Challenges Arising from Prerequisite Testing in Cybersecurity Games

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Contents

Overview

What? Determining participant skills before a cybersecurity game

Why? Unexplored problem of providing game balance

Main contributions:

- Applying **prerequisite tests** in cybersecurity games
- Their experimental **evaluation**
- Identifying **challenges** of this approach

Cybersecurity games, Capture the Flag (CTF)

- Software applications for exercising cybersecurity skills
- Benefits: practicing, learning, competing
- Problem: often **only for experts**

Source: http://secureacom.com.au/computer-networking-sydney/
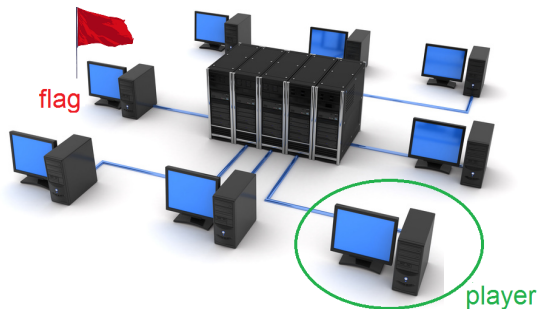
How and why determine player's skills?

a) **Self-assessment**
- Can be inaccurate

b) **Prerequisite testing**
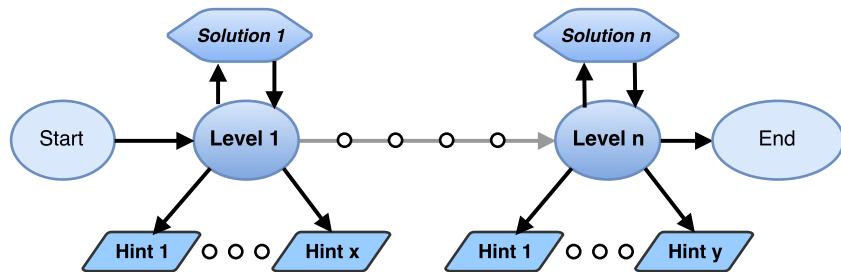- Various applications in classroom

- Research in cybersecurity education is in its early phase
- **No examined games use prerequisite testing**

The KYPO – Cyber Exercise & Research Platform

- Sophisticated virtual environment for security training, cyber defense research, forensic analysis, and network simulation
- Visit www.kypo.cz

Our CTF games in KYPO

- Player data:
  - Events: hints taken, solutions displayed, incorrect flags
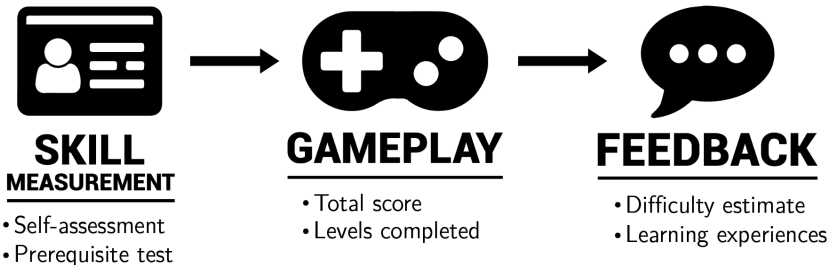 - Metrics: score, levels finished

Research questions

1. Can a **prerequisite test** accurately model learners' performance in cybersecurity games?
2. Is **self-assessment** a reliable indicator of ability in the context of cybersecurity?

Experiment design: overview

- 67 participants of various background (high-school students, university students, and professionals)

SKILL
MEASUREMENT
- Self-assessment
- Prerequisite test

GAMEPLAY
- Total score
- Levels completed

FEEDBACK
- Difficulty estimate
- Learning experiences

Experiment design: details

67 participants				
Session 1	Session 2	Session 3	Session 4	Session 5
9 ♂, 1 ♀	4 ♂, 3 ♀	15 ♂, 3 ♀	12 ♂, 0 ♀	19 ♂, 1 ♀

Pretest 1		Pretest 2
5 items	+ 2 items	4 items

Self-assessment
3 items

Game 1	Game 2
6 levels	4 levels

Post-game feedback

Selected statistically significant linear model
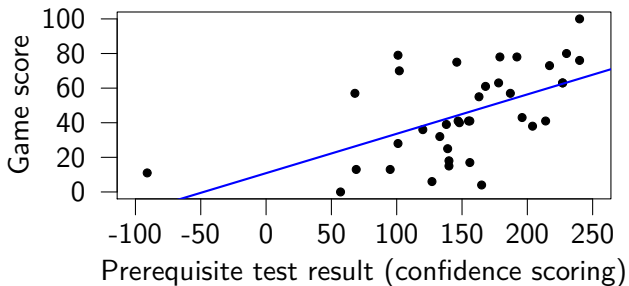
Model	R^2	F-statistic	p-value
$T = 10.87 + 0.23 \cdot P_c$	0.31	15.66	< 0.001

Answering the research questions

1. Can a **prerequisite test** accurately model learners' performance in cybersecurity games?
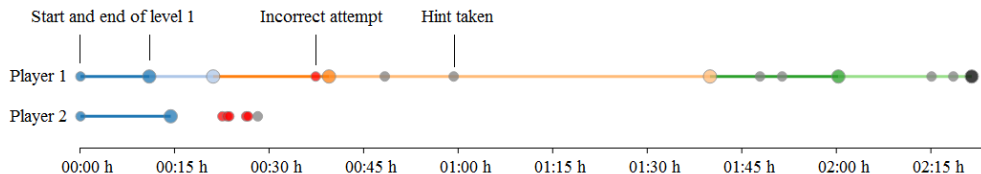
   Models predicted game performance based on pretest.

2. Is **self-assessment** a reliable indicator of ability in the context of cybersecurity?

   Self-assessment was inaccurate (as in previous studies).

- Visualizing game events uncovered anomalies

Challenges

1. Calibrating test questions
2. Min. length, max. information
3. Embedding the pretest in the game

Summary

- *Prerequisite testing can predict players' performance in serious games*
- Practical consequences:
  - **Pioneering attempt** in an unexplored area
  - **Application**: the first prerequisite tests for KYPO games
  - Motivated the development of the **visualizer tool**[1]
  - Implications on research by identifying the **challenges**
  - Benefit for **cybersecurity educators**

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[1]https://github.com/JuroUhlar/kypo-angular

The end

We are looking for collaborators – organizers of similar games – for future work!

- Does prerequisite testing work in other games?

To learn more and get in touch, you can:

- Read the paper ☺
- Tweet @csirtmu
- E-mail svabensky@ics.muni.cz
- Stay for a chat ☺

Thank you! Questions and feedback are welcome.