Evaluating and Implementing Anti-Spam Solutions

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Presentation agenda

- Definitions of spam
- Why spam is a problem - and why you should care
- Experiences of three sites
- Common anti-spam technologies
  - How they work
  - How effective they are
  - Strengths/weaknesses
  - How spammers try to sneak messages past them
- Anti-spam software evaluation techniques

Defining spam

- Every person, every site, and every anti-spam product has their own definition of spam
- Definite spam: pornographic, phishing, ...
- Not spam: work email, email from friends, nag-o-grams from your mother, ...
- Grey area: newsletters, mailing lists, unsolicited email from sites like Amazon
- Be sure your anti-spam software has the same definition of spam that you do (or can be configured to)

Spam by the numbers

- Spam being sent on average worldwide (IDC)
  - 4 million in 2001
  - 17 billion in 2004
- Half of all business emails are spam (Time Magazine)
- Productivity cost is $8.9 billion (Time Magazine)
- Revenue for vendors selling anti-spam products will reach approximately $130 million in 2003, and soar by 200 percent in 2004 to $360 million (Ferris)

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Direct effects of spam

- Wastes network bandwidth
- Wastes CPU and disk on mail server
- Wastes CPU and disk on desktops
- Wastes end users’ time
- Wastes administrators’ time
- Pisses off everyone in general

Indirect effects of spam

- Legal exposure
- “Brand damage”
- Lost productivity over and above the time directly spent dealing with spam
- Increasing downward slide of modern society

How much is spam costing you?

- Lots of complex ROI formulas and whiz-bang web calculators out there - feel free to use them
- ROI factors to consider:
  - How much are you paying employees to deal with spam?
  - How much money are you losing because employees are dealing with spam instead of working?
  - How much is the additional hardware/bandwidth costing you?

Example site: Bio-pharm manufacturer

- Two sites, one on each coast. Two email servers at each site (one primary, one backup)
- 40,000 incoming email messages each day
- About 55% of all incoming mail was spam
- Anti-spam solution couldn’t filter out legitimate mail containing pharmaceutical marketing phrases
- Most email consisted of either technical or business content

Example site: University

- Large public university with 30,000 email accounts on four central mail servers
- 300,000 incoming messages on average weekday, 80,000 on weekends. Diverse content.
- Almost 70% of all incoming mail was spam (public email directory)
- Mail servers were already heavily loaded, so solution had to be lightweight
- Solution had to give students/faculty access to all filtered messages for censorship reasons

Example site: Government agency

- Government agency in Europe with nine mail servers in various locations.
- 75,000 incoming email messages each day
- 35% of incoming mail was spam
- Incoming mail could potentially have content in any major European language
- Solution had to conform to EU rules for exposing and deleting message content

Spam filtering technologies

- Heuristic (rules)
- Bayesian (statistical)
- Signature matching
- DNS blacklisting
- Challenge/response
- Legal
- Retribution

Heuristic: How it works

- Matches rules (usually regular expression based) against the headers and content of an email message
- Simplest heuristic filters just look for bad words
- More complex heuristic filters use hundreds and hundreds of rules to search for features of a message that indicate it is or isn't spam
- Each rule has a different weight, with a larger weight indicating a message is more likely to be spam

Heuristic: How it works

- The weights of every rule a message matches are added together
- If the total weight is greater than a specified threshold, the message is considered spam

Heuristic: Effectiveness

- One of the highest spam detection rate of current filtering methods (90% to 95%)
- Simple implementations tend to have a relatively high false positive rate (0.5%)
- More evolved implementations have an acceptable false positive rate

Heuristic: Strengths and weaknesses

- Excellent accuracy
- Easy to install and maintain
- If a spammer gets his hands on a copy of the software, it’s trivial to circumvent
- Rules have to be updated on a regular basis to catch new spam tricks

Heuristic: Circumvention

- If rules are public (freeware solutions), or even if they’re not, spammers can craft their messages to deliberately avoid detection
- Spammers tend to be lazy, so frequent rule updates discourage this
- Spammers can deliberately word their messages in an attempt to evade detection even without having the rules, but this usually happens at the expense of their message content

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Bayesian: How it works

- The filter "learns" what you consider spam by looking at large bodies of spam and non-spam messages you present to it
- Basically, the filter uses the frequency of certain words appearing in spam messages to figure out the statistical probability that a message containing those words is spam
- Each word of an incoming message is examined to determine the probability that it indicates the message is spam

Bayesian: How it works

- If the sum of the probabilities of interesting words in the message is above a certain threshold, the message is treated as spam

Bayesian: Effectiveness

- *When trained properly*, a Bayesian filter has almost perfect accuracy
- When the training is done incorrectly, the results will not make people happy

Bayesian: Strengths and weaknesses

- Excellent accuracy (for most people)
- Snorts up CPU and memory like a junkie who needs a fix
- Most implementations aren't suitable for large-scale production use (accuracy suffers badly)
- Requires substantial user education on how to train it properly. Autotraining systems can help alleviate this issue.

Bayesian: Circumvention

- Only sure way to circumvent a Bayesian filter is to avoid the use of a lot of "spammy" words in a message.
- Kind of hard to sell viagra without using the word "viagra", though.
- No known circumvention technique to date has worked
- Spammers have tried sneaking messages by the filter by including large numbers of non-spam words in the message, but most Bayesian filters are smart enough to ignore that

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Signature matching: How it works

- The anti-spam software vendor sets up a large set of test addresses and uses them as spam bait
- Whenever a test address receives a spam message, the vendor creates a signature for it
- The signatures are a hash of the message headers and body, and (at least in theory) are specific to that message
- The signatures for spam messages go into a giant database, which is pushed out to customer mail servers every few minutes

Signature matching: How it works

- When a message is received by a customer's mail server, the anti-spam software calculates its signature
- The message's signature is compared against the signatures in the database. If it matches, it's treated as spam

Signature matching: Effectiveness

- Very low false positive rate (not quite as low as the vendors advertise, but still very low)
- Low spam detection rate. Despite vendor claims of 99.9% accuracy, 50% to 70% is more accurate.
- Published numbers for the largest vendor of signature matching software give it only 70% accuracy (MIT Technology Review)

Signature matching: Strengths and weaknesses

- Significant numbers of false positives aren't likely to occur
- Relatively low system load
- Low spam detection accuracy
- Very easy to circumvent with modern spamware
- Requires very frequent database updates, with accuracy falling off significantly in a matter of hours if something prevents the updates from occurring

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Signature matching: Circumvention

- Old signatures are removed from the database quickly, so “old” spam will sail right through
- Simple signature hashing algorithms are easy to beat by adding random text or words to each message
- Vendors come up with new signature generation algorithms all the time, but they’re all easy to beat with modern spamware that makes major modifications to each message

DNS blacklisting: How it works

- When a connection is established to your mail server, the mail server performs a DNS lookup of the remote site against a special DNS server
- The special DNS server is actually a giant database of IP addresses and domains that are known to send large quantities of spam
- Based on the return value from the DNS lookup, your mail server either accepts or rejects the connection

DNS blacklisting: Effectiveness

- Has a relatively low spam detection rate, around 40% for most sites
- Because it requires so little system resources, most sites use it as a first line of defense against spam

DNS blacklisting: Strengths and weaknesses

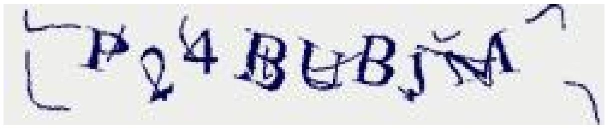
- Allows you to block messages from spam domains without having to even examine the message
- Requires very little system resources
- Has a very low spam detection rate, and can be easily avoided by a savvy spammer
- Good chance you’re going to lose legitimate mail because a legit site accidentally got blacklisted
- You have no control over what sites are blacklisted and which sites are not

DNS blacklisting: Circumvention

- Domains and IP addresses are cheap - easy for spammers to constantly hop around between domains
- Too easy to write a worm/virus that turns desktop systems into “spam zombies”, the sheer quantity of which makes it impossible to keep the database up to date
- If a spammer hacks/spoofs a site you *must* receive mail from, it’ll force you to turn off blacklisting for your domain

Challenge/response: How it works

- When a message is received by the C/R software, it holds the message and sends a challenge message back to the sender
- The challenge message directs the sender to a web site, where they have to pass some sort of test to prove that they're human (rather than automated spamware)
- Most common is distorted text image
- Sample:



Challenge/response: How it works

- If the sender passes the challenge, then the original message is delivered to the recipient
- If the sender doesn’t pass the challenge within a specified period of time, the message is dropped
- Some implementations whitelist a sender who passes the challenge, so future messages won’t require a re-test

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Challenge/response: Effectiveness

- On paper, this method has a 100% spam catch rate and a 0% false positive rate
- That requires everybody to play by the rules, and since when have spammers done that?
- Reality is that spam catch rate can be 0% if a spammer is smart/lucky, with an unacceptably high false positive rate

Challenge/response: Strengths and weaknesses

- Major strength is that it looks good on paper
- Lots and lots of weaknesses:
  - Can’t deal with mailing lists and automated messages
  - Confuses a lot of senders
  - Easy to circumvent if whitelisting is enabled
  - Unacceptable mail delays
  - Honks off a lot of senders (including me), who won’t do the challenges

Challenge/response: Circumvention

- If you’re using whitelisting, a spammer just has to get lucky and guess an address you might have whitelisted (mailing list, Amazon, travel agency)
- Use porn fiends to solve the challenges (Simson Garfinkel)
- “Rent brains” in developing countries
- Odd twist: spammers are sending out bogus messages that look like challenges. They skate right by most anti-spam software, and either contain a marketing message or direct recipients to a web site that does

Legal: How it (doesn't) work

- "Legit" spammers have a powerful lobby, so most anti-spam legislation is chock-full-o-loopholes
- It's all but impossible to pursue a spammer over national borders...
- ...And there will always be one jurisdiction that welcomes spammer money with open arms
- Most spammers ignore anti-spam laws anyway
- Published numbers indicate less than 15% of sexually explicit spam obeys current FTC regulations (Vircom)

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Retribution

- Filters that fight back (FFB)
  - Crawl all URLs listed in message, bringing down spamvertized web site, driving up spammer bandwidth costs
- Tar pitting
  - Email server deliberately slows down SMTP transaction, slowing down spammer as well
- Neither one works particularly well, and both have the potential to get IT staff fired

Filtering technology wrap-up

- Heuristic, Bayesian, and DNS blacklisting work
- Signature matching and challenge/response don't
- Anti-spam laws mostly force the quasi-legit mailers to cross over to the dark side
- Retribution, while fun, isn't terribly constructive
- Any one filtering method can be circumvented by a spammer with sufficient time and resources
- An anti-spam solution with multiple filtering methods is the way to go

Evaluating anti-spam software

- Filter evaluation criteria
- User interface evaluation criteria
- Non-production testing methods
- Production testing methods
- Evaluation fallacies
- Soliciting user feedback

Filter evaluation criteria

- Accuracy
- Configurability
- Information
- Filtering methods
- Performance
- Security
- Time required to implement and maintain

Accuracy

- Two key measures of accuracy: spam detection rate and false positive rate
- A lot of poorly written spam filters have high spam detection rates and high false positive rates, and vice versa
- A good solution strikes a balance with a high spam detection rate and a low false positive rate
- Messages identified as spam shouldn’t be immediately discarded - even the best spam filters make mistakes from time to time

Configurability

- Software should be extensively configurable to work with your site, but it should also be effective out-of-the-box so you don't have to spend hours getting it to work
- System administrators should be able to add, delete, and modify filtering rules
- Users should be able to personalize their spam filtering options, if the administrator chooses to allow them to
- Users should not have to install software on their desktops to perform configuration tasks

Information

- Both administrators and users should be able to quickly tell why a message was classified as spam
- Anti-spam software should provide succinct but useful log files with at least one entry for every message examined by the software
- At least basic statistics (number of incoming messages, number of messages filtered, etc) should be provided

Filtering methods

- Anti-spam software that provides only one filtering method should be avoided
- Anti-spam products should use filter methods that provide a rich feature set while balancing accuracy and system resource consumption
- Avoid methods that are easy to circumvent or confuse users, such as signature checking and challenge/response

Performance

- Email is an application that’s highly visible to both internal and external users
- Message processing delays will quickly be noticed, so an anti-spam product should not become a bottleneck
- Anti-spam software should be scaleable, so it can grow as your site grows

Security

- Your site's email messages are private communications that could do serious harm if lost, made public, or given to a competitor
- Messages with sensitive content should not be sent off-site for filtering
- The administrator should have the ability to approve or reject new spam filtering rules before they are put into place
- Anti-spam software shouldn't send any information whatsoever offsite without the administrator's specific permission

Time required to implement/maintain

- Solution shouldn't require more time to manage than the problem
- The administrator should have the option to shove as much administration as possible off to the end users:
  - Filtering thresholds
  - Quarantine preview and release
  - Whitelists and blacklists

User interface evaluation criteria

- Simple and natural dialog
- Natural language support
- Minimize user memory load
- Consistency
- Feedback
- Clearly marked exits
- Good error messages
- Help and documentation

Simple and natural dialog

- Instructions and labels in the interface should be written in a conversational tone
- Jargon or acronyms that would be unfamiliar to end users should be avoided

Natural language support

- The interface has to be able to speak the same language as the users for it to be useful
- Most of the world’s population is at least somewhat functional in English, but the abbreviated language used in some parts of user interfaces may be confusing
- You can’t expect anti-spam software to “speak” all of the world’s languages out-of-the-box, but it should be easy for the system administrator or a translator to rewrite all instructions and labels in the user’s native language

Minimize user memory load

- End users shouldn’t have to remember information specific to the interface between usage sessions
- Interface should be clear and intuitive
- Help should be easily obtainable

Consistency

- The interface should have a consistent layout, color scheme, and text
- Changes between different parts of the interface can disorient and confuse users
- A consistent layout reduces the amount of time new users need to become comfortable using the interface

Feedback

- The interface should provide clear feedback about actions it's taking on the user's behalf
- Example: if the user chooses to release a quarantined message, the interface should clearly state that the message has been released
- Just returning the user to the page they started from might leave them in doubt as to whether or not the message really was released

Clearly marked exits

- Users should be able to exit the interface (logout) from anywhere it makes sense to do so
- User should also be able to return to their main page from anywhere in the interface
- The interface should warn the user about unsaved changes before allowing them to exit

Good error messages

- If an error occurs, the error message should be informative
- A sad face will effectively convey the fact that an error occurred, but it won’t be much help in fixing what’s wrong
- First tier helpdesk staff should be able to tell if a serious error requiring system administrator intervention has occurred
- What caused the error (and what needs to be done to fix it) should be obvious from the error text

Help and documentation

- Help for the user interface should be contained in the user interface
- The average user isn't going to read documentation on how to use anti-spam software, regardless of how pretty the pictures are
- They'd much rather bombard the system administrator with the same question over and over again, which wastes valuable admin time

Non-production testing methods

- Non-production testing has no effect on your live mailstream or production mail server
- Corpus testing: large blocks of known spam and non-spam messages are run through anti-spam software on a test system
- Forking user mail: production mail server forks a copy of incoming messages for select users off to a test system running the anti-spam software

Production testing

- Production testing involves running your live mailstream through an anti-spam product
- Production testing will almost always be visible to end users, so be sure to plan it carefully
- Make sure you choose a good cross-section of your organization to participate in the testing
- Give the test users plenty of warning before the test period starts and before it ends
- Create a mailing list for the test users to post questions/issues to. Have IT staff monitor it.

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Production testing methods

- Log monitoring: incoming messages are not modified in any way, but the anti-spam software logs whether or not a message would have been considered spam
- Header insertion: insert informational headers in messages it processes
- Subject modification: prepend a token ([SPAM]) to the subject line of messages that are identified as spam
- Full testing: enable the anti-spam software’s full range of spam handling techniques, including quarantining and discarding

Evaluation fallacies

- Using a small group of testers - you need enough to be statistically significant
- Using only testers from one department or workgroup - won’t give a true idea of accuracy or user response
- Fowarding spam - strips off important headers
- Using raw spam from public repositories
- Using homogenous message blocks to test Bayesian filters

User feedback

- Soliciting user feedback at the end of an evaluation is important
- If you don’t ask for your users’ opinions then, you’re going to get them later anyways
- In addition to the obvious questions regarding accuracy, true/false perception questions can be useful in the decision making process:
  - Using *product* would improve my email workflow
  - *Product* would reduce the amount of time I spend dealing with junk email
  - Learning how to use *product* was easy for me

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