
Visual-Similarity-Based Phishing Detection

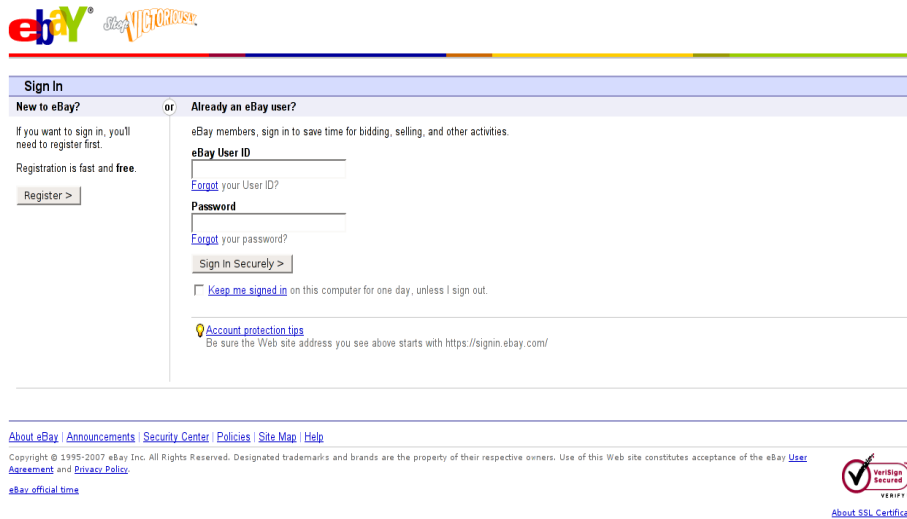
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Vienna (AT)

What is phishing?

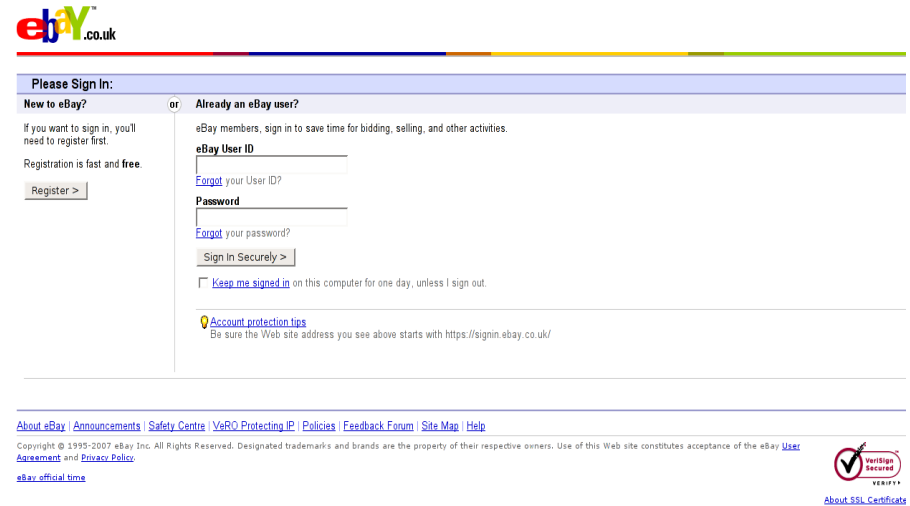
- A form of **online fraud** aimed at stealing user's sensitive information
- The attacker crafts a web page that mimicks the original page and spreads its URL using emails
- An important and current problem:
 - More than 25000 phishing attacks in Dec. 2007
 - "Do yourself" phishing kits
 - Can be combined with other online attacks

Phishing: an example



The screenshot shows the genuine eBay sign-in page. At the top left is the eBay logo with the text "eBay MARKETPLACE". Below the logo is a horizontal bar with a rainbow gradient. The main heading is "Sign In". There are two tabs: "New to eBay?" and "Already an eBay user?". The "New to eBay?" tab is selected. The text says: "If you want to sign in, you'll need to register first. Registration is fast and free." There is a "Register >" button. The "Already an eBay user?" tab is also visible. The text says: "eBay members, sign in to save time for bidding, selling, and other activities." There are input fields for "eBay User ID" and "Password". There are links for "Forgot your User ID?" and "Forgot your password?". There is a "Sign In Securely >" button. There is a checkbox for "Keep me signed in on this computer for one day, unless I sign out." There is a link for "Account protection tips" with the text "Be sure the Web site address you see above starts with https://signin.ebay.com/". At the bottom, there are links for "About eBay", "Announcements", "Security Center", "Policies", "Site Map", and "Help". There is a copyright notice: "Copyright © 1995-2007 eBay Inc. All Rights Reserved. Designated trademarks and brands are the property of their respective owners. Use of this Web site constitutes acceptance of the eBay User Agreement and Privacy Policy." There is an "eBay official time" link. There is a "VeriSign Secured" logo with the text "VERI***" and "About SSL Certificate".

The genuine page



The screenshot shows a phishing page that mimics the eBay sign-in page. At the top left is the eBay logo with the text "eBay.co.uk". Below the logo is a horizontal bar with a rainbow gradient. The main heading is "Please Sign In:". There are two tabs: "New to eBay?" and "Already an eBay user?". The "New to eBay?" tab is selected. The text says: "If you want to sign in, you'll need to register first. Registration is fast and free." There is a "Register >" button. The "Already an eBay user?" tab is also visible. The text says: "eBay members, sign in to save time for bidding, selling, and other activities." There are input fields for "eBay User ID" and "Password". There are links for "Forgot your User ID?" and "Forgot your password?". There is a "Sign In Securely >" button. There is a checkbox for "Keep me signed in on this computer for one day, unless I sign out." There is a link for "Account protection tips" with the text "Be sure the Web site address you see above starts with https://signin.ebay.co.uk/". At the bottom, there are links for "About eBay", "Announcements", "Safety Centre", "VeRO Protecting IP", "Policies", "Feedback Forum", "Site Map", and "Help". There is a copyright notice: "Copyright © 1995-2007 eBay Inc. All Rights Reserved. Designated trademarks and brands are the property of their respective owners. Use of this Web site constitutes acceptance of the eBay User Agreement and Privacy Policy." There is an "eBay official time" link. There is a "VeriSign Secured" logo with the text "VERI***" and "About SSL Certificate".

The phishing page

Against phishing: state of the art

- At the email level
 - Blocking suspected emails (similarly to antispam techniques)
 - Sender authentication (*not widely used*)
- Black lists (*uneffective vs. zero day attack*)
- Browser-integrated solutions
 - Domain-specific passwords
 - Detect suspected URLs
 - AntiPhish, prevents sending credentials to untrusted unknown websites...

Antiphish

1. Store user's credentials and link to corresponding sites:
 - <username1, passwd1, url1>
 - <username2, passwd2, url2>
 - . . .
2. Whenever credentials are to be sent to a website, check if it is trusted
 - Problem: what if the user uses the **same credentials** on many websites? False positives
 - Solution: check if the website is **suspiciously similar** to the trusted one

Contribution of this work

- A novel visual comparison technique for phishing detection
- **Compare** the suspected web page with the corresponding genuine one: if they are too similar, raise an alert
 - Thought to be part of AntiPhish
 - ... but can also be integrated in other solutions: e.g., in a mail server to block suspected emails

Visual comparison: overview

- Why "visual"?
- Users get convinced to be on a legitimate page mainly by perceived page content
- We compare page features that **affect user perception**:
 - Text blocks
 - Images
 - Overall image (the page **as rendered by the browser**)
- We obtain a visual similarity index

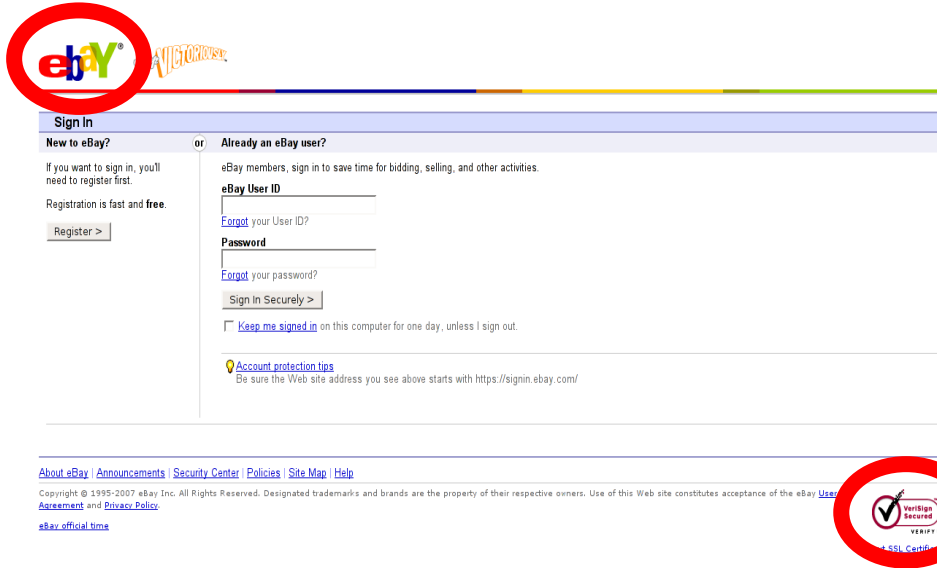
What we consider

- Text blocks:
 - textual content, foreground color, background color, font size, font family name, position
- Images:
 - `src` attribute, area ($w \times h$), color histograms, 2D Haar transform, position
- Overall image:
 - color histograms, 2D Haar transform

Comparison

1. We compute distances between elements of each text block pairs, image pairs and the overall image pair:
 - a similarity index for each pair

Comparison



Sign In

New to eBay? or **Already an eBay user?**

If you want to sign in, you'll need to register first.

Registration is fast and free.

[Register >](#)

eBay members, sign in to save time for bidding, selling, and other activities.

eBay User ID

[Forgot](#) your User ID?

Password

[Forgot](#) your password?

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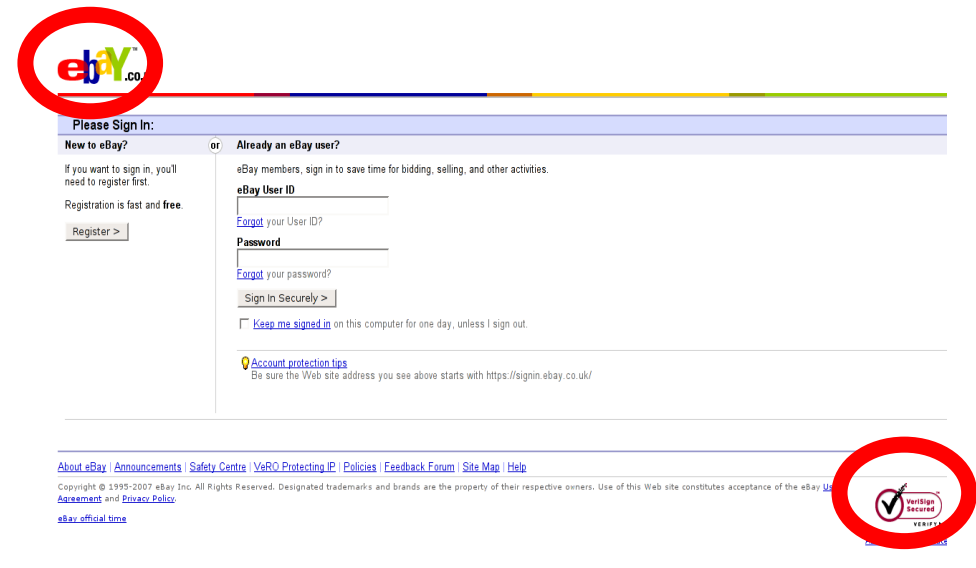

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1. ebay logo vs ebay logo
2. ebay logo vs verisign logo
3. verisign logo vs ebay logo
4. verisign logo vs verisign logo
5. ...

Comparison

1. We compute distances between elements of each text block pairs, image pairs and the overall image pair:
 - a similarity index for each pair
2. We consider only the first 10 **best-matching** text block pairs, the 5 best-matching image pairs, the 2 overall images:
 - three similarity indexes for text, images, overall image
3. We obtain the final similarity index averaging indexes of text blocks, images and overall image
 - Some weights (coefficients) are set by domain knowledge, the others by optimization on a small training set
 - Some algorithm optimization in order to reduce computational effort

Experimental evaluation: dataset

Dataset

- **41 positive pairs** <genuine page, phishing page>, partitioned according to visual similarity
 - 20 level 0: almost perfect visual match
 - 14 level 1: small differences
 - 7 level 2: noticeable differences
- **161 negative pairs** <genuine page, different page>
 - 115 with a login form
 - 46 without a login form

Positive pairs: example

Sign in

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Register >

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eBay User ID

Login your User ID?

Password

Login your password?

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Account protection tips

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VeriSign Secure

About SSL Certificate

The genuine page

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VeriSign Secure

About SSL Certificate

Place Your Credit Card on File

Use this form to place your credit card on file for automatic monthly payment of your eBay seller fees. These are the fees eBay charges sellers for listing and selling items. The information is protected using the industry standard [SSL](#).

Contact name

Credit or debit card number

Visa, MasterCard, American Express, or Discover

Card Identification number

This is the 3-dgt number on the back of your credit or debit card. For American Express cards, use the 4-digit number on the front of the card. [Learn more](#).

Expiration date

Card PIN Number

4-Digit code used in ATM's

Cardholder name

Billing address (must match monthly statement address)

E-mail address

City

State

Zip code

County

Pin

Mother's Maiden Name

Social Security Number

Date of Birth

Continue >

Please click the Continue button only once.

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VeriSign Secure

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Testing methodology

- Portion of the dataset used for training
 - 14 on 41 positive pairs
 - 21 on 161 negative pairs
- FPR and FNR computed on the remaining part

Results

- Satisfying results:

| Levels | t | f_p | n_n | FPR | f_n | n_p | FNR |
|------------------|-------|-------|-------|-----|-------|-------|------|
| All (0, 1 and 2) | 0.956 | 0 | 140 | 0% | 2 | 27 | 7.4% |
| Only 0 and 1 | 0.956 | 0 | 140 | 0% | 0 | 20 | 0.0% |
| Only 0 | 0.956 | 0 | 140 | 0% | 0 | 11 | 0.0% |

- **No false positives**
- Only 2 false negatives (level 2, rather difficult to detect)

False negative: a sample

Bad Login :: Empty Fields...



Member Number:
Enter your member number in the field above.

Password:
(First-Time Users, use the last four digits of your Social Security Number as your password.)
Enter the Security Code Shown Below:



Submit

Attention First-Time Users of 1st United's New Internet Banking Site:

1. To enter the new site, enter your member number in the Member Number field.
2. Enter the last four digits of the Primary Member's Social Security Number in the Password field.
3. Enter the Security Code with shown in the Security Code field.
4. Click submit and follow the instructions to continue.

Unauthorized use of these systems is strictly prohibited and is a subject to prosecution under the Computer Fraud and Abuse Act of 1986 and Title 18, U.S. Code, Sec. 1030 and 1030A. First Systems Corporation may monitor and audit usage of this system. All passwords are hereby notified to the use of this system is subject to change without notice.



Welcome to 1st United Services Credit Union Login
Please renewed your account immediately. Complete the form below and click "Submit" to finish. * Denotes required field.

Card Number:

Expiration Date:

Electronic Signature: (max 50)

Email Address:

Submit

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Thanks

Questions?
