# Improving Survivability of Situational Awareness by Multi-Objective Genetic Programming

Klaus Zaerens, prof. Jouko Vankka
National Defence University, Finland
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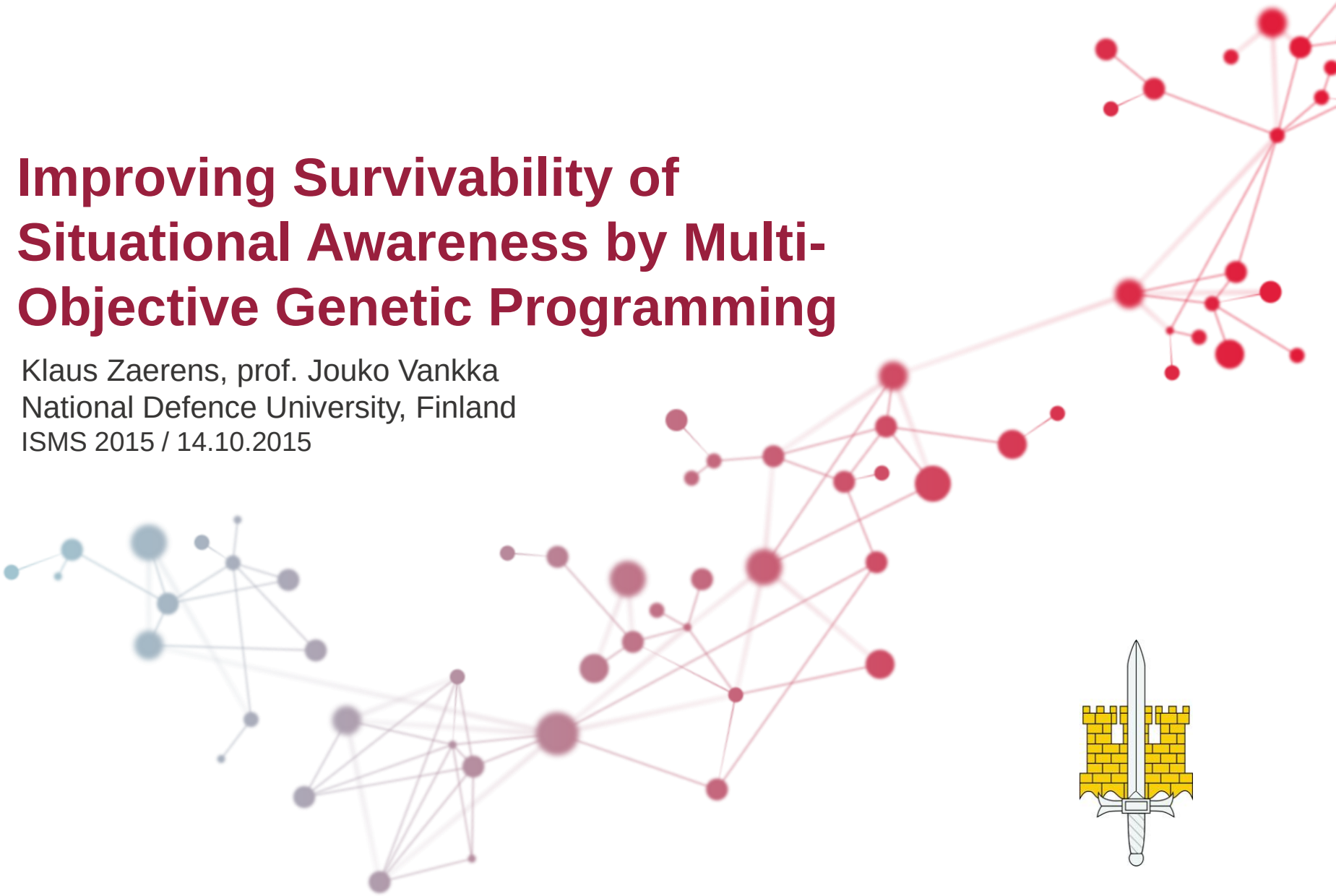


# Outline

Background

Problem setting, enhanced survivability

Situational Awareness and Common Operative Picture

Genetic programming approach for COP

Features of improved operability

Future work

Conclusions

# Background

- Utilization of cloud computing in military systems
  - Properties of high security cloud environment
  - Requirements for dynamic creation of a such environment
  - Analyzing the vulnerability and resilience after a change in system
  - Awareness of the capabilities and current security level
  - Concept of knowledge management as a service

- Survivability of the high security system
  - Fault tolerance
  - SOA and process recovery
  - Enhanced knowledge management

# Problem setting, enhanced survivability

Problem setting:

- How can we ensure the operative capability while one or several information sources are unavailable?
- What is the difference with situational awareness and common operative picture?
- What improves the survivability of situational awareness?
- How can we determine the essential information for certain operative group from massive amount of data?

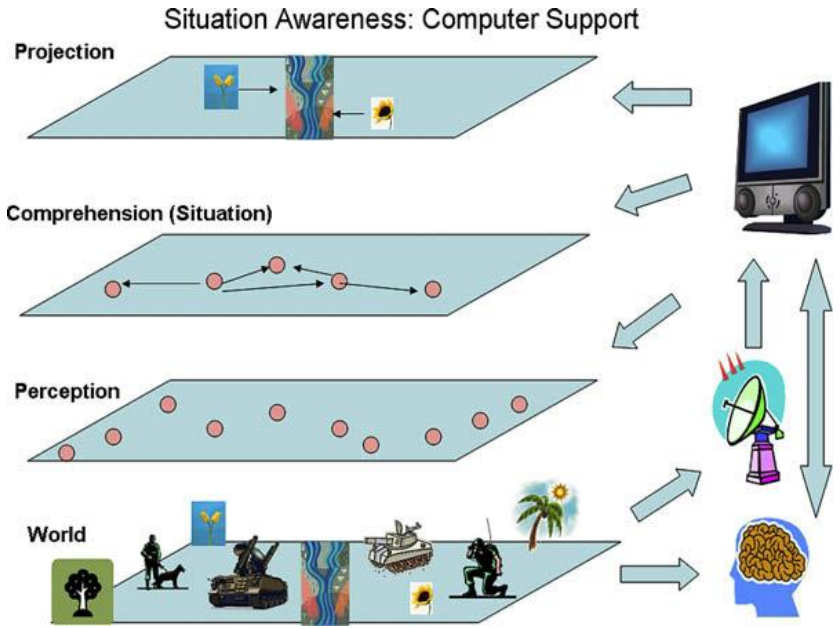
Focusing to following characteristics:

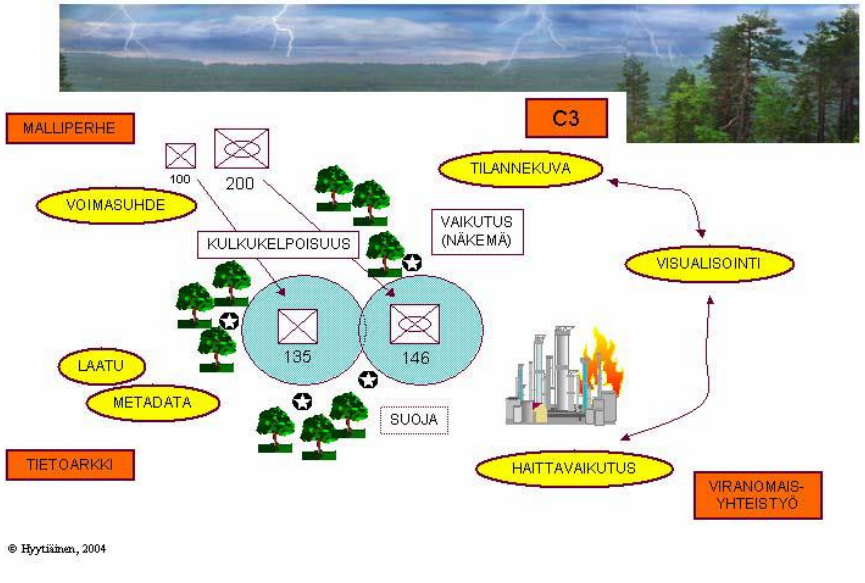
1. Situation Awareness and relation to Common Operative Picture
2. Understanding the phenomena by improving the knowledge on the data
3. Analyzing the evolvement of the situation from the single operative group point of view
4. Predicted situation adaptation to real information during recovery

Resulting:

- Enhanced survivability by semantic evolution
- Data filtering
- Improved operability in offline conditions

# Situational Awareness and Common Operative Picture




- Situation awareness
  - Projection of real life
  - Objective approach
  - Projection function bounded by human design
- Picture source: Kokar, Matheus, Baclawski 2007

- Common operative picture
  - Situational awareness appended with operational and mission information
  - Subjective approach
  - Support for decision making
  - COP bounded by mission and participants

# Genetic programming approach for (connectionless) COP

- Approach focuses on subjective COP
  - What is the sufficient information needed for successful operation?
  - What is the (most probable) situation at T+1 in relation to our mission?
  - Individual movements of observed objects are not interesting, but the phenomena they represent is.

- Genetic programming
  - Solution space includes all possible solutions (all programs that can construct prediction to the evolvement of situation).
  - Each calculation step narrows solution space to probable and more relevant solution space
  - Prediction accuracy decreases as T+n increases, yet provides sufficient information for operation
  - As the fit function represents mission objective, algorithm tends to predict worst case scenario.

# Algorithm for multi-objective genetic programming

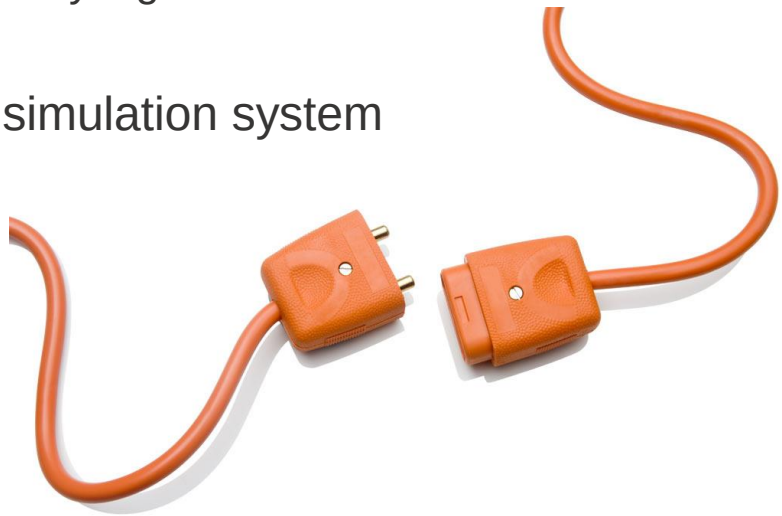
1. Create fit function for each COP user (multi-objective approach)
2. Select information that is relevant to COP user (data filtering, initial population creation)
3. Generate population of random programs
4. Run programs and evaluate their quality
5. Breed fitter programs (deletion, mutation, adaptation)
6. Loop phases 4-5 as needed (exit criteria is met)

# Features of improved operability

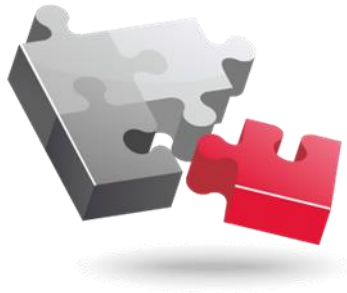
- Semantic evolution
  - Filtering of relevant information
  - Tolerance for false information and deception
  - Faulty calculation step is corrected on the next step
- Collaboration of COP
  - Accuracy on local level can be increased by adaption of local trusted observations
  - Utilization of local results (subjective COP) on global level (Situational awareness)
- Computational challenge
  - Calculation power needed increases exponentially by the number of subjective COP:s
  - Prediction accuracy increases as the amount of data increases
  - On the other hand,
    - approach supports concurrency and data filtering
    - fit function is not to be exactly met

# Future work

- Improvement of fit function
  - Dynamic creation of fit function
- Stress test
  - Seeking computational boundaries in relation of requestors and data sources
  - Optimizing the calculation frequency concerning evolvement of the situation and prediction at certain time
- Data filtering and categorization
  - Utilizing self-organizing neural networks and fuzzy logic
- Extending survivable prediction model to a simulation system



# Conclusions



- Multi-objective genetic programming enables us
  - to predict evolvement of situation even in if connections are offline
  - to extract essential information in relation to mission from data sources
  - to manage concurrent situations and objectives simultaneously
  - to determine semantic evolution and improve recovery methods

- With improved survivability we enhance
  - Fault tolerance in overall system
  - The trustworthiness of knowledge
  - Operability in swarming operations
  - Situational awareness

# Thank you

Klaus.Zaerens@iki.fi

Jouko.Vankka@mil.fi

National Defence University, Finland

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