Science of Security Lablet, University of Maryland

Measuring Visual Perceptions of Security

Adam J. Aviv

# *Task 8*
User-Centric Design

The development of new usable-security measurement techniques and metrics to inform the design and development of new cybersecurity applications

Empirical Measurements of Human Behavior

Dear Dr. Jennifer Ann Golbeck,
Your current University Directory password will expire in 35 days (on December 02, 2013 at 4:08 PM EST). Please update your password as soon as possible by visiting the University Directory Password Web site:

password.umd.edu
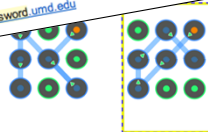
Developing User-Based Security and Usability Metrics

Prediction Using Single Feature
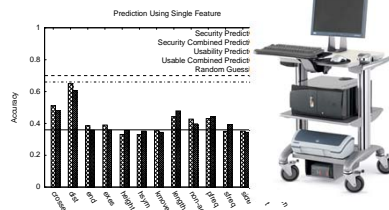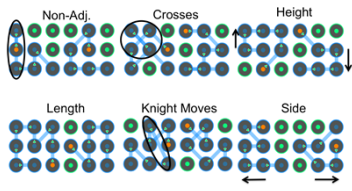
Hard Problem Connections

- (#3) Security-Metric-Driven Evaluation, Design, Development and Deployment

- (#5) Understanding and Accounting for Human Behavior

7/2/2014   Adam J. Aviv   3

Current Projects

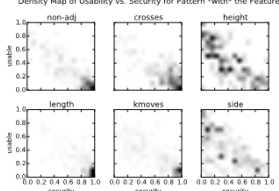*Measuring Visual Perceptions of Security and Usability*

Measuring the Impact of Security Policies on User Behavior

7/2/2014   Adam J. Aviv   4

Adam J. Aviv

MEASURING VISUAL PERCEPTIONS OF SECURITY

7/2/2014   Adam J. Aviv   5

We have a "pretty good" understanding of the text-based passwords people select

7/2/2014   Adam J. Aviv   6

arstechnica

MAIN MENU ⌄   MY STORIES: 25 ⌄   JOBS   FORUMS   SUBSCRIBE NOW

RISK ASSESSMENT / SECURITY & HACKTIVISM

8 million leaked passwords connected to LinkedIn, dating website (updated)

An unknown hacker posted the lists online and asked for help in cracking them.

by Dan Goodin - June 6 2012, 1:05pm EDT

BLACK HAT   THE WEB   132

```
0d2d32ea81418189eca21d1ff27fc65adb88fcd6:sm
873a5f2d901d579680fc5a5bd040ab241ac5d4a0:sa
0dde6e765f94b007f2ebed3b8fe3fcc84c7744bc:tu
e1abf2ee6113dae0b0d2ec8e8c6331b2a2308c18:st
33f059739de4286fcdd65482dc840069b62f94f9:th
dd0ea828e93ab88988691037e442c9e0d1baa6d1:sa
82ccd756877b247c989380d758c4a02bd7cccd2f:kr
2688b21ce3822ed3c923d8eb5e3454f7e4b7b2b5:al
d9ba61eef61ed406551cd9b37dee351d2d31866f:al
7f4d8f4a4128faf2f0b35b3f39a9e940310463c6:ro
1bd32f0d7301f3494050f2452faefde13b319e04:Na
e644c8ea288aead799f04e01bd01b739437052b9:es
6b6dc44810694d4cd41283b5c300a47656688462:nf
```

7/2/2014   Adam J. Aviv   7

Visual Systems:
Graphical Passwords

7/2/2014   Adam J. Aviv   8

Graphical passwords are not used for remote authentication:
No large leaks!

Recent Surveys of Graphical Passwords

- Bristol Study [ATOY: WiSec'13]
  - Asked users to provide one "easy" and one "secure" password pattern.

(a) Start points   (b) End points   (c) Monograms

- Picture Gesture [ZASH: Sec'13]
  - Locked the course website using the picture password

- Quantifying Pattern [UDWH: CCS'13]
  - Pen and Paper
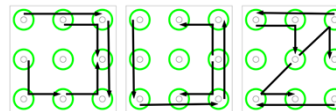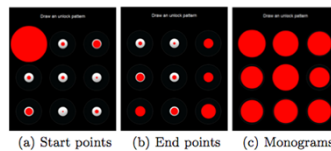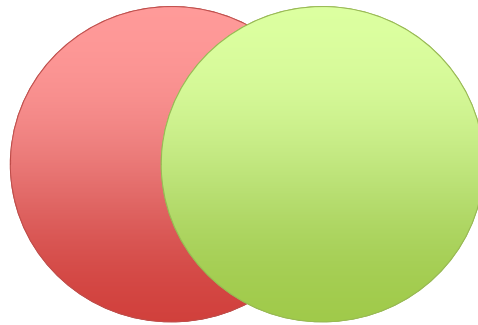 - Adversarial Reward Experiment

Figure 8: The most frequent 3-grams, from most frequent (left) to less frequent (right).

Insight from Different Question?

What visual properties of passwords do people **_perceive_** as secure?

Perceived "Secure" Passwords   Known Metric of Security

7/2/2014   Adam J. Aviv   11

Research Questions

- Can we *measure the visual perception* of security and usability?

- Which *visual features most affect perceptions* of security and usability?

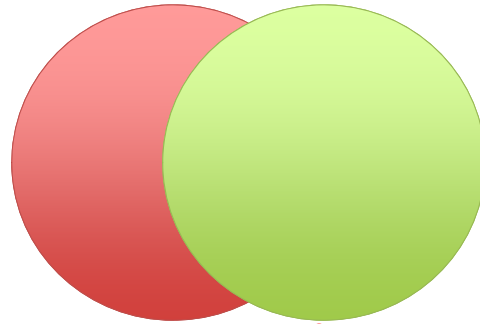- Can we *apply and predict perceptions* to better understand user choice?

7/2/2014   Adam J. Aviv   12

Larger Research Goal

Design new security systems
where perceptions of security
match

a known metric of security
to improve security inherently.

7/2/2014   Adam J. Aviv   13

Outline

Motivation

Survey Methodology

Survey Results

Predicting Perceptions

{-1 , 0, 1}

7/2/2014   Adam J. Aviv   14

SURVEY METHODOLOGIES

A   **B**

Which password is more secure?

Pairwise Preference Survey
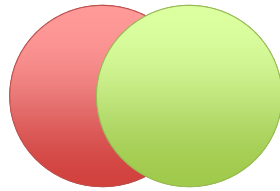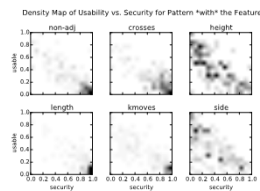
Password Comparison: Security

In this section, each question will present you with two Android passwords. Your job is to determine which of the passwords is the most **secure**.

1 of 50

Users were asked to select between two patterns based on security or usability

Could also select "same" if the patterns had equal security or usability

Next   Cancel

By **carefully selecting the pairs**, we can isolate the set of features in patterns that **inform perceived security or usability**

7/2/2014 · Adam J. Aviv · 17

Features Surveyed

Non-Adjacent · Crosses · Height

Length · Knight Moves · Side

7/2/2014 · Adam J. Aviv · 18

Individual Password Ratings

Password Classification
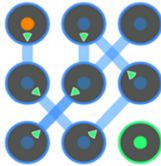
In this section, each question will present you with an Android password which you must classify.

Does the above password appear to be symmetrical?

1 of 25

○ Yes
○ No

Individual rating survey placed *between* two pairwise preference surveys to break up the workflow

Describe any symbols or geometric shapes which appear in the password.

(Leave blank if there are none).

Requested ratings on symmetry, security, usability, and information about any observed shapes.

Rate the security of this password.   Describe the usability of this password.

○ This password is highly insecure.   ○ This password is highly unusable.
○ This password is insecure.   ○ This password is unusable.
○ This password is secure.   ○ This password is usable.
○ This password is highly secure.   ○ This password is highly usable.

[Next]

19

Password Preference Survey Statistics

- Amazon Mechanical Turk (two hits)
  - (1) $2.50 HIT
  - (2) $1.50 HIT with $1.00 Bonus

- 1108 Unique Pairs of Patterns
  - 2136 total passwords analyzed
  - Avg: 11.03 ratings per pair

- 384 Total Participants
  - 354 owned/used Android devices
  - 72% (257) use the Password Pattern
  - 96% (249) of Password Pattern users say their pattern is "sufficient" to secure the device

7/2/2014   Adam J. Aviv   20

SURVEY RESULTS

7/2/2014   Adam J. Aviv   21

Result Terminology

- Each pattern pair (p1, p2) has the following statistics:
  - *sec(p)* : fraction of participants preferring the pattern p as more secure in the pair

  - *use(p)*: fraction of participations preferring the pattern p as more usable in the pair

  - *samesec(p1,p2)*: fraction of participants preferring neither patterns p1 and p2 as more secure

  - *sameuse(p1,p2)*: fraction of participants preferring neither patterns p1 and p2 as more usable

  - *with:* Refers to the pattern with the feature
  - *without*: Refers to the pattern without the feature

7/2/2014   Adam J. Aviv   22

Measurement Based Results
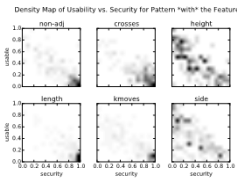
Feature Preferences **Feature to Feature Comparisons** **Reviewing Prior Study**
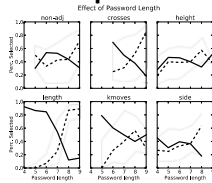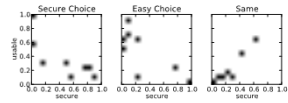
Ranking Feature Preferences **Individual Ratings**
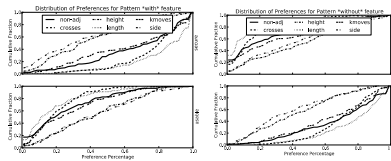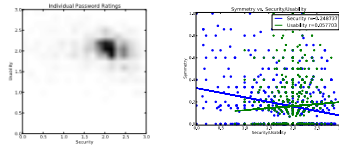
7/2/2014 Adam J. Aviv 23

Features Affecting Perceptions
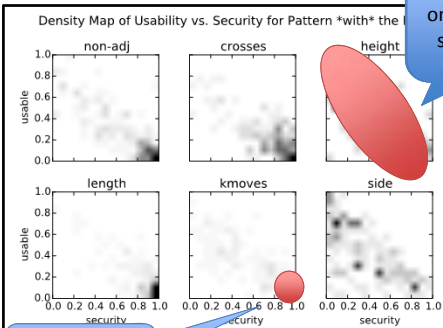
WITH Feature WITHOUT Feature
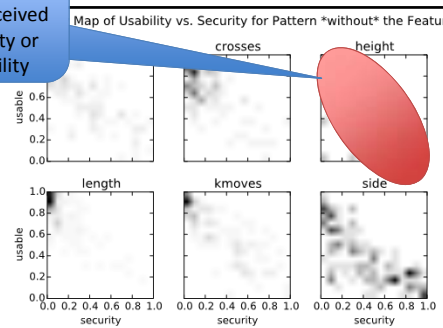
Height has little affect on perceived security or usability

kmoves percieved to add security

Percent selected *usable* or *secure* for patterns that
exude the feature (left) versus patterns that do not (right)

7/2/2014 Adam J. Aviv 24

Comparing Features: Affects of Length

Effect of Password Length

Security Preference

Usability Preference

7/2/2014   Adam J. Aviv   25
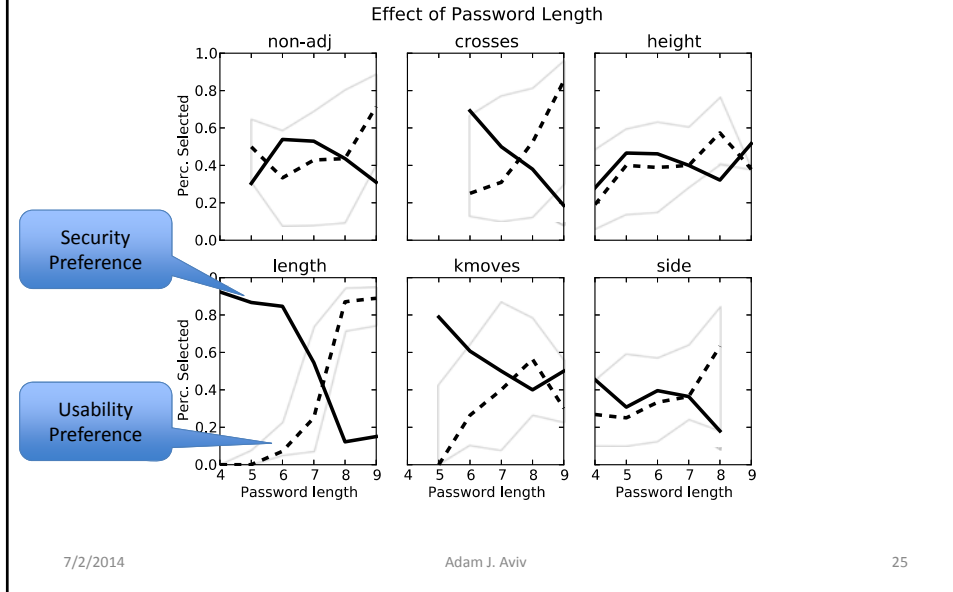
Comparing Complexity Features

Density Map of Secure and Easy Patterns Comparing Features

kmoves are perceived more usable in comparison to non-adj and crosses
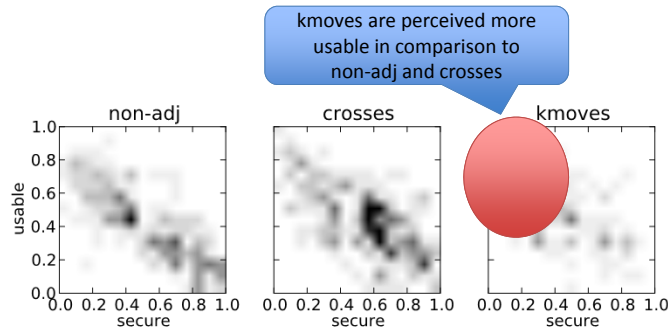
Pattern Feature Comparisons
non-adj to crosses to kmoves,

7/2/2014   Adam J. Aviv   26

Comparing to Bristol Study

Density Map of Secure and Easy Patterns from Bristol Data Set

Easy Choice perceived slightly more usable

Secure Choice perceived slight more secure

Secure Choice · Easy Choice · Same

usable · secure · secure · secure

8 easy/secure choices from Bristol dataset

7/2/2014 · Adam J. Aviv · 27

Motivation · Survey Methodology

Survey Results · Predicting Perceptions

0
0.7
0.3
4
0
1

0
0
0.3
4
0
0

{-1 , 0, 1}

PREDICTING PERCEPTIONS

7/2/2014 · Adam J. Aviv · 28

Applying Preference Data

Can we use what we've learned to *predict* perceptions
of security and usability?

?

Non-Adj	0
Height	0.7
Side	0.3
Length	4
K-Moves	0
Crosses	1

	0	Non-Adj
	0	Height
	0.3	Side
	4	Length
	0	K-Moves
	0	Crosses

ML
Model

{-1 , 0, 1}

7/2/2014   Adam J. Aviv   29

---

¹[ATOY: WiSec'13]   ²[UDWH: CCS'13]   ³[ASM: FC'13]   ⁴[vOT: TISS'08]

Additional Features

Exes   Start Point[1,2]   End Point[1,2]   Stoke Distribution[3]

Stroke
Distance[3]

Vertical
Symmetry[3,4]

Horizontal
Symmetry[3,4]

Point Distribution[3]

7/2/2014   Adam J. Aviv   30

15

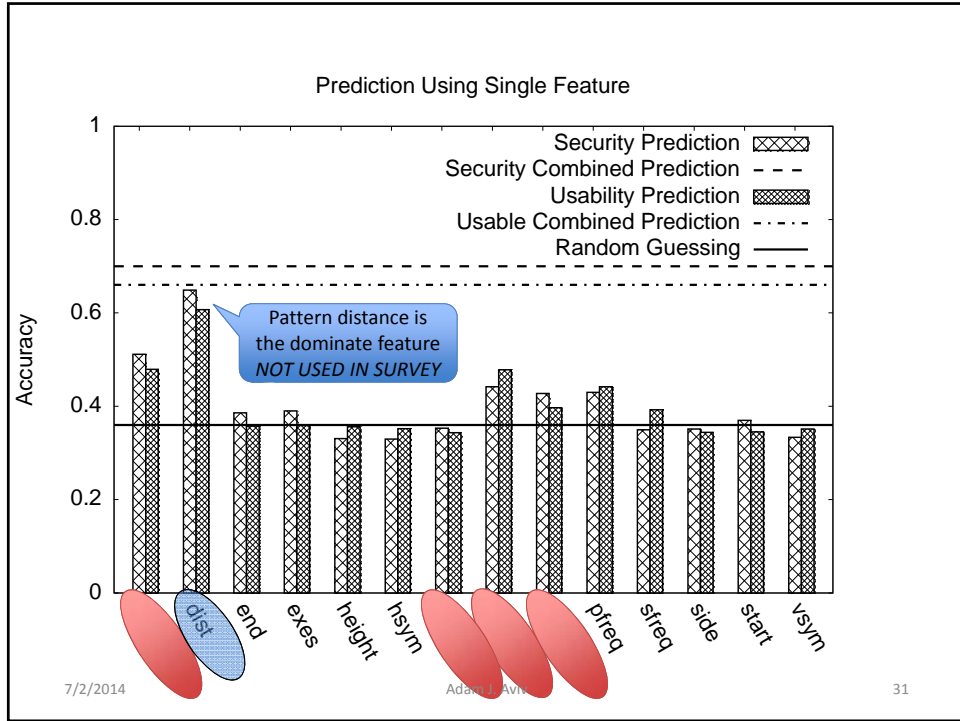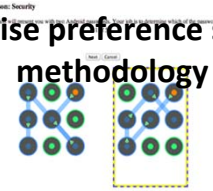**CONCLUSIONS AND FUTURE DIRECTIONS**

Summary Results

Designing systems where a perceptions of security matches some known metric of security
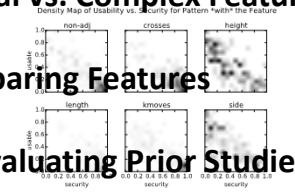
Pairwise preference survey methodology

Spatial vs. Complex Features
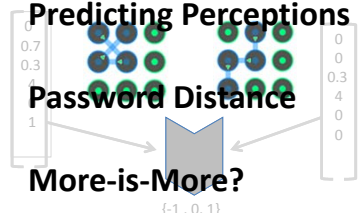
Comparing Features

Re-Evaluating Prior Studies

Predicting Perceptions

Password Distance

More-is-More?

{-1 , 0, 1}

7/2/2014   Adam J. Aviv   33

Future Directions

- *Perception Informed Password Meters and Metrics*
    - Use perception information to develop better password meters for graphical passwords
    - Guessability metrics for graphical passwords that leverage perception data and other surveys

- *Development of New Visual Password Systems*
    - Are there visual password system where perceptions better match user choice

- *Mechanical Turk on-device Surveys of Visual Passwords*
    - Against terms-of-service to distribute programs through Mechanical Turk
    - Develop in-browser methods to **revaluate** prior studies.

7/2/2014   Adam J. Aviv   34

Science of Security Lablet, University of Maryland

Thanks!
Questions?

Adam J. Aviv

ADDITIONAL RESULTS

Ranking Features

Cumulative Fraction Graphs:
The percept of patterns receiving a preference at that value above

Distribution of Preferences for Pattern *with* feature
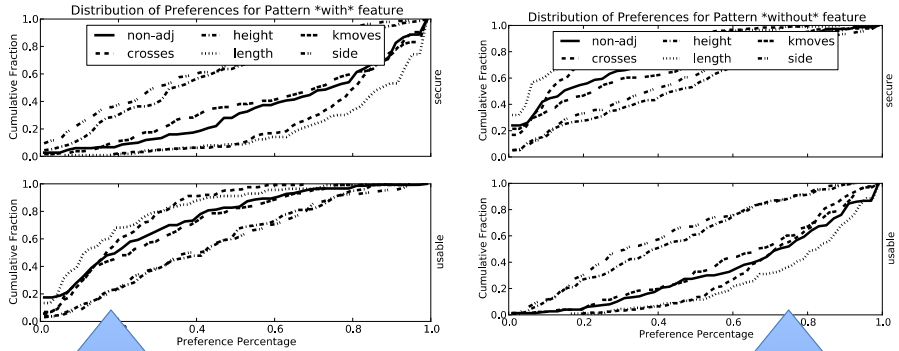
Distribution of Preferences for Pattern *without* feature

Patterns with the feature:
Area between usability and security curves measure how much added value of the feature

Patterns without the feature:
Area between usability and security curves measure how much reduction in value of not have the feature

Adam J. Aviv

Added and Removed Value

Feature	With-Pref		Feature	Without-Pref
length	24.36		height	3.22
kmoves	22.12		side	-2.16
crosses	21.75		length	-17.28
non-adj	20.56		non-adj	-22.07
height	-2.27		crosses	-22.60
side	-5.55		kmoves	-23.80

7/2/2014   Adam J. Aviv   38

Individual Ratings

Highly Usable

Average rating of at least 2 in both categories, at least security and usability

Individual Password Ratings

Highly **un**usable and Highly **in**secure

Highly Secure

7/2/2014   Adam J. Aviv   39

Symmetry Effects

Symmetry vs. Security/Usability

As patterns appear more symmetric, negatively correlated with security.

Security r=-0.248737
Usability r=0.057703

Small positive correlation between symmetry and usability

7/2/2014   Adam J. Aviv   40

20