Supplementary Material: Full Metric Tables

TinyLearnED: Adaptive On-Device Edge Learning for IoT Anomaly Detection

Table S1. Full detection metrics for all candidate anomaly-detection models per attack and edge board (complements Table 3 of the main paper, which reports F1 only; the main paper bolds the best learned model per column). ACC: accuracy, PREC: precision, REC: recall, F1: F1 score, FPR: false-positive rate, all in %.

		Edge 1					Edge 2					Edge 3					Edge 4				
Attack	**Model**	ACC	PREC	REC	F1	FPR	ACC	PREC	REC	F1	FPR	ACC	PREC	REC	F1	FPR	ACC	PREC	REC	F1	FPR
LT	Null Model	78.9	100.0	78.9	88.2	0.0	78.9	100.0	78.9	88.2	0.0	78.9	100.0	78.9	88.2	0.0	78.9	100.0	78.9	88.2	0.0
	Moving Median	97.3	93.8	93.4	93.6	1.6	90.0	71.6	86.9	78.5	9.2	89.7	72.2	83.0	77.2	8.6	80.6	52.6	79.9	63.4	19.2
	Isolation Forest	95.9	85.7	96.8	90.9	4.3	87.3	64.2	89.8	74.9	13.4	91.4	73.7	91.8	81.8	8.8	84.9	60.1	84.5	70.2	15.0
	LSTM	98.4	94.6	97.9	96.2	1.5	95.0	83.8	94.4	88.8	4.9	95.0	84.3	94.0	88.9	4.7	88.1	66.3	88.3	75.7	12.0
	1D-CNN	95.5	89.3	89.6	89.4	2.9	87.3	66.1	81.9	73.1	11.2	87.1	67.5	75.2	71.1	9.7	81.8	54.6	81.6	65.4	18.2
	One-Class SVM	97.4	94.7	92.8	93.8	1.4	89.8	70.7	88.3	78.5	9.8	89.6	72.4	82.3	77.0	8.4	80.7	52.8	83.0	64.5	19.9
	AE-Dense	96.5	90.1	93.7	91.9	2.8	87.8	67.9	80.3	73.6	10.1	88.4	69.8	79.6	74.4	9.2	76.7	45.3	50.4	47.7	16.3
	AE-LSTM	98.7	95.3	98.6	96.9	1.3	95.4	84.5	95.7	89.7	4.7	97.2	91.8	95.0	93.4	2.3	87.4	66.7	92.0	77.3	14.0
VS	Null Model	68.4	100.0	68.4	81.2	0.0	68.4	100.0	68.4	81.2	0.0	68.4	100.0	68.4	81.2	0.0	68.4	100.0	68.4	81.2	0.0
	Moving Median	72.4	54.3	78.5	64.2	30.5	82.2	69.0	79.6	73.9	16.5	86.5	73.5	89.6	80.8	14.9	71.1	52.6	87.1	65.6	36.3
	Isolation Forest	74.8	56.0	94.2	70.2	34.1	81.6	65.9	86.5	74.8	20.6	80.0	61.7	96.9	75.4	27.9	79.9	62.5	91.1	74.1	25.3
	LSTM	89.6	79.9	89.6	84.5	10.4	92.1	82.6	95.1	88.4	9.3	97.3	93.3	98.6	95.9	3.3	72.9	54.7	83.4	66.1	31.9
	1D-CNN	70.0	51.5	85.7	64.3	37.3	73.3	55.4	79.7	65.4	29.6	53.5	39.7	90.5	55.2	63.5	35.2	32.4	97.1	48.6	93.4
	One-Class SVM	81.5	66.0	85.5	74.5	20.4	85.0	71.8	86.8	78.6	15.8	88.0	75.3	92.4	83.0	14.0	71.5	53.2	80.6	64.1	32.7
	AE-Dense	70.6	52.4	74.0	61.4	31.0	74.4	56.8	79.2	66.2	27.8	83.0	68.3	86.3	76.3	18.5	62.7	44.6	73.5	55.5	42.2
	AE-LSTM	88.7	78.4	88.8	83.3	11.4	92.5	83.3	95.4	88.9	8.9	97.4	94.0	98.1	96.0	2.9	80.1	64.1	84.6	72.9	21.9
VSP	Null Model	66.4	100.0	66.4	79.8	0.0	66.4	100.0	66.4	79.8	0.0	66.4	100.0	66.4	79.8	0.0	66.4	100.0	66.4	79.8	0.0
	Moving Median	33.7	33.7	100.0	50.4	99.9	33.7	33.7	100.0	50.4	100.0	58.5	43.8	82.0	57.1	53.5	33.6	33.6	100.0	50.4	100.0
	Isolation Forest	66.4	50.0	91.4	64.7	46.4	33.6	33.6	100.0	50.3	100.0	58.5	43.8	82.0	57.1	53.5	34.3	33.8	99.2	50.4	98.6
	LSTM	79.2	63.7	88.9	74.2	25.7	36.4	34.6	99.8	51.3	95.8	80.9	65.4	91.6	76.3	24.6	38.7	35.1	96.4	51.4	90.5
	1D-CNN	65.0	49.0	92.9	64.1	49.2	33.7	33.7	100.0	50.4	99.9	73.5	57.0	86.6	68.8	33.1	34.4	33.8	99.2	50.4	98.4
	One-Class SVM	59.3	44.6	86.6	58.9	54.6	33.7	33.7	100.0	50.4	100.0	69.7	53.0	85.6	65.5	38.4	34.1	33.8	99.6	50.4	99.0
	AE-Dense	36.9	34.5	97.1	50.9	93.6	33.6	33.6	100.0	50.4	100.0	61.6	46.1	84.1	59.6	49.9	33.6	33.6	100.0	50.4	100.0
	AE-LSTM	77.9	62.1	87.5	72.7	27.0	37.0	34.7	99.3	51.5	94.7	88.4	78.1	91.0	84.0	13.0	36.9	34.7	98.7	51.3	94.4

Table S2. Full per-edge accuracy, precision, recall, F1 score, and FPR for TinyLearnED under different 3D-printing attacks. Deltas are relative to the Inference Only baseline; positive FPR deltas indicate FPR reduction.

	Edge	Learning	Accuracy	Precision	Recall	F1 Score	FPR	Mode
LT Attack	edge1	Inference Only	0.987	0.953	0.986	0.969	0.013	Static
		OFT	0.987 (+0.000)	0.953 (+0.000)	0.986 (+0.000)	0.969 (+0.000)	0.013 (+0.000)	Adaptive
		FL (Every 50 inf.)	0.990 (+0.003)	0.965 (+0.012)	0.987 (+0.001)	0.976 (+0.007)	0.010 (+0.003)	Adaptive
		FL+OFT (Every 50 inf.)	0.962 (-0.025)	0.891 (-0.062)	0.928 (-0.058)	0.909 (-0.060)	0.029 (-0.016)	Adaptive
		FL+OFT (Every 150 inf.)	0.989 (+0.002)	0.965 (+0.012)	0.986 (+0.000)	0.976 (+0.007)	0.010 (+0.003)	Adaptive
	edge2	Inference Only	0.954	0.845	0.957	0.897	0.047	Static
		OFT	0.953 (-0.001)	0.848 (+0.003)	0.949 (-0.008)	0.896 (-0.001)	0.045 (+0.002)	Adaptive
		FL (Every 50 inf.)	0.958 (+0.004)	0.858 (+0.013)	0.962 (+0.005)	0.907 (+0.010)	0.043 (+0.004)	Adaptive
		FL+OFT (Every 50 inf.)	0.965 (+0.011)	0.870 (+0.025)	0.965 (+0.008)	0.915 (+0.018)	0.040 (+0.007)	Adaptive
		FL+OFT (Every 150 inf.)	0.970 (+0.016)	0.880 (+0.035)	0.970 (+0.013)	0.923 (+0.026)	0.035 (+0.012)	Adaptive
	edge3	Inference Only	0.972	0.918	0.950	0.934	0.023	Static
		OFT	0.971 (-0.001)	0.919 (+0.001)	0.946 (-0.004)	0.933 (-0.001)	0.022 (+0.001)	Adaptive
		FL (Every 50 inf.)	0.973 (+0.001)	0.925 (+0.007)	0.950 (+0.000)	0.937 (+0.003)	0.021 (+0.002)	Adaptive
		FL+OFT (Every 50 inf.)	0.925 (-0.047)	0.812 (-0.106)	0.820 (-0.130)	0.816 (-0.118)	0.048 (-0.025)	Adaptive
		FL+OFT (Every 150 inf.)	0.976 (+0.004)	0.932 (+0.014)	0.964 (+0.014)	0.947 (+0.013)	0.020 (+0.003)	Adaptive
	edge4	Inference Only	0.874	0.667	0.920	0.773	0.140	Static
		OFT	0.924 (+0.050)	0.750 (+0.083)	0.940 (+0.020)	0.834 (+0.061)	0.080 (+0.060)	Adaptive
		FL (Every 50 inf.)	0.887 (+0.013)	0.700 (+0.033)	0.910 (-0.010)	0.791 (+0.018)	0.120 (+0.020)	Adaptive
		FL+OFT (Every 50 inf.)	0.891 (+0.017)	0.714 (+0.047)	0.770 (-0.150)	0.741 (-0.032)	0.079 (+0.061)	Adaptive
		FL+OFT (Every 150 inf.)	0.934 (+0.060)	0.780 (+0.113)	0.930 (+0.010)	0.848 (+0.075)	0.065 (+0.075)	Adaptive
VS Attack	edge1	Inference Only	0.887	0.784	0.888	0.833	0.114	Static
		OFT	0.924 (+0.037)	0.876 (+0.092)	0.887 (-0.001)	0.881 (+0.048)	0.059 (+0.055)	Adaptive
		FL (Every 50 inf.)	0.899 (+0.012)	0.805 (+0.021)	0.900 (+0.012)	0.850 (+0.017)	0.102 (+0.012)	Adaptive
		FL+OFT (Every 50 inf.)	0.910 (+0.023)	0.813 (+0.029)	0.918 (+0.030)	0.862 (+0.029)	0.094 (+0.020)	Adaptive
		FL+OFT (Every 150 inf.)	0.933 (+0.046)	0.891 (+0.107)	0.898 (+0.010)	0.894 (+0.061)	0.051 (+0.063)	Adaptive
	edge2	Inference Only	0.925	0.833	0.954	0.889	0.089	Static
		OFT	0.931 (+0.006)	0.870 (+0.037)	0.919 (-0.035)	0.894 (+0.005)	0.064 (+0.025)	Adaptive
		FL (Every 50 inf.)	0.940 (+0.015)	0.880 (+0.047)	0.940 (-0.014)	0.909 (+0.020)	0.060 (+0.029)	Adaptive
		FL+OFT (Every 50 inf.)	0.878 (-0.047)	0.798 (-0.035)	0.807 (-0.147)	0.802 (-0.087)	0.091 (-0.002)	Adaptive
		FL+OFT (Every 150 inf.)	0.945 (+0.020)	0.890 (+0.057)	0.945 (-0.009)	0.917 (+0.028)	0.055 (+0.034)	Adaptive
	edge3	Inference Only	0.974	0.940	0.981	0.960	0.029	Static
		OFT	0.975 (+0.001)	0.949 (+0.009)	0.972 (-0.009)	0.960 (+0.000)	0.024 (+0.005)	Adaptive
		FL (Every 50 inf.)	0.979 (+0.005)	0.951 (+0.011)	0.984 (+0.003)	0.967 (+0.007)	0.024 (+0.005)	Adaptive
		FL+OFT (Every 50 inf.)	0.985 (+0.011)	0.960 (+0.020)	0.985 (+0.004)	0.972 (+0.012)	0.015 (+0.014)	Adaptive
		FL+OFT (Every 150 inf.)	0.980 (+0.006)	0.955 (+0.015)	0.980 (-0.001)	0.967 (+0.007)	0.020 (+0.009)	Adaptive
	edge4	Inference Only	0.801	0.641	0.846	0.729	0.219	Static
		OFT	0.880 (+0.079)	0.794 (+0.153)	0.838 (-0.008)	0.815 (+0.086)	0.101 (+0.118)	Adaptive
		FL (Every 50 inf.)	0.810 (+0.009)	0.653 (+0.012)	0.860 (+0.014)	0.742 (+0.013)	0.214 (+0.005)	Adaptive
		FL+OFT (Every 50 inf.)	0.826 (+0.025)	0.675 (+0.034)	0.835 (-0.011)	0.746 (+0.017)	0.178 (+0.041)	Adaptive
		FL+OFT (Every 150 inf.)	0.892 (+0.091)	0.800 (+0.159)	0.883 (+0.037)	0.839 (+0.110)	0.104 (+0.115)	Adaptive
VSP Attack	edge1	Inference Only	0.779	0.621	0.875	0.727	0.270	Static
		OFT	0.778 (-0.001)	0.618 (-0.003)	0.892 (+0.017)	0.730 (+0.003)	0.280 (-0.010)	Adaptive
		FL (Every 50 inf.)	0.786 (+0.007)	0.632 (+0.011)	0.886 (+0.011)	0.738 (+0.011)	0.265 (+0.005)	Adaptive
		FL+OFT (Every 50 inf.)	0.737 (-0.042)	0.535 (-0.086)	0.888 (+0.013)	0.668 (-0.059)	0.327 (-0.057)	Adaptive
		FL+OFT (Every 150 inf.)	0.789 (+0.010)	0.648 (+0.027)	0.834 (-0.041)	0.729 (+0.002)	0.234 (+0.036)	Adaptive
	edge2	Inference Only	0.370	0.347	0.993	0.515	0.947	Static
		OFT	0.370 (+0.000)	0.347 (+0.000)	0.993 (+0.000)	0.515 (+0.000)	0.946 (+0.001)	Adaptive
		FL (Every 50 inf.)	0.372 (+0.002)	0.350 (+0.003)	0.996 (+0.003)	0.519 (+0.004)	0.948 (-0.001)	Adaptive
		FL+OFT (Every 50 inf.)	0.601 (+0.231)	0.421 (+0.074)	0.904 (-0.089)	0.574 (+0.059)	0.528 (+0.419)	Adaptive
		FL+OFT (Every 150 inf.)	0.376 (+0.006)	0.351 (+0.004)	0.982 (-0.011)	0.517 (+0.002)	0.937 (+0.010)	Adaptive
	edge3	Inference Only	0.884	0.781	0.910	0.840	0.130	Static
		OFT	0.881 (-0.003)	0.770 (-0.011)	0.924 (+0.014)	0.840 (+0.000)	0.140 (-0.010)	Adaptive
		FL (Every 50 inf.)	0.892 (+0.008)	0.795 (+0.014)	0.918 (+0.008)	0.852 (+0.012)	0.122 (+0.008)	Adaptive
		FL+OFT (Every 50 inf.)	0.742 (-0.142)	0.543 (-0.238)	0.845 (-0.065)	0.661 (-0.179)	0.302 (-0.172)	Adaptive
		FL+OFT (Every 150 inf.)	0.868 (-0.016)	0.812 (+0.031)	0.790 (-0.120)	0.801 (-0.039)	0.093 (+0.037)	Adaptive
	edge4	Inference Only	0.369	0.347	0.987	0.513	0.944	Static
		OFT	0.369 (+0.000)	0.347 (+0.000)	0.986 (-0.001)	0.513 (+0.000)	0.944 (+0.000)	Adaptive
		FL (Every 50 inf.)	0.369 (+0.000)	0.349 (+0.002)	0.992 (+0.005)	0.516 (+0.003)	0.950 (-0.006)	Adaptive
		FL+OFT (Every 50 inf.)	0.696 (+0.327)	0.494 (+0.147)	0.836 (-0.151)	0.621 (+0.108)	0.363 (+0.581)	Adaptive
		FL+OFT (Every 150 inf.)	0.374 (+0.005)	0.350 (+0.003)	0.980 (-0.007)	0.516 (+0.003)	0.939 (+0.005)	Adaptive

Precision, recall, F1 score, and FPR are computed with anomaly as the positive class.
FPR deltas are improvements relative to the Inference Only baseline; a positive value indicates a reduction in FPR.