How do the learning algorithms influence the performance of the filter and HeeNAMA?

To measure the influence of different machine learning techniques in the filter, we replace the deep learning based filter with classifiers based on Naïve Bayes, Random Forest and SVM. Evaluation results are presented in the table. The first column of this table presents subject applications. The second column and the third column present performance of HeeNAMA when deep learning based filter is employed (i.e., the default setting of HeeNAMA). The remaining columns present the performance of HeeNAMA with alternative filters that are based on traditional machine learning techniques, i.e., Naïve Bayes, Random Forest, and SVM.

Table 1 Influence of Machine Learning Techniques

Applications	Deep Learning		Naïve Bayes		Random Forest		SVM	
	Precision	Recall	Precision	Recall	Precision	Recall	Precision	Recall
Ant	80.82%	63.59%	76.64%	36.38%	82.08%	54.03%	79.33%	61.97%
Batik	75.46%	60.86%	69.86%	32.26%	75.96%	53.84%	74.00%	61.59%
Cassandra	81.00%	59.00%	74.78%	44.74%	77.06%	52.66%	76.38%	56.82%
Log4J	84.00%	67.31%	78.50%	40.52%	81.96%	56.91%	79.66%	63.39%
Lucene-solr	86.00%	62.60%	78.56%	44.59%	82.25%	55.56%	80.16%	68.23%
Maven2	87.03%	67.04%	71.88%	43.66%	91.53%	64.35%	79.95%	71.51%
Maven3	73.89%	64.53%	69.40%	42.45%	80.70%	59.76%	75.29%	65.33%
Xalan-J	79.77%	53.06%	65.40%	29.03%	73.31%	51.71%	71.54%	56.33%
Xerces	78.47%	47.90%	71.74%	17.74%	71.91%	42.34%	69.25%	52.48%
Average	**83.36%**	**61.16%**	**76.47%**	**41.29%**	**80.22%**	**54.35%**	**78.19%**	**64.04%**

From the table, we make the following observations:

- First, deep learning outperforms Naïve Bayes and Random Forest for the task. Replacing it with Naïve Bayes and Random Forest results in reduction in both precision and recall. The minimal reduction in precision and recall is 3.77%=(83.36%-80.22%)/83.36% and 11.13%=(61.16%-54.35%)/61.16%, respectively.
- Second, replacing deep learning based filter with SVM based classifier increases recall at the cost of significant reduction in precision. The precision reduction 6.20%=(83.36%-78.19%)/83.36% is more significant than the increase in recall 4.71%=(64.04%-61.16%)/61.16%. Moreover, high precision is often more critical than high recall for code completion task.

We conclude from the preceding analysis that deep learning works well, and replacing it with alternative learning techniques like Naïve Bayes, Random Forest, and SVM, fails to improve the performance of HeeNAMA.