Optimising Botnet Detection via Swarm Intelligence
For Consumer IoT

Detailed Evaluation Results
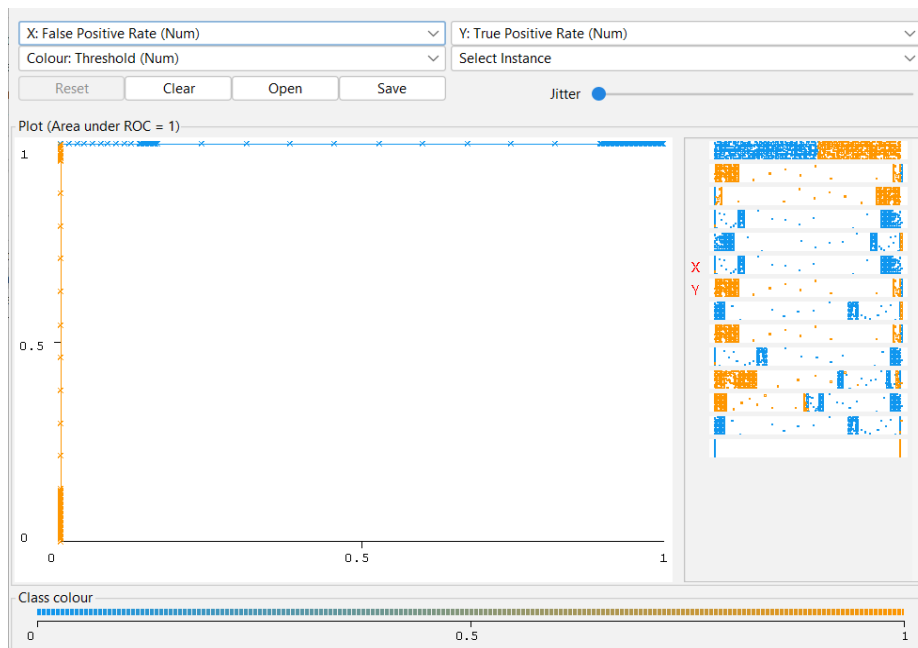
ANTHI DATASET

Total Features :137

CLASSIFICATION	Binary (Is Malicious)
FS Method	ANT Search
Selected Attributes Subset	[5 7 8 18 20 28 56 61 70 72 80 92 95 119 127 131]
No. Of Features Selected	16

| ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.53	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
Naïve Bayes	0.27	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
RF	26.83	100	0	1	0	0	0.0001	0	1	0	1	1	1	1	1	1
AdaBoast	0.44	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	0.58	0.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1
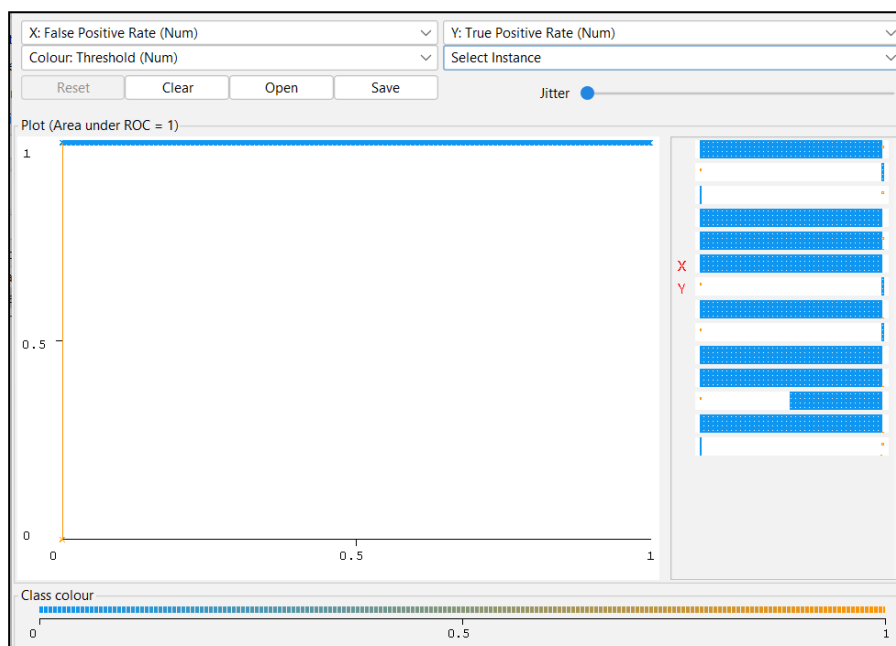
ROC Curve – BayesNet

ROC Curve – Naïve Bayes

ROC Curve – Random Forest
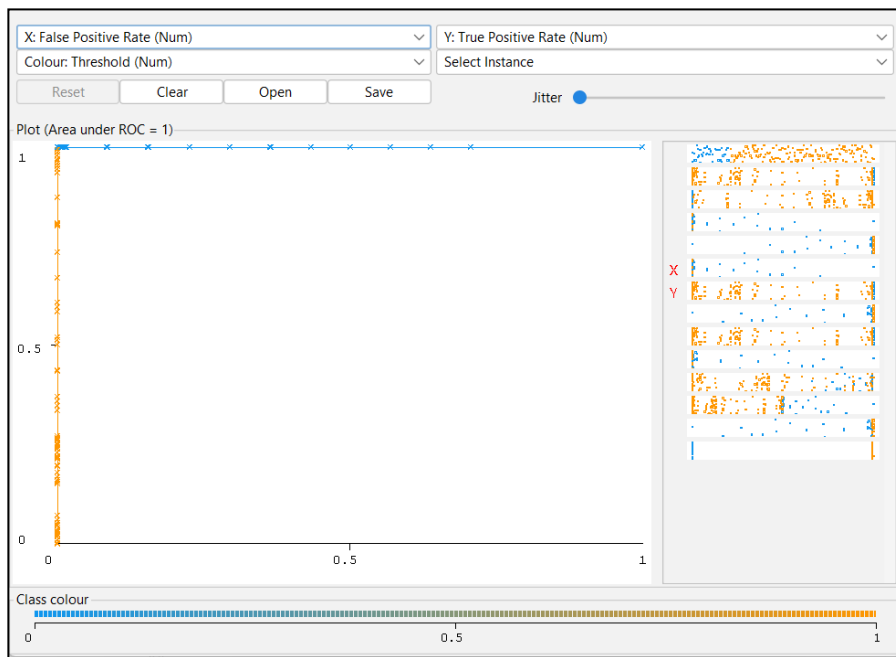
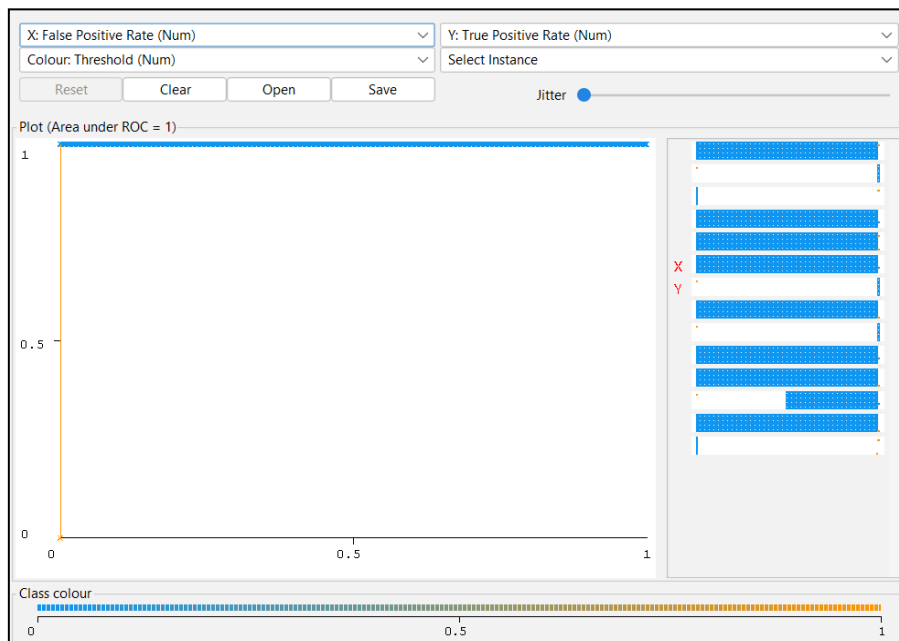## RoC Curve – AdaBoast
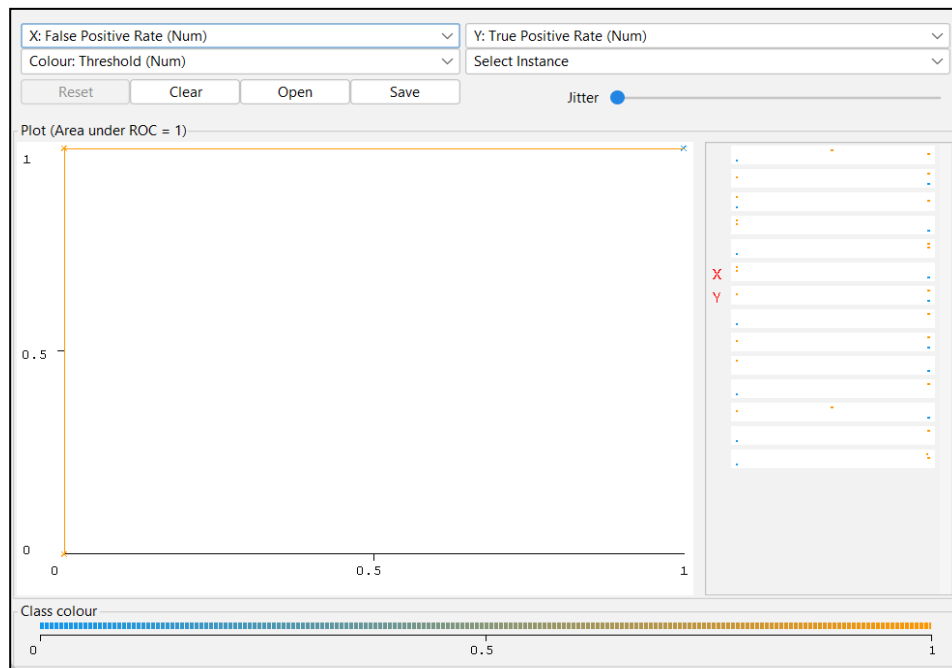
ROC Curve – J48
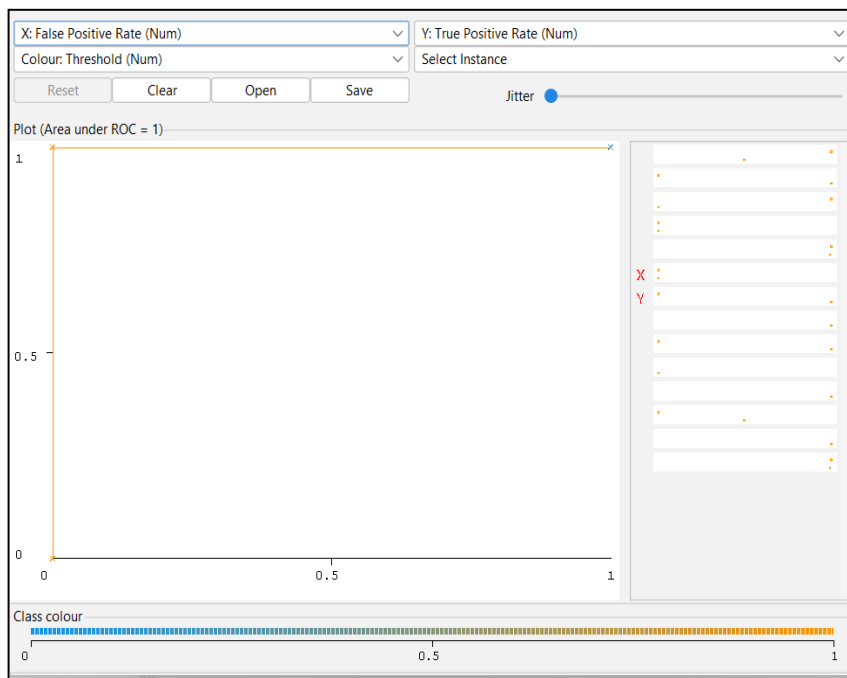
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	BAT Search
Selected Attributes Subset	[3 5 7 8 10 12 19 20 27 31 38 51 56 57 59 72 77 80 82 84 86 104 106 108 109 123 133]
No. Of Features Selected	27

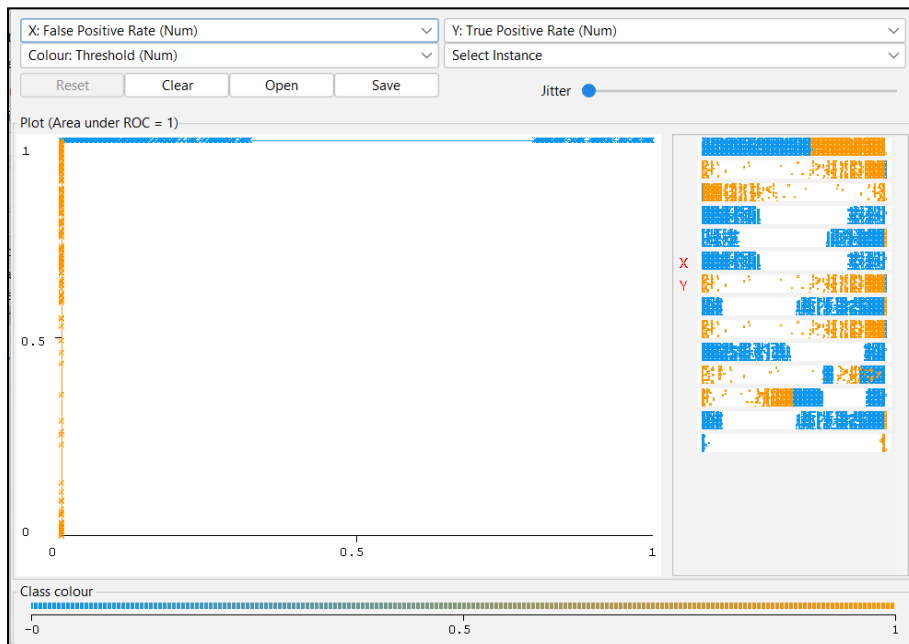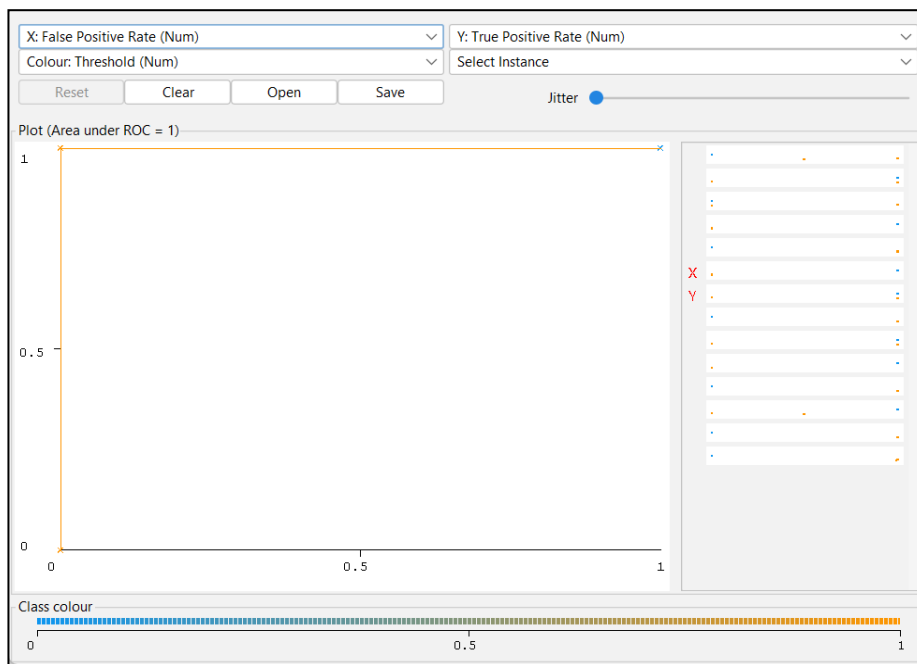| ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	1.47	100	0	1	0	0	0	0.0001	1	0	1	1	1	1	1	1
Naïve Bayes	0.56	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
RF	25.16	100	0	1	0	0.0003	0.0016	0.0545	1	0	1	1	1	1	1	1
AdaBoast	0.73	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	0.69	99.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1
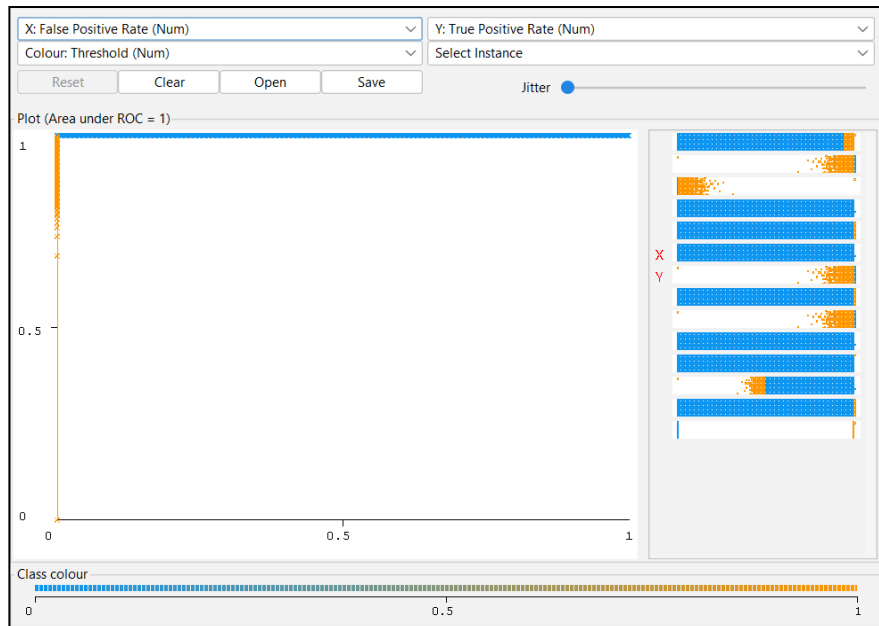
ROC Curve – BayesNet

ROC Curve – Naïve Bayes

ROC Curve – Random Forest

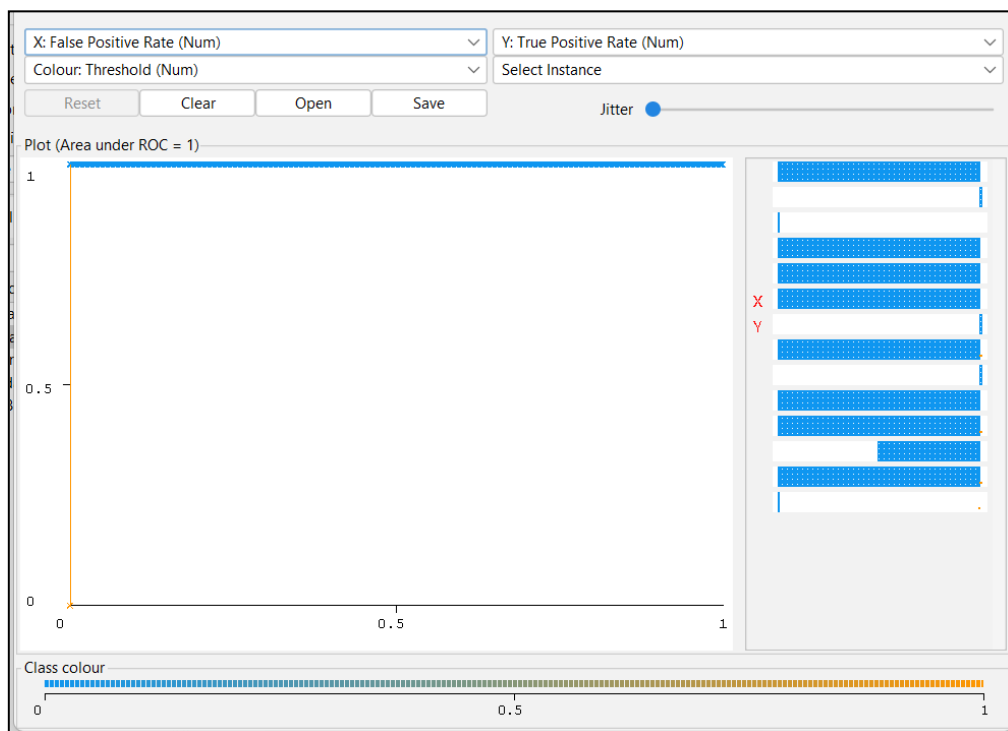## RoC Curve – AdaBoast

ROC Curve – J48
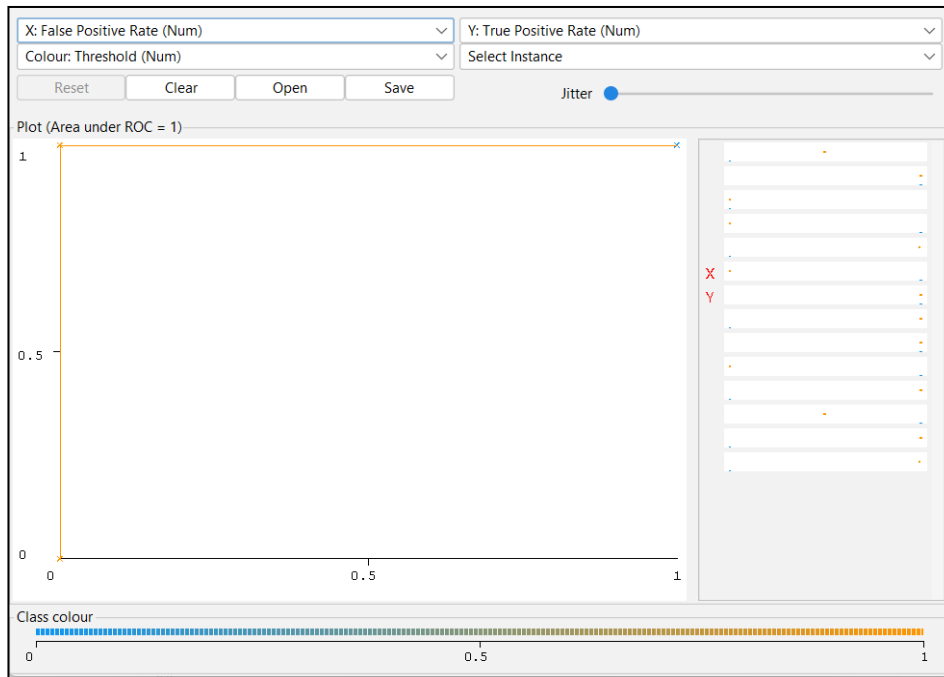
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	Cukoo Search
Selected Attributes Subset	[5 28 37 40 61]
No. Of Features Selected	5
Total Features	137

| ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.22	99.99	0.01	0.9998	0.0002	0.0087	0.0403	1.7439	1	0	1	1	1	1	1	1
Naïve Bayes	0.08	99.9986	0.0014	1	0	0.0037	0.0027	0.7372	1	0	1	1	1	1	1	1
RF	8.55	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
AdaBoast	0.14	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	0.13	99.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1
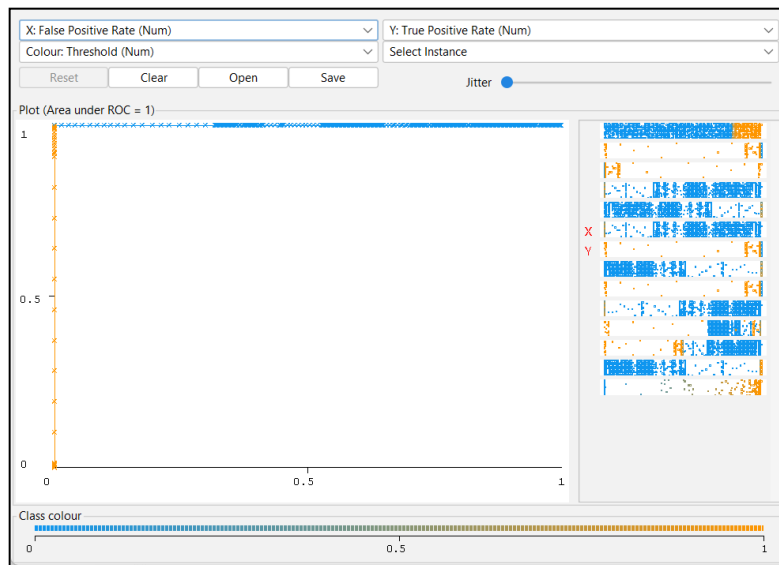
ROC Curve – BayesNet

ROC Curve – Naïve Bayes

ROC Curve – Random Forest
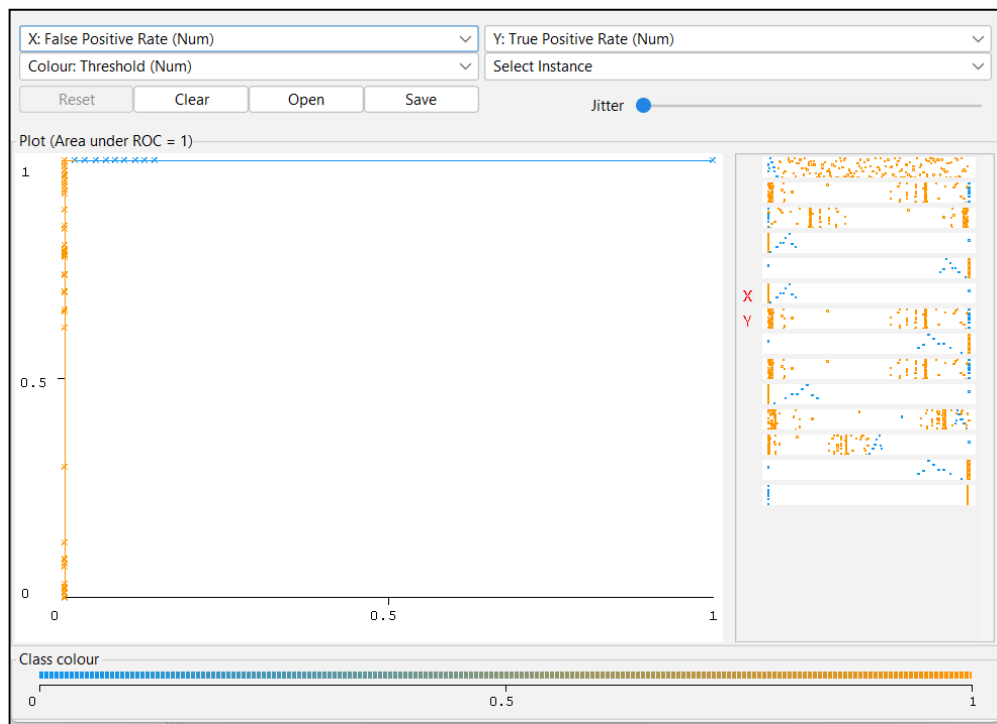
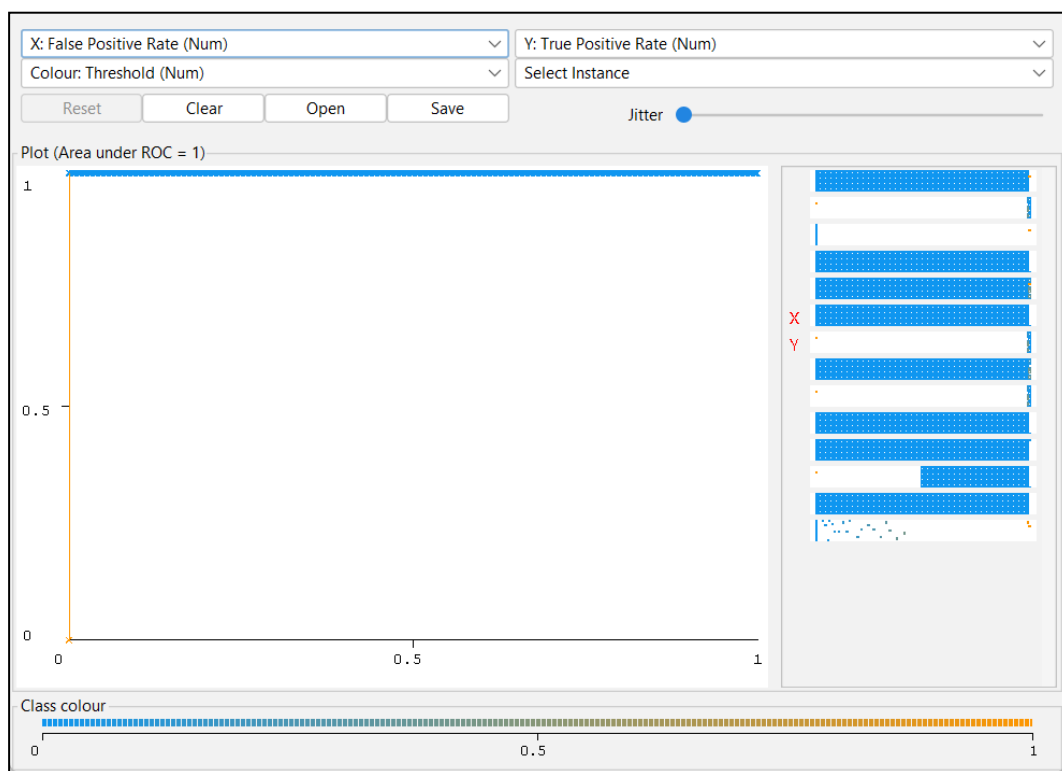## RoC Curve – AdaBoast
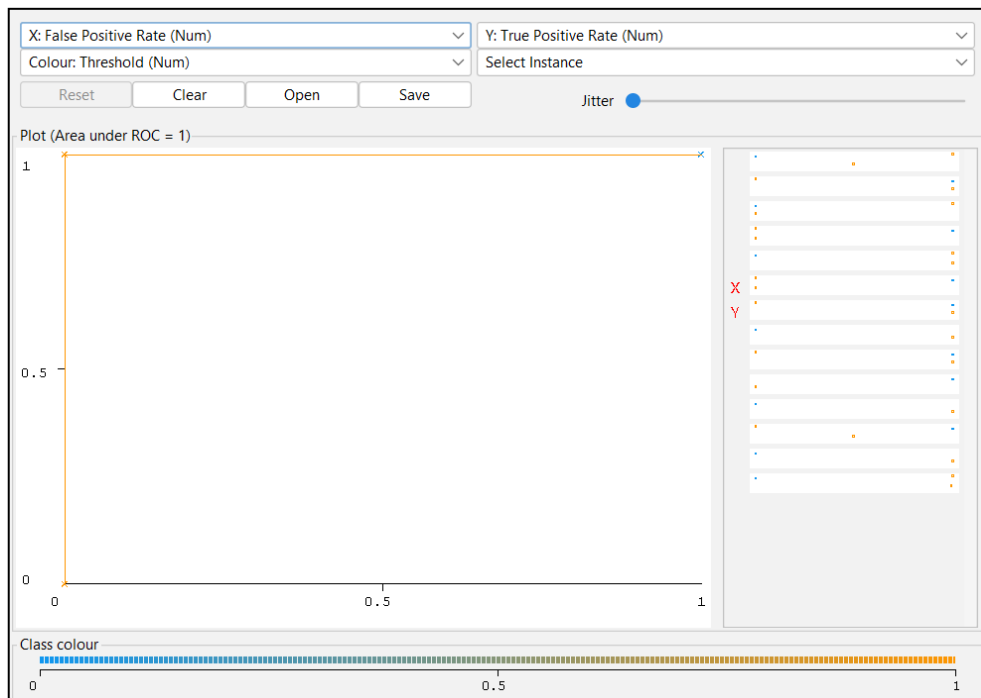
ROC Curve – J48
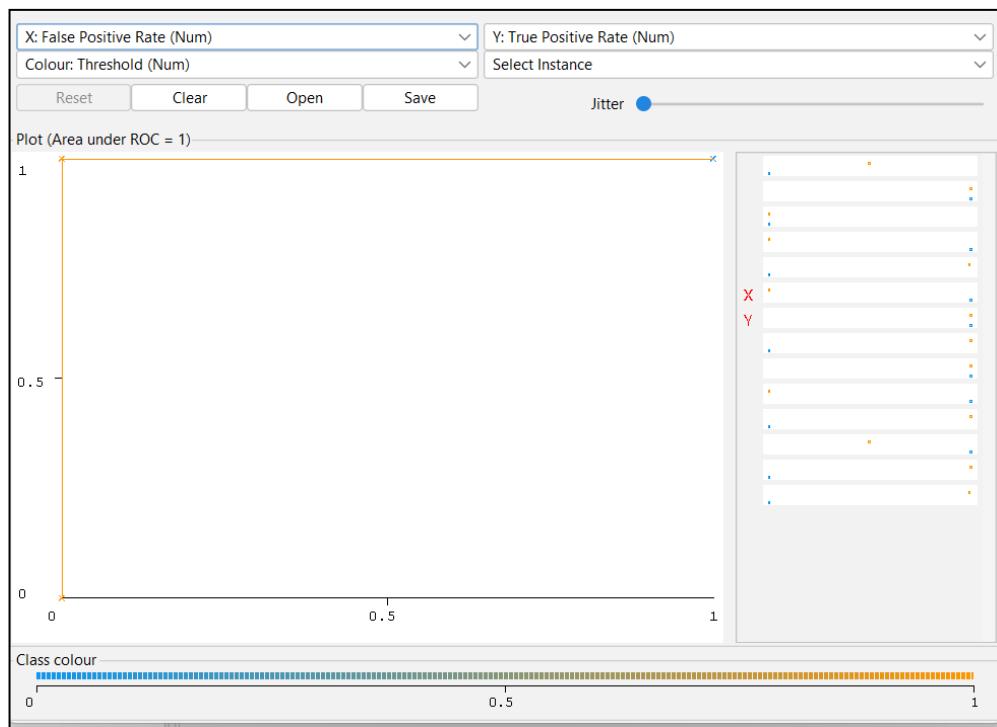
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	Elephant Search
Selected Attributes Subset	[5,12,18,19,56,61,78,82,92,101,109,119,134]
No. Of Features Selected	13
Total Features	137

| ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.42	100	0	1	0	0.0001	0.0007	0.0122	1	0	1	1	1	1	1	1
Naïve Bayes	0.21	99.9887	0.0113	0.9998	0.0001	0.009	0.0189	1.792	1	0	1	1	1	1	1	1
RF	26.46	100	0	1	0	0.0007	0.0048	0.1392	1	0	1	1	1	1	1	1
AdaBoast	0.42	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	0.33	99.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1
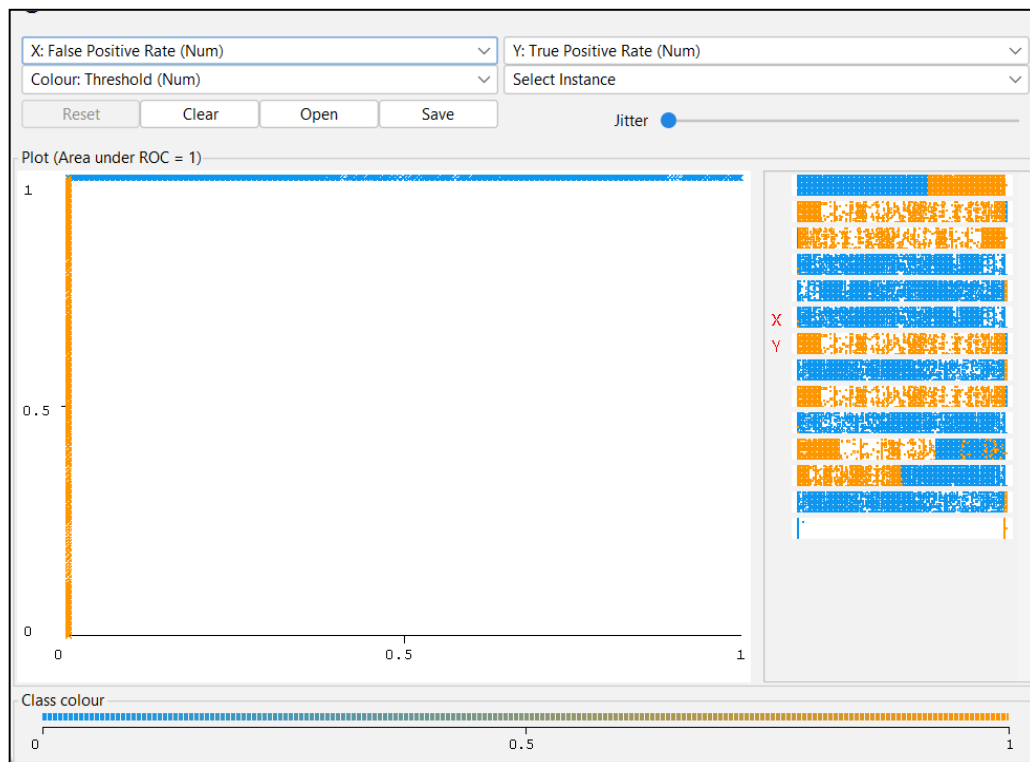
ROC Curve – BayesNet

ROC Curve – Naïve Bayes

ROC Curve – Random Forest
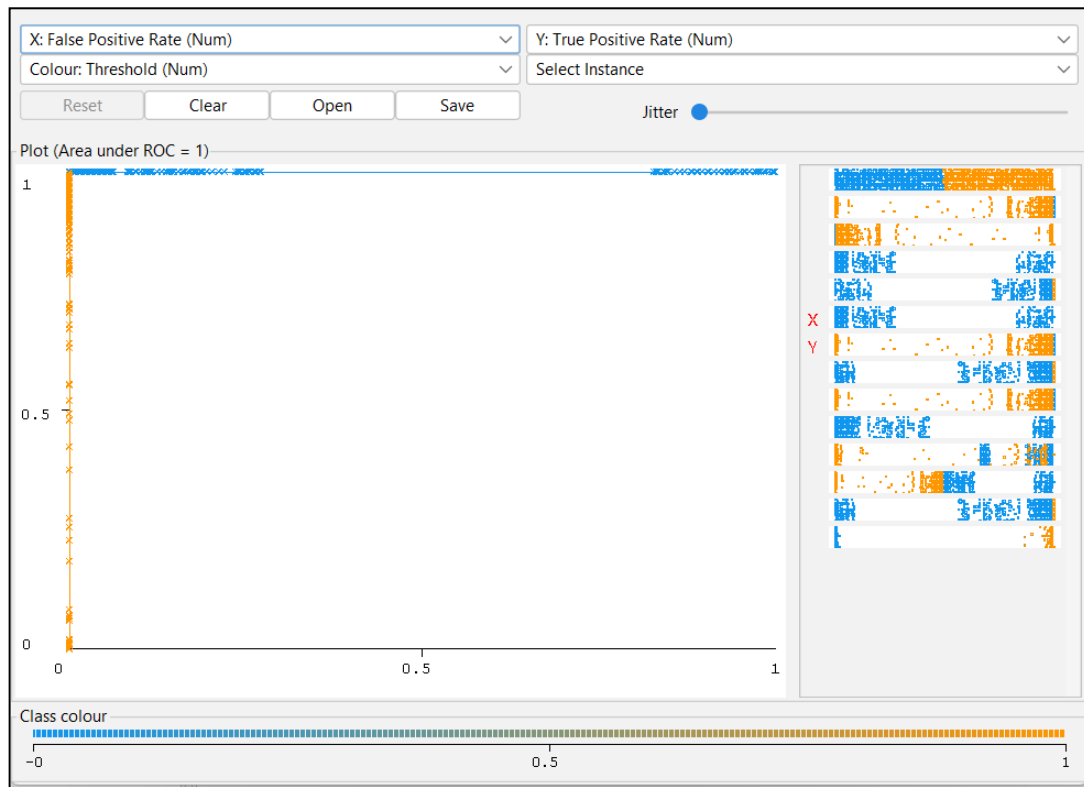
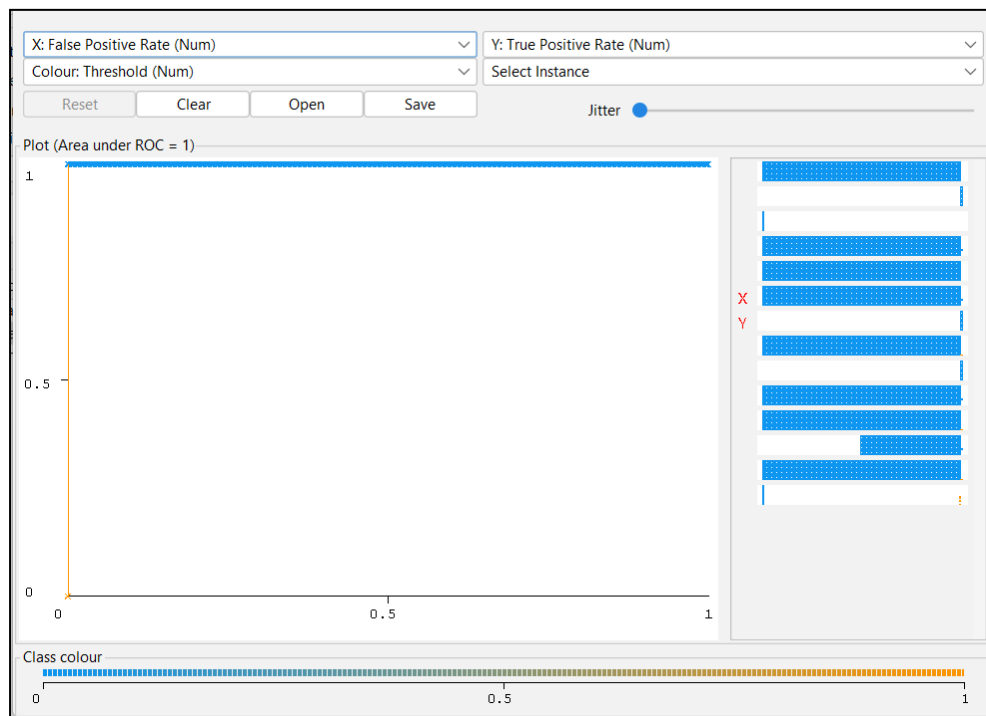## RoC Curve – AdaBoast
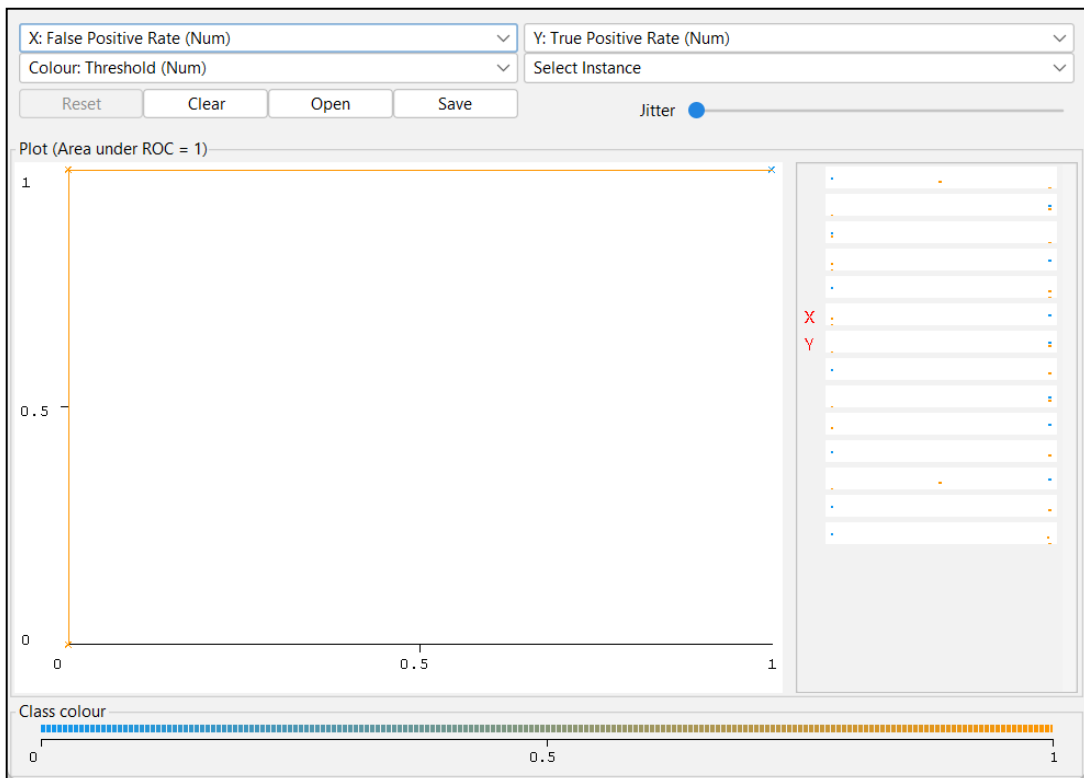
ROC Curve – J48
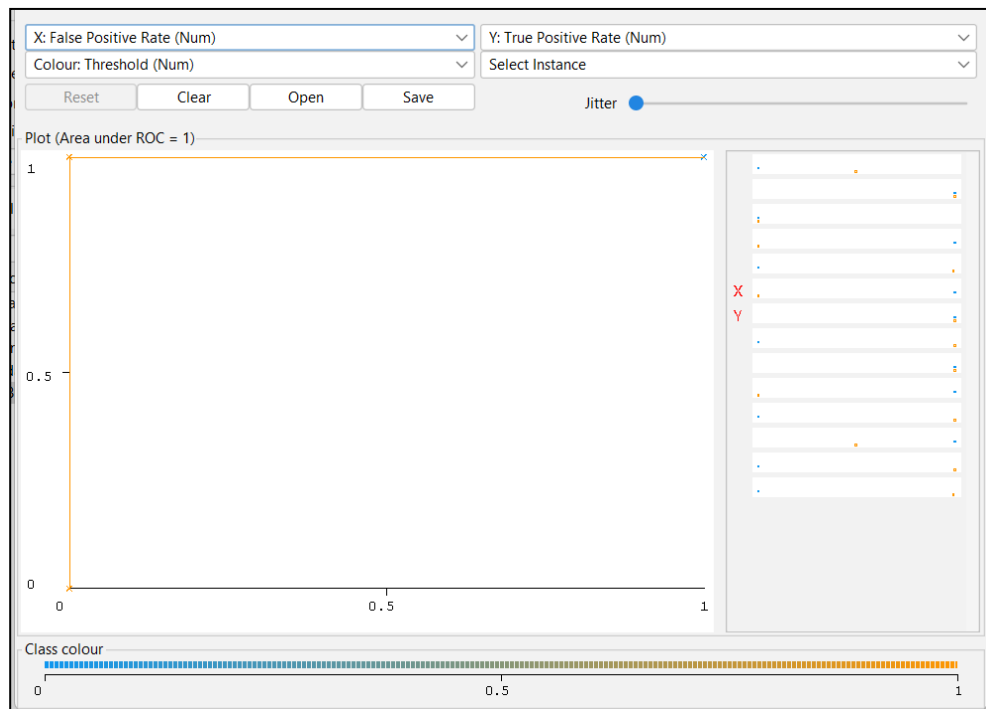
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	FireFly Search (FA)
Selected Attributes Subset	[4,5,8,17,19,27,29,33,39,42,81,100,122,123,129,134]
No. Of Features Selected	16
Total Features	137

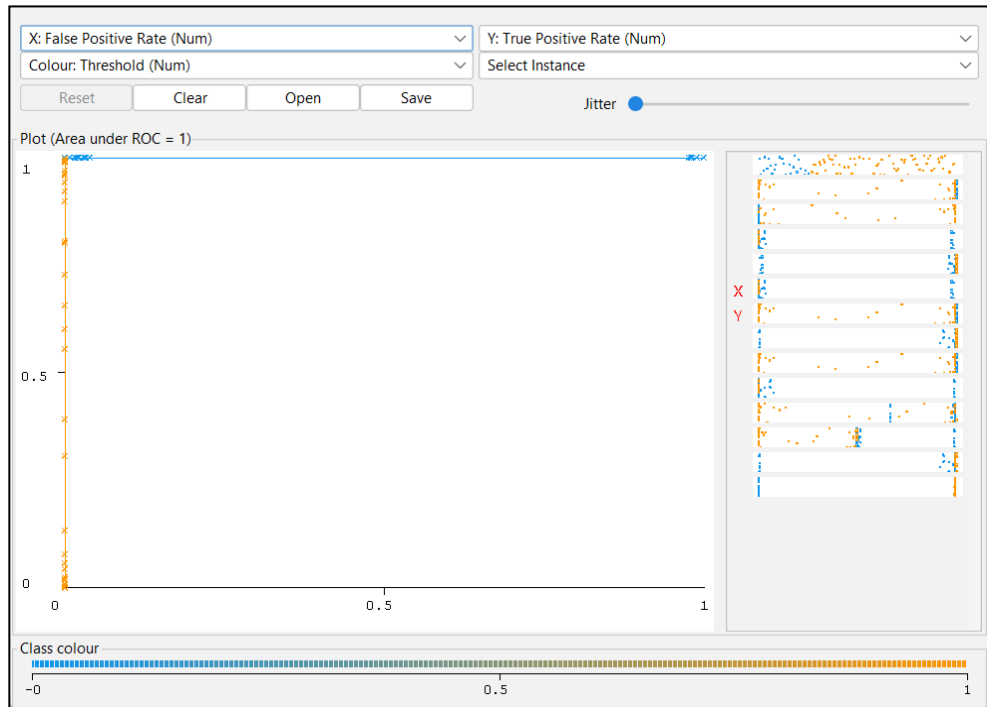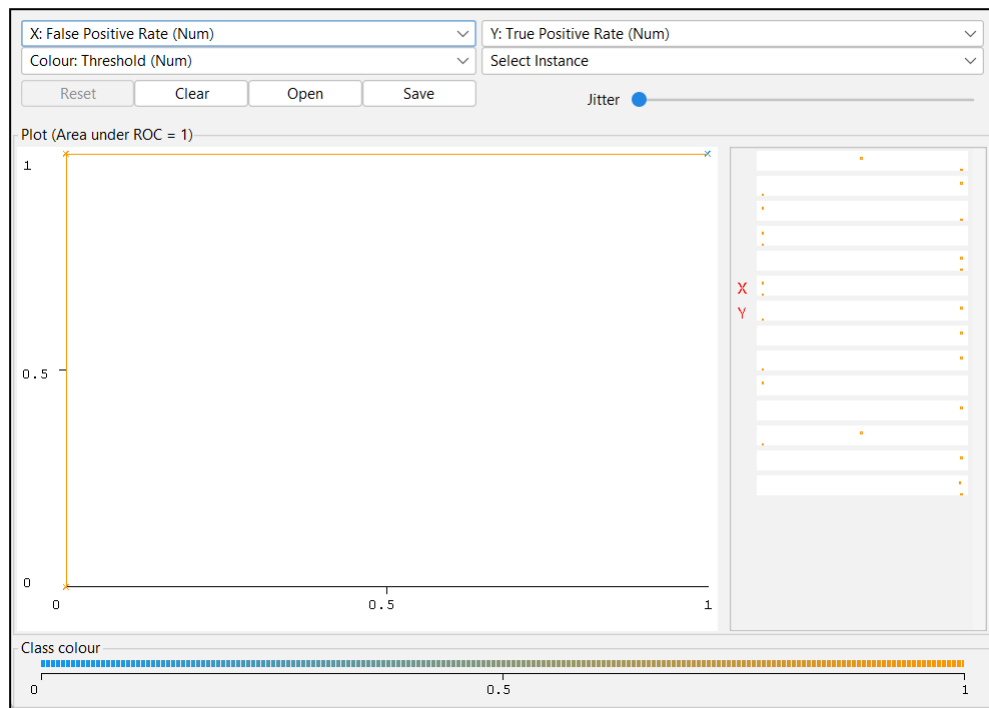| ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.64	100	0	1	0	0	0	0.0001	1	0	1	1	1	1	1	1
Naïve Bayes	0.25	99.9968	0.0032	0.9999	0	0.0056	0.0063	1.1261	1	0	1	1	1	1	1	1
RF	79.19	100	0	1	0.0001	0.0018	0.0235	0.3608	1	0	1	1	1	1	1	1
AdaBoast	3.45	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	3.24	99.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1
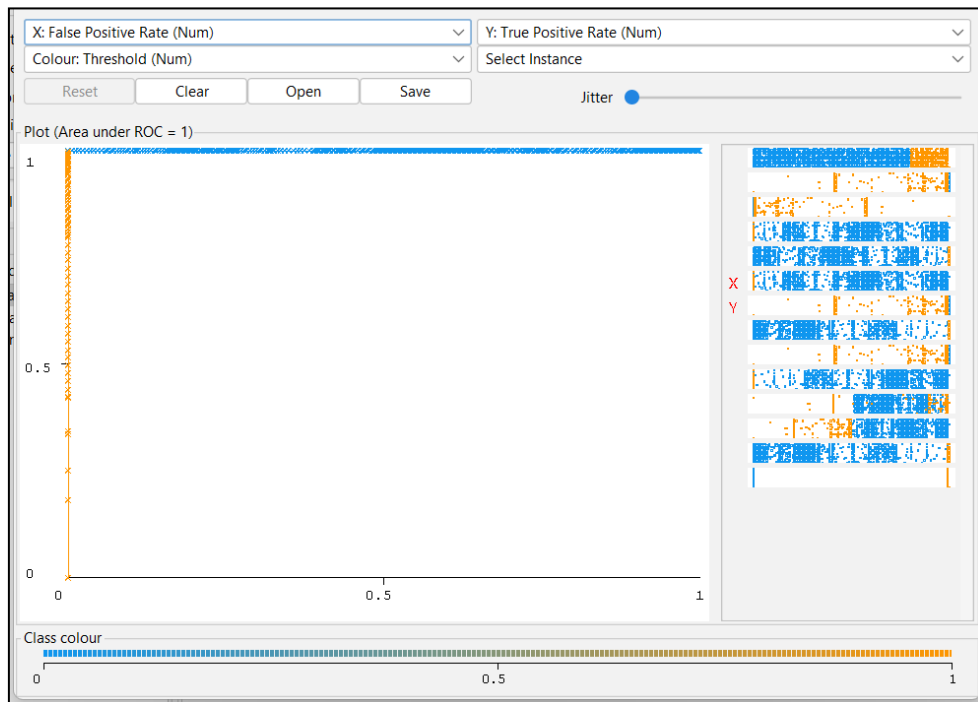
ROC Curve – BayesNet

ROC Curve – Naïve Bayes

ROC Curve – Random Forest

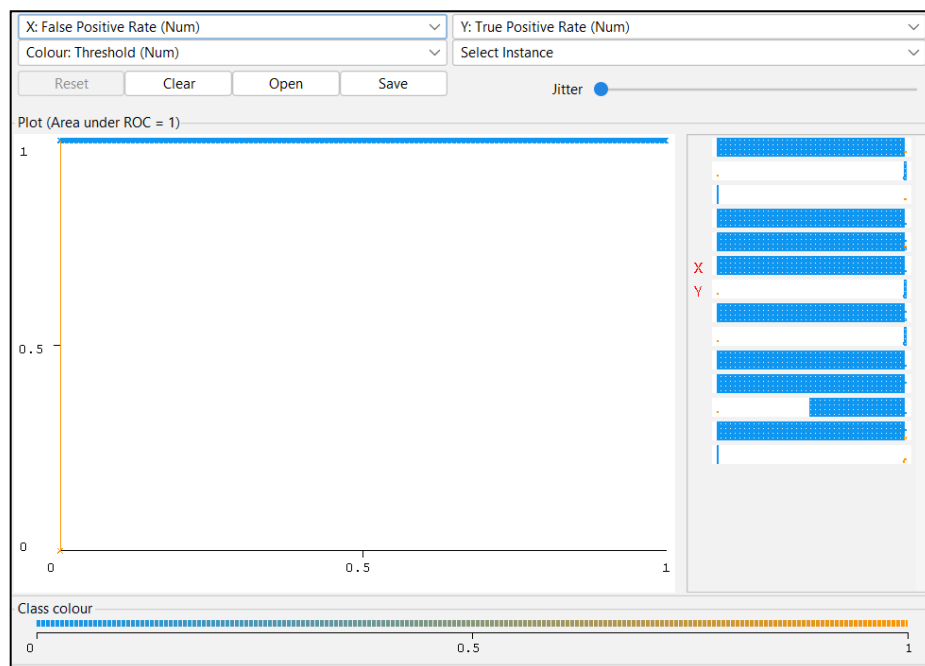## RoC Curve – AdaBoast

ROC Curve – J48
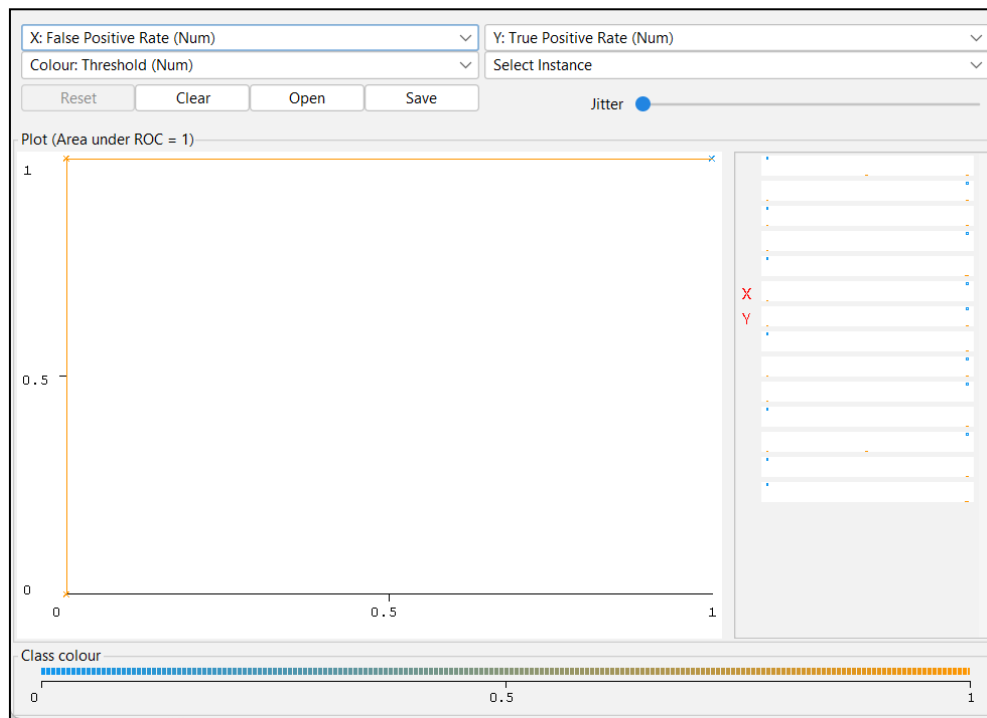
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	Flower Search(FPO)
Selected Attributes Subset	5 41 99 109 126 131
No. Of Features Selected	6
Total Features	137

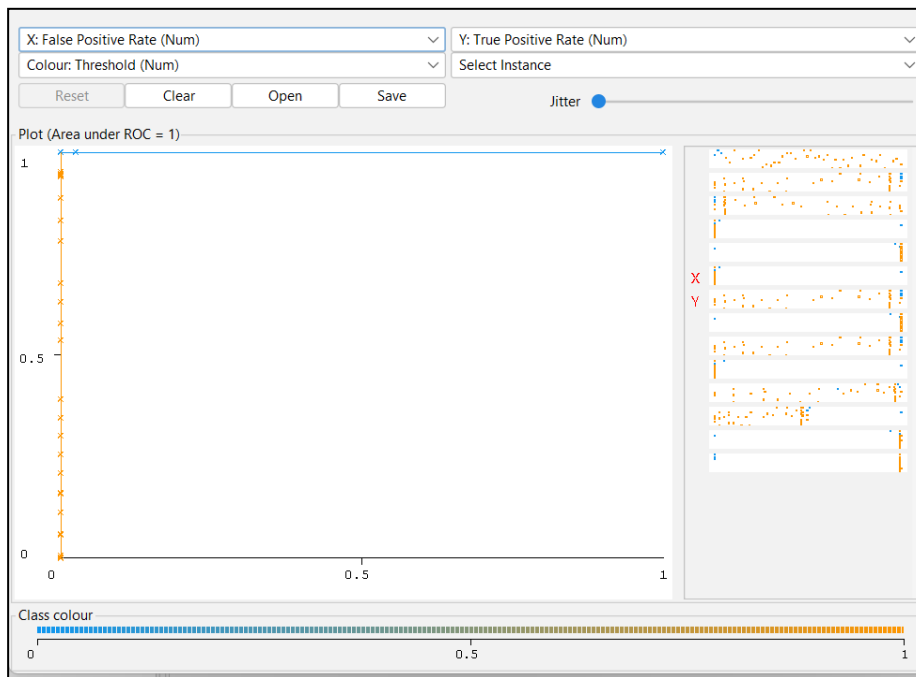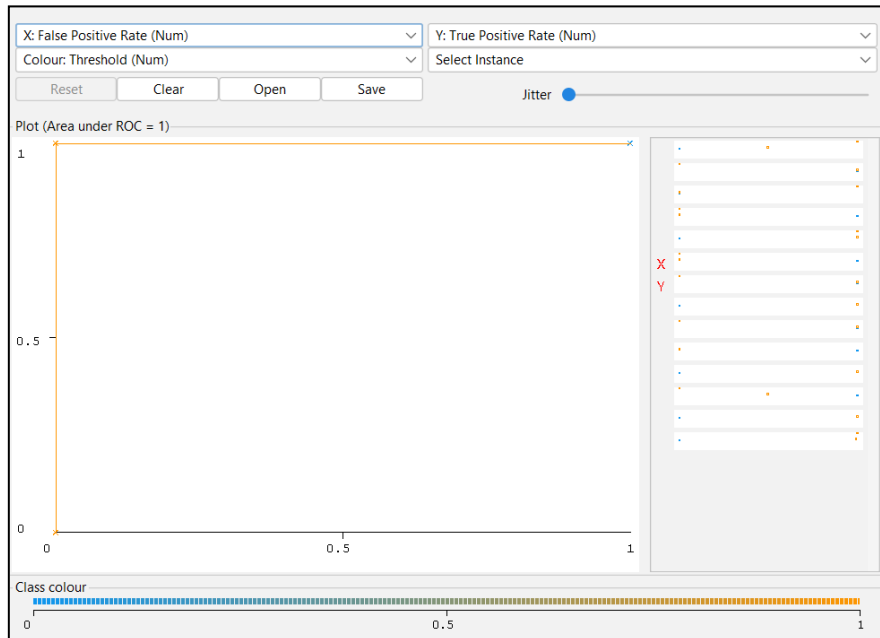| ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.42	100	0	1	0	0	0,001	0,0048	1	0	1	1	1	1	1	1
Naïve Bayes	0.11	99.9982	0.0018	1	0	0.0043	0.0036	0.8513	1	0	1	1	1	1	1	1
RF	10.63	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
AdaBoast	0.23	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	0.27	99.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1
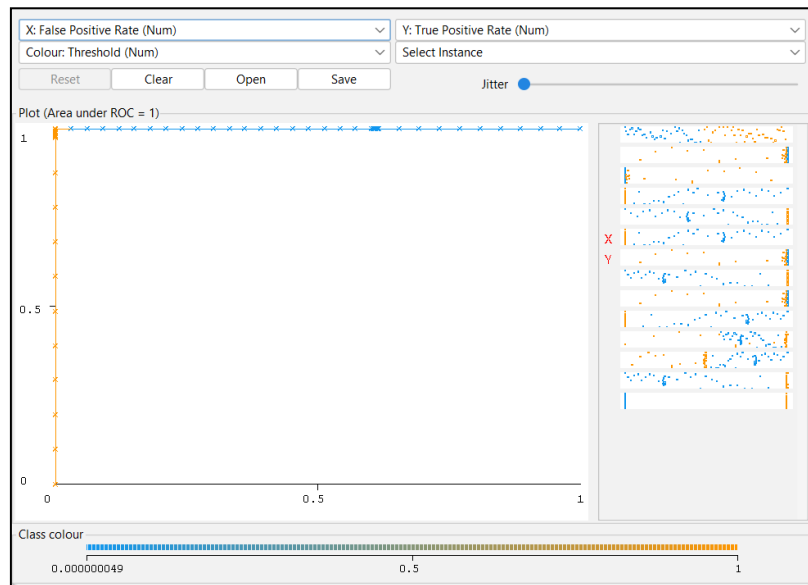
ROC Curve – BayesNet

ROC Curve – Naïve Bayes

ROC Curve – Random Forest

RoC Curve – AdaBoast

ROC Curve – J48
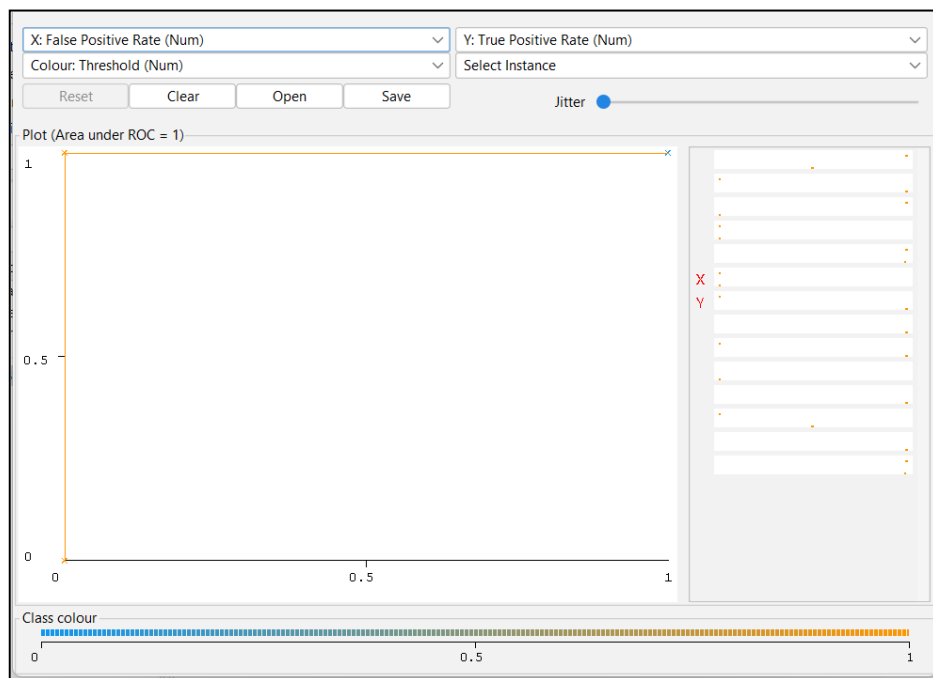
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	Harmony Search
Selected Attributes Subset	5 36 54 116 132
No. Of Features Selected	5
Total Features	137

ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.22	100	0	1	0	0.0001	0.0013	0.019	1	0	1	1	1	1	1	1
Naïve Bayes	0.09	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
RF	14.72	100	0	1	0	0	0	0.0051	1	0	1	1	1	1	1	1
AdaBoast	0.17	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	0.14	99.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1
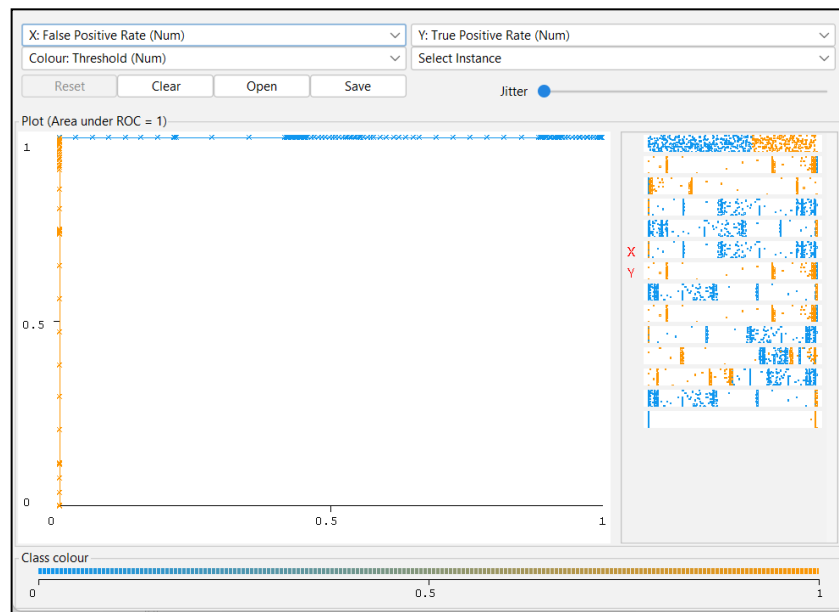
ROC Curve – BayesNet

ROC Curve – Naïve Bayes

ROC Curve – Random Forest
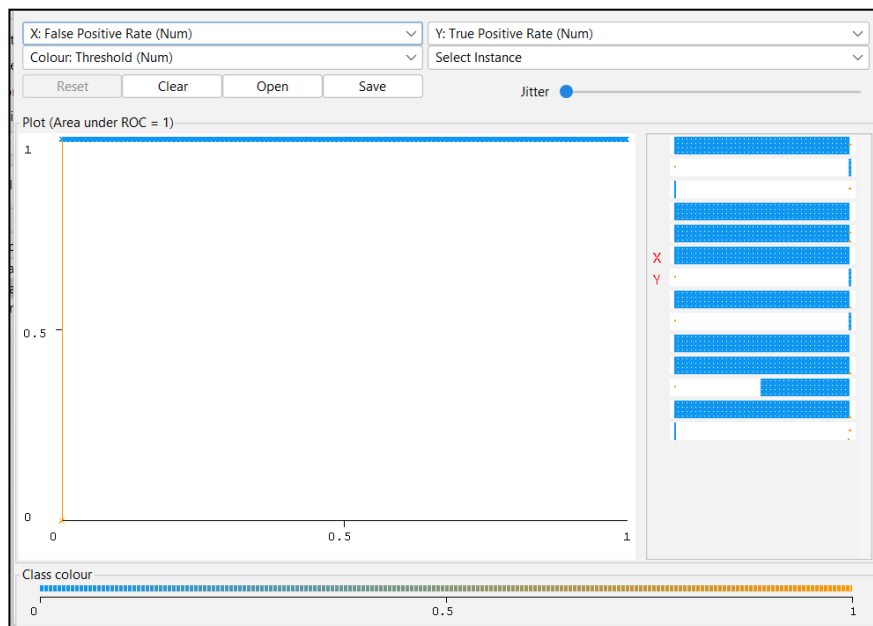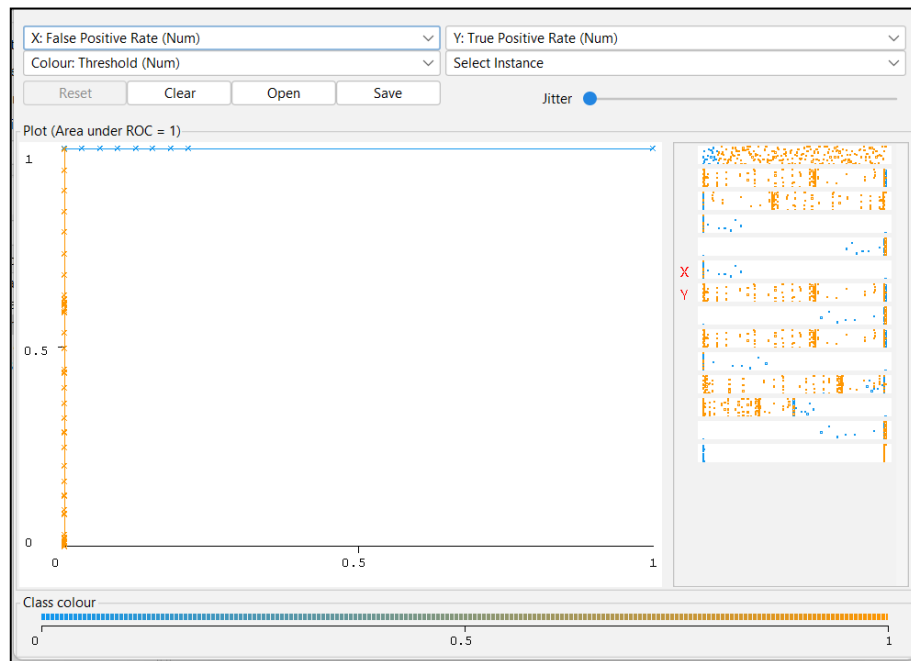

RoC Curve – AdaBoast

ROC Curve – J48
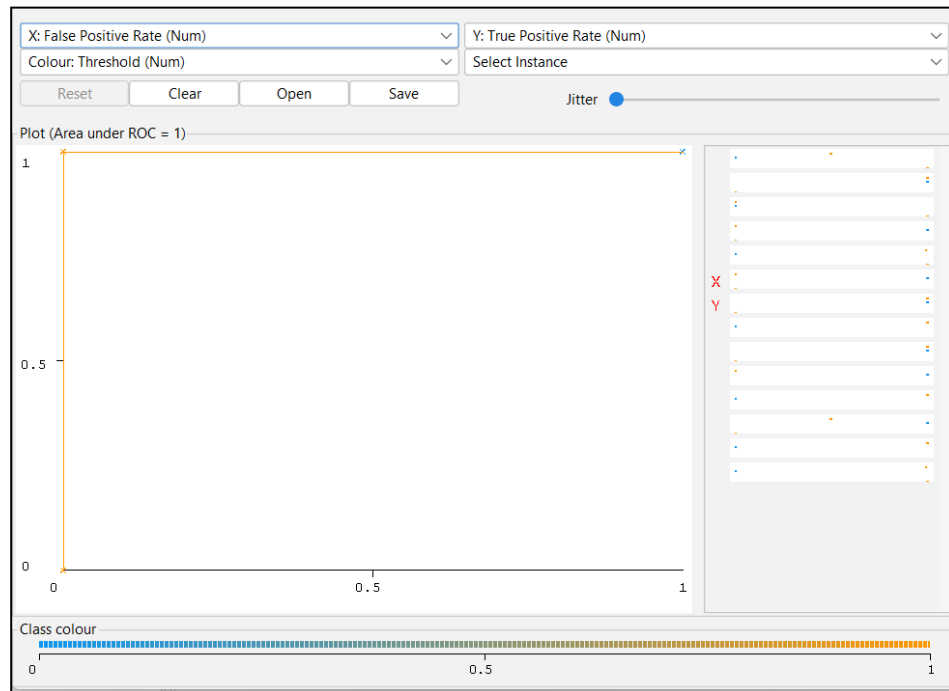
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	PSO Search
Selected Attributes Subset	5 13 26 53 59 65 118
No. Of Features Selected	7
Total Features	137

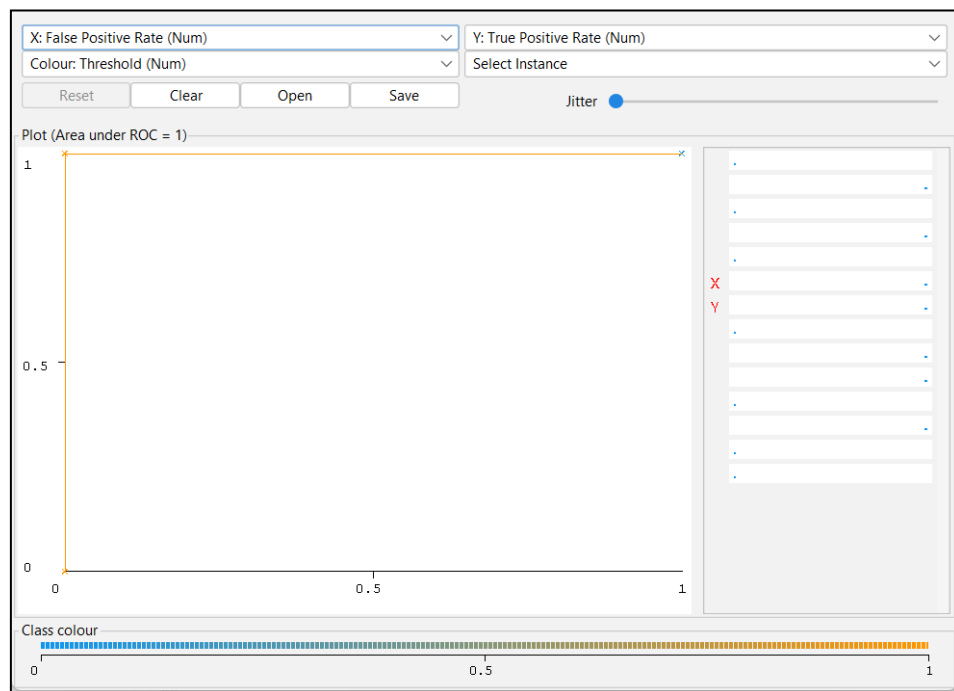| ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.36	99.9964	0.0036	0.9999	0.0001	0.0049	0.0162	0.9834	1	0	1	1	1	1	1	1
Naïve Bayes	0.16	99.9316	0.0684	0.9986	0.0007	0.0261	0.1366	5.2233	1	0	1	1	1	1	1	1
RF	12.45	100	0	1	0	0.0001	0.0002	0.019	1	0	1	1	1	1	1	1
AdaBoast	0.22	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	0.2	99.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1
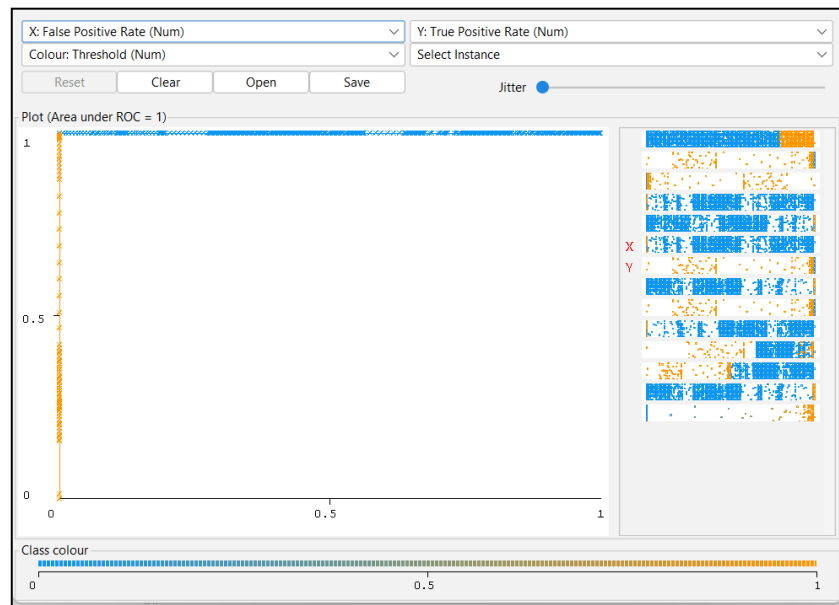
ROC Curve – BayesNet

ROC Curve – Naïve Bayes

ROC Curve – Random Forest
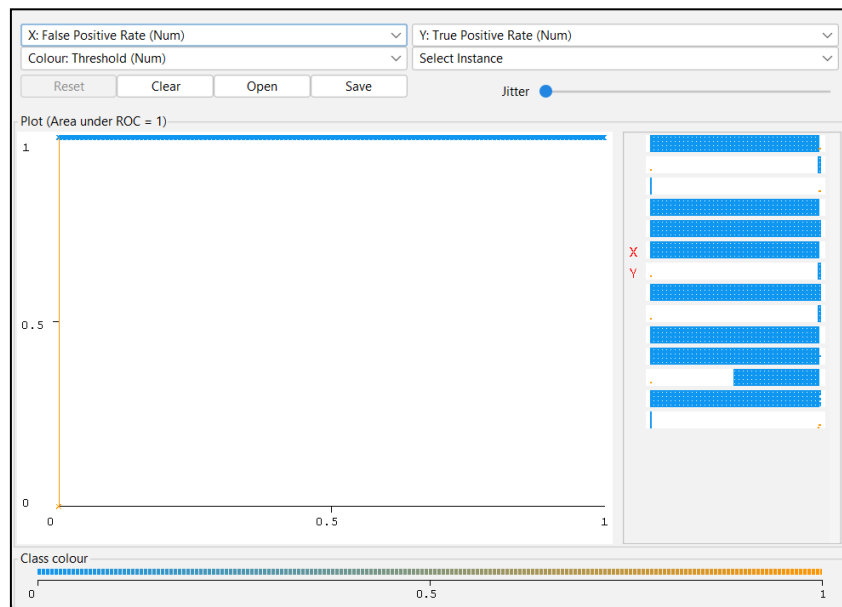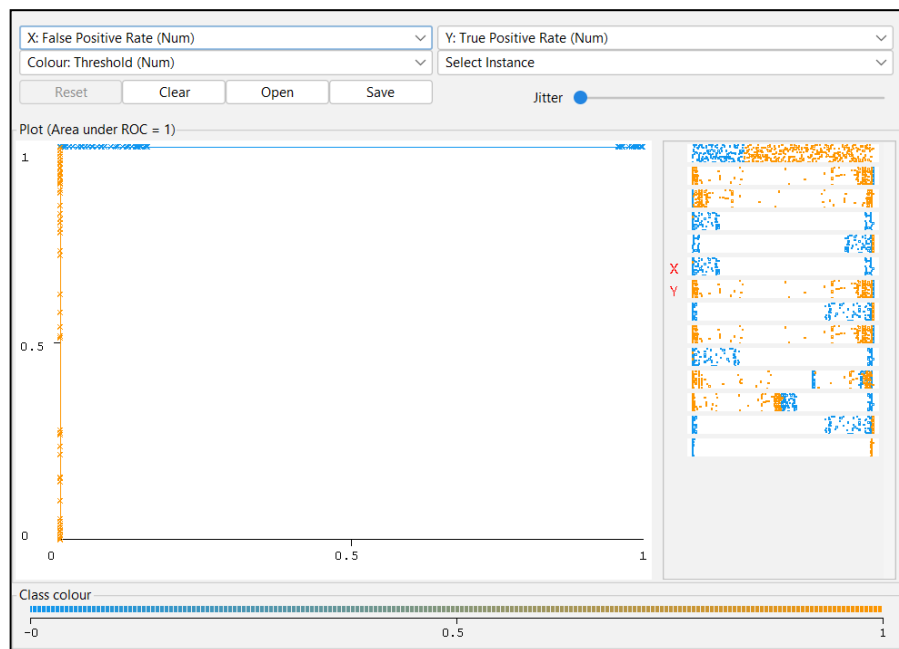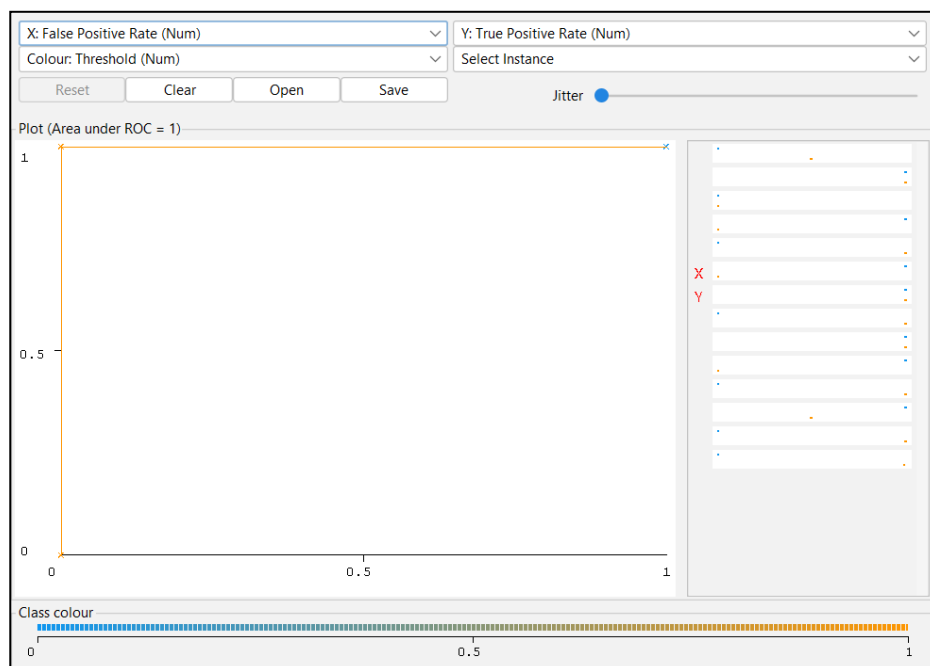

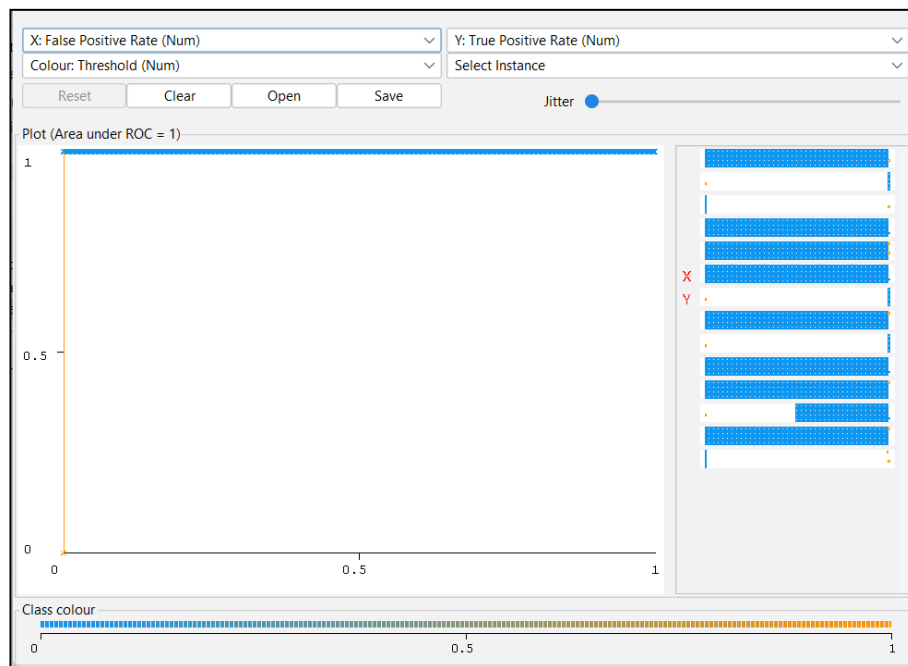RoC Curve – AdaBoast

ROC Curve – J48
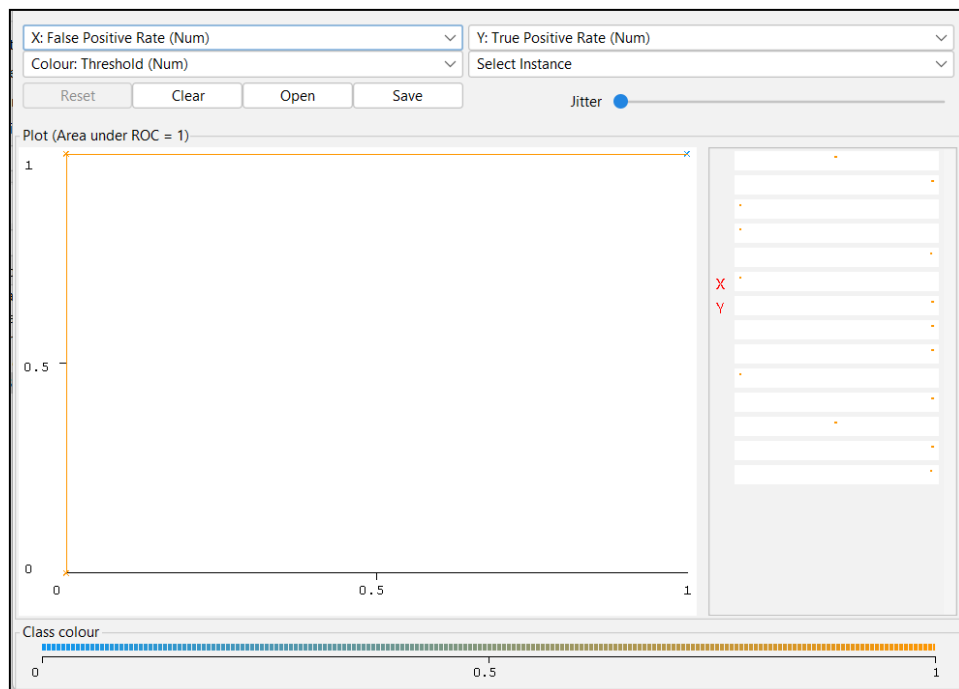
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	Rhinoceros Search
Selected Attributes Subset	[8,56,60,73,81,99,114,120]
No. Of Features Selected	8
Total Features	137

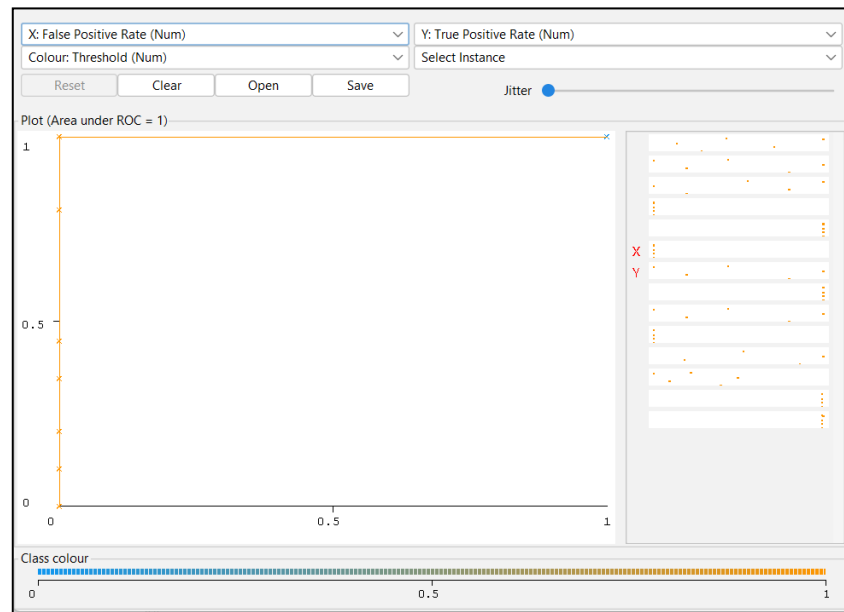| ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.23	100	0	1	0	0	0.001	0.001	1	0	1	1	1	1	1	1
Naïve Bayes	0.01 1	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
RF	14.8 4	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
AdaBoast	0.19	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
J.48	0.17	99.9995	0.000 5	1	0	0.002 1	0.0009	0.4256	1	0	1	1	1	1	1	1
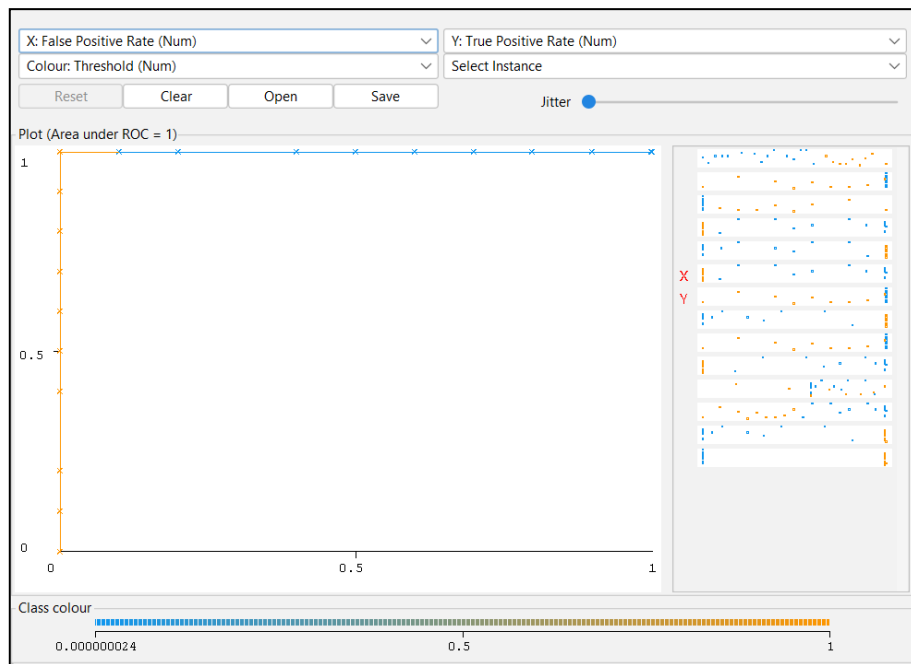
ROC Curve – BayesNet

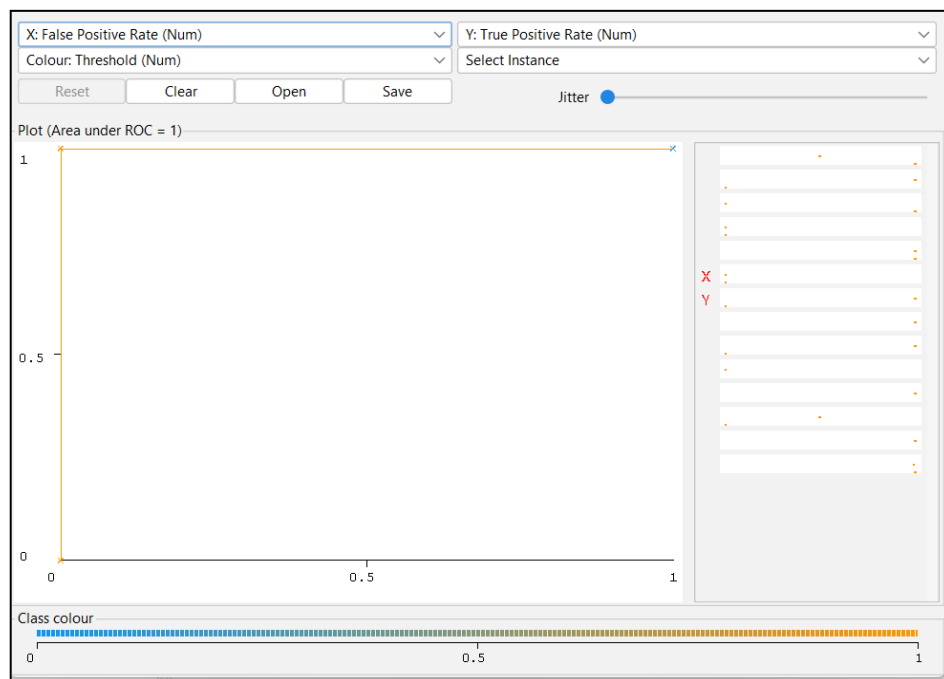## ROC Curve – Naïve Bayes

ROC Curve – Random Forest

RoC Curve – AdaBoast

ROC Curve – J48
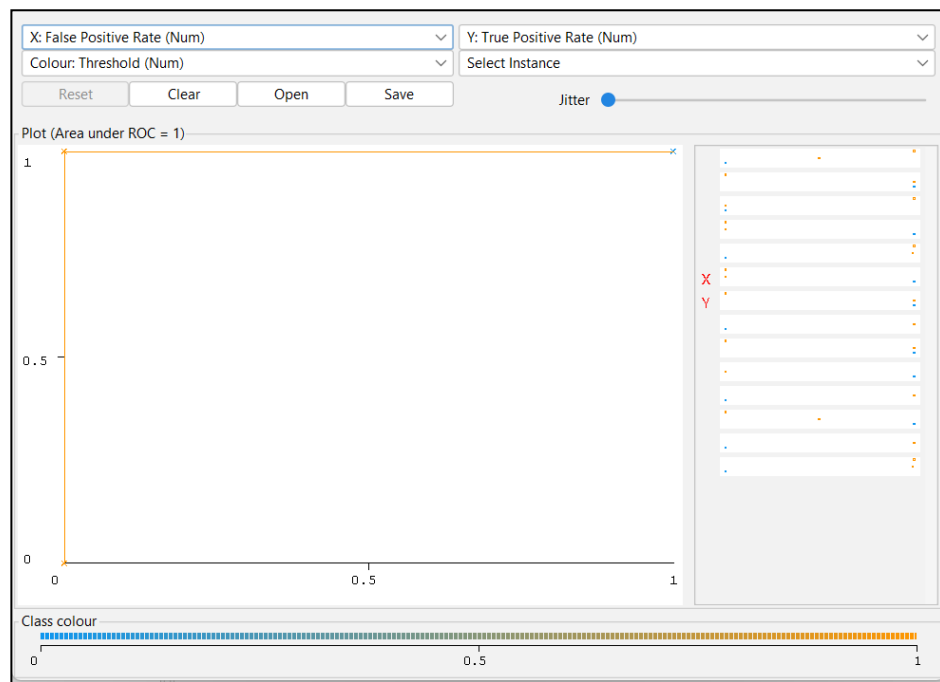
CLASSIFICATION	Binary (Is Malicious)
Instances/Records	220785
FS Method	Bee Search (ABC)
Selected Attributes Subset	[2 5 9 17 32]
No. Of Features Selected	5
Total Features	137

ML Algorithm	Time	Accuracy	FAR	Kappa	Mean Abs Error	RMS Error	Relative Abs Error	Root Related Sqrd Error	TP	FP	Precision	Recall	F-Measure	MCC	ROC Area	RPC Area
BayesNet	0.27	100	0	1	0	0.0001	0.0013	0.019	1	0	1	1	1	1	1	1
Naïve Bayes	0.13	100	0	1	0	0	0	0	1	0	1	1	1	1	1	1
RF	15.77	100	0	1	0	0	0	0.0051	1	0	1	1	1	1	1	1
AdaBoast	0.27	100	0	1	0	0	0	0	1	0	1	1	1	1	1	
J.48	0.19	99.9995	0.0005	1	0	0.0021	0.0009	0.4256	1	0	1	1	1	1	1	1