

Real-Time Cell Sorting with Scalable In Situ FPGA-Accelerated Deep Learning

Supplementary Material

1 Benchmark Results

Table [S1](#) shows a comprehensive comparison of classification performance on the LymphoMNIST and MNIST datasets, including the test accuracy achieved by common machine learning classifiers across a range of hyperparameter configurations. Notably, there is a large performance disparity between the two datasets which reflects the increased complexity of LymphoMNIST. For instance, the tree-based methods such as `DecisionTreeClassifier` performed significantly worse on LymphoMNIST compared to MNIST across the entire hyperparameter search space. `GradientBoostingClassifier` shows significant improvement in accuracy on MNIST as the model complexity (e.g., number of estimators) increases, while achieving modest gains on LymphoMNIST relative to `DecisionTreeClassifier`.

Furthermore, `KNeighborsClassifier` and `RandomForestClassifier` also achieve superior accuracy on MNIST, while their performance on LymphoMNIST demonstrates their difficulty in capturing complex features. `LogisticRegression` and `LinearSVC` also achieve only moderate accuracy on LymphoMNIST, further highlighting the necessity for specialized approaches. This comparative analysis shows the value of LymphoMNIST as a challenging benchmark for advancing ML models and provides a complementary perspective to MNIST's utility in assessing general-purpose algorithmic performance. This exploration provides a foundation for future investigation into improving ML efficacy on datasets like LymphoMNIST.

Table S1. Comparison of Classification Accuracy on LymphoMNIST and MNIST Datasets.

Classifier	Parameters	Test Accuracy	
		Our Dataset	MNIST
DecisionTreeClassifier	criterion=gini, max_depth=10, splitter=best	0.498	0.866
	criterion=gini, max_depth=50, splitter=best	0.453	0.877
	criterion=gini, max_depth=100, splitter=best	0.452	0.879
	criterion=gini, max_depth=10, splitter=random	0.498	0.853
	criterion=gini, max_depth=50, splitter=random	0.449	0.873
	criterion=gini, max_depth=100, splitter=random	0.457	0.875
	criterion=entropy, max_depth=10, splitter=best	0.498	0.873
	criterion=entropy, max_depth=50, splitter=best	0.454	0.886
	criterion=entropy, max_depth=100, splitter=best	0.457	0.886
	criterion=entropy, max_depth=10, splitter=random	0.502	0.861
	criterion=entropy, max_depth=50, splitter=random	0.452	0.883
	criterion=entropy, max_depth=100, splitter=random	0.451	0.881
GradientBoostingClassifier	max_depth=3, n_estimators=10, loss=deviance	0.502	0.846
	max_depth=10, n_estimators=10, loss=deviance	0.555	0.933
	max_depth=50, n_estimators=10, loss=deviance	0.498	0.888
	max_depth=3, n_estimators=50, loss=deviance	0.532	0.926
	max_depth=10, n_estimators=50, loss=deviance	0.610	0.964
	max_depth=3, n_estimators=100, loss=deviance	0.553	0.949
	max_depth=10, n_estimators=100, loss=deviance	0.628	0.969
KNeighborsClassifier	weights=uniform, n_neighbors=1, p=1	0.489	0.955
	weights=uniform, n_neighbors=1, p=2	0.490	0.943
	weights=distance, n_neighbors=1, p=1	0.489	0.955
	weights=distance, n_neighbors=1, p=2	0.490	0.943
	weights=uniform, n_neighbors=5, p=1	0.506	0.957
	weights=uniform, n_neighbors=5, p=2	0.499	0.944
	weights=distance, n_neighbors=5, p=1	0.527	0.959
	weights=distance, n_neighbors=5, p=2	0.517	0.945
	weights=uniform, n_neighbors=9, p=1	0.523	0.955
	weights=uniform, n_neighbors=9, p=2	0.522	0.943
	weights=distance, n_neighbors=9, p=1	0.536	0.955
	weights=distance, n_neighbors=9, p=2	0.533	0.944
LinearSVC	loss=squared_hinge, C=1.0, penalty=l2, multi_class=ovr	0.531	0.912
	loss=squared_hinge, C=10.0, penalty=l2, multi_class=ovr	0.531	0.885
	loss=squared_hinge, C=100.0, penalty=l2, multi_class=ovr	0.531	0.873
LogisticRegression	C=1.0, penalty=l2, multi_class=ovr	0.545	0.917
	C=10.0, penalty=l2, multi_class=ovr	0.542	0.916
RandomForestClassifier	criterion=gini, max_depth=10, n_estimators=10	0.535	0.930
	criterion=gini, max_depth=50, n_estimators=10	0.525	0.948
	criterion=gini, max_depth=100, n_estimators=10	0.523	0.948
	criterion=entropy, max_depth=10, n_estimators=10	0.532	0.933
	criterion=entropy, max_depth=50, n_estimators=10	0.528	0.949
	criterion=entropy, max_depth=100, n_estimators=10	0.531	0.949
	criterion=gini, max_depth=10, n_estimators=50	0.543	0.945
	criterion=gini, max_depth=50, n_estimators=50	0.575	0.968
	criterion=gini, max_depth=100, n_estimators=50	0.578	0.967
	criterion=entropy, max_depth=10, n_estimators=50	0.543	0.947
	criterion=entropy, max_depth=50, n_estimators=50	0.578	0.967
	criterion=entropy, max_depth=100, n_estimators=50	0.575	0.968