Countermeasures against Malicious Software

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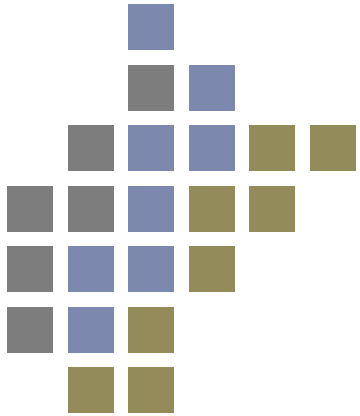
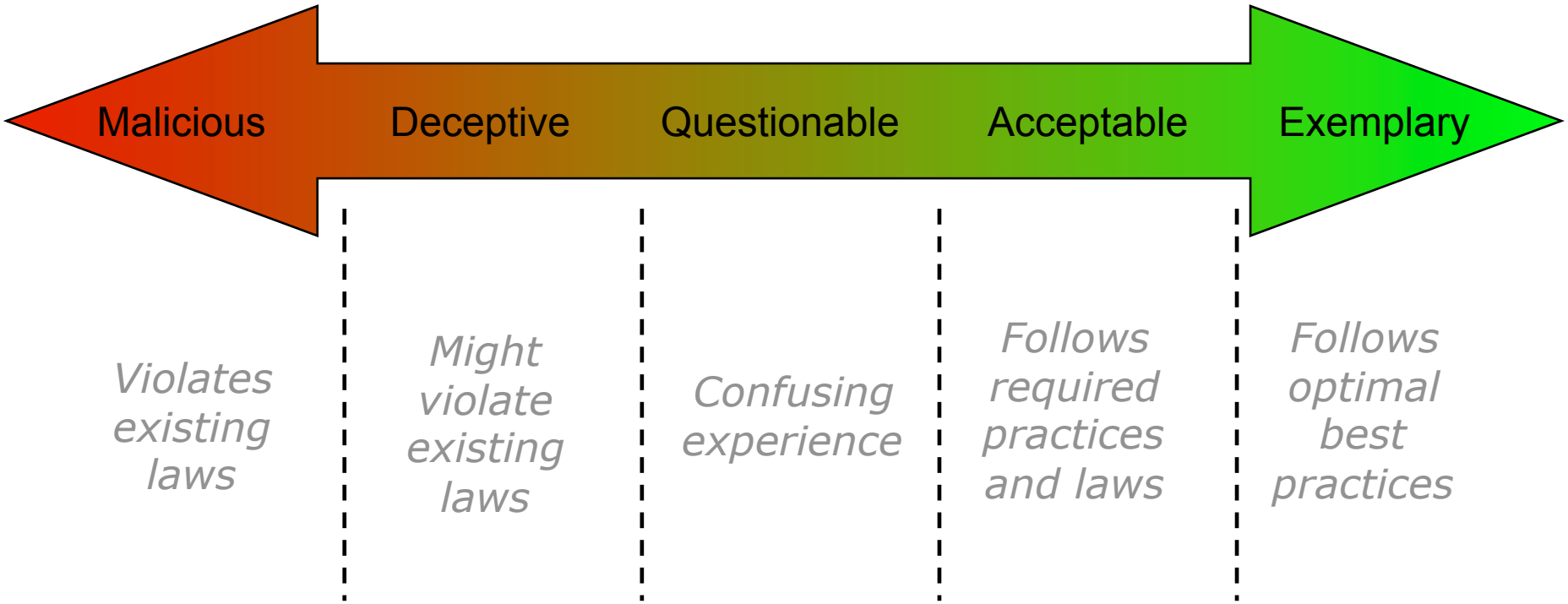
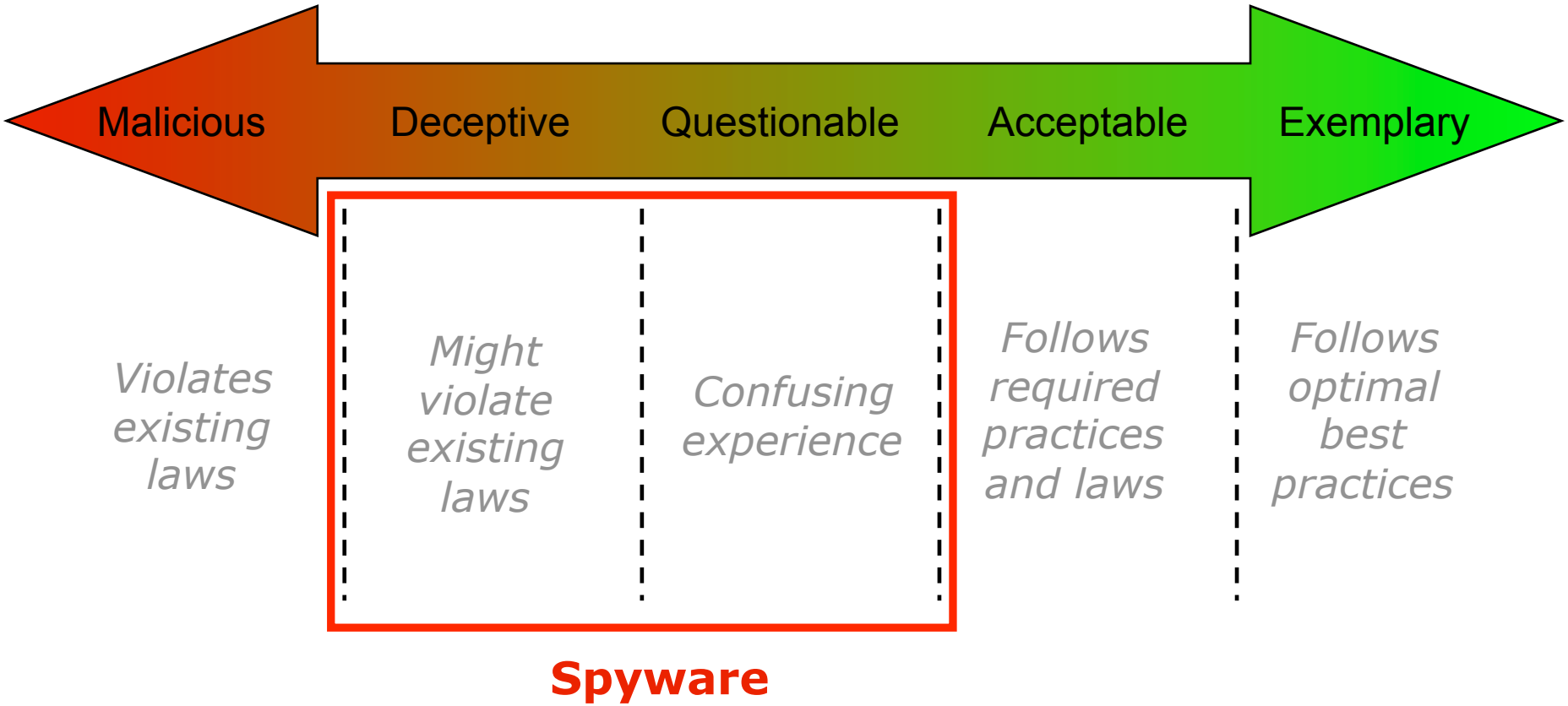


Software Behaviour

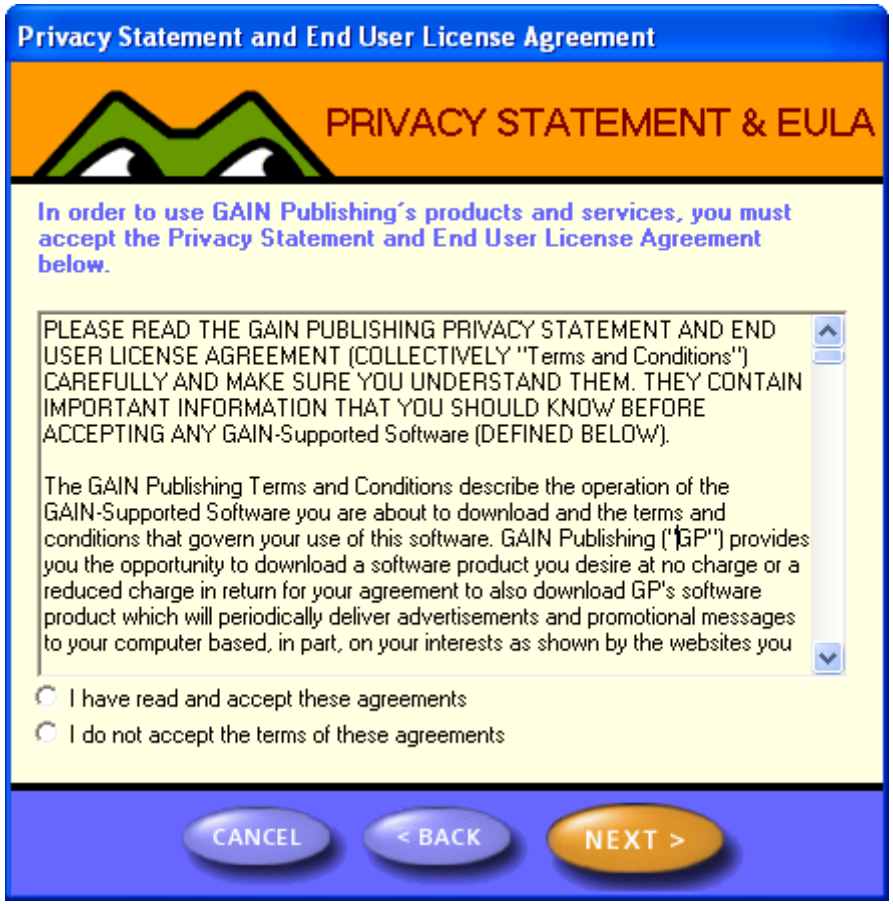


Software Behaviour



The Spyware Problem (i)

- We use the Gator software as an example of what users face on the Internet
- During the installation users face an End User License Agreement (EULA)
- It contains 6,645 words and is presented in a small window
- Would you read it?



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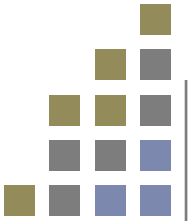

The Spyware Problem (ii)

- The EULA reveals that the following programs are installed:
  - eWallet
  - Precision Time
  - Date Manager
  - Offer Companion
  - Weatherscope
  - SearchScout Toolbar
- Such programs create large revenues for the their developers
- Spyware corporations report annual revenues in excess of $50 Million each

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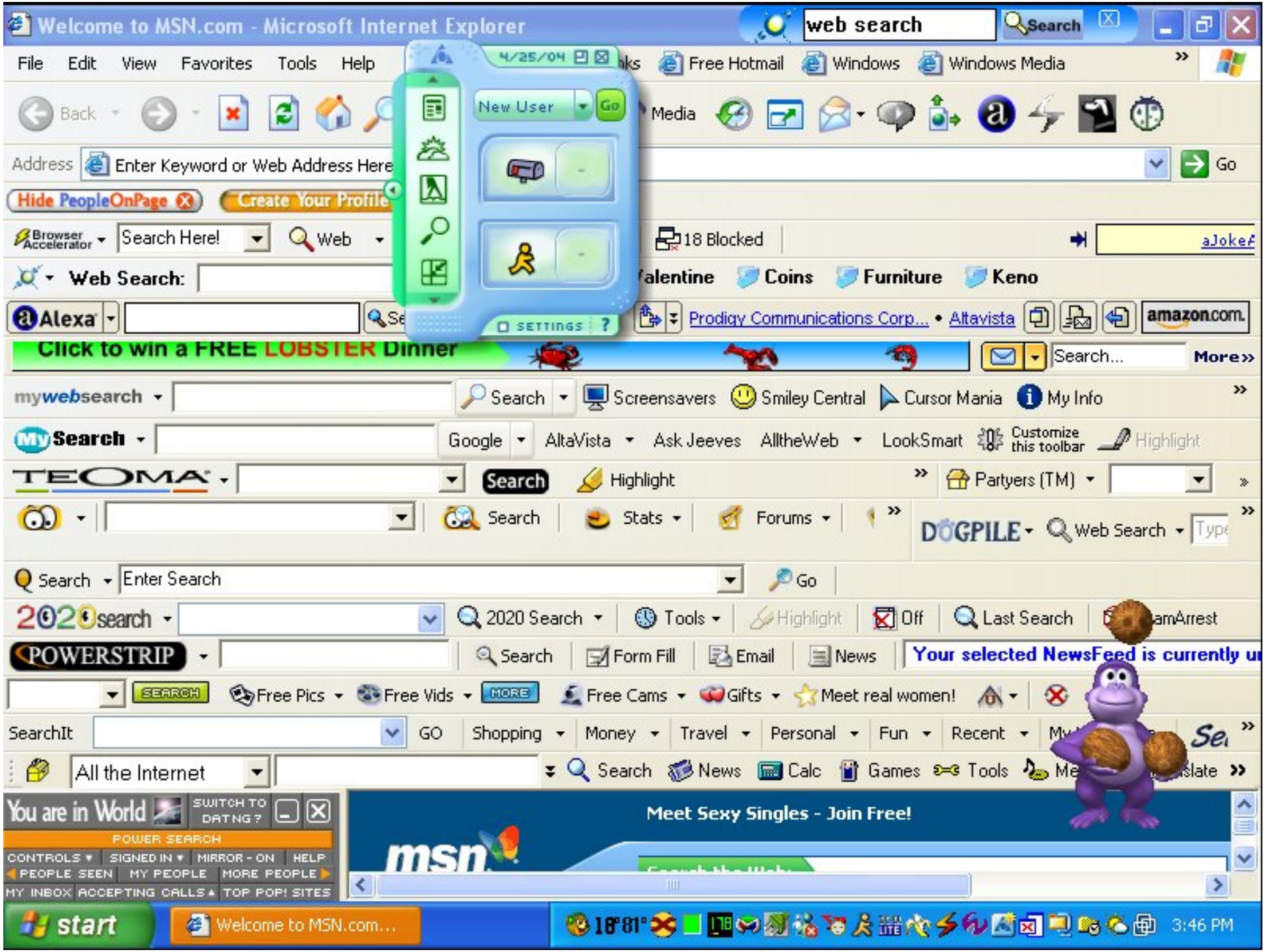
Welcome to MSN.com - Microsoft Internet Explorer
web search
Search
File Edit View Favorites Tools Help
Free Hotmail
Windows
Windows Media
Back
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Enter Keyword or Web Address Here
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MORE
Free Cams
Gifts
Meet real women!
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Shopping
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Travel
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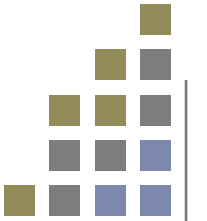
Fun
Recent
All the Internet
Search
News
Calc
Games
Tools
You are in World
SWITCH TO DATING?
POWER SEARCH
CONTROLS
SIGNED IN
MIRROR - ON
HELP
PEOPLE SEEN
MY PEOPLE
MORE PEOPLE
MY INBOX
ACCEPTING CALLS
TOP POP! SITES
Meet Sexy Singles - Join Free!
msn
start
Welcome to MSN.com...
3:46 PM



Software Reputation System (i)

- Similar reputation systems are being successfully used by for instance Amazon.com and IMDb.com
- We put forward the idea of using *collaborative reputation systems* to help inform users about the effects of software
- Gather previous users' knowledge about software and present it to the new user
- Users provide ratings and comments for the software they use most frequently
- This information is sent to a central repository where it is transformed into *software reputations*

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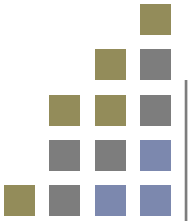

Software Reputation System (ii)

- When a new user is about to install a software he/she is presented with the software reputation
- The software reputation allows the user to make a more informed decision regarding the software installation
- This protection is *preventive* since the user make this decision before the software is allowed to execute
- To mitigate antagonistic intentions from users we make use of *trust factors* and *meta ratings*

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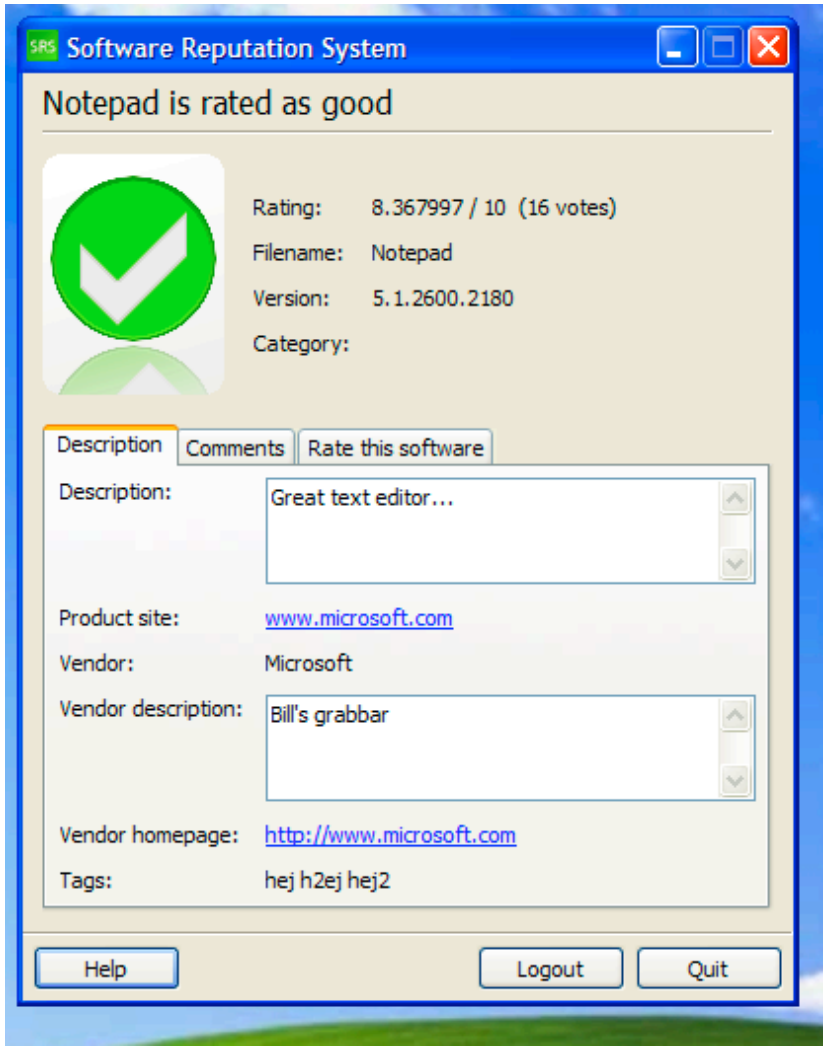
Software Reputation System (iii)

- We are developing a proof-of-concept tool which is integrated into Microsoft Explorer software
- A beta version will be available in late November

www.softwareputation.com



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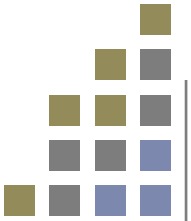

EULA analysis (i)

- Spyware distributors typically mention in the End User License Agreement (EULA) if their application hosts spyware
  - The main reason seems to be to avoid legal repercussions
  - The EULA act as a last escape route in court
- EULAs are notoriously difficult for normal computer users to understand
- However, we believe it is possible for computers to exploit the fact that spyware hosting is mentioned in in the EULA

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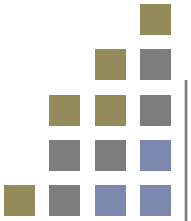

EULA analysis (ii)

- Inspired by spam filtering services we apply data miners (classification algorithms) to classify EULAs as good or bad
- Data miners generalize from training examples of EULAs with known classification
- We generated a data set by collecting 1000 programs with EULAs and classifying each EULA as either good or bad
  - 900 good and 100 bad programs and EULA
- Then we evaluated 15 popular classification algorithms using this data set

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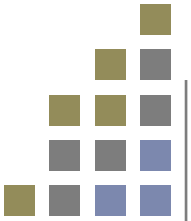

State-of-the-art tools

- There exist one web based EULA analyzing services that rely on “simple” keyword matching
- The tools assign a score related to the number of found spyware keywords
- The actual classification of software as either spyware or legitimate is very much up to the user

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Results

Algorithm	Accuracy % correct	AUC	Training Time seconds	Testing Time seconds
AdaBoostM1	73.82(5.79) ●	0.78(0.04) ●	3.55(0.28)	0.00(0.01)
DecisionStump	68.82(11.11)	0.69(0.11)	0.33(0.08)	0.00(0.00)
HyperPipes	76.47(7.59) ●	0.90(0.07) ●	0.04(0.01)	0.07(0.09)
IBk	77.94(5.59) ●	0.78(0.06) ●	0.04(0.01)	0.13(0.02)
J48	73.24(10.23) ●	0.73(0.10) ●	1.29(0.23)	0.00(0.01)
JRip	71.18(5.33) ●	0.72(0.07) ●	2.02(0.23)	0.00(0.00)
KStar	59.71(4.17) ●○	0.68(0.07) ●	0.00(0.00)	9.20(0.42)
NaiveBayes	79.41(9.80) ●	0.80(0.10) ●	0.31(0.02)	0.11(0.05)
NaiveBayesNominal	**93.94(6.42) ●+**	**0.92(0.06) ●**	**0.03(0.01)**	**0.00(0.01)**
PART	72.65(10.74) ●	0.72(0.11) ●	2.41(2.15)	0.00(0.01)
RandomForest	75.29(7.10) ●	0.83(0.08) ●	3.64(0.20)	0.00(0.00)
RBFNetwork	77.35(7.73) ●	0.78(0.09) ●	1.46(0.19)	0.17(0.02)
Ridor	67.65(11.35)	0.68(0.11)	0.87(0.11)	0.00(0.01)
SMO	**95.53(1.97) ●+**	**0.82(0.08) ●**	**0.25(0.08)**	**0.00(0.00)**
VotedPerceptron	81.47(6.66) ●	0.87(0.07) ●	0.04(0.01)	0.02(0.01)
ZeroR (baseline)	50.00(0.00)	0.50(0.00)	0.00(0.01)	0.00(0.00)
EULA analyzer	72.7 (3.86)	N/A	N/A	N/A

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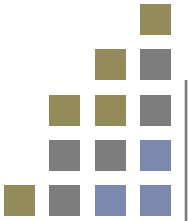

Evaluating the technique

- Using data miners to distinguish between legitimate software and spyware is absolutely possible
  - 2 miners perform significantly better than the state-of-the-art web service
- Accuracy could be even further increased by tweaking the classifier algorithms to the problem at hand
  - In our experiments all algorithms executed with the default settings
- This technique could be implemented in a tool that automatically detects and analyze EULAs and present the result to the user

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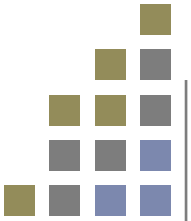

Conclusion

- We believe that EULA analyzer tools and a software reputation system can greatly help users handle malicious software
- Further research is required when it comes to mitigating antagonistic intentions among “bad users”
- A new PhD student financed by .SE will focus on this in beginning of 2009

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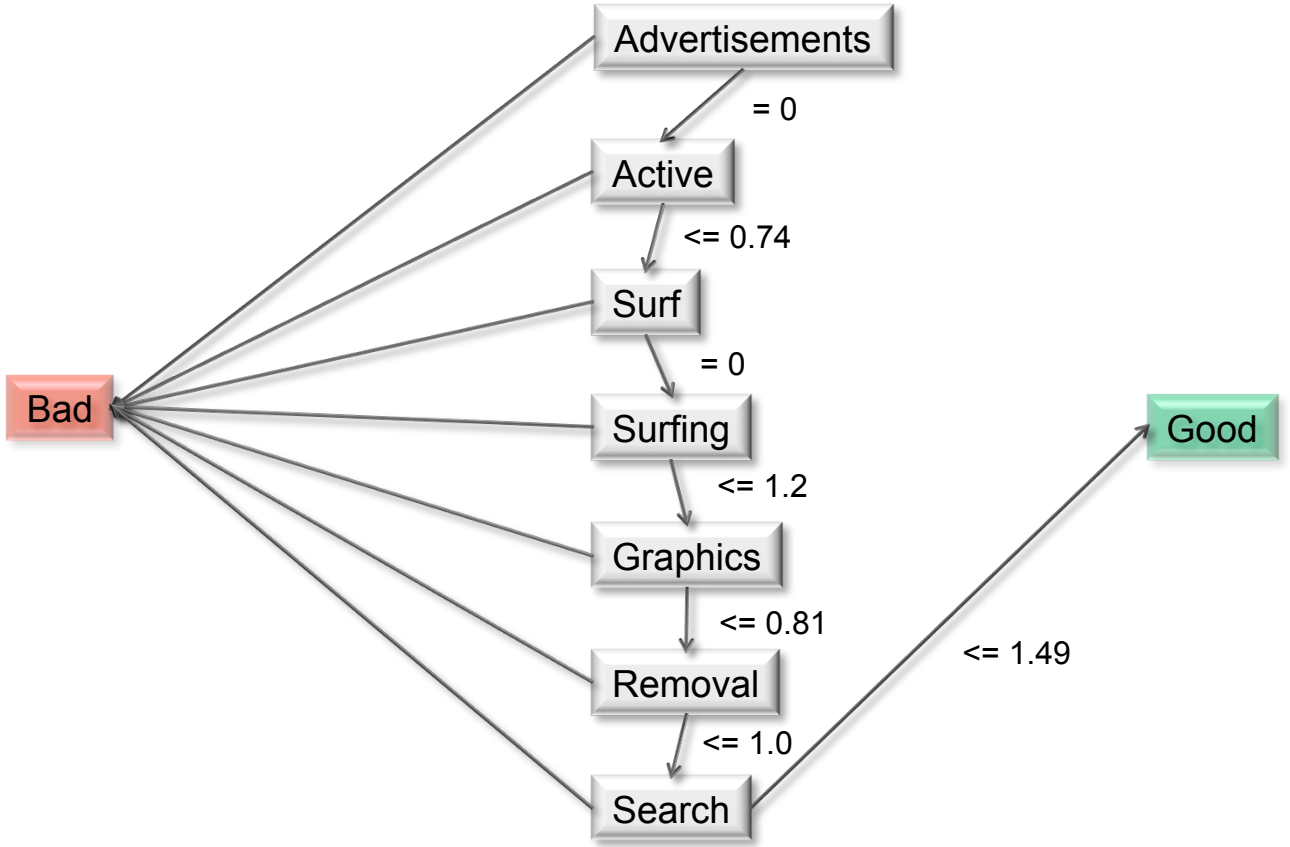
Example of the J4.8 algorithm



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