Ovarian Cancer Histotypes: Report of Statistical Findings

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Preface

This report of statistical findings describes the classification of ovarian cancer histotypes using data from NanoString CodeSets.

Marina Pavanello conducted the initial exploratory data analysis, Cathy Tang implemented class imbalance techniques, Derek Chiu conducted the normalization and statistical analysis, and Lauren Tindale and Aline Talhouk are the project leads.

1. Introduction

Ovarian cancer has five major histotypes: high-grade serous carcinoma (HGSC), low-grade serous carcinoma (LGSC), endometrioid carcinoma (ENOC), mucinous carcinoma (MUC), and clear cell carcinoma (CCOC). A common problem with classifying these histotypes is that there is a class imbalance issue. HGSC dominates the distribution, commonly accounting for 70% of cases in many patient cohorts, while the other four histotypes are spread over the rest of the cases. Subsampling methods like up-sampling, down-sampling, and SMOTE can be used to mitigate this problem.

The supervised learning is performed under a consensus framework: we consider various classification algorithms and use evaluation metrics like accuracy, F1-score, Kappa, and G-mean to inform the decision of which methods to carry forward for prediction in confirmation and validation sets.

2. Methods

We use 5 classification algorithms and 4 subsampling methods across 500 repetitions in the supervised learning framework for the Training Set, CS1 and CS2. The pipeline was run using SLURM batch jobs submitted to a partition on a CentOS 7 server. Implementations of the techniques below were called from the splendid package.

- Classifiers:
  - Random Forest
  - SVM
  - Adaboost
  - Multinomial Regression Model with Ridge Penalty
  - Multinomial Regression Model with LASSO Penalty
- Subsampling:
  - None
  - Down-sampling
  - Up-sampling
  - SMOTE

3. Distributions

3.1 Full Data

The histotype distributions on the full data are shown below.

3.2 Training Set

The training set distributions for CS1 and CS2 are shown below.

3.3 Common Samples

3.4 Histotypes in Classifier Data

Table 3.1: All CodeSet Histotype Groups

Histotype Group	CS1	CS2	CS3
HGSC	123	646	1644
non-HGSC	162	219	587

Table 3.2: All CodeSet Major Reviewed Histotypes

Reviewed Histotype	CS1	CS2	CS3	CS1 %	CS2 %	CS3 %
CCOC	48	60	172	18.0	7.3	8.0
ENOC	60	33	237	22.6	4.0	11.0
HGSC	123	646	1644	46.2	78.7	76.0
LGSC	19	21	40	7.1	2.6	1.9
MUC	16	61	69	6.0	7.4	3.2

Table 3.3: All CodeSet Reviewed Histotypes

Reviewed Histotype	CS1	CS2	CS3
CARCINOMA-NOS	0	1	23
CCOC	48	60	172
CTRL	0	12	0
ENOC	60	33	237
HGSC	123	646	1644
LGSC	19	21	40
MBOT	0	19	3
MIXED (ENOC/CCOC)	0	0	1
MIXED (ENOC/LGSC)	0	0	1
MIXED (HGSC/CCOC)	0	0	1
MMMT	0	0	29
MUC	16	61	69
Other/Exclude	0	0	8
SBOT	19	12	2
serous LMP	0	0	1

Table 3.4: CS1 Histotypes

CodeSet	Reviewed Histotype	n
CS1	CCOC	48
CS1	ENOC	60
CS1	HGSC	123
CS1	LGSC	19
CS1	MUC	16
CS1	SBOT	19

Table 3.5: CS2 Histotypes

CodeSet	Reviewed Histotype	n
CS2	CARCINOMA-NOS	1
CS2	CCOC	60
CS2	CTRL	12
CS2	ENOC	33
CS2	HGSC	646
CS2	LGSC	21
CS2	MBOT	19
CS2	MUC	61
CS2	SBOT	12

Table 3.6: CS3 Histotypes

CodeSet	Reviewed Histotype	n
CS3	CARCINOMA-NOS	23
CS3	CCOC	172
CS3	ENOC	237
CS3	HGSC	1644
CS3	LGSC	40
CS3	MBOT	3
CS3	MIXED (ENOC/CCOC)	1
CS3	MIXED (ENOC/LGSC)	1
CS3	MIXED (HGSC/CCOC)	1
CS3	MMMT	29
CS3	MUC	69
CS3	Other/Exclude	8
CS3	SBOT	2
CS3	serous LMP	1

Table 3.7: Common Summary ID CodeSet Histotypes

Reviewed Histotype	CS1	CS2	CS3
CCOC	3	4	9
ENOC	4	4	9
HGSC	57	62	94
LGSC	7	5	8
MUC	7	5	11

Table 3.8: CS1 Training Set Histotypes

Histotype	n	%
CCC	57	18.8%
ENOCa	59	19.4%
HGSC	156	51.3%
LGSC	16	5.3%
MUC	16	5.3%

Table 3.9: CS2 Training Set Histotypes

Histotype	n	%
CCOC	68	7.2%
ENOC	30	3.2%
HGSC	757	80.1%
LGSC	29	3.1%
MUC	61	6.5%

Table 3.10: All Common Samples Histotype Distribution

revHist	CS1	CS2	CS3
CCOC	3	4	3
ENOC	4	4	3
HGSC	55	58	70
LGSC	7	5	4
MUC	7	5	5

Table 3.11: Distinct Common Samples Histotype Distribution

revHist	CS1	CS2	CS3
CCOC	3	3	3
ENOC	3	3	3
HGSC	53	53	53
LGSC	4	4	4
MUC	5	5	5

Table 3.12: Distinct Common CS2 and CS3 Samples Histotype Distribution

revHist	CS2	CS3
CCOC	3	3
ENOC	3	3
HGSC	71	71
LGSC	4	4
MUC	5	5

Table 3.13: Common Samples Across Sites Histotype Distribution

revHist	AOC	USC	Vancouver
CCOC	3	3	3
ENOC	3	3	3
HGSC	13	13	26
LGSC	2	2	2
MUC	3	3	3

Table 3.14: Distinct Common Samples Across Sites Histotype Distribution

revHist	AOC	USC	Vancouver
CCOC	3	3	3
ENOC	3	3	3
HGSC	13	13	13
LGSC	2	2	2
MUC	3	3	3

Table 3.15: CS3/CS4/CS5 Common Samples Histotype Distribution

revHist	CS3	CS4	CS5
HGSC	46	46	46
NA	26	26	26

Table 3.16: CS3/CS4/CS5 Pools Distribution

Pool	CS3	CS4	CS5
Pool1	12	5	4
Pool2	5	5	4
Pool3	5	5	4
Pool4	NA	2	1
Pool5	NA	2	1
Pool6	NA	2	0
Pool7	NA	2	1
Pool8	NA	2	1
Pool9	NA	2	1
Pool10	NA	2	1
Pool11	NA	2	1

Table 3.17: Full Training Set Histotype Distribution by CodeSet

Variable	Levels	CS1	CS2	CS3	Total
Histotype	HGSC	119 (49%)	625 (80%)	474 (94%)	1218 (80%)
	CCOC	44 (18%)	53 (7%)	8 (2%)	105 (7%)
	ENOC	55 (23%)	28 (4%)	8 (2%)	91 (6%)
	MUC	12 (5%)	58 (7%)	9 (2%)	79 (5%)
	LGSC	13 (5%)	19 (2%)	6 (1%)	38 (2%)
Total	N (%)	243 (16%)	783 (51%)	505 (33%)	1531 (100%)

Table 3.18: Histotype Distribution by CodeSet/Datasets

Variable	Levels	CS1 All	CS2 All	Confirmation	Validation
Histotype	HGSC	122 (47%)	645 (79%)	422 (66%)	675 (74%)
	CCOC	47 (18%)	59 (7%)	74 (12%)	79 (9%)
	ENOC	58 (22%)	31 (4%)	106 (17%)	113 (12%)
	MUC	15 (6%)	60 (7%)	27 (4%)	26 (3%)
	LGSC	17 (7%)	20 (2%)	13 (2%)	18 (2%)
Total	N (%)	259 (10%)	815 (31%)	642 (24%)	911 (35%)

4. Results

We show internal validation summaries for the combined classifier training set, as well as the CS1 and CS2 sets with duplicates included. The F1-scores, kappa, and G-mean are the measures of interest. Algorithms are sorted by descending value based on the overallaccuracy of the training set. The point ranges show the median, 5th and 95th percentiles, coloured by subsampling methods.

4.1 Training Set

4.1.1 Accuracy

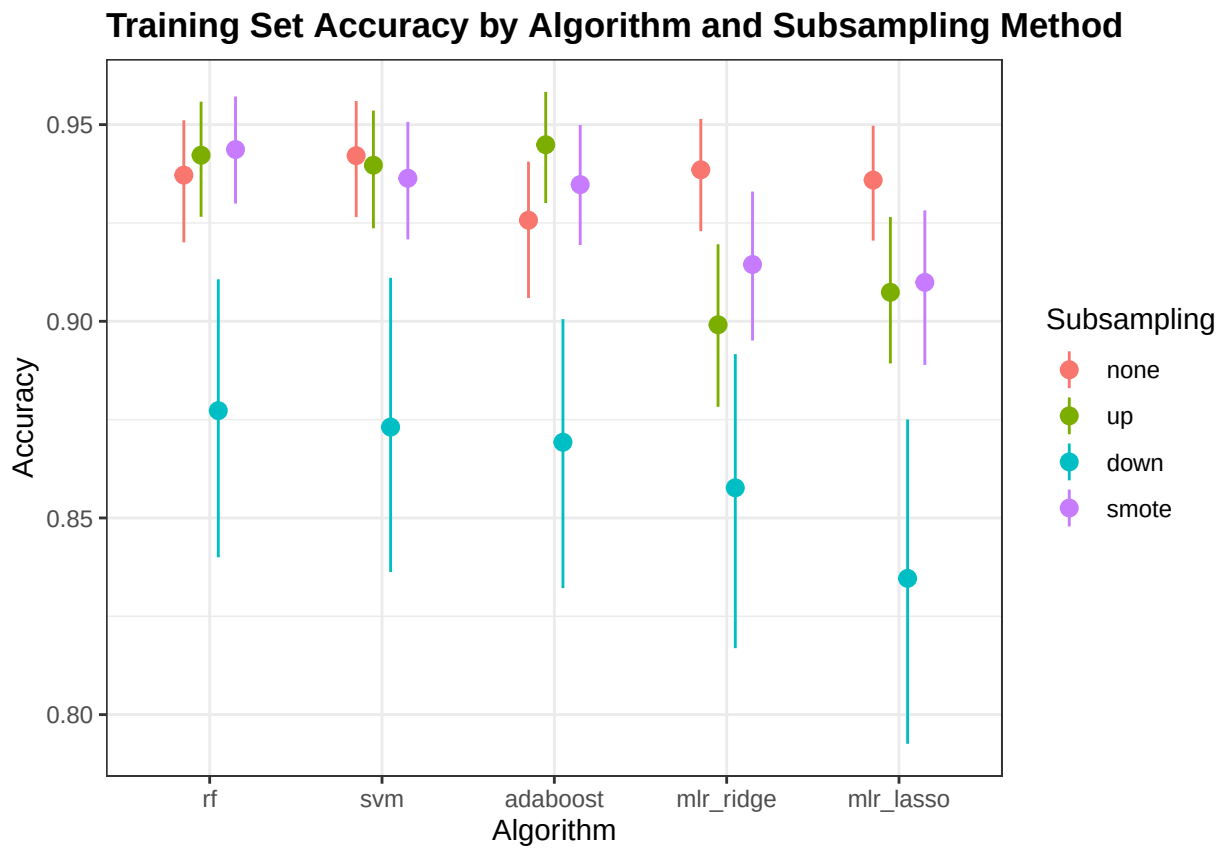

Figure 4.1: Training Set Accuracy

Table 4.1: Training Set Accuracy by Algorithm and Subsampling Method

sampling	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	0.937	0.942	0.926	0.939	0.936
up	0.942	0.94	**0.945**	0.899	0.907
down	0.877	0.873	0.869	0.858	0.835
smote	0.944	0.936	0.935	0.914	0.91

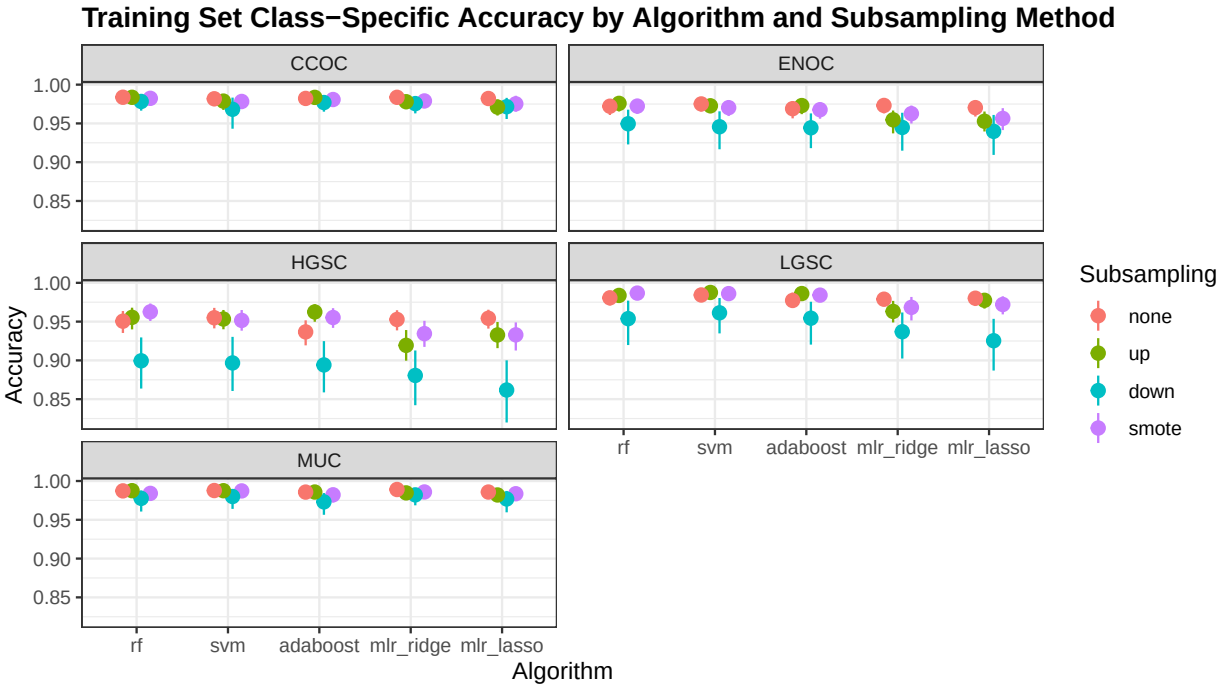

Figure 4.2: Training Set Class-Specific Accuracy

Table 4.2: Training Set Class-Specific Accuracy by Algorithm and Subsampling Method

sampling	histotype	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	CCOC	0.984	0.982	0.982	0.984	0.982
none	ENOC	0.972	0.975	0.969	0.973	0.97
none	HGSC	0.951	0.955	0.937	0.953	0.954
none	LGSC	0.981	0.984	0.977	0.979	0.98
none	MUC	0.987	0.988	0.986	**0.989**	0.986
up	CCOC	0.984	0.979	0.984	0.978	0.971
up	ENOC	0.976	0.973	0.973	0.955	0.953
up	HGSC	0.956	0.953	0.962	0.919	0.933
up	LGSC	0.984	0.988	0.986	0.963	0.977
up	MUC	0.988	0.988	0.986	0.985	0.982
down	CCOC	0.978	0.968	0.977	0.976	0.972
down	ENOC	0.95	0.946	0.944	0.945	0.94
down	HGSC	0.899	0.897	0.894	0.881	0.862
down	LGSC	0.954	0.961	0.954	0.937	0.925
down	MUC	0.978	0.98	0.973	0.982	0.977
smote	CCOC	0.982	0.978	0.981	0.979	0.975
smote	ENOC	0.972	0.97	0.968	0.963	0.956
smote	HGSC	0.963	0.952	0.955	0.934	0.933
smote	LGSC	0.987	0.986	0.984	0.968	0.972
smote	MUC	0.984	0.987	0.982	0.986	0.984

Table 4.3: Training Set Macro-Averaged F1-Score by Algorithm and Subsampling Method

sampling	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	0.763	0.827	0.725	0.772	0.783
up	0.804	0.827	0.829	0.772	0.765
down	0.736	0.731	0.722	0.723	0.69
smote	**0.835**	0.824	0.817	0.788	0.775

4.1.2 F1-Score

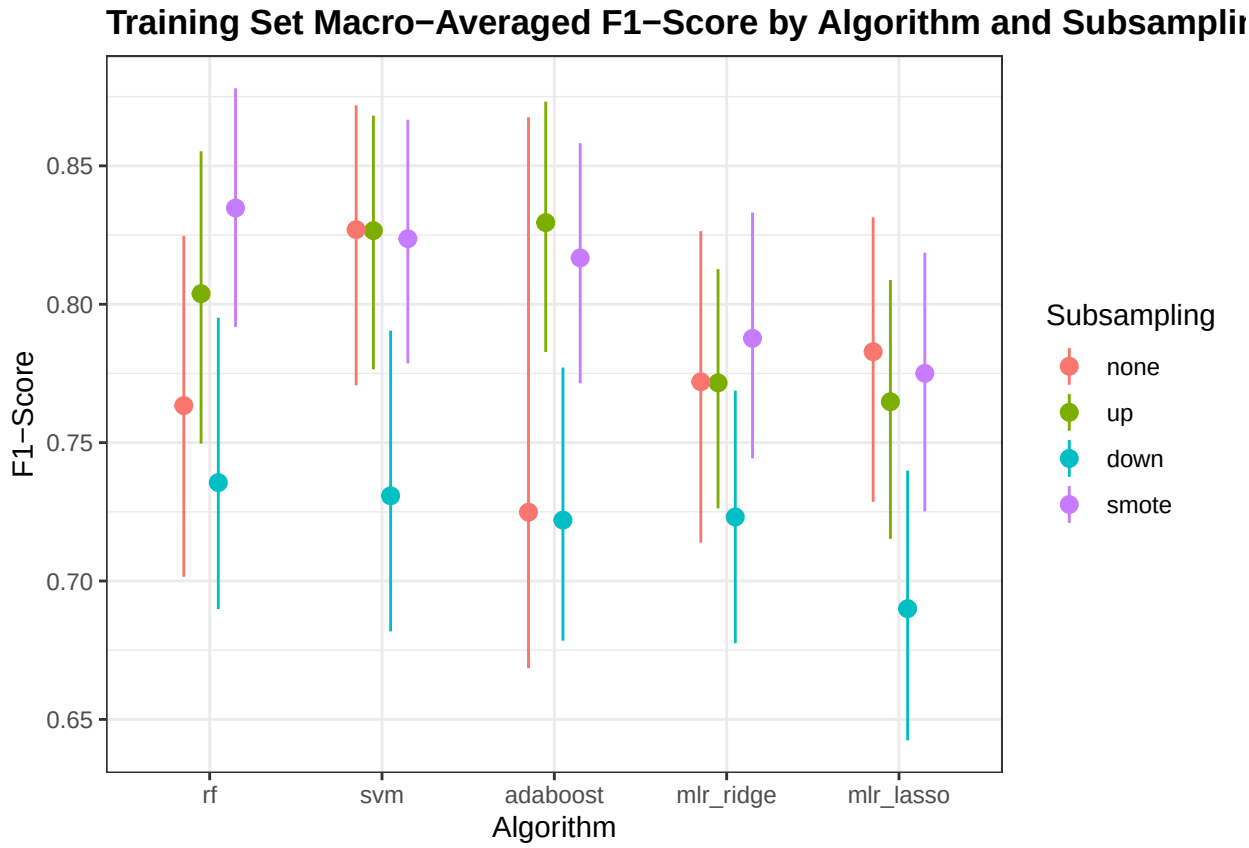

Figure 4.3: Training Set F1-Score

Table 4.4: Training Set Class-Specific F1-Score by Algorithm and Subsampling Method

sampling	histotype	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	CCOC	0.873	0.857	0.857	0.871	0.862
none	ENOC	0.733	0.776	0.679	0.758	0.737
none	HGSC	0.97	0.972	0.962	0.971	0.972
none	LGSC	0.375	0.667	0.182	0.381	0.5
none	MUC	0.868	0.875	0.852	0.887	0.857
up	CCOC	0.868	0.831	0.87	0.842	0.795
up	ENOC	0.772	0.75	0.769	0.675	0.636
up	HGSC	0.973	0.971	**0.977**	0.947	0.957
up	LGSC	0.538	0.72	0.667	0.542	0.621
up	MUC	0.877	0.867	0.862	0.853	0.825
down	CCOC	0.842	0.782	0.833	0.826	0.804
down	ENOC	0.657	0.632	0.619	0.629	0.602
down	HGSC	0.934	0.931	0.93	0.92	0.906
down	LGSC	0.476	0.522	0.473	0.407	0.364
down	MUC	0.8	0.808	0.768	0.828	0.791
smote	CCOC	0.87	0.831	0.857	0.847	0.827
smote	ENOC	0.767	0.754	0.735	0.714	0.667
smote	HGSC	0.976	0.97	0.972	0.958	0.957
smote	LGSC	0.727	0.714	0.703	0.571	0.588
smote	MUC	0.848	0.868	0.833	0.863	0.841

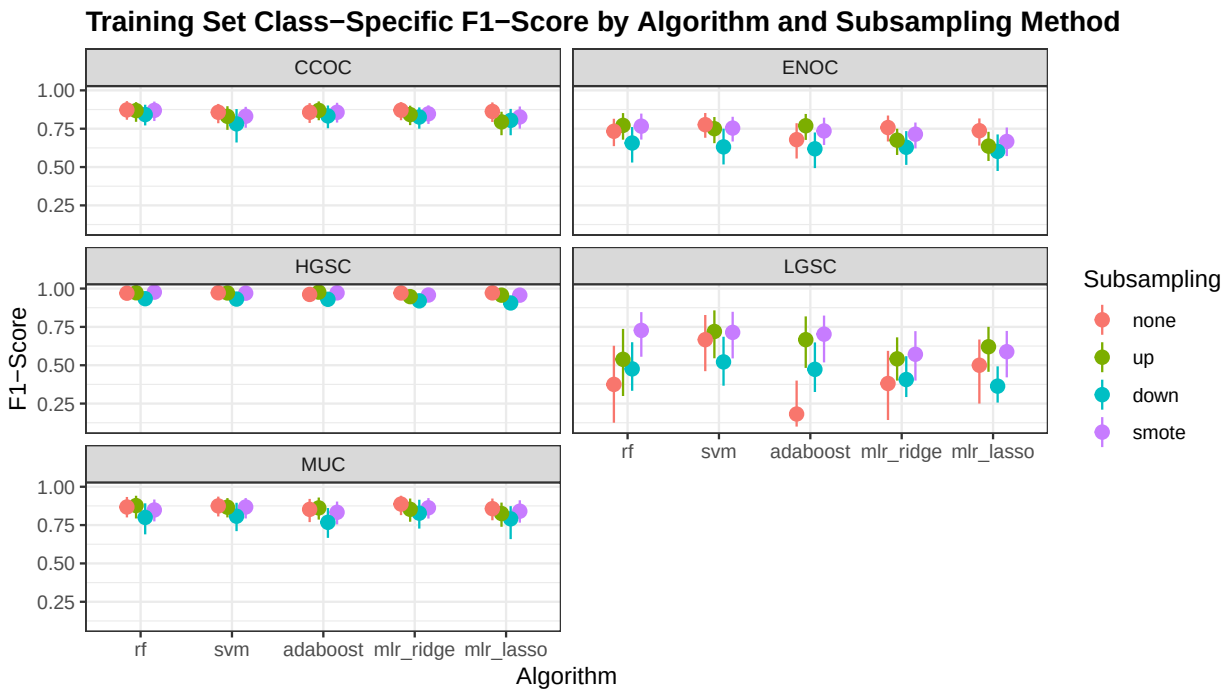

Figure 4.4: Training Set Class-Specific F1-Score

Table 4.5: Training Set Kappa by Algorithm and Subsampling Method

sampling	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	0.805	0.828	0.758	0.813	0.811
up	0.823	0.817	**0.84**	0.75	0.754
down	0.705	0.694	0.689	0.671	0.632
smote	**0.84**	0.816	0.819	0.778	0.765

4.1.3 Kappa

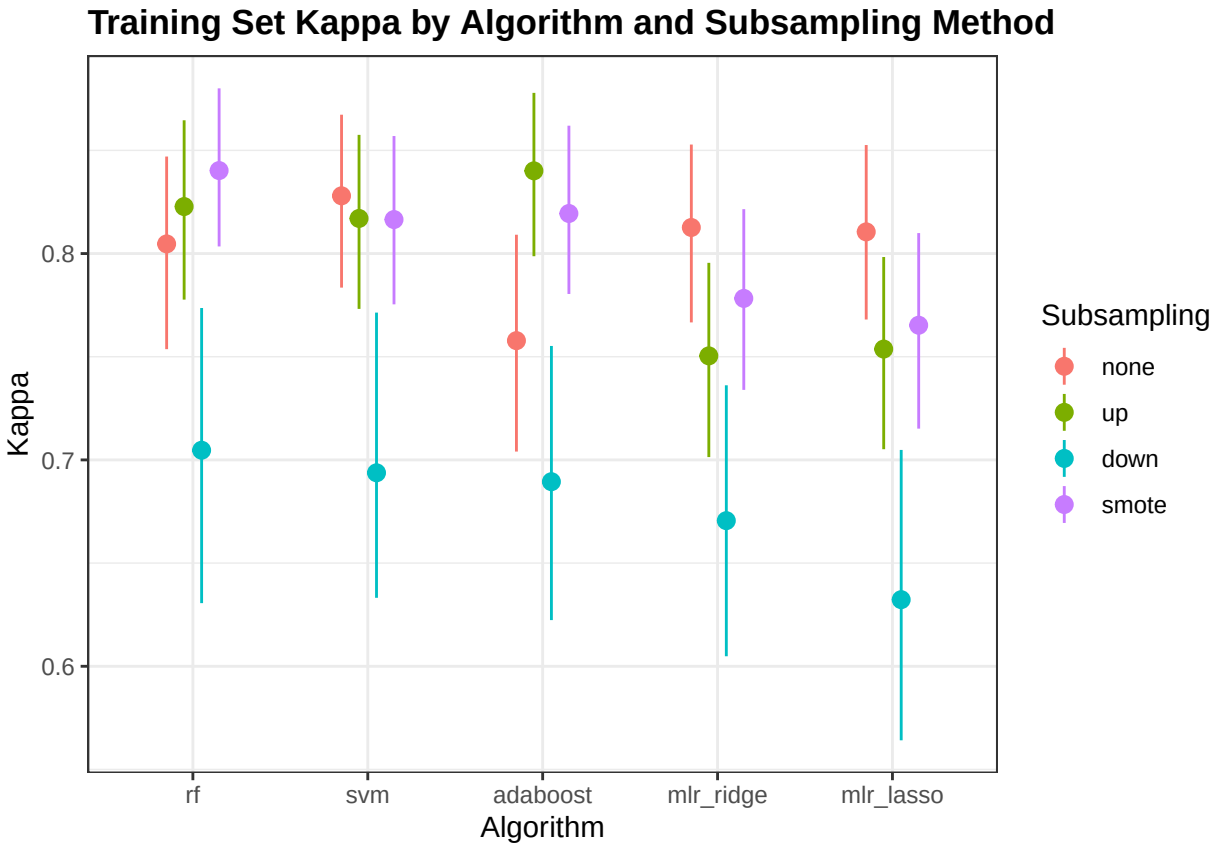

Figure 4.5: Training Set Kappa

Table 4.6: Training Set Class-Specific Kappa by Algorithm and Subsampling Method

sampling	histotype	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	CCOC	0.864	0.847	0.848	0.861	0.853
none	ENOC	0.719	0.763	0.663	0.743	0.721
none	HGSC	0.834	0.855	0.781	0.845	0.854
none	LGSC	0.37	0.658	0.13	0.371	0.49
none	MUC	0.861	0.87	0.845	0.88	0.852
up	CCOC	0.86	0.82	0.861	0.83	0.779
up	ENOC	0.759	0.737	0.754	0.651	0.613
up	HGSC	0.851	0.847	0.882	0.778	0.803
up	LGSC	0.529	0.714	0.662	0.525	0.611
up	MUC	0.871	0.859	0.855	0.845	0.815
down	CCOC	0.831	0.764	0.822	0.813	0.787
down	ENOC	0.629	0.604	0.589	0.599	0.57
down	HGSC	0.732	0.721	0.718	0.689	0.654
down	LGSC	0.459	0.506	0.451	0.384	0.34
down	MUC	0.786	0.798	0.753	0.817	0.78
smote	CCOC	0.861	0.82	0.848	0.835	0.814
smote	ENOC	0.751	0.74	0.718	0.695	0.647
smote	HGSC	**0.885**	0.848	0.864	0.812	0.806
smote	LGSC	0.72	0.707	0.693	0.555	0.572
smote	MUC	0.839	0.861	0.825	0.856	0.833

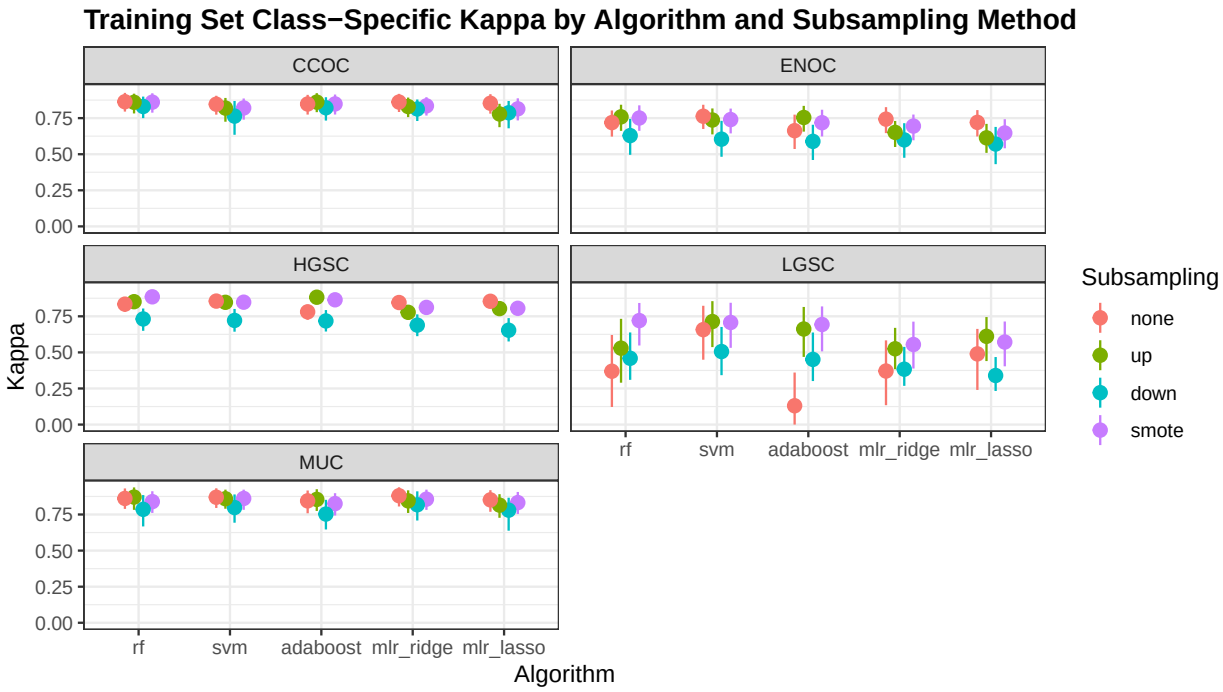

Figure 4.6: Training Set Class-Specific Kappa

Table 4.7: Training Set G-mean by Algorithm and Subsampling Method

sampling	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	0.639	0.79	0.482	0.672	0.725
up	0.719	0.776	0.805	**0.875**	0.806
down	0.859	0.85	0.848	0.863	0.84
smote	0.837	0.808	0.839	0.866	0.843

4.1.4 G-mean

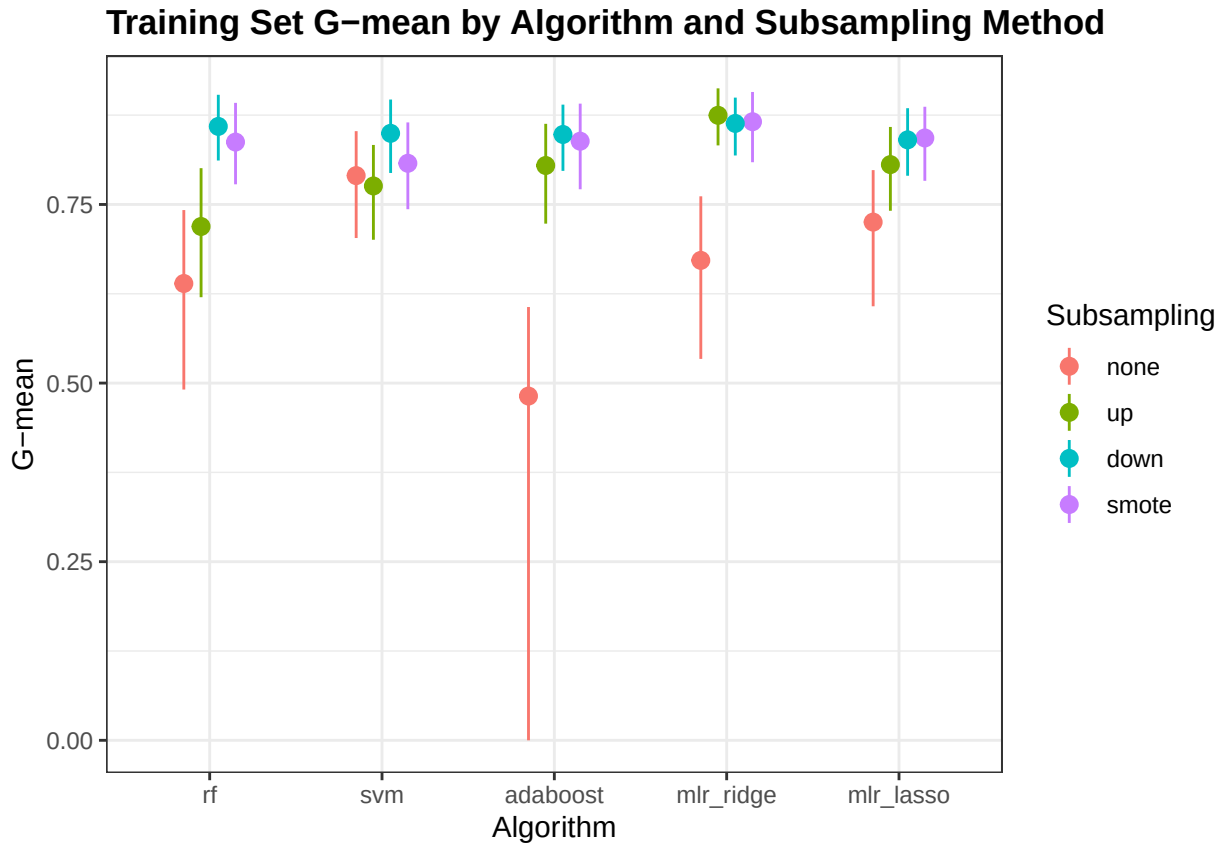

Figure 4.7: Training Set G-mean

Table 4.8: Training Set Class-Specific G-mean by Algorithm and Subsampling Method

sampling	histotype	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	CCOC	0.903	0.899	0.887	0.908	0.913
none	ENOC	0.806	0.853	0.75	0.841	0.83
none	HGSC	0.879	0.91	0.836	0.895	0.909
none	LGSC	0.499	0.796	0.267	0.521	0.645
none	MUC	0.922	0.914	0.906	0.932	0.922
up	CCOC	0.898	0.871	0.909	0.925	0.893
up	ENOC	0.837	0.831	0.87	0.879	0.825
up	HGSC	0.892	0.895	0.932	0.934	0.922
up	LGSC	0.632	0.815	0.792	**0.944**	0.874
up	MUC	0.924	0.901	0.935	0.943	0.91
down	CCOC	0.923	0.912	0.917	0.917	0.914
down	ENOC	0.883	0.877	0.862	0.88	0.857
down	HGSC	0.921	0.916	0.918	0.91	0.898
down	LGSC	0.921	0.932	0.918	0.937	0.919
down	MUC	0.927	0.914	0.928	0.934	0.919
smote	CCOC	0.924	0.888	0.919	0.924	0.919
smote	ENOC	0.878	0.865	0.866	0.879	0.853
smote	HGSC	**0.944**	0.915	0.942	0.938	0.933
smote	LGSC	0.85	0.85	0.875	0.932	0.905
smote	MUC	0.93	0.909	0.931	0.935	0.926

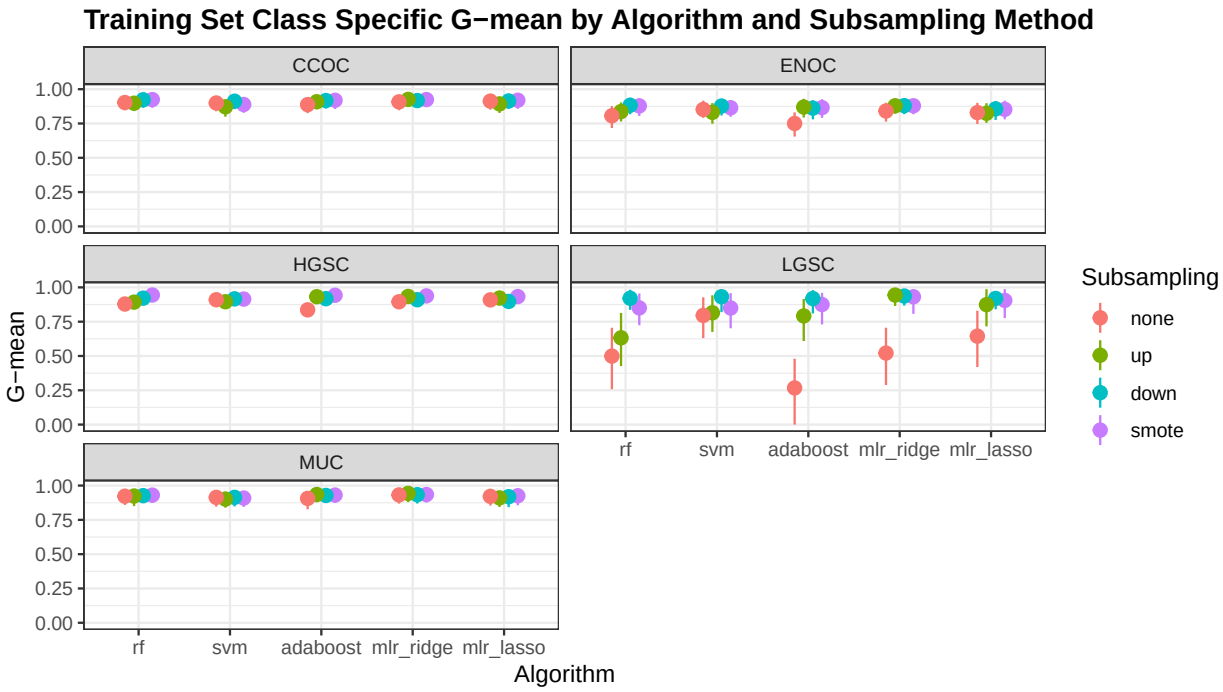

Figure 4.8: Training Set Class-Specific G-mean

4.2 Two-Step Training Set

4.2.1 Accuracy

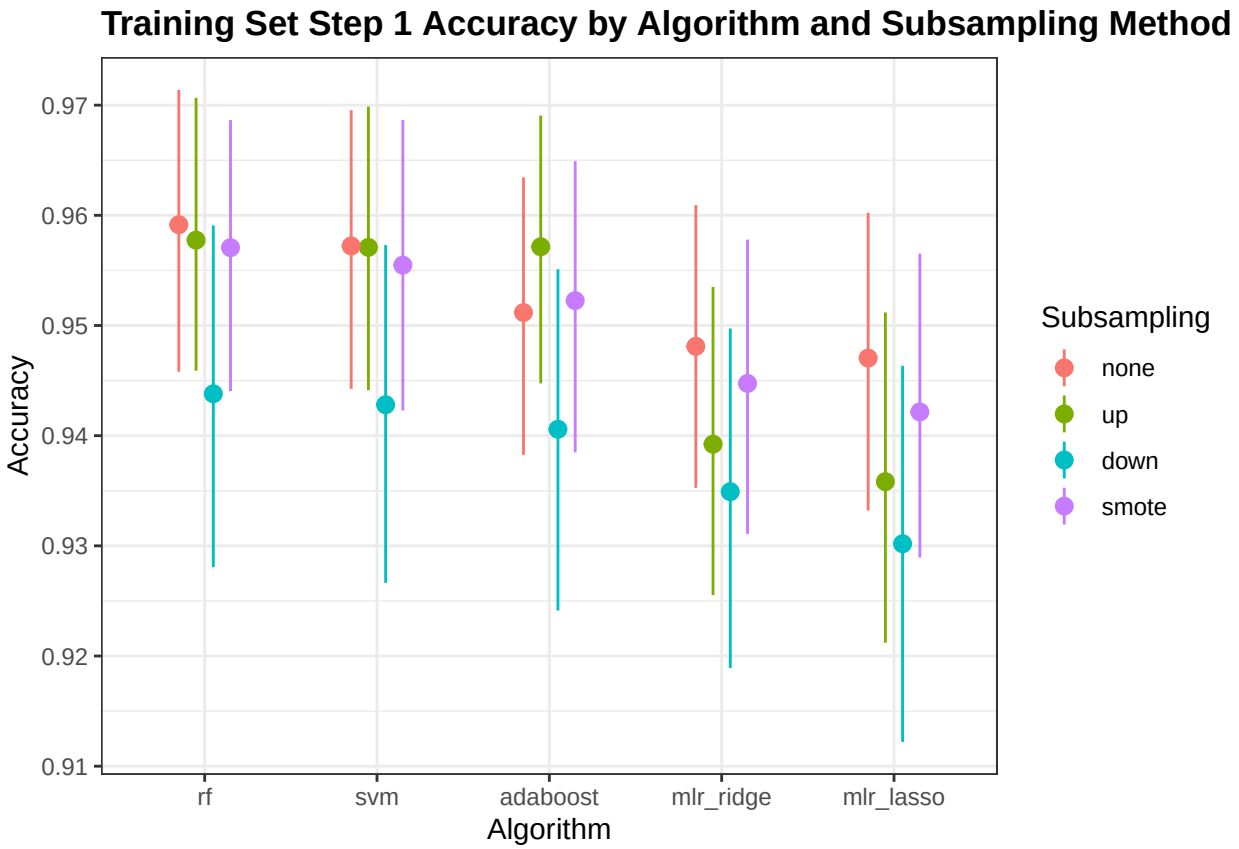

Figure 4.9: Training Set Step 1 Accuracy

Table 4.9: Training Set Step 1 Accuracy by Algorithm and Subsampling Method

sampling	rf	svm	adaboost	mlr_ridge	mlr_lasso
none	**0.959**	0.957	0.951	0.948	0.947
up	0.958	0.957	0.957	0.939	0.936
down	0.944	0.943	0.941	0.935	0.93
smote	0.957	0.955	0.952	0.945	0.942

Table 4.10: Training Set Step 2 Accuracy by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.889	0.881	0.882	0.884	0.872
up	**0.89**	0.879	0.878	0.881	0.868
down	0.87	0.869	0.867	0.857	0.855
smote	0.883	0.88	0.877	0.875	0.87

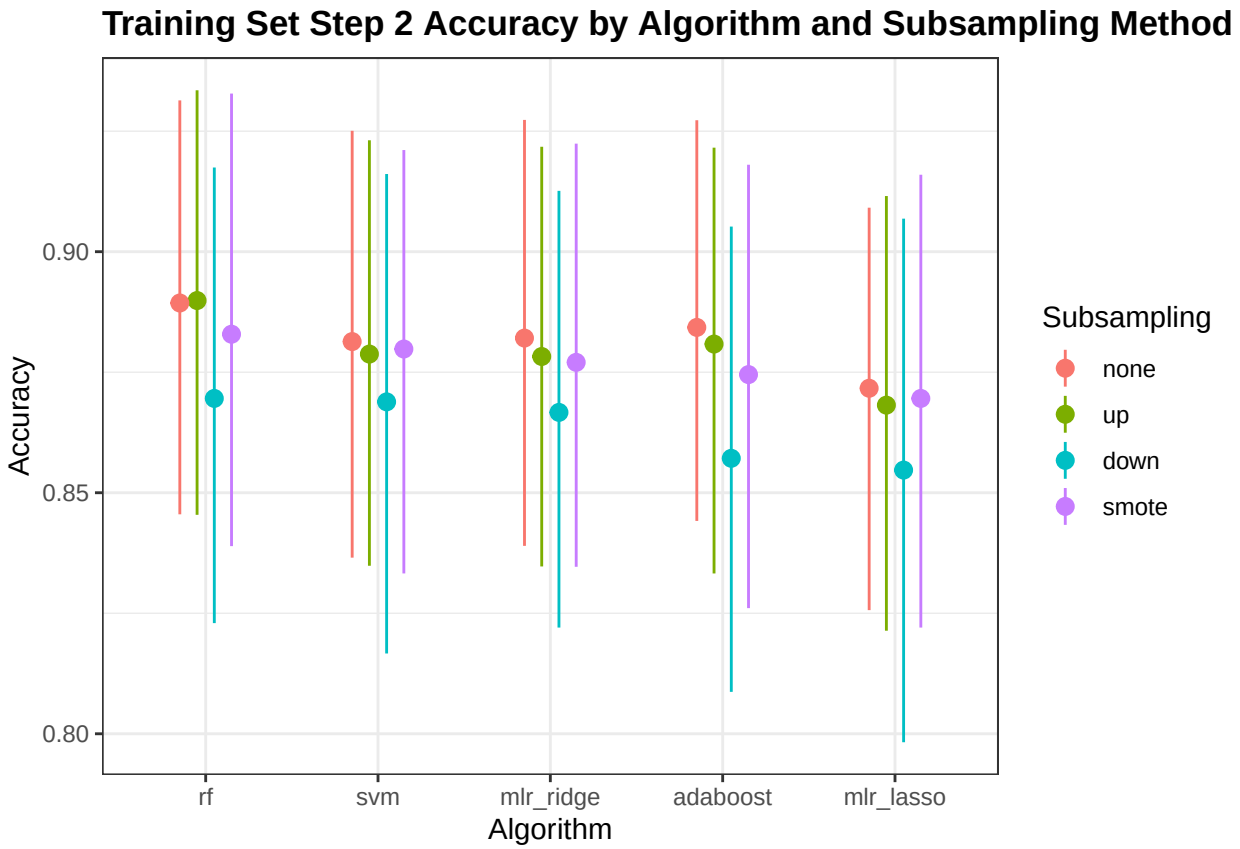

Figure 4.10: Training Set Step 2 Accuracy

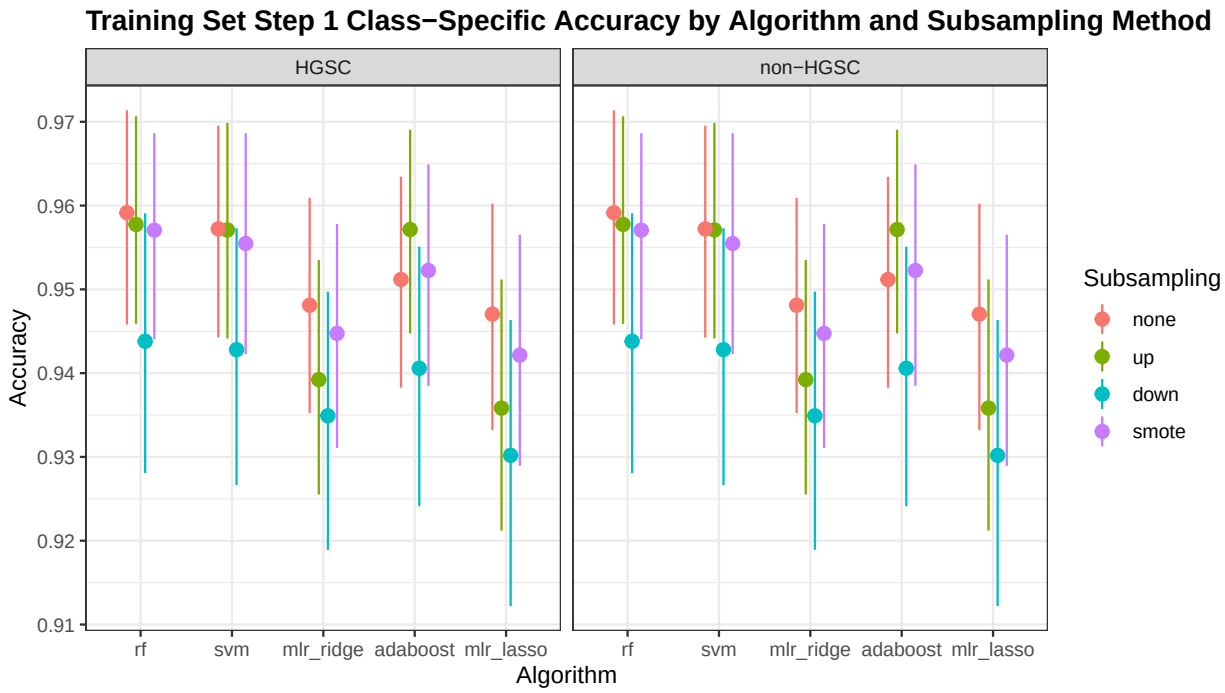

Figure 4.11: Training Set Step 1 Class-Specific Accuracy

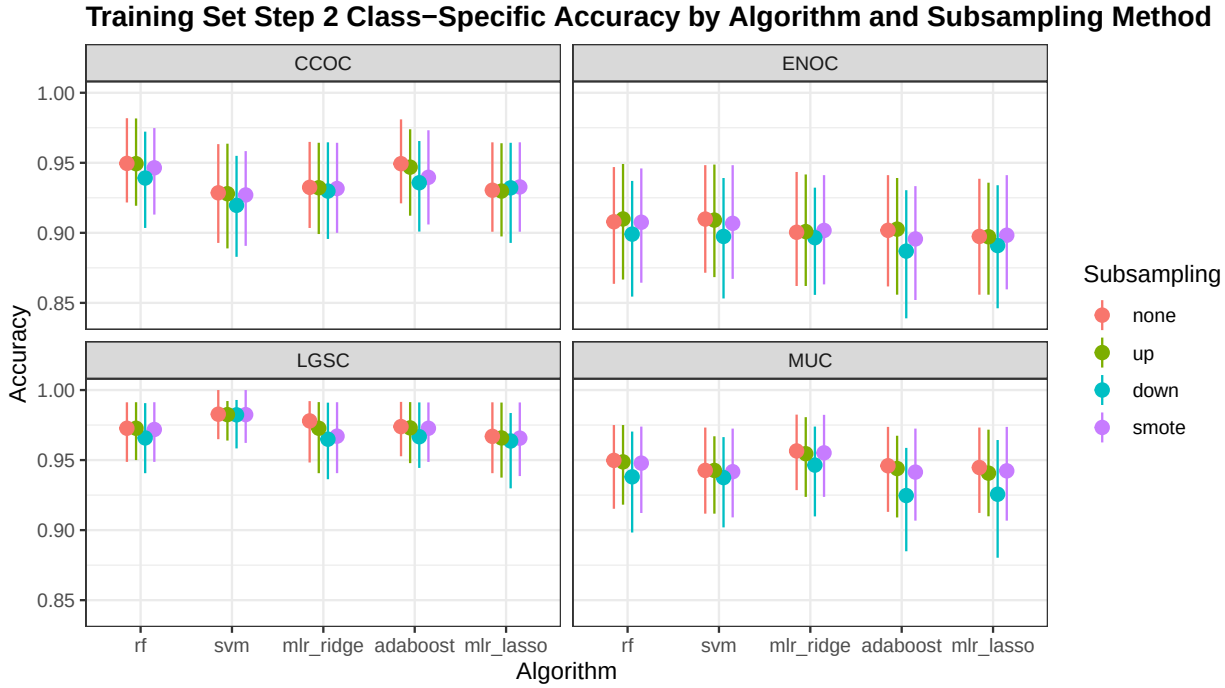

Figure 4.12: Training Set Step 2 Class-Specific Accuracy

Table 4.11: Training Set Step 1 Class-Specific Accuracy by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	HGSC	**0.959**	0.957	0.948	0.951	0.947
none	non-HGSC	**0.959**	0.957	0.948	0.951	0.947
up	HGSC	0.958	0.957	0.939	0.957	0.936
up	non-HGSC	0.958	0.957	0.939	0.957	0.936
down	HGSC	0.944	0.943	0.935	0.941	0.93
down	non-HGSC	0.944	0.943	0.935	0.941	0.93
smote	HGSC	0.957	0.955	0.945	0.952	0.942
smote	non-HGSC	0.957	0.955	0.945	0.952	0.942

Table 4.12: Training Set Step 2 Class-Specific Accuracy by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.95	0.929	0.932	0.949	0.93
none	ENOC	0.908	0.91	0.9	0.902	0.897
none	LGSC	0.973	**0.983**	0.978	0.974	0.967
none	MUC	0.95	0.943	0.957	0.946	0.945
up	CCOC	0.949	0.928	0.932	0.947	0.93
up	ENOC	0.91	0.909	0.901	0.903	0.897
up	LGSC	0.973	0.982	0.973	0.973	0.966
up	MUC	0.949	0.943	0.955	0.944	0.941
down	CCOC	0.939	0.92	0.93	0.936	0.932
down	ENOC	0.899	0.897	0.897	0.887	0.891
down	LGSC	0.966	0.982	0.965	0.967	0.964
down	MUC	0.938	0.938	0.946	0.925	0.926
smote	CCOC	0.946	0.927	0.932	0.94	0.933
smote	ENOC	0.908	0.907	0.902	0.896	0.898
smote	LGSC	0.972	0.982	0.967	0.973	0.966
smote	MUC	0.948	0.942	0.955	0.941	0.942

4.2.2 F1-Score

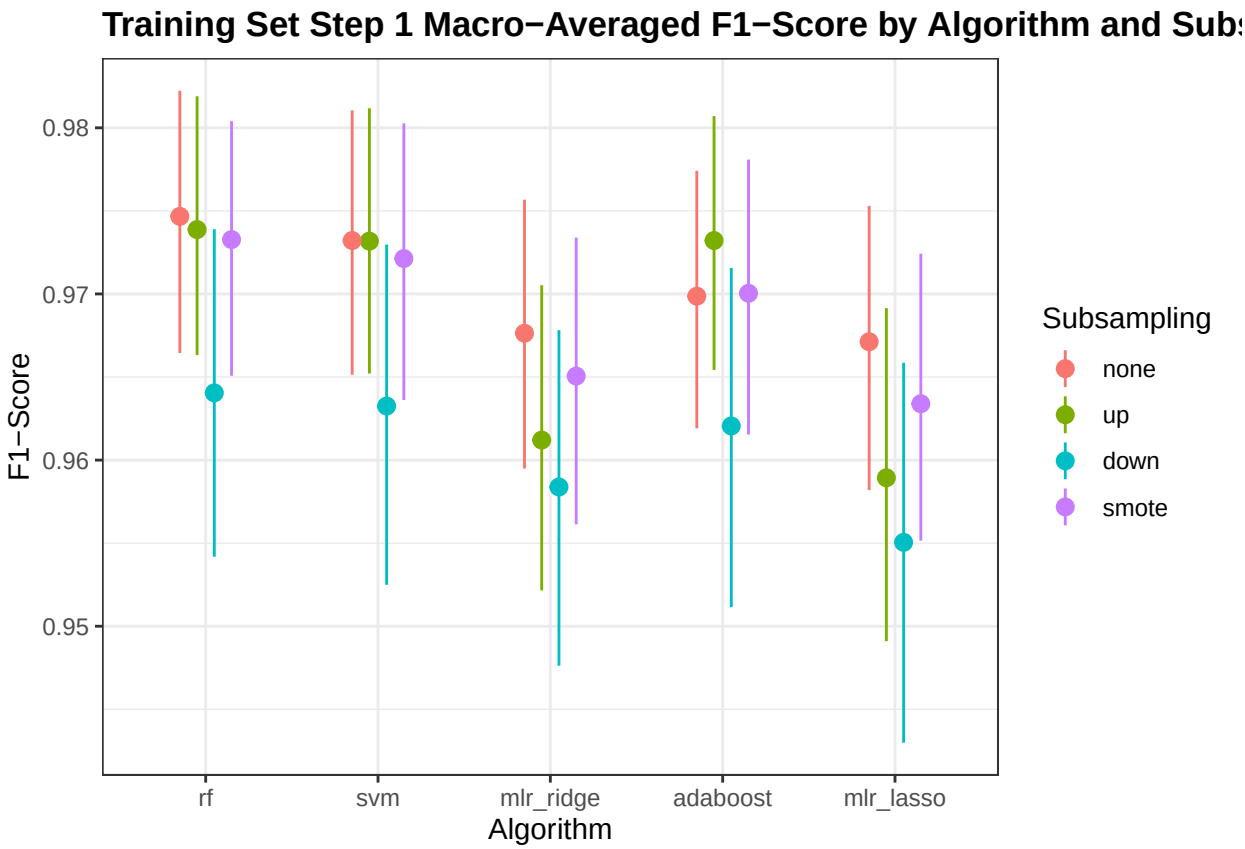

Figure 4.13: Training Set Step 1 F1-Score

Table 4.13: Training Set Step 1 Macro-Averaged F1-Score by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	**0.975**	0.973	0.968	0.97	0.967
up	0.974	0.973	0.961	0.973	0.959
down	0.964	0.963	0.958	0.962	0.955
smote	0.973	0.972	0.965	0.97	0.963

Table 4.14: Training Set Step 2 Macro-Averaged F1-Score by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	**0.887**	0.886	0.886	0.884	0.87
up	0.886	0.885	0.879	0.879	0.867
down	0.868	0.875	0.867	0.859	0.852
smote	0.881	0.884	0.876	0.874	0.868

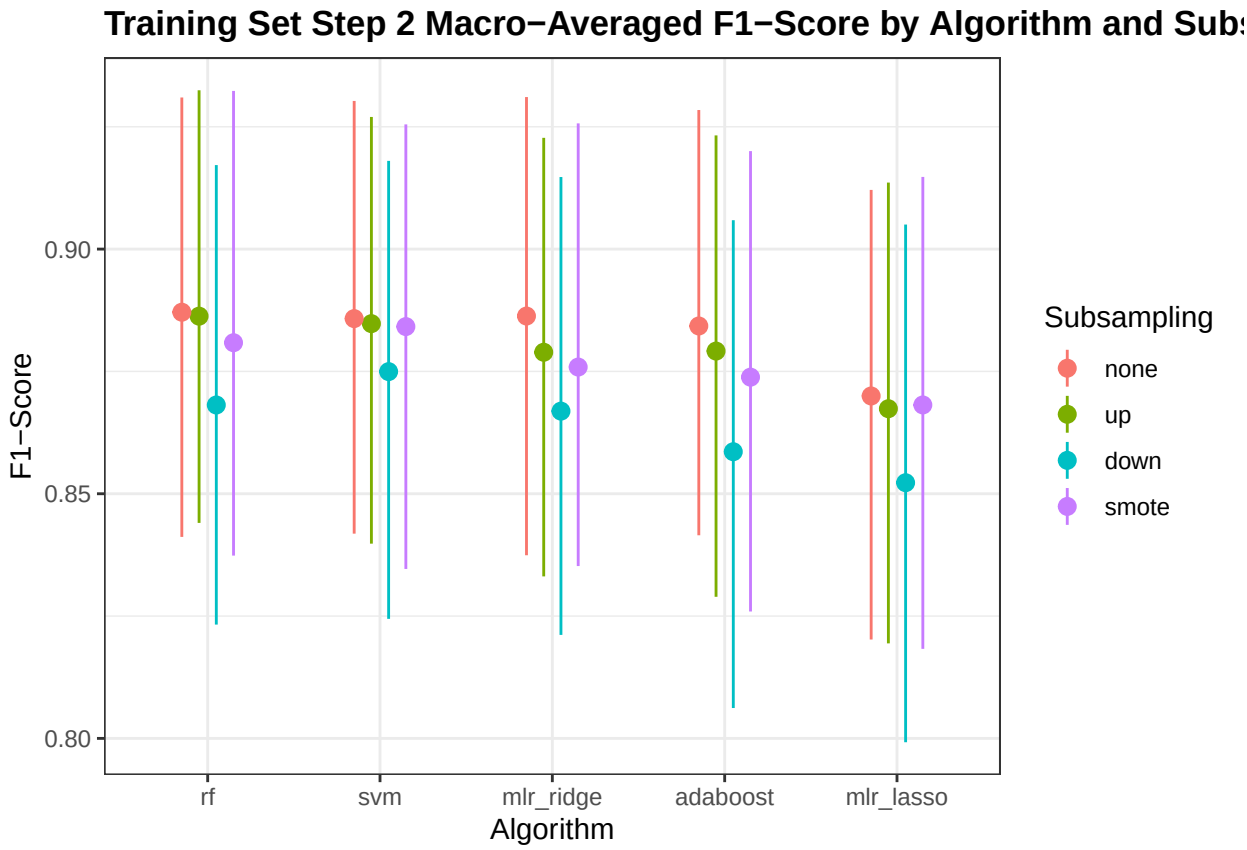

Figure 4.14: Training Set Step 2 F1-Score

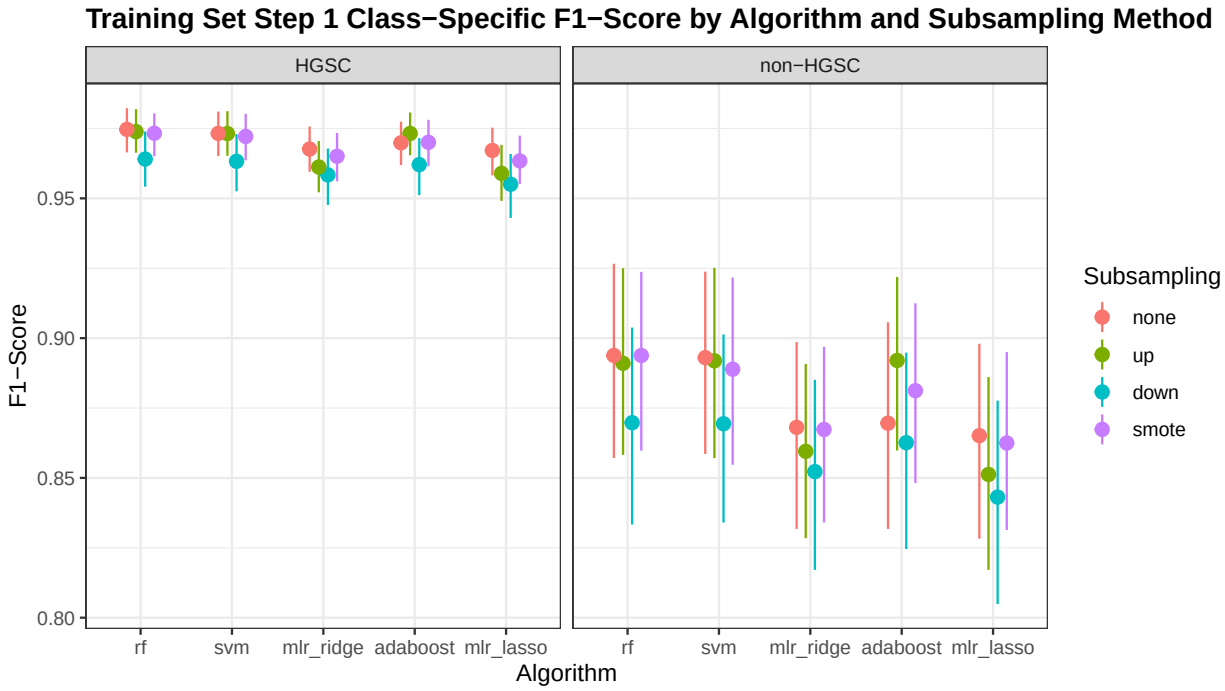

Figure 4.15: Training Set Step 1 Class-Specific F1-Score

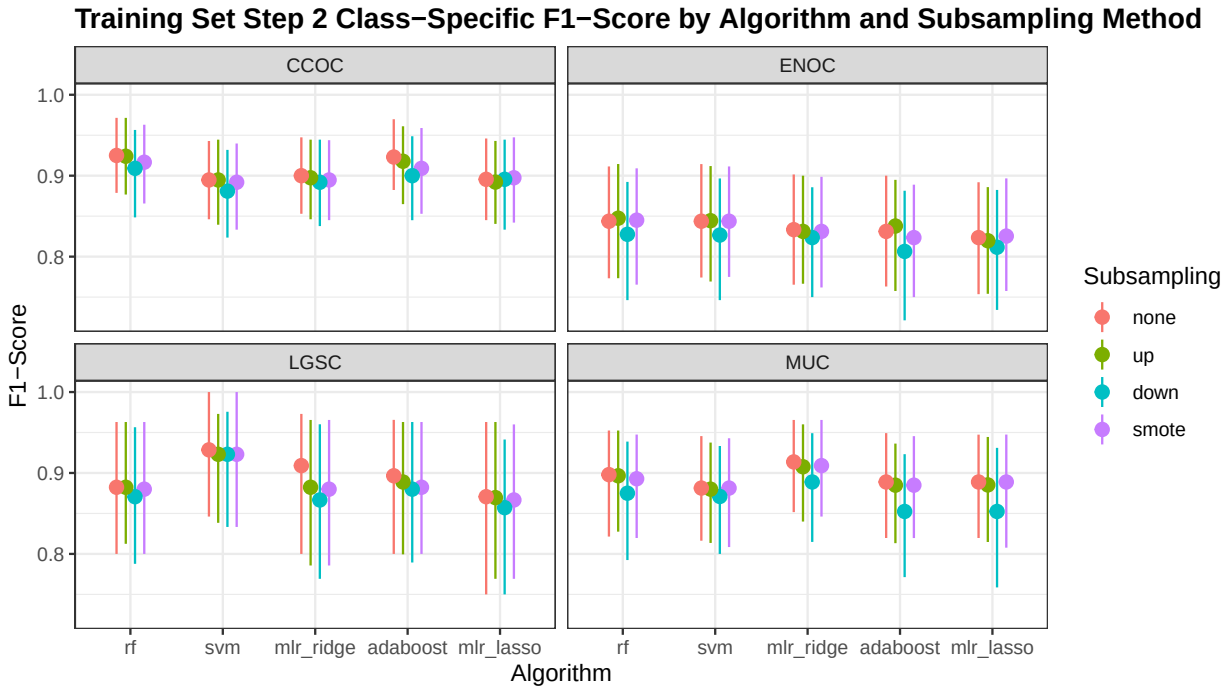

Figure 4.16: Training Set Step 2 Class-Specific F1-Score

Show 50 entries

Search:

Training Set Step 1 Class-Specific F1-Score by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
All	All	All	All	All	All	All
none	HGSC	\textbf{0.975}	0.973	0.968	0.97	0.967
none	non-HGSC	0.894	0.893	0.868	0.87	0.865
up	HGSC	0.974	0.973	0.961	0.973	0.959
up	non-HGSC	0.891	0.892	0.86	0.892	0.851
down	HGSC	0.964	0.963	0.958	0.962	0.955
down	non-HGSC	0.87	0.869	0.852	0.863	0.843
smote	HGSC	0.973	0.972	0.965	0.97	0.963
smote	non-HGSC	0.894	0.889	0.867	0.881	0.862

Showing 1 to 8 of 8 entries

Previous 1 Next

Show 50 entries Search:

Training Set Step 2 Class-Specific F1-Score by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
All	All	All	All	All	All	All
none	CCOC	0.925	0.895	0.9	0.923	0.896
none	ENOC	0.844	0.844	0.833	0.831	0.824
none	LGSC	0.882	\textbf{0.929}	0.909	0.897	0.871
none	MUC	0.898	0.881	0.914	0.889	0.889
up	CCOC	0.924	0.895	0.897	0.918	0.892
up	ENOC	0.847	0.844	0.831	0.838	0.82
up	LGSC	0.882	0.923	0.882	0.889	0.87
up	MUC	0.897	0.88	0.908	0.885	0.885
down	CCOC	0.909	0.881	0.892	0.9	0.896
down	ENOC	0.828	0.827	0.824	0.806	0.812
down	LGSC	0.871	0.923	0.867	0.88	0.857
down	MUC	0.875	0.871	0.889	0.852	0.852
smote	CCOC	0.917	0.892	0.895	0.909	0.897
smote	ENOC	0.845	0.844	0.831	0.824	0.825
smote	LGSC	0.88	0.923	0.88	0.882	0.867
smote	MUC	0.893	0.881	0.909	0.885	0.889

Showing 1 to 16 of 16 entries Previous 1 Next

4.2.3 Kappa

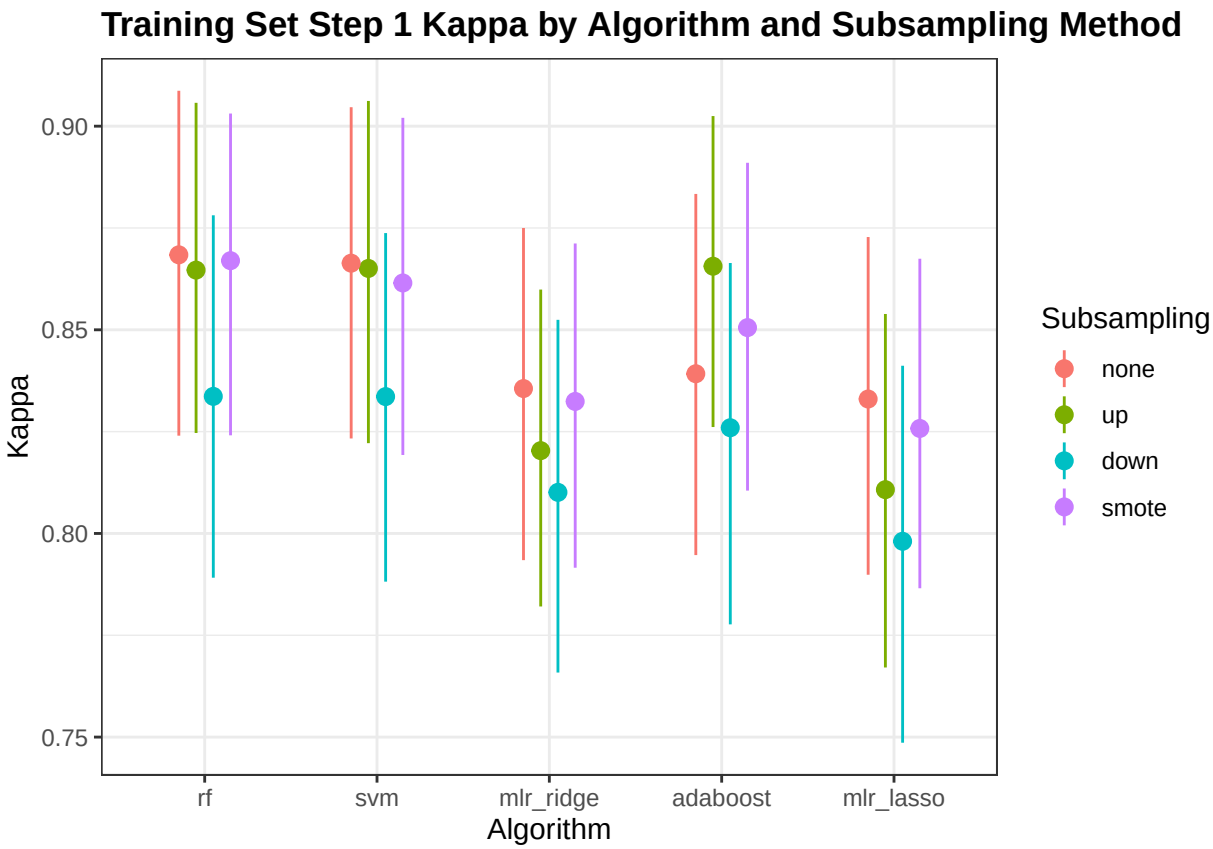

Figure 4.17: Training Set Step 1 Kappa

Table 4.15: Training Set Step 1 Kappa by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	**0.868**	0.866	0.836	0.839	0.833
up	0.865	0.865	0.82	0.866	0.811
down	0.834	0.834	0.81	0.826	0.798
smote	0.867	0.862	0.832	0.851	0.826

Table 4.16: Training Set Step 2 Kappa by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.847	0.835	0.837	0.841	0.822
up	**0.848**	0.832	0.833	0.836	0.818
down	0.821	0.819	0.817	0.803	0.8
smote	0.839	0.834	0.83	0.827	0.821

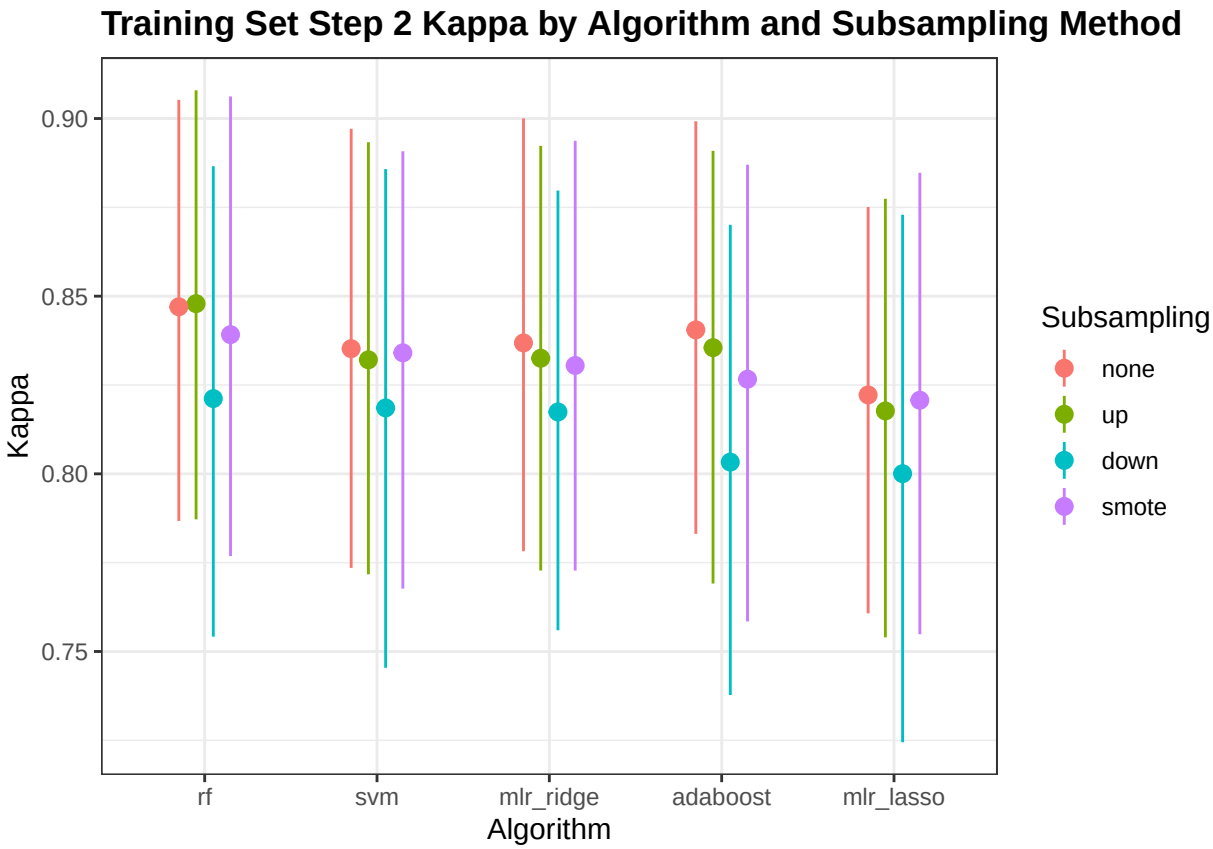

Figure 4.18: Training Set Step 2 Kappa

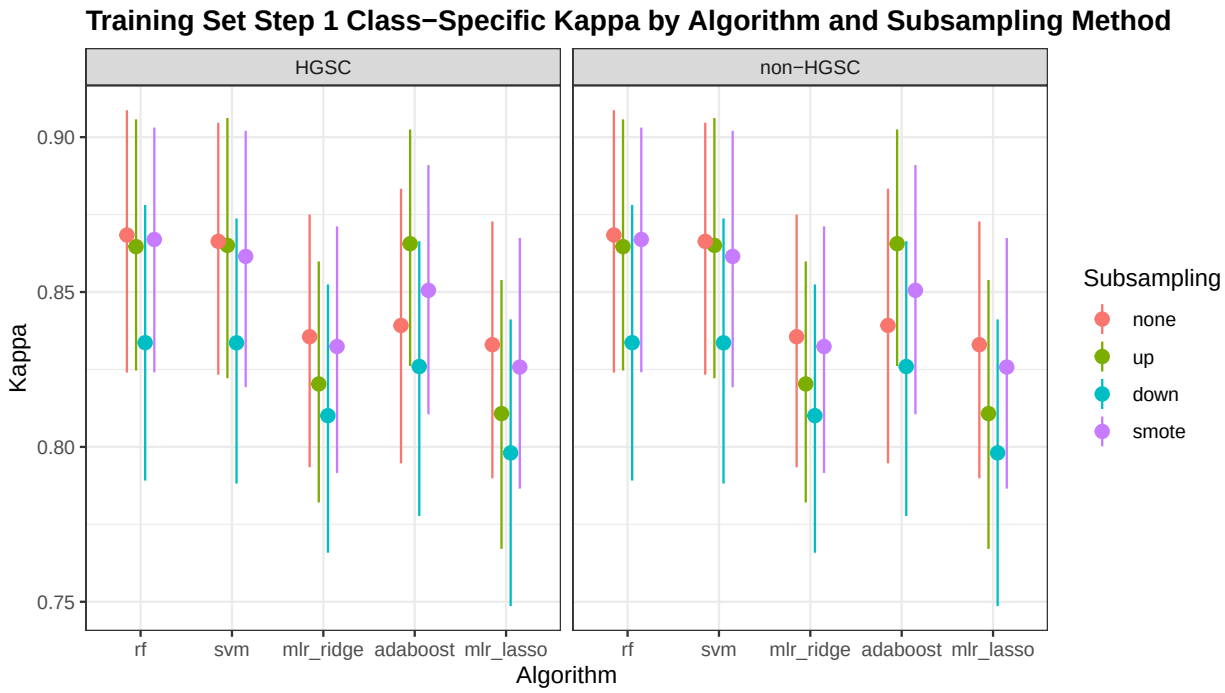

Figure 4.19: Training Set Step 1 Class-Specific Kappa

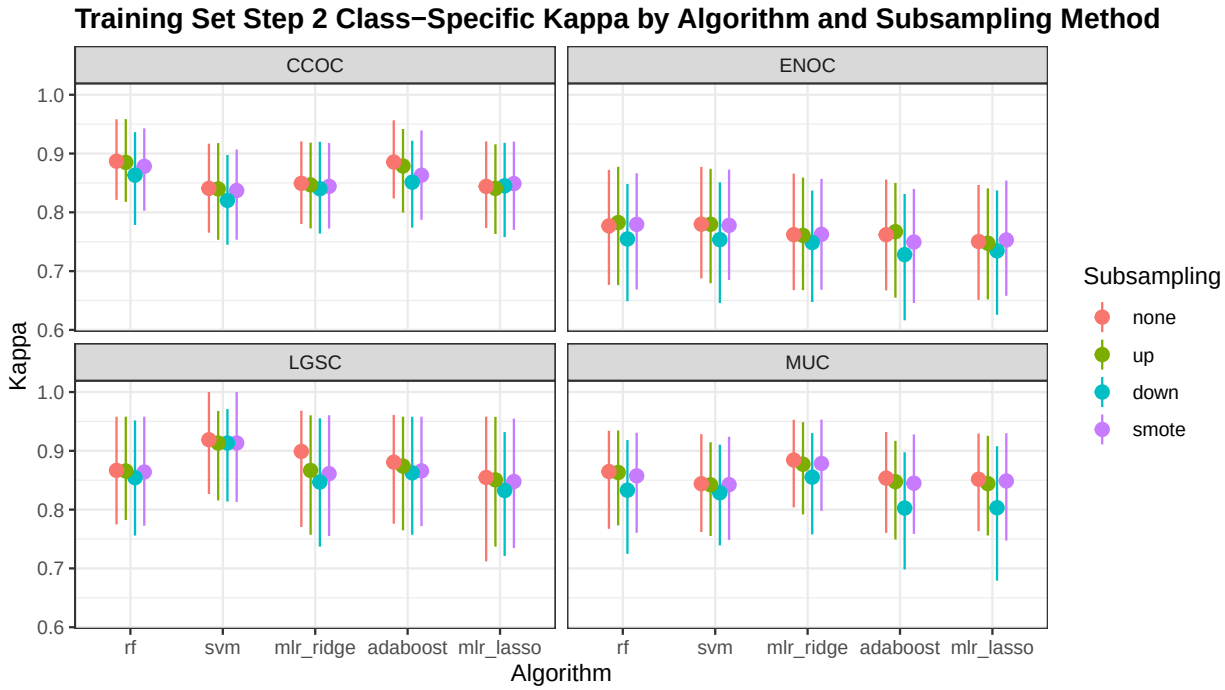

Figure 4.20: Training Set Step 2 Class-Specific Kappa

Table 4.17: Training Set Step 1 Class-Specific Kappa by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	HGSC	**0.868**	0.866	0.836	0.839	0.833
none	non-HGSC	**0.868**	0.866	0.836	0.839	0.833
up	HGSC	0.865	0.865	0.82	0.866	0.811
up	non-HGSC	0.865	0.865	0.82	0.866	0.811
down	HGSC	0.834	0.834	0.81	0.826	0.798
down	non-HGSC	0.834	0.834	0.81	0.826	0.798
smote	HGSC	0.867	0.862	0.832	0.851	0.826
smote	non-HGSC	0.867	0.862	0.832	0.851	0.826

Table 4.18: Training Set Step 2 Class-Specific Kappa by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.887	0.841	0.849	0.885	0.844
none	ENOC	0.777	0.78	0.762	0.762	0.75
none	LGSC	0.867	**0.919**	0.899	0.881	0.855
none	MUC	0.865	0.844	0.884	0.854	0.852
up	CCOC	0.885	0.84	0.847	0.879	0.841
up	ENOC	0.783	0.78	0.761	0.767	0.747
up	LGSC	0.866	0.913	0.867	0.874	0.851
up	MUC	0.863	0.842	0.877	0.847	0.844
down	CCOC	0.863	0.82	0.84	0.851	0.845
down	ENOC	0.755	0.754	0.749	0.728	0.734
down	LGSC	0.854	0.913	0.847	0.863	0.832
down	MUC	0.833	0.829	0.855	0.803	0.803
smote	CCOC	0.878	0.837	0.844	0.863	0.849
smote	ENOC	0.78	0.778	0.763	0.75	0.753
smote	LGSC	0.864	0.913	0.861	0.866	0.848
smote	MUC	0.857	0.842	0.879	0.845	0.849

4.2.4 G-mean

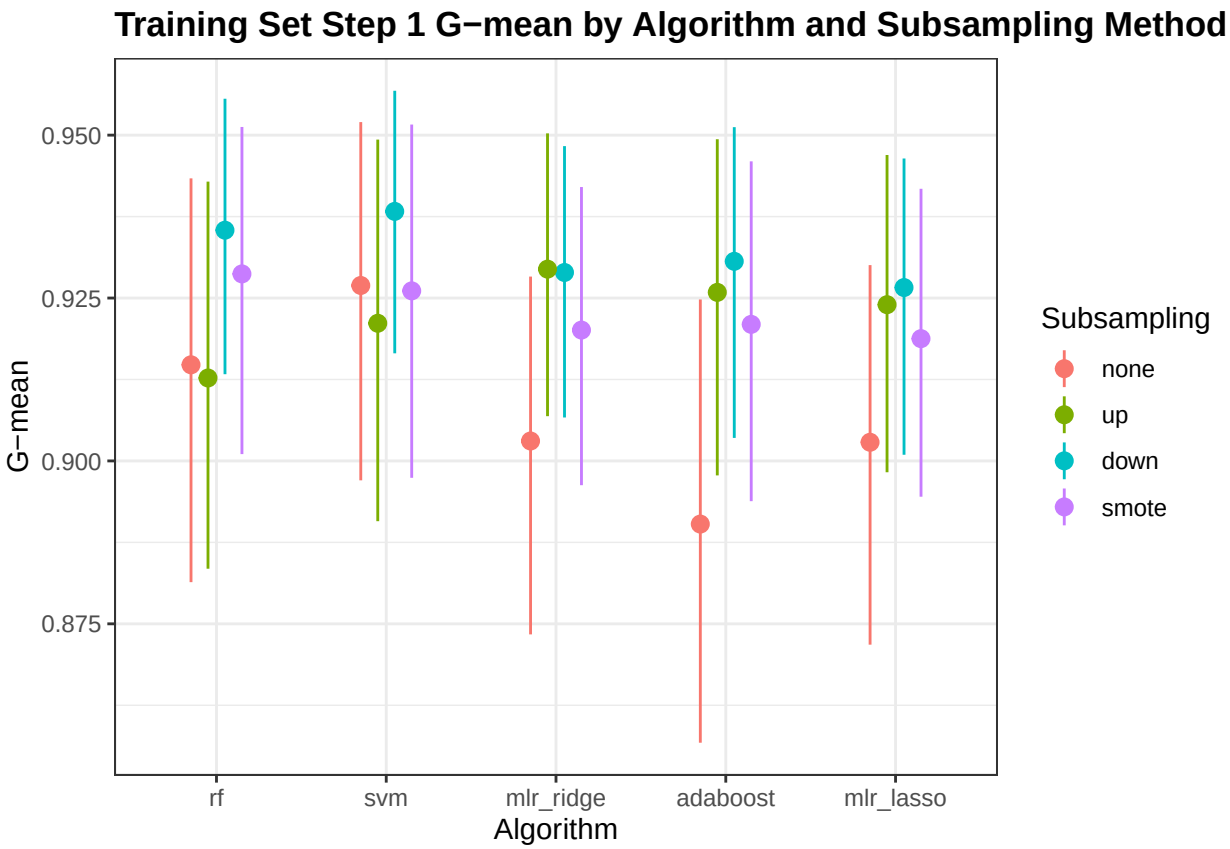

Figure 4.21: Training Set Step 1 G-mean

Table 4.19: Training Set Step 1 G-mean by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.915	0.927	0.903	0.89	0.903
up	0.913	0.921	0.929	0.926	0.924
down	0.935	**0.938**	0.929	0.931	0.927
smote	0.929	0.926	0.92	0.921	0.919

Table 4.20: Training Set Step 2 G-mean by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.891	0.884	0.889	0.886	0.873
up	**0.893**	0.879	0.887	0.885	0.875
down	0.877	0.874	0.876	0.867	0.864
smote	0.89	0.881	0.885	0.879	0.877

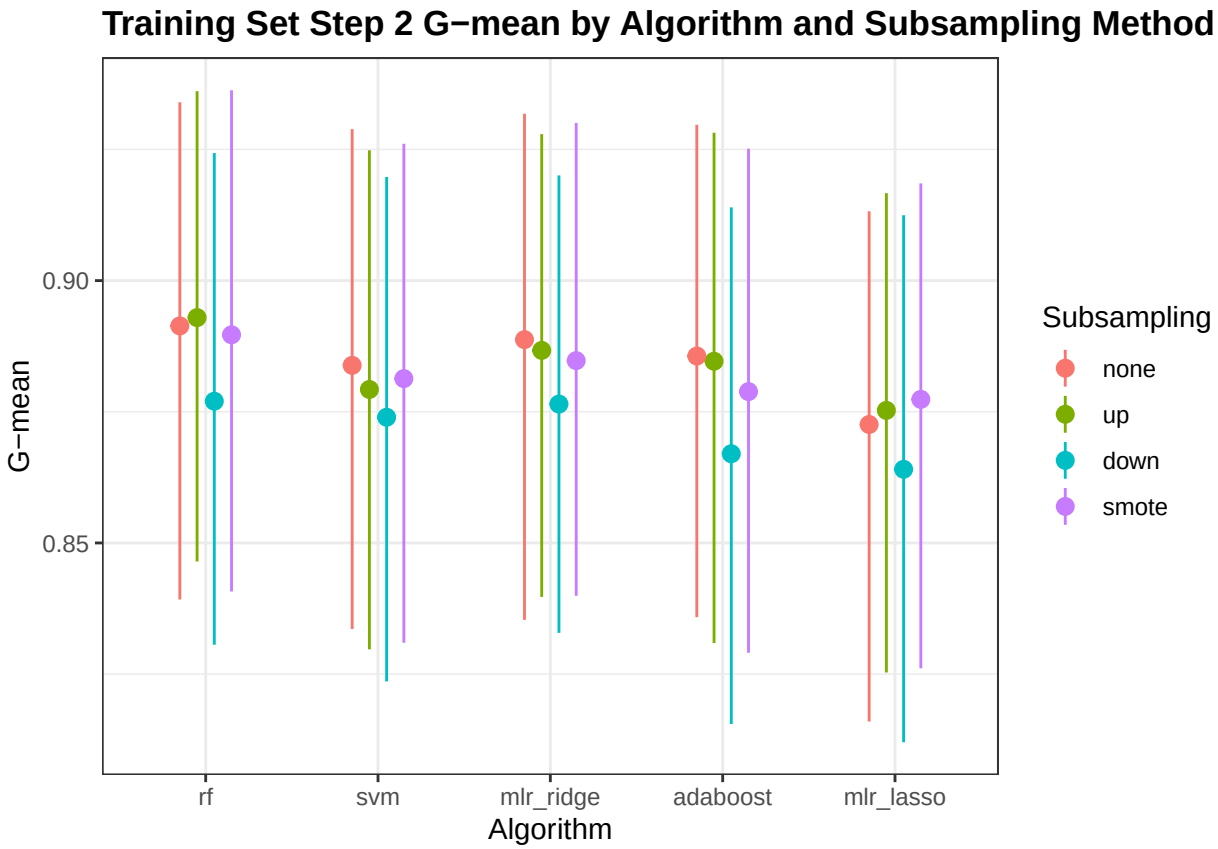

Figure 4.22: Training Set Step 2 G-mean

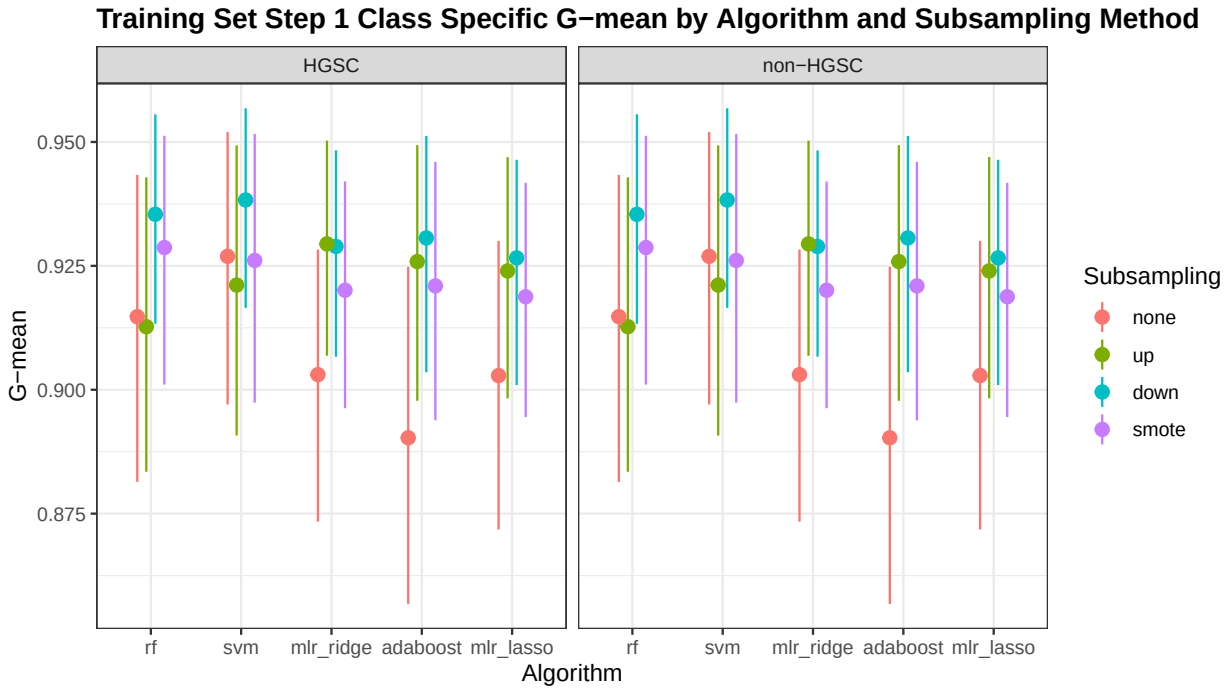

Figure 4.23: Training Set Step 1 Class-Specific G-mean

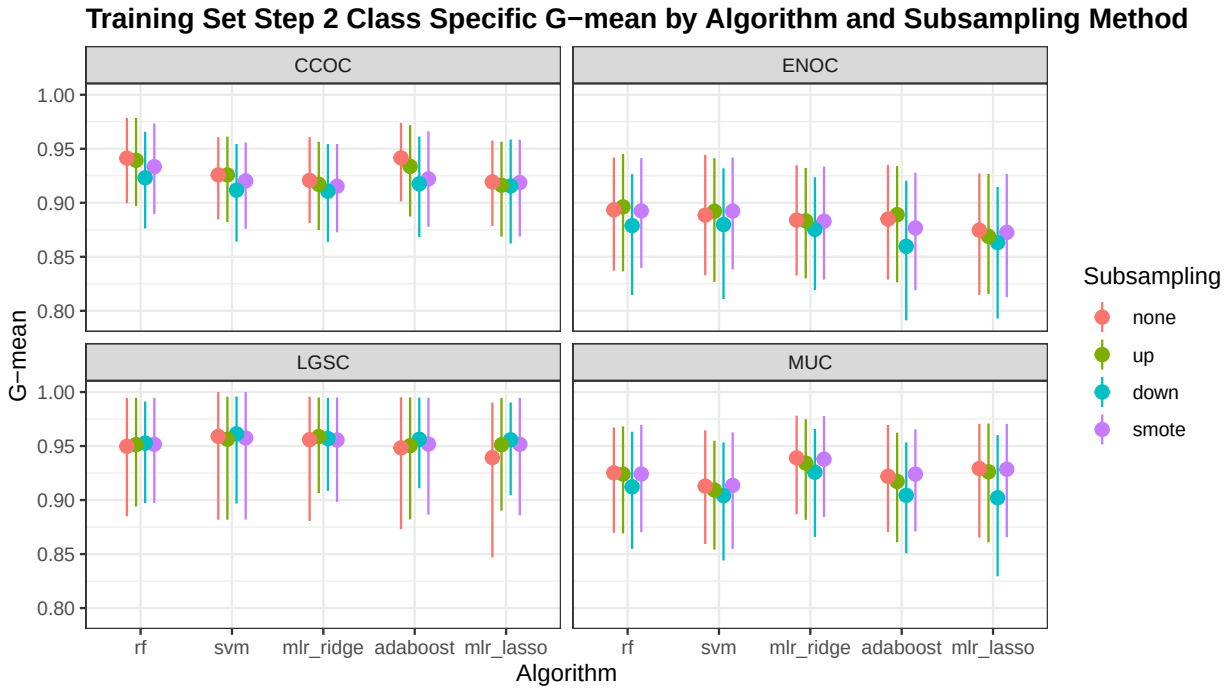

Figure 4.24: Training Set Step 2 Class-Specific G-mean

Table 4.21: Training Set Step 1 Class-Specific G-mean by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	HGSC	0.915	0.927	0.903	0.89	0.903
none	non-HGSC	0.915	0.927	0.903	0.89	0.903
up	HGSC	0.913	0.921	0.929	0.926	0.924
up	non-HGSC	0.913	0.921	0.929	0.926	0.924
down	HGSC	0.935	**0.938**	0.929	0.931	0.927
down	non-HGSC	0.935	**0.938**	0.929	0.931	0.927
smote	HGSC	0.929	0.926	0.92	0.921	0.919
smote	non-HGSC	0.929	0.926	0.92	0.921	0.919

Table 4.22: Training Set Step 2 Class-Specific G-mean by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.941	0.926	0.921	0.942	0.919
none	ENOC	0.893	0.889	0.884	0.885	0.875
none	LGSC	0.95	0.959	0.956	0.948	0.939
none	MUC	0.925	0.913	0.939	0.922	0.929
up	CCOC	0.939	0.926	0.917	0.934	0.916
up	ENOC	0.896	0.892	0.883	0.889	0.869
up	LGSC	0.951	0.956	0.959	0.95	0.951
up	MUC	0.924	0.909	0.934	0.917	0.926
down	CCOC	0.923	0.912	0.911	0.918	0.916
down	ENOC	0.879	0.88	0.875	0.86	0.863
down	LGSC	0.953	**0.961**	0.957	0.956	0.956
down	MUC	0.912	0.904	0.926	0.904	0.902
smote	CCOC	0.933	0.92	0.915	0.922	0.919
smote	ENOC	0.892	0.892	0.883	0.877	0.873
smote	LGSC	0.952	0.957	0.956	0.952	0.952
smote	MUC	0.924	0.914	0.938	0.924	0.929

Table 4.23: CS1 Set Accuracy by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.838	0.852	0.845	0.813	0.832
up	**0.862**	0.843	0.842	0.844	0.826
down	0.809	0.811	0.783	0.773	0.764
smote	0.856	0.842	0.837	0.842	0.823

4.3 CS1 Set

4.3.1 Accuracy

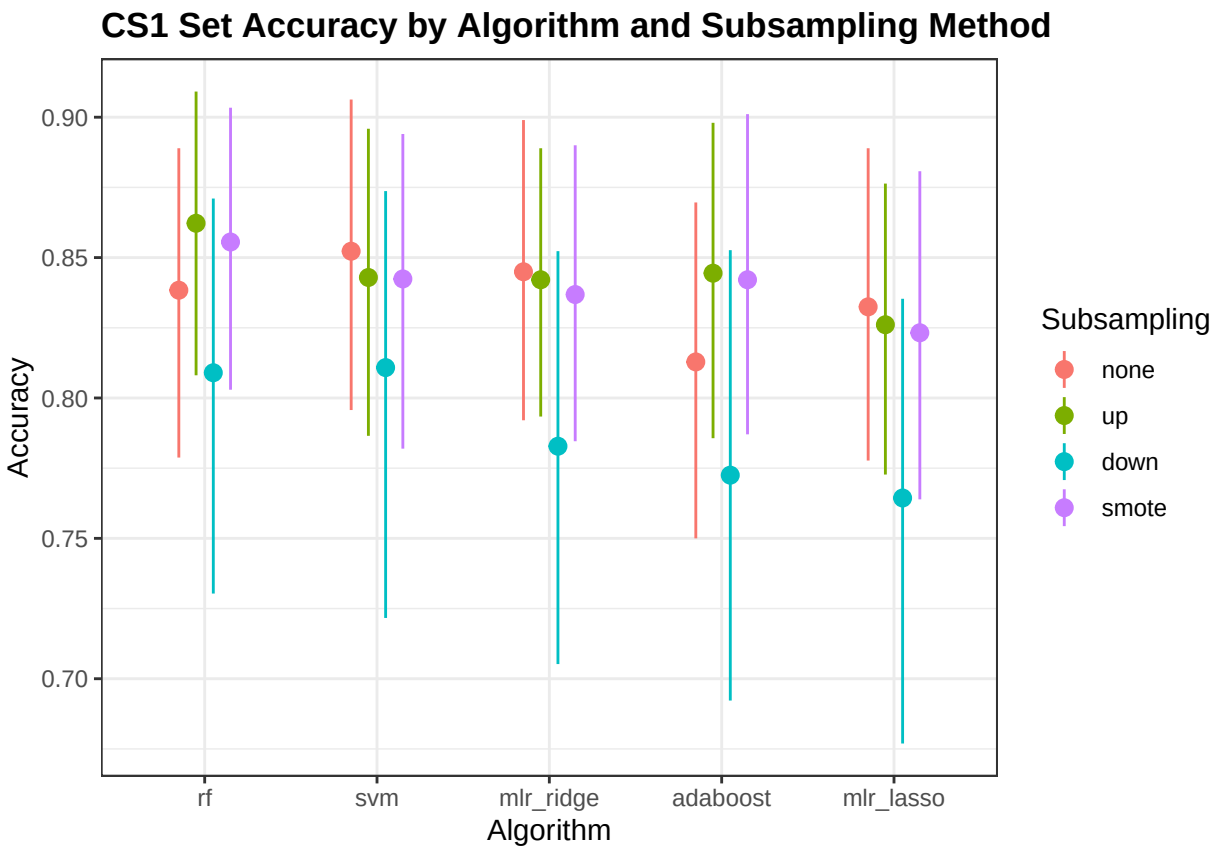

Figure 4.25: CS1 Set Accuracy

Table 4.24: CS1 Set Class-Specific Accuracy by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.941	0.939	0.936	0.937	0.935
none	ENOC	0.897	0.909	0.897	0.895	0.895
none	HGSC	0.907	0.908	0.91	0.883	0.899
none	LGSC	0.958	0.978	0.969	0.947	0.959
none	MUC	0.978	0.978	**0.98**	0.971	**0.98**
up	CCOC	0.943	0.937	0.93	0.94	0.918
up	ENOC	0.906	0.901	0.898	0.898	0.879
up	HGSC	0.926	0.903	0.911	0.912	0.907
up	LGSC	0.969	0.979	0.968	0.967	0.967
up	MUC	**0.98**	0.978	0.979	0.979	**0.98**
down	CCOC	0.936	0.933	0.939	0.929	0.925
down	ENOC	0.883	0.882	0.88	0.865	0.868
down	HGSC	0.885	0.879	0.859	0.862	0.854
down	LGSC	0.943	0.966	0.922	0.929	0.923
down	MUC	0.978	0.971	0.971	0.97	0.968
smote	CCOC	0.941	0.937	0.932	0.939	0.927
smote	ENOC	0.896	0.899	0.896	0.89	0.888
smote	HGSC	0.925	0.904	0.906	0.915	0.898
smote	LGSC	0.969	0.978	0.968	0.969	0.959
smote	MUC	0.979	0.977	0.979	0.978	0.979

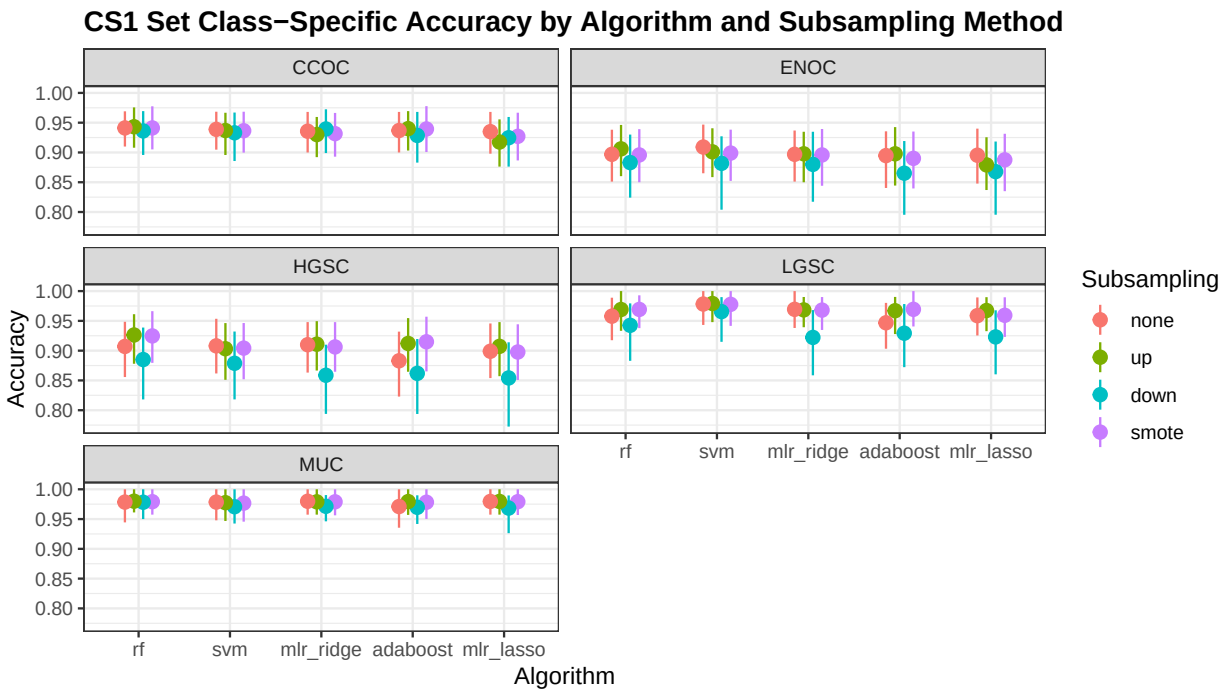

Figure 4.26: CS1 Set Class-Specific Accuracy

Table 4.25: CS1 Set Macro-Averaged F1-Score by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.76	0.812	0.806	0.725	0.784
up	0.812	0.8	0.809	0.791	0.793
down	0.771	0.775	0.752	0.734	0.723
smote	**0.818**	0.797	0.808	0.807	0.794

4.3.2 F1-Score

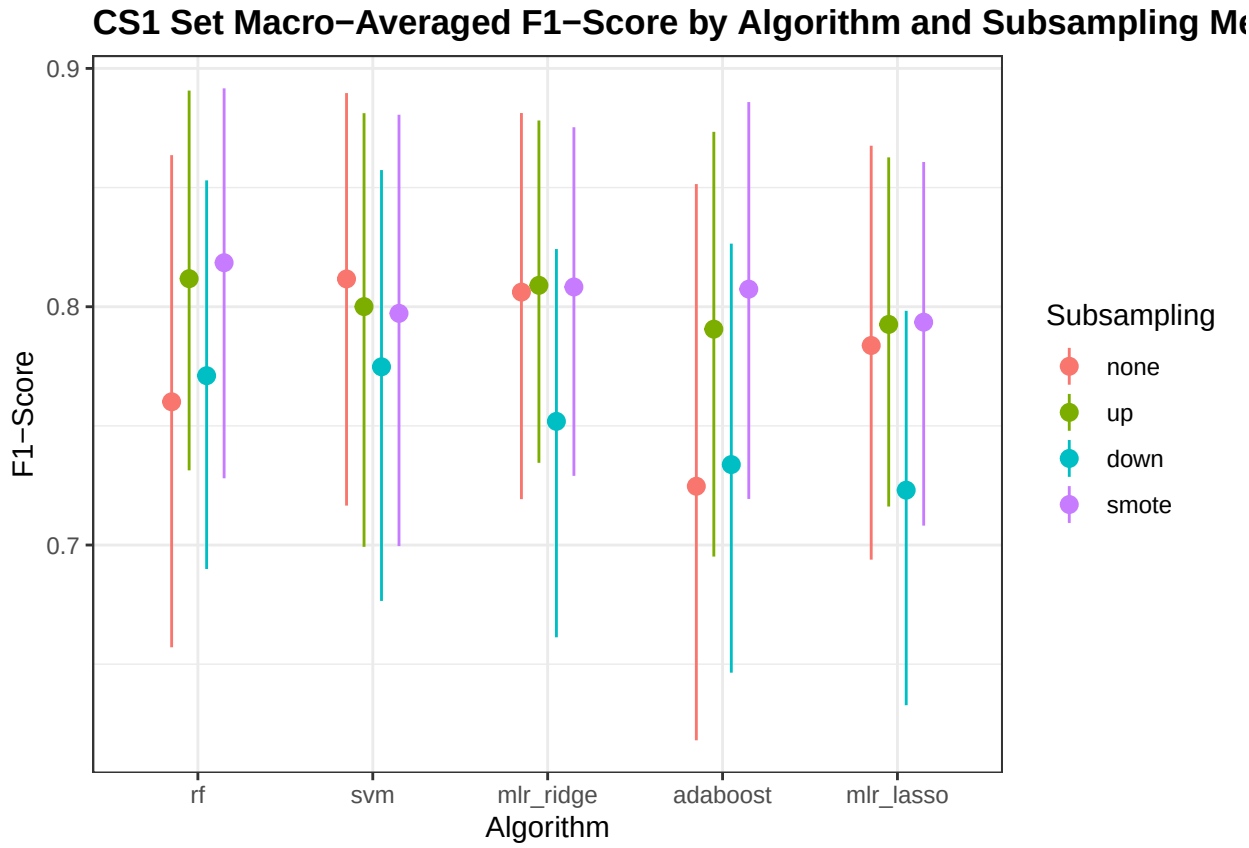

Figure 4.27: CS1 Set F1-Score

Table 4.26: CS1 Set Class-Specific F1-Score by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.828	0.824	0.819	0.821	0.813
none	ENOC	0.779	0.791	0.769	0.762	0.766
none	HGSC	0.907	0.905	0.907	0.887	0.897
none	LGSC	0.545	0.8	0.727	0.4	0.667
none	MUC	0.769	0.769	0.8	0.667	0.8
up	CCOC	0.839	0.812	0.811	0.829	0.774
up	ENOC	0.792	0.777	0.766	0.773	0.739
up	HGSC	**0.925**	0.903	0.903	0.911	0.9
up	LGSC	0.714	0.8	0.778	0.667	0.75
up	MUC	0.833	0.75	0.8	0.8	0.8
down	CCOC	0.824	0.812	0.828	0.811	0.791
down	ENOC	0.75	0.75	0.744	0.699	0.711
down	HGSC	0.87	0.866	0.833	0.841	0.829
down	LGSC	0.667	0.75	0.6	0.615	0.586
down	MUC	0.8	0.75	0.75	0.75	0.727
smote	CCOC	0.833	0.824	0.812	0.831	0.8
smote	ENOC	0.783	0.783	0.769	0.768	0.756
smote	HGSC	0.92	0.901	0.897	0.909	0.886
smote	LGSC	0.75	0.8	0.769	0.75	0.714
smote	MUC	0.8	0.727	0.8	0.8	0.8

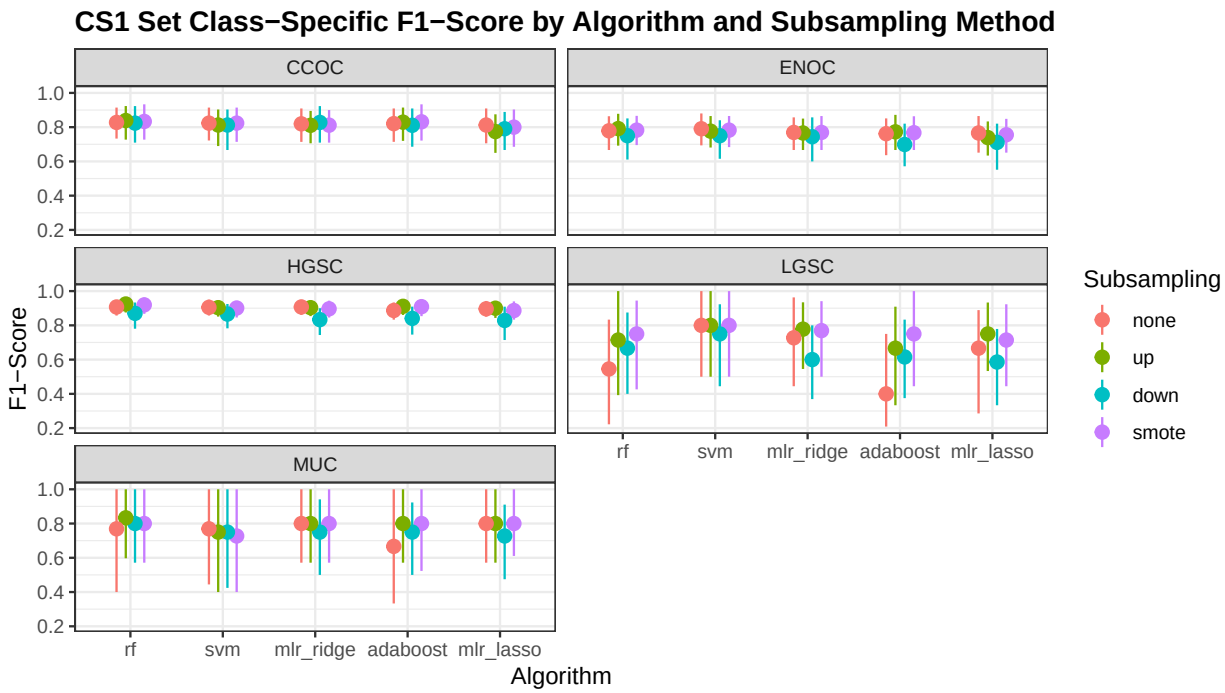

Figure 4.28: CS1 Set Class-Specific F1-Score

Table 4.27: CS1 Set Kappa by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.755	0.78	0.767	0.714	0.752
up	**0.796**	0.763	0.77	0.768	0.748
down	0.731	0.73	0.702	0.682	0.67
smote	0.789	0.767	0.765	0.769	0.747

4.3.3 Kappa

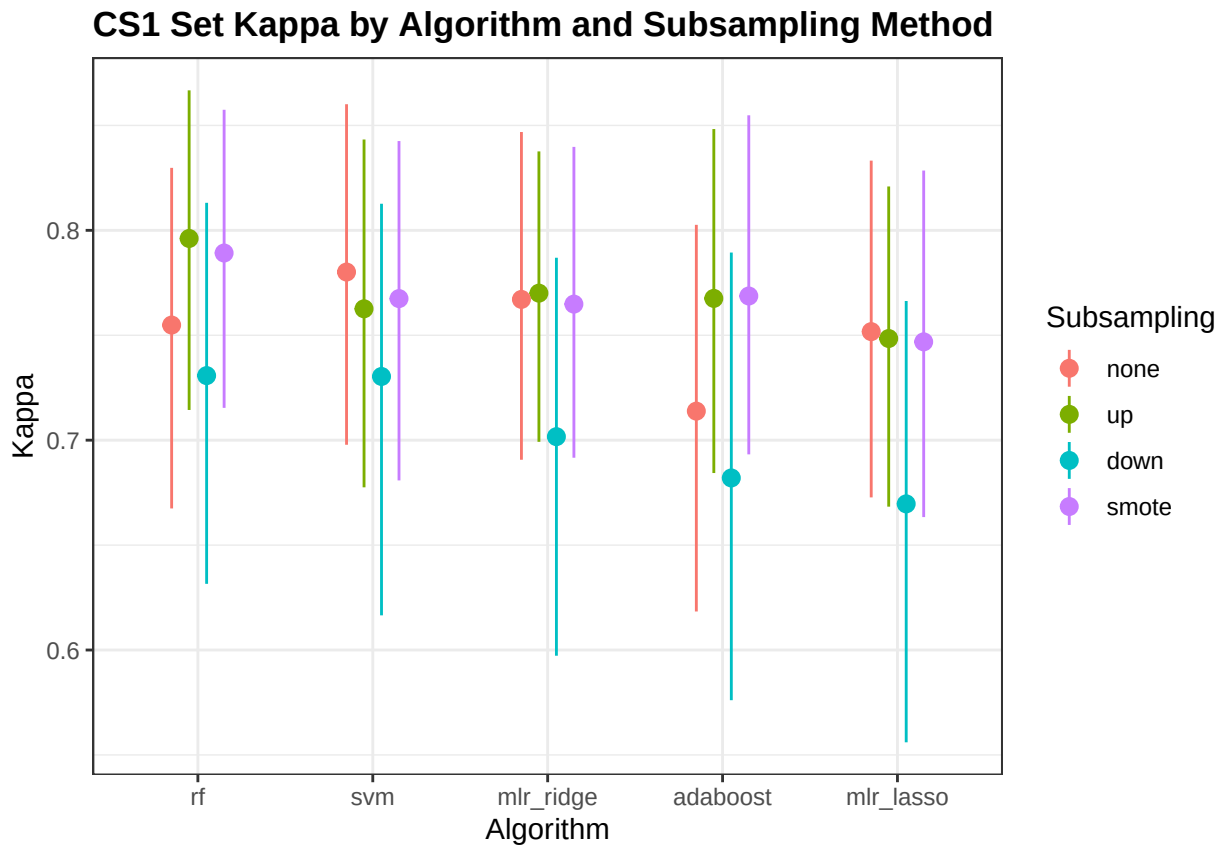

Figure 4.29: CS1 Set Kappa

Table 4.28: CS1 Set Class-Specific Kappa by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.794	0.787	0.777	0.782	0.775
none	ENOC	0.71	0.733	0.701	0.695	0.697
none	HGSC	0.814	0.815	0.819	0.767	0.798
none	LGSC	0.521	0.789	0.712	0.311	0.64
none	MUC	0.753	0.752	0.795	0.657	0.795
up	CCOC	0.804	0.775	0.767	0.795	0.72
up	ENOC	0.733	0.713	0.699	0.708	0.659
up	HGSC	**0.852**	0.807	0.82	0.824	0.813
up	LGSC	0.693	0.795	0.756	0.651	0.728
up	MUC	0.823	0.738	0.79	0.79	0.795
down	CCOC	0.785	0.771	0.794	0.763	0.747
down	ENOC	0.671	0.672	0.667	0.611	0.621
down	HGSC	0.767	0.756	0.713	0.722	0.702
down	LGSC	0.627	0.727	0.56	0.572	0.542
down	MUC	0.788	0.739	0.74	0.739	0.711
smote	CCOC	0.798	0.785	0.769	0.794	0.754
smote	ENOC	0.712	0.714	0.699	0.696	0.681
smote	HGSC	0.849	0.809	0.81	0.828	0.794
smote	LGSC	0.74	0.784	0.754	0.74	0.694
smote	MUC	0.79	0.71	0.789	0.788	0.79

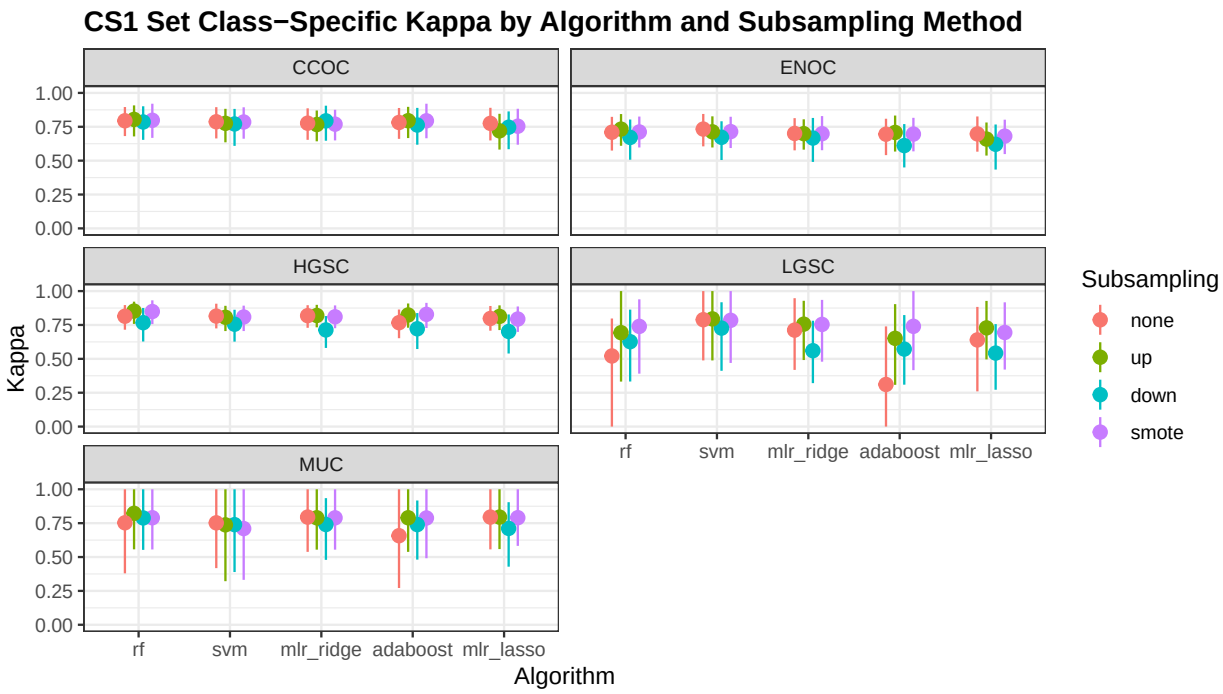

Figure 4.30: CS1 Set Class-Specific Kappa

Table 4.29: CS1 Set G-mean by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.67	0.769	0.761	0.555	0.742
up	0.766	0.741	0.818	0.741	0.798
down	0.811	0.786	0.807	0.785	0.773
smote	0.806	0.751	**0.819**	0.795	0.806

4.3.4 G-mean

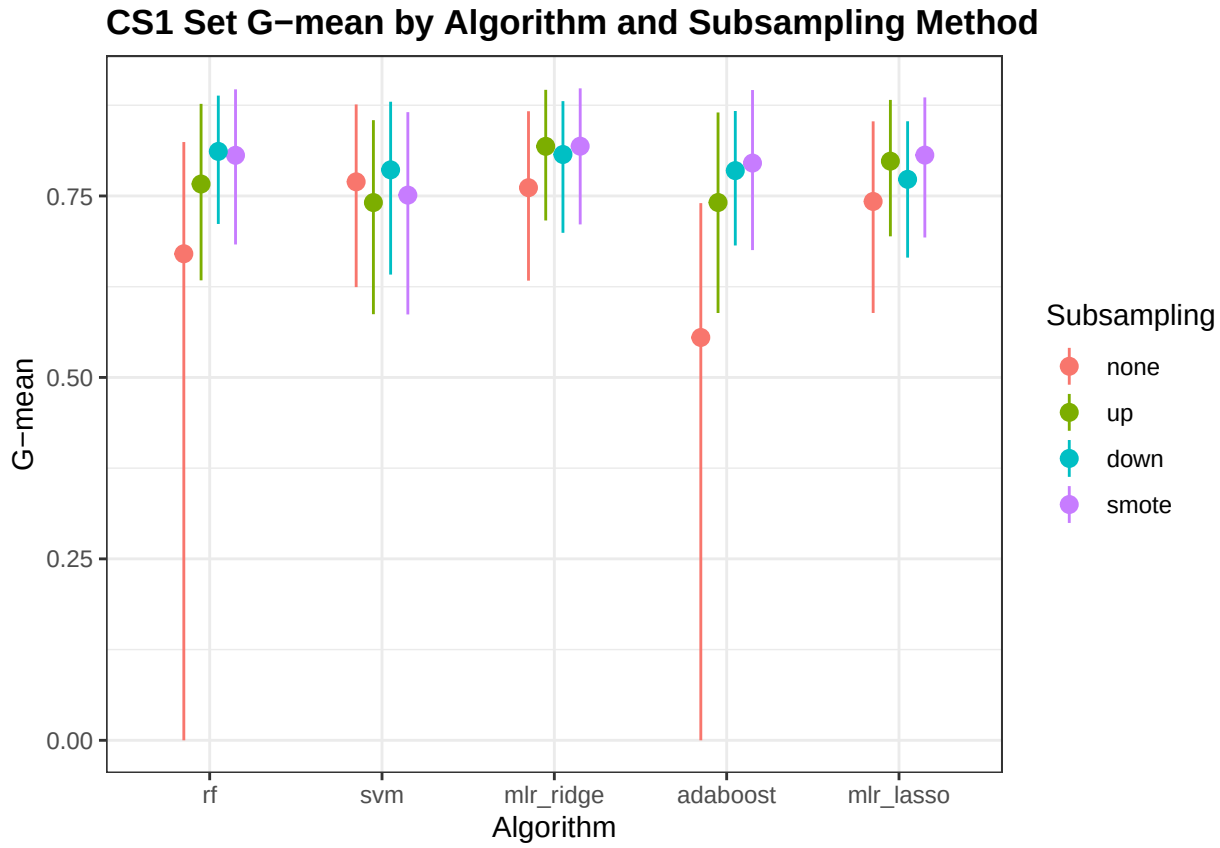

Figure 4.31: CS1 Set G-mean

Table 4.30: CS1 Set Class-Specific G-mean by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.888	0.885	0.883	0.876	0.882
none	ENOC	0.859	0.862	0.845	0.838	0.846
none	HGSC	0.908	0.909	0.91	0.883	0.899
none	LGSC	0.612	0.845	0.786	0.446	0.745
none	MUC	0.816	0.816	0.866	0.77	0.866
up	CCOC	0.891	0.882	0.889	0.888	0.87
up	ENOC	0.869	0.845	0.844	0.851	0.828
up	HGSC	0.927	0.905	0.908	0.913	0.905
up	LGSC	0.756	0.841	0.925	0.707	0.907
up	MUC	0.889	0.775	0.889	0.866	0.882
down	CCOC	0.899	0.882	0.899	0.89	0.878
down	ENOC	0.837	0.847	0.838	0.802	0.813
down	HGSC	0.878	0.874	0.846	0.853	0.842
down	LGSC	0.908	0.907	**0.938**	0.909	0.882
down	MUC	0.894	0.861	0.884	0.888	0.886
smote	CCOC	0.896	0.891	0.895	0.897	0.885
smote	ENOC	0.875	0.861	0.856	0.859	0.845
smote	HGSC	0.923	0.905	0.902	0.913	0.894
smote	LGSC	0.859	0.816	0.915	0.856	0.897
smote	MUC	0.889	0.775	0.889	0.883	0.89

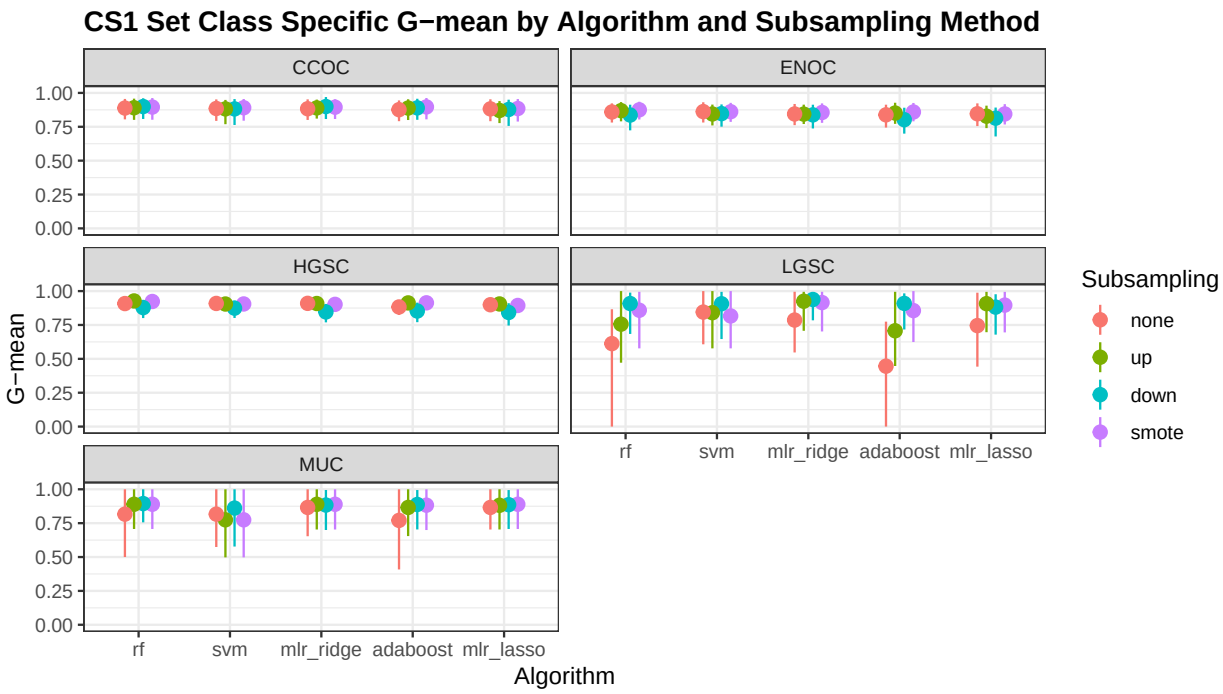

Figure 4.32: CS1 Set Class-Specific G-mean

Table 4.31: CS2 Set Accuracy by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.924	0.926	**0.936**	0.908	0.928
up	0.927	0.925	0.919	0.931	0.92
down	0.857	0.844	0.812	0.841	0.814
smote	0.925	0.922	0.912	0.923	0.899

4.4 CS2 Set

4.4.1 Accuracy

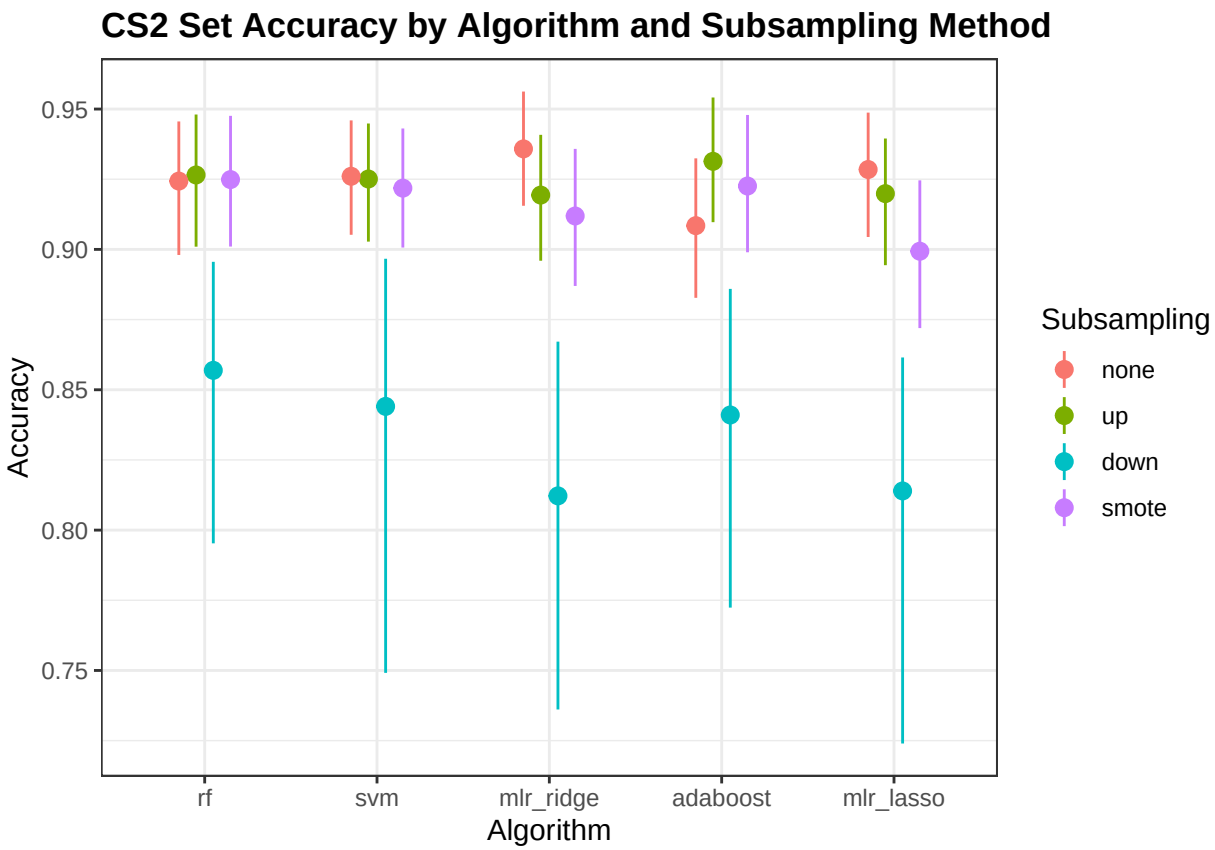

Figure 4.33: CS2 Set Accuracy

Table 4.32: CS2 Set Class-Specific Accuracy by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.986	0.983	**0.987**	0.983	0.984
none	ENOC	0.973	0.98	0.977	0.966	0.974
none	HGSC	0.93	0.936	0.949	0.911	0.944
none	LGSC	0.977	0.976	0.977	0.976	0.975
none	MUC	0.983	0.979	0.983	0.981	0.98
up	CCOC	0.986	0.981	**0.987**	0.986	0.984
up	ENOC	0.977	0.98	0.967	0.979	0.967
up	HGSC	0.931	0.933	0.938	0.941	0.939
up	LGSC	0.977	0.979	0.971	0.977	0.971
up	MUC	0.983	0.98	0.977	0.98	0.977
down	CCOC	0.98	0.959	0.976	0.979	0.97
down	ENOC	0.958	0.955	0.951	0.957	0.943
down	HGSC	0.878	0.869	0.839	0.865	0.843
down	LGSC	0.948	0.955	0.922	0.94	0.921
down	MUC	0.953	0.96	0.943	0.948	0.961
smote	CCOC	0.986	0.98	0.984	0.984	0.98
smote	ENOC	0.974	0.978	0.964	0.974	0.96
smote	HGSC	0.94	0.933	0.931	0.939	0.922
smote	LGSC	0.977	0.98	0.969	0.978	0.964
smote	MUC	0.973	0.975	0.977	0.971	0.974

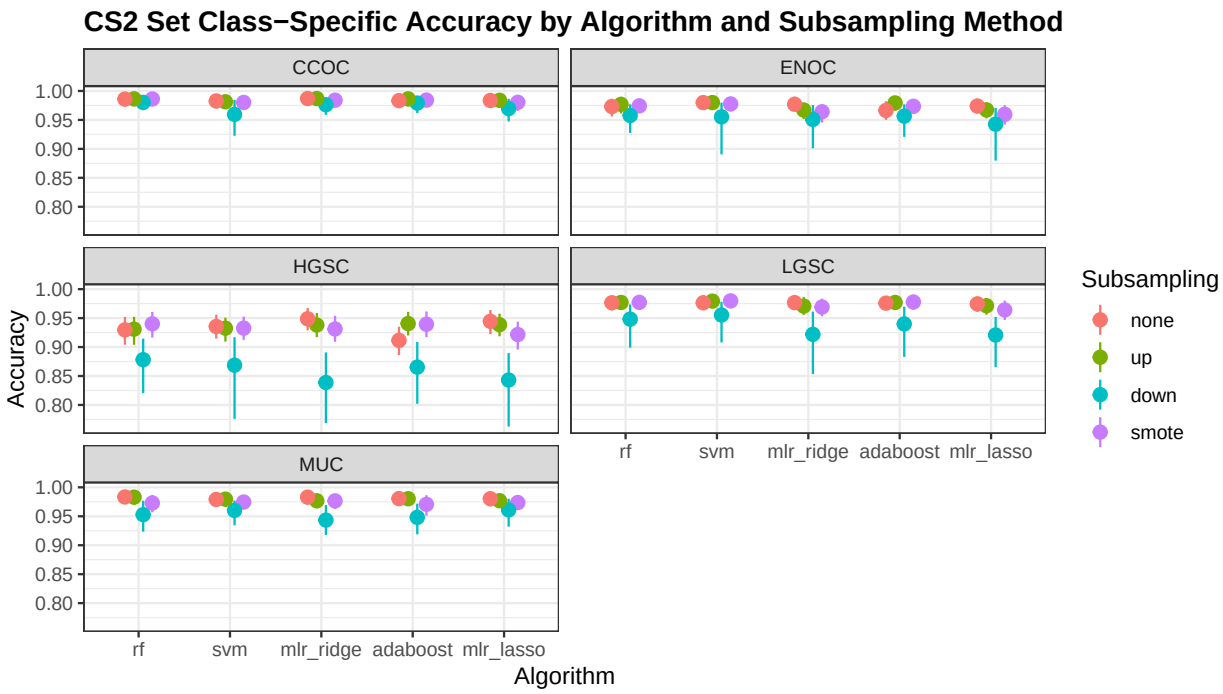

Figure 4.34: CS2 Set Class-Specific Accuracy

Table 4.33: CS2 Set Macro-Averaged F1-Score by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.725	0.762	0.755	0.748	0.739
up	0.722	0.752	**0.773**	0.739	0.757
down	0.696	0.673	0.649	0.675	0.647
smote	**0.773**	0.754	0.761	0.766	0.733

4.4.2 F1-Score

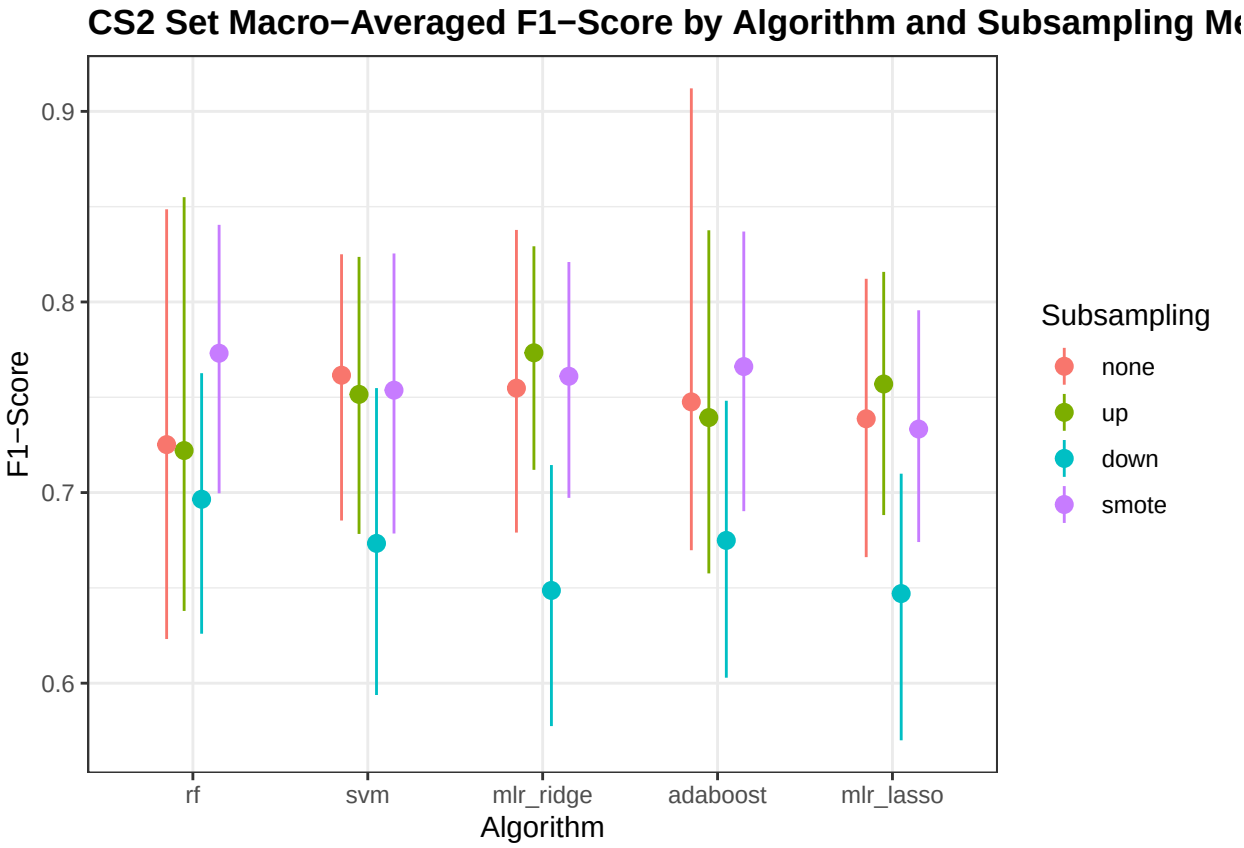

Figure 4.35: CS2 Set F1-Score

Table 4.34: CS2 Set Class-Specific F1-Score by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.889	0.865	0.905	0.872	0.884
none	ENOC	0.5	0.7	0.667	0.267	0.615
none	HGSC	0.957	0.96	**0.968**	0.947	0.965
none	LGSC	0.25	0.462	0.4	0.268	0.375
none	MUC	0.884	0.84	0.878	0.864	0.868
up	CCOC	0.895	0.857	0.913	0.898	0.894
up	ENOC	0.571	0.667	0.593	0.667	0.593
up	HGSC	0.958	0.959	0.96	0.963	0.961
up	LGSC	0.25	0.462	0.583	0.286	0.5
up	MUC	0.872	0.84	0.846	0.87	0.842
down	CCOC	0.872	0.76	0.84	0.857	0.8
down	ENOC	0.552	0.517	0.486	0.522	0.452
down	HGSC	0.918	0.911	0.888	0.908	0.892
down	LGSC	0.435	0.444	0.341	0.387	0.333
down	MUC	0.727	0.744	0.692	0.714	0.755
smote	CCOC	0.902	0.85	0.898	0.898	0.867
smote	ENOC	0.667	0.64	0.571	0.632	0.543
smote	HGSC	0.962	0.959	0.955	0.961	0.949
smote	LGSC	0.533	0.5	0.556	0.545	0.5
smote	MUC	0.826	0.821	0.843	0.816	0.83

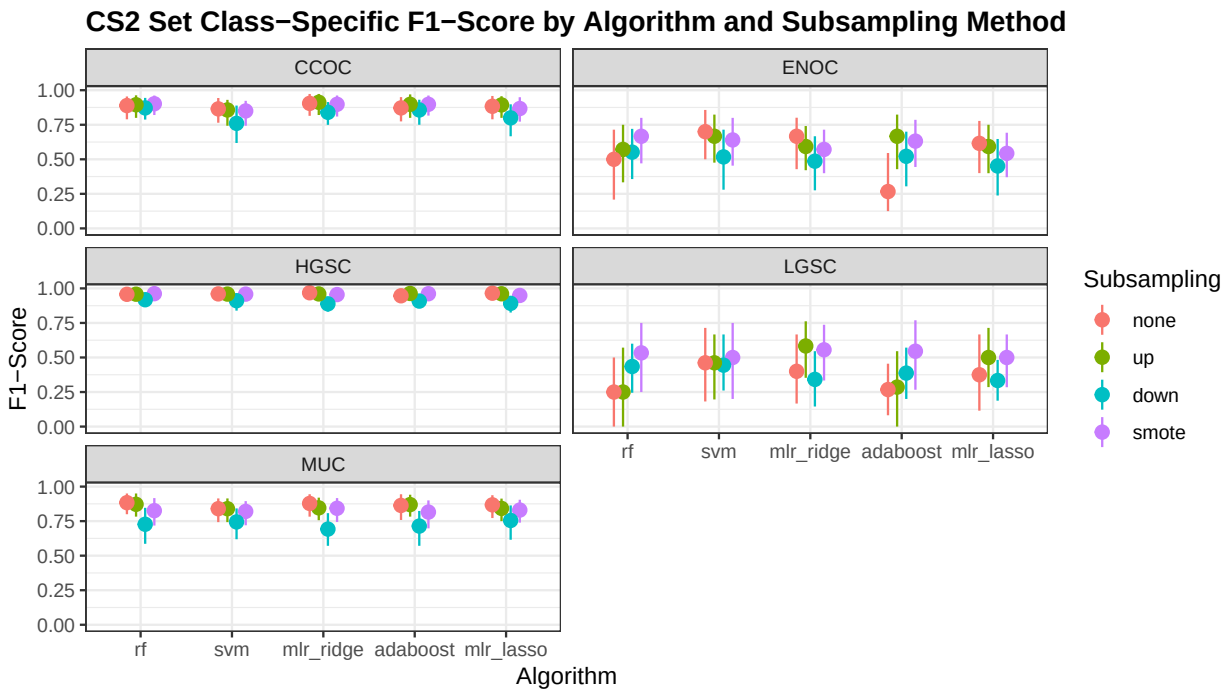

Figure 4.36: CS2 Set Class-Specific F1-Score

Table 4.35: CS2 Set Kappa by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.756	0.777	**0.81**	0.691	0.79
up	0.763	0.766	0.79	0.792	0.782
down	0.67	0.64	0.595	0.639	0.595
smote	0.793	0.762	0.773	0.786	0.744

4.4.3 Kappa

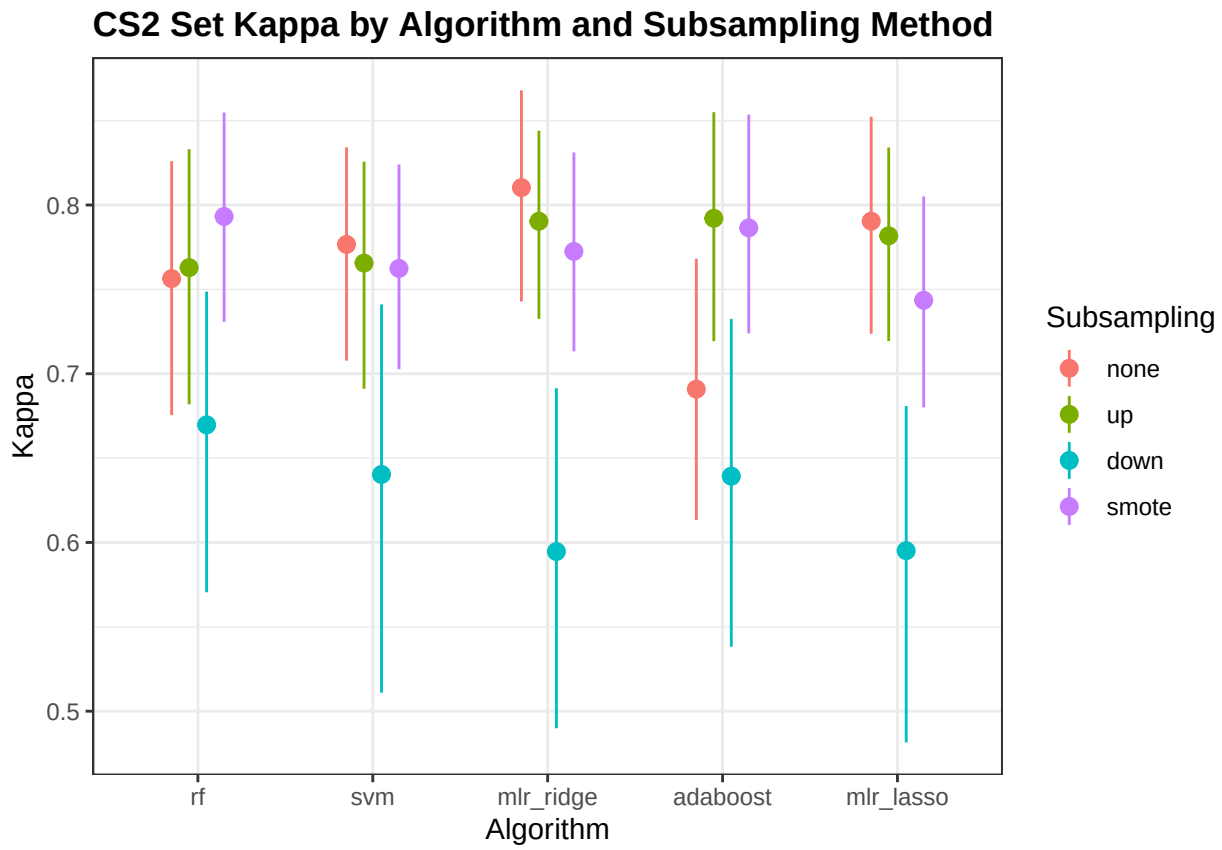

Figure 4.37: CS2 Set Kappa

Table 4.36: CS2 Set Class-Specific Kappa by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.88	0.856	0.898	0.863	0.875
none	ENOC	0.483	0.689	0.654	0.177	0.599
none	HGSC	0.762	0.792	0.838	0.68	0.822
none	LGSC	0.158	0.451	0.386	0	0.357
none	MUC	0.875	0.826	0.869	0.853	0.856
up	CCOC	0.888	0.844	**0.905**	0.889	0.885
up	ENOC	0.563	0.658	0.574	0.654	0.574
up	HGSC	0.764	0.773	0.822	0.805	0.816
up	LGSC	0.214	0.439	0.566	0.246	0.49
up	MUC	0.862	0.826	0.832	0.858	0.831
down	CCOC	0.862	0.74	0.826	0.847	0.785
down	ENOC	0.53	0.494	0.459	0.498	0.425
down	HGSC	0.683	0.661	0.609	0.655	0.614
down	LGSC	0.41	0.429	0.314	0.363	0.304
down	MUC	0.703	0.725	0.664	0.688	0.731
smote	CCOC	0.893	0.839	0.889	0.889	0.856
smote	ENOC	0.653	0.625	0.552	0.621	0.521
smote	HGSC	0.82	0.78	0.803	0.82	0.78
smote	LGSC	0.522	0.494	0.542	0.539	0.486
smote	MUC	0.81	0.808	0.831	0.799	0.815

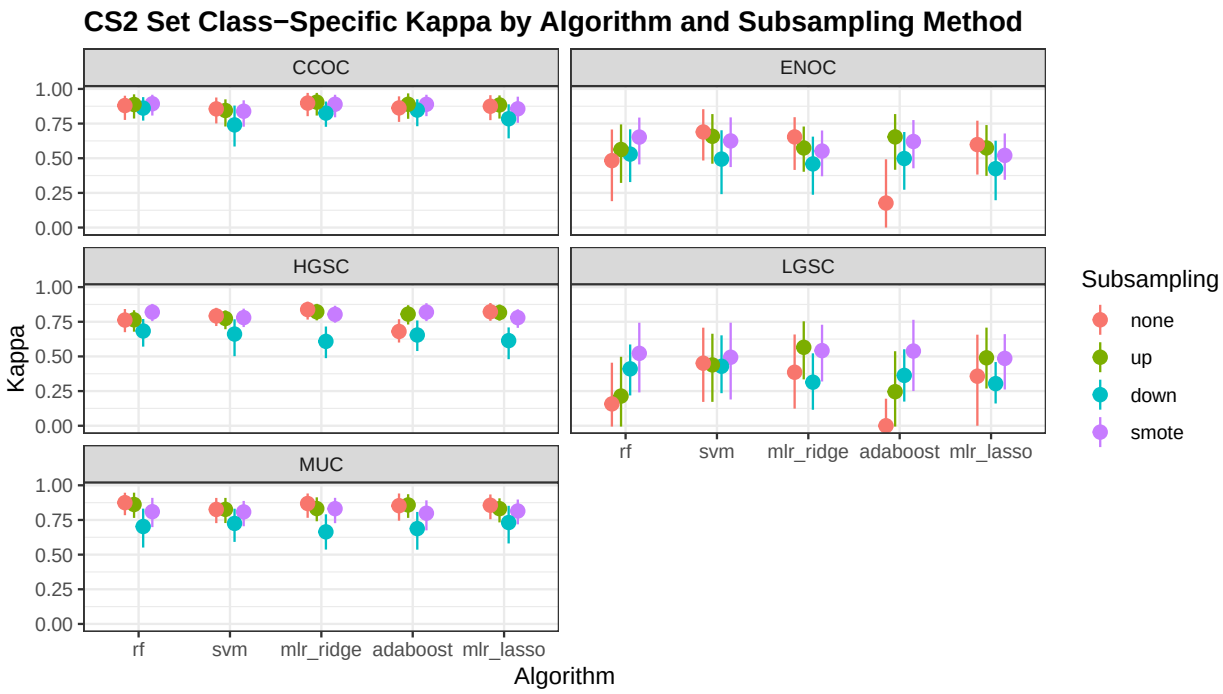

Figure 4.38: CS2 Set Class-Specific Kappa

Table 4.37: CS2 Set G-mean by Algorithm and Subsampling Method

sampling	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	0.169	0.683	0.648	0	0.652
up	0.496	0.643	**0.828**	0.572	0.764
down	**0.828**	0.798	0.798	0.807	0.79
smote	0.761	0.674	0.821	0.752	0.797

4.4.4 G-mean

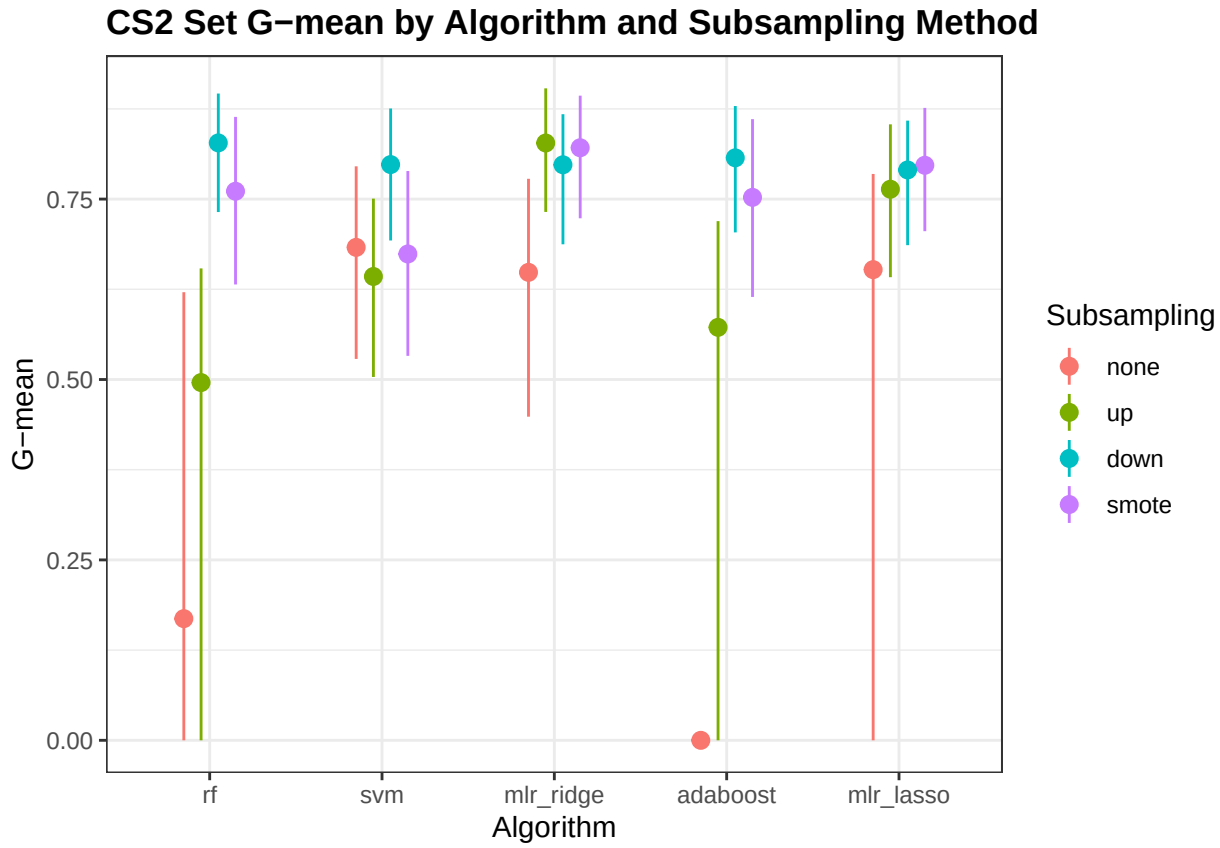

Figure 4.39: CS2 Set G-mean

Table 4.38: CS2 Set Class-Specific G-mean by Algorithm and Subsampling Method

sampling	histotype	rf	svm	mlr_ridge	adaboost	mlr_lasso
none	CCOC	0.911	0.892	0.934	0.888	0.924
none	ENOC	0.577	0.773	0.735	0.316	0.732
none	HGSC	0.827	0.864	0.891	0.764	0.89
none	LGSC	0.302	0.651	0.547	0	0.574
none	MUC	0.918	0.883	0.927	0.894	0.928
up	CCOC	0.909	0.866	**0.96**	0.931	0.938
up	ENOC	0.639	0.739	0.797	0.707	0.786
up	HGSC	0.825	0.837	0.938	0.869	0.918
up	LGSC	0.354	0.602	0.9	0.408	0.769
up	MUC	0.903	0.873	0.934	0.932	0.921
down	CCOC	0.958	0.937	0.929	0.947	0.919
down	ENOC	0.821	0.813	0.781	0.8	0.789
down	HGSC	0.903	0.888	0.878	0.892	0.877
down	LGSC	0.893	0.878	0.886	0.881	0.889
down	MUC	0.913	0.881	0.912	0.914	0.895
smote	CCOC	0.957	0.88	0.957	0.953	0.938
smote	ENOC	0.798	0.734	0.802	0.782	0.795
smote	HGSC	0.919	0.857	0.931	0.915	0.92
smote	LGSC	0.74	0.666	0.883	0.739	0.853
smote	MUC	0.929	0.882	0.929	0.927	0.915

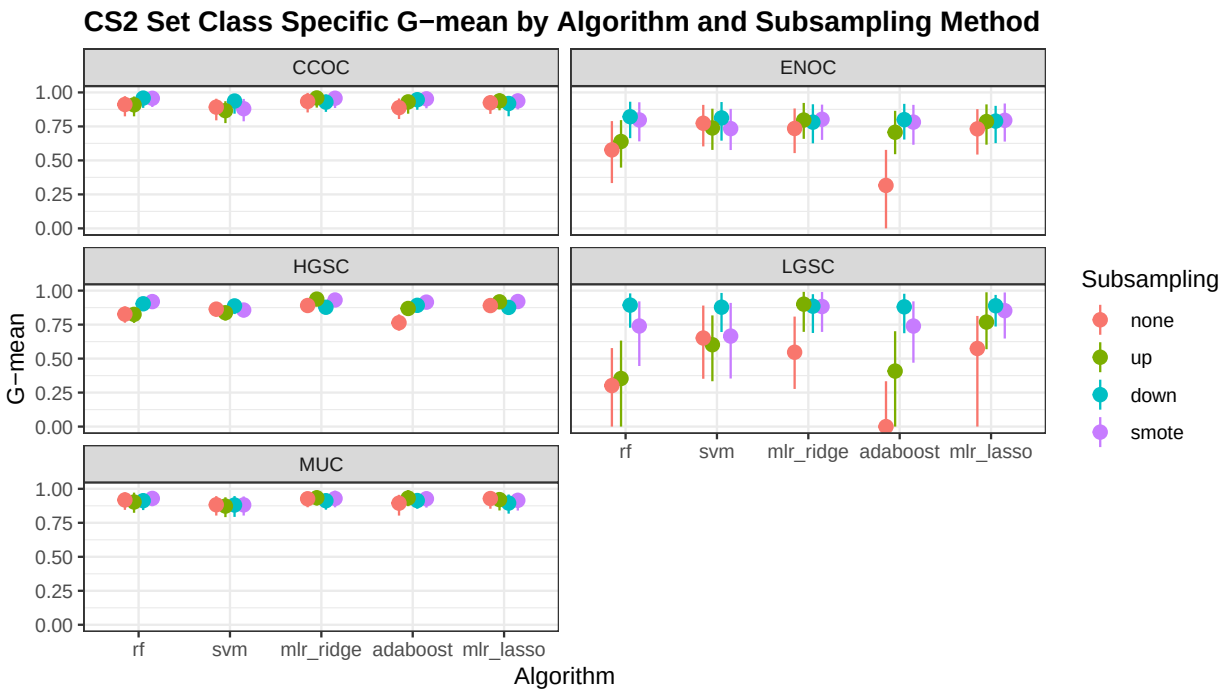

Figure 4.40: CS2 Set Class-Specific G-mean

Table 4.39: SMOTE Kappa by Algorithm and Dataset

dataset	rf	svm	mlr_ridge	adaboost	mlr_lasso
Training	**0.84**	0.816	0.778	0.819	0.765
CS1	0.789	0.767	0.765	0.769	0.747
CS2	0.793	0.762	0.773	0.786	0.744

4.5 SMOTE Kappa Summary

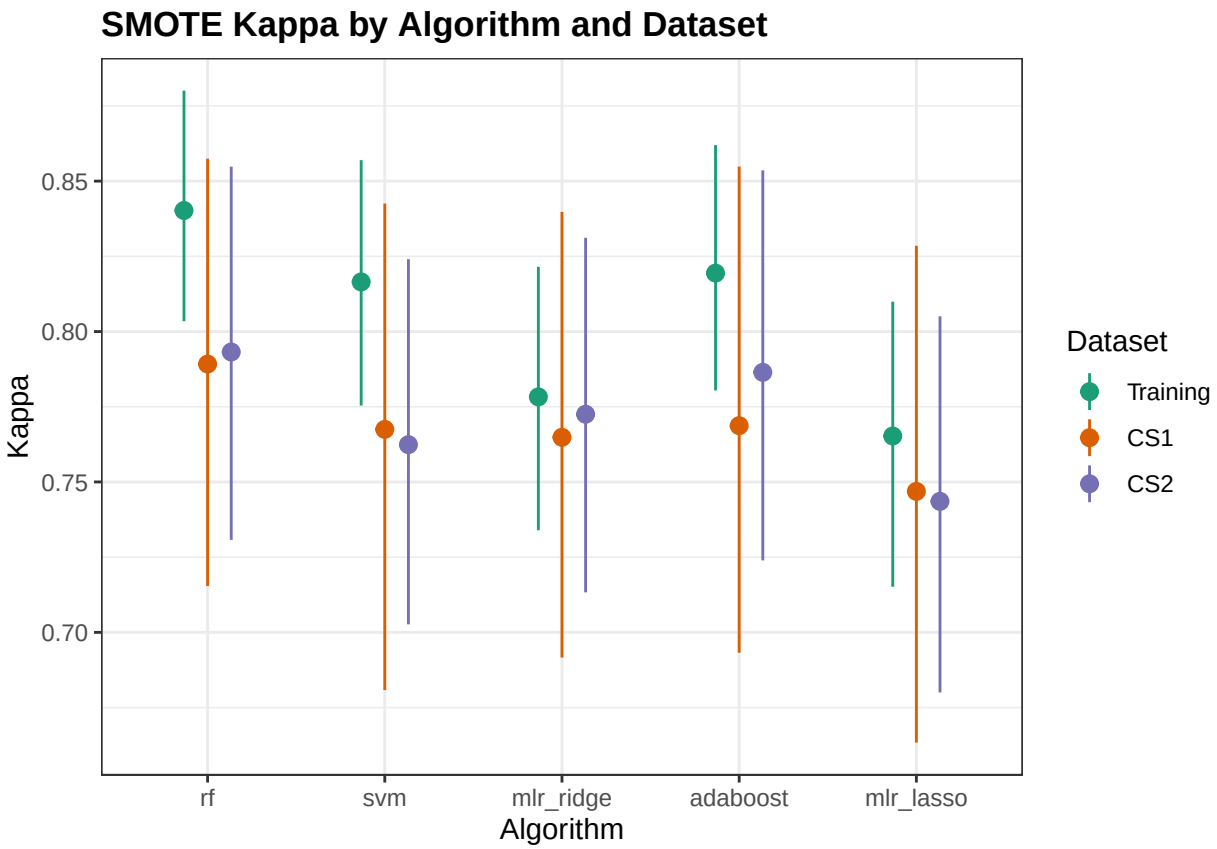

Figure 4.41: SMOTE Kappa by Algorithm and Dataset

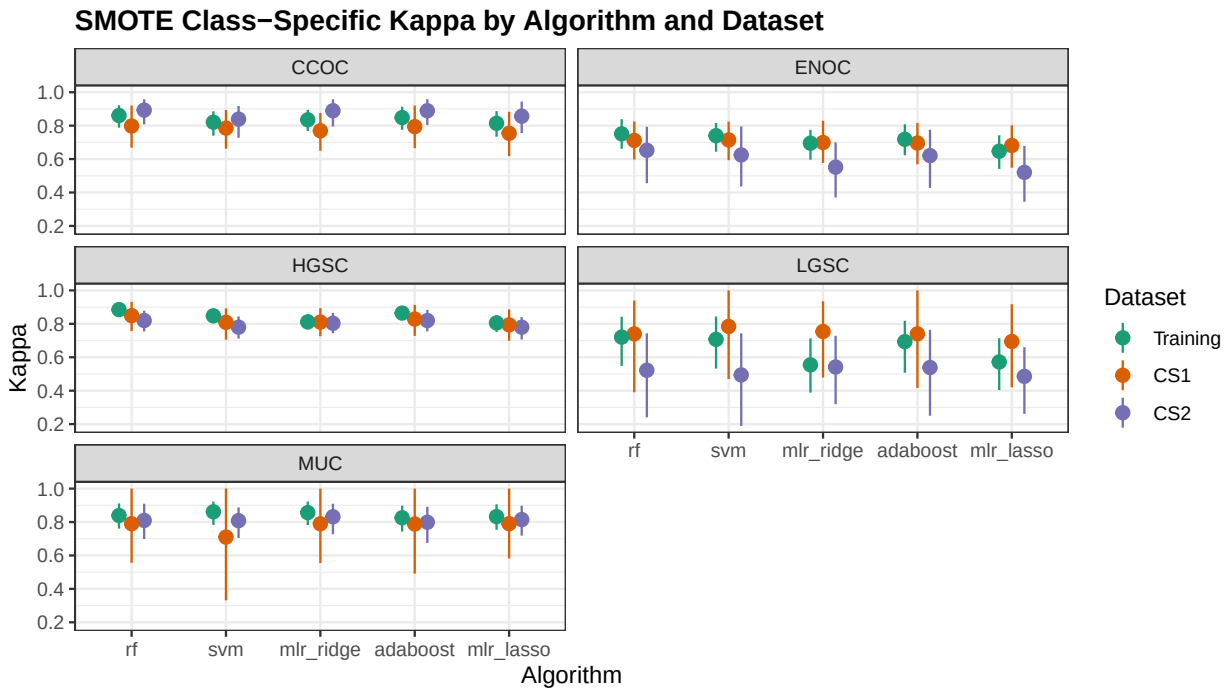

Figure 4.42: SMOTE Class-Specific Kappa by Algorithm and Dataset

4.6 Overlap with SPOT

There are 13 genes out of the 72 classifier set that overlap with the SPOT signature: HIF1A, CXCL10, DUSP4, SOX17, MITF, CDKN3, BRCA2, CEACAM5, ANXA4, SERPINE1, TCF7L1, CRABP2, DNAJC9.

4.7 Rank Aggregation

Show 50 entries Search:

F1-Score Summary by Model and Class

model	CCOC	ENOC	HGSC	LGSC	MUC
All	All	All	All	All	All
sequential-none	0.907	0.983	0.973	0.952	0.897
2S-rf-none	0.925	0.844	0.975	0.882	0.898
2S-rf-up	0.924	0.847	0.974	0.882	0.897
sequential-smote	0.907	0.971	0.973	0.931	0.9
sequential-down	0.904	0.971	0.964	0.933	0.898
2S-adaboost-up	0.918	0.838	0.973	0.889	0.885
2S-rf-smote	0.917	0.845	0.973	0.88	0.893
2S-adaboost-none	0.923	0.831	0.97	0.897	0.889
2S-mlr_ridge-none	0.9	0.833	0.968	0.909	0.914
sequential-up	0.897	0.971	0.973	0.929	0.885
rf-up	0.868	0.772	0.973	0.538	0.877
2S-svm-none	0.895	0.844	0.973	0.929	0.881
2S-svm-up	0.895	0.844	0.973	0.923	0.88
2S-svm-smote	0.892	0.844	0.972	0.923	0.881
2S-rf-down	0.909	0.828	0.964	0.871	0.875
2S-mlr_lasso-smote	0.897	0.825	0.963	0.867	0.889
2S-mlr_ridge-up	0.897	0.831	0.961	0.882	0.908
2S-adaboost-smote	0.909	0.824	0.97	0.882	0.885
2S-mlr_ridge-down	0.892	0.824	0.958	0.867	0.889
2S-mlr_lasso-none	0.896	0.824	0.967	0.871	0.889
2S-mlr_ridge-smote	0.895	0.831	0.965	0.88	0.909
2S-mlr_lasso-up	0.892	0.82	0.959	0.87	0.885
2S-svm-down	0.881	0.827	0.963	0.923	0.871
svm-none	0.857	0.776	0.972	0.667	0.875
rf-smote	0.87	0.767	0.976	0.727	0.848
mlr_ridge-none	0.871	0.758	0.971	0.381	0.887
2S-adaboost-down	0.9	0.806	0.962	0.88	0.852
rf-none	0.873	0.733	0.97	0.375	0.868
svm-up	0.831	0.75	0.971	0.72	0.867
mlr_lasso-none	0.862	0.737	0.972	0.5	0.857
adaboost-up	0.87	0.769	0.977	0.667	0.862
adaboost-smote	0.857	0.735	0.972	0.703	0.833
mlr_ridge-up	0.842	0.675	0.947	0.542	0.853
mlr_ridge-smote	0.847	0.714	0.958	0.571	0.863
mlr_lasso-smote	0.827	0.667	0.957	0.588	0.841
rf-down	0.842	0.657	0.934	0.476	0.8
adaboost-none	0.857	0.679	0.962	0.182	0.852
2S-mlr_lasso-down	0.896	0.812	0.955	0.857	0.852
mlr_lasso-up	0.795	0.636	0.957	0.621	0.825
svm-smote	0.831	0.754	0.97	0.714	0.868
svm-down	0.782	0.632	0.931	0.522	0.808
mlr_ridge-down	0.826	0.629	0.92	0.407	0.828
mlr_lasso-down	0.804	0.602	0.906	0.364	0.791
adaboost-down	0.833	0.619	0.93	0.473	0.768

Showing 1 to 44 of 44 entries Previous 1 Next

Table 4.40: Class-specific F1-scores on Confirmation Sets

method	HGSC	CCOC	ENOC	LGSC	MUC
2S-rf-none	0.914	0.872	0.772	0.439	0.717
sequential-none	0.903	0.915	0.922	0.500	0.711
2S-rf-smote	0.903	0.871	0.749	0.392	0.691
sequential-smote	0.903	0.922	0.911	0.500	0.745
rf-none	0.901	0.879	0.553	0.133	0.760

The 44 methods (algorithm-sampling combinations) are ordered in the table by their aggregated ranks using the Genetic Algorithm. We see that the best performing methods involve the 2-stage and sequential algorithms.

4.8 Test Set Performance

Now we'd like to see how our best methods perform in the confirmation and validation sets. The class-specific F1-scores will be used.

The top 4 methods are:

- **sequential-none**: sequential algorithm with no subsampling. The sequence of models and algorithms used are:
  - HGSC vs. non-HGSC using SVM
  - MUC vs. non-MUC using ridge regression
  - CCOC vs. non-CCOC using random forest
  - ENOC vs. LGSC using SVM
- **2S-rf-none**: 2-step method using random forest algorithm with no subsampling
- **2S-rf-up**: 2-step method using random forest algorithm with upsampling
- **sequential-smote**: sequential algorithm with SMOTE subsampling. The sequence of models and algorithms used are:
  - HGSC vs. non-HGSC using random forest
  - CCOC vs. non-CCOC using random forest
  - MUC vs. non-MUC using SVM
  - ENOC vs. LGSC using random forest

As a comparison we also show the F1-scores from the **rf-none** to see how the best methods improve from it.

4.8.1 Confirmation Set

In the confirmation set, **2S-rf-none** improves drastically in LGSC classification compard to **rf-none**, with moderate improvement in ENOC, and minor improvement in HGSC and CCOC. There is a decrease in MUC performance. **sequential-none** improves on **2S-rf-none** in all classes except for marginal decrease in HGSC performance.

4.8.2 Validation Set

Similarly in the validation set, **2S-rf-none** improves drastically in LGSC classification compared to **rf-none**, with large improvement in ENOC, and minor improvement in HGSC and CCOC. There is a decrease in MUC performance. **sequential-none** improves on **2S-rf-none** in all classes except for a small decrease in CCOC performance and same performance for LGSC.

Table 4.41: Class-specific F1-scores on Validation Sets

method	HGSC	CCOC	ENOC	LGSC	MUC
2S-rf-none	0.940	0.946	0.892	0.811	0.764
sequential-none	0.950	0.944	0.964	0.789	0.800
2S-rf-smote	0.934	0.945	0.877	0.780	0.750
sequential-smote	0.940	0.949	0.955	0.750	0.767
rf-none	0.933	0.867	0.628	0.182	0.778