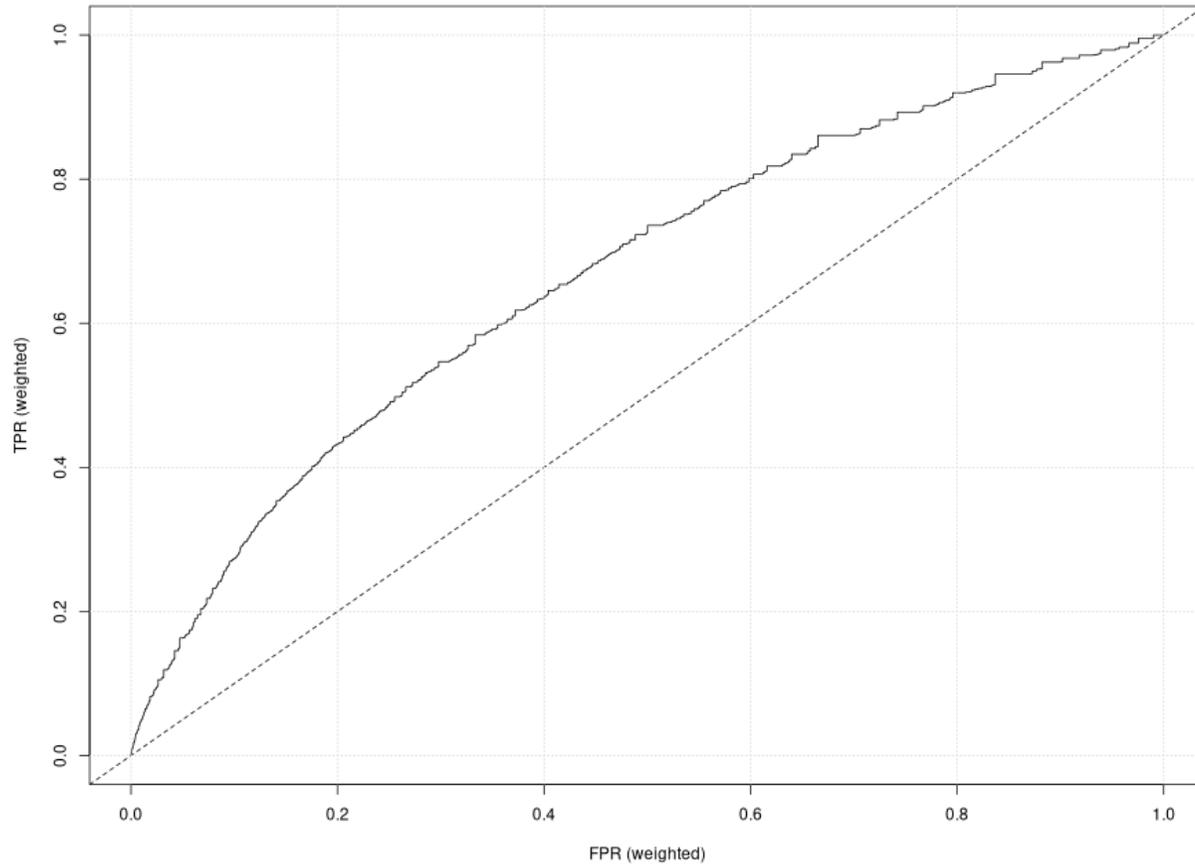
Weighted ROC: avNNet AUC=0.60006



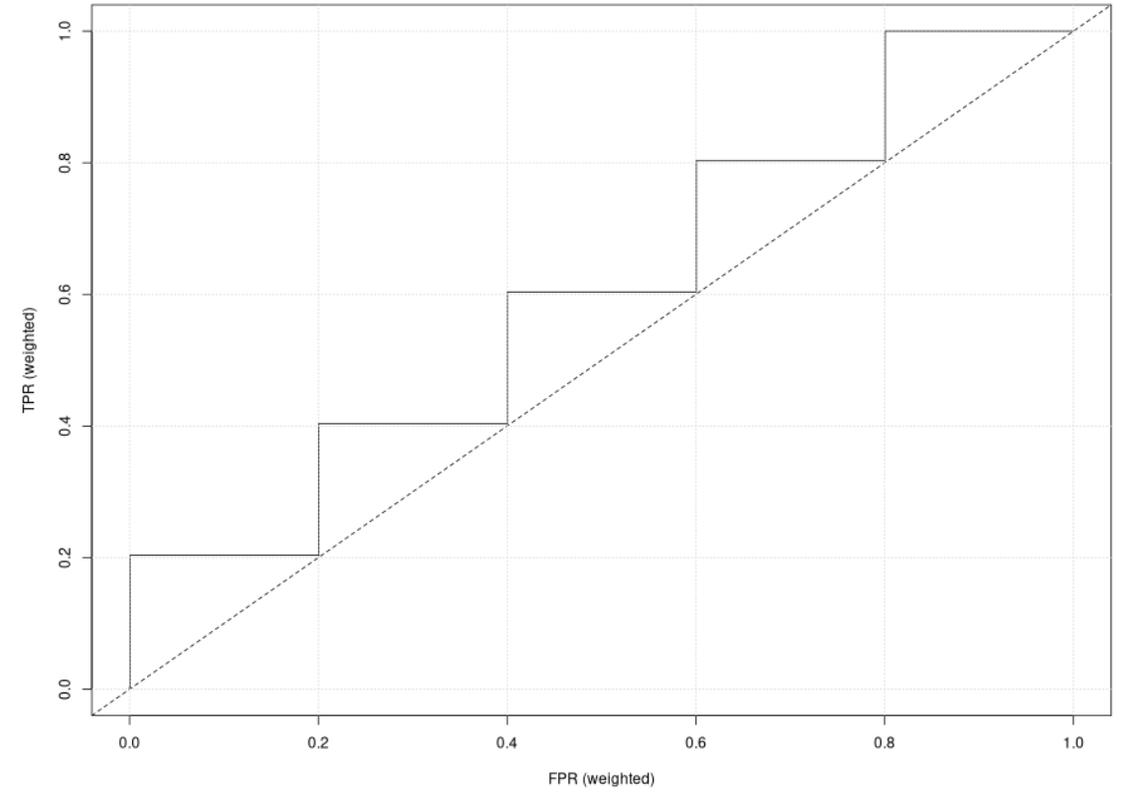
Weighted ROC: bam AUC=0.67122



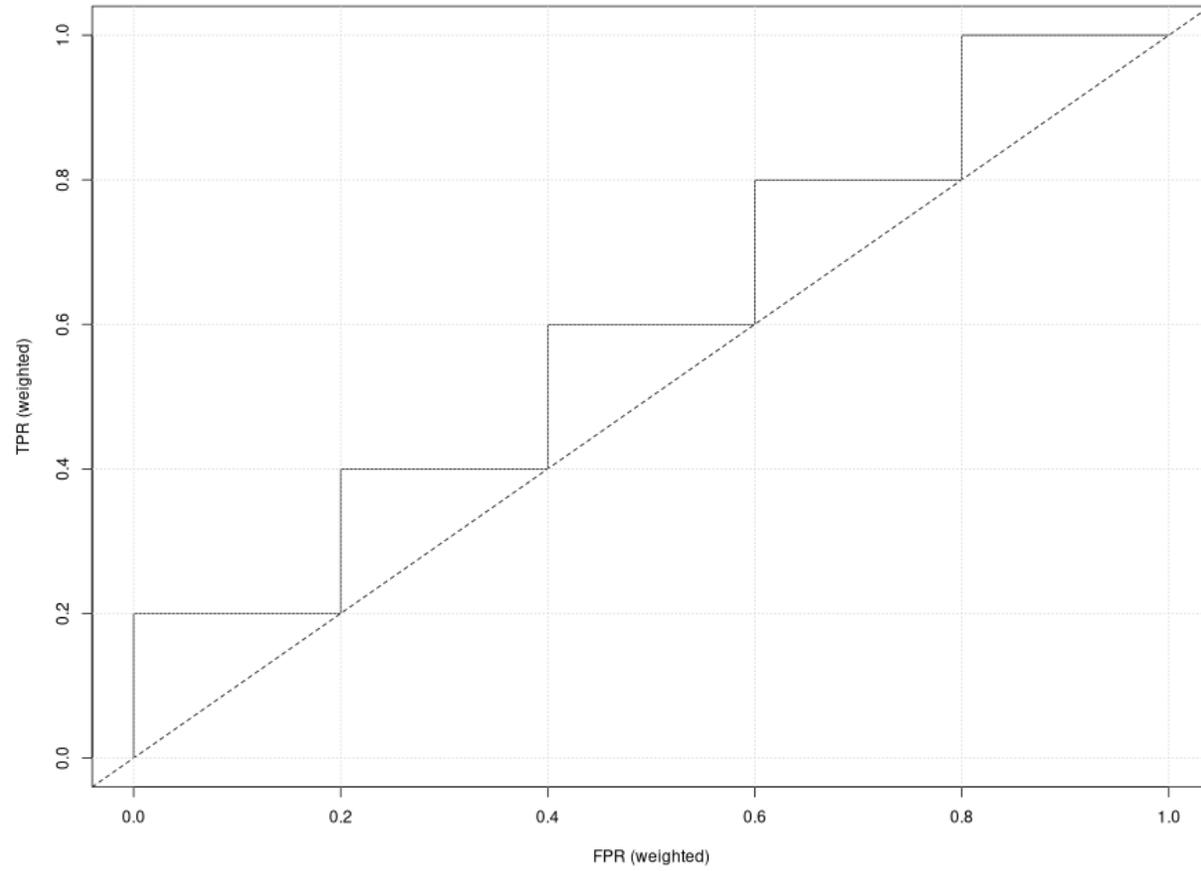
Weighted ROC: blackboost AUC=0.66872



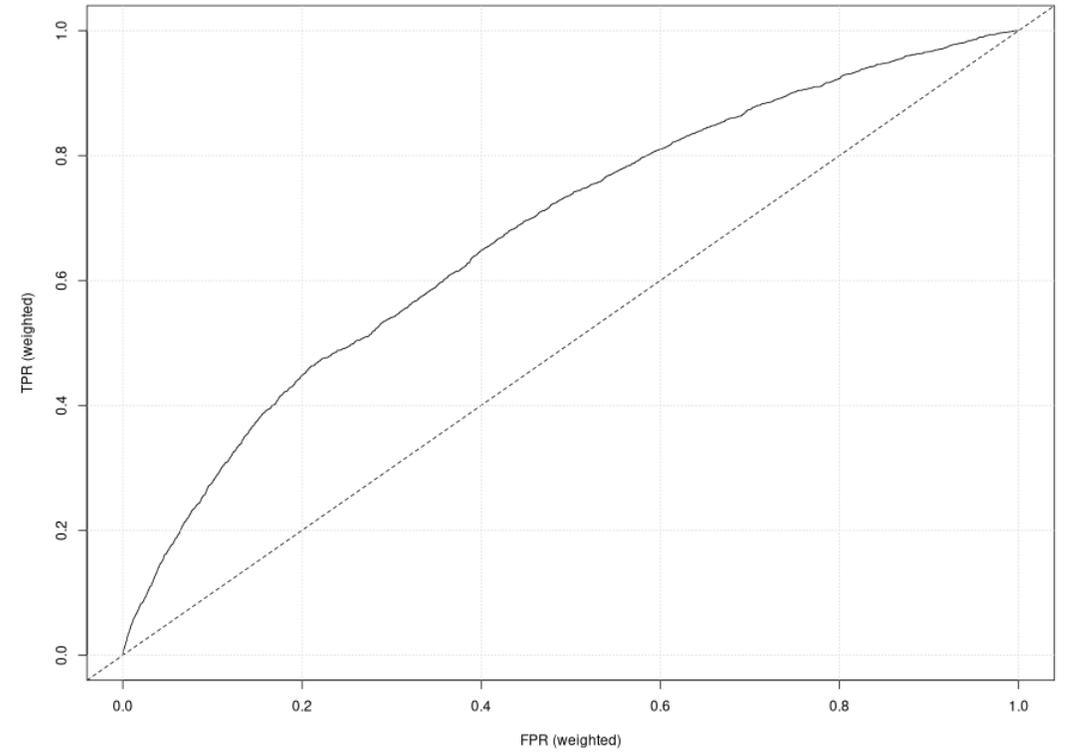
Weighted ROC: C5.0Rules AUC=0.60238



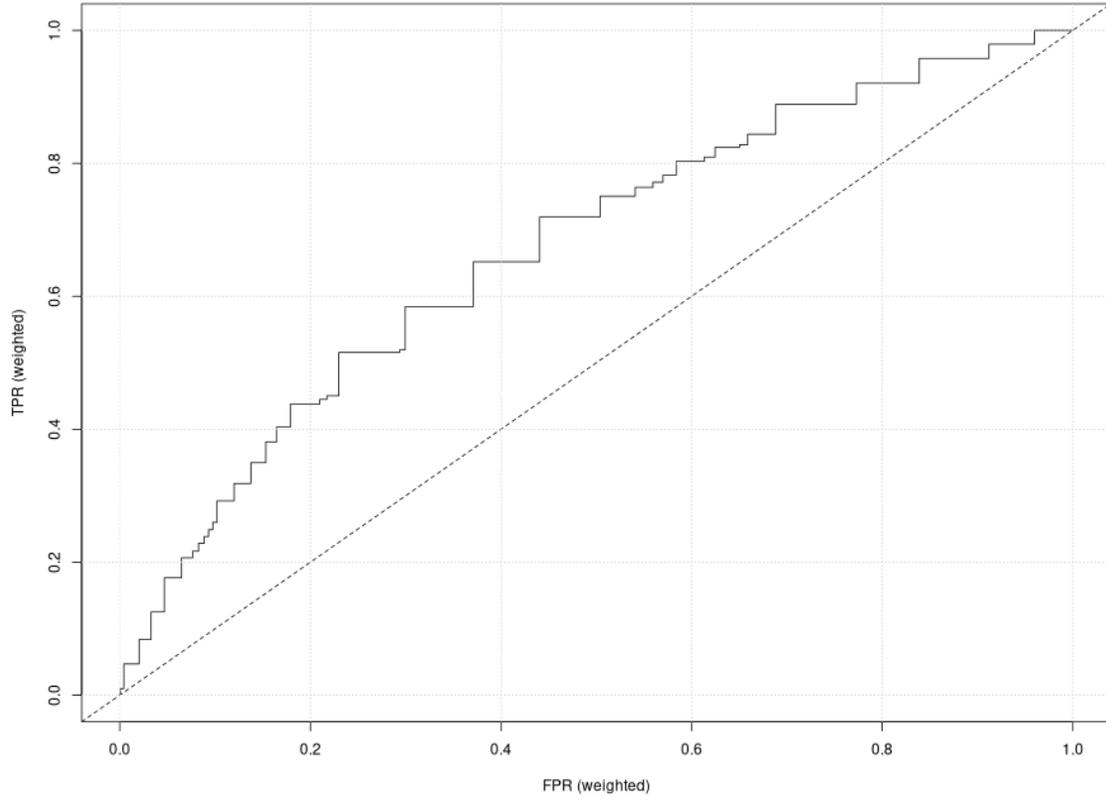
Weighted ROC: C5.0Tree AUC=0.59987



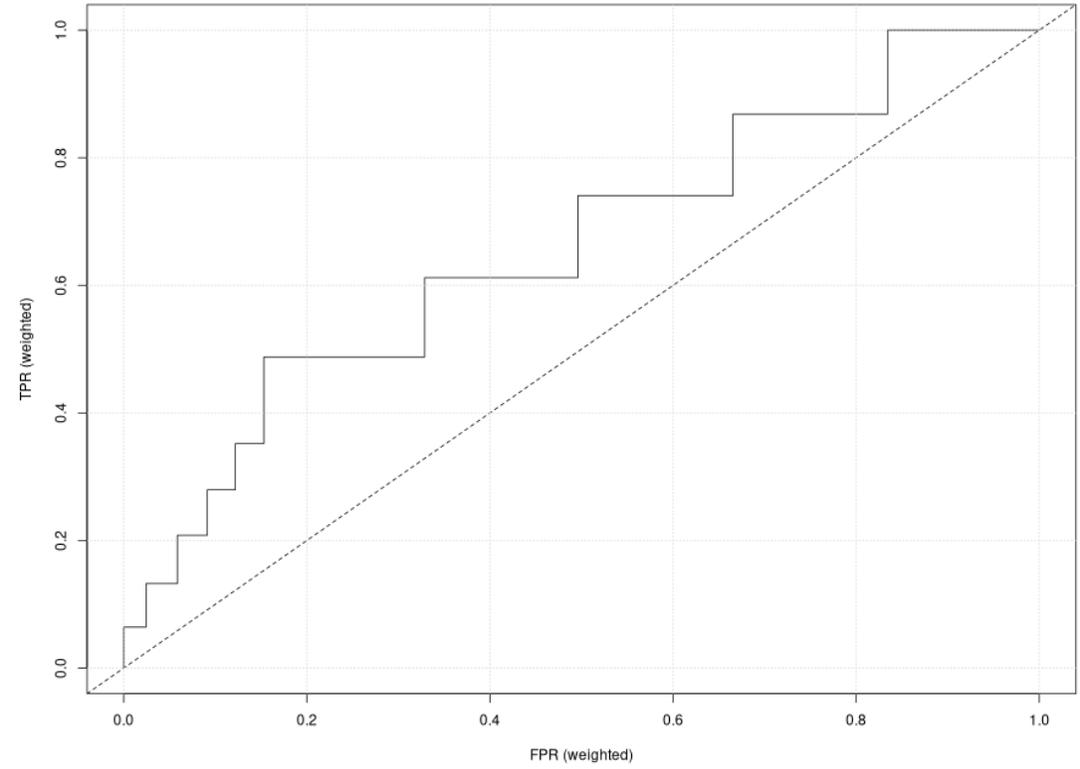
Weighted ROC: cforest AUC=0.67566



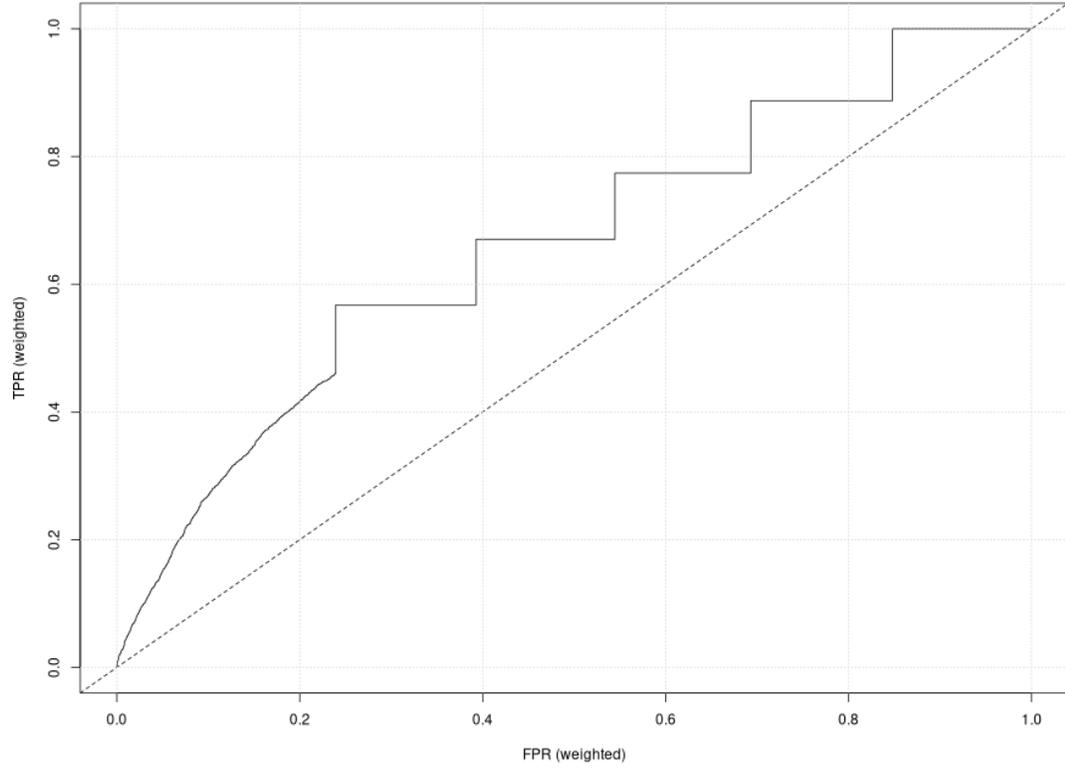
Weighted ROC: ctree AUC=0.67259



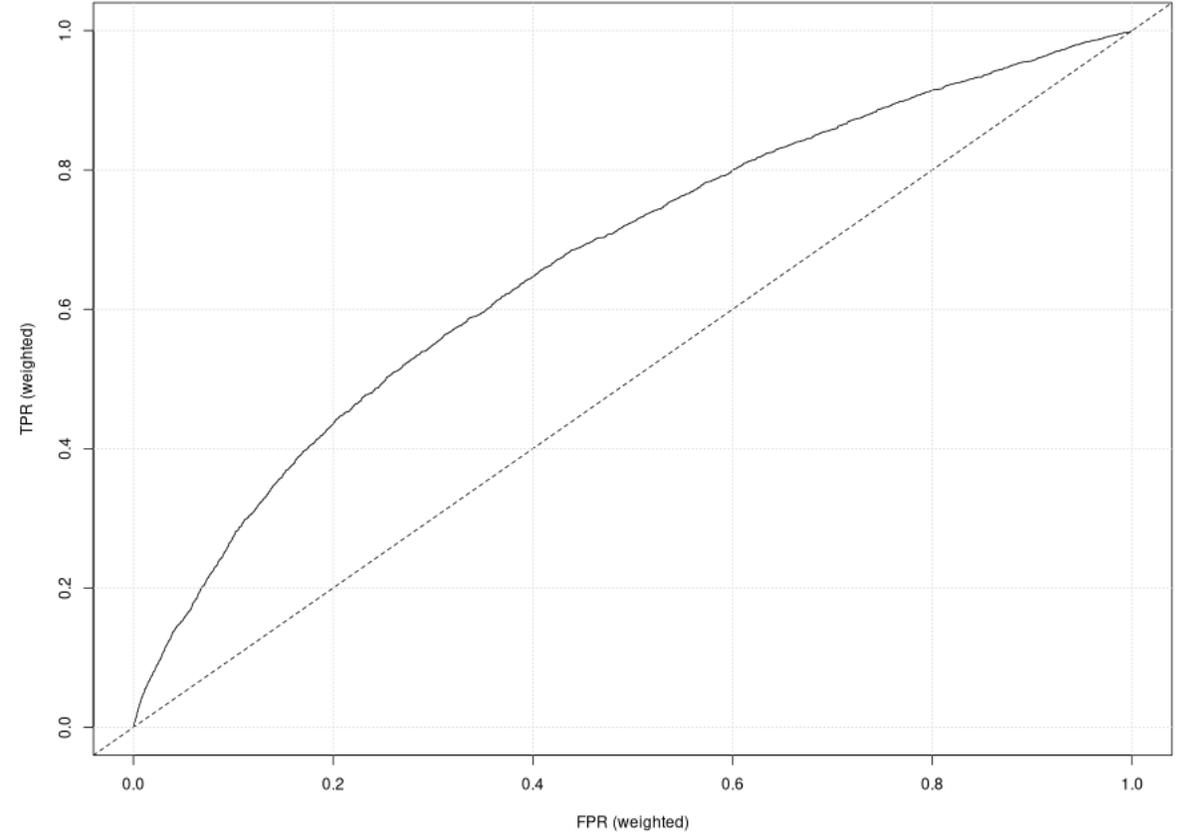
Weighted ROC: ctree2 AUC=0.65826



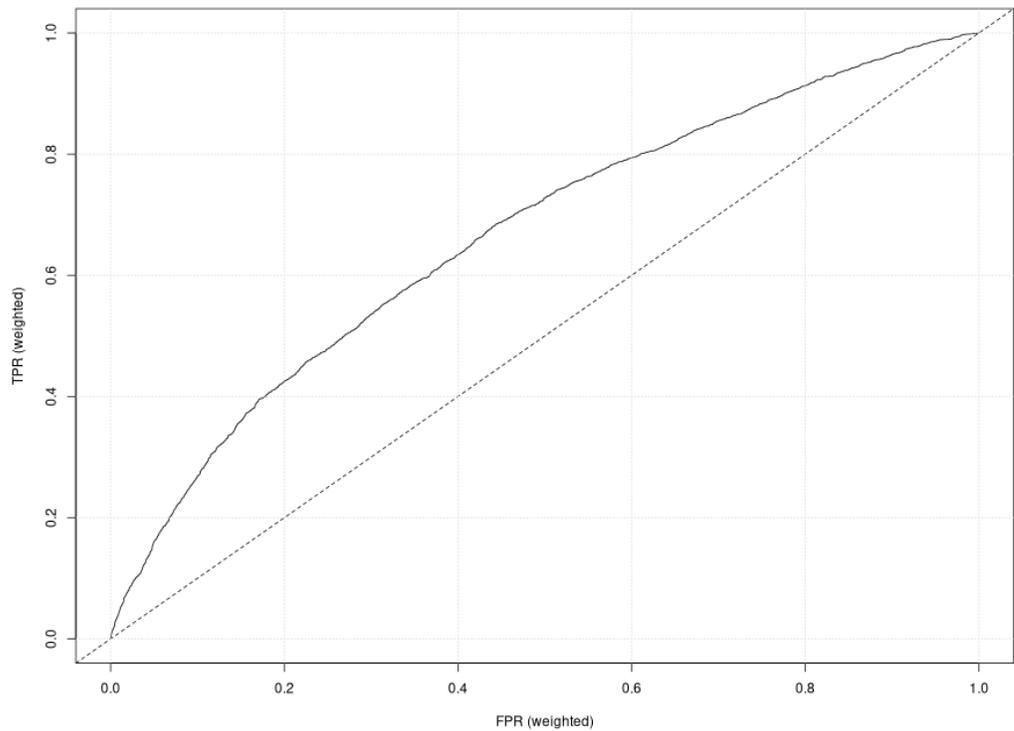
Weighted ROC: fda AUC=0.66023



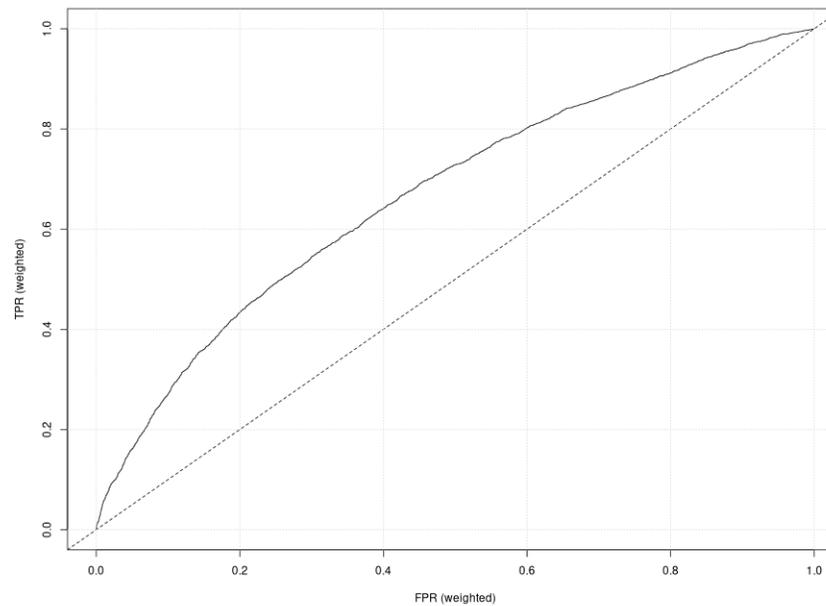
Weighted ROC: gam AUC=0.66908



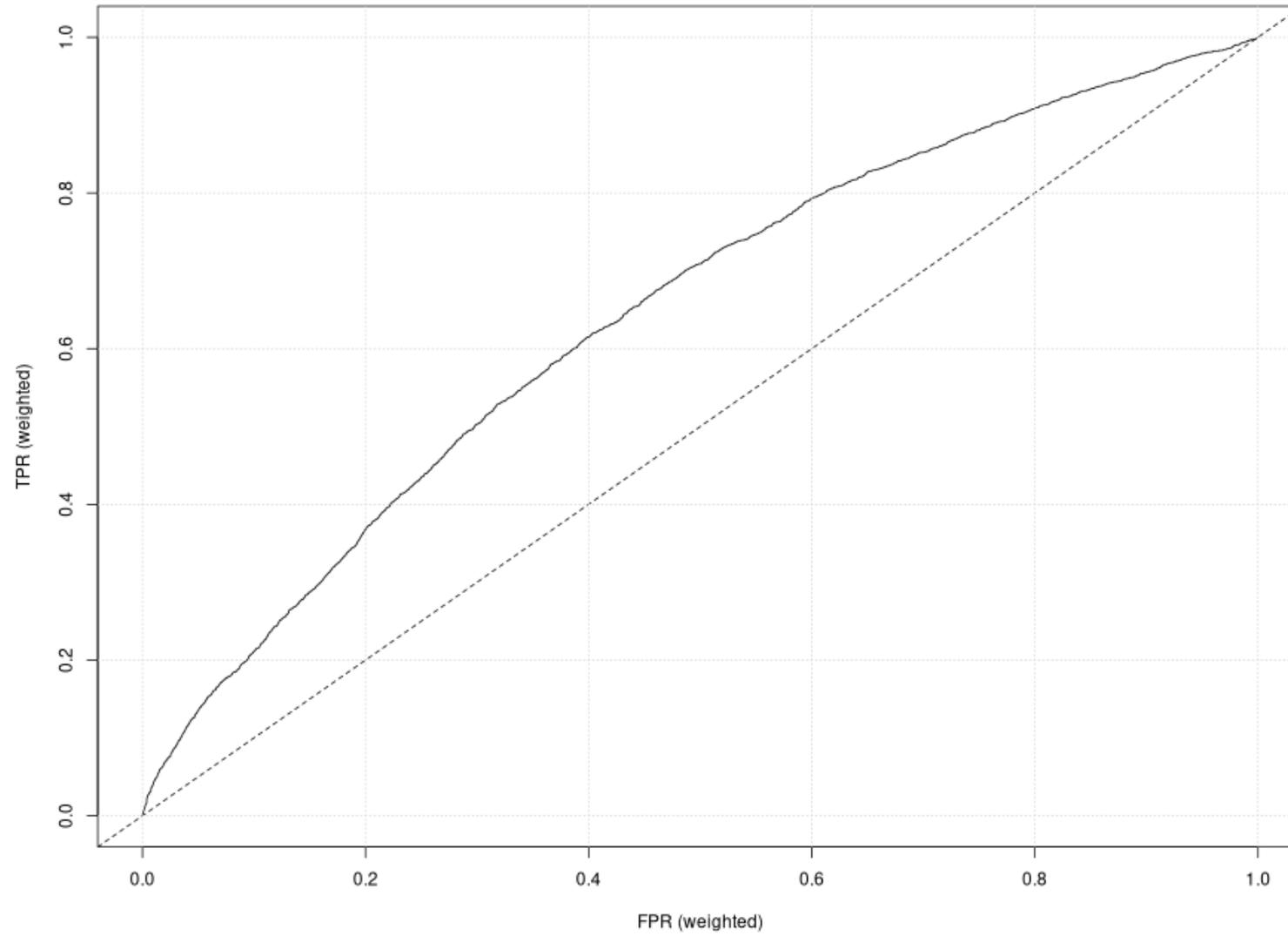
Weighted ROC: gamboost AUC=0.66503



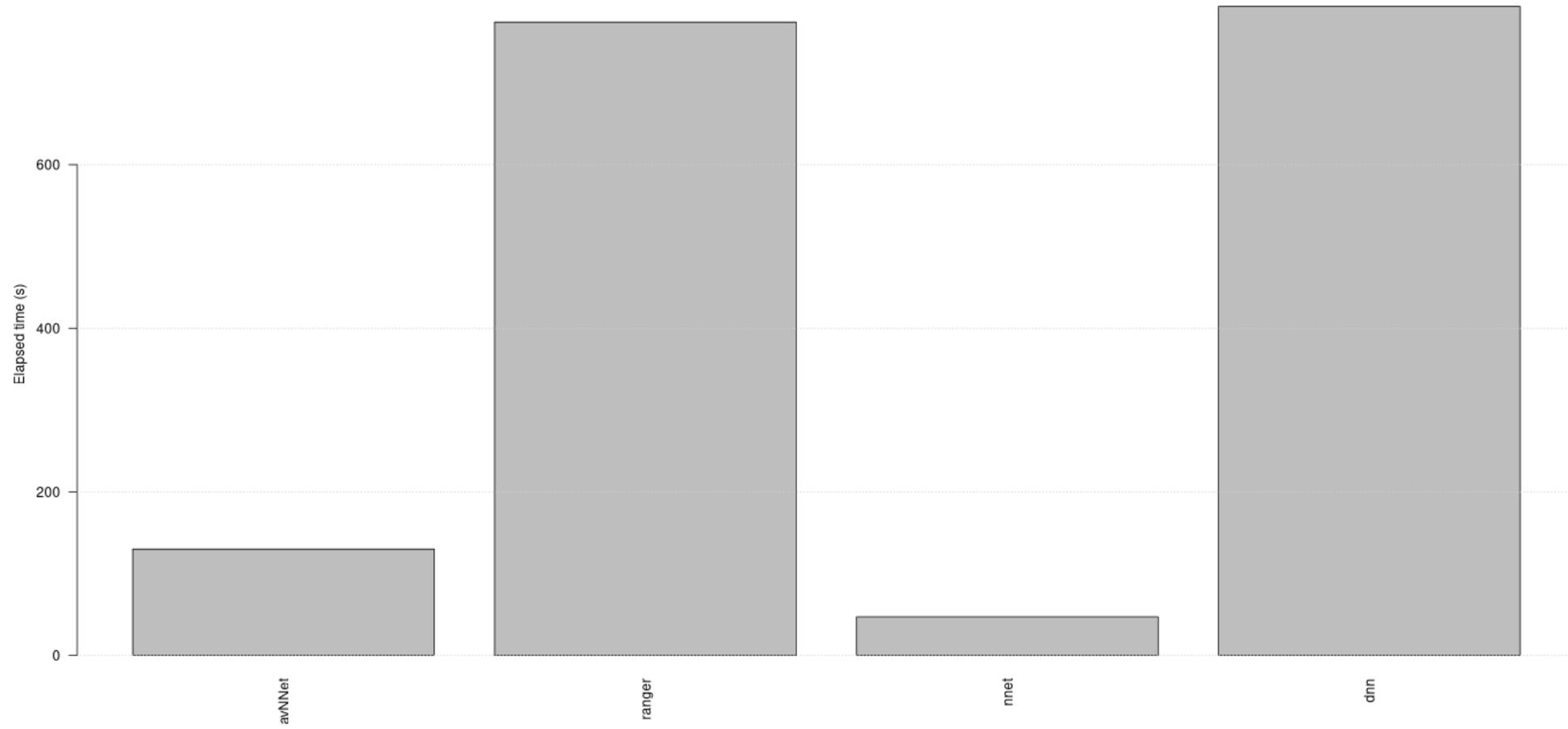
Weighted ROC: gamLoess AUC=0.66925



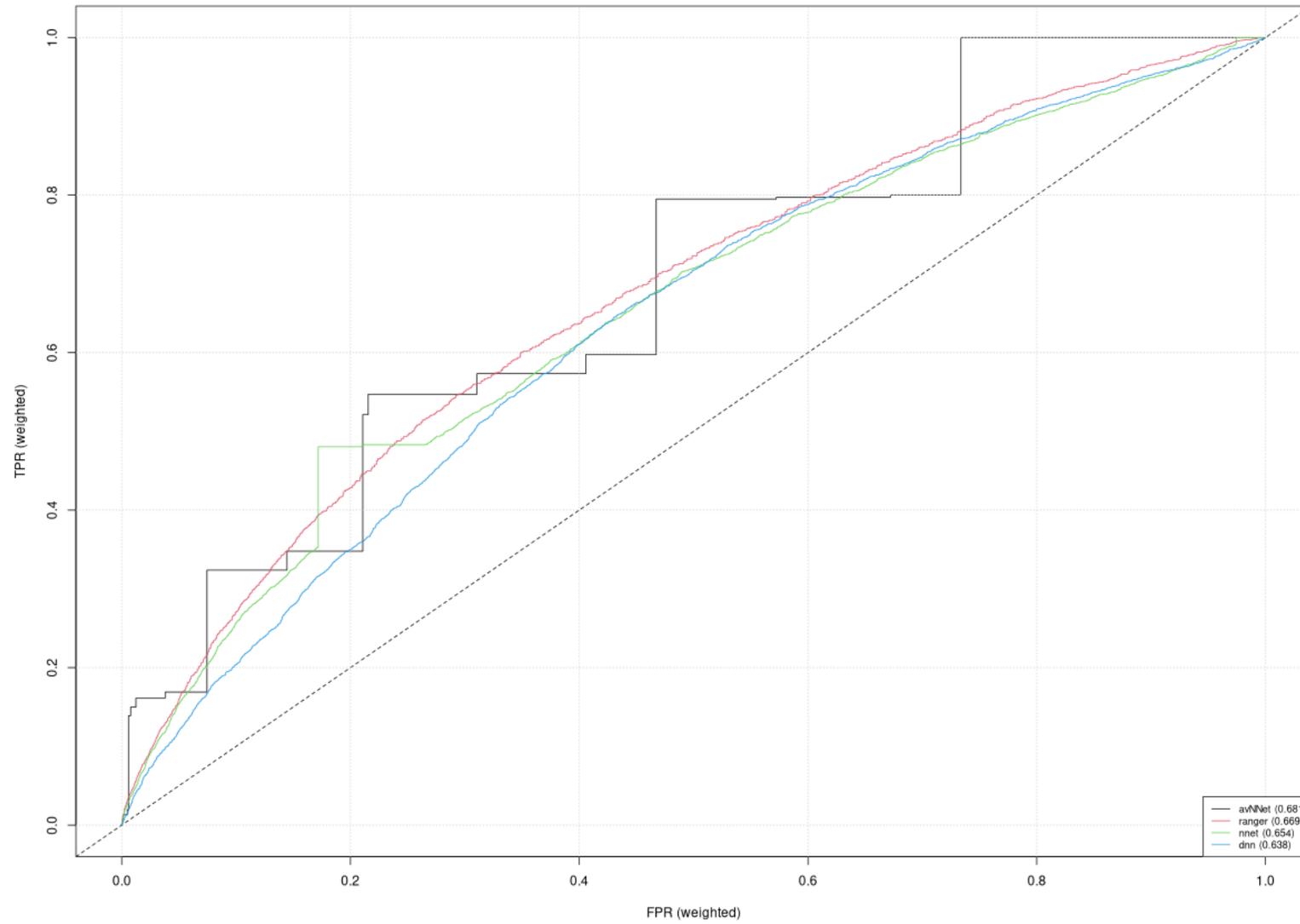
Weighted ROC: gamSpline AUC=0.64367



Elapsed time by method



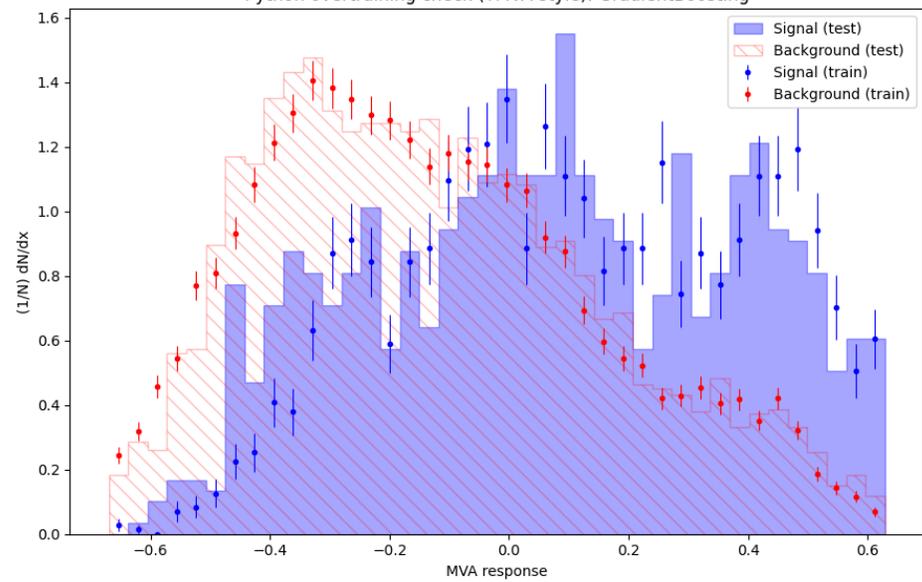
Weighted ROC curves (top 4)



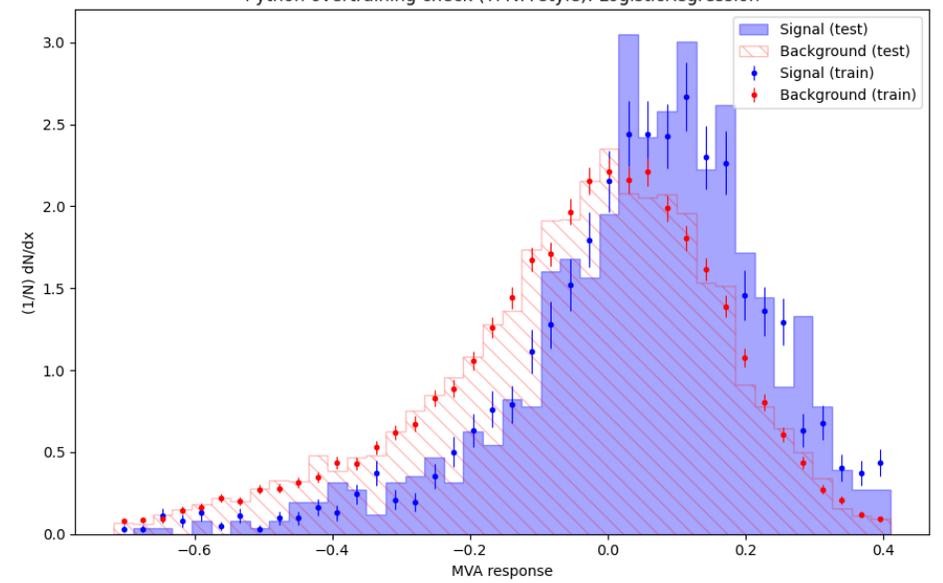
Python package results with CPU run times and sig/bkg ratios 03.03.2026

Algorithm	overall_oof_auc	overall_oof_wacc	mean_fold_auc	std_fold_auc	mean_fold_wacc	std_fold_wacc	cpu_sec_nested	wall_sec_nested	n_iter	outer_k	inner_k
GradientBoosting	0.67482	0.62379	0.675134	0.01051	0.623787	0.0108	7267.226	7295.312	25	5	3
ExtraTrees	0.673411	0.619695	0.673515	0.010477	0.619693	0.009589	1756.487	956.0188	25	5	3
RandomForest	0.67238	0.620409	0.673045	0.010076	0.620407	0.010415	11232.07	5691.417	25	5	3
SVC	0.671871	0.622698	0.672906	0.011466	0.622696	0.014309	1717.938	1724.99	12	5	3
HistGradientBoosting	0.668984	0.61906	0.670825	0.011496	0.619058	0.013581	150.8099	79.4174	25	5	3
MLP	0.660661	0.51298	0.660391	0.024628	0.512979	0.009094	612.0528	325.417	25	5	3
AdaBoost	0.660288	0.620915	0.667745	0.008661	0.620913	0.008934	1634.281	1641.34	25	5	3
KNN	0.655979	0.50016	0.656032	0.009047	0.50016	0.000391	205.196	205.9402	25	5	3
SGDClassifier	0.654416	0.576342	0.654547	0.011232	0.576341	0.004277	20.87878	20.96031	25	5	3
Bagging	0.653939	0.505979	0.654744	0.008789	0.50598	0.00354	47.32443	2039.316	25	5	3
QDA	0.651292	0.520597	0.6514	0.006987	0.520597	0.001775	2.142721	1.081121	25	5	3
GaussianNB	0.639867	0.612395	0.6407	0.006545	0.612393	0.00922	0.285183	0.286684	25	5	3
LogisticRegression	0.639509	0.603746	0.639506	0.011228	0.603744	0.013164	7.47437	3.784579	25	5	3
LinearSVC	0.637216	0.600697	0.637195	0.011291	0.600695	0.011075	3.788604	3.809592	25	5	3
LDA	0.631748	0.501218	0.631761	0.010358	0.501218	0.000734	1.475312	0.789616	25	5	3

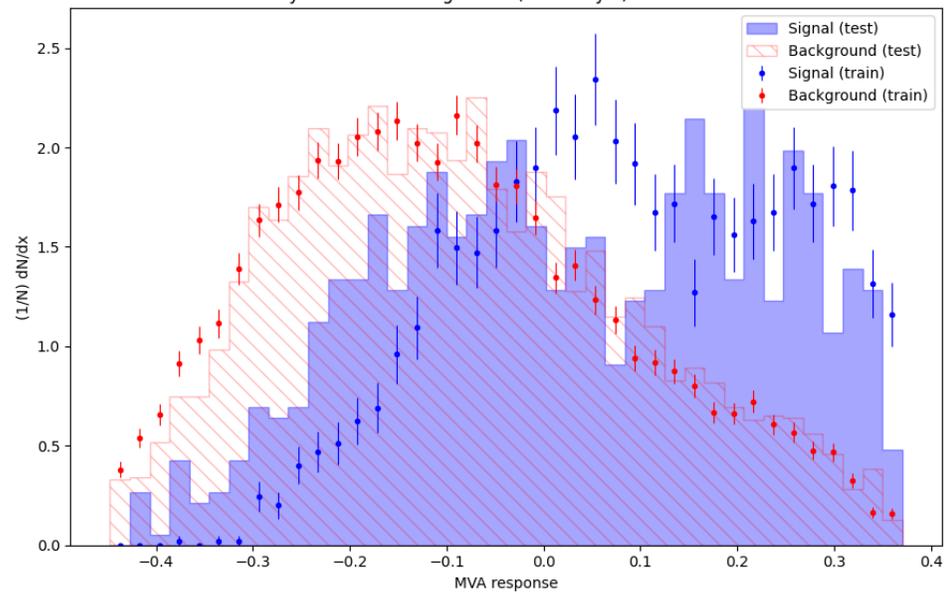
Python overtraining check (TMVA-style): GradientBoosting



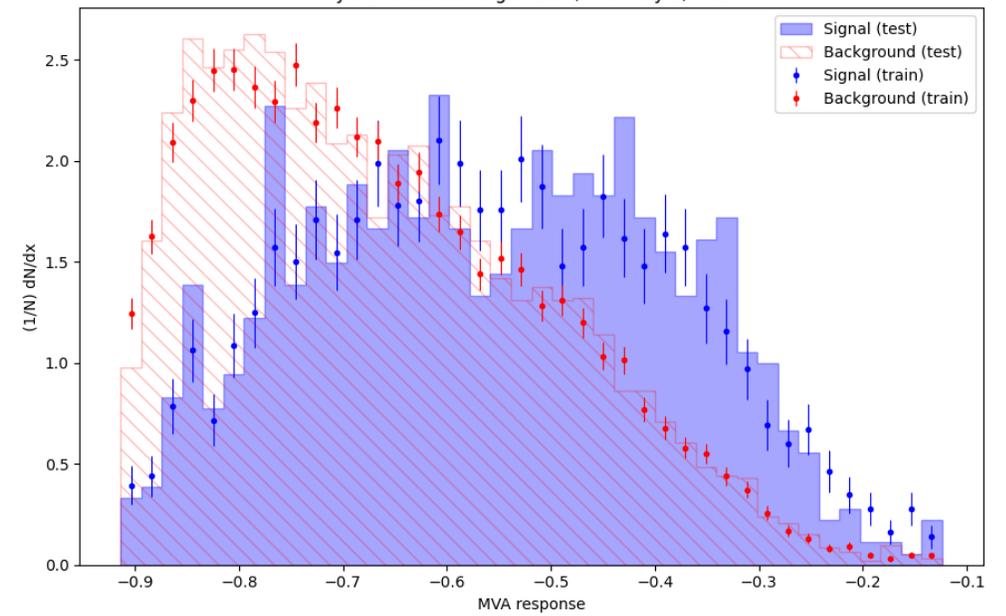
Python overtraining check (TMVA-style): LogisticRegression



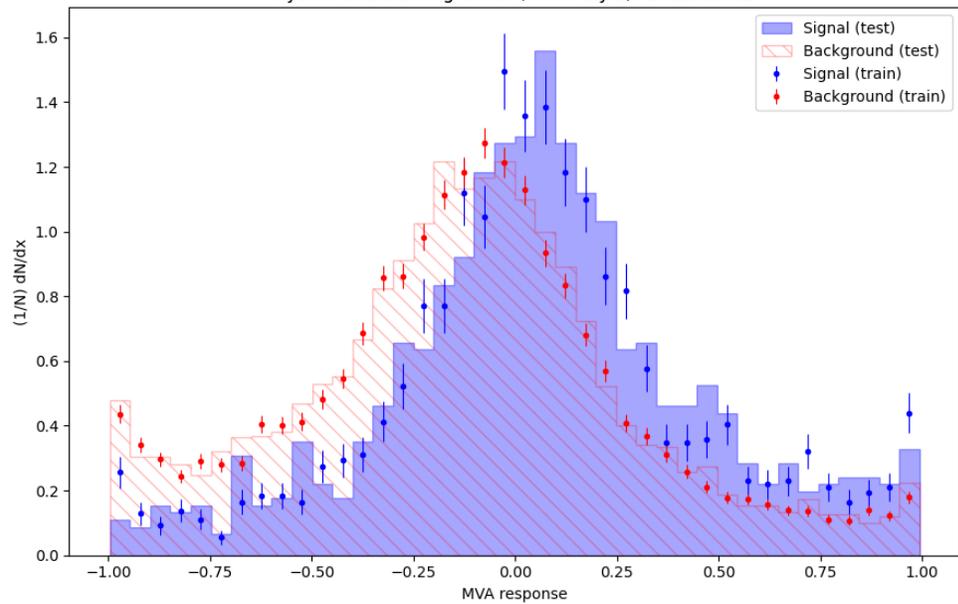
Python overtraining check (TMVA-style): ExtraTrees



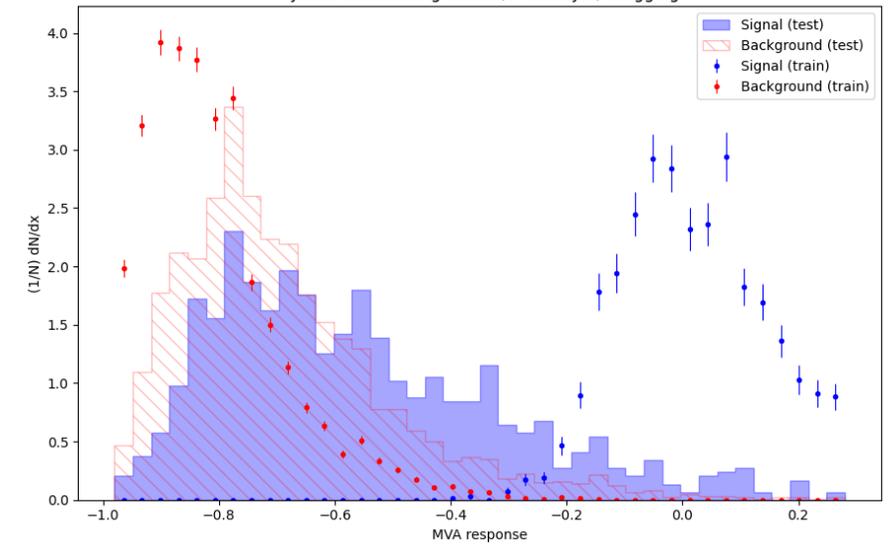
Python overtraining check (TMVA-style): MLP



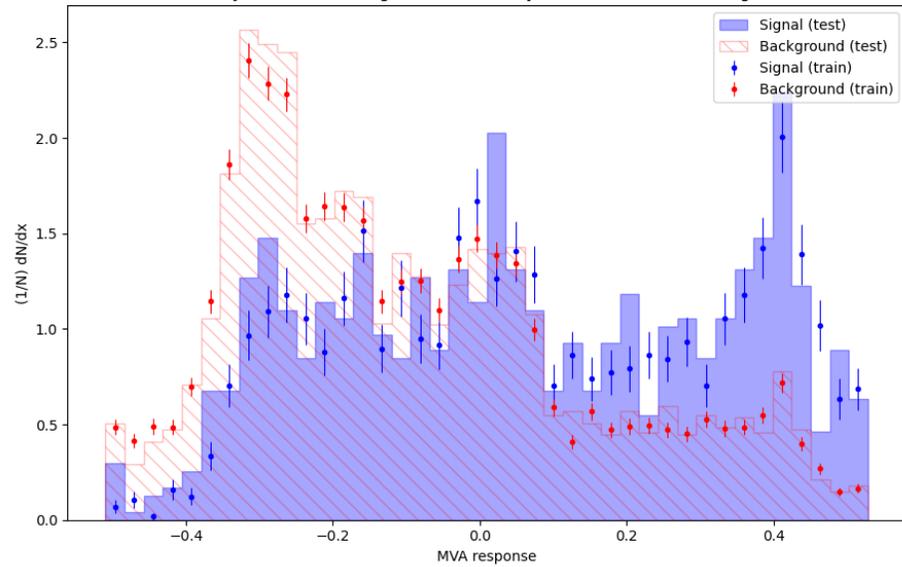
Python overtraining check (TMVA-style): GaussianNB



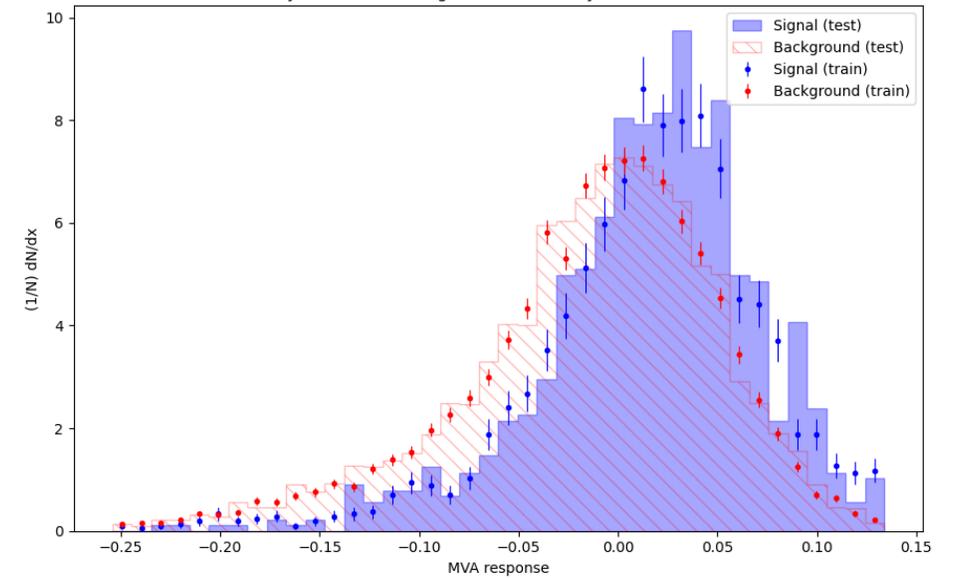
Python overtraining check (TMVA-style): Bagging

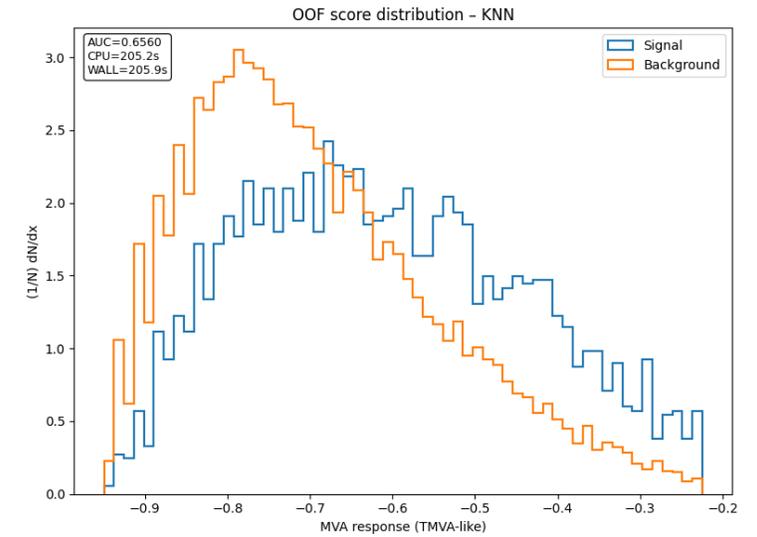
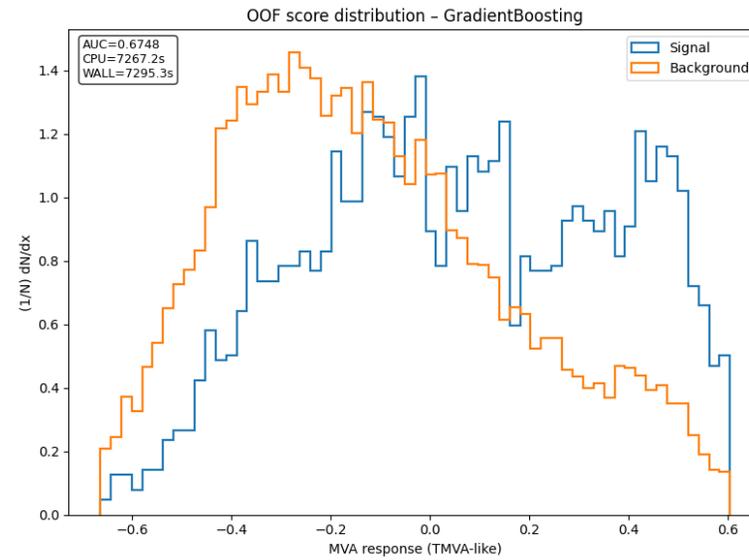
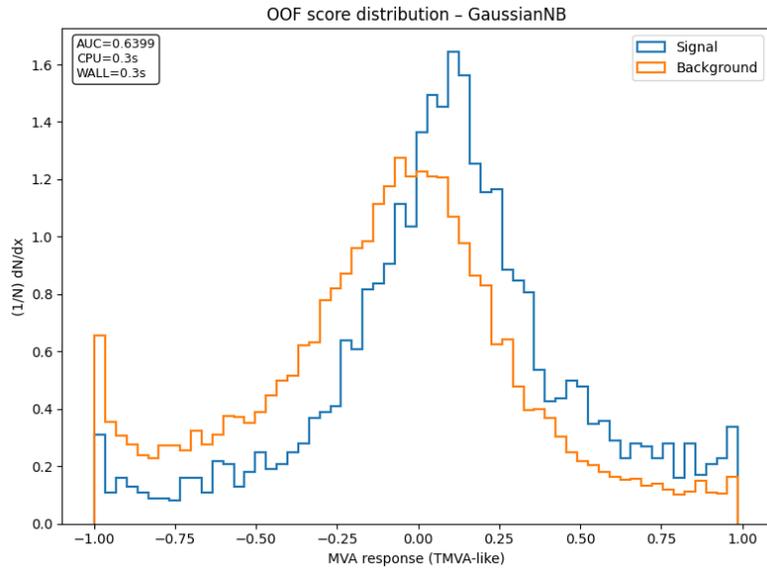
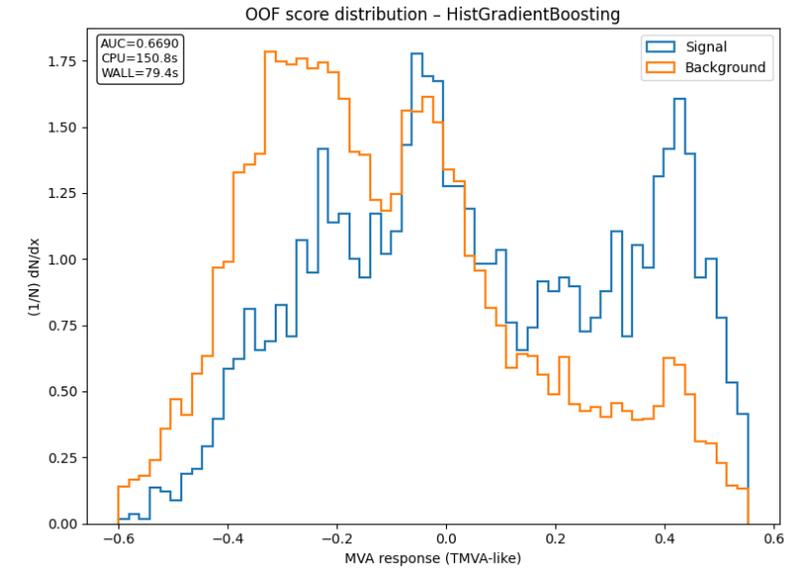
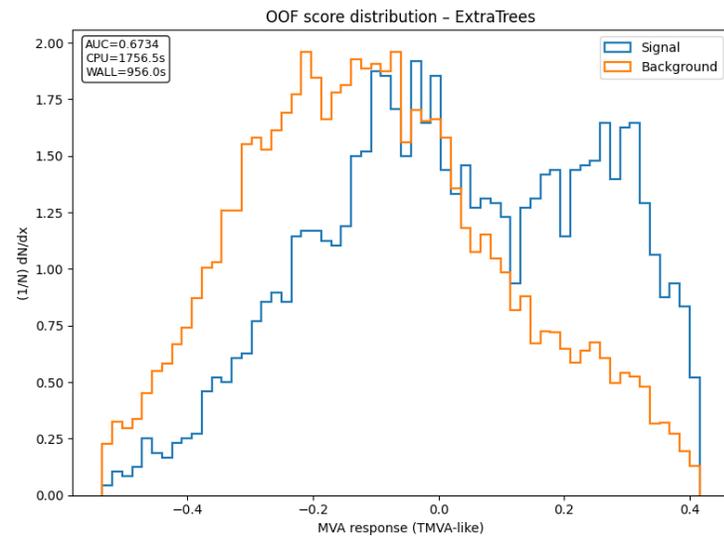
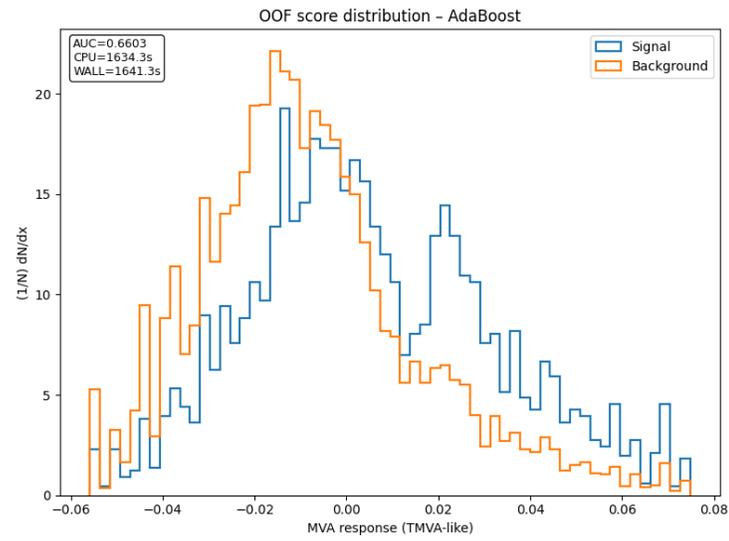


Python overtraining check (TMVA-style): HistGradientBoosting

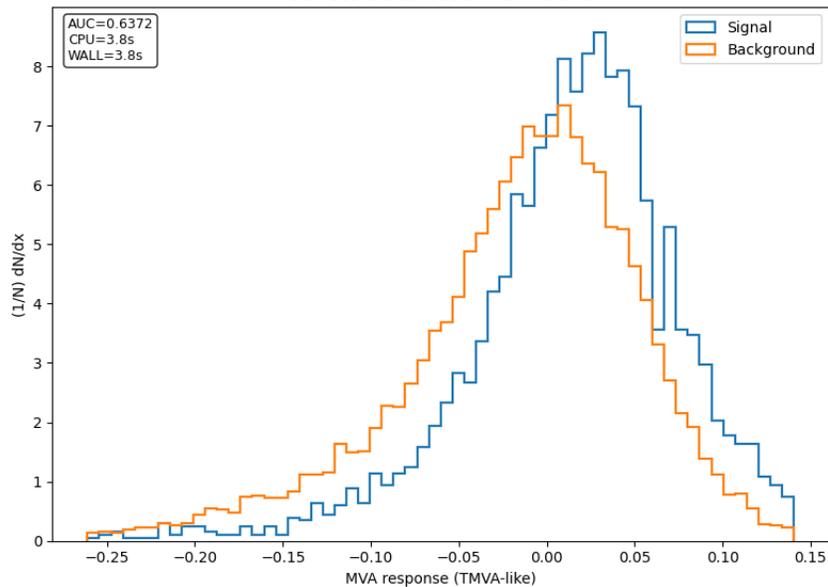


Python overtraining check (TMVA-style): LinearSVC

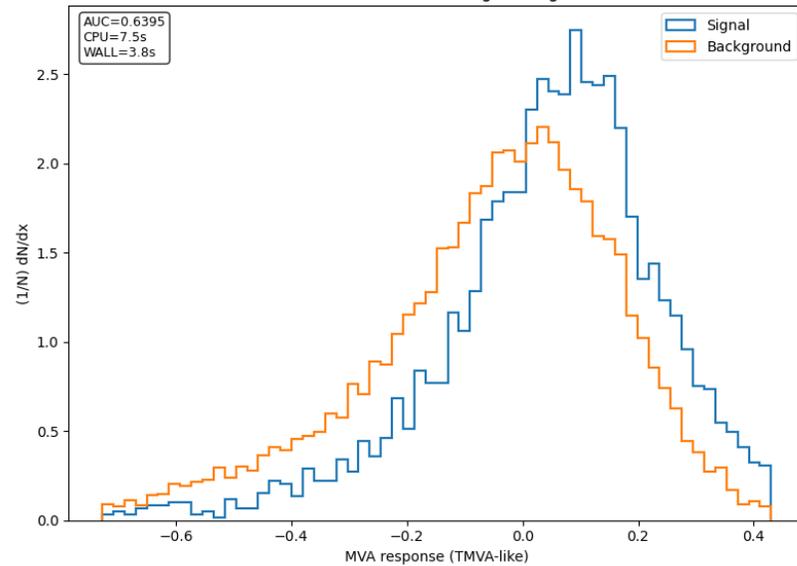




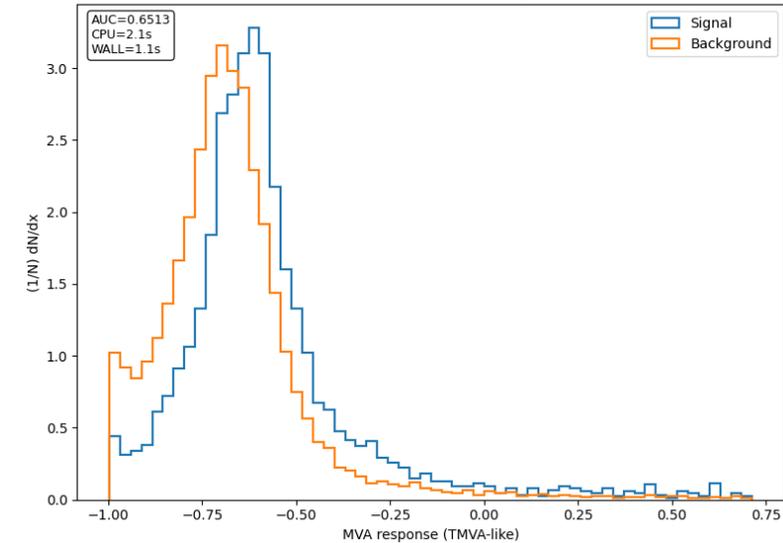
OOF score distribution - LinearSVC



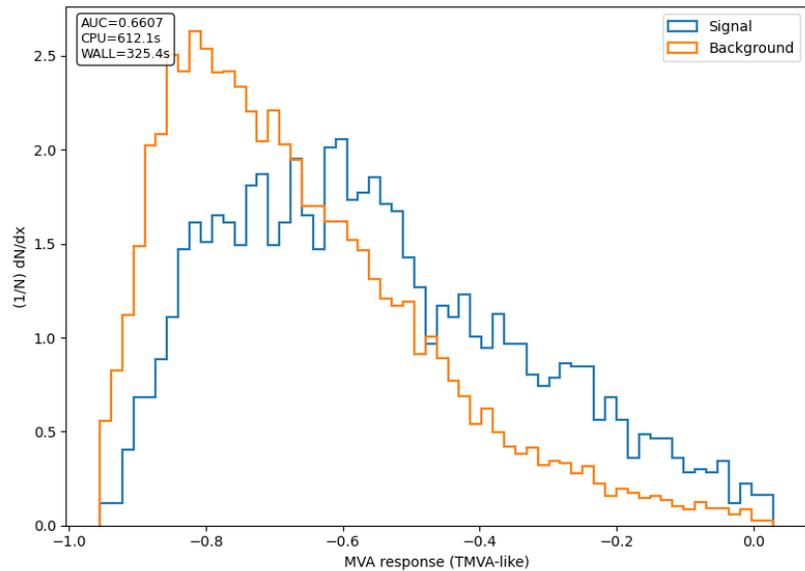
OOF score distribution - LogisticRegression



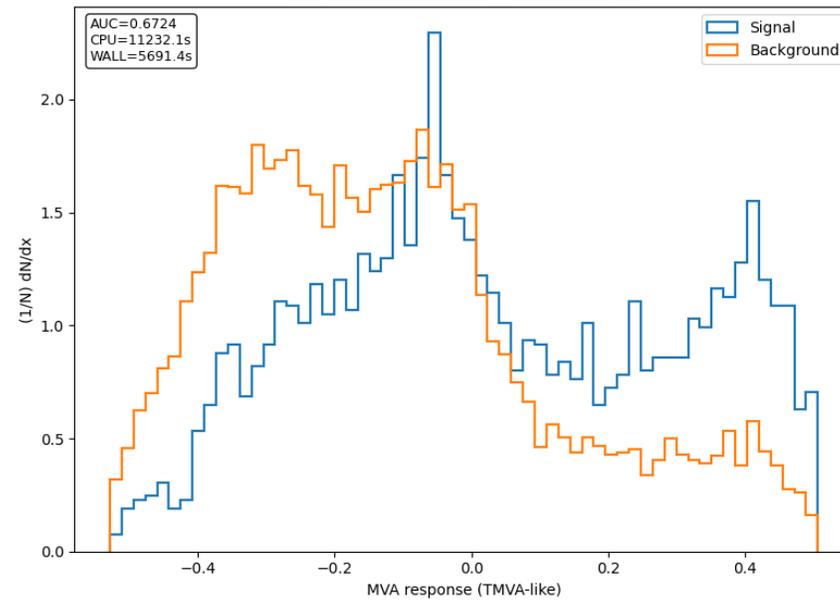
OOF score distribution - QDA



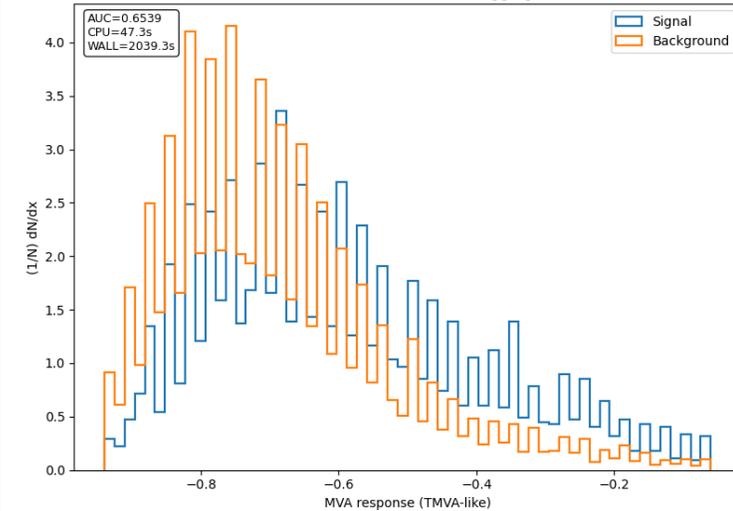
OOF score distribution - MLP



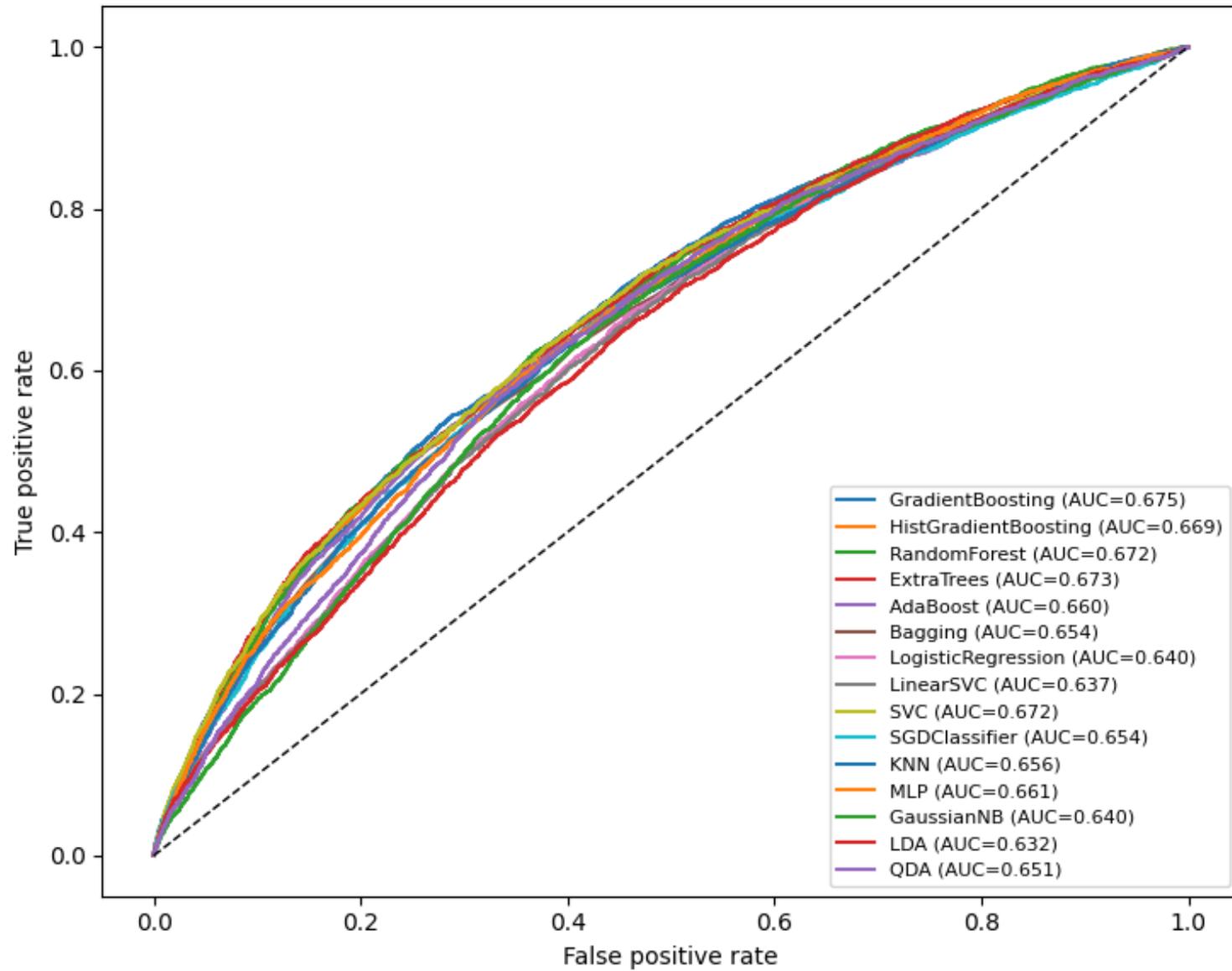
OOF score distribution - RandomForest



OOF score distribution - Bagging



Common OOF ROC - all algorithms

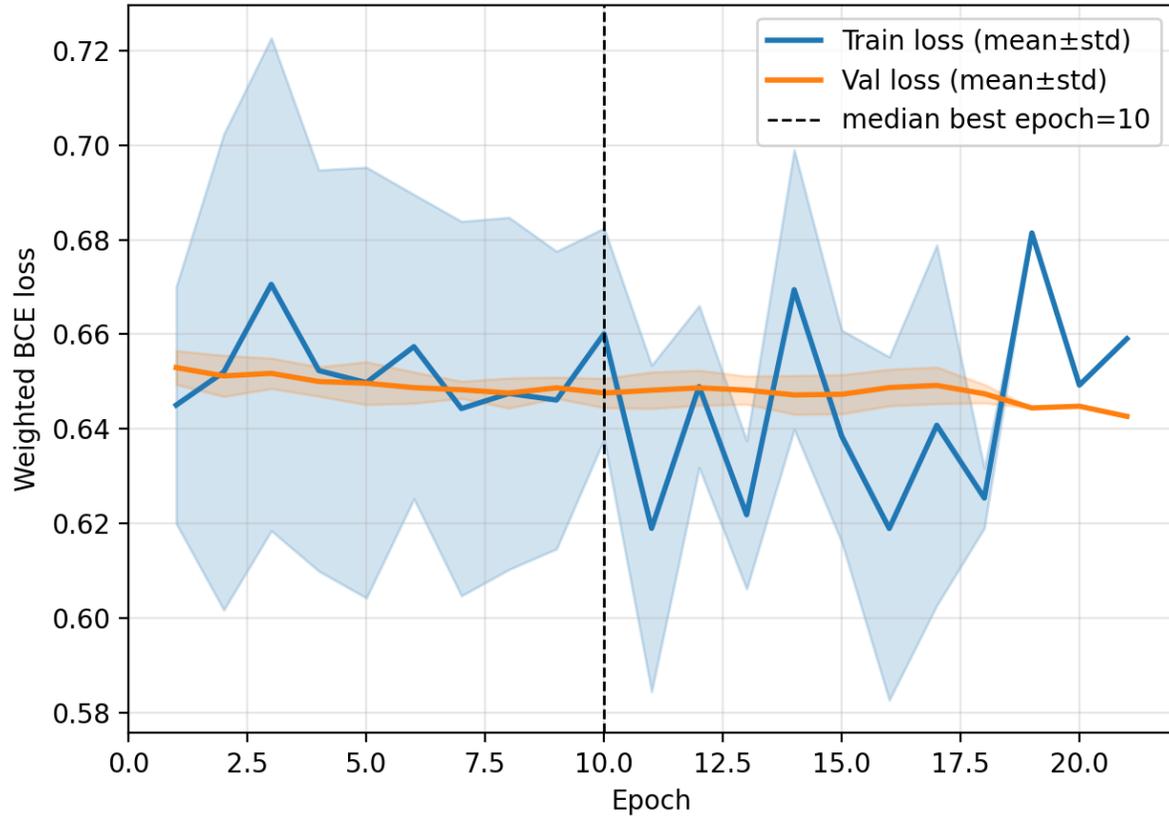


Transformers
Early stopping,
CPU run times and sig/bkg ratios
03.03.2026

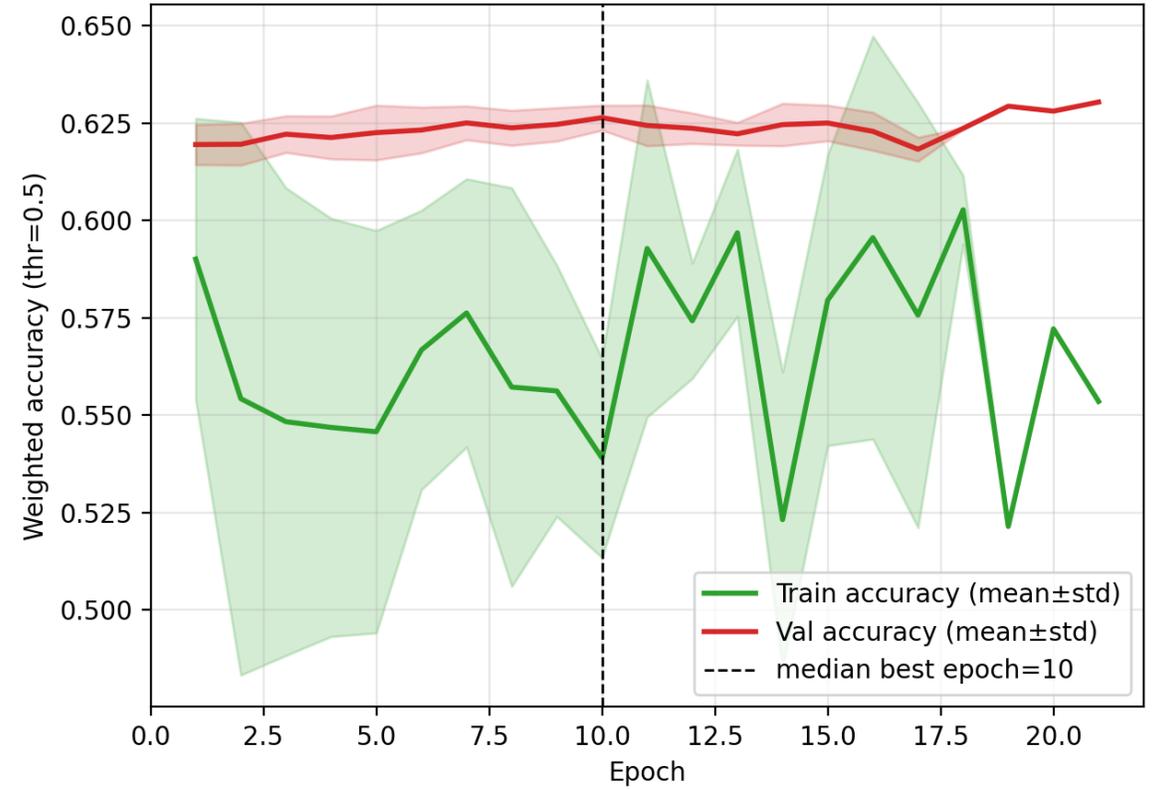
fold	runtime_sec	n_train	n_val	best_inner_auc	best_epoch	train_loss	val_loss	train_auc	val_auc	train_acc	val_acc
0	3893.703	70052	17514	0.670883	12	0.642104	0.647656	0.68096	0.67204	0.632172	0.626379
1	4639.915	70052	17514	0.671533	10	0.645683	0.648728	0.674652	0.668433	0.62691	0.62607
2	4179.028	70053	17513	0.667581	5	0.646528	0.644797	0.672512	0.6755	0.62525	0.632705
3	2446.346	70053	17513	0.671611	7	0.643465	0.649791	0.676896	0.665011	0.628329	0.619499
4	2811.628	70054	17512	0.669293	15	0.640449	0.641936	0.681297	0.677288	0.631266	0.629463

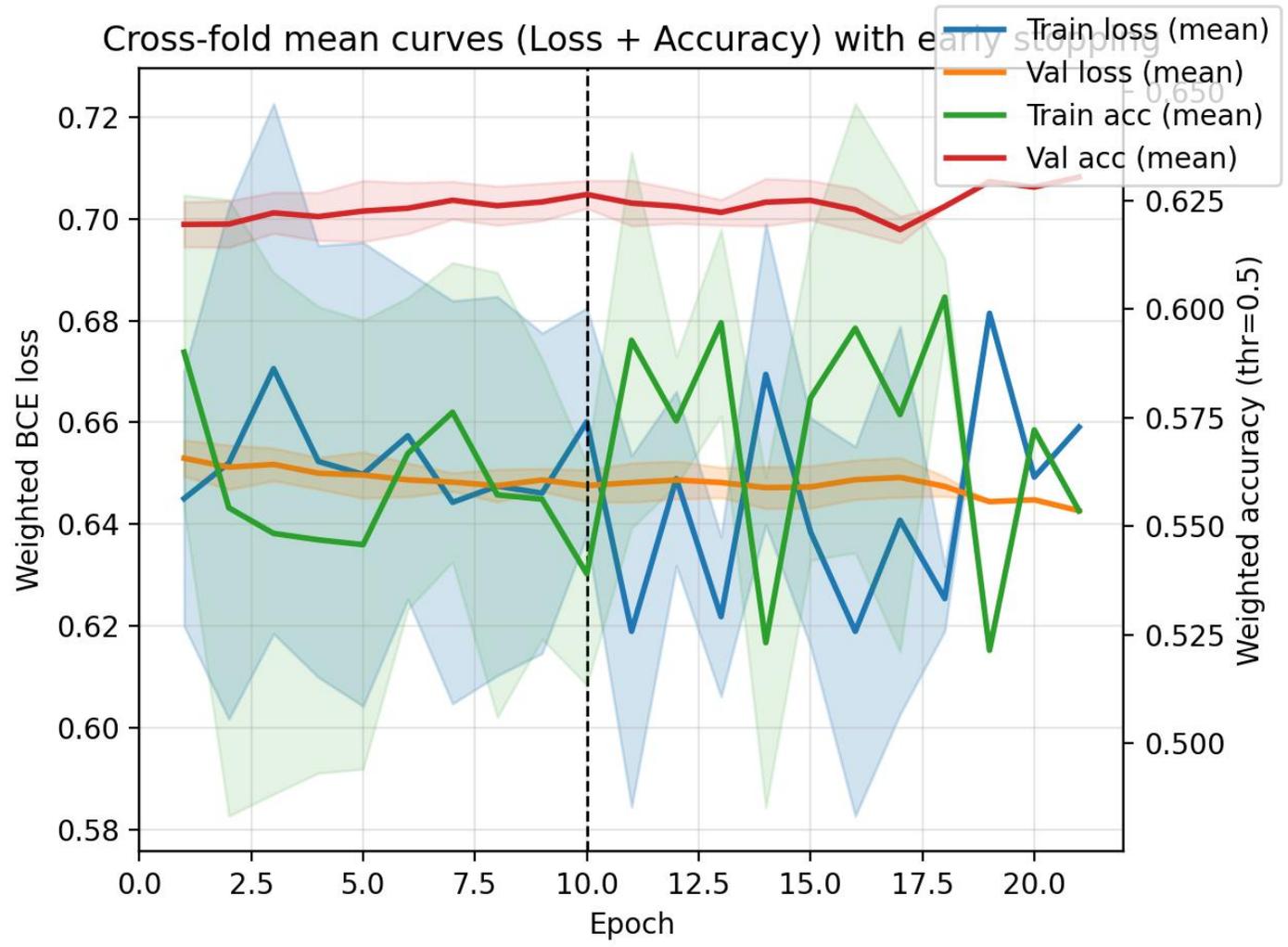
epoch	n folds used	train_loss_mean	train_loss_std	val_loss_mean	val_loss_std	train_acc_mean	train_acc_std	val_acc_mean	val_acc_std
1	5	0.645015	0.025086	0.652949	0.003567	0.590046	0.036111	0.619461	0.005166
2	5	0.652015	0.050332	0.651187	0.004352	0.554195	0.070961	0.619532	0.005365
3	5	0.670562	0.052131	0.651732	0.003212	0.548293	0.060034	0.622118	0.004704
4	5	0.652319	0.042433	0.65	0.00311	0.546813	0.053703	0.621262	0.005506
5	5	0.649778	0.045562	0.649649	0.004533	0.545707	0.051659	0.622521	0.007032
6	5	0.657378	0.0322	0.648704	0.003308	0.566699	0.03588	0.623183	0.00588
7	5	0.644278	0.039604	0.648256	0.001799	0.576211	0.034442	0.625012	0.004348
8	5	0.64748	0.037251	0.647565	0.003187	0.557174	0.05118	0.623746	0.004502
9	5	0.646077	0.031479	0.648675	0.002245	0.556191	0.032252	0.624626	0.004299
10	5	0.660113	0.022351	0.647566	0.003105	0.538984	0.02558	0.626352	0.003198
11	5	0.618931	0.034516	0.648152	0.003864	0.592764	0.043261	0.624347	0.005233
12	4	0.648928	0.017114	0.648665	0.003714	0.574202	0.014831	0.623632	0.003927
13	4	0.621808	0.015681	0.648177	0.002969	0.596798	0.021465	0.622217	0.002929
14	3	0.669437	0.02957	0.647165	0.004101	0.52314	0.037978	0.624574	0.005464
15	3	0.638445	0.022408	0.647302	0.004141	0.579514	0.037362	0.624983	0.004581
16	3	0.618907	0.036292	0.648724	0.003861	0.595558	0.051739	0.622849	0.004893
17	2	0.640758	0.038116	0.649175	0.003873	0.57564	0.054571	0.618251	0.003072
18	2	0.625345	0.006334	0.647416	0.001946	0.602715	0.008795	0.623605	0.000225
19	1	0.681443	0	0.64441	0	0.52139	0	0.629303	0
20	1	0.64924	0	0.644774	0	0.57213	0	0.628041	0
21	1	0.659062	0	0.64263	0	0.553495	0	0.630362	0

Cross-fold learning curve (Loss) with early stopping

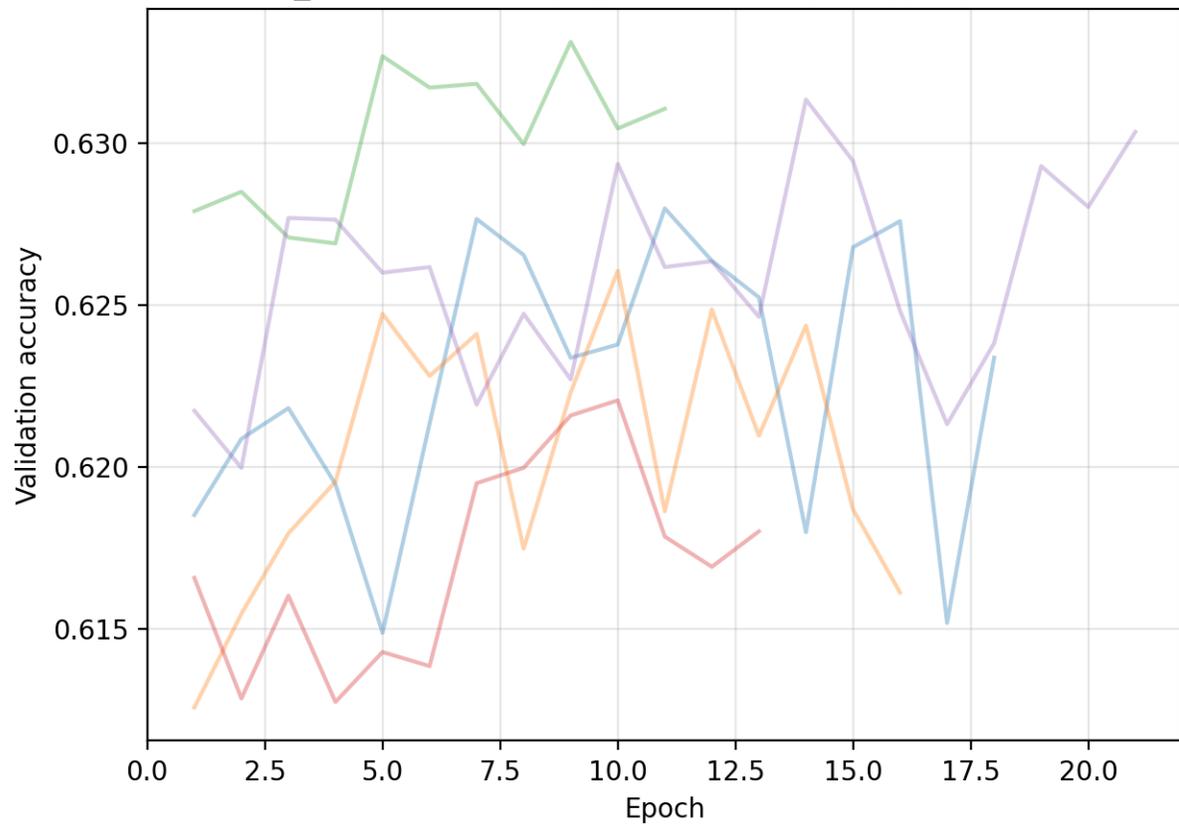


Cross-fold learning curve (Accuracy) with early stopping

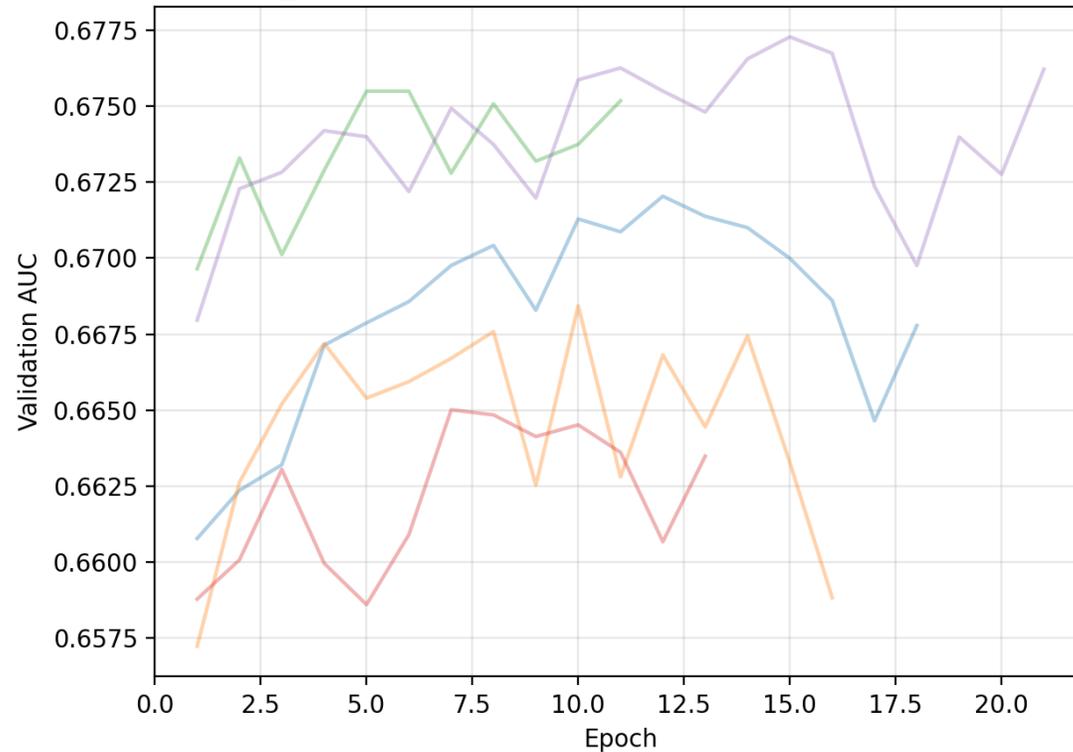




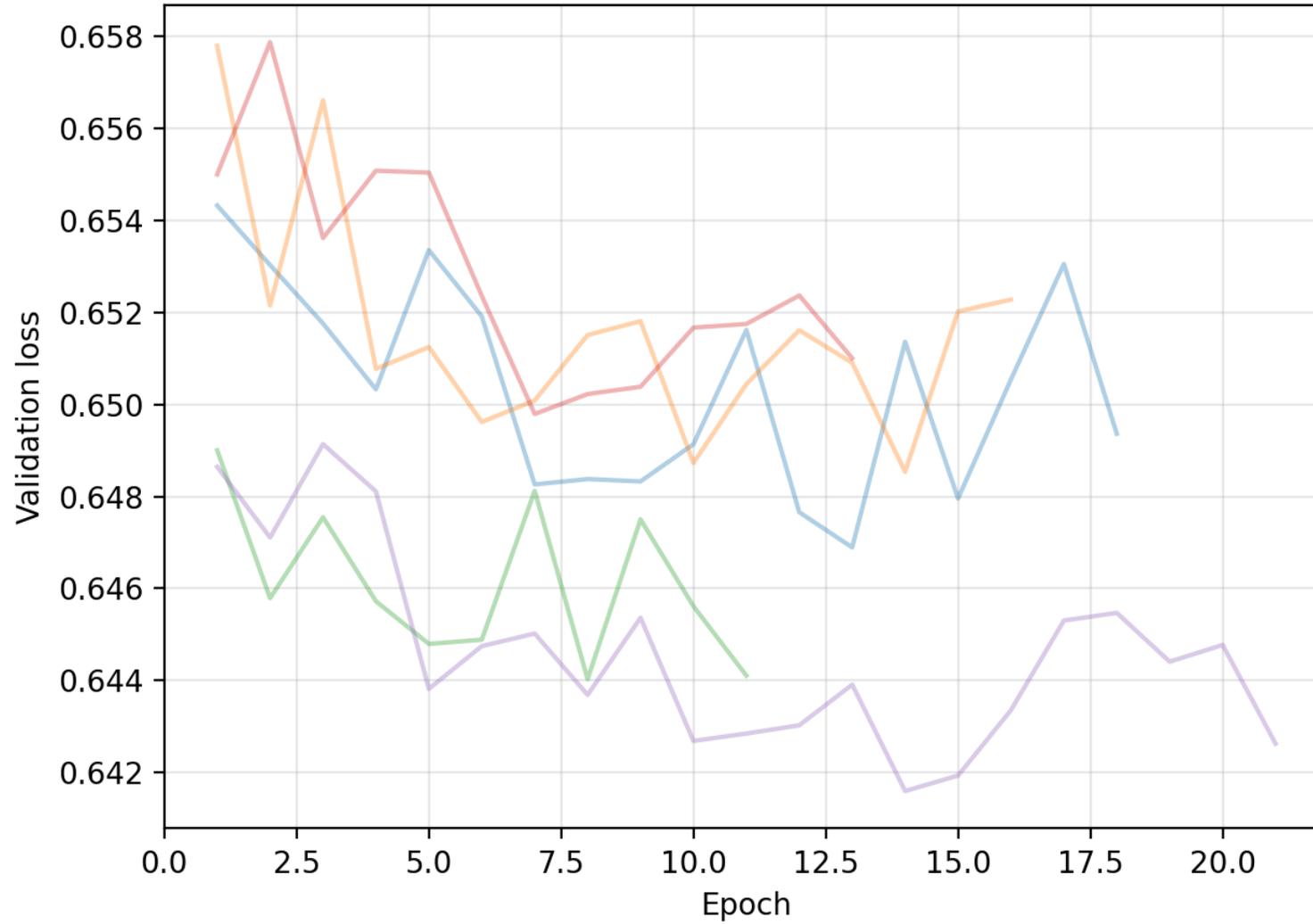
val_acc: all folds (spaghetti) — early stopping varies



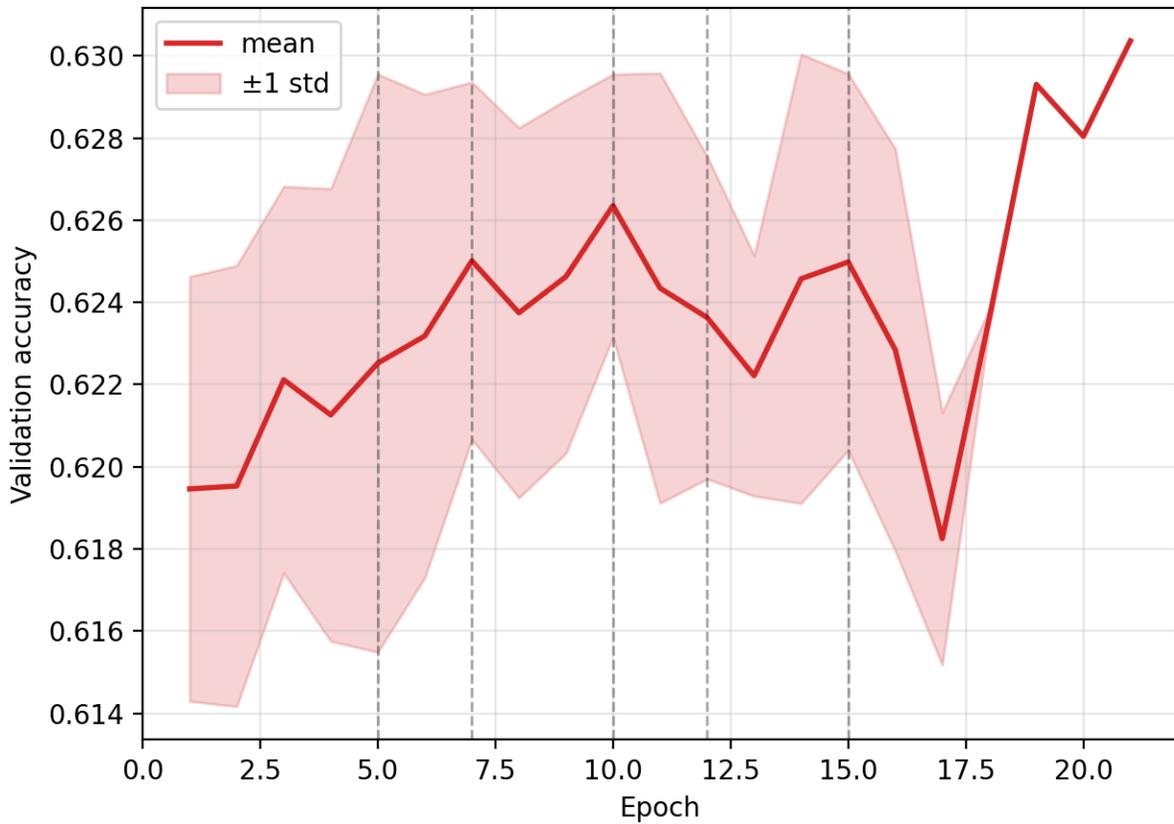
val_auc: all folds (spaghetti) — early stopping varies



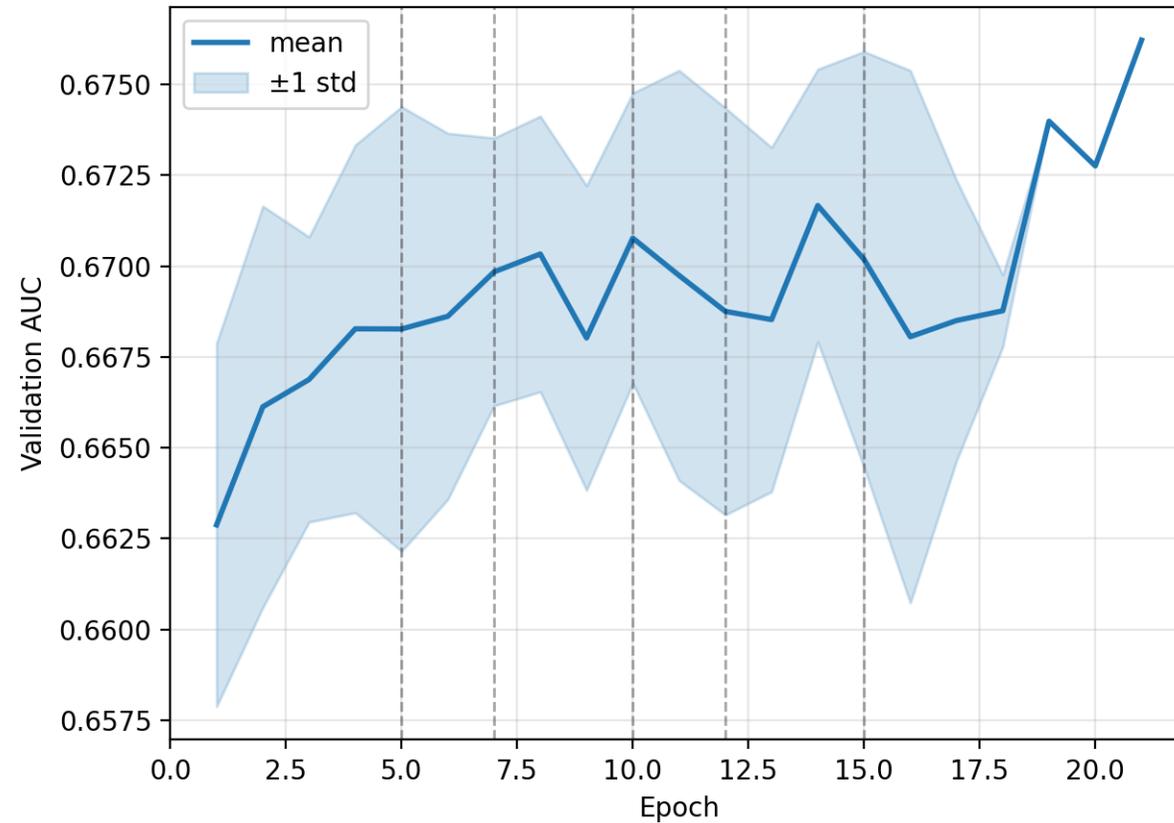
val_loss: all folds (spaghetti) — early stopping varies



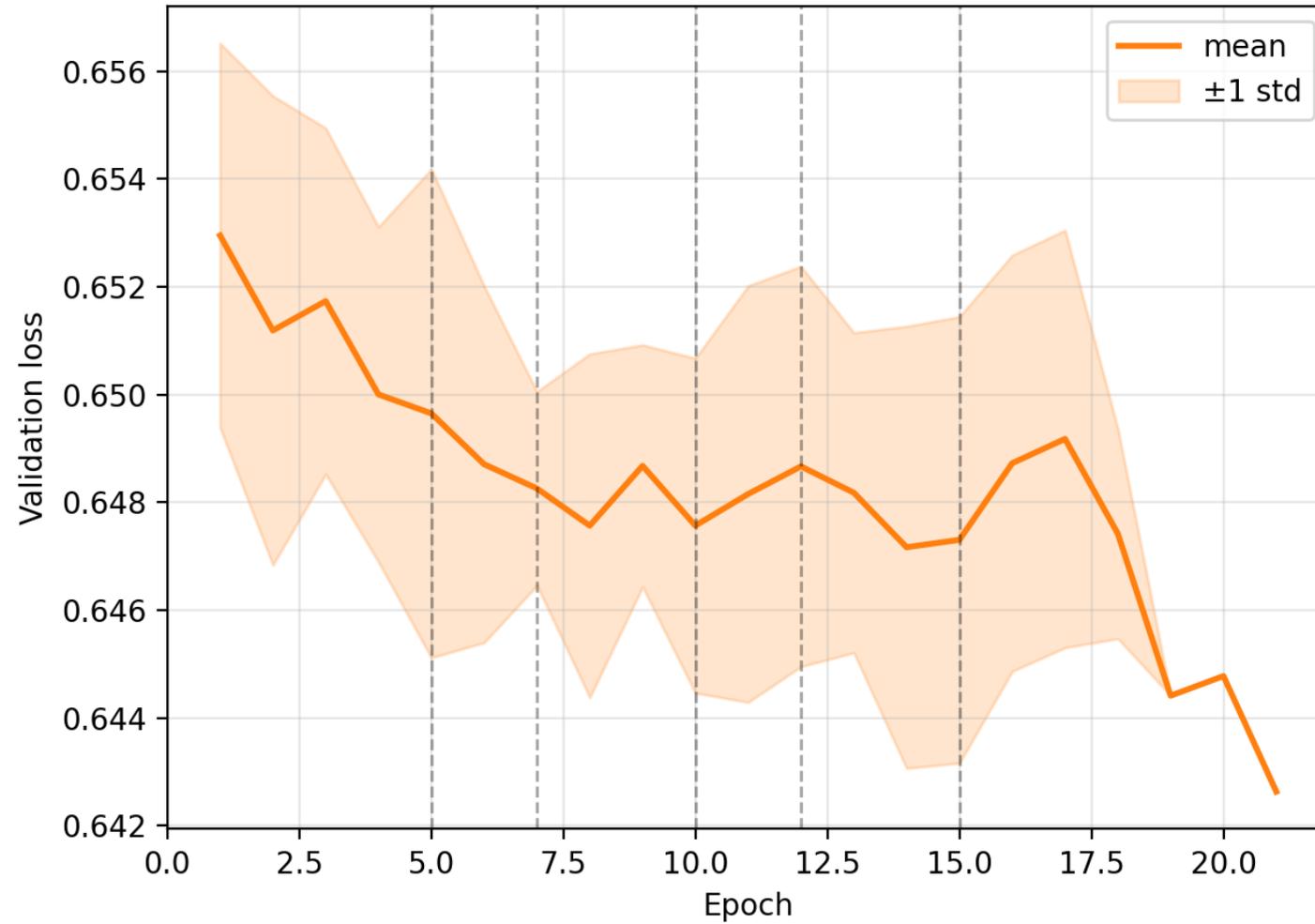
val_acc: mean±std across folds (vlines=best epochs; median=10)

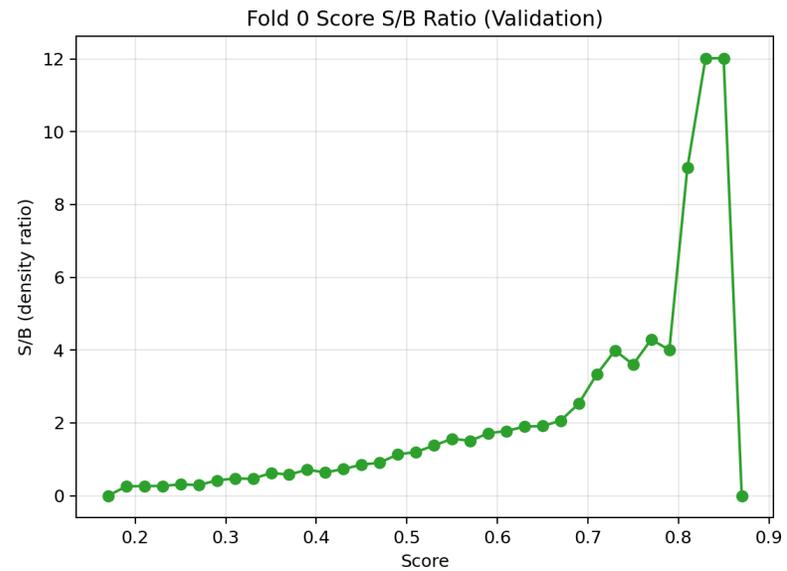
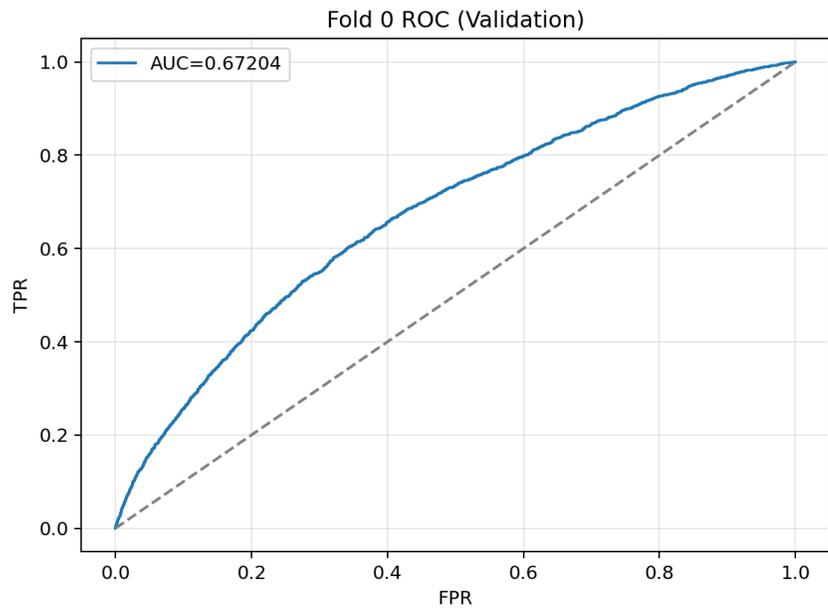
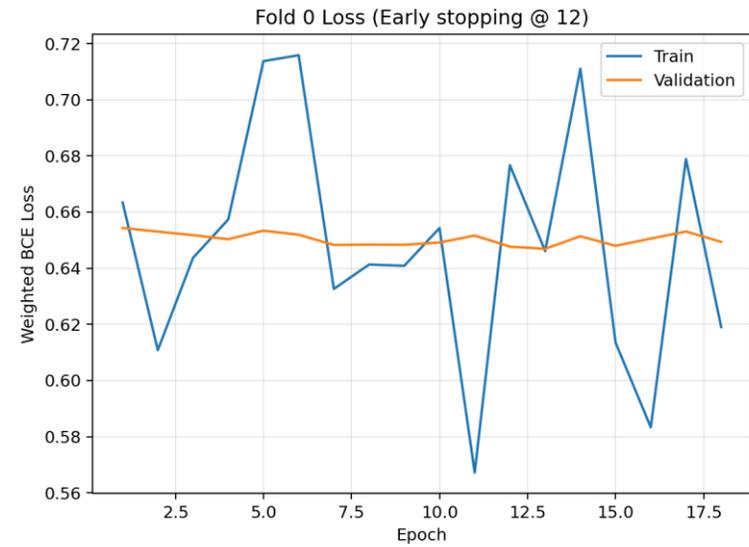
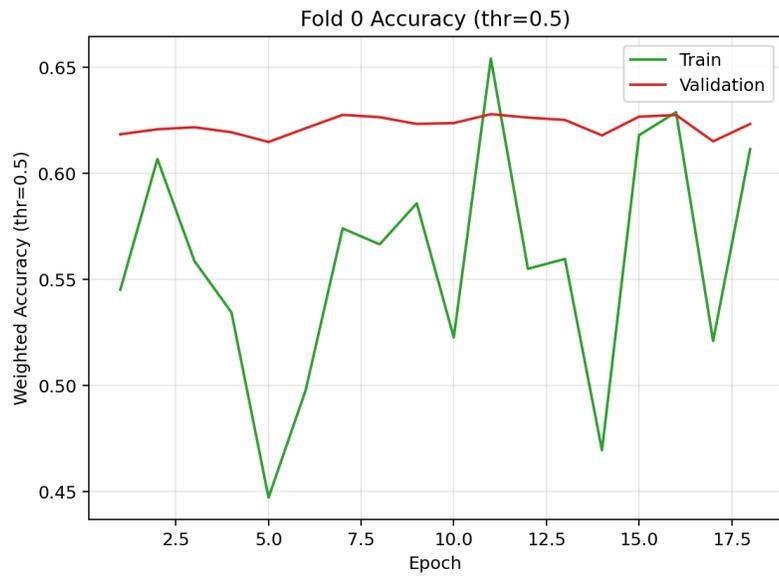


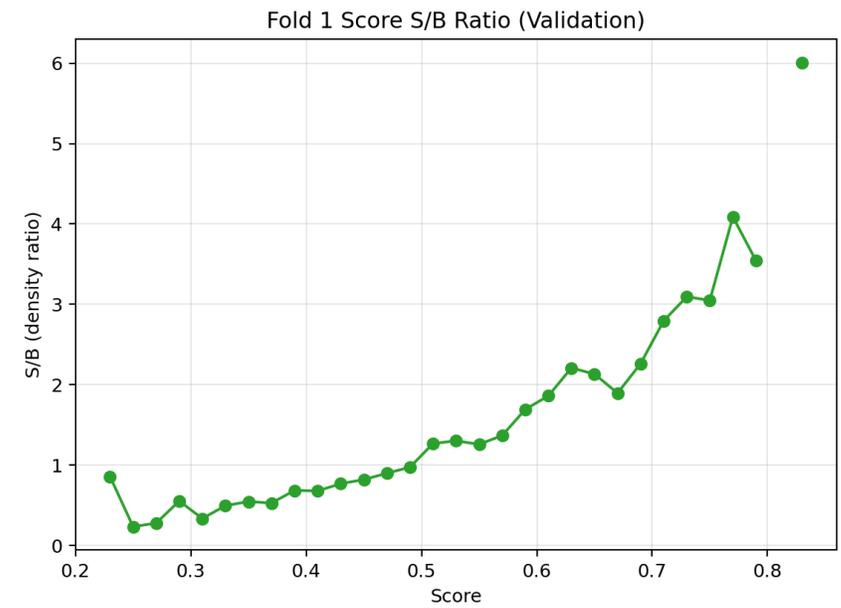
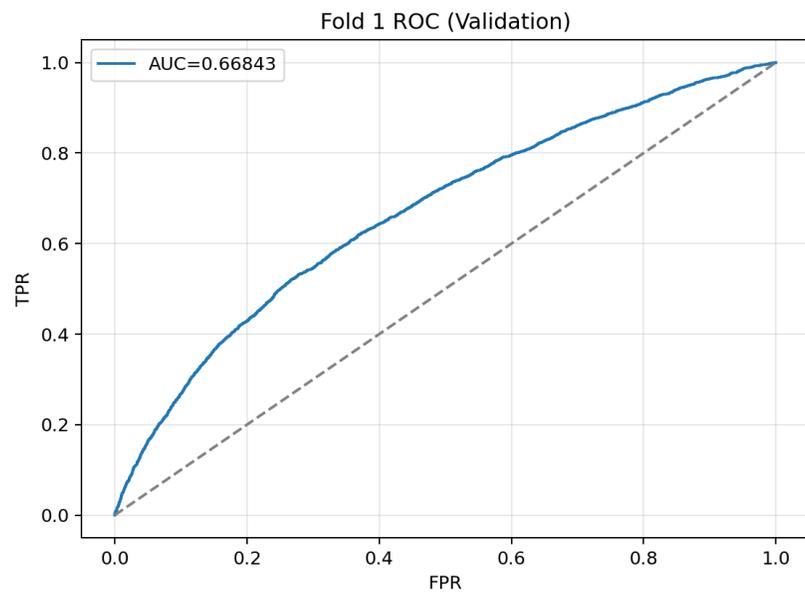
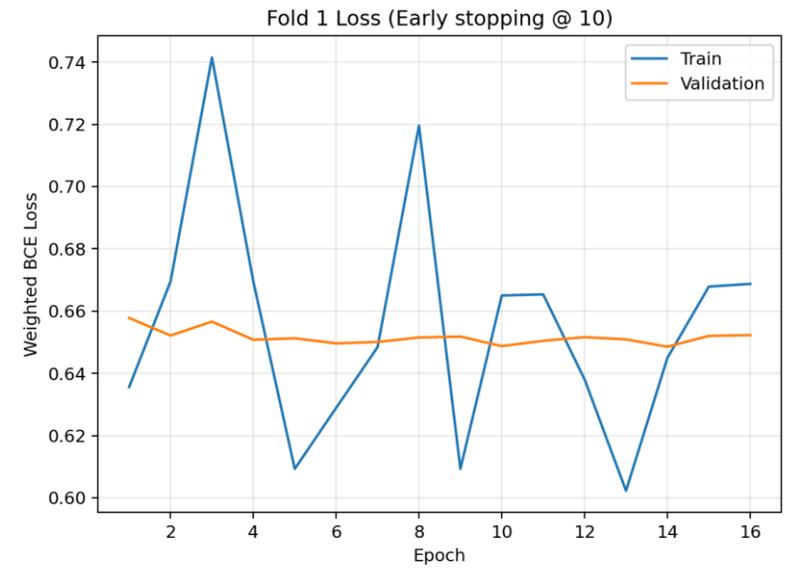
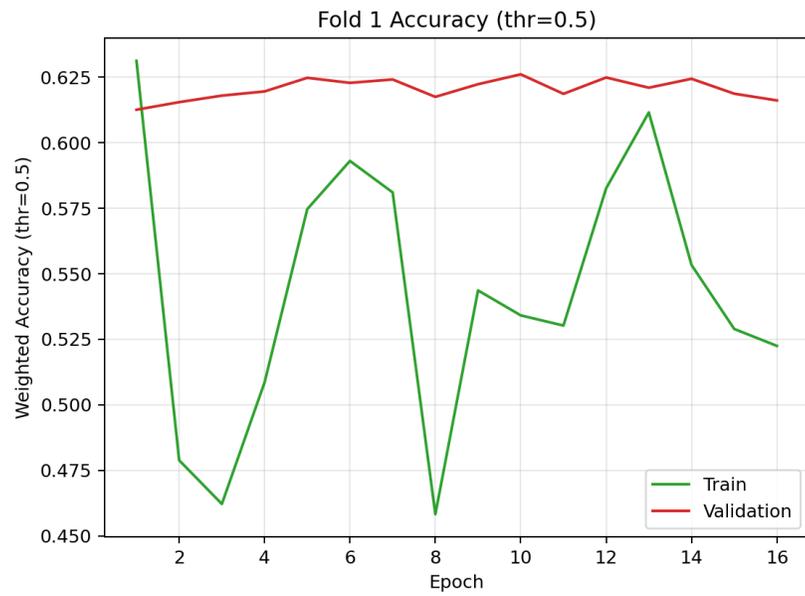
val_auc: mean±std across folds (vlines=best epochs; median=10)



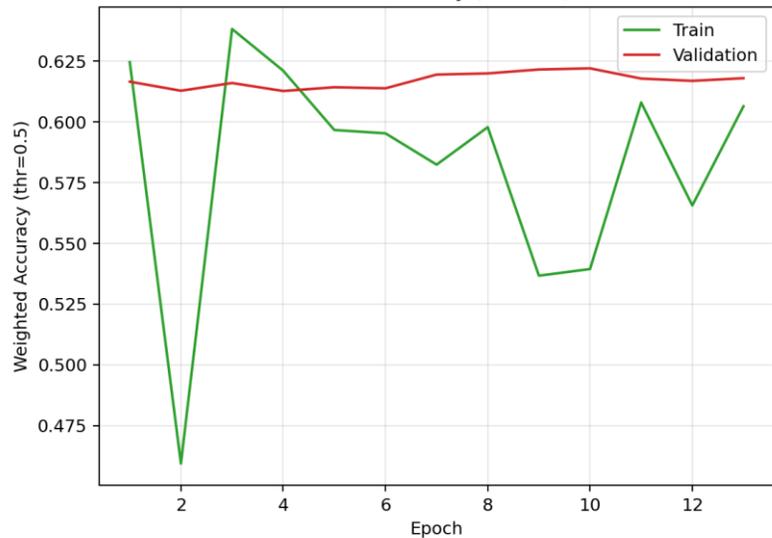
val_loss: mean \pm std across folds (vlines=best epochs; median=10)



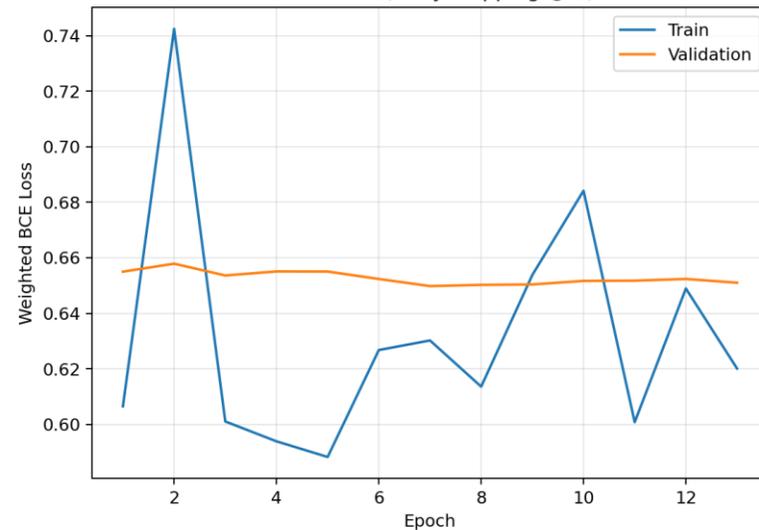




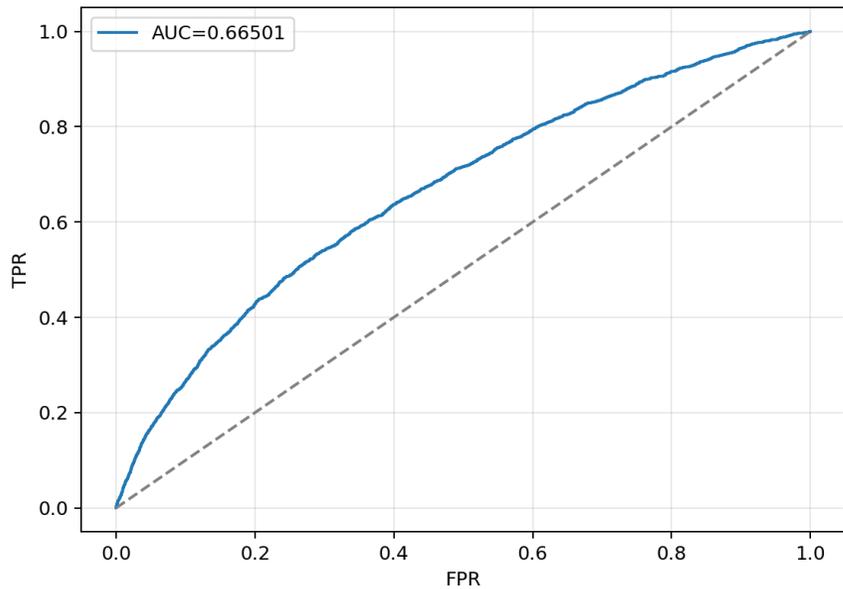
Fold 3 Accuracy (thr=0.5)



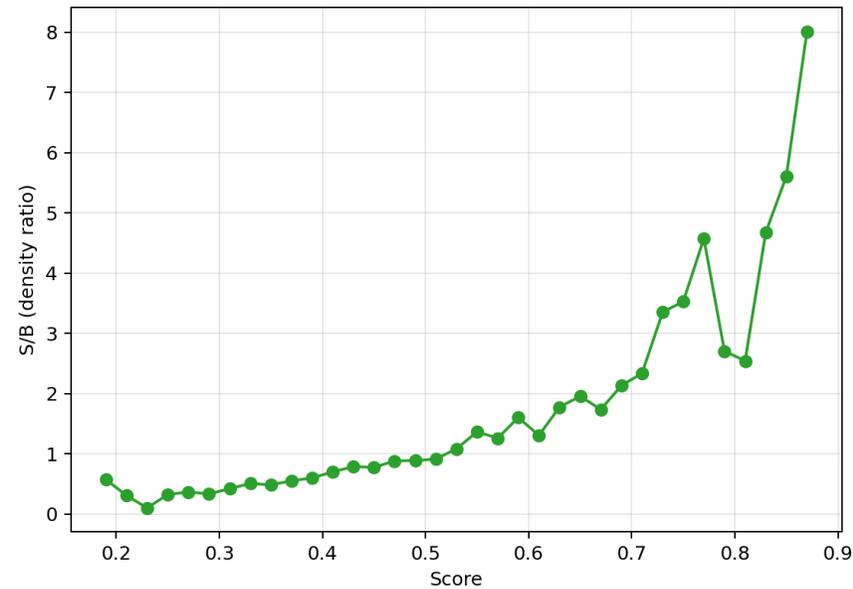
Fold 3 Loss (Early stopping @ 7)



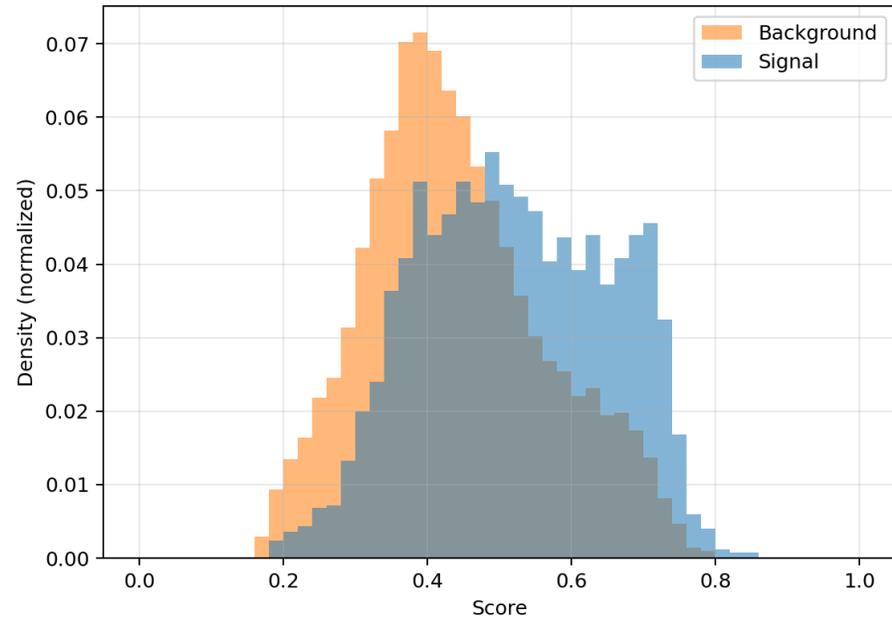
Fold 3 ROC (Validation)



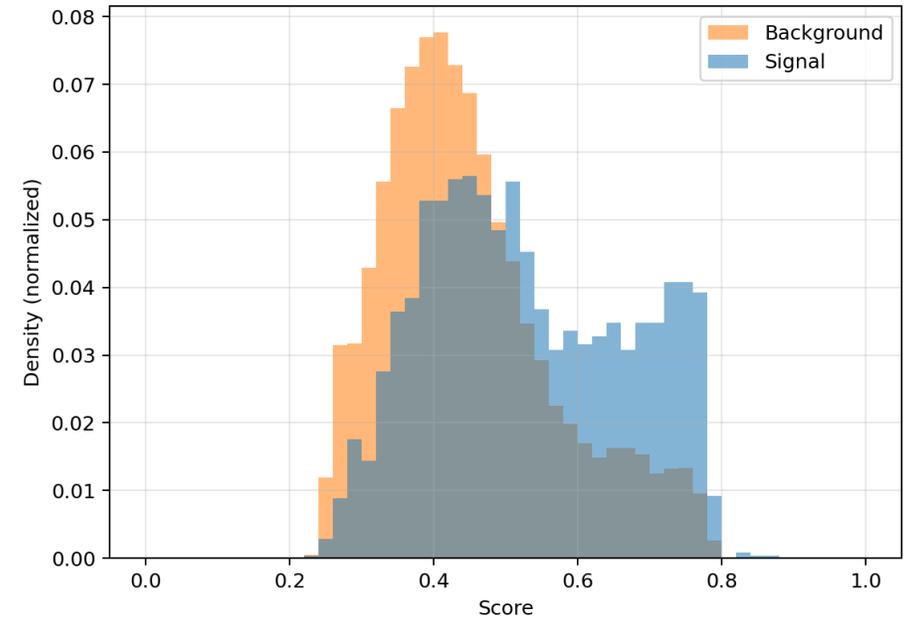
Fold 3 Score S/B Ratio (Validation)



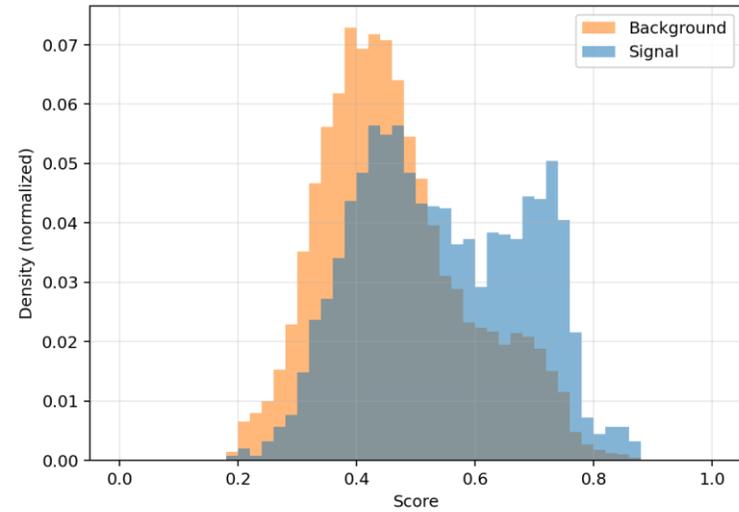
Fold 0 Score Distribution (Validation)



Fold 1 Score Distribution (Validation)

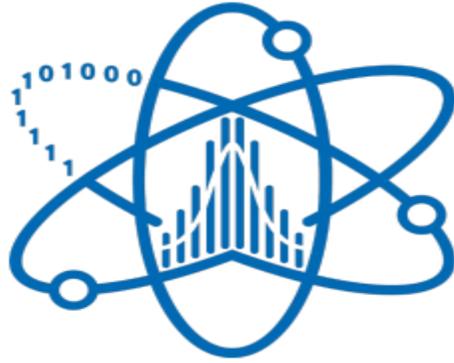


Fold 3 Score Distribution (Validation)





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государственного
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Thank you for your attention!!!