Modeling and optimizing evolving security situations

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Outline

Security Situation Management

- The aim is to provide the best possible security of a system with given amount of resources, taking existing situation into account.
- At the same time at least the standard requirements should be satisfied, if possible.
- Solutions are usually needed yesterday. Therefore detailed risk analysis is not a good option.
- The goal is achieved by coarse-grained analysis of security situation and optimisation of resource usage.

Situation Description: Security Goals

Security class is determined by security levels, associated with security goals:

- confidentiality (C),
- integrity (I),
- availability (A),
- non-repudiation (N).

e.g. `C2 I1 A1 N2`

The model can be *extended* by adding security goals.

Situation Description: Parameters of the Model

- Available resources — r
- Integral measure of security — S
- Security measures groups — $g_1, g_2, \ldots, g_n$
- Security levels of measures groups — $l_1, l_2, \ldots, l_n$
- Security confidences granted by measures groups — $q_1, q_2, \ldots, q_n$
- Relative importance of measures groups: weights — $a_1, a_2, \ldots, a_n$, where $\sum_{i=1}^{n} a_i = 1$

Abstract Security Profile

An *abstract security profile p* is an assignment of security levels to each group of security measures:

$$p = (l_1, l_2, \ldots, l_n)$$

Cost Function

The cost function h gives the costs $h(l, g)$ required for implementing security measures of a group g for a level l.

The costs of implementing a given abstract security profile:

$$costs(p) = \sum_{i=1}^{n} h(l_i, g_i)$$

Goal 1: Keep the value of $costs(p)$ as low as possible.

Levels Requirement Function

Function s produces a required security level $s(c, g)$ for a group g when the security class is c. The requirements may be prescribed by security standards such as BSI, NISPOM or ISKE.

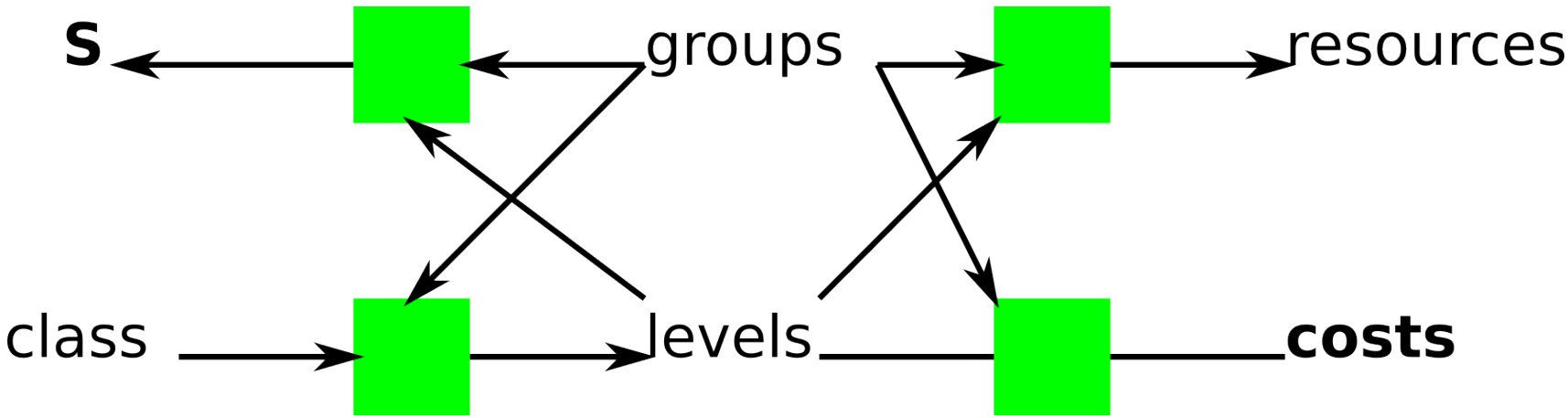
Integrated Security Metrics

The overall security of a system is described by means of an integrated security metrics (integral security confidence) S.

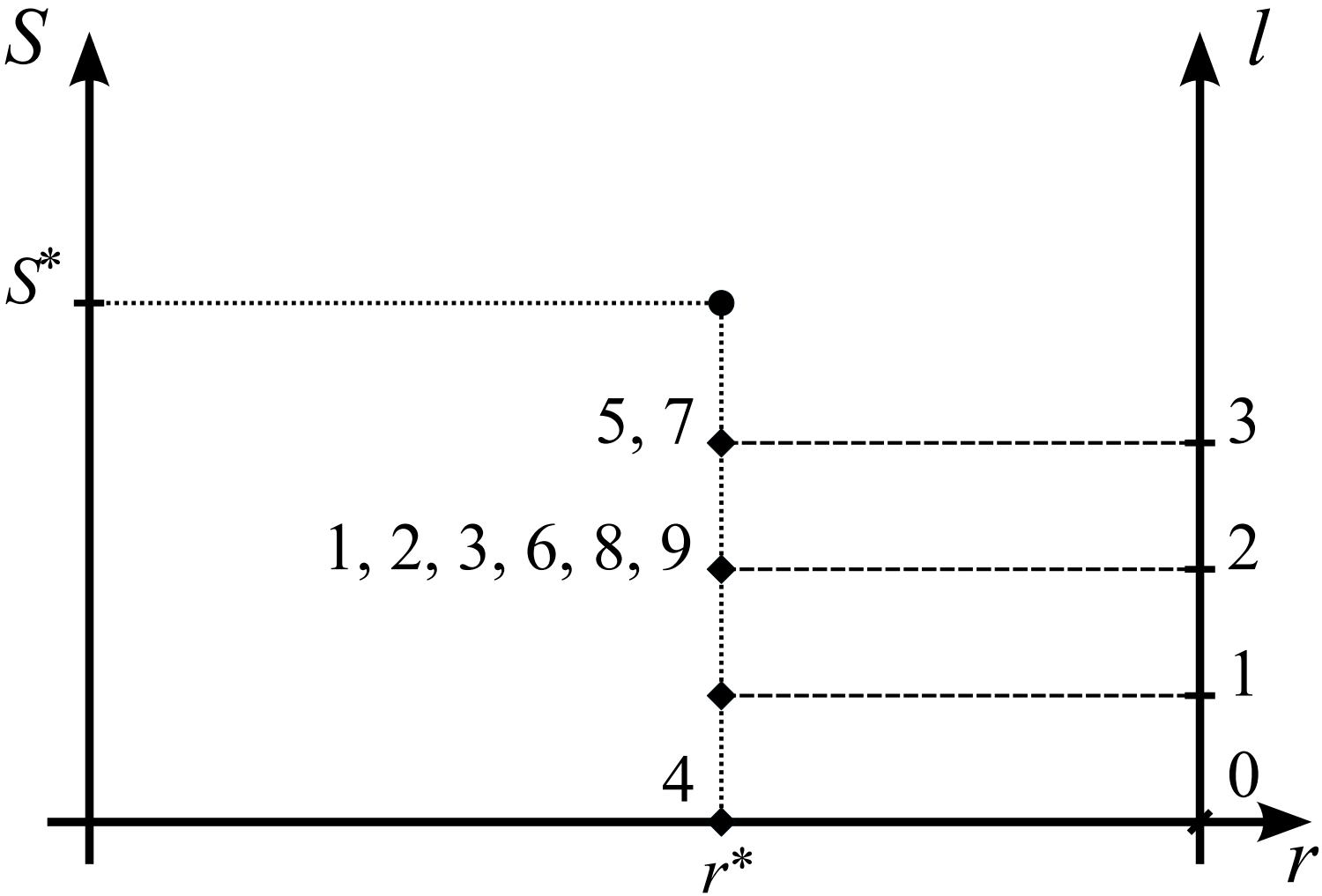
$$S = \sum_{i=1}^{n} a_i q_i$$

Goal 2: Increase security confidence of a system.

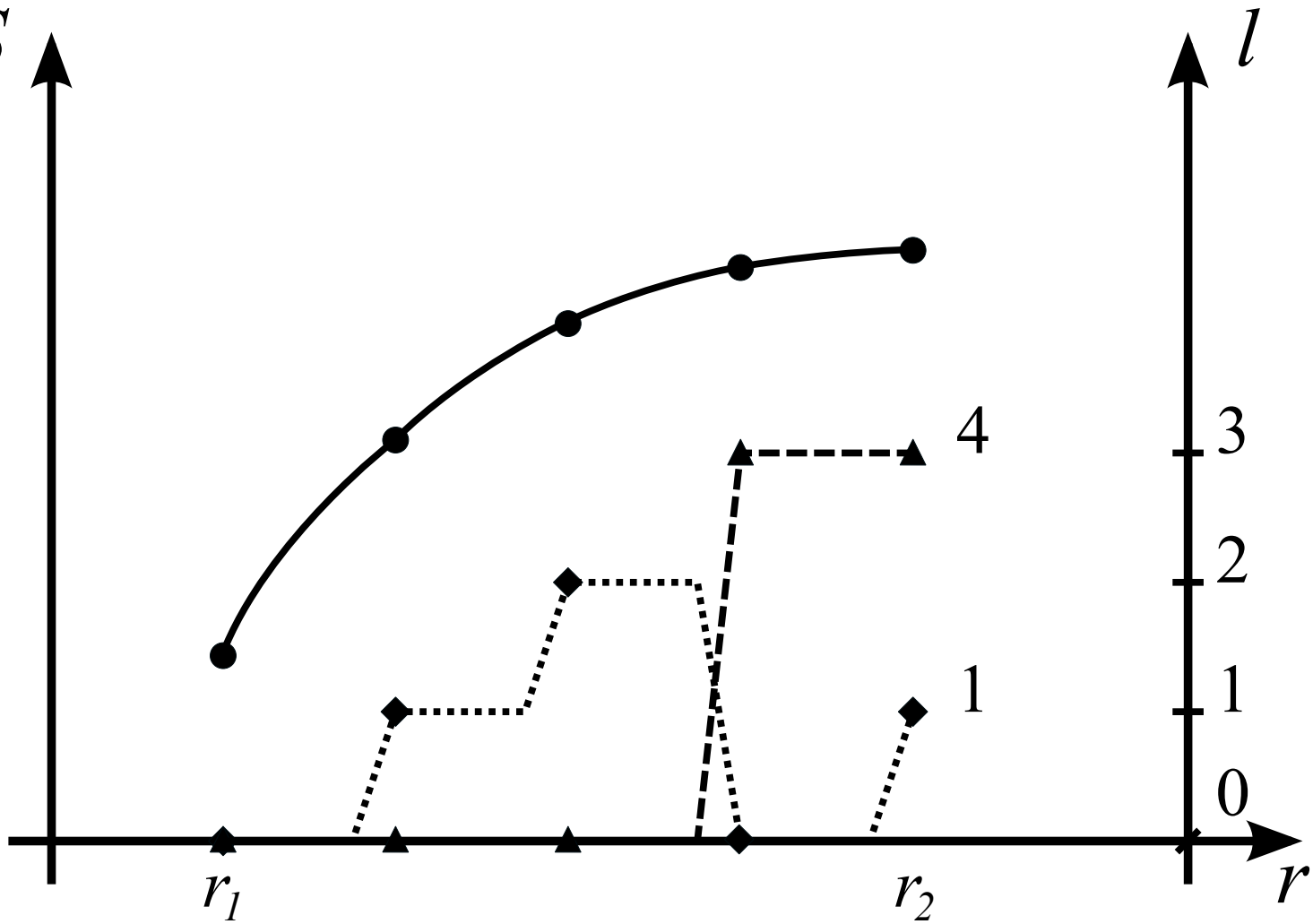
Dependencies



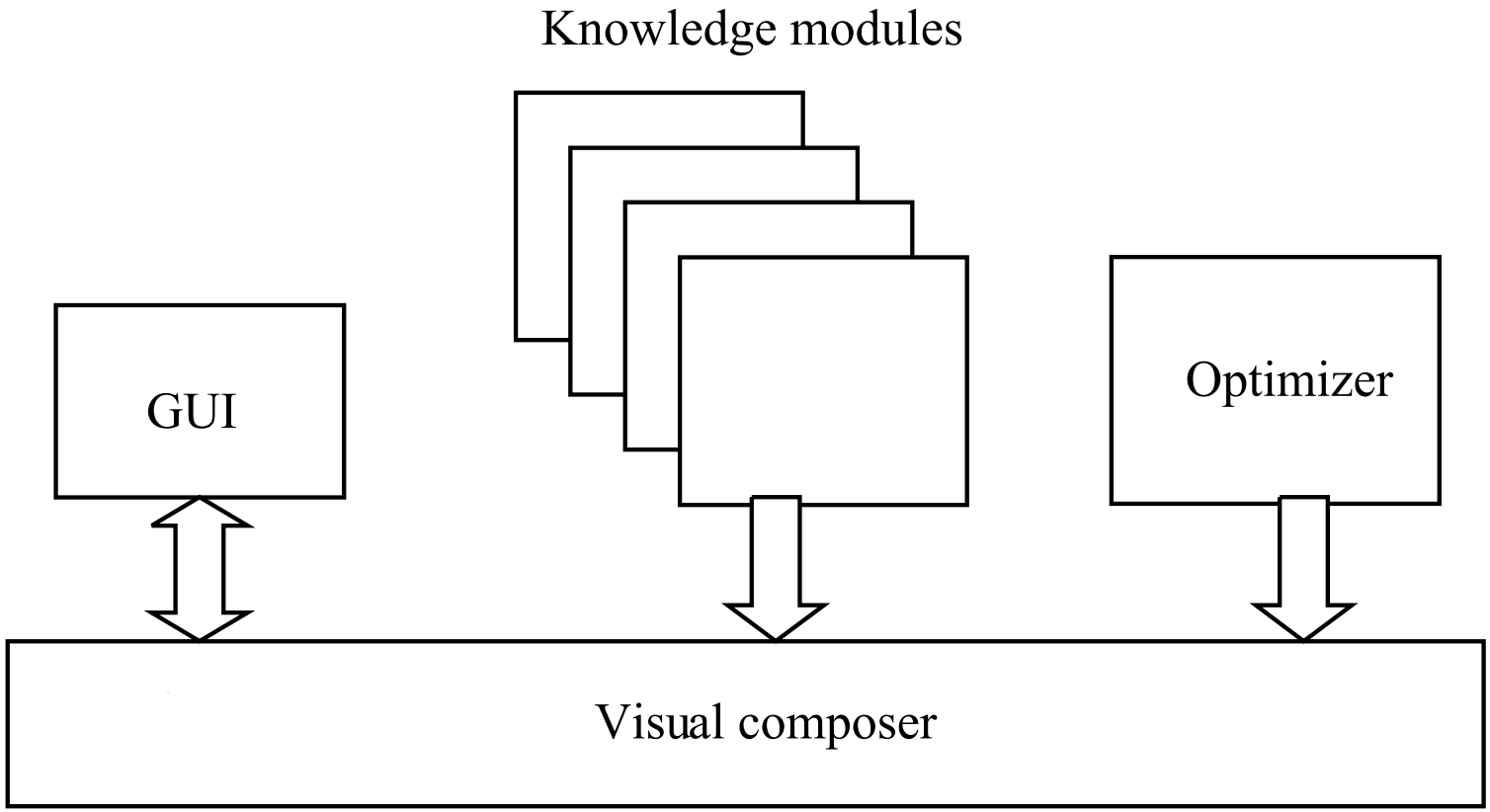
Conventional Graded Security Solution



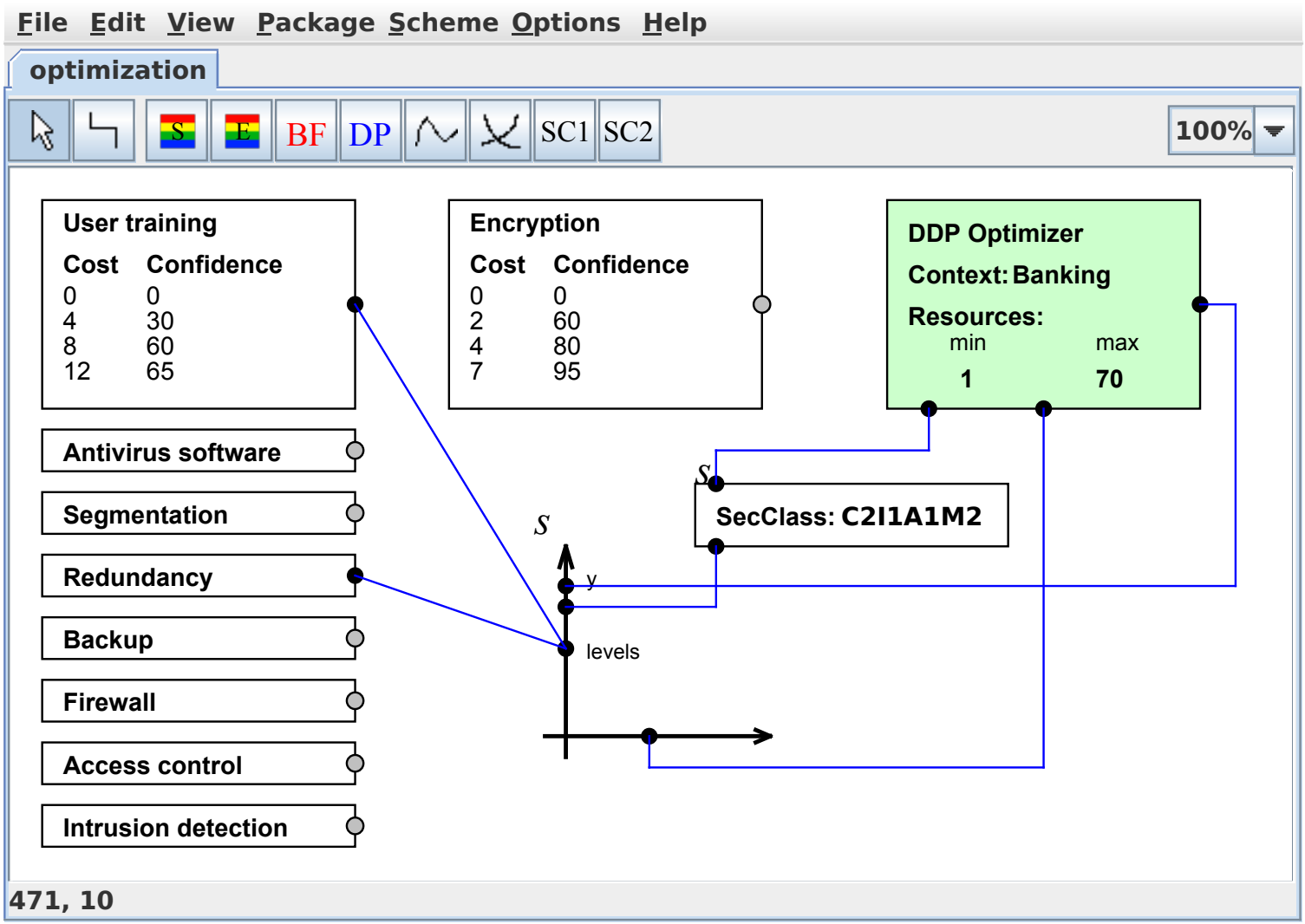
Pareto-Optimal Security Solutions



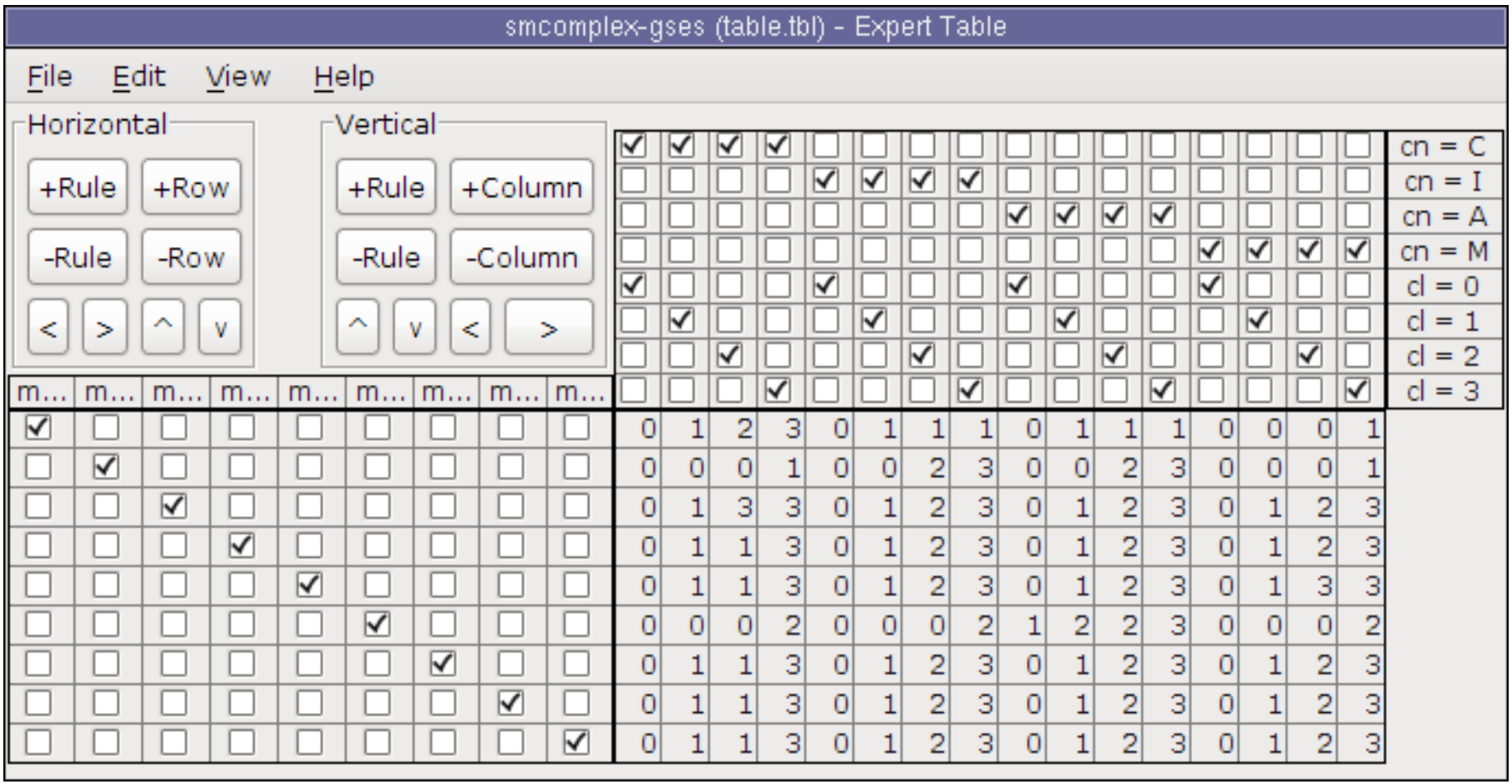
Graded Security Expert System



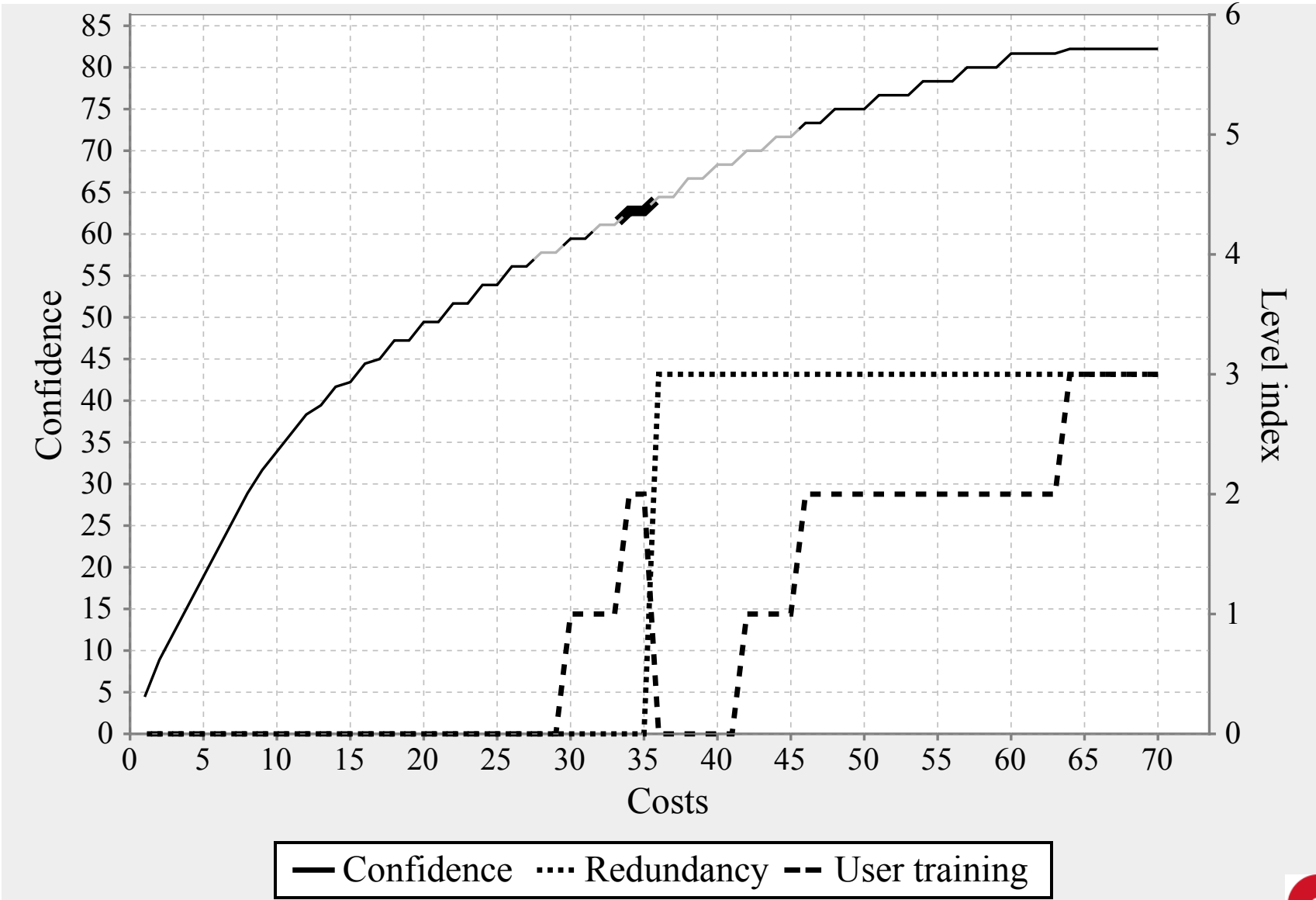
Visual Specification



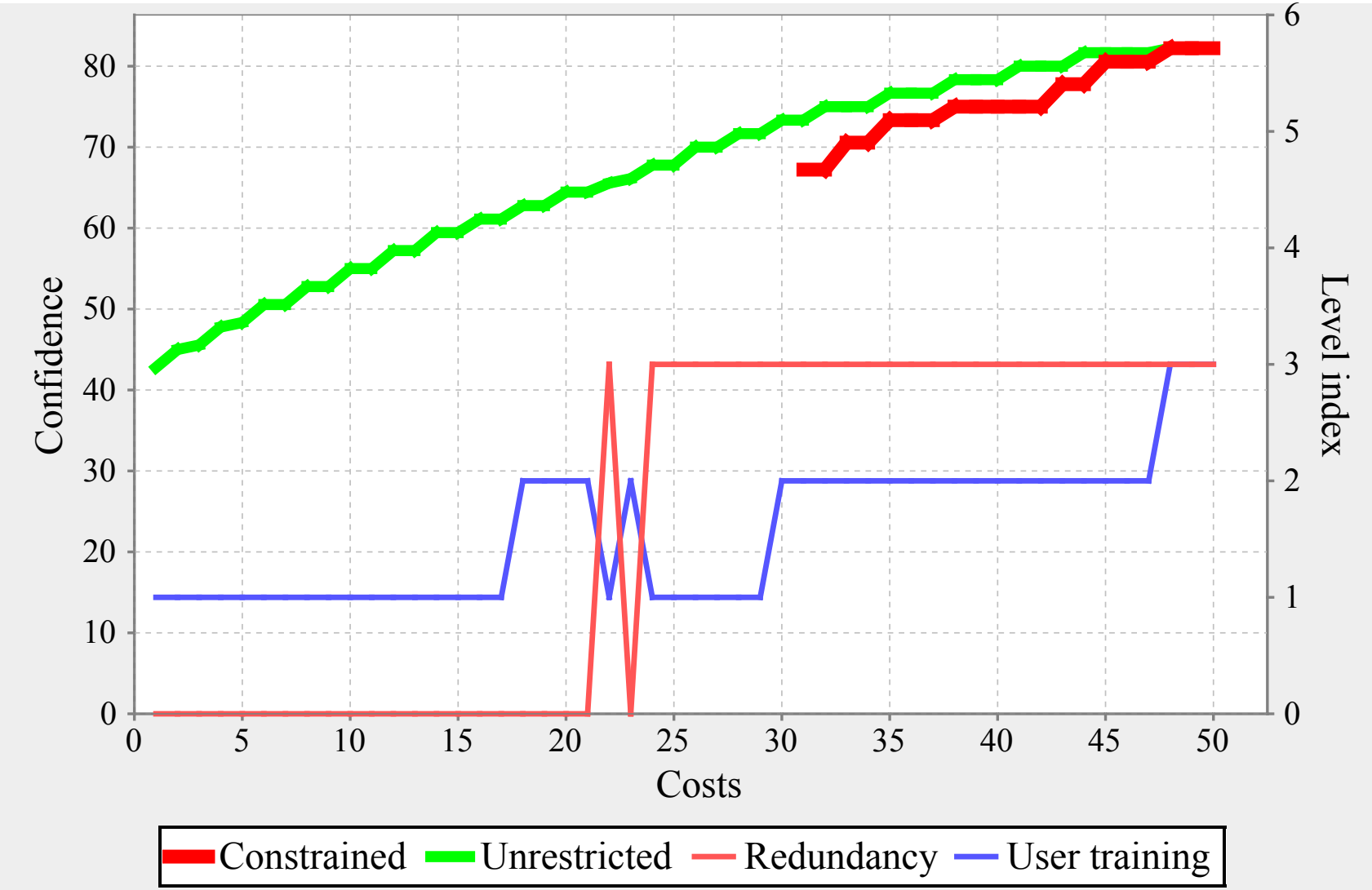
Knowledge Modules as Decision Tables



Example of Results



Example of Results with Constraints



Future Work

- Combine the optimization package with risk analysis tools (e.g. attack trees)?
- Improve the visual language and the user interface
- Collect and accumulate expert knowledge and real data
- Experiments with real data
- Implement dependant measure groups
- Analyze sensitivity of results wrt inaccurate input data

Summary

A CoCoViLa package was developed to help the IT manager/security expert answer the following questions quickly:

- How much resources are needed to achieve the required level of information security?
- What is the best way to spend the IT security budget?
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There is a pilot project to test the system in practice.

References

- CoCoViLa — Compiler Compiler for Visual Languages, `http://www.cs.ioc.ee/cocovila/`
- A. Ojamaa, E. Tyugu, J. Kivimaa. Pareto-optimal situation analysis for selection of security measures. In: MILCOM 08: Assuring Mission Success: Unclassified Proceedings, November 17-19 San Diego, 2008, 7 p.