

A Study of the Learnability of Relational Properties

Model Counting Meets Machine Learning (MCML)

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CCS Concepts • **Mathematics of computing** → *Spectra of graphs*; • **Computing methodologies** → *Cross-validation*;

Keywords Relational properties, machine learning, model counting, SAT solving, Alloy, ApproxMC, ProjMC

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1 Datasets

Alloy models used in paper are stored under datasets/alloy-models directory, where both models with and without symmetry breaking are included. Datasets generated using the Alloy models are stored in csv files under datasets/csv directory.

Alloy generated ground-truth Conjunctive Normal Form (CNF) formulas are in datasets/cnf directory. There are two sub-directories for two sizes of scopes. Directory large contains CNF formulas with a big scope (as shown in Table 1 of Submitted Paper), directory small contains CNF formulas for a smaller scope.

The datasets/accmc directory contains the CNF formulas for the AccMC, which quantifies the accuracy of trained ML models with respect to ground truth formulas. There

are 4 sub-directories: (1) groundoff_treeoff, containing CNF files when ground truth is without symmetry breaking constraints and decision tree was trained on datasets generated by turning symmetry breaking Off; (2) groundoff_treeon, containing CNF files when ground truth is without symmetry breaking constraints and decision tree was trained on datasets generated by turning symmetry breaking On; (3) groundon_treeoff, containing CNF files when ground truth has symmetry breaking constraints and decision tree was trained on datasets generated by turning symmetry breaking Off; and (4) groundon_treeon, containing CNF files when ground truth has symmetry breaking constraints and decision tree was trained on datasets generated by turning symmetry breaking On. The file names follow the naming convention label_property.cnf (e.g., tf_equivalence.cnf refers to the case when equivalence property was satisfied but decision tree predicted the label false). These CNF formulas will be regenerated using the commands presented at end of document.

The datasets/diffmc directory contains CNF formulas for DiffMC, which quantifies the semantic differences between the two trained models. There are two subdirectories: (1) treeon_treeon, containing CNF files when decision trees were trained on dataset generated using symmetry breaking; and (2) treeoff_treeoff, containing CNF files of tree when decision trees were generated on datasets without symmetry breaking. The file names follow the naming convention label_property.cnf (e.g., tf_equivalence.cnf refers to the case when one tree predicted the label true and other predicted the label false). These CNF formulas will be regenerated using the commands presented at end of document.

2 Property specifications in Alloy

The Alloy specification that follows formalizes the properties used in our study; all of them are well-known properties of relations (and graphs); some of them are part of the standard specifications included with the Alloy distribution (<http://alloytools.org/download.html>); the predicates describe the properties; the run commands provide the scopes used in the study.

```
// set and relation declaration
```

*Research performed while at the University of Texas at Austin.

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```

sig S {
  r: set S
}

// predicates

pred Antisymmetric() {
  all s, t: S | s->t in r and t->s in r implies s = t
}

pred Bijective() {
  Surjective[]
  Injective[]
}

pred Connex() {
  all s, t: S | s->t in r or t->s in r
}

pred Equivalence() {
  Reflexive[]
  Symmetric[]
  Transitive[]
}

pred Function() { // total function
  all s: S | one s.r
}

pred Functional() { // total or partial function
  all s: S | lone s.r
}

pred Injective() {
  Functional[]
  all s: S | some s.r
}

pred Irreflexive() {
  all s, t: S | s->t in r implies s != t
}

pred NonStrictOrder() {
  Reflexive[]
  Antisymmetric[]
  Transitive[]
}

pred PartialOrder() {
  Antisymmetric[]
  Transitive[]
}

pred PreOrder() {
  Reflexive[]
  Transitive[]
}

```

```

pred Reflexive() {
  all s: S | s->s in r
}

pred StrictOrder() {
  Irreflexive[]
  Transitive[]
}

pred Surjective() {
  Functional[]
  all s: S | some s.~r
}

pred Symmetric() {
  all s, t: S | s->t in r implies t->s in r
}

pred TotalOrder() {
  PartialOrder[]
  Connex[]
}

pred Transitive() {
  all s, t, u: S | s->t in r and t->u in r implies s->u in r
}

// commands

run Antisymmetric for exactly 5 S

run Bijective for exactly 14 S

run Connex for exactly 6 S

run Equivalence for exactly 20 S

run Function for exactly 8 S

run Functional for exactly 8 S

run Injective for exactly 8 S

run Irreflexive for exactly 5 S

run NonStrictOrder for exactly 7 S

run PartialOrder for exactly 6 S

run PreOrder for exactly 7 S

run Reflexive for exactly 5 S

run StrictOrder for exactly 7 S

run Surjective for exactly 14 S

```

run TotalOrder for exactly 13 S

run Transitive for exactly 6 S

3 CNF statistics

This section provides the tables that show the basic information, i.e., total number of primary variables, total number of all variables, total number of clauses in the CNF formulas that are created for the model counting problems. The formulas that quantify differences between two decision trees have much fewer variables (in total) and clauses than the formulas that quantify differences between ground truth and decision trees.

Table 1. *Ground truth (Symmetry Breaking Off)– Decision Tree (Symmetry Breaking Off)* Statistics for CNF formulas. The number of primary variables, and the total number of variables and total number of clauses are tabulated for each of the four cases considered (i.e., true positive (TP), false negative (FN), false positive (FP), and true negative (TN)).

<i>Property</i>	<i>Prim. Var</i>	<i>TP Total Var</i>	<i>TP Clauses</i>	<i>FN Total Var</i>	<i>FN Clauses</i>	<i>FP Total Var</i>	<i>FP Clauses</i>	<i>TN Total Var</i>	<i>TN Clauses</i>
<i>Antisymmetric</i>	25	41	1015	41	1031	147	1185	147	1201
<i>Bijjective</i>	81	258	400	258	335	258	464	258	399
<i>Connex</i>	25	41	69	41	74	133	231	133	236
<i>Equivalence</i>	100	1959	2591	1959	2582	1960	3349	1960	3340
<i>Function</i>	36	103	206	103	163	113	282	113	239
<i>Functional</i>	36	103	233	103	165	113	239	113	171
<i>Injective</i>	36	105	203	105	158	105	205	105	160
<i>Irreflexive</i>	25	31	10	31	6	125	147	125	143
<i>NonStrictOrder</i>	36	391	507	391	489	392	624	392	606
<i>PartialOrder</i>	25	223	514	223	435	223	576	223	497
<i>PreOrder</i>	36	390	528	390	516	3980	659	390	647
<i>Reflexive</i>	25	31	10	31	6	81	98	81	94
<i>StrictOrder</i>	36	390	480	390	464	390	611	390	595
<i>Surjective</i>	81	255	381	255	313	255	383	255	315
<i>TotalOrder</i>	81	1391	1834	1391	1819	1391	2331	1391	2316
<i>Transitive</i>	25	221	774	221	672	229	862	229	760

Table 2. *Ground truth (Symmetry Breaking Off)– Decision Tree (Symmetry Breaking On) Statistics for CNF formulas. The number of primary variables, and the total number of variables and total number of clauses are tabulated for each of the four cases considered (i.e., true positive (TP), false negative (FN), false positive (FP), and true negative (TN)).*

<i>Property</i>	<i>Prim. Var</i>	<i>TP Total Var</i>	<i>TP Clauses</i>	<i>FN Total Var</i>	<i>FN Clauses</i>	<i>FP Total Var</i>	<i>FP Clauses</i>	<i>TN Total Var</i>	<i>TN Clauses</i>
<i>Antisymmetric</i>	25	41	132	41	107	147	302	147	277
<i>Bijjective</i>	196	608	785	608	778	608	954	608	947
<i>Connex</i>	36	58	58	58	45	183	283	183	270
<i>Equivalence</i>	400	15814	22260	15814	22254	15815	29273	15815	298267
<i>Function</i>	64	185	245	185	235	183	349	183	339
<i>Functional</i>	64	185	228	185	218	183	206	183	196
<i>Injective</i>	64	187	242	187	235	187	244	187	237
<i>Irreflexive</i>	25	31	10	31	6	125	147	125	143
<i>NonStrictOrder</i>	49	627	780	627	770	628	986	628	976
<i>PartialOrder</i>	36	390	536	390	486	390	658	390	608
<i>PreOrder</i>	49	626	758	626	749	626	984	626	975
<i>Reflexive</i>	25	31	10	31	6	81	98	81	94
<i>StrictOrder</i>	49	626	755	626	747	626	981	626	973
<i>Surjective</i>	196	605	752	605	745	605	754	605	747
<i>TotalOrder</i>	169	4243	5799	4243	5790	4243	7504	4243	7495
<i>Transitive</i>	36	388	562	388	490	316	570	316	498

Table 3. *Ground truth (Symmetry Breaking On)– Decision Tree (Symmetry Breaking Off)* Statistics for CNF formulas. The number of primary variables, and the total number of variables and total number of clauses are tabulated for each of the four cases considered (i.e., true positive (TP), false negative (FN), false positive (FP), and true negative (TN)).

<i>Property</i>	<i>Prim. Var</i>	<i>TP Total Var</i>	<i>TP Clauses</i>	<i>FN Total Var</i>	<i>FN Clauses</i>	<i>FP Total Var</i>	<i>FP Clauses</i>	<i>TN Total Var</i>	<i>TN Clauses</i>
<i>Antisymmetric</i>	25	167	1221	167	1237	305	1446	305	1462
<i>Bijjective</i>	81	764	1258	764	1193	764	1321	764	1256
<i>Connex</i>	25	167	275	167	280	291	492	291	497
<i>Equivalence</i>	100	2591	3673	2591	3664	2592	4439	2592	4430
<i>Function</i>	36	300	533	300	490	330	643	330	600
<i>Functional</i>	36	300	560	300	492	330	600	330	532
<i>Injective</i>	36	302	530	302	485	302	531	302	486
<i>Irreflexive</i>	25	157	216	157	212	283	408	283	404
<i>NonStrictOrder</i>	36	588	834	588	816	589	950	589	932
<i>PartialOrder</i>	25	349	720	349	641	349	781	349	702
<i>PreOrder</i>	36	587	855	587	843	587	985	587	973
<i>Reflexive</i>	25	157	216	157	212	223	331	223	327
<i>StrictOrder</i>	36	587	807	587	791	587	937	587	921
<i>Surjective</i>	81	761	1239	761	1171	761	1240	761	1172
<i>TotalOrder</i>	81	1897	2692	1897	2677	1897	3188	1897	3173
<i>Transitive</i>	25	347	980	347	878	403	1151	403	1049

Table 4. *Ground truth (Symmetry Breaking On)– Decision Tree (Symmetry Breaking On)* Statistics for CNF formulas. The number of primary variables, and the total number of variables and total number of clauses are tabulated for each of the four cases considered (i.e., true positive (TP), false negative (FN), false positive (FP), and true negative (TN)).

<i>Property</i>	<i>Prim. Var</i>	<i>TP Total Var</i>	<i>TP Clauses</i>	<i>FN Total Var</i>	<i>FN Clauses</i>	<i>FP Total Var</i>	<i>FP Clauses</i>	<i>TN Total Var</i>	<i>TN Clauses</i>
<i>Antisymmetric</i>	25	167	338	167	313	305	563	305	538
<i>Bijective</i>	196	1949	3088	1949	3081	1949	3256	1949	3249
<i>Connex</i>	36	255	385	255	372	420	679	420	666
<i>Equivalence</i>	400	18666	27202	18666	27196	18667	34233	18667	34227
<i>Function</i>	64	572	898	572	888	598	1050	598	1040
<i>Functional</i>	64	572	881	572	871	598	907	598	897
<i>Injective</i>	64	574	895	574	888	574	896	574	889
<i>Irreflexive</i>	25	157	216	157	212	283	408	283	404
<i>NonStrictOrder</i>	49	911	1256	911	1246	912	1461	912	1451
<i>PartialOrder</i>	36	587	863	587	813	587	984	587	934
<i>PreOrder</i>	49	910	1234	910	1225	910	1459	910	1450
<i>Reflexive</i>	25	157	216	157	212	223	331	223	327
<i>StrictOrder</i>	49	910	1231	910	1223	910	1456	910	1448
<i>Surjective</i>	196	1946	3055	1946	3048	1946	3056	1946	3049
<i>TotalOrder</i>	169	5385	7757	5385	7748	5385	9461	5385	9452
<i>Transitive</i>	36	585	889	585	817	573	1001	573	929

4 **ApproxMC Results for Acc_{MC}**

Table 5. Decision Tree (*Symmetry Breaking On*) performance for the entire state space w.r.t. ϕ – default symmetry breaking./

Property	TP	FN	FP	TN	Time[s]	Accuracy	Precision	Recall	F1
Antisymmetric	55296	220	6.55E+04	2.00E+06	0.9	0.9690	0.4576	0.9960	0.6271
Bijective	25088	0	1.12E+48	4.02E+49	219.3	0.9729	0.0000	1.0000	0.0000
Connex	147456	1	1.97E+06	2.42E+09	1.3	0.9992	0.0698	1.0000	0.1304
Equivalence	11264	3	-	-	-	-	-	0.9997	-
Function	16640	30	1.56E+14	2.03E+16	6.0	0.9924	0.0000	0.9982	0.0000
Functional	35328	6	1.17E+14	2.03E+16	6.3	0.9943	0.0000	0.9998	0.0000
Injective	16640	3	4.75E+14	3.80E+15	6.1	0.8889	0.0000	0.9998	0.0000
Irreflexive	36352	0	0	1.57E+06	0.4	1.0000	1.0000	1.0000	1.0000
NonStrictOrder	26112	0	3.96E+09	7.04E+11	3.1	0.9944	0.0000	1.0000	0.0000
PartialOrder	88064	78	1.49E+07	4.45E+08	2.3	0.9675	0.0059	0.9991	0.0116
PreOrder	43008	3	6.44E+09	7.04E+11	3.5	0.9909	0.0000	0.9999	0.0000
Reflexive	35840	0	0	1.51E+06	0.4	1.0000	1.0000	1.0000	1.0000
Strictorder	29184	0	6.04E+09	7.04E+11	3.0	0.9915	0.0000	1.0000	0.0000
Surjective	25088	0	3.07E+46	4.24E+49	208.1	0.9993	0.0000	1.0000	0.0000
TotalOrder	14848	0	6.47E+39	3.75E+42	95.7	0.9983	0.0000	1.0000	0.0000
Transitive	102400	100	3.46E+07	2.55E+09	2.1	0.9866	0.0030	0.9990	0.0059

Table 6. Decision Tree (*Symmetry Breaking On*) performance for the entire state space w.r.t. ϕ – without symmetry breaking.

Property	TP	FN	FP	TN	Time[s]	Accuracy	Precision	Recall	F1
Antisymmetric	425984	1474560	4.10E+05	3.15E+07	1.3	0.9442	0.5098	0.2241	0.3114
Bijective	-	-	5.88E+56	1.00E+59	-	-	-	-	-
Connex	2.36E+06	1.13E+07	4.30E+07	6.87E+10	1.9	0.9992	0.0520	0.1731	0.0800
Equivalence	-	-	2.02E+118	2.58E+120	-	-	-	-	-
Function	1.18E+06	1.65E+07	1.44E+17	1.84E+19	86.6	0.9922	0.0000	0.0667	0.0000
Functional	1.31E+07	3.20E+07	3.60E+16	1.84E+19	277.5	0.9980	0.0000	0.2907	0.0000
Injective	4.52E+06	1.31E+07	7.21E+16	1.84E+19	79.6	0.9961	0.0000	0.2565	0.0000
Irreflexive	1.05E+06	0	0	3.25E+07	0.5	1.0000	1.0000	1.0000	1.0000
NonStrictOrder	4.06E+06	2.42E+06	5.84E+11	5.63E+14	8.9	0.9990	0.0000	0.6263	0.0000
PartialOrder	2.95E+06	5.64E+06	4.28E+08	6.87E+10	2.9	0.9937	0.0068	0.3435	0.0134
PreOrder	4.72E+06	4.39E+06	7.56E+11	5.63E+14	16.6	0.9987	0.0000	0.5180	0.0000
Reflexive	1.05E+06	0	0	3.25E+07	0.6	1.0000	1.0000	1.0000	1.0000
StrictOrder	3.15E+06	3.60E+06	9.62E+11	5.63E+14	8.3	0.9983	0.0000	0.4660	0.0000
Surjective	-	-	3.92E+56	1.00E+59	-	-	-	-	-
TotalOrder	3.02E+09	3.36E+09	7.31E+47	7.48E+50	3059.5	0.9990	0.0000	0.4737	0.0000
Transitive	2.23E+06	7.08E+06	5.87E+08	6.87E+10	3.6	0.9914	0.0038	0.2394	0.0074

Table 7. Decision Tree (*Symmetry Breaking Off*) performance for the entire state space w.r.t. ϕ – default symmetry breaking.

Property	TP	FN	FP	TN	Time[s]	Accuracy	Precision	Recall	F1
Antisymmetric	55296	0	0	2.03E+06	0.7	1.0000	1.0000	1.0000	1.0000
Bijective	176	0	6.42E+16	7.84E+19	10.1	0.9992	0.0000	1.0000	0.0000
Connex	2368	0	1.33E+04	3.21E+06	0.6	0.9959	0.1510	1.0000	0.2624
Equivalence	88	0	4.87E+21	5.59E+24	15.7	0.9991	0.0000	1.0000	0.0000
Function	672	6	1.36E+07	1.74E+09	1.6	0.9922	0.0000	0.9912	0.0001
Functional	1536	0	6.03E+06	1.68E+09	1.5	0.9964	0.0003	1.0000	0.0005
Injective	672	0	3.93E+06	4.53E+08	1.5	0.9914	0.0002	1.0000	0.0003
Irreflexive	36352	0	0	1.57E+06	0.4	1.0000	1.0000	1.0000	1.0000
NonStrictOrder	2048	0	1.28E+06	4.61E+08	1.5	0.9972	0.0016	1.0000	0.0032
PartialPrder	4544	0	1.18E+04	8.36E+05	1.0	0.9862	0.2784	1.0000	0.4356
PreOrder	3776	1	1.34E+06	4.61E+08	1.6	0.9971	0.0028	0.9997	0.0056
Reflexive	35840	0	0	1.51E+06	0.5	1.0000	1.0000	1.0000	1.0000
StrictOrder	2208	0	1.06E+06	4.53E+08	1.5	0.9977	0.0021	1.0000	0.0041
Surjective	176	0	2.48E+17	7.72E+19	10.9	0.9968	0.0000	1.0000	0.0000
TotalOrder	368	0	3.27E+16	7.84E+19	9.4	0.9996	0.0000	1.0000	0.0000
Transitive	5760	51	2.87E+04	3.01E+06	0.8	0.9906	0.1673	0.9912	0.2863

Table 8. Decision Tree (*Symmetry Breaking Off*) performance for the entire state space w.r.t. ϕ – without symmetry breaking.

<i>Property</i>	<i>TP</i>	<i>FN</i>	<i>FP</i>	<i>TN</i>	<i>Time[s]</i>	<i>Accuracy</i>	<i>Precision</i>	<i>Recall</i>	<i>F1</i>
<i>Antisymmetric</i>	1998848	336	1.31E+04	3.15E+07	2.1	0.9996	0.9935	0.9998	0.9967
<i>Bijjective</i>	360448	0	4.50E+21	2.42E+24	225.8	0.9981	0.0000	1.0000	0.0000
<i>Connex</i>	64512	98	2.21E+05	3.36E+07	0.8	0.9935	0.2258	0.9985	0.3683
<i>Equivalence</i>	120832	0	6.96E+26	1.27E+30	34.1	0.9995	0.0000	1.0000	0.0000
<i>Function</i>	47104	31	7.05E+08	6.87E+10	2.4	0.9899	0.0001	0.9993	0.0001
<i>Functional</i>	116736	30	3.77E+08	6.87E+10	2.6	0.9945	0.0003	0.9997	0.0006
<i>Injective</i>	47104	50	8.56E+08	6.87E+10	2.3	0.9877	0.0001	0.9989	0.0001
<i>Irreflexive</i>	1048576	0	0	3.25E+07	0.5	1.0000	1.0000	1.0000	1.0000
<i>NonStrictOrder</i>	129024	66	1.17E+08	6.87E+10	1.9	0.9983	0.0011	0.9995	0.0022
<i>PartialOrder</i>	145408	114	4.59E+05	3.30E+07	1.2	0.9864	0.2407	0.9992	0.3879
<i>PreOrder</i>	229376	80	1.93E+08	6.87E+10	2.0	0.9972	0.0012	0.9997	0.0024
<i>Reflexive</i>	1048576	0	0	3.25E+07	0.5	1.0000	1.0000	1.0000	1.0000
<i>StrictOrder</i>	135168	31	1.43E+08	6.87E+10	1.9	0.9979	0.0009	0.9998	0.0019
<i>Surjective</i>	360448	0	3.76E+21	2.42E+24	283.3	0.9984	0.0000	1.0000	0.0000
<i>TotalOrder</i>	401408	0	7.01E+20	2.42E+24	8.4	0.9997	0.0000	1.0000	0.0000
<i>Transitive</i>	151552	1504	8.03E+05	3.25E+07	2.0	0.9760	0.1588	0.9902	0.2737

5 ProjMC Results for Acc_{MC}

Table 9. Decision Tree (*Symmetry Breaking On*) performance for the entire state space w.r.t. ϕ – default symmetry breaking./⁶

<i>Property</i>	<i>TP</i>	<i>FN</i>	<i>FP</i>	<i>TN</i>	<i>Time[s]</i>	<i>Accuracy</i>	<i>Precision</i>	<i>Recall</i>	<i>F1</i>
<i>Antisymmetric</i>	56503	220	66288	1.96E+06	0.3	0.9681	0.4602	0.9961	0.6295
<i>Bijjective</i>	25043	0	-	-	-	-	-	1.0000	-
<i>Connex</i>	1.49E+05	1	1.92E+06	2.20E+09	7.5	0.9991	0.0720	1.0000	0.1344
<i>Equivalence</i>	10943	3	-	-	-	-	-	0.9997	-
<i>Function</i>	16501	30	-	-	-	-	-	0.9982	-
<i>Functional</i>	35011	6	-	-	-	-	-	0.9998	-
<i>Injective</i>	16528	3	-	-	-	-	-	0.9998	-
<i>Irreflexive</i>	35886	0	0	1.51E+06	0.2	1.0000	1.0000	1.0000	1.0000
<i>NonStrictOrder</i>	26387	0	4.07E+09	-	-	-	0.0000	1.0000	0.0000
<i>PartialOrder</i>	82285	74	1.44E+07	4.18E+08	156.5	0.9667	0.0057	0.9991	0.0113
<i>PreOrder</i>	43648	3	-	-	-	-	-	0.9999	-
<i>Reflexive</i>	35886	0	0	1.51E+06	0.2	1.0000	1.0000	1.0000	1.0000
<i>StrictOrder</i>	26387	0	5.84E+09	-	-	-	0.0000	1.0000	0.0000
<i>Surjective</i>	25043	0	-	-	-	-	-	1.0000	-
<i>TotalOrder</i>	15511	0	-	-	-	-	-	1.0000	-
<i>Transitive</i>	95468	96	3.69E+07	2.60E+09	8.0	0.9860	0.0026	0.9990	0.0051

Table 10. Decision Tree (*Symmetry Breaking On*) performance for the entire state space w.r.t. ϕ – without symmetry breaking.

<i>Property</i>	<i>TP</i>	<i>FN</i>	<i>FP</i>	<i>TN</i>	<i>Time[s]</i>	<i>Accuracy</i>	<i>Precision</i>	<i>Recall</i>	<i>F1</i>
<i>Antisymmetric</i>	3.95E+05	1.49E+06	4.08E+05	3.13E+07	0.1	0.9435	0.4919	0.2095	0.2939
<i>Bijective</i>	-	-	-	-	-	-	-	-	-
<i>Connex</i>	2.53E+06	1.18E+07	4.52E+07	6.87E+10	9.2	0.9992	0.0530	0.1766	0.0815
<i>Equivalence</i>	-	-	-	-	-	-	-	-	-
<i>Function</i>	1.16E+06	1.56E+07	-	-	-	-	-	0.0692	-
<i>Functional</i>	1.24E+07	3.07E+07	3.60E+16	1.84E+19	3139.0	0.9980	0.0000	0.2877	0.0000
<i>Injective</i>	4.59E+06	1.22E+07	-	-	-	-	-	0.2734	-
<i>Irreflexive</i>	1.05E+06	0	0	3.25E+07	0.0	1.0000	1.0000	1.0000	1.0000
<i>NonStrictOrder</i>	3.73E+06	2.39E+06	5.84E+11	5.62E+14	621.0	0.9990	0.0000	0.6095	0.0000
<i>PartialOrder</i>	2.78E+06	5.55E+06	4.19E+08	6.83E+10	16.1	0.9938	0.0066	0.3337	0.0129
<i>PreOrder</i>	5.20E+06	4.34E+06	7.56E+11	5.62E+14	1606.6	0.9987	0.0000	0.5451	0.0000
<i>Reflexive</i>	1.05E+06	0	0	3.25E+07	0.0	1.0000	1.0000	1.0000	1.0000
<i>StrictOrder</i>	2.99E+06	3.14E+06	9.62E+11	5.62E+14	752.5	0.9983	0.0000	0.4878	0.0000
<i>Surjective</i>	-	-	-	-	-	-	-	-	-
<i>TotalOrder</i>	-	-	-	-	-	-	-	-	-
<i>Transitive</i>	2.47E+06	6.95E+06	6.24E+08	6.81E+10	130.3	0.9908	0.0039	0.2622	0.0078

Table 11. Decision Tree (*Symmetry Breaking Off*) performance for the entire state space w.r.t. ϕ – default symmetry breaking.

<i>Property</i>	<i>TP</i>	<i>FN</i>	<i>FP</i>	<i>TN</i>	<i>Time[s]</i>	<i>Accuracy</i>	<i>Precision</i>	<i>Recall</i>	<i>F1</i>
<i>Antisymmetric</i>	56723	0	0	2.02E+06	2.9	1.0000	1.0000	1.0000	1.0000
<i>Bijjective</i>	179	0	-	-	-	-	-	1.0000	-
<i>Connex</i>	2461	0	13289	3.15E+06	0.2	0.9958	0.1563	1.0000	0.2703
<i>Equivalence</i>	89	0	-	-	-	-	-	1.0000	-
<i>Function</i>	616	6	1.33E+07	1.62E+09	156.0	0.9919	0.0000	0.9904	0.0001
<i>Functional</i>	1375	0	5.79E+06	1.60E+09	55.5	0.9964	0.0002	1.0000	0.0005
<i>Injective</i>	622	0	3.63E+06	4.29E+08	140.4	0.9916	0.0002	1.0000	0.0003
<i>Irreflexive</i>	35886	0	0	1.51E+06	0.2	1.0000	1.0000	1.0000	1.0000
<i>NonStrictOrder</i>	2146	0	1.23E+06	4.31E+08	80.2	0.9972	0.0017	1.0000	0.0035
<i>PartialOrder</i>	4728	0	11766	8.81E+05	3.2	0.9869	0.2866	1.0000	0.4456
<i>PreOrder</i>	3655	1	1.33E+06	4.31E+08	111.9	0.9969	0.0027	0.9997	0.0055
<i>Reflexive</i>	35886	0	0	1.51E+06	0.2	1.0000	1.0000	1.0000	1.0000
<i>StrictOrder</i>	2146	0	1.19E+06	4.31E+08	63.6	0.9972	0.0018	1.0000	0.0036
<i>Surjective</i>	179	0	-	-	-	-	-	1.0000	-
<i>TotalOrder</i>	323	0	-	-	-	-	-	1.0000	-
<i>Transitive</i>	5487	51	30218	2.83E+06	1.6	0.9894	0.1537	0.9908	0.2661

Table 12. Decision Tree (*Symmetry Breaking Off*) performance for the entire state space w.r.t. ϕ – without symmetry breaking.

<i>Property</i>	<i>TP</i>	<i>FN</i>	<i>FP</i>	<i>TN</i>	<i>Time[s]</i>	<i>Accuracy</i>	<i>Precision</i>	<i>Recall</i>	<i>F1</i>
<i>Antisymmetric</i>	1.89E+06	332	11788	3.17E+07	1.5	0.9996	0.9938	0.9998	0.9968
<i>Bijjective</i>	3.63E+05	0	-	-	-	-	-	1.0000	-
<i>Connex</i>	58953	96	2.21E+05	3.33E+07	0.3	0.9934	0.2106	0.9984	0.3478
<i>Equivalence</i>	1.16E+05	0	-	-	-	-	-	1.0000	-
<i>Function</i>	46625	31	7.15E+08	-	-	-	0.0001	0.9993	0.0001
<i>Functional</i>	1.18E+05	30	3.98E+08	6.83E+10	10.2	0.9942	0.0003	0.9997	0.0006
<i>Injective</i>	46606	50	7.97E+08	6.79E+10	15.1	0.9884	0.0001	0.9989	0.0001
<i>Irreflexive</i>	1.05E+06	0	0	3.25E+07	0.0	1.0000	1.0000	1.0000	1.0000
<i>NonStrictOrder</i>	1.30E+05	66	1.10E+08	6.86E+10	12.2	0.9984	0.0012	0.9995	0.0024
<i>PartialOrder</i>	1.35E+05	114	4.11E+05	3.30E+07	0.8	0.9877	0.2473	0.9992	0.3964
<i>PreOrder</i>	2.09E+05	75	1.88E+08	6.85E+10	34.5	0.9973	0.0011	0.9996	0.0022
<i>Reflexive</i>	1.05E+06	0	0	3.25E+07	0.0	1.0000	1.0000	1.0000	1.0000
<i>StrictOrder</i>	1.30E+05	31	1.48E+08	6.86E+10	14.1	0.9978	0.0009	0.9998	0.0018
<i>Surjective</i>	3.63E+05	0	-	-	-	-	-	1.0000	-
<i>TotalOrder</i>	3.63E+05	0	-	-	-	-	-	1.0000	-
<i>Transitive</i>	1.53E+05	1338	7.90E+05	3.26E+07	14.9	0.9764	0.1622	0.9913	0.2789

6 ApproxMC Results for Diff_{MC}

Table 13. Evaluating differences between decision tree models. (*Symmetry Breaking Off*)

<i>Subject</i>	<i>TT</i>	<i>TF</i>	<i>FT</i>	<i>FF</i>	<i>Diff</i>	<i>Time [s]</i>
<i>Antisymmetric</i>	2.00E+06	7.68E+02	6.40E+02	3.15E+07	0.00	1.8
<i>Bijjective</i>	2.80E+21	1.66E+21	1.70E+21	2.42E+24	0.14	14.7
<i>Connex</i>	2.95E+05	5.44E+02	5.44E+02	3.36E+07	0.00	0.7
<i>Equivalence</i>	6.96E+26	0	0	1.27E+30	0.00	11.7
<i>Function</i>	5.87E+08	9.02E+07	5.24E+07	6.87E+10	0.21	2.4
<i>Functional</i>	3.19E+08	5.24E+07	5.14E+07	6.87E+10	0.15	2.5
<i>Injective</i>	8.22E+08	2.83E+07	2.83E+07	6.87E+10	0.08	2.2
<i>Irreflexive</i>	1.05E+06	0	0	3.25E+07	0.00	0.5
<i>NonStrictOrder</i>	1.09E+08	1.10E+07	1.10E+07	6.87E+10	0.03	1.7
<i>PartialOrder</i>	5.49E+05	2.71E+04	2.05E+04	3.30E+07	0.14	1.4
<i>PreOrder</i>	1.89E+08	1.02E+07	1.05E+07	6.87E+10	0.03	1.9
<i>Reflexive</i>	1.05E+06	0	0	3.25E+07	0.00	0.5
<i>StrictOrder</i>	1.41E+08	1.57E+06	1.57E+06	6.87E+10	0.00	1.7
<i>Surjective</i>	2.73E+21	1.25E+21	1.25E+21	2.42E+24	0.10	15.2
<i>TotalOrder</i>	6.83E+20	4.61E+18	4.61E+18	2.42E+24	0.00	11.3
<i>Transitive</i>	9.01E+05	8.19E+04	1.00E+05	3.25E+07	0.54	2.8

7 ProjMC Results for Diff_{MC}

Table 14. Evaluating differences between decision tree models. (*Symmetry Breaking On*)

<i>Subject</i>	<i>TT</i>	<i>TF</i>	<i>FT</i>	<i>FF</i>	<i>Diff</i>	<i>Time [s]</i>
<i>Antisymmetric</i>	7.69E+05	3.39E+04	3.13E+04	3.27E+07	0.19	0.0
<i>Bijjective</i>	9.19E+54	5.79E+56	3.83E+56	9.95E+58	0.96	0.0
<i>Connex</i>	3.59E+07	1.18E+07	1.18E+07	6.87E+10	0.03	0.0
<i>Equivalence</i>	7.88E+116	1.94E+118	3.96E+118	2.52E+120	2.29	0.0
<i>Function</i>	6.31E+16	8.11E+16	8.11E+16	1.82E+19	0.88	0.0
<i>Functional</i>	2.03E+16	1.58E+16	1.58E+16	1.84E+19	0.17	0.0
<i>Injective</i>	7.21E+16	0.00E+00	0.00E+00	1.84E+19	0.00	0.0
<i>Irreflexive</i>	1.05E+06	0.00E+00	0.00E+00	3.25E+07	0.00	0.0
<i>NonStrictOrder</i>	2.92E+11	2.92E+11	2.92E+11	5.62E+14	0.10	0.0
<i>PartialOrder</i>	3.09E+08	1.12E+08	1.08E+08	6.82E+10	0.32	0.0
<i>PreOrder</i>	3.78E+11	3.78E+11	3.78E+11	5.62E+14	0.13	0.0
<i>Reflexive</i>	1.05E+06	0.00E+00	0.00E+00	3.25E+07	0.00	0.0
<i>StrictOrder</i>	6.18E+11	3.44E+11	3.44E+11	5.62E+14	0.12	0.0
<i>Surjective</i>	2.45E+55	3.68E+56	3.68E+56	9.97E+58	0.73	0.0
<i>TotalOrder</i>	3.65E+47	3.65E+47	3.65E+47	7.47E+50	0.10	0.0
<i>Transitive</i>	4.27E+08	2.00E+08	1.96E+08	6.79E+10	0.58	0.1

Table 15. Evaluating differences between decision tree models. (*Symmetry Breaking Off*)

<i>Subject</i>	<i>TT</i>	<i>TF</i>	<i>FT</i>	<i>FF</i>	<i>Diff</i>	<i>Time [s]</i>
<i>Antisymmetric</i>	1.90E+06	7.44E+02	6.16E+02	3.17E+07	0.00	0.1
<i>Bijjective</i>	2.80E+21	1.59E+21	1.74E+21	2.41E+24	0.14	0
<i>Connex</i>	2.79E+05	5.44E+02	5.44E+02	3.33E+07	0.00	0
<i>Equivalence</i>	6.96E+26	0.00E+00	0.00E+00	1.27E+30	0.00	0
<i>Function</i>	6.34E+08	8.15E+07	5.11E+07	6.80E+10	0.19	0
<i>Functional</i>	3.46E+08	5.17E+07	4.75E+07	6.83E+10	0.14	0
<i>Injective</i>	7.69E+08	2.83E+07	2.83E+07	6.79E+10	0.08	0
<i>Irreflexive</i>	1.05E+06	0.00E+00	0.00E+00	3.25E+07	0.00	0
<i>NonStrictOrder</i>	9.97E+07	1.06E+07	1.06E+07	6.86E+10	0.03	0
<i>PartialOrder</i>	5.20E+05	2.65E+04	1.96E+04	3.30E+07	0.14	0
<i>PreOrder</i>	1.78E+08	1.03E+07	1.03E+07	6.85E+10	0.03	0
<i>Reflexive</i>	1.05E+06	0.00E+00	0.00E+00	3.25E+07	0.00	0
<i>StrictOrder</i>	1.46E+08	1.57E+06	1.57E+06	6.86E+10	0.00	0
<i>Surjective</i>	2.75E+21	1.13E+21	1.20E+21	2.41E+24	0.10	0
<i>TotalOrder</i>	7.06E+20	4.61E+18	4.61E+18	2.42E+24	0.00	0
<i>Transitive</i>	8.68E+05	7.45E+04	9.29E+04	3.25E+07	0.50	0.1

8 Detailed results

The tables in this section present the detailed results of training the ML models for the properties in our study and evaluating their performance using the training and test datasets created using Alloy. The ratio gives the *training* : *test* ratio.

8.1 Symmetry Breaking On

Table 16. AntiSymmetric Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	14,239	0	58	14,065	0.9980	0.9959	1.0000	0.9980
	RFT	14,237	2	23	14,100	0.9991	0.9984	0.9999	0.9991
	GBDT	14,186	53	321	13,802	0.9868	0.9779	0.9963	0.9870
	ABT	13,346	893	1,209	12,914	0.9259	0.9169	0.9373	0.9270
	SVM	14,239	0	44	14,079	0.9984	0.9969	1.0000	0.9985
	MLP	14,239	0	3	14,120	0.9999	0.9998	1.0000	0.9999
50:50	DT	28,463	8	145	28,107	0.9973	0.9949	0.9997	0.9973
	RFT	28,461	10	76	28,176	0.9985	0.9973	0.9996	0.9985
	GBDT	28,343	128	658	27,594	0.9861	0.9773	0.9955	0.9863
	ABT	26,666	1,805	2,394	25,858	0.9260	0.9176	0.9366	0.9270
	SVM	28,471	0	227	28,025	0.9960	0.9921	1.0000	0.9960
	MLP	28,471	0	5	28,247	0.9999	0.9998	1.0000	0.9999
25:75	DT	42,491	68	306	42,220	0.9956	0.9928	0.9984	0.9956
	RFT	42,540	19	213	42,313	0.9973	0.9950	0.9996	0.9973
	GBDT	42,385	174	963	41,563	0.9866	0.9778	0.9959	0.9868
	ABT	39,852	2,707	3,721	38,805	0.9245	0.9146	0.9364	0.9254
	SVM	42,559	0	733	41,793	0.9914	0.9831	1.0000	0.9915
	MLP	42,559	0	67	42,459	0.9992	0.9984	1.0000	0.9992
10:90	DT	50,756	220	664	50,462	0.9913	0.9871	0.9957	0.9914
	RFT	50,921	55	560	50,566	0.9940	0.9891	0.9989	0.9940
	GBDT	50,773	203	1,245	49,881	0.9858	0.9761	0.9960	0.9859
	ABT	47,673	3,303	4,503	46,623	0.9235	0.9137	0.9352	0.9243
	SVM	50,815	161	1,507	49,619	0.9837	0.9712	0.9968	0.9839
	MLP	50,976	0	290	50,836	0.9972	0.9943	1.0000	0.9972
1:99	DT	54,209	1,940	3,412	52,751	0.9523	0.9408	0.9654	0.9530
	RFT	55,178	971	2,274	53,889	0.9711	0.9604	0.9827	0.9714
	GBDT	55,877	272	1,792	54,371	0.9816	0.9689	0.9952	0.9819
	ABT	52,283	3,866	5,382	50,781	0.9177	0.9067	0.9311	0.9187
	SVM	54,914	1,235	4,988	51,175	0.9446	0.9167	0.9780	0.9464
	MLP	55,555	594	2,689	53,474	0.9708	0.9538	0.9894	0.9713

Table 17. Bijective Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	6,221	0	9	6,292	0.9993	0.9986	1.0000	0.9993
	RFT	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
	GBDT	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
	ABT	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
	SVM	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
	MLP	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
50:50	DT	12,466	0	17	12,560	0.9993	0.9986	1.0000	0.9993
	RFT	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
	GBDT	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
	ABT	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
	SVM	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
	MLP	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
25:75	DT	18,723	1	40	18,801	0.9989	0.9979	0.9999	0.9989
	RFT	18,724	0	0	18,841	1.0000	1.0000	1.0000	1.0000
	GBDT	18,724	0	0	18,841	1.0000	1.0000	1.0000	1.0000
	ABT	18,724	0	0	18,841	1.0000	1.0000	1.0000	1.0000
	SVM	18,724	0	0	18,841	1.0000	1.0000	1.0000	1.0000
	MLP	18,724	0	0	18,841	1.0000	1.0000	1.0000	1.0000
10:90	DT	22,506	0	131	22,441	0.9971	0.9942	1.0000	0.9971
	RFT	22,504	2	0	22,572	1.0000	1.0000	0.9999	1.0000
	GBDT	22,506	0	0	22,572	1.0000	1.0000	1.0000	1.0000
	ABT	22,506	0	0	22,572	1.0000	1.0000	1.0000	1.0000
	SVM	22,506	0	0	22,572	1.0000	1.0000	1.0000	1.0000
	MLP	22,505	1	0	22,572	1.0000	1.0000	1.0000	1.0000
1:99	DT	24,760	14	747	24,065	0.9847	0.9707	0.9994	0.9849
	RFT	24,757	17	0	24,812	0.9997	1.0000	0.9993	0.9997
	GBDT	24,774	0	1	24,811	1.0000	1.0000	1.0000	1.0000
	ABT	24,774	0	0	24,812	1.0000	1.0000	1.0000	1.0000
	SVM	24,774	0	0	24,812	1.0000	1.0000	1.0000	1.0000
	MLP	24,773	1	0	24,812	1.0000	1.0000	1.0000	1.0000

Table 18. Connex Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	37,146	0	12	37,284	0.9998	0.9997	1.0000	0.9998
	RFT	37,146	0	5	37,291	0.9999	0.9999	1.0000	0.9999
	GBDT	37,146	0	70	37,226	0.9991	0.9981	1.0000	0.9991
	ABT	37,146	0	56	37,240	0.9992	0.9985	1.0000	0.9992
	SVM	37,146	0	19	37,277	0.9997	0.9995	1.0000	0.9997
	MLP	37,146	0	13	37,283	0.9998	0.9997	1.0000	0.9998
50:50	DT	74,281	0	21	74,582	0.9999	0.9997	1.0000	0.9999
	RFT	74,281	0	13	74,590	0.9999	0.9998	1.0000	0.9999
	GBDT	74,281	0	150	74,453	0.9990	0.9980	1.0000	0.9990
	ABT	74,281	0	120	74,483	0.9992	0.9984	1.0000	0.9992
	SVM	74,281	0	54	74,549	0.9996	0.9993	1.0000	0.9996
	MLP	74,281	0	19	74,584	0.9999	0.9997	1.0000	0.9999
25:75	DT	111,544	0	65	111,717	0.9997	0.9994	1.0000	0.9997
	RFT	111,544	0	33	111,749	0.9999	0.9997	1.0000	0.9999
	GBDT	111,544	0	256	111,526	0.9989	0.9977	1.0000	0.9989
	ABT	111,531	13	198	111,584	0.9991	0.9982	0.9999	0.9991
	SVM	111,544	0	123	111,659	0.9994	0.9989	1.0000	0.9994
	MLP	111,544	0	55	111,727	0.9998	0.9995	1.0000	0.9998
10:90	DT	133,959	1	98	133,934	0.9996	0.9993	1.0000	0.9996
	RFT	133,959	1	48	133,984	0.9998	0.9996	1.0000	0.9998
	GBDT	133,960	0	357	133,675	0.9987	0.9973	1.0000	0.9987
	ABT	133,946	14	229	133,803	0.9991	0.9983	0.9999	0.9991
	SVM	133,960	0	264	133,768	0.9990	0.9980	1.0000	0.9990
	MLP	133,959	1	104	133,928	0.9996	0.9992	1.0000	0.9996
1:99	DT	147,384	1	263	147,143	0.9991	0.9982	1.0000	0.9991
	RFT	147,384	1	148	147,258	0.9995	0.9990	1.0000	0.9995
	GBDT	147,385	0	637	146,769	0.9978	0.9957	1.0000	0.9978
	ABT	147,385	0	442	146,964	0.9985	0.9970	1.0000	0.9985
	SVM	147,385	0	922	146,484	0.9969	0.9938	1.0000	0.9969
	MLP	147,384	1	1,220	146,186	0.9959	0.9918	1.0000	0.9959

Table 19. Equivalence Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	2,752	2	10	2,709	0.9978	0.9964	0.9993	0.9978
	RFT	2,753	1	0	2,719	0.9998	1.0000	0.9996	0.9998
	GBDT	2,753	1	0	2,719	0.9998	1.0000	0.9996	0.9998
	ABT	2,753	1	0	2,719	0.9998	1.0000	0.9996	0.9998
	SVM	2,753	1	0	2,719	0.9998	1.0000	0.9996	0.9998
	MLP	2,753	1	0	2,719	0.9998	1.0000	0.9996	0.9998
50:50	DT	5,515	2	3	5,426	0.9995	0.9995	0.9996	0.9995
	RFT	5,513	4	0	5,429	0.9996	1.0000	0.9993	0.9996
	GBDT	5,513	4	0	5,429	0.9996	1.0000	0.9993	0.9996
	ABT	5,514	3	0	5,429	0.9997	1.0000	0.9995	0.9997
	SVM	5,512	5	0	5,429	0.9995	1.0000	0.9991	0.9995
	MLP	5,512	5	0	5,429	0.9995	1.0000	0.9991	0.9995
25:75	DT	8,215	24	88	8,092	0.9932	0.9894	0.9971	0.9932
	RFT	8,215	24	0	8,180	0.9985	1.0000	0.9971	0.9985
	GBDT	8,230	9	0	8,180	0.9995	1.0000	0.9989	0.9995
	ABT	8,234	5	0	8,180	0.9997	1.0000	0.9994	0.9997
	SVM	8,225	14	0	8,180	0.9991	1.0000	0.9983	0.9991
	MLP	8,226	13	0	8,180	0.9992	1.0000	0.9984	0.9992
10:90	DT	9,858	3	80	9,762	0.9958	0.9920	0.9997	0.9958
	RFT	9,837	24	0	9,842	0.9988	1.0000	0.9976	0.9988
	GBDT	9,854	7	0	9,842	0.9996	1.0000	0.9993	0.9996
	ABT	9,856	5	0	9,842	0.9997	1.0000	0.9995	0.9997
	SVM	9,845	16	0	9,842	0.9992	1.0000	0.9984	0.9992
	MLP	9,848	13	0	9,842	0.9993	1.0000	0.9987	0.9993
1:99	DT	10,816	18	712	10,128	0.9663	0.9382	0.9983	0.9674
	RFT	10,706	128	4	10,836	0.9939	0.9996	0.9882	0.9939
	GBDT	10,816	18	61	10,779	0.9964	0.9944	0.9983	0.9964
	ABT	10,823	11	12	10,828	0.9989	0.9989	0.9990	0.9989
	SVM	10,783	51	0	10,840	0.9976	1.0000	0.9953	0.9976
	MLP	10,817	17	0	10,840	0.9992	1.0000	0.9984	0.9992

Table 20. Function Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	4,134	0	2	4,130	0.9998	0.9995	1.0000	0.9998
	RFT	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
	GBDT	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
	ABT	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
	SVM	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
	MLP	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
50:50	DT	8,298	3	6	8,224	0.9995	0.9993	0.9996	0.9995
	RFT	8,301	0	0	8,230	1.0000	1.0000	1.0000	1.0000
	GBDT	8,301	0	0	8,230	1.0000	1.0000	1.0000	1.0000
	ABT	8,301	0	1	8,229	0.9999	0.9999	1.0000	0.9999
	SVM	8,301	0	0	8,230	1.0000	1.0000	1.0000	1.0000
	MLP	8,301	0	1	8,229	0.9999	0.9999	1.0000	0.9999
25:75	DT	12,440	3	31	12,323	0.9986	0.9975	0.9998	0.9986
	RFT	12,440	3	0	12,354	0.9999	1.0000	0.9998	0.9999
	GBDT	12,443	0	0	12,354	1.0000	1.0000	1.0000	1.0000
	ABT	12,443	0	2	12,352	0.9999	0.9998	1.0000	0.9999
	SVM	12,443	0	0	12,354	1.0000	1.0000	1.0000	1.0000
	MLP	12,443	0	2	12,352	0.9999	0.9998	1.0000	0.9999
10:90	DT	14,878	30	108	14,740	0.9954	0.9928	0.9980	0.9954
	RFT	14,904	4	1	14,847	0.9998	0.9999	0.9997	0.9998
	GBDT	14,908	0	3	14,845	0.9999	0.9998	1.0000	0.9999
	ABT	14,907	1	1	14,847	0.9999	0.9999	0.9999	0.9999
	SVM	14,908	0	0	14,848	1.0000	1.0000	1.0000	1.0000
	MLP	14,907	1	5	14,843	0.9998	0.9997	0.9999	0.9998
1:99	DT	16,360	1	520	15,851	0.9841	0.9692	0.9999	0.9843
	RFT	16,360	1	4	16,367	0.9998	0.9998	0.9999	0.9998
	GBDT	16,360	1	111	16,260	0.9966	0.9933	0.9999	0.9966
	ABT	16,361	0	30	16,341	0.9991	0.9982	1.0000	0.9991
	SVM	16,361	0	0	16,371	1.0000	1.0000	1.0000	1.0000
	MLP	16,360	1	11	16,360	0.9996	0.9993	0.9999	0.9996

Table 21. Functional Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	8,756	0	5	8,748	0.9997	0.9994	1.0000	0.9997
	RFT	8,756	0	1	8,752	0.9999	0.9999	1.0000	0.9999
	GBDT	8,756	0	2	8,751	0.9999	0.9998	1.0000	0.9999
	ABT	8,756	0	1	8,752	0.9999	0.9999	1.0000	0.9999
	SVM	8,756	0	0	8,753	1.0000	1.0000	1.0000	1.0000
	MLP	8,756	0	1	8,752	0.9999	0.9999	1.0000	0.9999
50:50	DT	17,506	0	27	17,484	0.9992	0.9985	1.0000	0.9992
	RFT	17,506	0	0	17,511	1.0000	1.0000	1.0000	1.0000
	GBDT	17,506	0	5	17,506	0.9999	0.9997	1.0000	0.9999
	ABT	17,506	0	4	17,507	0.9999	0.9998	1.0000	0.9999
	SVM	17,506	0	0	17,511	1.0000	1.0000	1.0000	1.0000
	MLP	17,506	0	5	17,506	0.9999	0.9997	1.0000	0.9999
25:75	DT	26,171	0	24	26,331	0.9995	0.9991	1.0000	0.9995
	RFT	26,171	0	2	26,353	1.0000	0.9999	1.0000	1.0000
	GBDT	26,171	0	5	26,350	0.9999	0.9998	1.0000	0.9999
	ABT	26,171	0	4	26,351	0.9999	0.9998	1.0000	0.9999
	SVM	26,171	0	1	26,354	1.0000	1.0000	1.0000	1.0000
	MLP	26,170	1	6	26,349	0.9999	0.9998	1.0000	0.9999
10:90	DT	31,410	6	53	31,562	0.9991	0.9983	0.9998	0.9991
	RFT	31,416	0	1	31,614	1.0000	1.0000	1.0000	1.0000
	GBDT	31,416	0	7	31,608	0.9999	0.9998	1.0000	0.9999
	ABT	31,416	0	4	31,611	0.9999	0.9999	1.0000	0.9999
	SVM	31,416	0	1	31,614	1.0000	1.0000	1.0000	1.0000
	MLP	31,415	1	12	31,603	0.9998	0.9996	1.0000	0.9998
1:99	DT	34,627	42	535	34,130	0.9917	0.9848	0.9988	0.9917
	RFT	34,657	12	9	34,656	0.9997	0.9997	0.9997	0.9997
	GBDT	34,669	0	49	34,616	0.9993	0.9986	1.0000	0.9993
	ABT	34,669	0	19	34,646	0.9997	0.9995	1.0000	0.9997
	SVM	34,669	0	1	34,664	1.0000	1.0000	1.0000	1.0000
	MLP	34,647	22	52	34,613	0.9989	0.9985	0.9994	0.9989

Table 22. Injective Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	4,134	0	4	4,128	0.9995	0.9990	1.0000	0.9995
	RFT	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
	GBDT	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
	ABT	4,134	0	2	4,130	0.9998	0.9995	1.0000	0.9998
	SVM	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
	MLP	4,134	0	0	4,132	1.0000	1.0000	1.0000	1.0000
50:50	DT	8,301	0	7	8,223	0.9996	0.9992	1.0000	0.9996
	RFT	8,301	0	0	8,230	1.0000	1.0000	1.0000	1.0000
	GBDT	8,301	0	2	8,228	0.9999	0.9998	1.0000	0.9999
	ABT	8,301	0	1	8,229	0.9999	0.9999	1.0000	0.9999
	SVM	8,301	0	0	8,230	1.0000	1.0000	1.0000	1.0000
	MLP	8,301	0	0	8,230	1.0000	1.0000	1.0000	1.0000
25:75	DT	12,442	1	28	12,326	0.9988	0.9978	0.9999	0.9988
	RFT	12,443	0	0	12,354	1.0000	1.0000	1.0000	1.0000
	GBDT	12,443	0	0	12,354	1.0000	1.0000	1.0000	1.0000
	ABT	12,443	0	3	12,351	0.9999	0.9998	1.0000	0.9999
	SVM	12,443	0	0	12,354	1.0000	1.0000	1.0000	1.0000
	MLP	12,443	0	2	12,352	0.9999	0.9998	1.0000	0.9999
10:90	DT	14,905	3	58	14,790	0.9979	0.9961	0.9998	0.9980
	RFT	14,907	1	0	14,848	1.0000	1.0000	0.9999	1.0000
	GBDT	14,908	0	3	14,845	0.9999	0.9998	1.0000	0.9999
	ABT	14,908	0	1	14,847	1.0000	0.9999	1.0000	1.0000
	SVM	14,908	0	0	14,848	1.0000	1.0000	1.0000	1.0000
	MLP	14,907	1	5	14,843	0.9998	0.9997	0.9999	0.9998
1:99	DT	16,361	0	267	16,104	0.9918	0.9839	1.0000	0.9919
	RFT	16,344	17	7	16,364	0.9993	0.9996	0.9990	0.9993
	GBDT	16,361	0	36	16,335	0.9989	0.9978	1.0000	0.9989
	ABT	16,360	1	13	16,358	0.9996	0.9992	0.9999	0.9996
	SVM	16,361	0	0	16,371	1.0000	1.0000	1.0000	1.0000
	MLP	16,359	2	16	16,355	0.9995	0.9990	0.9999	0.9995

Table 23. Irreflexive Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	RFT	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	GBDT	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	ABT	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	SVM	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	MLP	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
50:50	DT	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
	RFT	17,980	1	0	17,905	1.0000	1.0000	0.9999	1.0000
	GBDT	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
	ABT	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
	SVM	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
	MLP	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
25:75	DT	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
	RFT	26,818	1	0	27,010	1.0000	1.0000	1.0000	1.0000
	GBDT	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
	ABT	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
	SVM	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
	MLP	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
10:90	DT	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	RFT	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	GBDT	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	ABT	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	SVM	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	MLP	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
1:99	DT	35,531	0	0	35,524	1.0000	1.0000	1.0000	1.0000
	RFT	35,530	1	9	35,515	0.9999	0.9997	1.0000	0.9999
	GBDT	35,531	0	0	35,524	1.0000	1.0000	1.0000	1.0000
	ABT	35,531	0	0	35,524	1.0000	1.0000	1.0000	1.0000
	SVM	35,531	0	781	34,743	0.9890	0.9785	1.0000	0.9891
	MLP	35,531	0	237	35,287	0.9967	0.9934	1.0000	0.9967

Table 24. NonStrictOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	6,590	0	3	6,601	0.9998	0.9995	1.0000	0.9998
	RFT	6,590	0	0	6,604	1.0000	1.0000	1.0000	1.0000
	GBDT	6,590	0	10	6,594	0.9992	0.9985	1.0000	0.9992
	ABT	6,590	0	10	6,594	0.9992	0.9985	1.0000	0.9992
	SVM	6,590	0	1	6,603	0.9999	0.9998	1.0000	0.9999
	MLP	6,590	0	5	6,599	0.9996	0.9992	1.0000	0.9996
50:50	DT	13,181	0	12	13,194	0.9995	0.9991	1.0000	0.9995
	RFT	13,181	0	0	13,206	1.0000	1.0000	1.0000	1.0000
	GBDT	13,181	0	16	13,190	0.9994	0.9988	1.0000	0.9994
	ABT	13,178	3	17	13,189	0.9992	0.9987	0.9998	0.9992
	SVM	13,181	0	8	13,198	0.9997	0.9994	1.0000	0.9997
	MLP	13,181	0	9	13,197	0.9997	0.9993	1.0000	0.9997
25:75	DT	19,729	0	20	19,832	0.9995	0.9990	1.0000	0.9995
	RFT	19,729	0	1	19,851	1.0000	0.9999	1.0000	1.0000
	GBDT	19,729	0	29	19,823	0.9993	0.9985	1.0000	0.9993
	ABT	19,727	2	45	19,807	0.9988	0.9977	0.9999	0.9988
	SVM	19,729	0	17	19,835	0.9996	0.9991	1.0000	0.9996
	MLP	19,729	0	27	19,825	0.9993	0.9986	1.0000	0.9993
10:90	DT	23,713	0	27	23,757	0.9994	0.9989	1.0000	0.9994
	RFT	23,713	0	3	23,781	0.9999	0.9999	1.0000	0.9999
	GBDT	23,713	0	43	23,741	0.9991	0.9982	1.0000	0.9991
	ABT	23,708	5	60	23,724	0.9986	0.9975	0.9998	0.9986
	SVM	23,713	0	38	23,746	0.9992	0.9984	1.0000	0.9992
	MLP	23,713	0	73	23,711	0.9985	0.9969	1.0000	0.9985
1:99	DT	26,105	0	141	26,001	0.9973	0.9946	1.0000	0.9973
	RFT	26,089	16	25	26,117	0.9992	0.9990	0.9994	0.9992
	GBDT	26,105	0	138	26,004	0.9974	0.9947	1.0000	0.9974
	ABT	26,105	0	239	25,903	0.9954	0.9909	1.0000	0.9954
	SVM	25,838	267	110	26,032	0.9928	0.9958	0.9898	0.9928
	MLP	25,983	122	205	25,937	0.9937	0.9922	0.9953	0.9937

Table 25. PartialOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	20,521	0	17	20,642	0.9996	0.9992	1.0000	0.9996
	RFT	20,521	0	5	20,654	0.9999	0.9998	1.0000	0.9999
	GBDT	20,515	6	197	20,462	0.9951	0.9905	0.9997	0.9951
	ABT	19,342	1,179	1,243	19,416	0.9412	0.9396	0.9425	0.9411
	SVM	20,521	0	30	20,629	0.9993	0.9985	1.0000	0.9993
	MLP	20,521	0	15	20,644	0.9996	0.9993	1.0000	0.9996
50:50	DT	41,226	4	86	41,043	0.9989	0.9979	0.9999	0.9989
	RFT	41,228	2	16	41,113	0.9998	0.9996	1.0000	0.9998
	GBDT	41,216	14	416	40,713	0.9948	0.9900	0.9997	0.9948
	ABT	38,953	2,277	2,574	38,555	0.9411	0.9380	0.9448	0.9414
	SVM	41,230	0	81	41,048	0.9990	0.9980	1.0000	0.9990
	MLP	41,226	4	33	41,096	0.9996	0.9992	0.9999	0.9996
25:75	DT	61,880	5	201	61,453	0.9983	0.9968	0.9999	0.9983
	RFT	61,884	1	44	61,610	0.9996	0.9993	1.0000	0.9996
	GBDT	61,874	11	587	61,067	0.9952	0.9906	0.9998	0.9952
	ABT	58,427	3,458	3,721	57,933	0.9419	0.9401	0.9441	0.9421
	SVM	61,885	0	165	61,489	0.9987	0.9973	1.0000	0.9987
	MLP	61,885	0	114	61,540	0.9991	0.9982	1.0000	0.9991
10:90	DT	74,106	74	475	73,592	0.9963	0.9936	0.9990	0.9963
	RFT	74,149	31	83	73,984	0.9992	0.9989	0.9996	0.9992
	GBDT	74,162	18	816	73,251	0.9944	0.9891	0.9998	0.9944
	ABT	70,026	4,154	4,541	69,526	0.9413	0.9391	0.9440	0.9415
	SVM	74,174	6	356	73,711	0.9976	0.9952	0.9999	0.9976
	MLP	74,177	3	249	73,818	0.9983	0.9967	1.0000	0.9983
1:99	DT	81,145	412	2,887	78,627	0.9798	0.9656	0.9949	0.9801
	RFT	80,954	603	517	80,997	0.9931	0.9937	0.9926	0.9931
	GBDT	81,263	294	1,274	80,240	0.9904	0.9846	0.9964	0.9904
	ABT	76,892	4,665	5,337	76,177	0.9387	0.9351	0.9428	0.9389
	SVM	79,695	1,862	1,898	79,616	0.9769	0.9767	0.9772	0.9770
	MLP	81,173	384	1,094	80,420	0.9909	0.9867	0.9953	0.9910

Table 26. PreOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	10,869	0	8	10,949	0.9996	0.9993	1.0000	0.9996
	RFT	10,869	0	1	10,956	1.0000	0.9999	1.0000	1.0000
	GBDT	10,868	1	26	10,931	0.9988	0.9976	0.9999	0.9988
	ABT	10,868	1	48	10,909	0.9978	0.9956	0.9999	0.9978
	SVM	10,868	1	6	10,951	0.9997	0.9994	0.9999	0.9997
	MLP	10,868	1	2	10,955	0.9999	0.9998	0.9999	0.9999
50:50	DT	21,835	1	27	21,788	0.9994	0.9988	1.0000	0.9994
	RFT	21,832	4	1	21,814	0.9999	1.0000	0.9998	0.9999
	GBDT	21,833	3	53	21,762	0.9987	0.9976	0.9999	0.9987
	ABT	21,823	13	79	21,736	0.9979	0.9964	0.9994	0.9979
	SVM	21,833	3	18	21,797	0.9995	0.9992	0.9999	0.9995
	MLP	21,832	4	16	21,799	0.9995	0.9993	0.9998	0.9995
25:75	DT	32,684	1	47	32,745	0.9993	0.9986	1.0000	0.9993
	RFT	32,676	9	8	32,784	0.9997	0.9998	0.9997	0.9997
	GBDT	32,682	3	88	32,704	0.9986	0.9973	0.9999	0.9986
	ABT	32,678	7	98	32,694	0.9984	0.9970	0.9998	0.9984
	SVM	32,682	3	46	32,746	0.9993	0.9986	0.9999	0.9993
	MLP	32,665	20	26	32,766	0.9993	0.9992	0.9994	0.9993
10:90	DT	39,181	3	57	39,331	0.9992	0.9985	0.9999	0.9992
	RFT	39,169	15	17	39,371	0.9996	0.9996	0.9996	0.9996
	GBDT	39,181	3	127	39,261	0.9983	0.9968	0.9999	0.9983
	ABT	39,182	2	123	39,265	0.9984	0.9969	0.9999	0.9984
	SVM	39,179	5	84	39,304	0.9989	0.9979	0.9999	0.9989
	MLP	39,141	43	93	39,295	0.9983	0.9976	0.9989	0.9983
1:99	DT	43,208	1	182	43,038	0.9979	0.9958	1.0000	0.9979
	RFT	43,201	8	86	43,134	0.9989	0.9980	0.9998	0.9989
	GBDT	43,207	2	335	42,885	0.9961	0.9923	1.0000	0.9961
	ABT	43,208	1	198	43,022	0.9977	0.9954	1.0000	0.9977
	SVM	43,177	32	350	42,870	0.9956	0.9920	0.9993	0.9956
	MLP	43,155	54	638	42,582	0.9920	0.9854	0.9988	0.9920

Table 27. Reflexive Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	RFT	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	GBDT	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	ABT	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	SVM	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
	MLP	9,014	0	0	8,929	1.0000	1.0000	1.0000	1.0000
50:50	DT	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
	RFT	17,980	1	4	17,901	0.9999	0.9998	0.9999	0.9999
	GBDT	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
	ABT	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
	SVM	17,981	0	0	17,905	1.0000	1.0000	1.0000	1.0000
	MLP	17,980	1	0	17,905	1.0000	1.0000	0.9999	1.0000
25:75	DT	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
	RFT	26,818	1	0	27,010	1.0000	1.0000	1.0000	1.0000
	GBDT	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
	ABT	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
	SVM	26,819	0	0	27,010	1.0000	1.0000	1.0000	1.0000
	MLP	26,818	1	0	27,010	1.0000	1.0000	1.0000	1.0000
10:90	DT	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	RFT	32,205	1	2	32,387	1.0000	0.9999	1.0000	1.0000
	GBDT	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	ABT	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	SVM	32,206	0	0	32,389	1.0000	1.0000	1.0000	1.0000
	MLP	32,205	1	1	32,388	1.0000	1.0000	1.0000	1.0000
1:99	DT	35,531	0	0	35,524	1.0000	1.0000	1.0000	1.0000
	RFT	35,530	1	59	35,465	0.9992	0.9983	1.0000	0.9992
	GBDT	35,531	0	0	35,524	1.0000	1.0000	1.0000	1.0000
	ABT	35,531	0	0	35,524	1.0000	1.0000	1.0000	1.0000
	SVM	35,531	0	543	34,981	0.9924	0.9849	1.0000	0.9924
	MLP	35,529	2	1,153	34,371	0.9837	0.9686	0.9999	0.9840

Table 28. StrictOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	6,590	0	3	6,601	0.9998	0.9995	1.0000	0.9998
	RFT	6,590	0	1	6,603	0.9999	0.9998	1.0000	0.9999
	GBDT	6,590	0	7	6,597	0.9995	0.9989	1.0000	0.9995
	ABT	6,590	0	6	6,598	0.9995	0.9991	1.0000	0.9995
	SVM	6,590	0	3	6,601	0.9998	0.9995	1.0000	0.9998
	MLP	6,590	0	4	6,600	0.9997	0.9994	1.0000	0.9997
50:50	DT	13,181	0	9	13,197	0.9997	0.9993	1.0000	0.9997
	RFT	13,181	0	0	13,206	1.0000	1.0000	1.0000	1.0000
	GBDT	13,181	0	15	13,191	0.9994	0.9989	1.0000	0.9994
	ABT	13,180	1	21	13,185	0.9992	0.9984	0.9999	0.9992
	SVM	13,181	0	5	13,201	0.9998	0.9996	1.0000	0.9998
	MLP	13,181	0	10	13,196	0.9996	0.9992	1.0000	0.9996
25:75	DT	19,729	0	18	19,834	0.9995	0.9991	1.0000	0.9995
	RFT	19,729	0	1	19,851	1.0000	0.9999	1.0000	1.0000
	GBDT	19,729	0	28	19,824	0.9993	0.9986	1.0000	0.9993
	ABT	19,729	0	51	19,801	0.9987	0.9974	1.0000	0.9987
	SVM	19,729	0	15	19,837	0.9996	0.9992	1.0000	0.9996
	MLP	19,729	0	25	19,827	0.9994	0.9987	1.0000	0.9994
10:90	DT	23,713	0	43	23,741	0.9991	0.9982	1.0000	0.9991
	RFT	23,713	0	6	23,778	0.9999	0.9997	1.0000	0.9999
	GBDT	23,713	0	72	23,712	0.9985	0.9970	1.0000	0.9985
	ABT	23,713	0	78	23,706	0.9984	0.9967	1.0000	0.9984
	SVM	23,713	0	52	23,732	0.9989	0.9978	1.0000	0.9989
	MLP	23,713	0	47	23,737	0.9990	0.9980	1.0000	0.9990
1:99	DT	26,105	0	713	25,429	0.9864	0.9734	1.0000	0.9865
	RFT	25,995	110	75	26,067	0.9965	0.9971	0.9958	0.9965
	GBDT	26,093	12	229	25,913	0.9954	0.9913	0.9995	0.9954
	ABT	26,105	0	265	25,877	0.9949	0.9900	1.0000	0.9949
	SVM	25,839	266	140	26,002	0.9922	0.9946	0.9898	0.9922
	MLP	25,989	116	202	25,940	0.9939	0.9923	0.9956	0.9939

Table 29. Surjective Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	6,221	0	11	6,290	0.9991	0.9982	1.0000	0.9991
	RFT	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
	GBDT	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
	ABT	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
	SVM	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
	MLP	6,221	0	0	6,301	1.0000	1.0000	1.0000	1.0000
50:50	DT	12,466	0	9	12,568	0.9996	0.9993	1.0000	0.9996
	RFT	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
	GBDT	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
	ABT	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
	SVM	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
	MLP	12,466	0	0	12,577	1.0000	1.0000	1.0000	1.0000
25:75	DT	18,718	6	38	18,803	0.9988	0.9980	0.9997	0.9988
	RFT	18,723	1	0	18,841	1.0000	1.0000	0.9999	1.0000
	GBDT	18,724	0	0	18,841	1.0000	1.0000	1.0000	1.0000
	ABT	18,724	0	0	18,841	1.0000	1.0000	1.0000	1.0000
	SVM	18,724	0	0	18,841	1.0000	1.0000	1.0000	1.0000
	MLP	18,723	1	0	18,841	1.0000	1.0000	0.9999	1.0000
10:90	DT	22,506	0	89	22,483	0.9980	0.9961	1.0000	0.9980
	RFT	22,506	0	0	22,572	1.0000	1.0000	1.0000	1.0000
	GBDT	22,506	0	0	22,572	1.0000	1.0000	1.0000	1.0000
	ABT	22,506	0	0	22,572	1.0000	1.0000	1.0000	1.0000
	SVM	22,506	0	0	22,572	1.0000	1.0000	1.0000	1.0000
	MLP	22,505	1	0	22,572	1.0000	1.0000	1.0000	1.0000
1:99	DT	24,772	2	766	24,046	0.9845	0.9700	0.9999	0.9847
	RFT	24,774	0	0	24,812	1.0000	1.0000	1.0000	1.0000
	GBDT	24,774	0	0	24,812	1.0000	1.0000	1.0000	1.0000
	ABT	24,774	0	1	24,811	1.0000	1.0000	1.0000	1.0000
	SVM	24,774	0	0	24,812	1.0000	1.0000	1.0000	1.0000
	MLP	24,773	1	0	24,812	1.0000	1.0000	1.0000	1.0000

Table 30. TotalOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	3,910	0	0	3,846	1.0000	1.0000	1.0000	1.0000
	RFT	3,910	0	0	3,846	1.0000	1.0000	1.0000	1.0000
	GBDT	3,910	0	0	3,846	1.0000	1.0000	1.0000	1.0000
	ABT	3,910	0	0	3,846	1.0000	1.0000	1.0000	1.0000
	SVM	3,910	0	0	3,846	1.0000	1.0000	1.0000	1.0000
	MLP	3,910	0	1	3,845	0.9999	0.9997	1.0000	0.9999
50:50	DT	7,827	0	3	7,681	0.9998	0.9996	1.0000	0.9998
	RFT	7,827	0	0	7,684	1.0000	1.0000	1.0000	1.0000
	GBDT	7,827	0	1	7,683	0.9999	0.9999	1.0000	0.9999
	ABT	7,827	0	2	7,682	0.9999	0.9997	1.0000	0.9999
	SVM	7,827	0	0	7,684	1.0000	1.0000	1.0000	1.0000
	MLP	7,827	0	2	7,682	0.9999	0.9997	1.0000	0.9999
25:75	DT	11,719	0	5	11,543	0.9998	0.9996	1.0000	0.9998
	RFT	11,719	0	0	11,548	1.0000	1.0000	1.0000	1.0000
	GBDT	11,719	0	1	11,547	1.0000	0.9999	1.0000	1.0000
	ABT	11,719	0	4	11,544	0.9998	0.9997	1.0000	0.9998
	SVM	11,719	0	0	11,548	1.0000	1.0000	1.0000	1.0000
	MLP	11,719	0	4	11,544	0.9998	0.9997	1.0000	0.9998
10:90	DT	13,999	0	17	13,904	0.9994	0.9988	1.0000	0.9994
	RFT	13,999	0	0	13,921	1.0000	1.0000	1.0000	1.0000
	GBDT	13,999	0	4	13,917	0.9999	0.9997	1.0000	0.9999
	ABT	13,999	0	5	13,916	0.9998	0.9996	1.0000	0.9998
	SVM	13,999	0	0	13,921	1.0000	1.0000	1.0000	1.0000
	MLP	13,999	0	12	13,909	0.9996	0.9991	1.0000	0.9996
1:99	DT	15,367	0	506	14,839	0.9835	0.9681	1.0000	0.9838
	RFT	15,245	122	0	15,345	0.9960	1.0000	0.9921	0.9960
	GBDT	15,367	0	72	15,273	0.9977	0.9953	1.0000	0.9977
	ABT	15,367	0	86	15,259	0.9972	0.9944	1.0000	0.9972
	SVM	15,293	74	0	15,345	0.9976	1.0000	0.9952	0.9976
	MLP	15,261	106	27	15,318	0.9957	0.9982	0.9931	0.9957

Table 31. Transitive Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	23,929	7	45	23,801	0.9989	0.9981	0.9997	0.9989
	RFT	23,932	4	13	23,833	0.9996	0.9995	0.9998	0.9996
	GBDT	23,880	56	339	23,507	0.9917	0.9860	0.9977	0.9918
	ABT	22,521	1,415	1,891	21,955	0.9308	0.9225	0.9409	0.9316
	SVM	23,927	9	67	23,779	0.9984	0.9972	0.9996	0.9984
	MLP	23,933	3	20	23,826	0.9995	0.9992	0.9999	0.9995
50:50	DT	47,738	18	124	47,684	0.9985	0.9974	0.9996	0.9985
	RFT	47,740	16	31	47,777	0.9995	0.9994	0.9997	0.9995
	GBDT	47,644	112	678	47,130	0.9917	0.9860	0.9977	0.9918
	ABT	44,949	2,807	3,837	43,971	0.9305	0.9214	0.9412	0.9312
	SVM	47,731	25	139	47,669	0.9983	0.9971	0.9995	0.9983
	MLP	47,745	11	70	47,738	0.9992	0.9985	0.9998	0.9992
25:75	DT	71,626	35	373	71,312	0.9972	0.9948	0.9995	0.9972
	RFT	71,637	24	87	71,598	0.9992	0.9988	0.9997	0.9992
	GBDT	71,513	148	1,166	70,519	0.9908	0.9840	0.9979	0.9909
	ABT	67,565	4,096	5,930	65,755	0.9301	0.9193	0.9428	0.9309
	SVM	71,604	57	307	71,378	0.9975	0.9957	0.9992	0.9975
	MLP	71,655	6	161	71,524	0.9988	0.9978	0.9999	0.9988
10:90	DT	85,904	96	781	85,235	0.9949	0.9910	0.9989	0.9949
	RFT	85,833	167	181	85,835	0.9980	0.9979	0.9981	0.9980
	GBDT	85,814	186	1,338	84,678	0.9911	0.9846	0.9978	0.9912
	ABT	81,044	4,956	7,546	78,470	0.9273	0.9148	0.9424	0.9284
	SVM	85,865	135	627	85,389	0.9956	0.9928	0.9984	0.9956
	MLP	85,976	24	269	85,747	0.9983	0.9969	0.9997	0.9983
1:99	DT	93,255	1,364	4,074	90,524	0.9713	0.9581	0.9856	0.9717
	RFT	93,383	1,236	589	94,009	0.9904	0.9937	0.9869	0.9903
	GBDT	94,044	575	1,749	92,849	0.9877	0.9817	0.9939	0.9878
	ABT	88,328	6,291	7,783	86,815	0.9256	0.9190	0.9335	0.9262
	SVM	92,898	1,721	2,489	92,109	0.9778	0.9739	0.9818	0.9778
	MLP	93,859	760	1,321	93,277	0.9890	0.9861	0.9920	0.9890

8.2 Symmetry Breaking Off

Table 32. AntiSymmetric Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	472,626	0	0	472,158	1.0000	1.0000	1.0000	1.0000
	RFT	472,626	0	16	472,142	1.0000	1.0000	1.0000	1.0000
	GBDT	472,626	0	1,176	470,982	0.9988	0.9975	1.0000	0.9988
	ABT	423,128	49,498	100,618	371,540	0.8411	0.8079	0.8953	0.8493
	SVM	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
	MLP	472,626	0	0	472,158	1.0000	1.0000	1.0000	1.0000
50:50	DT	944,147	0	7	945,414	1.0000	1.0000	1.0000	1.0000
	RFT	944,146	1	113	945,308	0.9999	0.9999	1.0000	0.9999
	GBDT	944,147	0	1,659	943,762	0.9991	0.9982	1.0000	0.9991
	ABT	845,391	98,756	201,165	744,256	0.8413	0.8078	0.8954	0.8493
	SVM	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
	MLP	944,147	0	0	945,421	1.0000	1.0000	1.0000	1.0000
25:75	DT	1,417,241	0	71	1,417,040	1.0000	0.9999	1.0000	1.0000
	RFT	1,417,233	8	397	1,416,714	0.9999	0.9997	1.0000	0.9999
	GBDT	1,417,241	0	2,337	1,414,774	0.9992	0.9984	1.0000	0.9992
	ABT	1,269,629	147,612	301,741	1,115,370	0.8415	0.8080	0.8958	0.8496
	SVM	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
	MLP	1,417,241	0	0	1,417,111	1.0000	1.0000	1.0000	1.0000
10:90	DT	1,700,404	332	645	1,699,842	0.9997	0.9996	0.9998	0.9997
	RFT	1,700,671	65	1,735	1,698,752	0.9995	0.9990	1.0000	0.9995
	GBDT	1,700,736	0	1,220	1,699,267	0.9996	0.9993	1.0000	0.9996
	ABT	1,523,764	176,972	362,263	1,338,224	0.8415	0.8079	0.8959	0.8497
	SVM	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
	MLP	1,700,736	0	0	1,700,487	1.0000	1.0000	1.0000	1.0000
1:99	DT	1,852,933	17,736	33,762	1,836,914	0.9862	0.9821	0.9905	0.9863
	RFT	1,866,037	4,632	24,601	1,846,075	0.9922	0.9870	0.9975	0.9922
	GBDT	1,870,669	0	8,789	1,861,887	0.9977	0.9953	1.0000	0.9977
	ABT	1,651,161	219,508	388,279	1,482,397	0.8375	0.8096	0.8827	0.8446
	SVM	1,870,669	0	0	1,870,676	1.0000	1.0000	1.0000	1.0000
	MLP	1,870,669	0	70	1,870,606	1.0000	1.0000	1.0000	1.0000

Table 33. Bijective Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	90,576	0	25	90,839	0.9999	0.9997	1.0000	0.9999
	RFT	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
	GBDT	90,576	0	1	90,863	1.0000	1.0000	1.0000	1.0000
	ABT	90,576	0	13	90,851	0.9999	0.9999	1.0000	0.9999
	SVM	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
	MLP	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
50:50	DT	181,096	0	75	181,709	0.9998	0.9996	1.0000	0.9998
	RFT	181,096	0	0	181,784	1.0000	1.0000	1.0000	1.0000
	GBDT	181,096	0	2	181,782	1.0000	1.0000	1.0000	1.0000
	ABT	181,096	0	19	181,765	0.9999	0.9999	1.0000	0.9999
	SVM	181,096	0	0	181,784	1.0000	1.0000	1.0000	1.0000
	MLP	181,096	0	0	181,784	1.0000	1.0000	1.0000	1.0000
25:75	DT	272,000	0	189	272,131	0.9997	0.9993	1.0000	0.9997
	RFT	272,000	0	0	272,320	1.0000	1.0000	1.0000	1.0000
	GBDT	272,000	0	4	272,316	1.0000	1.0000	1.0000	1.0000
	ABT	272,000	0	25	272,295	1.0000	0.9999	1.0000	1.0000
	SVM	272,000	0	0	272,320	1.0000	1.0000	1.0000	1.0000
	MLP	272,000	0	0	272,320	1.0000	1.0000	1.0000	1.0000
10:90	DT	326,624	0	575	325,985	0.9991	0.9982	1.0000	0.9991
	RFT	326,624	0	0	326,560	1.0000	1.0000	1.0000	1.0000
	GBDT	326,624	0	11	326,549	1.0000	1.0000	1.0000	1.0000
	ABT	326,624	0	42	326,518	0.9999	0.9999	1.0000	0.9999
	SVM	326,624	0	0	326,560	1.0000	1.0000	1.0000	1.0000
	MLP	326,624	0	1	326,559	1.0000	1.0000	1.0000	1.0000
1:99	DT	359,275	0	4,225	355,003	0.9941	0.9884	1.0000	0.9942
	RFT	359,275	0	4	359,224	1.0000	1.0000	1.0000	1.0000
	GBDT	359,275	0	26	359,202	1.0000	0.9999	1.0000	1.0000
	ABT	359,275	0	63	359,165	0.9999	0.9998	1.0000	0.9999
	SVM	359,275	0	0	359,228	1.0000	1.0000	1.0000	1.0000
	MLP	359,275	0	7	359,221	1.0000	1.0000	1.0000	1.0000

Table 34. Connex Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	14,887	0	36	14,602	0.9988	0.9976	1.0000	0.9988
	RFT	14,887	0	31	14,607	0.9990	0.9979	1.0000	0.9990
	GBDT	14,887	0	110	14,528	0.9963	0.9927	1.0000	0.9963
	ABT	14,887	0	290	14,348	0.9902	0.9809	1.0000	0.9904
	SVM	14,887	0	74	14,564	0.9975	0.9951	1.0000	0.9975
	MLP	14,887	0	12	14,626	0.9996	0.9992	1.0000	0.9996
50:50	DT	29,629	4	113	29,303	0.9980	0.9962	0.9999	0.9980
	RFT	29,633	0	91	29,325	0.9985	0.9969	1.0000	0.9985
	GBDT	29,633	0	224	29,192	0.9962	0.9925	1.0000	0.9962
	ABT	29,633	0	598	28,818	0.9899	0.9802	1.0000	0.9900
	SVM	29,633	0	163	29,253	0.9972	0.9945	1.0000	0.9973
	MLP	29,633	0	41	29,375	0.9993	0.9986	1.0000	0.9993
25:75	DT	44,288	9	192	44,085	0.9977	0.9957	0.9998	0.9977
	RFT	44,296	1	206	44,071	0.9977	0.9954	1.0000	0.9977
	GBDT	44,297	0	361	43,916	0.9959	0.9919	1.0000	0.9959
	ABT	44,297	0	902	43,375	0.9898	0.9800	1.0000	0.9899
	SVM	44,297	0	626	43,651	0.9929	0.9861	1.0000	0.9930
	MLP	44,297	0	83	44,194	0.9991	0.9981	1.0000	0.9991
10:90	DT	52,992	96	357	52,844	0.9957	0.9933	0.9982	0.9957
	RFT	53,088	0	413	52,788	0.9961	0.9923	1.0000	0.9961
	GBDT	53,088	0	488	52,713	0.9954	0.9909	1.0000	0.9954
	ABT	53,088	0	1,042	52,159	0.9902	0.9808	1.0000	0.9903
	SVM	53,088	0	1,471	51,730	0.9862	0.9730	1.0000	0.9863
	MLP	53,088	0	299	52,902	0.9972	0.9944	1.0000	0.9972
1:99	DT	58,045	405	741	57,727	0.9902	0.9874	0.9931	0.9902
	RFT	58,450	0	1,212	57,256	0.9896	0.9797	1.0000	0.9897
	GBDT	58,450	0	1,056	57,412	0.9910	0.9823	1.0000	0.9910
	ABT	58,387	63	1,089	57,379	0.9901	0.9817	0.9989	0.9902
	SVM	58,450	0	2,453	56,015	0.9790	0.9597	1.0000	0.9794
	MLP	58,450	0	1,858	56,610	0.9841	0.9692	1.0000	0.9844

Table 35. Equivalence Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	28,845	0	5	29,138	0.9999	0.9998	1.0000	0.9999
	RFT	28,845	0	0	29,143	1.0000	1.0000	1.0000	1.0000
	GBDT	28,845	0	21	29,122	0.9996	0.9993	1.0000	0.9996
	ABT	28,835	10	33	29,110	0.9993	0.9989	0.9997	0.9993
	SVM	28,845	0	23	29,120	0.9996	0.9992	1.0000	0.9996
	MLP	28,845	0	1	29,142	1.0000	1.0000	1.0000	1.0000
50:50	DT	57,699	0	12	58,264	0.9999	0.9998	1.0000	0.9999
	RFT	57,699	0	0	58,276	1.0000	1.0000	1.0000	1.0000
	GBDT	57,698	1	38	58,238	0.9997	0.9993	1.0000	0.9997
	ABT	57,678	21	58	58,218	0.9993	0.9990	0.9996	0.9993
	SVM	57,693	6	44	58,232	0.9996	0.9992	0.9999	0.9996
	MLP	57,698	1	3	58,273	1.0000	0.9999	1.0000	1.0000
25:75	DT	86,873	0	23	87,067	0.9999	0.9997	1.0000	0.9999
	RFT	86,873	0	1	87,089	1.0000	1.0000	1.0000	1.0000
	GBDT	86,872	1	55	87,035	0.9997	0.9994	1.0000	0.9997
	ABT	86,848	25	77	87,013	0.9994	0.9991	0.9997	0.9994
	SVM	86,856	17	70	87,020	0.9995	0.9992	0.9998	0.9995
	MLP	86,870	3	13	87,077	0.9999	0.9999	1.0000	0.9999
10:90	DT	104,356	0	60	104,339	0.9997	0.9994	1.0000	0.9997
	RFT	104,353	3	4	104,395	1.0000	1.0000	1.0000	1.0000
	GBDT	104,355	1	62	104,337	0.9997	0.9994	1.0000	0.9997
	ABT	104,351	5	112	104,287	0.9994	0.9989	1.0000	0.9994
	SVM	104,182	174	91	104,308	0.9987	0.9991	0.9983	0.9987
	MLP	104,236	120	74	104,325	0.9991	0.9993	0.9989	0.9991
1:99	DT	114,830	0	224	114,577	0.9990	0.9981	1.0000	0.9990
	RFT	114,723	107	64	114,737	0.9993	0.9994	0.9991	0.9993
	GBDT	114,829	1	177	114,624	0.9992	0.9985	1.0000	0.9992
	ABT	114,829	1	417	114,384	0.9982	0.9964	1.0000	0.9982
	SVM	113,981	849	85	114,716	0.9959	0.9993	0.9926	0.9959
	MLP	114,063	767	298	114,503	0.9954	0.9974	0.9933	0.9954

Table 36. Function Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	11,723	0	33	11,572	0.9986	0.9972	1.0000	0.9986
	RFT	11,723	0	1	11,604	1.0000	0.9999	1.0000	1.0000
	GBDT	11,723	0	50	11,555	0.9979	0.9958	1.0000	0.9979
	ABT	11,723	0	22	11,583	0.9991	0.9981	1.0000	0.9991
	SVM	11,723	0	1	11,604	1.0000	0.9999	1.0000	1.0000
	MLP	11,723	0	3	11,602	0.9999	0.9997	1.0000	0.9999
50:50	DT	23,340	0	96	23,220	0.9979	0.9959	1.0000	0.9979
	RFT	23,340	0	5	23,311	0.9999	0.9998	1.0000	0.9999
	GBDT	23,340	0	116	23,200	0.9975	0.9951	1.0000	0.9975
	ABT	23,340	0	48	23,268	0.9990	0.9979	1.0000	0.9990
	SVM	23,340	0	4	23,312	0.9999	0.9998	1.0000	0.9999
	MLP	23,340	0	12	23,304	0.9997	0.9995	1.0000	0.9997
25:75	DT	34,927	0	217	34,840	0.9969	0.9938	1.0000	0.9969
	RFT	34,927	0	14	35,043	0.9998	0.9996	1.0000	0.9998
	GBDT	34,927	0	172	34,885	0.9975	0.9951	1.0000	0.9975
	ABT	34,927	0	74	34,983	0.9989	0.9979	1.0000	0.9989
	SVM	34,927	0	16	35,041	0.9998	0.9995	1.0000	0.9998
	MLP	34,927	0	25	35,032	0.9996	0.9993	1.0000	0.9996
10:90	DT	41,861	31	421	41,668	0.9946	0.9900	0.9993	0.9946
	RFT	41,892	0	38	42,051	0.9995	0.9991	1.0000	0.9995
	GBDT	41,892	0	248	41,841	0.9970	0.9941	1.0000	0.9970
	ABT	41,892	0	98	41,991	0.9988	0.9977	1.0000	0.9988
	SVM	41,892	0	22	42,067	0.9997	0.9995	1.0000	0.9997
	MLP	41,892	0	61	42,028	0.9993	0.9985	1.0000	0.9993
1:99	DT	45,449	743	2,813	43,374	0.9615	0.9417	0.9839	0.9624
	RFT	46,101	91	397	45,790	0.9947	0.9915	0.9980	0.9947
	GBDT	46,192	0	589	45,598	0.9936	0.9874	1.0000	0.9937
	ABT	46,192	0	226	45,961	0.9976	0.9951	1.0000	0.9976
	SVM	46,192	0	90	46,097	0.9990	0.9981	1.0000	0.9990
	MLP	46,192	0	265	45,922	0.9971	0.9943	1.0000	0.9971

Table 37. Functional Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	29,189	0	44	29,592	0.9993	0.9985	1.0000	0.9992
	RFT	29,189	0	3	29,633	0.9999	0.9999	1.0000	0.9999
	GBDT	29,189	0	121	29,515	0.9979	0.9959	1.0000	0.9979
	ABT	29,189	0	47	29,589	0.9992	0.9984	1.0000	0.9992
	SVM	29,189	0	6	29,630	0.9999	0.9998	1.0000	0.9999
	MLP	29,189	0	8	29,628	0.9999	0.9997	1.0000	0.9999
50:50	DT	58,452	5	136	59,056	0.9988	0.9977	0.9999	0.9988
	RFT	58,457	0	8	59,184	0.9999	0.9999	1.0000	0.9999
	GBDT	58,457	0	226	58,966	0.9981	0.9961	1.0000	0.9981
	ABT	58,457	0	82	59,110	0.9993	0.9986	1.0000	0.9993
	SVM	58,457	0	12	59,180	0.9999	0.9998	1.0000	0.9999
	MLP	58,457	0	13	59,179	0.9999	0.9998	1.0000	0.9999
25:75	DT	88,123	0	364	87,987	0.9979	0.9959	1.0000	0.9979
	RFT	88,123	0	21	88,330	0.9999	0.9998	1.0000	0.9999
	GBDT	88,123	0	359	87,992	0.9980	0.9959	1.0000	0.9980
	ABT	88,123	0	144	88,207	0.9992	0.9984	1.0000	0.9992
	SVM	88,123	0	22	88,329	0.9999	0.9998	1.0000	0.9999
	MLP	88,123	0	50	88,301	0.9997	0.9994	1.0000	0.9997
10:90	DT	105,846	30	638	105,255	0.9968	0.9940	0.9997	0.9969
	RFT	105,876	0	31	105,862	0.9999	0.9997	1.0000	0.9999
	GBDT	105,876	0	438	105,455	0.9979	0.9959	1.0000	0.9979
	ABT	105,876	0	179	105,714	0.9992	0.9983	1.0000	0.9992
	SVM	105,876	0	66	105,827	0.9997	0.9994	1.0000	0.9997
	MLP	105,876	0	89	105,804	0.9996	0.9992	1.0000	0.9996
1:99	DT	115,896	595	3,298	113,157	0.9833	0.9723	0.9949	0.9835
	RFT	116,439	52	414	116,041	0.9980	0.9965	0.9996	0.9980
	GBDT	116,491	0	821	115,634	0.9965	0.9930	1.0000	0.9965
	ABT	116,491	0	301	116,154	0.9987	0.9974	1.0000	0.9987
	SVM	116,491	0	205	116,250	0.9991	0.9982	1.0000	0.9991
	MLP	116,491	0	312	116,143	0.9987	0.9973	1.0000	0.9987

Table 38. Injective Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	11,723	0	40	11,565	0.9983	0.9966	1.0000	0.9983
	RFT	11,723	0	4	11,601	0.9998	0.9997	1.0000	0.9998
	GBDT	11,723	0	66	11,539	0.9972	0.9944	1.0000	0.9972
	ABT	11,723	0	32	11,573	0.9986	0.9973	1.0000	0.9986
	SVM	11,723	0	0	11,605	1.0000	1.0000	1.0000	1.0000
	MLP	11,723	0	4	11,601	0.9998	0.9997	1.0000	0.9998
50:50	DT	23,335	5	94	23,222	0.9979	0.9960	0.9998	0.9979
	RFT	23,340	0	4	23,312	0.9999	0.9998	1.0000	0.9999
	GBDT	23,340	0	114	23,202	0.9976	0.9951	1.0000	0.9976
	ABT	23,340	0	53	23,263	0.9989	0.9977	1.0000	0.9989
	SVM	23,340	0	8	23,308	0.9998	0.9997	1.0000	0.9998
	MLP	23,340	0	8	23,308	0.9998	0.9997	1.0000	0.9998
25:75	DT	34,927	0	230	34,827	0.9967	0.9935	1.0000	0.9967
	RFT	34,927	0	15	35,042	0.9998	0.9996	1.0000	0.9998
	GBDT	34,927	0	207	34,850	0.9970	0.9941	1.0000	0.9970
	ABT	34,927	0	90	34,967	0.9987	0.9974	1.0000	0.9987
	SVM	34,927	0	18	35,039	0.9997	0.9995	1.0000	0.9997
	MLP	34,927	0	32	35,025	0.9995	0.9991	1.0000	0.9995
10:90	DT	41,842	50	474	41,615	0.9938	0.9888	0.9988	0.9938
	RFT	41,892	0	52	42,037	0.9994	0.9988	1.0000	0.9994
	GBDT	41,892	0	258	41,831	0.9969	0.9939	1.0000	0.9969
	ABT	41,892	0	113	41,976	0.9987	0.9973	1.0000	0.9987
	SVM	41,892	0	20	42,069	0.9998	0.9995	1.0000	0.9998
	MLP	41,892	0	55	42,034	0.9993	0.9987	1.0000	0.9993
1:99	DT	44,926	1,266	2,056	44,131	0.9640	0.9562	0.9726	0.9643
	RFT	45,976	216	530	45,657	0.9919	0.9886	0.9953	0.9920
	GBDT	46,192	0	639	45,548	0.9931	0.9864	1.0000	0.9931
	ABT	46,192	0	259	45,928	0.9972	0.9944	1.0000	0.9972
	SVM	46,192	0	87	46,100	0.9991	0.9981	1.0000	0.9991
	MLP	46,192	0	222	45,965	0.9976	0.9952	1.0000	0.9976

Table 39. Irreflexive Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	RFT	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	GBDT	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	ABT	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	SVM	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	MLP	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
50:50	DT	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	RFT	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	GBDT	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	ABT	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	SVM	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	MLP	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
25:75	DT	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	RFT	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	GBDT	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	ABT	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	SVM	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	MLP	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
10:90	DT	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	RFT	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	GBDT	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	ABT	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	SVM	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	MLP	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
1:99	DT	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000
	RFT	1,038,130	0	20	1,038,031	1.0000	1.0000	1.0000	1.0000
	GBDT	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000
	ABT	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000
	SVM	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000
	MLP	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000

Table 40. NonStrictOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	32,382	0	25	32,605	0.9996	0.9992	1.0000	0.9996
	RFT	32,382	0	3	32,627	1.0000	0.9999	1.0000	1.0000
	GBDT	32,382	0	183	32,447	0.9972	0.9944	1.0000	0.9972
	ABT	32,382	0	289	32,341	0.9956	0.9912	1.0000	0.9956
	SVM	32,382	0	19	32,611	0.9997	0.9994	1.0000	0.9997
	MLP	32,382	0	12	32,618	0.9998	0.9996	1.0000	0.9998
50:50	DT	64,786	2	57	65,178	0.9995	0.9991	1.0000	0.9995
	RFT	64,788	0	14	65,221	0.9999	0.9998	1.0000	0.9999
	GBDT	64,788	0	313	64,922	0.9976	0.9952	1.0000	0.9976
	ABT	64,786	2	574	64,661	0.9956	0.9912	1.0000	0.9956
	SVM	64,788	0	47	65,188	0.9996	0.9993	1.0000	0.9996
	MLP	64,788	0	32	65,203	0.9998	0.9995	1.0000	0.9998
25:75	DT	97,458	0	87	97,490	0.9996	0.9991	1.0000	0.9996
	RFT	97,458	0	35	97,542	0.9998	0.9996	1.0000	0.9998
	GBDT	97,458	0	480	97,097	0.9975	0.9951	1.0000	0.9975
	ABT	97,456	2	889	96,688	0.9954	0.9910	1.0000	0.9954
	SVM	97,458	0	122	97,455	0.9994	0.9987	1.0000	0.9994
	MLP	97,458	0	91	97,486	0.9995	0.9991	1.0000	0.9995
10:90	DT	116,961	66	175	116,840	0.9990	0.9985	0.9994	0.9990
	RFT	117,027	0	90	116,925	0.9996	0.9992	1.0000	0.9996
	GBDT	117,027	0	584	116,431	0.9975	0.9950	1.0000	0.9975
	ABT	116,851	176	1,000	116,015	0.9950	0.9915	0.9985	0.9950
	SVM	117,027	0	297	116,718	0.9987	0.9975	1.0000	0.9987
	MLP	117,027	0	250	116,765	0.9989	0.9979	1.0000	0.9989
1:99	DT	128,708	0	833	127,905	0.9968	0.9936	1.0000	0.9968
	RFT	128,702	6	563	128,175	0.9978	0.9956	1.0000	0.9978
	GBDT	128,708	0	1,170	127,568	0.9955	0.9910	1.0000	0.9955
	ABT	128,321	387	1,281	127,457	0.9935	0.9901	0.9970	0.9935
	SVM	128,708	0	1,345	127,393	0.9948	0.9897	1.0000	0.9948
	MLP	128,430	278	1,531	127,207	0.9930	0.9882	0.9978	0.9930

Table 41. PartialOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	33,765	0	102	33,829	0.9985	0.9970	1.0000	0.9985
	RFT	33,765	0	126	33,805	0.9981	0.9963	1.0000	0.9981
	GBDT	33,765	0	1,432	32,499	0.9788	0.9593	1.0000	0.9792
	ABT	27,344	6,421	4,317	29,614	0.8414	0.8636	0.8098	0.8359
	SVM	33,765	0	406	33,525	0.9940	0.9881	1.0000	0.9940
	MLP	33,765	0	74	33,857	0.9989	0.9978	1.0000	0.9989
50:50	DT	67,462	4	281	67,645	0.9979	0.9959	0.9999	0.9979
	RFT	67,466	0	328	67,598	0.9976	0.9952	1.0000	0.9976
	GBDT	67,466	0	2,984	64,942	0.9780	0.9576	1.0000	0.9784
	ABT	54,519	12,947	8,810	59,116	0.8393	0.8609	0.8081	0.8337
	SVM	67,466	0	1,110	66,816	0.9918	0.9838	1.0000	0.9918
	MLP	67,466	0	227	67,699	0.9983	0.9966	1.0000	0.9983
25:75	DT	101,348	32	659	101,049	0.9966	0.9935	0.9997	0.9966
	RFT	101,380	0	750	100,958	0.9963	0.9927	1.0000	0.9963
	GBDT	101,380	0	4,467	97,241	0.9780	0.9578	1.0000	0.9784
	ABT	81,961	19,419	13,194	88,514	0.8394	0.8613	0.8085	0.8341
	SVM	101,380	0	2,009	99,699	0.9901	0.9806	1.0000	0.9902
	MLP	101,380	0	473	101,235	0.9977	0.9954	1.0000	0.9977
10:90	DT	121,739	114	1,486	120,367	0.9934	0.9879	0.9991	0.9935
	RFT	121,834	19	1,321	120,532	0.9945	0.9893	0.9998	0.9945
	GBDT	121,853	0	5,430	116,423	0.9777	0.9573	1.0000	0.9782
	ABT	98,520	23,333	15,840	106,013	0.8393	0.8615	0.8085	0.8342
	SVM	121,853	0	3,376	118,477	0.9861	0.9730	1.0000	0.9863
	MLP	121,836	17	980	120,873	0.9959	0.9920	0.9999	0.9959
1:99	DT	132,619	1,440	6,816	127,202	0.9692	0.9511	0.9893	0.9698
	RFT	133,395	664	4,137	129,881	0.9821	0.9699	0.9950	0.9823
	GBDT	134,059	0	7,137	126,881	0.9734	0.9495	1.0000	0.9741
	ABT	110,836	23,223	20,967	113,051	0.8352	0.8409	0.8268	0.8338
	SVM	134,059	0	9,781	124,237	0.9635	0.9320	1.0000	0.9648
	MLP	133,901	158	4,080	129,938	0.9842	0.9704	0.9988	0.9844

Table 42. PreOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	52,638	0	51	52,075	0.9995	0.9990	1.0000	0.9995
	RFT	52,638	0	20	52,106	0.9998	0.9996	1.0000	0.9998
	GBDT	52,637	1	536	51,590	0.9949	0.9899	1.0000	0.9949
	ABT	52,496	142	765	51,361	0.9913	0.9856	0.9973	0.9914
	SVM	52,636	2	130	51,996	0.9987	0.9975	1.0000	0.9987
	MLP	52,638	0	49	52,077	0.9995	0.9991	1.0000	0.9995
50:50	DT	104,941	6	118	104,462	0.9994	0.9989	0.9999	0.9994
	RFT	104,945	2	68	104,512	0.9997	0.9994	1.0000	0.9997
	GBDT	104,938	9	1,015	103,565	0.9951	0.9904	0.9999	0.9951
	ABT	104,673	274	1,461	103,119	0.9917	0.9862	0.9974	0.9918
	SVM	104,935	12	280	104,300	0.9986	0.9973	0.9999	0.9986
	MLP	104,945	2	124	104,456	0.9994	0.9988	1.0000	0.9994
25:75	DT	157,096	45	265	156,885	0.9990	0.9983	0.9997	0.9990
	RFT	157,137	4	196	156,954	0.9994	0.9988	1.0000	0.9994
	GBDT	157,134	7	1,410	155,740	0.9955	0.9911	1.0000	0.9955
	ABT	156,798	343	2,191	154,959	0.9919	0.9862	0.9978	0.9920
	SVM	157,121	20	752	156,398	0.9975	0.9952	0.9999	0.9975
	MLP	157,110	31	262	156,888	0.9991	0.9983	0.9998	0.9991
10:90	DT	188,471	75	498	188,105	0.9985	0.9974	0.9996	0.9985
	RFT	188,525	21	450	188,153	0.9988	0.9976	0.9999	0.9988
	GBDT	188,539	7	1,824	186,779	0.9951	0.9904	1.0000	0.9952
	ABT	188,220	326	2,660	185,943	0.9921	0.9861	0.9983	0.9921
	SVM	188,545	1	2,554	186,049	0.9932	0.9866	1.0000	0.9933
	MLP	188,485	61	479	188,124	0.9986	0.9975	0.9997	0.9986
1:99	DT	206,961	393	1,699	205,811	0.9950	0.9919	0.9981	0.9950
	RFT	207,312	42	1,955	205,555	0.9952	0.9907	0.9998	0.9952
	GBDT	207,343	11	2,725	204,785	0.9934	0.9870	0.9999	0.9934
	ABT	206,531	823	2,693	204,817	0.9915	0.9871	0.9960	0.9916
	SVM	207,337	17	3,317	204,193	0.9920	0.9843	0.9999	0.9920
	MLP	207,054	300	2,247	205,263	0.9939	0.9893	0.9986	0.9939

Table 43. Reflexive Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	RFT	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	GBDT	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	ABT	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	SVM	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
	MLP	262,317	0	0	261,971	1.0000	1.0000	1.0000	1.0000
50:50	DT	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	RFT	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	GBDT	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	ABT	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	MLP	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
	MLP	524,487	0	0	524,089	1.0000	1.0000	1.0000	1.0000
25:75	DT	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	RFT	786,608	0	1	786,255	1.0000	1.0000	1.0000	1.0000
	GBDT	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	ABT	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	SVM	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
	MLP	786,608	0	0	786,256	1.0000	1.0000	1.0000	1.0000
10:90	DT	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	RFT	943,708	0	1	943,728	1.0000	1.0000	1.0000	1.0000
	GBDT	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	ABT	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	SVM	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
	MLP	943,708	0	0	943,729	1.0000	1.0000	1.0000	1.0000
1:99	DT	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000
	RFT	1,038,130	0	1	1,038,050	1.0000	1.0000	1.0000	1.0000
	GBDT	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000
	ABT	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000
	SVM	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000
	MLP	1,038,130	0	0	1,038,051	1.0000	1.0000	1.0000	1.0000

Table 44. StrictOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	32,382	0	16	32,614	0.9998	0.9995	1.0000	0.9998
	RFT	32,382	0	7	32,623	0.9999	0.9998	1.0000	0.9999
	GBDT	32,382	0	148	32,482	0.9977	0.9955	1.0000	0.9977
	ABT	32,382	0	283	32,347	0.9956	0.9913	1.0000	0.9956
	SVM	32,382	0	21	32,609	0.9997	0.9994	1.0000	0.9997
	MLP	32,382	0	9	32,621	0.9999	0.9997	1.0000	0.9999
50:50	DT	64,788	0	48	65,187	0.9996	0.9993	1.0000	0.9996
	RFT	64,788	0	22	65,213	0.9998	0.9997	1.0000	0.9998
	GBDT	64,788	0	306	64,929	0.9976	0.9953	1.0000	0.9976
	ABT	64,778	10	571	64,664	0.9955	0.9913	0.9998	0.9955
	SVM	64,788	0	54	65,181	0.9996	0.9992	1.0000	0.9996
	MLP	64,788	0	25	65,210	0.9998	0.9996	1.0000	0.9998
25:75	DT	97,445	13	81	97,496	0.9995	0.9992	0.9999	0.9995
	RFT	97,458	0	40	97,537	0.9998	0.9996	1.0000	0.9998
	GBDT	97,458	0	455	97,122	0.9977	0.9954	1.0000	0.9977
	ABT	97,442	16	856	96,721	0.9955	0.9913	0.9998	0.9955
	SVM	97,458	0	123	97,454	0.9994	0.9987	1.0000	0.9994
	MLP	97,458	0	79	97,498	0.9996	0.9992	1.0000	0.9996
10:90	DT	116,996	31	251	116,764	0.9988	0.9979	0.9997	0.9988
	RFT	117,027	0	156	116,859	0.9993	0.9987	1.0000	0.9993
	GBDT	117,027	0	596	116,419	0.9975	0.9949	1.0000	0.9975
	ABT	116,926	101	1,019	115,996	0.9952	0.9914	0.9991	0.9952
	SVM	117,027	0	345	116,670	0.9985	0.9971	1.0000	0.9985
	MLP	117,027	0	154	116,861	0.9993	0.9987	1.0000	0.9993
1:99	DT	128,629	79	865	127,873	0.9963	0.9933	0.9994	0.9963
	RFT	128,708	0	937	127,801	0.9964	0.9928	1.0000	0.9964
	GBDT	128,708	0	1,268	127,470	0.9951	0.9902	1.0000	0.9951
	ABT	128,510	198	1,268	127,470	0.9943	0.9902	0.9985	0.9943
	SVM	128,708	0	1,670	127,068	0.9935	0.9872	1.0000	0.9936
	MLP	128,708	0	937	127,801	0.9964	0.9928	1.0000	0.9964

Table 45. Surjective Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	90,576	0	21	90,843	0.9999	0.9998	1.0000	0.9999
	RFT	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
	GBDT	90,576	0	1	90,863	1.0000	1.0000	1.0000	1.0000
	ABT	90,576	0	4	90,860	1.0000	1.0000	1.0000	1.0000
	SVM	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
	MLP	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
50:50	DT	181,096	0	60	181,724	0.9998	0.9997	1.0000	0.9998
	RFT	181,096	0	0	181,784	1.0000	1.0000	1.0000	1.0000
	GBDT	181,096	0	10	181,774	1.0000	0.9999	1.0000	1.0000
	ABT	181,096	0	18	181,766	1.0000	0.9999	1.0000	1.0000
	SVM	181,096	0	0	181,784	1.0000	1.0000	1.0000	1.0000
	MLP	181,096	0	0	181,784	1.0000	1.0000	1.0000	1.0000
25:75	DT	272,000	0	196	272,124	0.9996	0.9993	1.0000	0.9996
	RFT	272,000	0	0	272,320	1.0000	1.0000	1.0000	1.0000
	GBDT	272,000	0	7	272,313	1.0000	1.0000	1.0000	1.0000
	ABT	272,000	0	39	272,281	0.9999	0.9999	1.0000	0.9999
	SVM	272,000	0	0	272,320	1.0000	1.0000	1.0000	1.0000
	MLP	272,000	0	0	272,320	1.0000	1.0000	1.0000	1.0000
10:90	DT	326,624	0	510	326,050	0.9992	0.9984	1.0000	0.9992
	RFT	326,624	0	0	326,560	1.0000	1.0000	1.0000	1.0000
	GBDT	326,624	0	14	326,546	1.0000	1.0000	1.0000	1.0000
	ABT	326,624	0	47	326,513	0.9999	0.9999	1.0000	0.9999
	SVM	326,624	0	0	326,560	1.0000	1.0000	1.0000	1.0000
	MLP	326,624	0	1	326,559	1.0000	1.0000	1.0000	1.0000
1:99	DT	359,275	0	3,902	355,326	0.9946	0.9893	1.0000	0.9946
	RFT	359,275	0	1	359,227	1.0000	1.0000	1.0000	1.0000
	GBDT	359,275	0	33	359,195	1.0000	0.9999	1.0000	1.0000
	ABT	359,275	0	98	359,130	0.9999	0.9997	1.0000	0.9999
	SVM	359,275	0	0	359,228	1.0000	1.0000	1.0000	1.0000
	MLP	359,275	0	10	359,218	1.0000	1.0000	1.0000	1.0000

Table 46. TotalOrder Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	90,576	0	8	90,856	1.0000	0.9999	1.0000	1.0000
	RFT	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
	GBDT	90,576	0	174	90,690	0.9990	0.9981	1.0000	0.9990
	ABT	90,576	0	174	90,690	0.9990	0.9981	1.0000	0.9990
	SVM	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
	MLP	90,576	0	0	90,864	1.0000	1.0000	1.0000	1.0000
50:50	DT	181,096	0	14	181,770	1.0000	0.9999	1.0000	1.0000
	RFT	181,096	0	0	181,784	1.0000	1.0000	1.0000	1.0000
	GBDT	181,096	0	321	181,463	0.9991	0.9982	1.0000	0.9991
	ABT	181,096	0	321	181,463	0.9991	0.9982	1.0000	0.9991
	SVM	181,096	0	0	181,784	1.0000	1.0000	1.0000	1.0000
	MLP	181,096	0	1	181,783	1.0000	1.0000	1.0000	1.0000
25:75	DT	272,000	0	25	272,295	1.0000	0.9999	1.0000	1.0000
	RFT	272,000	0	1	272,319	1.0000	1.0000	1.0000	1.0000
	GBDT	272,000	0	502	271,818	0.9991	0.9982	1.0000	0.9991
	ABT	272,000	0	502	271,818	0.9991	0.9982	1.0000	0.9991
	SVM	272,000	0	1	272,319	1.0000	1.0000	1.0000	1.0000
	MLP	272,000	0	3	272,317	1.0000	1.0000	1.0000	1.0000
10:90	DT	326,624	0	82	326,478	0.9999	0.9997	1.0000	0.9999
	RFT	326,624	0	0	326,560	1.0000	1.0000	1.0000	1.0000
	GBDT	326,624	0	606	325,954	0.9991	0.9981	1.0000	0.9991
	ABT	326,624	0	606	325,954	0.9991	0.9981	1.0000	0.9991
	SVM	326,624	0	5	326,555	1.0000	1.0000	1.0000	1.0000
	MLP	326,624	0	49	326,511	0.9999	0.9999	1.0000	0.9999
1:99	DT	359,275	0	258	358,970	0.9996	0.9993	1.0000	0.9996
	RFT	359,275	0	73	359,155	0.9999	0.9998	1.0000	0.9999
	GBDT	359,275	0	735	358,493	0.9990	0.9980	1.0000	0.9990
	ABT	359,275	0	755	358,473	0.9989	0.9979	1.0000	0.9990
	SVM	359,275	0	672	358,556	0.9991	0.9945	1.0000	0.9973
	MLP	359,275	0	1,970	357,258	0.9973	0.9981	1.0000	0.9973

Table 47. Transitive Property

Ratio	Model	TP	FN	FP	TN	Accuracy	Precision	Recall	F1 Score
75:25	DT	38,388	48	279	38,437	0.9958	0.9928	0.9988	0.9958
	RFT	38,424	12	210	38,506	0.9971	0.9946	0.9997	0.9971
	GBDT	38,115	321	2,321	36,395	0.9658	0.9426	0.9916	0.9665
	ABT	32,073	6,363	7,442	31,274	0.8211	0.8117	0.8345	0.8229
	SVM	38,230	206	948	37,768	0.9850	0.9758	0.9946	0.9851
	MLP	38,424	12	181	38,535	0.9975	0.9953	0.9997	0.9975
50:50	DT	76,811	183	715	76,594	0.9942	0.9908	0.9976	0.9942
	RFT	76,917	77	553	76,756	0.9959	0.9929	0.9990	0.9959
	GBDT	76,394	600	4,512	72,797	0.9669	0.9442	0.9922	0.9676
	ABT	64,032	12,962	14,604	62,705	0.8214	0.8143	0.8316	0.8229
	SVM	76,579	415	2,008	75,301	0.9843	0.9744	0.9946	0.9844
	MLP	76,936	58	449	76,860	0.9967	0.9942	0.9992	0.9967
25:75	DT	115,049	532	1,600	114,274	0.9908	0.9863	0.9954	0.9908
	RFT	115,314	267	1,187	114,687	0.9937	0.9898	0.9977	0.9937
	GBDT	114,646	935	6,612	109,262	0.9674	0.9455	0.9919	0.9681
	ABT	95,932	19,649	21,445	94,429	0.8225	0.8173	0.8300	0.8236
	SVM	114,981	600	3,470	112,404	0.9824	0.9707	0.9948	0.9826
	MLP	115,387	194	956	114,918	0.9950	0.9918	0.9983	0.9950
10:90	DT	137,511	1,338	3,228	135,669	0.9836	0.9771	0.9904	0.9837
	RFT	138,041	808	2,001	136,896	0.9899	0.9857	0.9942	0.9899
	GBDT	137,778	1,071	8,109	130,788	0.9669	0.9444	0.9923	0.9678
	ABT	113,897	24,952	24,516	114,381	0.8219	0.8229	0.8203	0.8216
	SVM	138,036	813	5,051	133,846	0.9789	0.9647	0.9941	0.9792
	MLP	138,181	668	2,499	136,398	0.9886	0.9822	0.9952	0.9887
1:99	DT	146,672	6,062	12,251	140,535	0.9401	0.9229	0.9603	0.9412
	RFT	148,396	4,338	6,555	146,231	0.9643	0.9577	0.9716	0.9646
	GBDT	150,955	1,779	10,796	141,990	0.9588	0.9333	0.9884	0.9600
	ABT	127,174	25,560	29,800	122,986	0.8188	0.8102	0.8327	0.8213
	SVM	151,415	1,319	11,993	140,793	0.9564	0.9266	0.9914	0.9579
	MLP	150,510	2,224	6,659	146,127	0.9709	0.9576	0.9854	0.9713