Juha Panula-Ontto
Project Researcher
University of Turku / Finland Futures Research Centre
M.Sc. (Admin.)
M.Sc. (Computer science)
+358 50 411 4501
juha.panula-ontto@utu.fi

AXIOM
Conceptually simple and flexible **cross-impact modeling**
and **analysis** approach
Cross-impact analysis (XIA) and modeling

- Origins in 1960’s; lot of methodological discussion in 1970’s
- XIA approaches are tools for modeling all kinds of systems
  - Energy systems, international politics, technology foresight, industry foresight projects
  - wide applicability
- XIA models can be used in
  - **Understanding** how the modeled system works; **identifying** important parts
  - Analysing **impact of changes**
  - **Policy evaluation**: strategic decision-making; intervention point evaluation
  - Multiple **actor simulations**: complex collaboration arrangements
  - **Morphological analysis**: identification of possible and probable system states
    - (scenarios)
XIA modeling vs other modeling approaches

- Input data (cross-impact model) is expert-sourced: using expert understanding in modeling
  - Fitness for foresight / futures
- Many systems do not have a lot of empirical or statistical data about them
- Important aspects of the system can be difficult to quantify
- Empirical data can be an impossibility
  - Enables modeling of systems where data-driven modeling is not feasible

- **Theory-driven modeling** instead of **data-driven modeling**

Different approaches

**STRUCTURE-FOCUSED**

- Matrix multiplication method
  - MICMAC
  - ADVIAN
- Cross-Impact Balances approach
  - EXIT

**PROBABILITY-FOCUSED**

- Gordon’s method
- SMIC (Godet)
- BASICS
- AXIOM
Why new cross-impact approaches?

- Problems in existing probability-oriented approaches:
  - **Impracticality**: Heavy cognitive load for experts
  - Modeling primitives have **limited modeling power**
  - Not suitable for **extensive system models**
  - Unclear **documentation**
  - Lacking **software implementations**

**AXIOM model**

- AXIOM models consist of **statements** with multiple possible states that are called **options**, and **impacts** between these options
- Statements: system components, states, driving forces, events
  - Temporal position, in relation to other statements
- Options: possible states of statements
  - mutually exclusive and (in theory) exhaustive
  - a probability (a priori, adjusted, a posteriori)
- Impacts: probability-changing interactions between **options**
Governing parties in Finland 2019-2023

True Finns
Green + SDP
Coal. + SPP
Rainbow coalition

AXIOM model

Economic growth (GDP) in 2023-2020
Low (0-1.5% p.a.)
High (>1.5% p.a.)

Statements

EU
EAEU
Non-aligned

Finland's membership in supranational unions 2022-2030

EU
EAEU
Non-aligned
Governing parties in Finland 2019-2023

True Finns
Green + SDP
Coal. + SPP
Rainbow coalition

Timesteps:
Temporal categories of statements

Economic Growth (GDP) in 2023-2020
Low (0-1.5%pa)
High (+1.5%pa)

EU
Finland's membership in supranational unions 2023-2020

Options

Low (0-1.5%pa)
High (+1.5%pa)

EAEU
Finland's membership in supranational unions 2023-2030

Non-allied
Adding the impacts to the cross-impact model.
Adding the impacts to the cross-impact model
Governing parties in Finland 2019-2023

True Finns
Green + SDP
Coal. + SPP
Rainbow coalition

Economic Growth (GDP) in 2023-2030
Low (0-1.5% pa)
High (1.5-4% pa)

Economic Growth (GDP) in 2023-2030
Low (0-1.5% pa)
High (1.5-4% pa)

Adding the impacts to the cross-impact model
A **valuated** AXIOM model
The impact indices correspond to probability adjustment functions

Adjusting the probability (0.5) of an option by function ”+3”
Adjusting the probability (0.5) of an option by function ”+3”:
Adjusted from 0.5 to 0.785

+4
+3
+2
+1
0
(-1)
(-2)
(-3)
(-4)

Adjusting the probability (0.1) of an option by function ”+4”

+4
+3
+2
+1
0
(-1)
(-2)
(-3)
(-4)
Adjusting the probability (0.1) of an option by function "+4":
Adjusted from 0.1 to 0.435

Probability adjustment functions replace conditional probabilities

- Expressing the interactions with indices is easier than with conditional probabilities
- Makes possible to model system in greater detail

- There can be as many probability adjustment functions as needed
- The probability adjustment functions need to have domain of [0,1] and a codomain of [0,1]
- The probability adjustment functions are referred by their names, usually indices, but the names can be words if preferred
- The expert evaluators need to understand the meaning of impact indices/names
  - the available probability functions must be presented in detail before valuation
Governing parties in Finland 2019-2023

- True Finns
- Green + SDP
- Coal. + SPP
- Rainbow coalition

Model evaluation

Statements with the lowest timestep are processed first, in random order.
The "temporal categories" in this model are 1 and 2; Statements in category 1 are evaluated first.

There is only one statement in the first temporal category.
Governing parties in Finland 2019-2023

- True Finns
- Green + SDP
- Coal. + SPP
- Rainbow coalition

Statement is evaluated, meaning one of its options will be assigned as its state.

The probability value of the option is the probability of selection of that particular option as the state.
The statement “Governing parties in Finland 2019-2023” is evaluated to option “Coalition party + SPP”.

The impacts of the option assigned as the state of the statement ensue.
Impact "+4" changes the probability of option "EU"

The probabilities of other options are also adjusted to preserve a valid probability distribution.
Impact "+2" changes the probability of "High" option of statement "Economic growth"; Probability of option "Low" is also adjusted to preserve the valid distribution.

All the statements in temporal category 1 have now been evaluated.
The statements in temporal category 2 are evaluated in random order.

The evaluation starts randomly at statement "Finland’s membership in supranational unions"
The evaluated statement is assigned a state

The impacts ensue
Governing parties in Finland 2019-2023

- True Finns: 0.3
- Green + SDP: 0.1
- Coal. + SPP: 0.25
- Rainbow Coalition: 0.35

Probabilities are adjusted.

Economic Growth (GDP) in 2023-2020

- Low (0%–1.5% p.a.): 0.25
- High (1.5%–4% p.a.): 0.75

The next statement in the random ordering of the statements in the temporal category is evaluated.
Governing parties in Finland 2019-2023

- True Finns
- Green + SDP
- Coal. + SPP
- Rainbow coalition

A state is assigned

Impacts ensue;
In this case, the impacted option is in a statement that has already been evaluated and has a state, so the impact does not change anything
All the statements in the model have been evaluated, and so the entire model has been evaluated.

The result of the model evaluation is called configuration; it can be thought of as a scenario.
### Configurations and iteration

The result of the evaluation (the configuration) can be tabulated as boolean values of all the options in the model.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth: High</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Economic growth: Low</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unions: EU</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unions: EAEU</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unions: Non-allied</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Coal+SPP</td>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Green+SDP</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Rainbow</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: True Finns</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Another model evaluation is performed, and another configuration is produced.
### Configurations and iteration

#### Statement: Option

| Economic growth: High | 0 | 1 | 0 |
| Economic growth: Low  | 1 | 0 | 1 |
| Unions: EU            | 1 | 1 | 1 |
| Unions: EAEU          | 0 | 0 | 0 |
| Unions: Non-allied    | 0 | 0 | 0 |
| Governing parties: Coal+SPP | 1 | 0 | 0 |
| Governing parties: Green+SDP | 0 | 0 | 0 |
| Governing parties: Rainbow | 0 | 1 | 0 |
| Governing parties: True Finns | 0 | 0 | 1 |

The process is repeated ...

---

### Configurations and iteration

#### Statement: Option

| Economic growth: High | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| Economic growth: Low  | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| Unions: EU            | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| Unions: EAEU          | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Unions: Non-allied    | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Governing parties: Coal+SPP | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Governing parties: Green+SDP | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Governing parties: Rainbow | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| Governing parties: True Finns | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

... a large number of times.
## Configurations and iteration

A set of configurations is called an iteration

### Example:

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Configuration Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth: High</td>
<td>0 1 0 1 0 0 1 0 0 1 0 1</td>
<td></td>
</tr>
<tr>
<td>Economic growth: Low</td>
<td>1 0 1 0 1 1 0 1 1 0 1 0</td>
<td></td>
</tr>
<tr>
<td>Unions: EU</td>
<td>1 1 1 0 0 1 1 1 1 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Unions: EAEU</td>
<td>0 0 0 0 0 0 0 0 0 0 1 1</td>
<td></td>
</tr>
<tr>
<td>Unions: Non-allied</td>
<td>0 0 0 1 1 0 0 0 0 1 0 0</td>
<td></td>
</tr>
<tr>
<td>Governing parties: Coal+SPP</td>
<td>1 0 0 0 0 0 0 0 0 1 0 0</td>
<td></td>
</tr>
<tr>
<td>Governing parties: Green+SDP</td>
<td>0 0 0 1 1 0 0 0 0 0 1</td>
<td></td>
</tr>
<tr>
<td>Governing parties: Rainbow</td>
<td>0 1 0 1 0 0 1 1 1 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Governing parties: True Finns</td>
<td>0 0 1 0 0 0 0 0 0 1 0</td>
<td></td>
</tr>
</tbody>
</table>

The iteration object can be analyzed with all association rule learning operations:

- Support
  - A posteriori probability for a single item
  - Joint probability
- Confidence
- Lift
- Conviction
### Configurations and iteration

<table>
<thead>
<tr>
<th>Statement: Option</th>
<th>A priori</th>
<th>A posteriori</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth: High</td>
<td>0.50</td>
<td>0.417</td>
</tr>
<tr>
<td>Economic growth: Low</td>
<td>0.50</td>
<td>0.583</td>
</tr>
<tr>
<td>Unions: EU</td>
<td>0.60</td>
<td>0.583</td>
</tr>
<tr>
<td>Unions: EAEU</td>
<td>0.10</td>
<td>0.167</td>
</tr>
<tr>
<td>Unions: Non-allied</td>
<td>0.30</td>
<td>0.250</td>
</tr>
<tr>
<td>Governing parties: Coal+SPP</td>
<td>0.25</td>
<td>0.167</td>
</tr>
<tr>
<td>Governing parties: Green+SDP</td>
<td>0.10</td>
<td>0.250</td>
</tr>
<tr>
<td>Governing parties: Rainbow</td>
<td>0.35</td>
<td>0.417</td>
</tr>
<tr>
<td>Governing parties: True Finns</td>
<td>0.30</td>
<td>0.167</td>
</tr>
</tbody>
</table>

The frequency of each option in the iteration is the *a posteriori probability* of the option in question. The probability of the option when all the systemic or higher-order impacts have been factored into its probability.

---

### A posteriori probabilities (12 configurations)

A number of 12 configurations is insufficient for computing stable *a posteriori* probabilities; minimum of 10^6 configurations are recommended.
## Intervention statements

- Statements can be flagged as intervention statements
  - This means the statement will have a predefined state in the model evaluation

- All possible combinations of options of different intervention statements (cartesian product) are processed in their own iterations (consisting of a great number of evaluations that result in configurations)

- The different iterations can be compared against each other for probability changes in target options
  - Maximising probability of desirable outcome(s)
  - Minimizing probability of undesirable outcome(s)

### Iteration set with 1 intervention statement and $10^6$ configurations / iteration

<table>
<thead>
<tr>
<th>Statement: Option</th>
<th>apriori</th>
<th>[0]</th>
<th>[1]</th>
<th>[2]</th>
<th>[3]</th>
<th>[4]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth: High</td>
<td>0.5</td>
<td>0.523</td>
<td>0.669</td>
<td>0.512</td>
<td>0.519</td>
<td>0.411</td>
</tr>
<tr>
<td>Economic growth: Low</td>
<td>0.5</td>
<td>0.478</td>
<td>0.331</td>
<td>0.488</td>
<td>0.481</td>
<td>0.59</td>
</tr>
<tr>
<td>Unions: EU</td>
<td>0.6</td>
<td>0.58</td>
<td>0.858</td>
<td>0.605</td>
<td>0.714</td>
<td>0.186</td>
</tr>
<tr>
<td>Unions: EAEU</td>
<td>0.1</td>
<td>0.088</td>
<td>0.038</td>
<td>0.094</td>
<td>0.077</td>
<td>0.141</td>
</tr>
<tr>
<td>Unions: Non-allied</td>
<td>0.3</td>
<td>0.332</td>
<td>0.105</td>
<td>0.302</td>
<td>0.209</td>
<td>0.673</td>
</tr>
<tr>
<td>Governing parties: Coal+SPP</td>
<td>0.25</td>
<td>0.25</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Green+SDP</td>
<td>0.1</td>
<td>0.1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Rainbow</td>
<td>0.35</td>
<td>0.35</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: True Finns</td>
<td>0.3</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

[0] = no intervention
[1] = Coalition and SPP
[2] = Green party and SDP
[3] = Rainbow coalition
[4] = True Finns
### Iteration set with 1 intervention statement and $10^6$ configurations / iteration

<table>
<thead>
<tr>
<th>Statement: Option</th>
<th>apriori</th>
<th>[0]</th>
<th>[1]</th>
<th>[2]</th>
<th>[3]</th>
<th>[4]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth: High</td>
<td>0.5</td>
<td>0.523</td>
<td><strong>0.669</strong></td>
<td>0.512</td>
<td>0.519</td>
<td>0.411</td>
</tr>
<tr>
<td>Economic growth: Low</td>
<td>0.5</td>
<td>0.478</td>
<td>0.331</td>
<td>0.488</td>
<td>0.481</td>
<td>0.59</td>
</tr>
<tr>
<td>Unions: EU</td>
<td>0.6</td>
<td>0.58</td>
<td>0.858</td>
<td>0.605</td>
<td>0.714</td>
<td>0.186</td>
</tr>
<tr>
<td>Unions: EAEU</td>
<td>0.1</td>
<td>0.088</td>
<td>0.038</td>
<td>0.094</td>
<td>0.077</td>
<td>0.141</td>
</tr>
<tr>
<td>Unions: Non-allied</td>
<td>0.3</td>
<td>0.332</td>
<td>0.105</td>
<td>0.302</td>
<td>0.209</td>
<td>0.673</td>
</tr>
<tr>
<td>Governing parties: Coal+SPP</td>
<td>0.25</td>
<td>0.25</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Green+SDP</td>
<td>0.1</td>
<td>0.1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Rainbow</td>
<td>0.35</td>
<td>0.35</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: True Finns</td>
<td>0.3</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

*Iteration set 1 (With active intervention option “Coalition party+SPP” maximises the probability of high economic growth)*

---

### Iteration set with 1 intervention statement and $10^6$ configurations / iteration

<table>
<thead>
<tr>
<th>Statement: Option</th>
<th>apriori</th>
<th>[0]</th>
<th>[1]</th>
<th>[2]</th>
<th>[3]</th>
<th>[4]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth: High</td>
<td>0.5</td>
<td>0.523</td>
<td><strong>0.669</strong></td>
<td>0.512</td>
<td>0.519</td>
<td>0.411</td>
</tr>
<tr>
<td>Economic growth: Low</td>
<td>0.5</td>
<td>0.478</td>
<td>0.331</td>
<td>0.488</td>
<td>0.481</td>
<td>0.59</td>
</tr>
<tr>
<td>Unions: EU</td>
<td>0.6</td>
<td>0.58</td>
<td>0.858</td>
<td>0.605</td>
<td>0.714</td>
<td>0.186</td>
</tr>
<tr>
<td>Unions: EAEU</td>
<td>0.1</td>
<td>0.088</td>
<td>0.038</td>
<td>0.094</td>
<td>0.077</td>
<td>0.141</td>
</tr>
<tr>
<td>Unions: Non-allied</td>
<td>0.3</td>
<td>0.332</td>
<td>0.105</td>
<td>0.302</td>
<td>0.209</td>
<td>0.673</td>
</tr>
<tr>
<td>Governing parties: Coal+SPP</td>
<td>0.25</td>
<td>0.25</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Green+SDP</td>
<td>0.1</td>
<td>0.1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Rainbow</td>
<td>0.35</td>
<td>0.35</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: True Finns</td>
<td>0.3</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

*Iteration set 4 (With active intervention option “True Finns” maximises the probability of a non-allied position)*
Probability of "partial scenarios" or morphologies

<table>
<thead>
<tr>
<th>Statement: Option</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth: High</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Economic growth: Low</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Unions: EU</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Unions: EAEU</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Unions: Non-allied</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Governing parties: Coal+SPP</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Governing parties: Green+SDP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: Rainbow</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Governing parties: True Finns</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

\[ P(1\wedge 3) = \frac{2}{12} \approx 0.17 \]

Larger model and timesteps

- Intervention statement
- Normal statement
- Target statement

2017-2019 | 2020-2024 | 2025-2029 | 2030-2040
Why AXIOM instead of Gordon/SMIC/BASICS?

- Flexible, powerful and practical modeling language
  - Multivalued statements
  - Temporal dimension in modeling with timestep
  - Expression of interactions with impact indices (referencing probability adjustment functions)
    - Greatly reduces cognitive load for expert valuations
    - Makes extensive models possible
- Good facilitation of analytical outputs
  - Iteration objects enable new analytical outputs
  - Once model is built, changes and interventions can be tested easily
  - New components can be added easily
- Transparent documentation
- Free, well documented, extensible software implementation

Further information

- (yet) unpublished EXIT method paper available on request
  - juha.panula-ontto@utu.fi
- "AXIOM Method for Cross-Impact Modeling and Analysis"
- AXIOM implementation
  - https://github.com/jmpaon/AXIOM
- EXIT implementation
  - https://github.com/jmpaon(EXIT