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Scythe

Proceedings and Bulletin of the International Data Farming Community

Issue 16 - Workshop 28

Proceedings and Bulletin of the International Data Farming Community

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Scythe

Proceedings and Bulletin of the International Data Farming Community

It is appropriate that the publication supporting the International Data Farming Workshop is named after a farming implement. In farming, a scythe is used to clear and harvest. We hope that the "Scythe" will perform a similar role for our *data* farming community by being a tool to help prepare for our data farming efforts and harvest the results. The Scythe is provided to all attendees of the Workshops. Electronic copies may be obtained by request to the editors. Please contact the editors for additional paper copies.

Articles, ideas for articles and material, and any commentary are always appreciated.

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International What-if Workshop 28

"Making Modeling and Simulation Effective for NATO Decision-Makers"

International Data Farming Community Overview

The International Data Farming Community is a consortium of researchers interested in the study of *Data Farming*, its methodologies, applications, tools, and evolution.

The primary venue for the Community is the biannual International Data Farming Workshops, where researchers participate in team-oriented model development, experimental design, and analysis using high performance computing resources... that is, Data Farming.

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Team 01: Cyber Defence in Support of NATO

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INTRODUCTION

Since IWW 27 was completed, Team 1 made progress in many ways in preparation for this workshop. One was simply running the model using basic data farming techniques and examining the veracity of the output. The model was also reviewed by Swedish FOI cyber subject matter experts and several important points were gathered from this interaction. Their main concern was that the model is very abstract, but in view of our primary task, to demonstrate the use of data farming in support of decision making, rather than examining cyber operations, the group collectively agreed to continue using the abstract model with additional details. Another recommendation was to use other tools (e.g., CAMEO, MulVal). Certainly CAMEO is suitable, but it is proprietary and expensive. Also, MulVal is readily available, but it is an analysis tool for specific networks, not necessarily Modeling and Simulation. The assumptions of a Swedish cyber expert (Holm) can be used as an input to our model (to be completed).

During IWIW 28 the team focused on integrating operational concepts with the technical model in order to understand more comprehensively the impact of having cyber services be targeted by cyber attackers.

Assumptions

The major assumptions identified during IWW28 are:

- The accuracy of the scenario is directly interconnected to our demonstration requirements, we understand that our scenario may not be as realistic as others may want it to be, but given our resource and time constraints, and the fact that this is an educational tool, we believe there is value in this exercise, regardless of its level of abstraction.
- The behaviors of the actors is based on information from the open-literature and assumptions by the analysis team.
- The impact on operational tasks may be adapted depending on doctrine and scenarios, these mappings are based on nominal values elicited from a limited number of people with some military experience.
- National rules of engagement (RoEs) and tactics, techniques, and procedures (TTPs) are not explicitly modeled, thus to adapt the model to specific RoEs and TTPs, the impact of services on tasks and operations should be adapted accordingly.
- The original guidance for this project had no discussion of tactical vs. operational vs. strategic, thus our model may not address all questions related to cyber impacts at these three levels, but we focused on the tactical level impacts.

The Operational Domain

The operational domain is characterized by a series of operational tasks that can be mapped to types of operations. These tasks consist of activities like “Movement to Contact”, “Area Defense”, “Cordon and Search”, etc. The team used various military doctrinal references (primarily US Army Field Manual 3.0) and the experience of the uniformed members to identify 20 operational tasks listed below.

- Movement to Contact
- Attack
- Exploitation
- Pursuit
- Area Defence
- Mobile Defence
- Retrograde

- Search and Attack
- Cordon and Search
- Search Operations
- Site Exploitation
- Raid
- Ambush
- Sniper Operations
- COIN Patrols
- Support the Governance
- Civil Control
- Civil Security
- Restore Essential Services
- Support Economic & Infrastructure Development

These were then mapped to 4 types of operations, namely: "Offense", "Defense", "Stability", and "Irregular Warfare". The benefit of having a mapping to fewer and higher level operational concepts facilitates the comparisons of alternatives later on. An example of the mapping between these is presented in the table below. This mapping captures the impact of any one task not being completed on the higher level operational category. This allows mapping the shortfall in any one task without having `compensatory` behaviors like a simple additive weight (SAW) method would produce, e.g., if 10 tasks impact a category, and one task is at a satisfaction level of 0% and the other 100%, the category satisfaction would be compensated and not reflect the fact that any one task can have a significant impact on the category.

Question: How much of an impact would we have on each operation if the military task cannot be accomplished to a satisfactory degree?	Offence	Defence	Stability	Irregular Warf
Movement to Contact	VH			
Attack	VH			
Exploitation	M			
Pursuit	M			
Area Defence		VH		
Mobile Defence		VH		
Retrograde		M		
Search and Attack	L			M
Cordon and Search	L			M
Search Operations	L			M
Site Exploitation	VL			VL
Raid	L			L
Ambush	L	L		M
Sniper Operations	L	L		L
COIN Patrols		VL		VL
Support the Governance		L	VH	
Civil Control		L	H	
Civil Security		L	H	
Restore Essential Services			M	
Support Economic & Infrastructure Development			M	

Table 1: Mapping of Operational Tasks to Types of Operations.

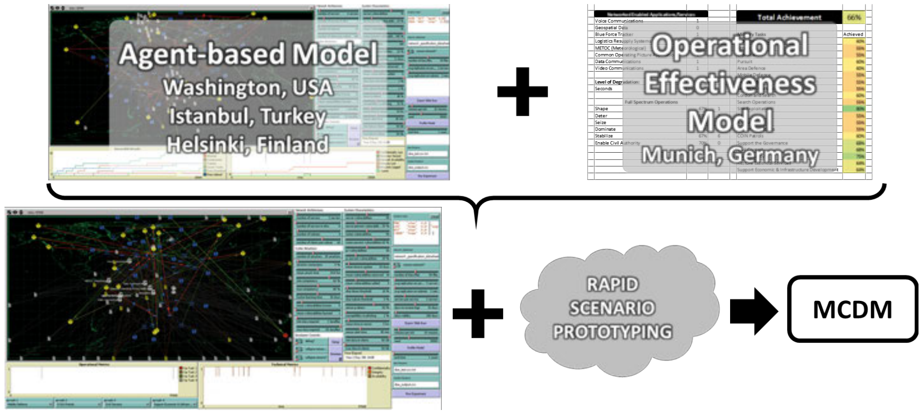

Figure 1: Integrating the technical and operational domains.

With a conceptual framework for mapping operational concepts to each other, and their impact if one cannot be achieved, the next task consisted in mapping the impact of having various networked services (those things that would be denied or compromised by cyber attackers) to the operational tasks. This mapping was captured with two matrices, one for the impact of having the service denied, and the other having the service compromised (with the implication that the enemy could not only intercept, but also modify the information to confuse the friendly forces).

Networked Enabled Applications/Services **Question**: How much of an impact would we have on each operation if the service/application was compromised?	Operational Threshold	Movement to Contact	Attack	Exploitation	Pursuit	Area Defence	Mobile Defence	Retrograde	Search and Attack	Cordon and Search
Voice Communications	<Second	VH	VH	VH	H	H	VH	M	H	H
Geospatial Data	Hours	H	H	M	M	H	VH	M	H	H
Blue Force Tracker	Minutes	VH	VH	VH	VH	M	VH	M	H	M
Logistics Resupply Systems	Hours	H	VH	H	M	M	H	L	M	L
METOC (Meteorological)	Minutes	L	M	VL	VL	H	M	L	L	VL
Common Operating Picture Application	Minutes	VH	VH	VH	VH	H	H	M	H	M
Data Communications	Seconds	L	M	M	M	L	M	L	M	L
Video Communications	<Second	L	VL	L	L	M	L	L	L	L

Table 2: Mapping between Networked Services and Operational Tasks.

RESULTS

The results consist of time histories of operational capability as a network is attacked. This allows decision makers to assess the technological and doctrinal changes (e.g., better network attack detection sensors, thresholds for network shutdowns, update rates) on operational capabilities.

The figure below shows an example of the results that can be generated from the framework. On the top you have the operational capability level for up to four types of operations or operational tasks. On the bottom are the more technical metrics, namely, Confidentiality, Integrity and Availability. On the abscissa is the time (generally the team simulated 5 years) and on the ordinate is the level of capability, with 1 representing 100%, and 0 representing 0% or total lack of ability to perform the operational activity or worst level of CIA.

It is important to caveat that the team recognizes that the data used is notional at best. The goal is to demonstrate the types of results that could be generated by a properly populated framework, but it is critical to recognize that the results generated by the framework as it stands are not to be used for real decision making exercises.

CONCLUSIONS

The team integrated operational concepts with a technical agent-based model to analyze the impact of technical and doctrinal cyber-defence alternatives on the ability to successfully accomplish operations at various levels of abstraction.

The team acknowledges the results produced are notional at best, but a framework like the one produced was considered by the team to be a valuable initial cut.

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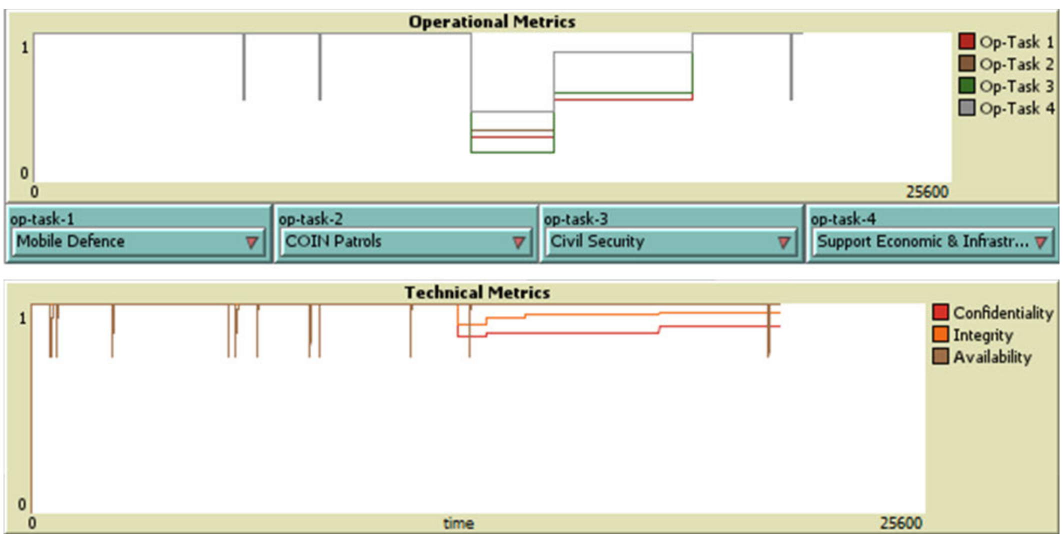

Figure 2: Example results from the integrated simulation.

Team 02: Data Analysis for Operation Planning in MSG-124

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Introduction

The NATO Modelling and Simulation Task Group MSG-124 Developing Actionable Data Farming Decision Support for NATO core objective is to apply data farming capabilities within NATO, PfP, and contact countries and agencies that could contribute to the development of improved decision support for NATO forces.

The main objective of the syndicate Operation Planning is to apply data farming concepts in order to provide NATO with actionable data farming capabilities in operation planning context related questions and to improve simulation based decision support.

Within this framework we develop a multi criteria decision support tool, with which a decision maker can plan how to use his resources in military operations. Thus, data farming is conducted in a decision making mode.

The Operation Planning syndicate of MSG-124 focuses its effort on decision support for operation planning at the NATO J5 branch, primarily on supporting work in phase 4a in the NATO Comprehensive Operations Planning Directive (COPD).

Reviewing the Implementation

Two simulation models are used to simulate the three phases of the Bogaland scenario [1], PAXSEM from Airbus Defence & Space and ITSimBw from Fraunhofer Institute IAIS.

PAXSEM is a physically based 3D agent based simulation model, which can be used for an air strike phase as well as the air battle part of an entry phase. Here, the combat between Bogaland and Northland can be modelled as a platform to platform single entity combat model.

On the other hand, the ground battle part of the entry phase and the entire land attack phase is modelled on an aggregated level, where a battalion is the smallest unit that is simulated. In this case, the capability-based planning approach of ITSimBw is used to model these phases.

As depicted in Figure 1 a scenario handover via Military Scenario Description Language (MSDL) is conducted between the entry and land phases. Information such as unit numbers, unit positions and unit hierarchy is transferred from PAXSEM to ITSimBw.

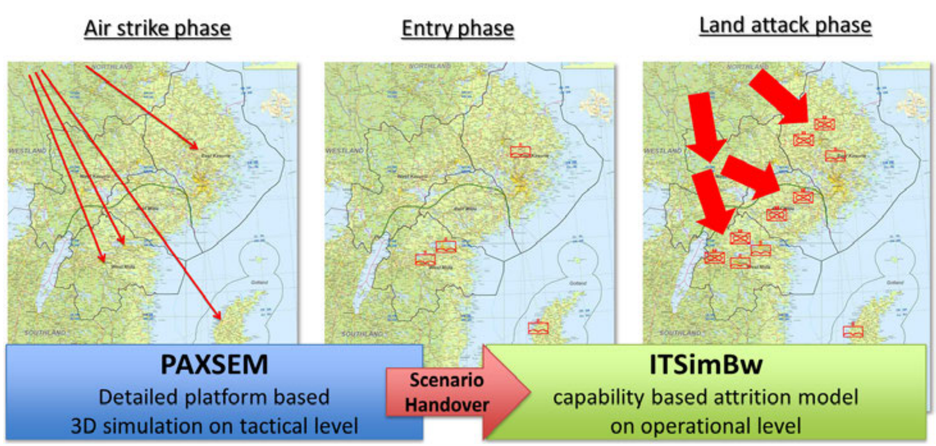


Figure 1 – Scenario phases overview.

An implementation review was carried out at the workshop verifying the simulation behavior and the implemented variations of all input factors and Measures of Effectiveness (MoE) in PAXSEM and ITSimBw. The scenario implementations were approved.

Analysis

Measures of Effectiveness

In a first step the Measures of Effectiveness (MoE) defined in [1] are used and analysed individually. These are for example the number of casualties per force and per unit type or the number of airports or land areas under control of a force.

In a second step we use aggregated MOE functions that consists of several weighted MoEs of the first step as an initial approach to this multi-criteria decision making problem.

In order to measure the success of the blue forces, two objective functions need to be defined for the airstrike/entry phase and for the land phase, respectively.

Essential for blue success in the airstrike/entry phase is to gain air supremacy and to prevent the red side from bringing in airborne troops to the airports. Therefore a penalty function for blue success is defined as follows and which has to be minimized in order to maximize the blue success.

$$
\begin{aligned}
&blueSuccessPenaltyFunction_{Air\&EntryPhase} = \\
&PercentageOfAirportsInControlOfRed \\
&+ (NumberOfLandedAirborneBtl / \\
&TotalNumAirborneBtl) \\
&+ \begin{pmatrix} RemainingStrengthAirforceRed / \\ RemainingStrengthAirforceBlue \end{pmatrix}
\end{aligned}
$$

For the land phase success of the blue forces is measured in their ability to defend as many of Bogaland's areas as possible. This objective function is the sum of 0/1 variables indicating the occupant of an area. 0 is indicating red occupation and 1 is indicating blue. Thus it has to be maximized for best blue performance. To take the importance of certain areas into account, Bogaland's capital and airport areas are included with a higher weight. The MoE for the land phase is defined as:

$$
\begin{aligned}
&blueSuccess_{LandPhase} = \\
&4 * OwnerCapital \\
&+ 2 * \begin{pmatrix} OwnerLinkoepingAirport \\ + OwnerNorkoepingAirport \\ + OwnerStockholmAirport \\ + OwnerVisbyAirport \end{pmatrix} \\
&+ \begin{pmatrix} OwnerBogalandEast \\ + OwnerBogalandNorth \\ + OwnerBogalandSouth \\ + OwnerBogalandWest \end{pmatrix}
\end{aligned}
$$

Design of Experiment

Though all overall questions like What are the most important factors for a blue win? or What is the optimal force ratio in the land phase for a blue win? could be easily answered, more detailed questions that correspond to a subset of all simulations may only be answered by few remaining simulation runs. Since the detailed questions are dependent on specific courses of action (CoA), certain input parameters had to be set to fixed values. A previously used crossed design of two small Nearly Orthogonal Latin Hypercubes (NOLH) left only a small number of simulation runs (e.g., 54 runs out of 50,000) for analysis.

To overcome this problem, we use a Nearly Orthogonal Nearly Balanced (NONB) design [3], which includes all decision and noise factors, including all categorical variables from the airstrike/ entry phase. This design consists of 2048 design points, crossed with 20 variations of the categorical variables from the land phase, to 40,960 design points.

The NONB spread sheet in [3] provides a fixed number of 512 design points for all input parameters. This already provides greater resolutions for each factor variation and more combinations with the other factors compared to the previous DOE by crossing two small NOLH designs. To further improve the resolution of the result set and therefore being able to perform more filtering on the results, all parameter ranges are adjusted to a meaningful range (instead of [0, Maximum]). The NONB design is also further expanded by stacking 4 NONB designs with permuted parameter variation columns with 512 design points each to gain a NONB DOE with 2048 design points in total.

Initial Results

The analysis is primarily conducted to verify the scenario implementation. Any insights are preliminary and used as examples of what kind of findings may be drawn from the simulation output by the decision support tool.

From an analysis of the total number of blue aircrafts in connection with the blue and red relative losses of aircrafts, we found stagnation of losses in percentage terms at approximately 50 aircrafts, see Figure 2. Thus, using more

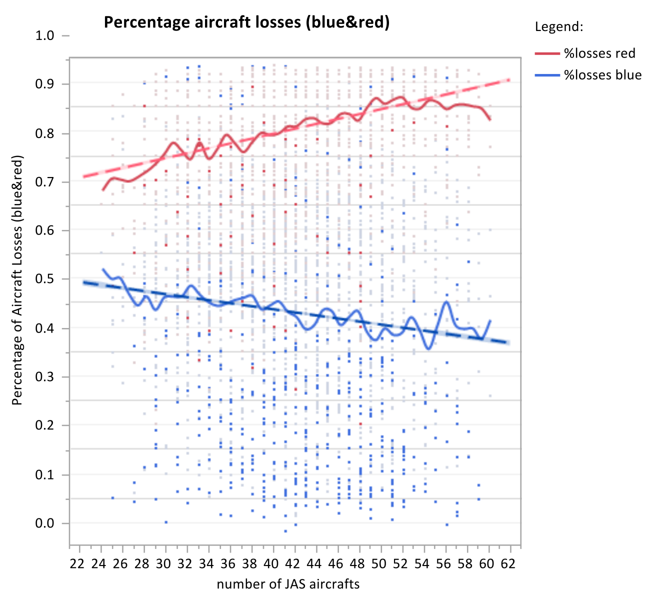


Figure 2 – Percentage losses of blue and red aircrafts vs. number of blue aircrafts..

than 50 blue aircrafts in this air battle does not result in higher red losses in this scenario.

Analyzing the number of blue and red fighters in connection with the percentage of blue battalions in the land phase showed a huge impact of fighters on the land battle result (Figure 3). A high number of red aircrafts and few blue aircrafts lead to blue battalion losses of over 70%. In contrast, blue forces have to have significantly more fighters available after the first two phases to achieve relative losses of blue battalions of fewer than 30%.

This is a clear indication that results from the air- and entry-phase have major effects on the land-phase. The Decision-Tool will have to cope with such correlations and bring them to the attention of the decision maker.

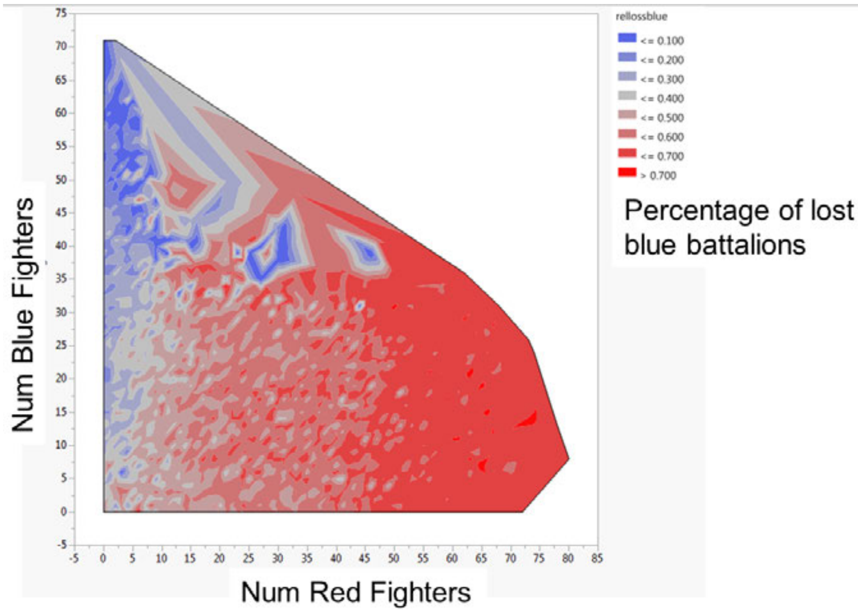


Figure 3 – Number of blue / red fighters vs. percentage of lost blue battalions (blue=low/red=high).

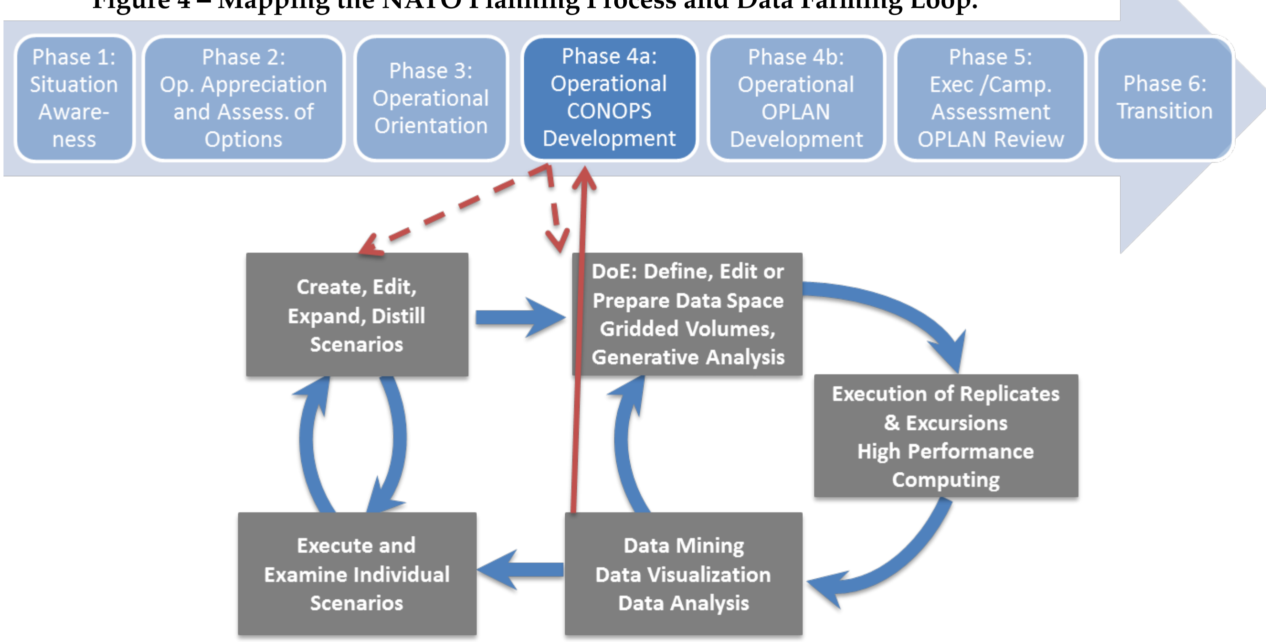
Decision SUPPORT

Mapping the Processes

The data farming decision support methodology can be placed within the NATO operation planning framework. In terms of the NATO Comprehensive Operations Planning Directive (COPD), data farming can give decision support to the phase 4a (Operational CONOPS development) at Joint Force Command (JFC) level. The idea is to support the NATO planning process by early experimentation of operation planning through data farming.

The decision support methods will not only deliver support on the J5-Level but are also intended to be used at air-/ land- and maritime- component level. These decision

Figure 4 – Mapping the NATO Planning Process and Data Farming Loop.



levels are exemplified in the Bogaland scenario. Operation planning can be executed for the three phases separately, which demonstrates using decision support at component level.

The Analysis Workflow

A workflow approach for analysis is defined in Figure 5.

Figure 5 shows the workflow of a single iteration of the data farming loop in supporting the NATO planning process. Based on the COPD Phase 4a, MoEs are defined and simulation runs are executed. Simultaneously the decision maker can set preferences on the defined MoEs to express his personal interest depending on the questions he wants to be answered [2]. The preferences and simulation results will then, after preparation by the operational analyst, serve as input to the decision making process.

The decision support process is split up into two parts. The first answers general questions like How to win the war? The second concentrate on specific questions like Why or How do we win the war? Each question is answered by specific decision-maker-views, which analyze and visualize the existing data in specific ways. The decision support process keeps track of the dataflow between the incorporated analysis views. It is also in charge of offering and handling data filtering functionalities for the decision maker.

FUTURE WORK

During 2015 the Operation Planning syndicate will develop a complete decision support process with a decision support tool that allows military decision makers and operational analysts to interact in an incremental way step-by-step and will perform an early test of concepts during the initial phase of operation planning.

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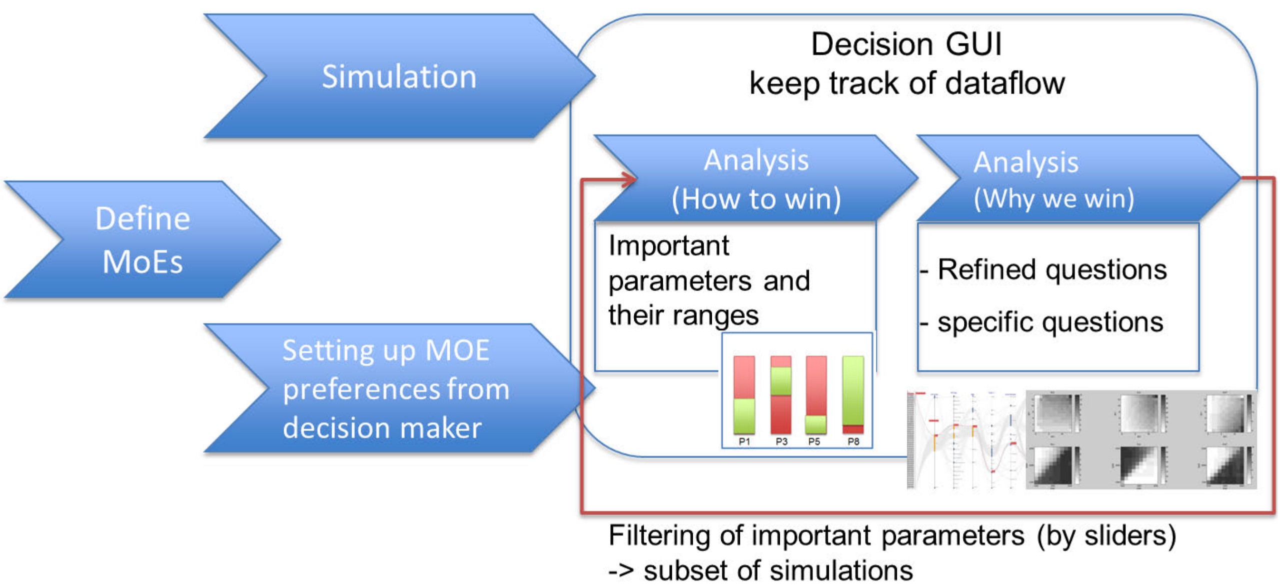

Figure 5 – Analysis Workflow Overview.

Team 03: Mass Casualty Decontamination Process

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Introduction

Transitioning protective equipment and techniques from a military environment to a civilian environment presents a number of complex challenges. These challenges become acute in a crisis situation where quick decisions must be made using limited information. In these situations there is a critical need for units to receive proper training and for decision makers to make realistic assumptions. The US Army's Maneuver Support Center of Excellence's (MSCoE), which manages the methods used in mass decontamination equipment, proposed an example of a challenging transition. MSCoE presented concerns that there would need to be modifications to the optimal equipment load out, set up producers, and expectations when transitioning from scenarios involving only military personnel, to dealing with large numbers of civilians. Team 6 was convened in order to identify the unique factors presented by a civilian population, and to determine if data farming an agent based model could lead to an optimized model for mass decontamination.

Our initial goals at this workshop were to research and understand previous work done in this domain, identify potential agent models, and to collaborate with other participants to give better insight into more specialized concepts such as social network modeling. If possible, we also wished to determine if there was a pre-existing agent model we could use to simulate our decontamination line, or if we would need to create a new model for this specific purpose.

Questions

To begin our research, we discussed how to bound our problem. We arrived at the following set of questions, which we would use as our measures of effectiveness for any model we might design.

1. What is the best mix of chemical decontamination elements to address a particular situation?
2. How important is response time?
3. How compliant will a crowd be authority?
4. How well do existing triage procedures scale with the size and area of a chemical incident?
5. How can we optimize a system to minimize the number of casualties and the severity of injuries?

Background

Before beginning the data farming process, it is important to understand how decontamination in the field is actually performed. Turing to the Guidelines for Mass Casualty Decontamination During An HAZMAT/Weapon of Mass Destruction Incident: Volumes I and II published by the Edgewood Chemical Biological Center can help with this.

The four principles of mass casualty decontamination are as follows:

- Time is critical in order to save the most lives
  - Immediate removal of clothing outside of the contaminated area for patients who have been visibly contaminated or who have been suspected of having been contaminated
  - Processing the victims through a high-volume, low-pressure water shower (~50-60 psi) is priority. This may aid in the removal of 80-90% of physical contamination in almost all cases.

- Provide effective mass casualty decontamination. Activities such as setting up commercial decontamination tents, tarps, additional decontamination equipment and/or creating a soap-water solution when time permits

- Conduct decontamination triage (a prioritization mechanism used by a first responder to determine whether victims emerging from a HAZMAT/WMD incident scene should be evacuated directly or to immediate mass casualty decontamination) prior to administering a high-volume, low-pressure water shower.

- When contamination involves chemical vapors, biological or radiological material, using gentle friction (using hands, cotton flannel or microfiber cloth or sponges) is recommended to aid in removal of contamination (start at the head and proceed down the body to the feet. Extra care should be taken to prevent the spread of contamination to the mouth, nose and eyes).

Figure 1 on the following page illustrates the decision tree to decide how to decontamination triage individuals.

Since time is critical, the first step in mass casualty decontamination is to establish zones for each step in the process. An initial isolation and protective action distances need to be established (according to the IAW Emergency Response Guidebook).

Decontamination setup should occur next; this includes primary and secondary decontamination lines. Rapid identification of victims who may not require decontamination can significantly reduce the time and resources needed to perform decontamination. First responders should provide guidance and instruction to victims to separate them into one of the following identified groups:

1. Ambulatoy and symptomatic (instruct victim to proceed to decontamination)
2. Non-ambulatory (assist victim through decontamination or transport directly to medical facility)
3. Ambulatory and non-symptomatic, but exposed to contaminant (instruct victim to proceed to decontamination)
4. Ambulatory and non-symptomatic with no obvious exposure to contaminate (instruct victim to proceed to safe refugre/observation area)

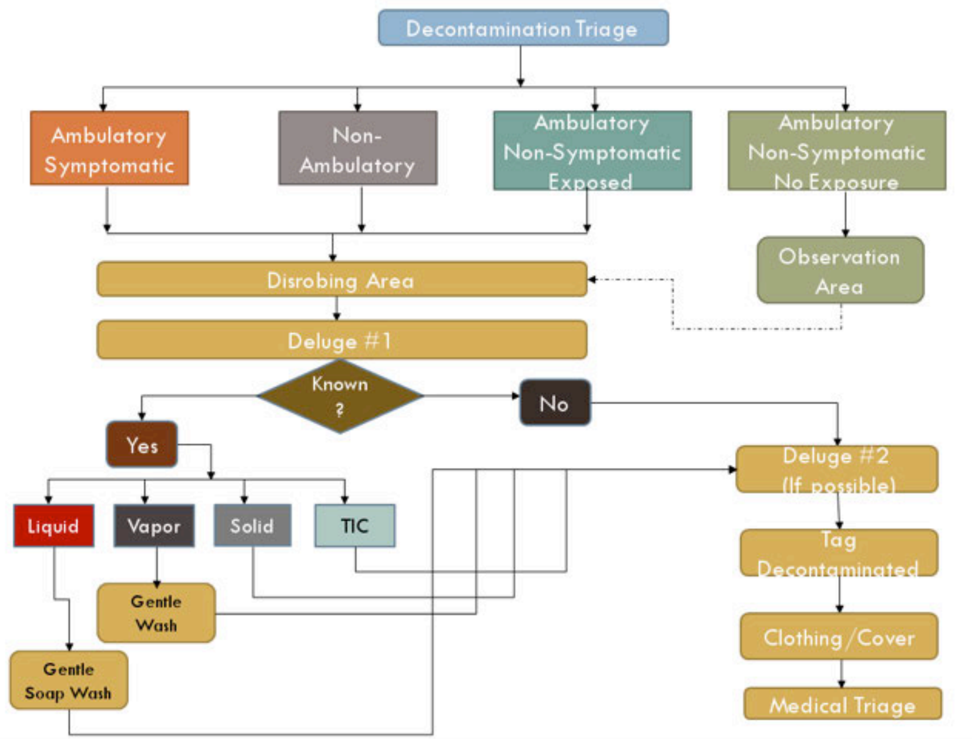

Figure 1: Decontamination Triage Decision Tree

After decontamination triage has taken place, victims directed to do so should proceed to the water shower deluge to undergo decontamination.

Following decontamination, victims should be provided clothing both to restore modesty and provide warmth. Decontaminated victims should also be identified (colored rubber bands, for example) to aid medical personnel and others in determining potential risk to themselves when treating or assisting victims. Following tagging, victims without additional visible symptoms should be directed to the area of safe refuge for observation where they can be monitored for delayed symptoms. Once the incident commander has consulted with appropriate response personnel and deems the incident scene to be safe and secure, the victims can be released from the safe refuge observation area.

The key to successful mass casualty decontamination is to use the fastest approach that will cause the least harm and do the most good for the majority of the victims. This can be highly dependent upon the resources available at the time of the incident, the number of people affected, and a multitude of outside factors such as weather. Data farming techniques can be utilized to determine the most effective methods of decontamination with a given set of resources. A detailed study of current techniques was conducted and detailed in the

Figure 3: Shower Deluge

next section.

Literature Search:

Our team was surprised by the amount of previous research conducted into scenarios very similar to our chosen topic. There has been a wealth of research done into crowd behaviors, emergent leadership roles, human geography, and entire thesis project based around the emergency services response to a chemical attack on a civilian target. Given the volumes of material we were able to access, the majority of our time was spent collecting and reading previous works. We will attempt to summarize the most useful information we found in this section.

Situational Awareness of an Infantry Unit in a Chemical Environment describes how to build a simulation using Pythagoras. Agents were used to represent chemicals as well as soldiers. Chemical agents "shoot" at soldiers to affect them, and the effectiveness of the shoot action is based upon distance, MOPP level and time of detection. An interesting facet of this simulation was that it represented Joint Chemical Agent Detectors (JCADs), and looked at how detectors and Unmanned Ground Vehicles (UGVs) equipped with sensors would increase situation awareness.

The factors to be farmed were: blue speed, the obedience of the soldiers after they put on their protective mask, internal communication effectiveness, external communication effectiveness, the number of Unmanned Arial Vehicles (UAVs), the number of UGVs, JCAD sensitivity, and the marksmanship of the soldiers after they don their protective mask. The measurements of effectiveness decided on were mission accomplishment and time to accomplish the mission.

We concluded that although this work included some useful information about using Pythatgoras to implement a model, it didn't actually include any usable results. Although input sets were generated, the article is several years old, and it is unlikely that much of that data still remains.

Exploring First Responder Tactics in a Terrorist Chemical Attack is a very extensive thesis exploring the effects of a chemical IED released into an urban civilian environment. Much of the thesis is concerned with the availability and arrival time of first responder units. The exact numbers and unit types outlined in the paper are not directly applicable to our situation as it focused primarily on units available in Singapore. This paper was by far the most useful piece of data farming related research we were able to locate. Not only was it closely aligned with our topic area, but it was also a complete work with complete input sets, test results and conclusions.

The premise of the scenario was to model the effectiveness of first responder units to a Chemical Improvised Explosive Device (CIED) attack on an urban shopping center. It built upon an exercise called NorthStar V, which featured military, civilian and government units from Singapore coordinating a response to the CIED event. Like the situational awareness study, it also used Pythagoras to simulate entity behaviors, but in this case implemented a very rich set of behaviors for individual entitles to take on. Many of the factors in the design focused on communication, timing, and the responsiveness of a crowd to first responder units. This data was very interesting to us, as it dovetailed well with our first three questions

Key insights:

- It proposed the idea that the addition of administrative elements to a live exercise contaminates the results of the exercise. It said that contamination should be accepted as a limitation of exercises, and acknowledges the value of an analysis tool.
- The model concluded that not all first responder elements correspond to a reduction in civilian casualties.
- It highlighted the need for crowd management by separating contaminated from non-contaminated individuals.
- It generated data relating responder effectiveness to communication reliability
- It made a genuine attempt to address the behavior of civilian agents in a terrorist scenario

Modeling Crowd and Trained Leader Behavior during Building Evacuation

This paper looked at simulating the behavior of tightly grouped entities which need to evacuate from a fixed indoor environment. The work used a purpose built model called the Multi-Agent Communication for Evacuation Simulation (Maces). A significant highlight of this work was the concept of entities having a cognitive map. Some entities are familiar with the entire map of a space, while others may only be familiar with the surrounding rooms. The simulation also introduced a leader/follower relationship into the design factors. As a result, their simulation roughly categorizes entities into 3 sets: entities with a strong mental map and strong leadership skills (first responders), entities with strong leadership but limited mental maps (explorers) and entities without leadership attributes (followers). The case where an entity may have a large mental map, but lacks a desire to lead was not addressed.

The results of their work produce mostly expected results. They highlight a pair of scenarios, which are relevant to the situation we are trying to address. Entities in an environment low on leaders tended to clump into large groups as they made their way to an exit, while simulations which featured large numbers of leaders lead to large numbers of small groups exploring independently.

It was decided that the research conducted by Pelechano and Badler is probably beyond the bounds of what would be considered as important contributing factors for decontamination optimization, but could be folded into future work if the scenario was enlarged to simulate the engagement of first responders to a civilian populace fleeing a public facility like a stadium or shopping mall.

Conclusion:

After conducting our research, we felt that we really needed two separate models to express this scenario. We needed to first model the behavior of entities after an incident and as first responder units arrived, we then needed to use that input set to drive a process optimization model representing the decontamination chain. It has become clear to us that there are a large number of outside influences affecting the selection of tactics and equipment when addressing the mass decontamination of civilians.

Two out of three studies used Pythagoras as the simulation engine, but they both noted some significant drawbacks. They wrote about difficulty generating input sets, and a great deal of work needing to be done by hand. We felt that perhaps Pythagoras was a good place to start farming an agent model, but that we may have a need great enough to warrant building a customized agent model better suited to our needs. We will have to start conducting runs before we know more.

We would like to thank Gary Horne, Klaus Peterson and Ted Meyer for their help throughout the study, their time and their insight.

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Team 04: Applying Data Farming Process to Decentralized Project Work

Team 4 Members

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Introduction

The Päivölä School of Mathematics has started a long term simulation project to simulate developing country in June 2013 [1]. The first version of HDRD simulation was presented in What if workshop 27 in January 2014 [2]. The students who started the project graduated in May 2014. The work has continued with new students and in workshop 28 there were three new teams to continue the project.

The models developed in What if workshop 27 used in What if? Workshop 28 were the hunger model [3] that was adapted to a historical setting, The Great Famine in Finland 1867-1869. The stand-alone crime model [4] was developed to handle villages and society in the case of Central African Republic.

A new team was going through data farming procedure to create a Recycling Model, which could later be adapted into the existing simulation engine.

PROJECT TEAMS

In the workshop 28, the project was implemented as three separate subprojects, each subproject having its own team.

Team 4A: Lunnikivi, Vivian & Tuukkanen, Aaro & Häihälä, Eero & Virtanen, Maisa: Crime Simulator

Team 4B: Herring, Jan-Kristian & Qianyue Jin: Great Famine Simulator

Team 4C: Hokkanen, Joel & Mustonen, Vili & Alvinen, Markus & Kääriäinen, Kaisla: Recycling Simulator

PROJECT WORKFLOW

Participation in the workshop happened in Finland and United States. Two members of the team participated in the workshop at U.S.A while the rest of the team worked on the simulation project remotely from Finland. One person from the two groups was responsible for maintaining the communication to the other group. The person's also coordinated and managed work of their groups.

On each team two second year students were responsible for the model and the paper. During the workshop four first year student supported the main teams and learned the data-farming process so that they will be able to continue with the process next year. We intend to develop this master – apprentice in the future.

Team 4A and Team 4B had previous research on which they based their own, while Team 4C started from scratch. All teams had started the project before the workshop but the main bulk of work took place during the workshop.

The teams followed the data farming process [5]. The primary focus was on developing the model and verifying it's validness (until more serious data analysis could take place.) We proceed rapidly through the data farming process as many times as possible to allow as many iterations of the process as possible.

The teams worked independently on their projects, however there were status checks during each day. Students were given guidance about the data farming process as well as how to proceed with their research in general.

Team 4A's simulator gave more realistic results than the previous crime model. The work could get trough the whole data farming procedure and we got first results. Team 4B improved the existing simulator so that testing it with historical data gave similar figures that were in literature. The model needs improvements. Team 4C created a proof-of-concept version of the recycling simulator.

There is room for future improvement in the simulators like validating the models and replacing simplifications with more accurate mathematical solutions. However the existing simulators give reasonable results.

CONCLUSIONS

The concept of decentralizing project members while participating in the workshop was successful. Part of the team participates in the workshop while the rest of the team works remotely. Communication between these two groups was implemented using instant messaging, where one person in the workshop was one communication link and one person in the remote team was the other communication link.

This concept enabled several people to work with the project while only two team members participated in the workshop, which saves resources. The collaboration with the data farming community in the workshop enabled feedback, state of art update and communication between different teams.

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Team 04a: Optimizing of Humanitarian Aid Deliveries in Central African Republic

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Introduction

Central African Republic (CAR) gained it's independence in 1960, and ever since it has suffered from internal conflicts[3]. Central African Republic, being one of the world's poorest countries, has over 2 million people in acute need of humanitarian aid.[2] Solely in the first half of 2014 both European Union and United Nations have established peacekeeping operations in CAR to stabilize the situation. [1][5]

The need for help is greater than the amount of resources available and humanitarian aid deliveries are being captured by criminals [6]. Therefore it is essential to use the resources as effectively as possible.

Scenario/Simplified world

In our scenario humanitarian aid arrives by airplane to an airport, which is secured by peacekeepers. From the airport humanitarian aid is delivered to other villages by trucks, which is the only way of transporting aid. The roads leading away from the village are potential places for carjackers to attack the deliveries. To prevent carjackings, the trucks delivering humanitarian aid can be secured by hiring guards, but this causes extra costs.

In the village there are normal citizens and amongst them are two kinds of criminals: carjackers and thieves. Carjackers capture humanitarian aid deliveries, and the thieves rob citizens. Both carjackers and thieves may run into guards during their missions.

Simulation model

Our simulation model is based on Hirvola and Voutilainen's Crime model, which is a part of "Humanitarian Assistance and Global Warming" (HAGW) simulator.[7] The model concentrates on modeling criminal actions in Somalia.

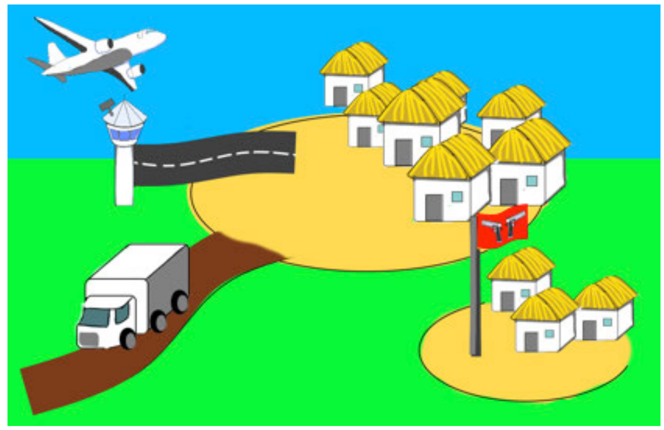
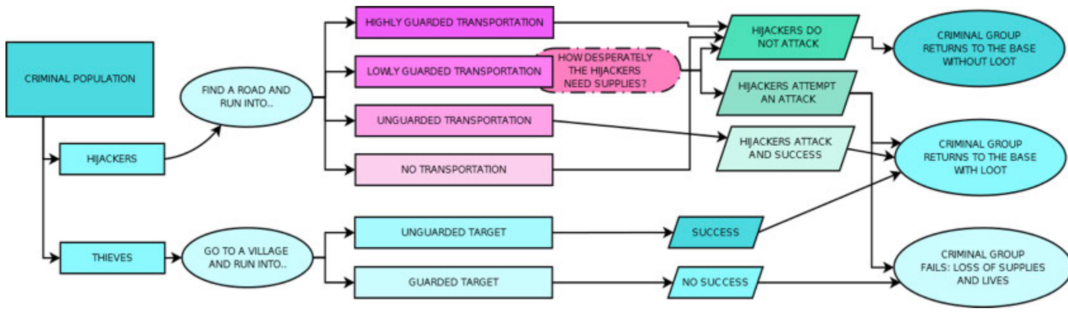


Figure 1: Illustration of the scenario

Although the conditions in Somalia differ from the ones in Central African Republic, Crime model suited our needs well, when modified: Pirates were erased, CAR being landlocked country, and the happenings on the trips of the carjackers and thieves were modeled specifically. The behavior of thieves was also modeled better whereas the original model, for example, allowed the criminals live on credit.

Figure 2: The map of Central African Republic [4]

Figure 2: Central Republic



The map of African [4]

Model Description

There are villages in the model. Each village contains ten thousand citizens. Then there is also a separate population of criminals. The criminal population consists of thieves and hijackers and they have storage of supplies: money, food and items. In the beginning of every week, groups of thieves and groups of carjackers leave for their business trips and grab some equipment along. Each trip takes one week.

The carjackers go to a random road on their operation area to look for trucks containing aid supplies. Each carjacker group inspects the first delivery they face. If the transportation is highly guarded, they let it pass and return to their base. However, if the first truck is unguarded, the bandits rob it and get supplies.

If the transportation is guarded on a low level, the carjackers may or may not attack it depending on how desperately they need more supplies. The carjackers can walk away, in which case they return to their base. Another option is that they attack. In that case the bandits may succeed or fail. On success they return to their base with loot. In case of failing they lose their supplies and lives.

The thieves go to steal food and money from the villagers. There is, however, a chance for them to run into guards such as peacekeepers. In that case the thieves lose their loot but they still might be able to flee. If they get away they return to the criminals' base empty handed and wait for the next trip.

Simulation / Design of Experiments

Time step in the model is one week and a single run simulates a time period of two years. Simulations are run several hundred times with each parameter set to minimize the effect of random.

To optimize the test values of the parameters of our model, we used Sanchez, Hernandez and Lucas' Nearly Orthogonal Latin Hypercube [8] to generate as different parameter sets as possible. Currently there are 33 different parameter sets.

The first two parameters (stealGroup and carjackGroup) are the sizes of the criminal groups that leave the criminal base every week. The parameters stealingSoldier and carjackSoldier are probabilities for the criminals to run into guards during their trips. The parameter moreCriminals indicates tells how many percents of normal citizens turn into criminals. SocietyProsperity and reliefSize indicate the situation of the society and therefore how profitable criminality is. The last parameter (transportsPerWeek) indicates how many humanitarian aid transportations are made weekly in a simulation run.

Parameter name	Type	Range
stealGroup	Integer	[3, 7]
carjackGroup	Integer	[2, 10]
stealingSoldier	Double	[0.1, 0.7]
carjackSoldier	Double	[0.1, 0.7]
moreCriminals	Double	[0.05, 0.20]
societyProsperity	Double	[0.5, 1.5]
reliefSize	Double	[0.5, 1.5]
transportsPerWeek	Integer	[0, 10]

Table 1: Model parameters

Output value	
Criminals	Integer
Food	Integer
Money	Integer
Items	Integer
Succeeded robberies	Integer
Failed robberies	Integer
Succeeded carjackings	Integer
Failed carjackings	Integer
Guard contacts for carjackers	Integer

Table 2 - Example of Possible Output Parameters

RESULTS AND ANALYSIS

In the end of every week the model prints out the current situation. The situation consists of the amount of criminals and their supplies, the amount of succeeded and failed carjackings and robberies and the number of contacts happened between carjackers and guards.

Given the number of attempted, failed and succeeded carjackings it is possible to arrestimate the expenses between separate simulation runs.

Figure 4: The amount of criminals and succeeded carjackings in the end of 20-years-long simulation. Each point is the average of 5 simulation runs with a single parameter set.

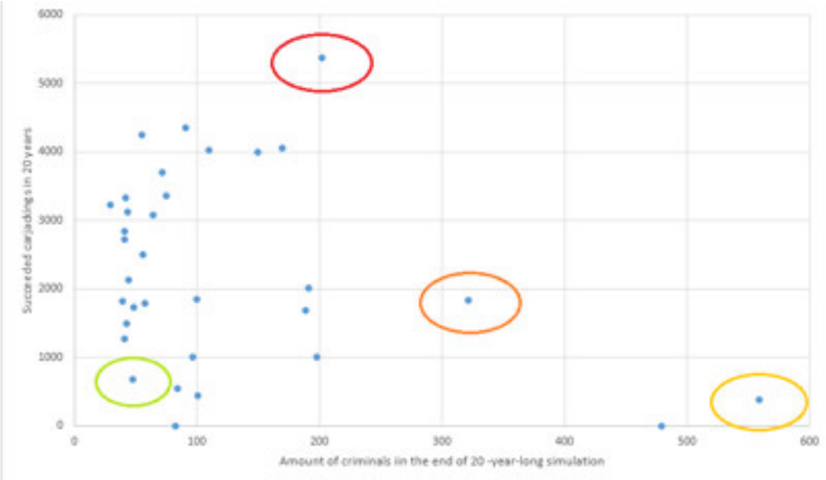


Figure 4: The amount of criminals and succeeded carjackings in the

The point circled with red represents the outcome with parameter set number 24. In the set there are few succeeded carjackings, but a lot of criminals. A look into the set's parameters show that there is only one transportation per week and the propability for the carjackers to run into guards is 0.1, which is very low.

The point circled with orange is parameter set number 32. In this set there are three deliveries per week and quite a low probability to run into guards. Normal citizens turn into crime with quite high per cent: 0.2, too. These parameters result as high number of criminals, though quite low number of succeeded carjackings.

In the third point, which is set number 28 and circled with yellow, there are only a few criminals, yet very large number succeeded carjackings. The set's parameters indicate that 8 deliveries are made every week, hijacking and robbing is profitable and there are few guards.

The last point, which is circled with green, is set number eleven. In this set there are few criminals and succeeded carjackings. This is very reasonable result, whereas there are few deliveries per week, capturing them is hardly profitable, few people turn into crime and it is very likely to run into guards during a mission.

It seems that large number of guards, small number of criminals and few deliveries result as a low number of succeeded carjackings. Decreasing the amount of guards and increasing the number of criminals emerge as increased carjackings. These results are very credible.

CONCLUSIONS

The model works with our modifications and can be used to model the humanitarian aid transportation carjackings in Central African Republic.

Further development of the model includes fixing parameters and outputs. More parameters may be added to be datafarmed for example the size of the society's population or delivery sizes. Also we have to decide which outputs are interesting in our case and we may have to either reduce the printing or add more values to output.

The future results should provide us with info which tells us which parameters had what kind of impacts in criminality and humanitarian aid getting to its correct destination.This would help the decision makers to make decisions which help the aid to reach its target.

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Team 04b: Using a simulation model for studying the historical famine in Finland in 1866-1868

Team 4b Members

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Introduction

The main point of our project was to create a simulation model that could be utilized in simulating the great hunger years of Finland. We used a simulation model (2) that had been originally designed to simulate Somalia.

The famine was caused by three rough consecutive winters which reduced crop size and denied ships from bringing food from abroad by freezing the sea early. Rural isolated areas were hit the hardest, and disease was widespread due to people being weakened by hunger.

Our data source of our historical data was Oiva Turpeinen, "Kainuun historia II: Väestö ja talous" or Kainuu's history II: Population and economy. We settled with simulating two villages in Kainuu called Sotkamo and Kajaani. Kainuu seemed like a good area to simulate as there was enough data on the two villages, the area was quite rural and isolated back then and it suffered greatly from starvation. Sotkamo was a larger village with a population of 7000 and Kajaani was 40km away with a smaller population of about 900. We extracted these populations as well as the distance, birth rate, deaths by disease and total deaths along with information about the general impact of the famine on the area from a book about Kainuu's population and economy in the 19th century.

The simulation software and model development

The software was originally designed to simulate Somalia and To simulate … 1866-1868 it would require modifications to be used for our simulations. There were also oversimplified models.. model for diseases and the farming produce was far higher than it could possibly be in Finland because it did not account for the Finnish winter. We changed farming to only produce one crop a year instead of three because that is more realistic for 19th century Finland as the crops had a very small period of time to grow each year . We changed the amount of food farming produced to also depend on the amount of citizens in a town, because the farming needed a lot of human work.

We needed to add a disease component to the model.

We improved the population model by making people eat less when they were close to running out of food, which is far more realistic than having them keep on eating at a constant speed. Finally we implemented disease by having citizens die on a weekly basis.

We ran simulations with three variables: the initial amount of food each village has, the initial amount of population each village has and the average size of a crop. All three variables were centered around our historical data but each was given a realistic margin of variance. The simulations yielded quite different results. We found that initial food was less important than the average crop size, as even with a large initial population most would die before the first crop, stabilizing the population of the village in the long run. Overall, even with only small variations the results differed from historical data significantly at times. We also tried running the engine with the exact historical values and the results were close to our historical data. The simulations showed that a fairly small change especially to the initial amount of food or population caused a drastic change in the end result.

We reduced trade between the villages to be very minimal as there were not any trucks back then.

We tossed the energy and crime components of the simulator because they were irrelevant and revamped the weather model to simply reduce the size of a year's crop depending on how harsh the winter was. We assumed that drought and other various weather elements were not relevant in the same way that they were in Somalia.

The amount of citizens which die has a small margin of variance that was made to represent our historical data on how many people died of disease.

Results

We ran one simulation with the default historical parameters. We also ran simulations with variations of the historical data, for example in the yellow simulation the initial population was higher and in the orange simulation the winter was harsher. The graphs in Figure 1 (next page) show the population of the larger village in three simulations.

Conclusion

The simulation was able to mode the famine quite accurately, the only important factor we thought as missing was the possibility for the villages to trade food if one was close to running out and the other had an abundance of stock. Aside from that the simulation yielded realistic results with both the historical and randomized parameters. The model could be further improved by adding the previously mentioned factor and by refining the food model, the farming in particular, as well as simulating contagiousness in the disease model.

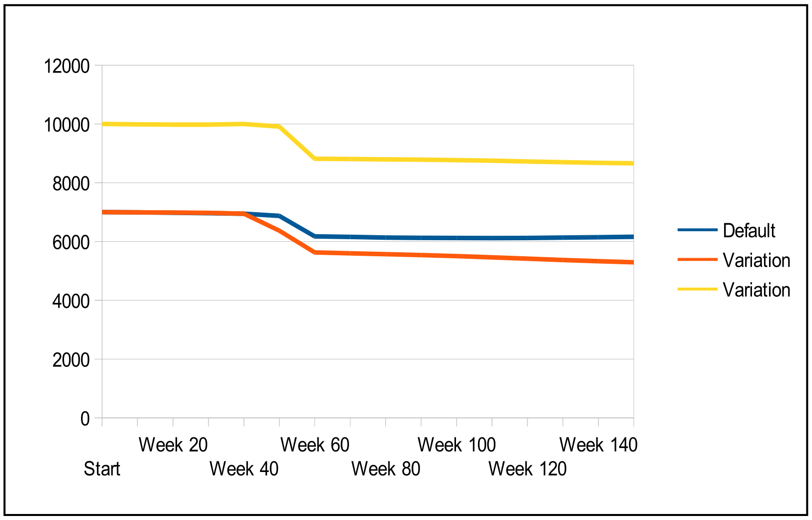

Figure 1: Village Population

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Team 04c: Using Data Farming to Model Recycling

Team 4c Members

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Introduction

Our goal is to create a data-farmable recycling model. The model should be capable to study minimum pollution and Carbon dioxide emissions, maximum recycled material and maximum profit from waste management. The model should have enough different kinds of waste producers, recycling centers, waste burning plants, landfills, roads, and logistics.

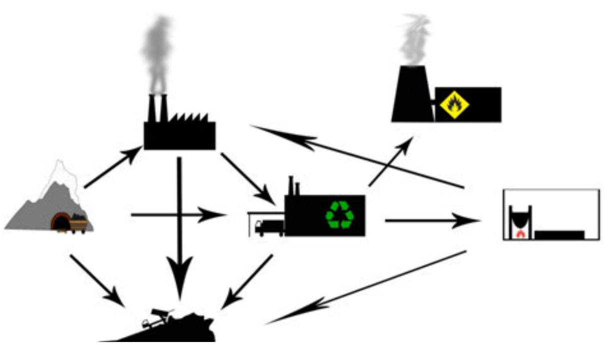

Figure 1 Recycling model

Model

Factories produce waste from recources. Waste can be landfilled or recycled. If waste is recycled, useful recources can be collected during process and can be used again in factory. In our model we recycle the waste and collect burnable materials from it. Burnable materials are transported to waste burning plant and produced to energy. Anything left from recycling process is landfilled. Recycled aluminum is transported to smelter and sold back to factory.

At the beginning of the project we had no engine to start with, so we created our own engine using python. We tested out our engine using aluminum as the main recyclable resource. After choosing what we want from the outcome we had to change the parameters . With new set of parameters we developped the engine to little bit further. Outcome started to fulfill our requirements and we decided to implement few features. Our focus point in developping the engine was in experiment definition loop. [1]

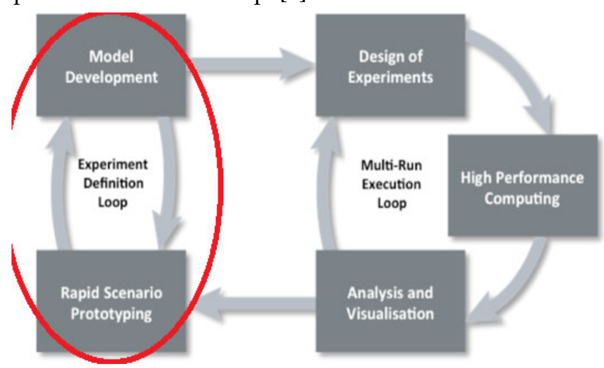

Figure 2 Data farming loop of loops. Our work focused on model development loop.

Running Scenario with Aluminum

We chose our first parameters and built our first version of the engine.We used aluminum in our first scenario. The main idea of our first scenario was to test out our engine and refine our parameters. Collecting burnable waste until the finished recycled product was 99 percent or more aluminum. Our parameters for aluminum [2]were

low level	-1,549	-120	550	1000	0	0	0
high level	-1,699	-250	700	50000	0	0	0
decimals	3	0	0	1	0	1	0
factor name	fuel	cost	profit	amount	plank	plank	plank
	-1,596	-250	672	19375	0	0	0
	-1,558	-153	681	28562,5	0	0	0
	-1,568	-177	559	13250	0	0	0
	-1,577	-201	597	50000	0	0	0
	-1,662	-242	616	7125	0	0	0
	-1,699	-161	606	40812,5	0	0	0

We got our first version of the engine and tried it with few parameters using worksheet by Susan Sanchez[4]. Our first parameters were the cost of recycling a ton of waste, amount of waste and the amount of aluminum contained per ton of waste. With these parameters we were able to run the simulation for the first time. We added new parameters to be more accurate with the cost of the recycling and transportation. [3] We also added maximum load to the transportation. Now we had in our recycling scenario a waste producer, transportation, recycling center, landfill and a waste incinerator. After collecting aluminum from waste, the unwanted waste is transported to waste incinerator to produce energy.

Conclusion

We achieved a datafarmabale model utilizing model development and rapid scenario prototyping. The next step is to combine recycling modeö to the HDRD simulation project. [5]

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Team 05: Data Farming for a Better Tomorrow

Team 5 Members

Steve Anderson
Ted Meyer
USA

Introduction

During the 21st Century, the world will face a variety of existential threats to the international security system. The human race must plan if we are going to survive. The foreign polices of every nation will be forced to adapt to these threats to regional and global stability. NATO is not exempt from these challenges. Over the past decade or more, the NATO body politic has realized that it is very expensive to react to crises after they have occurred. An ounce of prevention is worth a pound of cure. It is no small irony that in periods of economic austerity, that prevention planning is almost always a good investment. A recent example from the United States, New York Governor Como's observed, "I've faced a once in a century storm three years in a row." Governor Como faced challenges in draining the New York City subway system three consecutive times. An investment of millions could have saved billions. There is a need to engage proactive planning, in advance of need, to help influence and shape viable cost-effective solutions that can be implemented to mitigate the impacts of catastrophic events.

Existential Threats to International Security

Next generation planning tools are within our grasp. Big data, smart analytics, and new vistas of modeling and simulation await the study of nth order implications of complex and subtle interactions of emergent dynamic behaviors of cascading interdependencies. Data Farming is a valuable method for exploring axiologic topologies. New

Global-Physical/ Biological Dynamics	Limited/Limiting Resources	Demographics Dynamics and Imbalances	Fractures in Societal Cultural Identities and "Self Image"	Economics and Manufacturing Dynamics	Knowlegdge - the Maintenance, Control Acquistion thereof	Infratsructure Issues	Technological/ Scientific Breakthroughs	Transportation System Dynamics	Failures/Challenges in National and International Governance, Policy and
Climate Change	Rare Earths	Native gain of population from reproduction	Tribes / Tribalism	International Economic agreements - debtors/creditors	Fourth Estate Failure	Failing infrastructures	Human Brain Reverse Engineerring and understanding-artificial minds	Failure of tranportation systems	Migration / Immigration Policy
Solar Activity/Electric Grid Faiulure	Arable Crop Land	Loss of national populations from decreased fertility rates / disease healthcare functions	Nations and nationalism	Trade imbalances	Education and Training --- Costs and Processes and cross-cultural differences	Rising and Improving infrastructures	Ubiquitous and Revolutionary Computing--infinite memory and processing speed available on everything	Expensive Transportation	Economic and Trade Zones and Favored Nation Candidates
Volcano Eruptions	Fresh Water Sources	Migrations with positive forcing functions	Religions---Forces toward fundamentalism and exlusivity or inclusiveness and openess	Manufacturing Embalances	Good and Bad Propaganda	Military Capabilities and Assets, and Asset Reset needs and methods	Instant, high fidelity communications	"Instant" World Wide transportation	Nuclear Proliferation Treaties
Tsunamis	Trees/ Rain Forest/ Timber	Migrations with negative forcing functions	"Culture" and societal common visions	Rich -Middle Class -Poor dynamics	Keeping an acurately informed electorate		Nanotechnology comes of age-structural graphene, medicinal use, etc.		NATO and United Nations Authority, Responsibility and Resourcing
Violent Weather	Easy access metals	Population age balance	Formal societal "agreements" -generation to generation/ employer to employee/ government to governed	Flat-worldism and gapology	Instant communications impact on freedom and freedom repression		Metamaterials --potential revolutions in energy, computing, communications, stealth, construction		International Law and Local Governance
Biodiversity loss	Fossil Fuels	Population sex balance	Intensity and Diversity of Value systems	Market Impacts and manipulations	Information Control and Spin by Elected Governments, businesses, "interst groups", criminals, tyrants		Deep Electrical Storage		Ungoverned / Undergoverned /Misgoverned nations and regions
Disease evolution/ pandemics	Radioactive/ useful elements	Human evolutionary trends		Currency Exchange and Primary World Currency Choice	Digital Electronic Learning Opportunities		Wireless Energy Transfer		Tyrannies, dictators and U.S. responsibilities
Water Cycle Changes	Navigable Water			Resource Competition	Virtual Reality Education, Idea Exchange and Mind-Enhancement		High Fidelity, Complex-Part-System, Multi-Material 3-D "Printing" in high volume manufacturing regime		Personal freedom vs security in the U.S. and internationally
	Crop Types						Breakthrough in Stealth -either ending it or perfecting it		International Infrastructure and Geoengineering projects
	Crop quantities						Nuclear Fusion		War, Sanctions, and International Behaviors of National and non-nation actors
	Fertilizer sources						- Low Energy Nuclear Reactions		
	Wind Resouce								
	Water Current-Flow Resource								
	Geothermal resources								
	Ocean Food Chain Basis								

Figure 1: Decontamination Triage Decision Tree

visualization tools and techniques must be developed to render complex interactions into easily understood depictions. Special attention must be given to the verification and validation of data, algorithms, and hypothesis-based digital experimentation, because the findings of this research will influence public policies where billions of lives and trillions of euros are at stake. We must address this complexity head-on. Future planning must embrace this complexity, understand it, use it, and develop solutions that will yield win-win opportunities, and minimize unintended consequences.

Domestically

The environment and topology of Europe and North America is predicted to change significantly during the 21st Century. The roles and missions of the NATO's armed forces can be expected to change and adapt accordingly.

Warmer Weather The European heat waves of 2003 and 2006 are well documented. Apart from the loss of life, there are additional impacts, such as drought, crop failure, pullulating insects, food shortages, spread of diseases, desertification, etc. Hot regions of Europe and North America may become uninhabitable for some or all of the year. Cold regions, like northern Canada, Greenland, and Scandinavia, may become transformed, and the Arctic Ocean could have the busiest seaways on earth.

Stronger Storms If the trends are correct, storms will become stronger and demonstrate paths further north than have been observed in the past. Severe weather not only can encroach upon the routine functions of military operations, but cyclones and other violent weather can create crises that impact the general population and military bases. What should the role be for NATO military forces in the event more severe storms and resulting domestic humanitarian assistance and disaster relief missions?

Precipitation/Water Shortages Changing patterns of precipitation combined with unsustainable water use will fundamentally alter landscape of the Africa, the Middle East, Southern portions of Europe and North America. While most of Europe and North America may not experience water shortfalls, many of Europe's neighbors will. There may well be significant relocations of Africans and Middle Easterners who may be forced to seek their fortunes in Europe and North America. What should the role of NATO's armed forces in the face of regional water shortages? There will be a need for the civil engineering of dams and great aqueducts. There will be a need for the preservation of law and order in areas of widespread unrest and movement of civil populations.

Rising Sea Levels/Melting Ice The effects of climate change will continue to threaten the health and vitality of coastal communities around the world. "Scientific studies suggest high confidence that global mean sea level will rise 0.2 to 2 meters by the end of this century." The numbers could be higher, "there has been much debate over the potential effect of West Antarctic's volume being released into the ocean. The economic and ecological impacts of the resulting 5-m increase in global sea level would depend greatly on the rate at which this change might take place." Over time, more and more coastal communities will need to relocate. NATO Military ports and coastal bases will need to invest in infrastructure improvements, move to higher ground, or simply relocate. Tidal surges associated with hurricanes and typhoons, on top of rising waters will only exacerbate storm damage and flooding of low lying elevations. What should be the role of NATO's armed forces in the face of rising sea

Climatic Considerations	Implications	Domestic Implications	NATO Implications
Warmer Weather	• Spread of tropical disease • Crop failures & food shortages	• Increased energy demands • Medical immunizations • Increased food costs • Social unrest	• Increased energy demands • Medical immunizations • Increased food costs • Social unrest in host nations
Ice Melt	Floods / inundation	• Arctic theater of operation • Basing re-evaluation	• Arctic theater of operation • New roles & missions
Stronger storm Intensity	Greater devastation	• Contingency planning • Military Support for Civilians • Re-evaluation of certain coastal basing	• Humanitarian Assistance / Disaster Relief (HA/DR) Contingency planning • Re-evaluation of certain coastal basing overseas
Changing Patterns of Precipitation	• Water surpluses in some locales • Water shortages elsewhere	• Military Support for Civilians • Social unrest • Basing re-evaluations	• More HA/DR missions • Social unrest • Wars over resources • Overseas basing re-evaluations
Water Shortages	• Changes in arable land (crop failures & food shortages) • Mass migration • Fundamental changes in aquifers & water tables	• Military Support for Civilians • Social unrest • Basing re-evaluations	• More HA/DR missions • Social unrest, failure of governance • Wars over resources • Overseas basing re-evaluations
Rising Sea Levels	• Flooding / inundation • Mass migrations • Changes in thermal Hyaline cycle	• Military Support for Civilians • Social unrest • Basing re-evaluations (especially naval bases)	• More HA/DR missions • Social unrest, failure of governance • Wars over resources • Overseas basing re-evaluations

Figure 1: Decontamination Triage Decision Tree

levels? There will be a need for the civil engineering to protect coastal infrastructure. There will be a need for the preservation of law and order in areas of widespread unrest and movement of civil populations.

Internationally

It is most likely that the first symptoms of these existential threats will first be felt in other parts of the world; and that third world countries may experience greater impacts than NATO territories. Access to affordable energy, water shortages, etc. will elicit a cascade of implications upon agriculture, livestock, urbanization, economics and population. The tropics are expected to be hit hard. The complex causes-and-effects will lead to a situation where desperate people will likely take desperate measures, including mass evacuations out of unsustainable regions of the world. Long-term chronic trends – such as rising sea levels, water shortages, and inadequate resources – will be interspersed with acute events, some of which will be climactic – such as severe storms and violent weather – and other acute events may be man-made – such as major civil engineering efforts to redirect fresh water sources to new locations. These existential threats have the potential for great pain and suffering, conflicts across the spectrum from small internal scuffles to "acts of war" and geo-engineering. Long-standing friends and allies within NATO will not be able to escape the effects of these existential threats. As the next few decades unfold, the roles and missions of NATO can be expected to change and adapt accordingly. Internationally, NATO's armed forces are likely to be busier than ever before.

Summary

Scientific data is mounting, and during the 21st Century, NATO will be facing enormous challenges brought on by a variety of Existential Threats to International Security, including energy, water, climate change, etc.. It is imperative to engage in proactive planning, in advance of need, to help influence and shape viable cost-effective solutions that can be implemented in a timely manner.

The challenges before us are so large and complex; they cannot be effectively addressed using historic approaches. We must address this complexity head-on. We must step forward and take advantage of the next generation planning tools that are within our grasp. Future planning must embrace this complexity, understand it, use it, and develop solutions that will yield win-win opportunities, and minimize unintended consequences.

We propose to bring together government, academia and industry teams to work together to develop solutions to the challenges before us. We must conduct forums – domestically and internationally -- to set forth courses of action, identify the best and brightest minds, collect the data, and carefully build the interdependent analytics and robust visualization needed to study and assess these daunting challenges, then we must all tenaciously pursue viable solutions for not only ourselves, but our posterity.

In support of this end, Team 5 members have seized the initiative and created the following non-profit foundations to interact with government, academia and industry partners to use Data Farming to explore emergent existential threats to international security, and conduct "what if?" assessments and research into ways and means to mitigate the effects of existential threats. Ultimately, the goal is to save lives and protect private and public investments.

International Association for Foresight and Solutions

Specific Purpose

To save lives, preserve resources and protect private and public investments *through research, education, and planning.*

Association's Philosophy

The association is focused upon multi-discipline education and research topics with major regional and global implications

- Selected topics will be analyzed and assessed with the utmost academic rigor, scrutiny and integrity
- Statistical trends, patterns and insights will be documented and published
- Topics of highest importance will be further examined to assess a scope of alternative courses of action
- The goal of the association is to identify ameliorating courses of action that lead to collaboratively beneficial solutions (i.e., "win-win" or winNth outcomes) across multiple domains
- Publish findings, conduct courses and seminars, and provide educational materials

Institute for Confronting Global Challenges

Scientific institute with the goal of conducting multi-discipline research into topics significant regional and global implications

- Advocate the establishment of a "data observatory" of any/all information repositories needed to conduct research
- Conduct research into smart analytics and information analysis to address challenges associated with distributed massive data sets
- Conduct research into innovative modeling and simulation tools and techniques to enable credible and insightful predictive analysis for selected topic areas
- Support a range of "what if?" analyses to explore a range of cross-disciplinary courses of action that could be taken to enhance positive trends and/or mitigate aversive trends
- Collaborate with government, academia and industry to enlist best practices, methodologies and tools are used – striving for continued improvement and excellence
- Publish findings, conduct courses and seminars, and provide educational materials

Foundation for Prediction, Mitigation and Planning

Educational institute with the goal of making cutting-edge research available to the general public

- Special emphasis on multi-discipline research topics with major regional and global implications, with an initial focus on North America and the United States
- The foundation has a non-partisan, apolitical perspective on the long-term implications of short-term decisions
- Provide planning support for individuals, communities, corporations, non-profits, municipal, local and state governments
- Publish findings, conduct courses and customized training, and provide educational materials

Finally

Team 5 is committed to using Data Farming for a Better Tomorrow. Our philosophy to interdisciplinary problem solving is to reach out to the best and brightest minds across government, academia and industry and forge a coalition of the willing. We strive to not only identify key scientifically-based risk areas facing NATO and our communities, but we seek to partner with solutions-minded professionals who can identify appropriate, adequate, and affordable solutions or mitigation strategies.

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IDEAS

+ ACTION

= CHANGE

Team 06: Data Farming and Networks

Team 6 Members

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Introduction

Data farming is an integration of distillation modeling, experimental design, rapid prototyping, high performance computing, big data analysis techniques and collaborative processes. This What-If Workshop team is undertaking an ongoing study and effort to integrate network analysis techniques into data farming processes and analysis. The application of social network analysis (SNA) techniques to understand network emergence and evolution within simulations has been examined at previous data farming workshops. The changing landscape of complex system modeling requires us to look at networks and be able to examine and relate network statistics to outcome landscapes and effectiveness.

Question

From previous workshops we have demonstrated that we can quantify attributes of communication, proximity, interaction, homophily and other networks extracted from ABMs. This effort is aimed at addressing the following related questions:

- Can we use these metrics as measures of effectiveness or thesholds for evaluation of models?
- Can we use these metrics to compare various classes of models and scenarios to begin to develop a taxonomy of implicit extracted network types?

Focus

The focus of this effort will be the researching and preparing a paper on network analysis of implicit networks in data farming output. We will examine and report on the utility of various network metrics and statistics in classification / differentiation of networks found within the class of models typical built in data farming efforts. Some metrics we will examine include network entropy, complexity, connectedness, and well as other commons network statistics.

Initial Model, Scenarios,

The initial model/scenario we will be examining is the Pythagoras Chat scenario reported on in previous workshop bulletins (Scythe 9, 10, 11, 12, 14). The following 4 excursions will be compared for our analysis.

- Class 1: All agents chat only to like-minded agents; movement is toward like-minded agents
- Class 2: All agents proselytize to opposing agents; movement is toward opposing agents
- Class 3: Agents have no preferences; Movement is minimized and agents chat to closest agents
- Class 4: Agents are randomly distribution of 3 classes above.
- Various balances of agent types are considered/data farmed

Network Statistics and Measurements of Effectiveness

We will be examining these scenarios using multiple metrics to determine which metrics are most effective in differentiating the classes of network consistently. We will determine which metrics are consistently highly correlated and which vary correlation depending on the class of scenario. Metrics will include statistics delineating the entropy (Structural information content of network) as well as other complexity network statistics.

We will examine the time series as well, capturing metrics over time and determining how the statistics vary by class over time. We will also be examining metrics for the sub-nets and there relation to the median net values.

Tools

We expect to be using the QuaCN (Quantitative Analyze of Complex Networks) and other R packages to measure entropy.

Way Ahead

We will be suing available time and resources to build the four Pythagoras Chat scenarios, Data farm these scenarios over basic network generation criteria such as link definitions, and analyze the result. The intent is to publish the resulting analysis in a peer reviewed journal.

What If? Workshop 29

When:
Where:
Hotel:

No fee for Workshop!

Tentative Agenda
Sunday
Monday
Tuesday
Friday.

Contact:
Dr. Gary Horne at datafarming@verizon.net.

Scythe - Proceedings and Bulletin of the International Data Farming Community

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