Supplementary Material: Complete Model Performance Results

I. Complete Model Configurations and Test Performance Evaluation Results

This supplementary material presents the complete results from 120 machine learning experiments. To identify the model best suited to real-world (held-out) data, the table lists the performance on the test set in descending order. Due to space constraints in the main paper, the complete experimental results are presented in the following pages across multiple tables.

TABLE I
TEST SET CLASSIFICATION PERFORMANCE - PART 1 (RANKS 1-40)

Rank	Model	Class Weight	Undersampling	Oversampling	Macro $F1$	AUC	$F1_0$	$F1_1$	Precision$_0$	Precision$_1$	Recall$_0$	Recall$_1$
1	XGBoost	1:3	–	–	0.8026	0.8724	0.9902	0.6150	0.9852	0.7708	0.9953	0.5115
2	LightGBM	1:3	Tomek	–	0.7980	0.8825	0.9900	0.6061	0.9850	0.7534	0.9949	0.5069
3	LightGBM	1:3	OSS	–	0.7960	0.8821	0.9899	0.6022	0.9849	0.7517	0.9949	0.5023
4	LightGBM	1:3	–	–	0.7956	0.8795	0.9900	0.6011	0.9846	0.7698	0.9955	0.4931
5	LightGBM	Log	OSS	–	0.7953	0.8836	0.9895	0.6011	0.9854	0.7107	0.9935	0.5207
6	XGBoost	Log	–	–	0.7942	0.8796	0.9895	0.5989	0.9853	0.7134	0.9936	0.5161
7	XGBoost	1:3	–	SMOTE	0.7941	0.8716	0.9898	0.5983	0.9848	0.7500	0.9949	0.4977
8	LightGBM	Log	Tomek	–	0.7937	0.8812	0.9896	0.5978	0.9850	0.7285	0.9942	0.5069
9	LightGBM	1:3	Tomek	SMOTE	0.7909	0.8816	0.9895	0.5924	0.9849	0.7219	0.9941	0.5023
10	XGBoost	Log	Tomek	–	0.7906	0.8677	0.9892	0.5920	0.9852	0.7025	0.9934	0.5115
11	XGBoost	1:5	Tomek	–	0.7895	0.8755	0.9887	0.5903	0.9858	0.6591	0.9915	0.5346
12	LightGBM	1:3	–	SMOTE	0.7892	0.8781	0.9896	0.5889	0.9845	0.7413	0.9948	0.4885
13	XGBoost	1:3	OSS	–	0.7890	0.8717	0.9897	0.5882	0.9844	0.7500	0.9951	0.4839
14	CatBoost	–	OSS	SMOTE	0.7886	0.8672	0.9903	0.5868	0.9834	0.8376	0.9973	0.4516
15	XGBoost	–	Tomek	–	0.7886	0.8807	0.9903	0.5868	0.9834	0.8376	0.9973	0.4516
16	LightGBM	1:5	Tomek	–	0.7874	0.8836	0.9887	0.5861	0.9855	0.6628	0.9918	0.5253
17	XGBoost	1:3	Tomek	–	0.7876	0.8747	0.9895	0.5856	0.9845	0.7310	0.9945	0.4885
18	LightGBM	Log	–	–	0.7873	0.8812	0.9892	0.5854	0.9848	0.7105	0.9938	0.4977
19	CatBoost	1:3	OSS	–	0.7870	0.8737	0.9893	0.5847	0.9846	0.7181	0.9941	0.4931
20	CatBoost	Log	OSS	–	0.7865	0.8701	0.9892	0.5838	0.9847	0.7059	0.9936	0.4977
21	LightGBM	1:5	OSS	–	0.7859	0.8824	0.9882	0.5835	0.9859	0.6359	0.9905	0.5392
22	XGBoost	Log	OSS	–	0.7860	0.8726	0.9890	0.5829	0.9849	0.6943	0.9932	0.5023
23	LightGBM	1:3	OSS	SMOTE	0.7857	0.8796	0.9891	0.5822	0.9847	0.7013	0.9935	0.4977
24	CatBoost	–	OSS	–	0.7863	0.8758	0.9905	0.5820	0.9829	0.8868	0.9983	0.4332
25	XGBoost	Log	OSS	SMOTE	0.7849	0.8723	0.9887	0.5812	0.9851	0.6727	0.9924	0.5115
26	LightGBM	Log	–	SMOTE	0.7845	0.8739	0.9891	0.5799	0.9846	0.7039	0.9936	0.4931
27	CatBoost	1:3	Tomek	–	0.7845	0.8769	0.9891	0.5799	0.9846	0.7039	0.9936	0.4931
28	CatBoost	1:3	–	–	0.7848	0.8675	0.9898	0.5797	0.9837	0.7812	0.9960	0.4608
29	CatBoost	–	–	SMOTE	0.7833	0.8872	0.9901	0.5766	0.9832	0.8276	0.9972	0.4424
30	XGBoost	–	Tomek	SMOTE	0.7831	0.8729	0.9904	0.5759	0.9828	0.8774	0.9982	0.4286
31	LightGBM	Log	Tomek	SMOTE	0.7819	0.8786	0.9887	0.5752	0.9849	0.6728	0.9925	0.5023
32	LightGBM	1:5	–	–	0.7813	0.8813	0.9883	0.5744	0.9853	0.6474	0.9914	0.5161
33	XGBoost	–	–	–	0.7817	0.8761	0.9902	0.5732	0.9829	0.8468	0.9976	0.4332
34	CatBoost	Log	Tomek	–	0.7808	0.8720	0.9887	0.5729	0.9847	0.6750	0.9927	0.4977
35	XGBoost	1:5	–	–	0.7803	0.8701	0.9878	0.5728	0.9858	0.6170	0.9898	0.5346
36	XGBoost	–	–	SMOTE	0.7814	0.8774	0.9905	0.5723	0.9825	0.9010	0.9986	0.4194
37	CatBoost	Log	–	–	0.7803	0.8748	0.9893	0.5714	0.9839	0.7286	0.9946	0.4700
38	XGBoost	1:3	Tomek	SMOTE	0.7802	0.8794	0.9890	0.5714	0.9842	0.7075	0.9939	0.4793
39	CatBoost	–	Tomek	–	0.7804	0.8802	0.9902	0.5706	0.9828	0.8532	0.9977	0.4286
40	XGBoost	Log	Tomek	SMOTE	0.7789	0.8652	0.9879	0.5700	0.9855	0.6230	0.9903	0.5253

* "–" = Not Applied

TABLE II
TEST SET CLASSIFICATION PERFORMANCE - PART 2 (RANKS 41-80)

Rank	Model	Class Weight	Undersampling	Oversampling	Macro $F1$	AUC	$F1_0$	$F1_1$	Precision$_0$	Precision$_1$	Recall$_0$	Recall$_1$
41	LightGBM	–	Tomek	SMOTE	0.7795	0.8776	0.9903	0.5687	0.9825	0.8835	0.9983	0.4194
42	XGBoost	–	OSS	SMOTE	0.7795	0.8742	0.9903	0.5687	0.9825	0.8835	0.9983	0.4194
43	XGBoost	1:5	OSS	–	0.7779	0.8779	0.9879	0.5678	0.9854	0.6243	0.9904	0.5207
44	CatBoost	Log	–	SMOTE	0.7775	0.8700	0.9880	0.5671	0.9853	0.6292	0.9907	0.5161
45	LightGBM	–	–	SMOTE	0.7787	0.8782	0.9905	0.5669	0.9822	0.9175	0.9989	0.4101
46	LightGBM	Log	OSS	SMOTE	0.7769	0.8779	0.9883	0.5654	0.9847	0.6545	0.9920	0.4977
47	CatBoost	–	Tomek	SMOTE	0.7777	0.8752	0.9900	0.5653	0.9827	0.8304	0.9973	0.4286
48	LightGBM	–	OSS	–	0.7777	0.8785	0.9902	0.5652	0.9825	0.8667	0.9980	0.4194
49	LightGBM	–	–	–	0.7773	0.8837	0.9903	0.5643	0.9824	0.8824	0.9983	0.4147
50	CatBoost	1:3	OSS	SMOTE	0.7757	0.8793	0.9881	0.5633	0.9849	0.6412	0.9914	0.5023
51	LightGBM	–	OSS	SMOTE	0.7768	0.8799	0.9903	0.5633	0.9822	0.8990	0.9986	0.4101
52	XGBoost	1:3	OSS	SMOTE	0.7758	0.8750	0.9885	0.5630	0.9843	0.6731	0.9928	0.4839
53	CatBoost	Log	Tomek	SMOTE	0.7753	0.8854	0.9880	0.5627	0.9850	0.6322	0.9910	0.5069
54	CatBoost	1:3	Tomek	SMOTE	0.7734	0.8759	0.9879	0.5590	0.9848	0.6301	0.9910	0.5023
55	CatBoost	1:3	–	SMOTE	0.7738	0.8672	0.9887	0.5589	0.9839	0.6892	0.9935	0.4700
56	XGBoost	1:5	–	SMOTE	0.7724	0.8697	0.9870	0.5577	0.9858	0.5829	0.9883	0.5346
57	XGBoost	Log	–	SMOTE	0.7723	0.8751	0.9879	0.5567	0.9847	0.6316	0.9911	0.4977
58	CatBoost	Log	OSS	SMOTE	0.7712	0.8881	0.9875	0.5550	0.9851	0.6066	0.9898	0.5115
59	XGBoost	–	OSS	–	0.7714	0.8782	0.9897	0.5532	0.9825	0.8125	0.9970	0.4194
60	CatBoost	–	–	–	0.7703	0.8641	0.9901	0.5506	0.9819	0.8788	0.9983	0.4009
61	CatBoost	1:5	Tomek	–	0.7652	0.8777	0.9867	0.5437	0.9852	0.5744	0.9883	0.5161
62	LightGBM	1:5	–	SMOTE	0.7640	0.8802	0.9864	0.5416	0.9855	0.5588	0.9873	0.5253
63	LightGBM	1:5	OSS	SMOTE	0.7634	0.8767	0.9861	0.5408	0.9858	0.5472	0.9864	0.5346
64	LightGBM	–	Tomek	–	0.7648	0.8778	0.9898	0.5397	0.9817	0.8673	0.9982	0.3917
65	XGBoost	1:5	Tomek	SMOTE	0.7626	0.8676	0.9862	0.5390	0.9855	0.5534	0.9870	0.5253
66	CatBoost	1:5	–	–	0.7617	0.8743	0.9870	0.5363	0.9845	0.5879	0.9894	0.4931
67	CatBoost	1:5	OSS	–	0.7611	0.8601	0.9863	0.5359	0.9852	0.5572	0.9874	0.5161
68	RandomForest	–	Tomek	SMOTE	0.7621	0.8488	0.9893	0.5350	0.9821	0.7857	0.9966	0.4055
69	RandomForest	–	–	SMOTE	0.7618	0.8514	0.9895	0.5342	0.9818	0.8190	0.9973	0.3963
70	CatBoost	1:5	–	SMOTE	0.7595	0.8717	0.9864	0.5327	0.9849	0.5612	0.9879	0.5069
71	XGBoost	1:5	OSS	SMOTE	0.7564	0.8707	0.9862	0.5266	0.9848	0.5533	0.9876	0.5023
72	LightGBM	1:5	Tomek	SMOTE	0.7541	0.8850	0.9853	0.5229	0.9855	0.5205	0.9852	0.5253
73	RandomForest	1:5	Tomek	SMOTE	0.7555	0.8622	0.9887	0.5223	0.9820	0.7333	0.9955	0.4055
74	RandomForest	–	OSS	SMOTE	0.7553	0.8507	0.9891	0.5215	0.9816	0.7798	0.9966	0.3917
75	RandomForest	Log	Tomek	SMOTE	0.7520	0.8525	0.9888	0.5152	0.9816	0.7522	0.9960	0.3917
76	CatBoost	1:5	Tomek	SMOTE	0.7493	0.8716	0.9849	0.5136	0.9853	0.5067	0.9845	0.5207
77	CatBoost	1:5	OSS	SMOTE	0.7489	0.8737	0.9845	0.5133	0.9857	0.4936	0.9832	0.5346
78	RandomForest	Log	–	SMOTE	0.7497	0.8581	0.9887	0.5106	0.9815	0.7500	0.9960	0.3871
79	RandomForest	1:3	Tomek	SMOTE	0.7474	0.8445	0.9886	0.5061	0.9814	0.7477	0.9960	0.3825
80	RandomForest	Log	Tomek	–	0.7459	0.8505	0.9887	0.5031	0.9812	0.7523	0.9962	0.3779

* "–" = Not Applied

TABLE III
TEST SET CLASSIFICATION PERFORMANCE - PART 3 (RANKS 81-120)

Rank	Model	Class Weight	Undersampling	Oversampling	Macro $F1$	AUC	$F1_0$	$F1_1$	Precision_0	Precision_1	Recall_0	Recall_1
81	RandomForest	1:3	OSS	SMOTE	0.7458	0.8544	0.9885	0.5030	0.9814	0.7345	0.9958	0.3825
82	RandomForest	–	Tomek	–	0.7452	0.8416	0.9889	0.5016	0.9810	0.7843	0.9969	0.3687
83	RandomForest	Log	OSS	SMOTE	0.7442	0.8550	0.9884	0.5000	0.9814	0.7217	0.9955	0.3825
84	RandomForest	1:5	OSS	SMOTE	0.7434	0.8485	0.9883	0.4985	0.9813	0.7155	0.9953	0.3825
85	RandomForest	1:5	–	SMOTE	0.7427	0.8433	0.9884	0.4970	0.9812	0.7257	0.9956	0.3779
86	RandomForest	1:3	–	SMOTE	0.7427	0.8540	0.9885	0.4969	0.9811	0.7431	0.9960	0.3733
87	RandomForest	–	–	–	0.7429	0.8616	0.9889	0.4968	0.9807	0.8041	0.9973	0.3594
88	RandomForest	–	OSS	–	0.7396	0.8506	0.9887	0.4906	0.9807	0.7723	0.9968	0.3594
89	RandomForest	1:3	OSS	–	0.7388	0.8446	0.9886	0.4890	0.9807	0.7647	0.9966	0.3594
90	RandomForest	Log	OSS	–	0.7357	0.8356	0.9882	0.4832	0.9808	0.7182	0.9956	0.3641
91	RandomForest	1:3	Tomek	–	0.7341	0.8512	0.9882	0.4800	0.9807	0.7222	0.9958	0.3594
92	RandomForest	1:3	–	–	0.7324	0.8429	0.9883	0.4765	0.9804	0.7451	0.9963	0.3502
93	RandomForest	1:5	Tomek	–	0.7300	0.8430	0.9882	0.4717	0.9803	0.7426	0.9963	0.3456
94	RandomForest	Log	–	–	0.7299	0.8436	0.9884	0.4713	0.9801	0.7629	0.9968	0.3410
95	RandomForest	1:5	OSS	–	0.7245	0.8511	0.9879	0.4611	0.9801	0.7115	0.9958	0.3410
96	RandomForest	1:5	–	–	0.7235	0.8565	0.9880	0.4591	0.9800	0.7228	0.9960	0.3364
97	LogisticRegression	Log	–	–	0.7089	0.8010	0.9856	0.4321	0.9806	0.5417	0.9907	0.3594
98	LogisticRegression	Log	OSS	–	0.7076	0.7968	0.9862	0.4290	0.9801	0.5781	0.9924	0.3410
99	LogisticRegression	1:3	OSS	–	0.7076	0.8042	0.9862	0.4290	0.9801	0.5781	0.9924	0.3410
100	LogisticRegression	1:5	OSS	–	0.7050	0.8064	0.9839	0.4261	0.9815	0.4670	0.9863	0.3917
101	LogisticRegression	1:3	–	–	0.7058	0.7932	0.9869	0.4246	0.9794	0.6389	0.9945	0.3180
102	LogisticRegression	1:5	–	–	0.7010	0.8061	0.9843	0.4178	0.9808	0.4819	0.9879	0.3687
103	LogisticRegression	Log	Tomek	–	0.6971	0.8034	0.9868	0.4075	0.9789	0.6373	0.9948	0.2995
104	LogisticRegression	1:5	Tomek	–	0.6956	0.8107	0.9846	0.4065	0.9801	0.4934	0.9891	0.3456
105	LogisticRegression	1:3	Tomek	–	0.6945	0.8004	0.9855	0.4035	0.9795	0.5385	0.9915	0.3226
106	LogisticRegression	1:3	OSS	SMOTE	0.6652	0.7978	0.9834	0.3471	0.9785	0.4315	0.9883	0.2903
107	LogisticRegression	1:5	–	SMOTE	0.6596	0.8109	0.9781	0.3412	0.9806	0.3175	0.9757	0.3687
108	LogisticRegression	Log	–	SMOTE	0.6577	0.7994	0.9804	0.3349	0.9793	0.3483	0.9815	0.3226
109	LogisticRegression	1:3	Tomek	SMOTE	0.6560	0.7738	0.9823	0.3298	0.9783	0.3899	0.9863	0.2857
110	LogisticRegression	–	OSS	SMOTE	0.6563	0.7874	0.9859	0.3267	0.9767	0.5904	0.9952	0.2258
111	LogisticRegression	Log	Tomek	SMOTE	0.6524	0.8011	0.9803	0.3245	0.9789	0.3418	0.9818	0.3088
112	LogisticRegression	–	Tomek	–	0.6522	0.7831	0.9868	0.3177	0.9761	0.7333	0.9977	0.2028
113	LogisticRegression	1:5	Tomek	SMOTE	0.6440	0.7919	0.9739	0.3140	0.9810	0.2642	0.9670	0.3871
114	LogisticRegression	1:3	–	SMOTE	0.6461	0.8042	0.9816	0.3105	0.9779	0.3620	0.9853	0.2719
115	LogisticRegression	1:5	OSS	SMOTE	0.6411	0.8023	0.9738	0.3083	0.9807	0.2603	0.9671	0.3779
116	LogisticRegression	Log	OSS	SMOTE	0.6404	0.7931	0.9794	0.3014	0.9783	0.3134	0.9805	0.2903
117	LogisticRegression	–	Tomek	SMOTE	0.6401	0.8006	0.9862	0.2939	0.9757	0.6613	0.9970	0.1889
118	LogisticRegression	–	OSS	–	0.6377	0.7874	0.9866	0.2889	0.9754	0.7358	0.9980	0.1797
119	LogisticRegression	–	–	SMOTE	0.6266	0.8014	0.9851	0.2680	0.9754	0.5270	0.9951	0.1797
120	LogisticRegression	–	–	–	0.6133	0.7858	0.9863	0.2403	0.9744	0.7561	0.9986	0.1429

* "–" = Not Applied