Chapter VIII
Incremental Learning for Interactive E-Mail Filtering

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ABSTRACT

In this paper, we propose a framework namely, Prediction-Learning-Distillation (PLD) for interactive document classification and distilling the misclassified documents. Whenever a user points out misclassified documents, the PLD learns from the mistakes and identifies the same mistakes from all other classified documents. The PLD then enforces this learning for future classifications. If the classifier fails to accept relevant documents or reject irrelevant documents on certain categories, then PLD will assign those documents as new positive/negative training instances. The classifier can then strengthen its weakness by learning from these new training instances. Our experiments results have demonstrated that the proposed algorithm can learn from user identified misclassified documents, and then distill the rest successfully.
INTRODUCTION

Even after the dot-com bubble, the growth of the Internet does not stop. For example, according to the Australian bureau of statistics (Australian Bureau of Statistics, 2005), at the end of September 2004, total Internet subscribers in Australia numbered over 5.7 million. This was an increase of over 520,000 (10%) from the end of March 2004, and data downloaded by subscribers during the September quarter 2004 increased significantly (72%) to 11,004 million MBs from the 6,409 million MBs downloaded during the March quarter 2004. This data indicates that more and more people are joining the Internet, and they have shown that they were using the Internet as one of the primary sources to gain information.

One of the main reasons people want to be connected is the ability to use email. Email was originally designed for asynchronous communications, the same as traditional post mail. However, since email service is useful, easy to use, and cheap to send and receive, a great number of applications have been built upon the email service, such as document delivery and archiving, work task delegation and task tracking. It is also used for storing personal names and addresses, for sending reminders, handling customer services, scheduling appointments, and for handling technical support queries (Whittaker & Sidner, 1996). Email has become an essential field in contact address books.

As a low-cost, common used contact method, there is always a drawback. Many email users start to realise themselves that they have been overloaded by the information from email. If the amount of email documents received each day by a user exceeds around 50, the time spent on analysing what are important and what is not, then replying to important ones, can take up a considerable amount of daily working hours. To many university academic staffs, a two-hour session of processing email has become a routine of a normal workday. The time wasted sifting through daily email is a time consuming, yet extremely important task. Consequently, document classifiers, especially email filters are put into practise to ensure that a user is not inundated with useless information, which in turn causes them to miss a critical email, file, or an announcement.

Problems with Email Filtering

Before applying filtering techniques, people would like to ask following questions:

- Can the filter guarantee effectiveness?
- Is the filter easy to use?
- Is the filter really a time saver?

An important assessment for the email filter is how many correct decisions the filter makes. People neither want junk mail to appear in their in-box folder, nor are they happy to see their legitimate mail to be dumped to the junk folder. Table 1 shows four filter decision types which are used to measure the quality of filter decision making (Sebastiani, 2002):

<table>
<thead>
<tr>
<th>Decision Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>The email item is spam.</td>
</tr>
<tr>
<td>Negative</td>
<td>The email is not spam.</td>
</tr>
<tr>
<td>True Positive</td>
<td>The filter correctly identifies the spam item as spam.</td>
</tr>
<tr>
<td>True Negative</td>
<td>The filter correctly identifies the legitimate item as legitimate.</td>
</tr>
<tr>
<td>False Positive</td>
<td>The filter incorrectly identifies the spam item as legitimate.</td>
</tr>
<tr>
<td>False Negative</td>
<td>The filter incorrectly identifies the legitimate item as spam.</td>
</tr>
</tbody>
</table>

Table 1: Filter Decision Types and Definitions

Positive means the email item is spam, while negative means the email is not spam. True positives (TP) and true negatives (TN) are right decisions, as user and filter agree each other; however, false negatives (FN) indicates that the filter considers the spam mail item is a legitimate mail item, while false positives (FP) denotes that the filter denotes the legitimate mail as junk.

If email filter users share the same preference, and they stick on their choice, then a fully automatic filter can be constructed by a knowledge engineering expert system such as TCS system (Hayes, Andersen, Nirenburg, & Schmandt, 1990). However, this is usually not the case. This general rule does not always apply to everyone. That is the reason why people do not put much credit on fully automatic filters because users doubt whether the general filtering rules can completely satisfy their preferences (Crawford, Kay, & McCreath,
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