

“Qualitative and quantitative methodologies for the assessment of rangeland governance”
INRAT, 3rd to 5th of December 2019.

BBN : Bayesian Belief Network

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BBN : Introduction

What is Bayesian Belief Network (BBN)?

- **Bayesian Belief Network (BBN)** is a probabilistic graphical model of causal relationships.
- BBN allows a representation of the variables conditionally independent → I.e. Represents dependency among the variables.



Bayesian belief networks are a convenient mathematical way of representing dependencies between multiple events.

What is Bayesian Belief Network (BBN)?

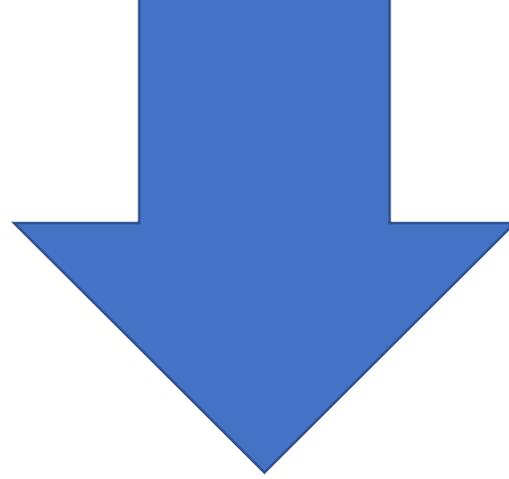
Two major tasks to understand the BBN :

- The Graphical structure
- The CP table

A BBN structure model

Nodes : are the features

Links/Edges : represents
relations between
features



BBN is a set of **nodes** connected by directed **edges**

Each node is associated with a ***conditional probability distribution*** which quantitatively expresses the strength of the relationship between that node and its parents.

Nodes

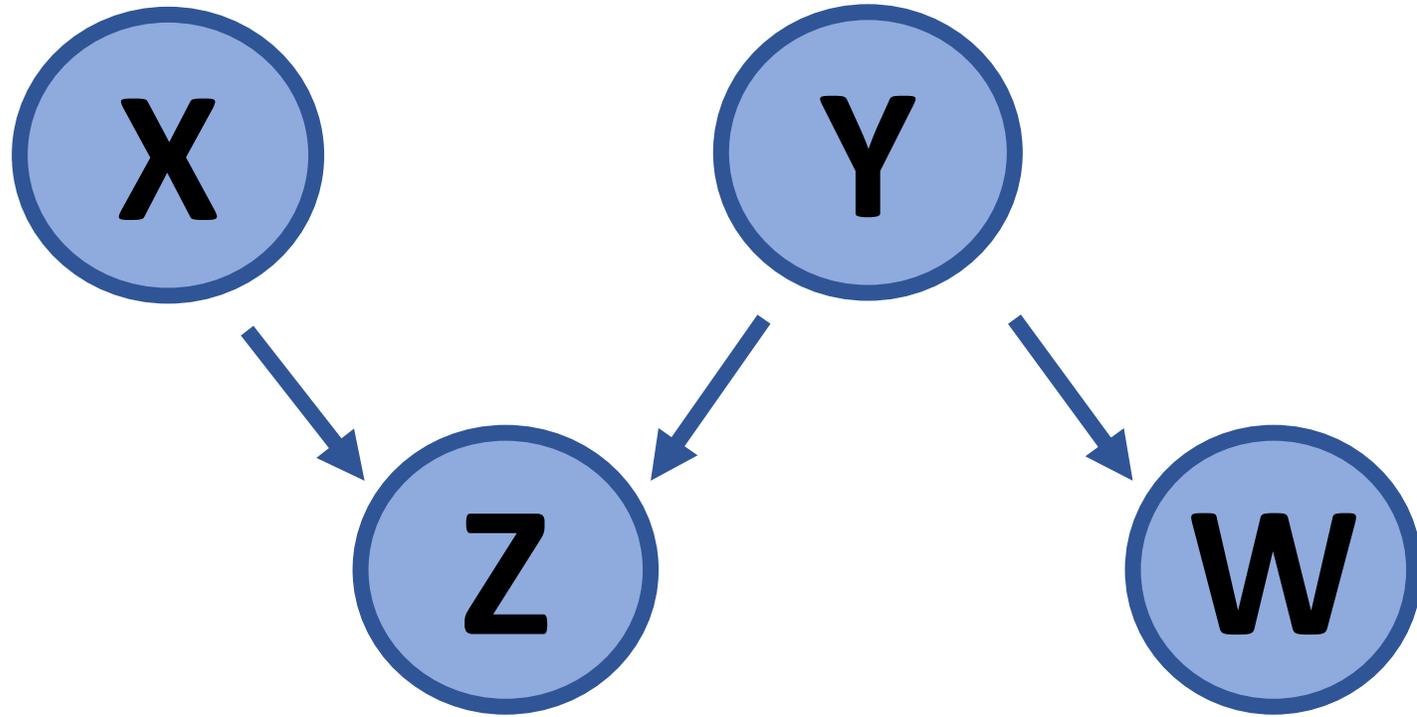
- Nodes : are the features.
- Each node is a discrete or continuous random variable.
- Takes multiple states/value/parameters,
- States occur with a certain probability → beliefs (Bayesian Belief Network)
- Beliefs (Conditional distribution) are gathered in a Conditional Probability Table CPT.

Links/Edges

- Dependency
- Represent direct or causal relationships between variables



Do not form cycles



- X and Y are the parents of Z
- W is the child node of Y
- No dependency between Z and W

3 discrete (Yes/No) variables

Train strike	Probability
Y	0.1
N	0.9

CPTs

Nodes

Train Strike (TS)

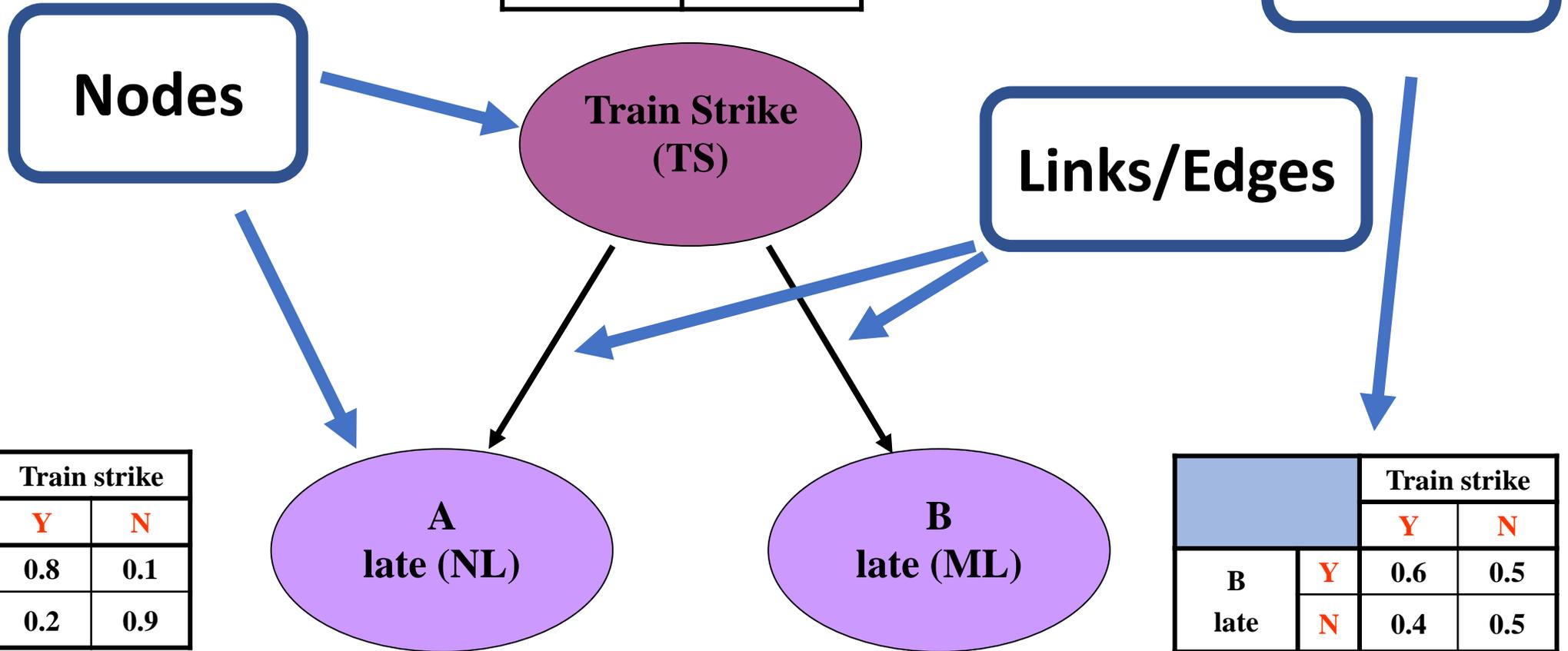
Links/Edges

A late (NL)

B late (ML)

		Train strike	
		Y	N
A late	Y	0.8	0.1
	N	0.2	0.9

		Train strike	
		Y	N
B late	Y	0.6	0.5
	N	0.4	0.5



Why BBN ?

BBN allows to calculate probabilities of different scenarios (events) relevant to the problem and to predict consequences of these scenarios

Parameters (states) estimation

→ Through likelihood estimation.

- Example :

We have :

- 40 times bad weather
- 60 times good weather

→ The likelihood of bad weather state is $40\% =$ bad weather is 40% likely to happen

Rangelands Governance and the use of the BBN approach

Rangelands Governance and the use of the BBN approach

- The capacity to assess the influences and interdependencies of different types of factors.
- uncovering aspects of governance that may affect adaptive rangeland resources in time and space.
- Provides a framework to visualized interactions between variables.

Rangelands Governance and the use of the BBN approach

- The possibility to integrate Ecology, Economics and Social Sciences within the same analytical decision model
- The possibility to cover both qualitative (stakeholder's opinions and knowledge) and quantitative data.
- Facilitate focus group discussions → a communication space between the different actors from multi-disciplinary backgrounds

Practical Training

Download NETICA

The screenshot shows a web browser window with the URL https://www.norsys.com/tutorials/netica/nt_toc_A.htm. The website header features the Norsys Software Corp. logo and a navigation menu with links for Home, Products, Downloads, Resources, Site Map, Order, and Corporate. The main content area is titled "Netica Tutorial" and includes a table of contents with tabs for "A - Introduction", "C - Intermediate", and "D - Advanced". The "A - Introduction" tab is selected, displaying the following content:

Preface: Keep in mind when doing tutorials that there is a great deal of assistance available from Netica's onscreen help, often about the exact networks of the tutorials. The Online Help is the best source for up-to-date documentation on Netica's features.
For suggested guidelines, read: [How to approach this tutorial](#)
Note: the links in this table of contents will open in a new tab, replacing itself when another topic is clicked. If you have clicked on a link and it doesn't appear to be opening, check the other Tutorial tabs open in your browser.

A. Introduction to Bayes Nets

1. What is a Bayes Net?
 - o Why are they useful?
 - o Why are they called Bayes nets?
 - o What are they used for?
 - Automated diagnosis
 - Prediction
 - Financial risk management, portfolio allocation, insurance
 - Modeling ecosystems
 - Sensor fusion
 - Monitoring and alerting
 - o Interesting Properties of Bayes Nets
2. Using a Bayes Net
 - o Compiling the net

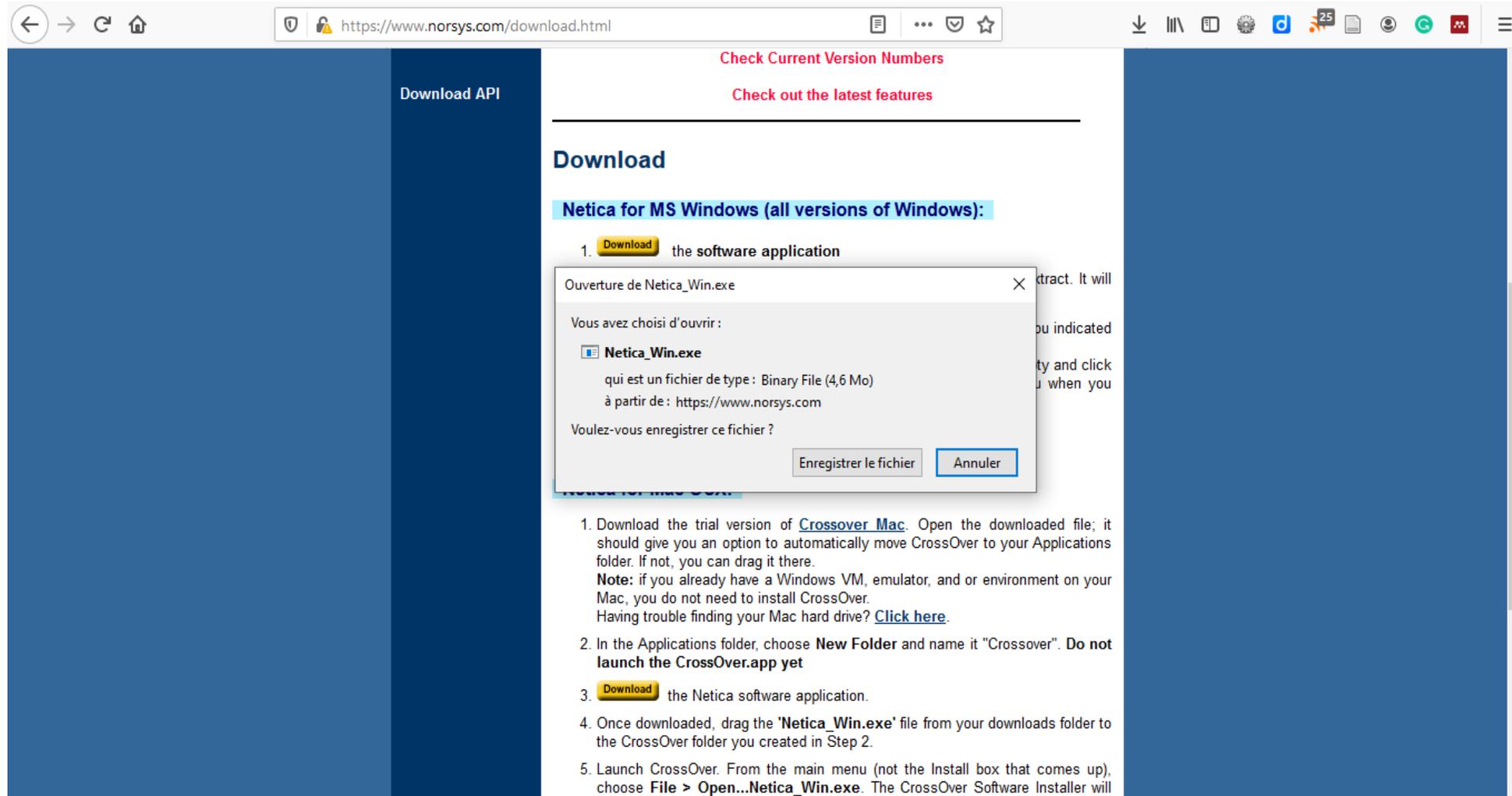
Download NETICA

The screenshot shows a web browser window with the URL <https://www.norsys.com/download.html>. The page has a dark blue sidebar on the left with the text "Download API". The main content area is white and contains the following elements:

- Two red links: "Check Current Version Numbers" and "Check out the latest features".
- A horizontal line.
- A blue heading: "Download".
- A blue sub-heading: "Netica for MS Windows (all versions of Windows):".
- A numbered list of four steps for Windows installation, with a yellow "Download" button icon next to step 1.
- A red link: "Online Installation Help".
- A blue sub-heading: "Netica for Mac OSX:".
- A numbered list of five steps for Mac installation, with a yellow "Download" button icon next to step 3.

At the bottom left of the browser window, a small white box contains the URL: https://www.norsys.com/downloads/Netica_Win.exe.

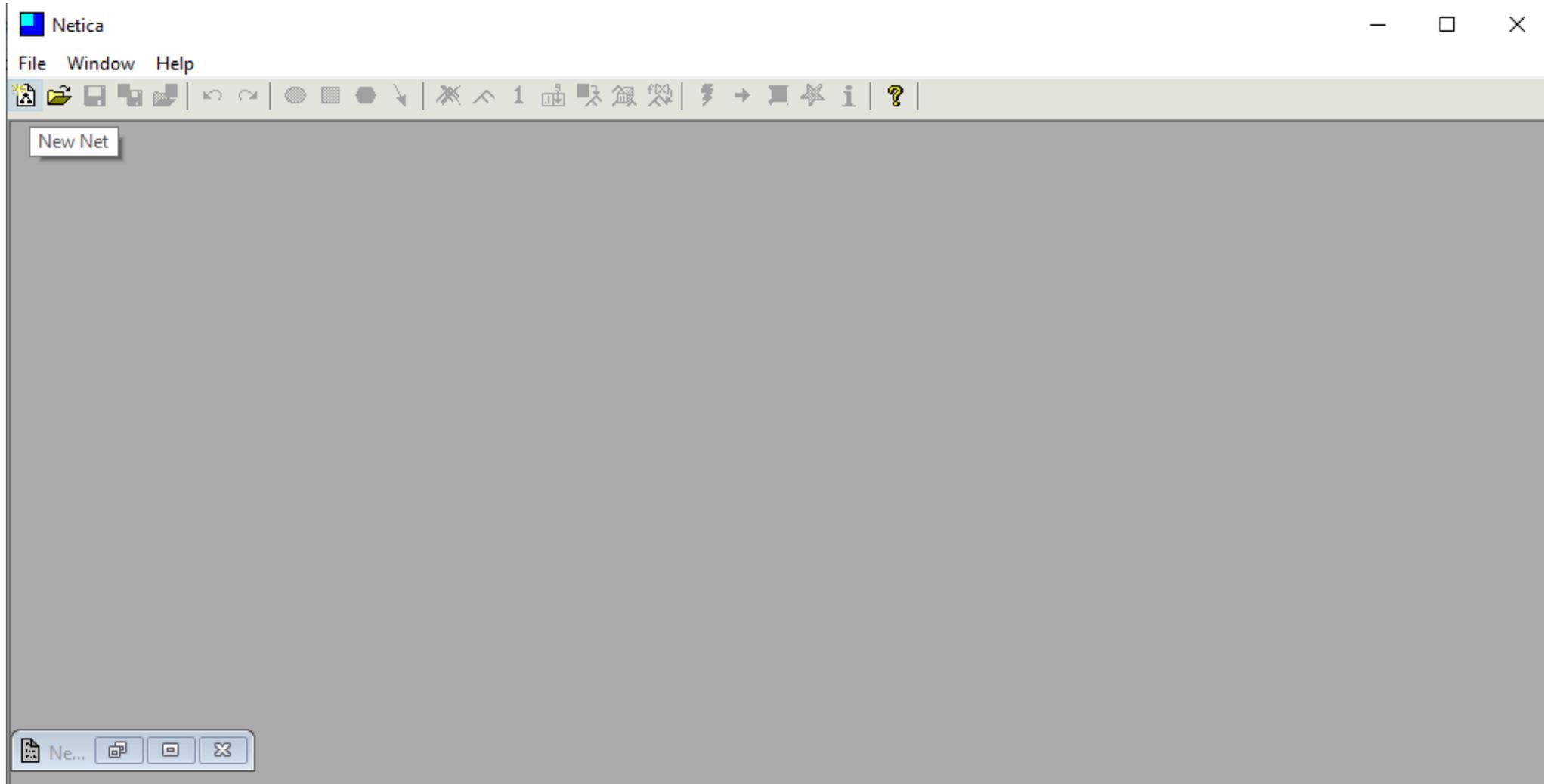
Download NETICA



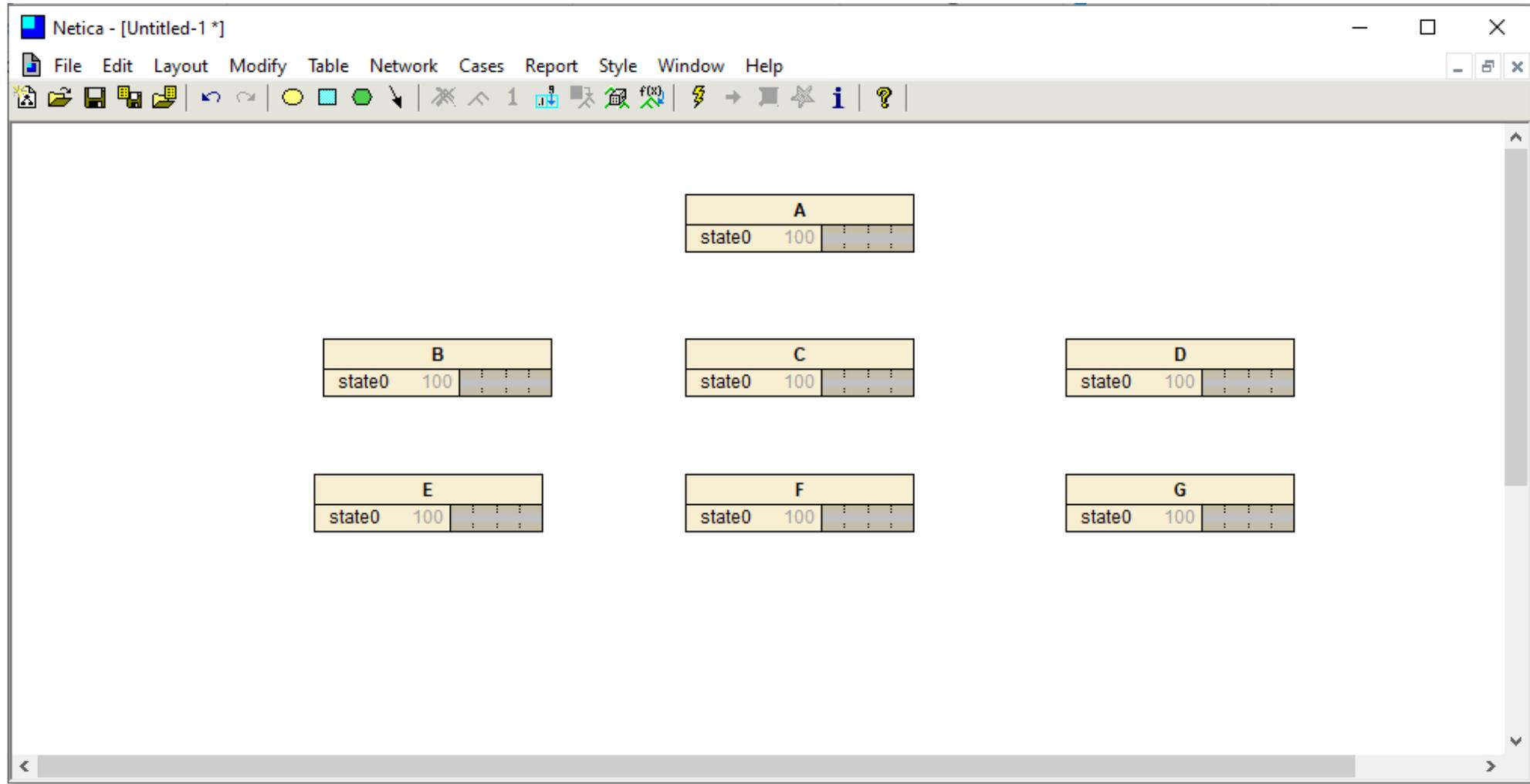
The screenshot shows a web browser window at <https://www.norsys.com/download.html>. The page has a dark blue sidebar on the left with the text "Download API". The main content area is white and contains the following elements:

- Two red links: "Check Current Version Numbers" and "Check out the latest features".
- A section header "Download".
- A blue highlighted box containing the text "Netica for MS Windows (all versions of Windows):".
- A numbered list starting with "1. [Download](#) the software application".
- An overlaid dialog box titled "Ouverture de Netica_Win.exe" with the following text:
 - "Vous avez choisi d'ouvrir :
 - Netica_Win.exe
 - qui est un fichier de type : Binary File (4,6 Mo)
 - à partir de : <https://www.norsys.com>
 - "Voulez-vous enregistrer ce fichier ?"
 - Buttons: "Enregistrer le fichier" and "Annuler".
- Additional instructions for installation, including a note about Crossover Mac and a link to find the Mac hard drive.
- Further steps in the numbered list: "2. In the Applications folder, choose **New Folder** and name it "Crossover". **Do not launch the CrossOver.app yet**", "3. [Download](#) the Netica software application.", "4. Once downloaded, drag the 'Netica_Win.exe' file from your downloads folder to the CrossOver folder you created in Step 2.", and "5. Launch CrossOver. From the main menu (not the Install box that comes up), choose **File > Open...Netica_Win.exe**. The CrossOver Software Installer will

Opening new net



Add Nodes



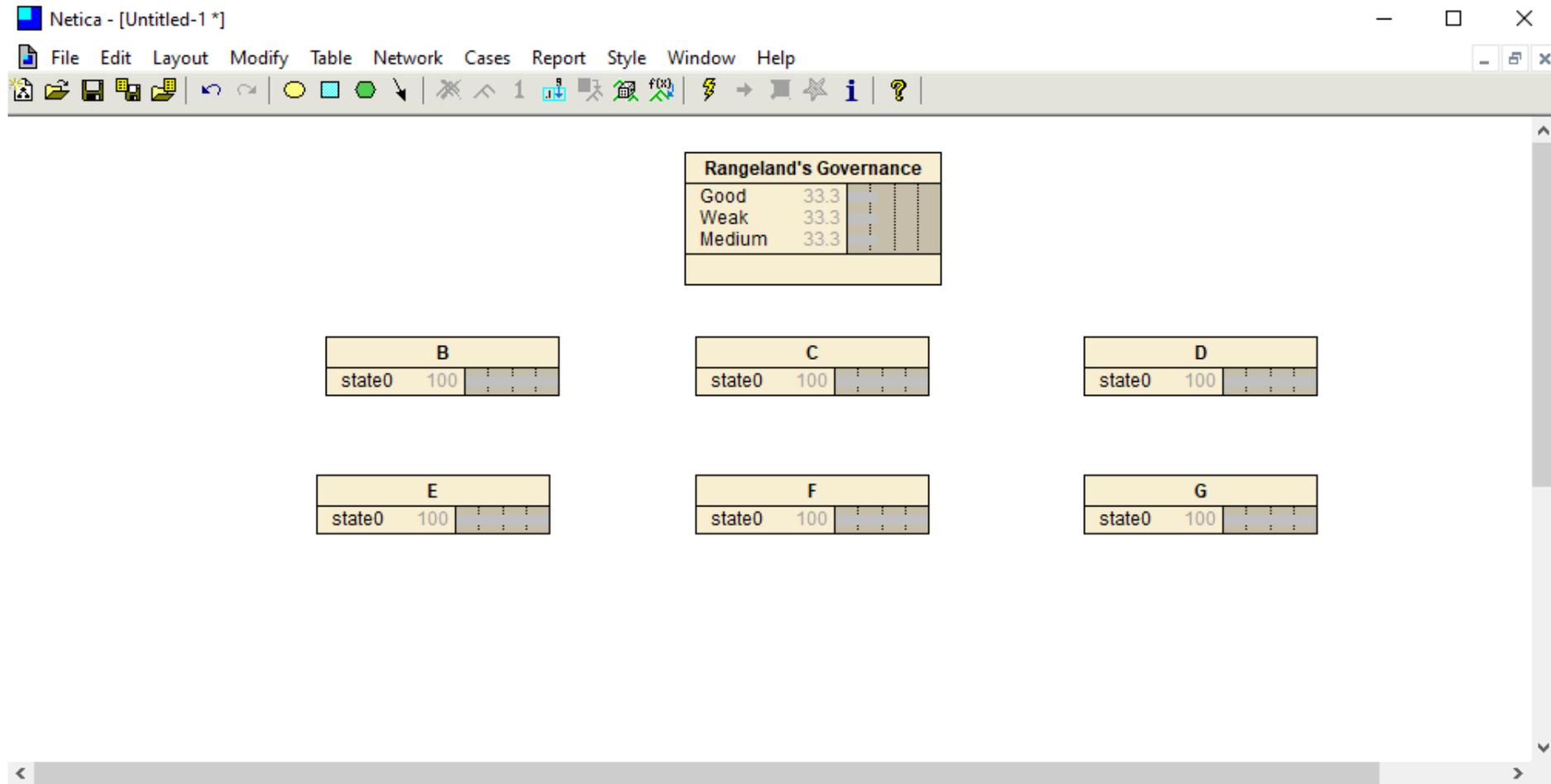
Modify nodes parameters

The screenshot displays the Netica software interface. A dialog box titled "GOV (node of Untitled_0)" is open, allowing for the modification of node parameters. The dialog box contains the following fields and controls:

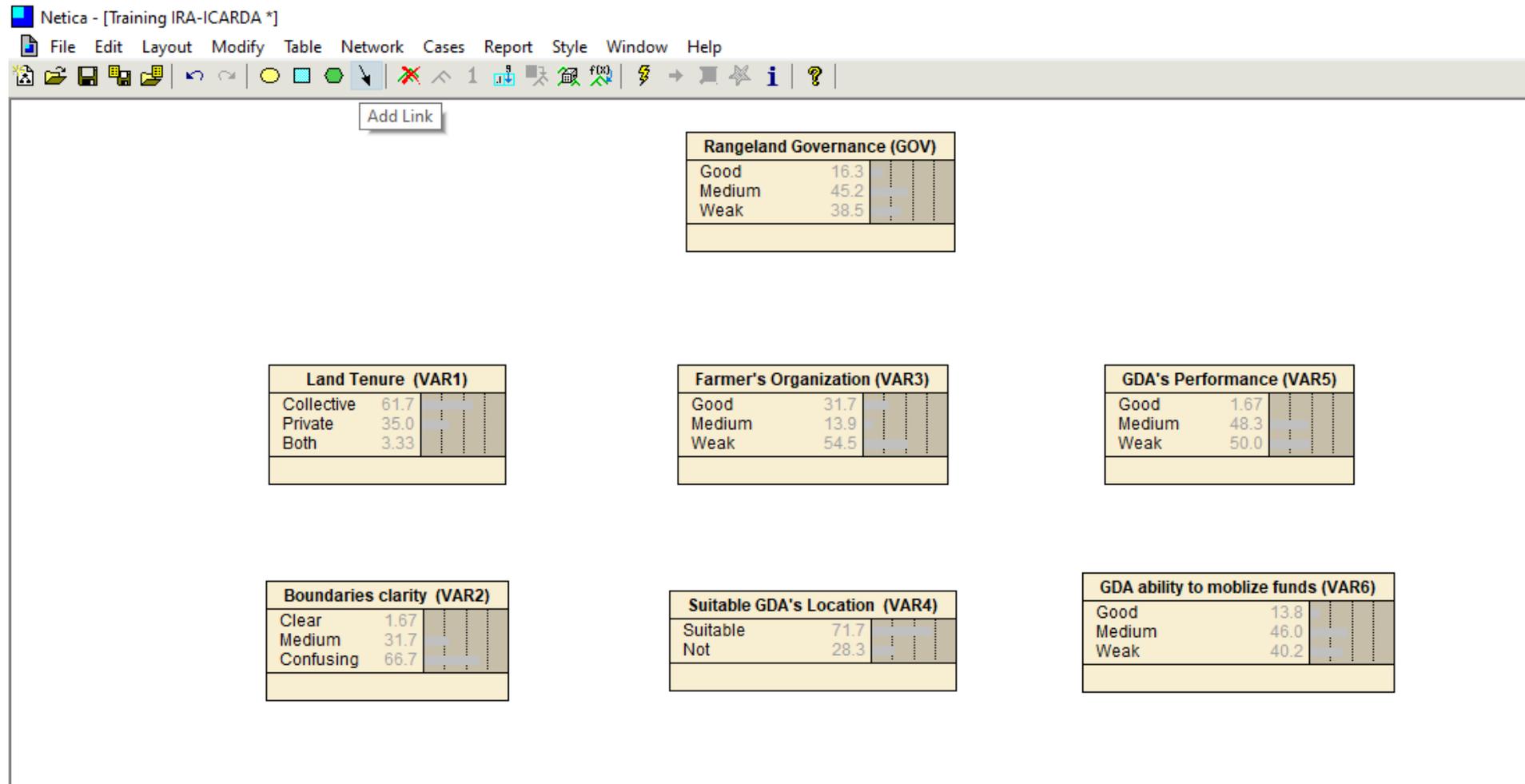
- Name:** GOV
- Title:** Rangeland Governance
- Nature:** Nature (dropdown menu)
- Discrete:** Discrete (dropdown menu)
- State:** Good (dropdown menu) with a "New" button
- Number:** 1 (text input) with a "Delete" button
- Description:** Description (dropdown menu) with a large text area below it
- Buttons:** OK, Apply, Reset, Close, Table, and Help

In the background, a network diagram is visible, showing two nodes labeled "B" and "E". Each node is represented by a yellow box with a table below it. Node "B" has a table with "state0" and "100". Node "E" also has a table with "state0" and "100".

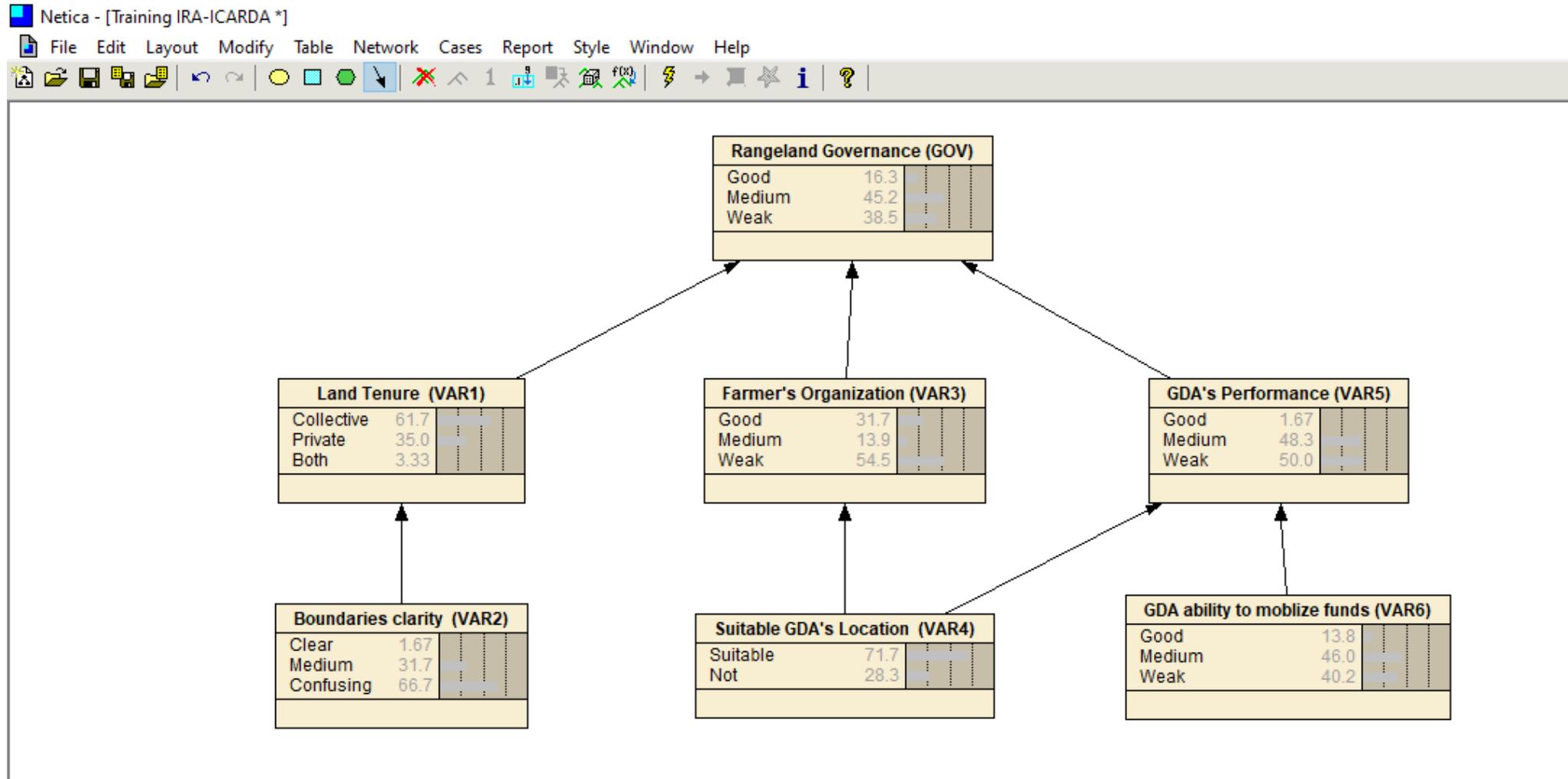
Modify nodes parameters : Results



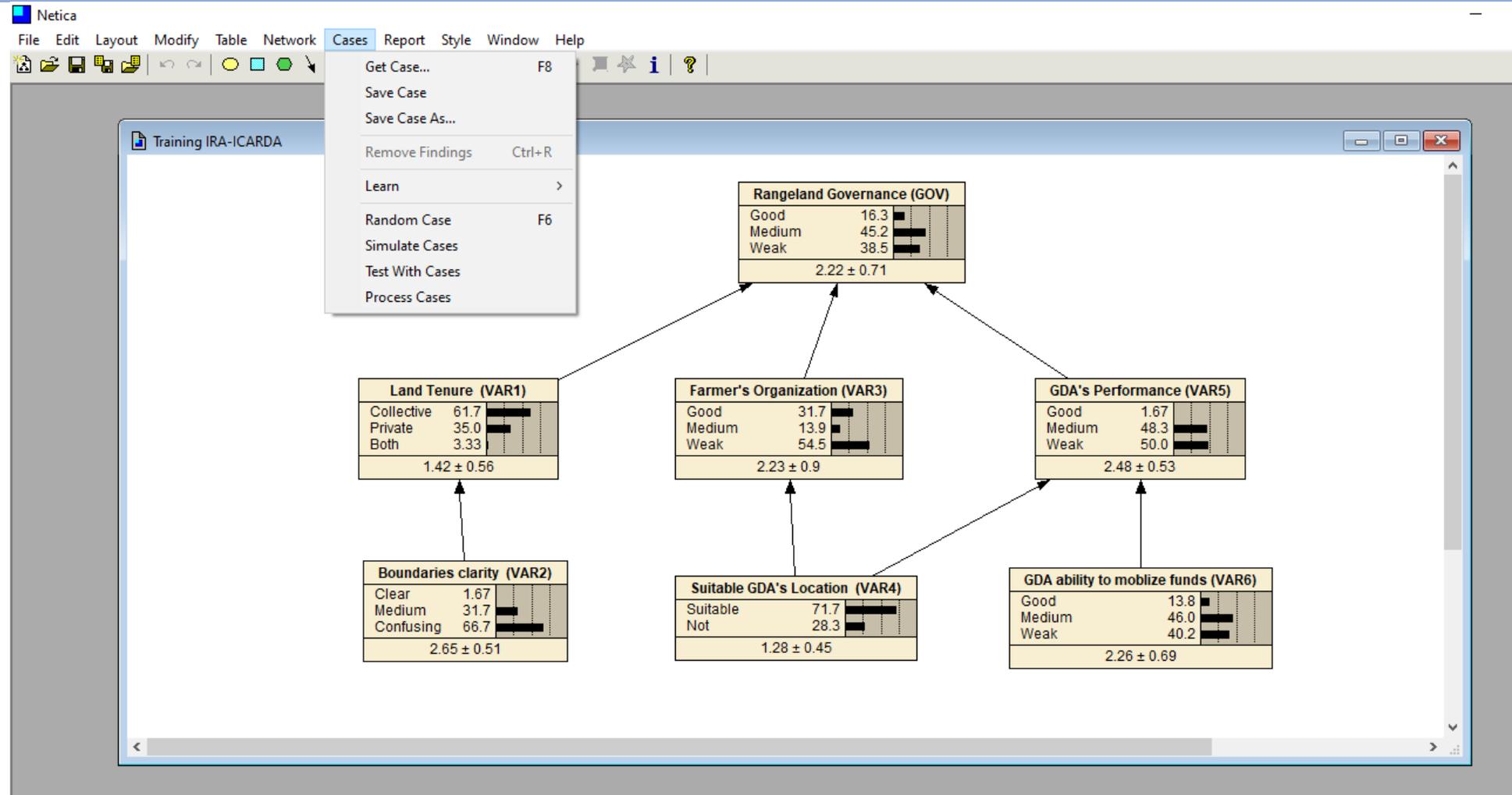
Modify nodes parameters : Results



Add edges/ links



Learn cases : Import data file



Learn cases : Import data file

The screenshot shows the Netica software interface with the 'Learn' menu open. The main window displays a Bayesian network diagram with six nodes, each containing a table of values and a bar chart. The nodes are:

- Land Tenure (VAR1)**: Collective (61.7), Private (35.0), Both (3.33). Mean: 1.42 ± 0.56
- Boundaries clarity (VAR2)**: Clear (1.67), Medium (31.7), Confusing (66.7). Mean: 2.65 ± 0.51
- Farmer's Organization (VAR3)**: Good (31.7), Medium (13.9), Weak (54.5). Mean: 2.23 ± 0.9
- Suitable GDA's Location (VAR4)**: Suitable (71.7), Not (28.3). Mean: 1.28 ± 0.45
- GDA's Performance (VAR5)**: Good (1.67), Medium (48.3), Weak (50.0). Mean: 2.48 ± 0.53
- GDA ability to mobilize funds (VAR6)**: Good (13.8), Medium (46.0), Weak (40.2). Mean: 2.26 ± 0.69

The 'Learn' menu is open, showing options such as 'Add Case File Nodes...', 'Learn TAN Structure', 'Incorp Case File', 'Incorporate Case', 'Learn Using EM', 'Learn Using Gradient', and 'Smooth CPTs'. The 'Incorporate Case' option is highlighted with the keyboard shortcut Ctrl+L.

Learn cases : Import data file

The screenshot shows the Netica software interface. A file selection dialog is open, showing the path 'Training ICARDA-IRA 3-5 de... > BBN' and a search bar. The file 'Training Data File' is selected. A tooltip for this file shows: 'Type : Document texte', 'Taille : 1,12 Ko', and 'Modifié le : 29/11/2019 21:06'. The dialog also shows a file name field and file type options (.cas, .uvf, .cs).

The background shows a network diagram with several variables and their associated data tables:

- and Governance (GOV)**: 16.3, 45.2, 38.5, 2.22 ± 0.71
- ocation (VAR3)**: 31.7, 13.9, 34.5, 0.9
- GDA's Performance (VAR5)**: Good (1.67), Medium (48.3), Weak (50.0), 2.48 ± 0.53
- ocation (VAR4)**: Suitable (71.7), Not (28.3), 1.28 ± 0.45
- GDA ability to mobilize funds (VAR6)**: Good (13.8), Medium (46.0), Weak (40.2), 2.26 ± 0.69
- Confusing**: Medium (31.7), Confusing (66.7), 2.65 ± 0.51

Learn cases : Import data file

The screenshot shows the Netica software interface with a Bayesian network diagram titled "Training IRA-ICARDA". The network consists of six nodes, each represented by a table of conditional probabilities and a mean value with standard deviation. A dialog box is open over the network, prompting the user to "Enter degree (normal is 1):".

Netica Interface:

- Menu: File, Edit, Layout, Modify, Table, Network, Cases, Report, Style, Window, Help
- Toolbar: Standard icons for file operations, navigation, and analysis.
- Window Title: Training IRA-ICARDA

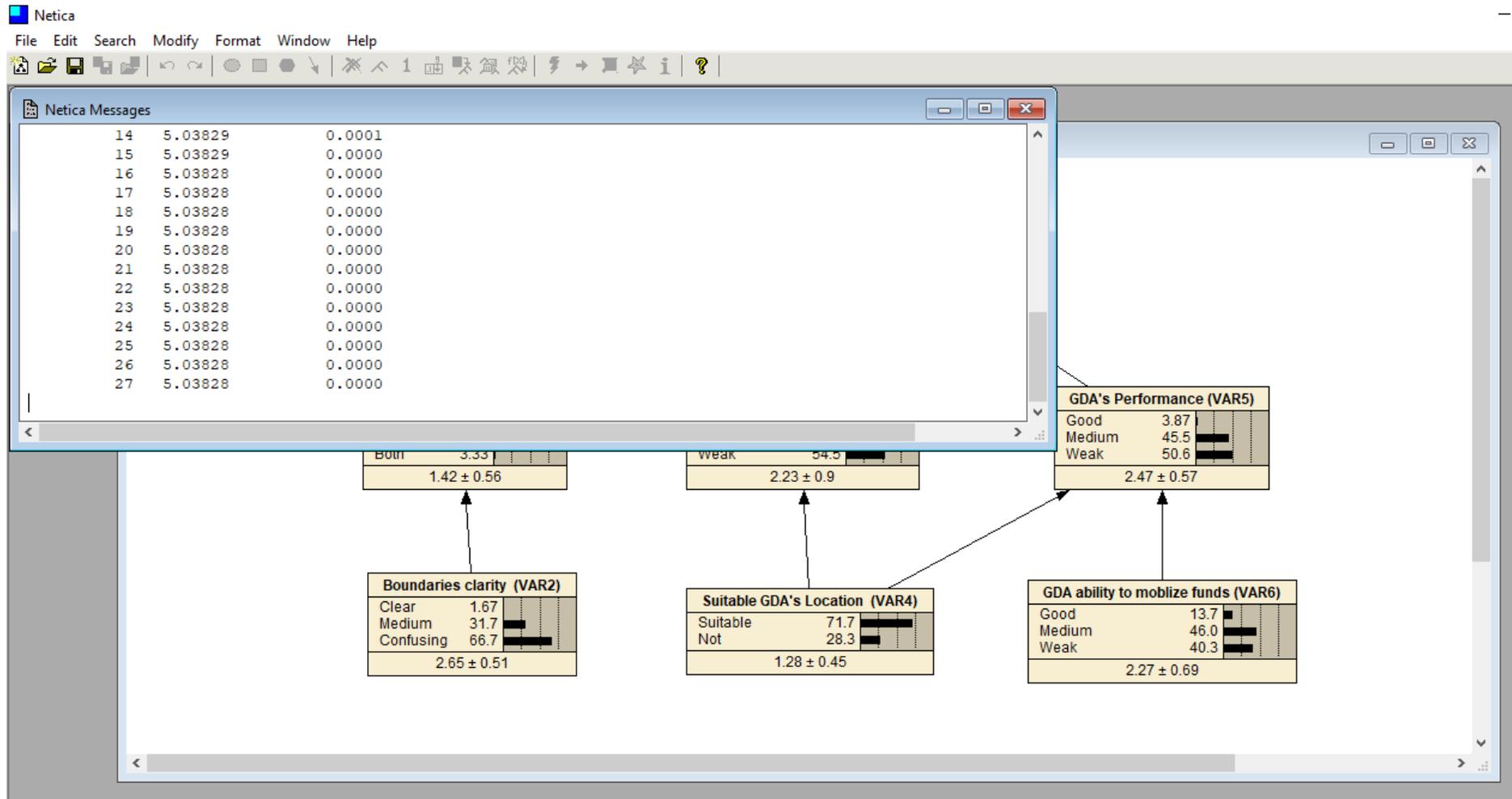
Bayesian Network Nodes:

- Rangeland Governance (GOV)**: Good (16.3), Medium (45.2), Weak (38.5). Mean: 2.22 ± 0.71
- Land Tenure (VAR1)**: Collective (61.7), Private (35.0), Both (3.33). Mean: 1.42 ± 0.56
- GDA's Performance (VAR5)**: Good (1.67), Medium (48.3), Weak (50.0). Mean: 2.48 ± 0.53
- Boundaries clarity (VAR2)**: Clear (1.67), Medium (31.7), Confusing (66.7). Mean: 2.65 ± 0.51
- Suitable GDA's Location (VAR4)**: Suitable (71.7), Not (28.3). Mean: 1.28 ± 0.45
- GDA ability to mobilize funds (VAR6)**: Good (13.8), Medium (46.0), Weak (40.2). Mean: 2.26 ± 0.69

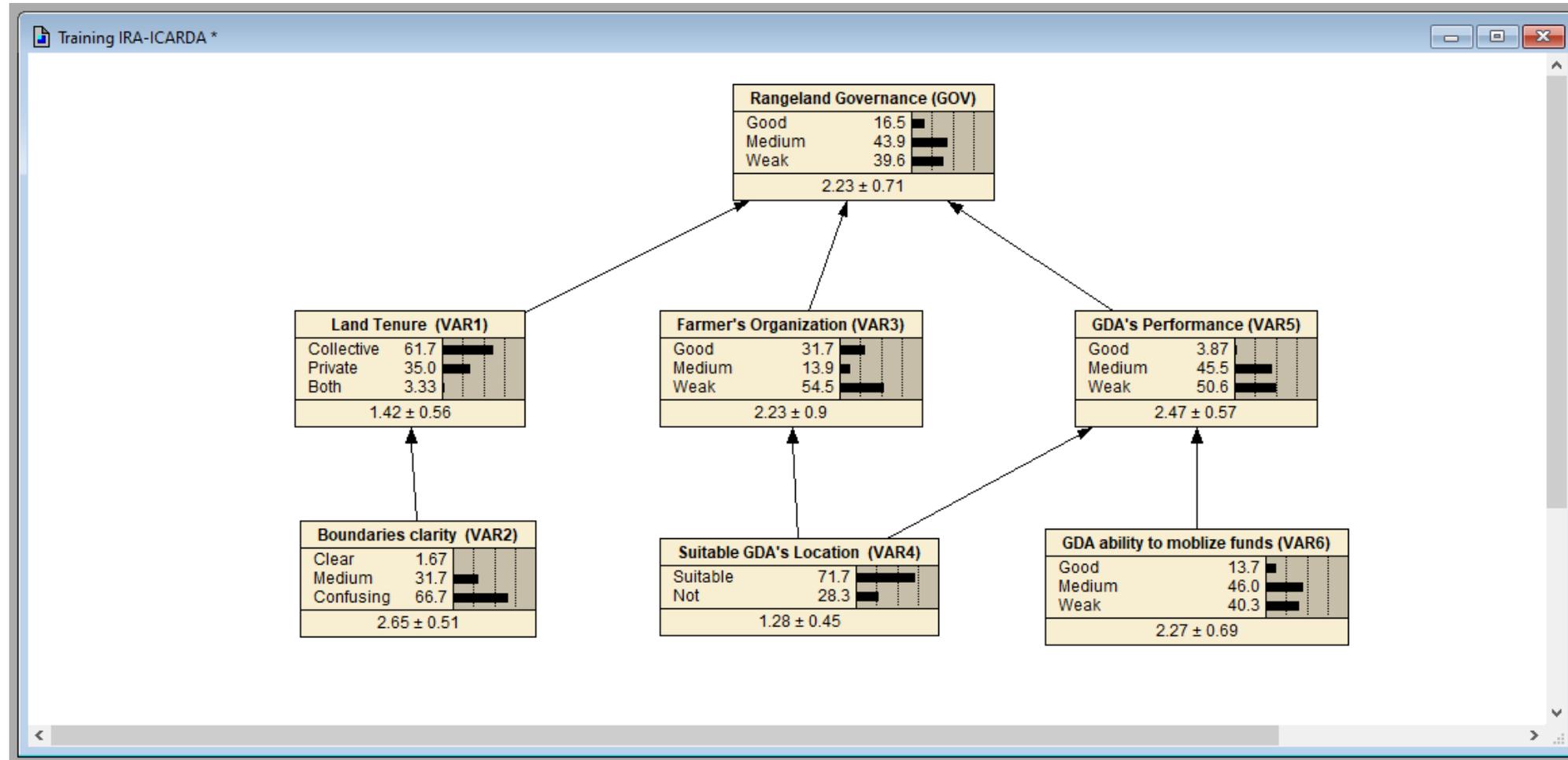
Dialog Box: Enter degree (normal is 1):

The dialog box contains a text input field with a cursor, and three buttons: OK, Revert, and Cancel.

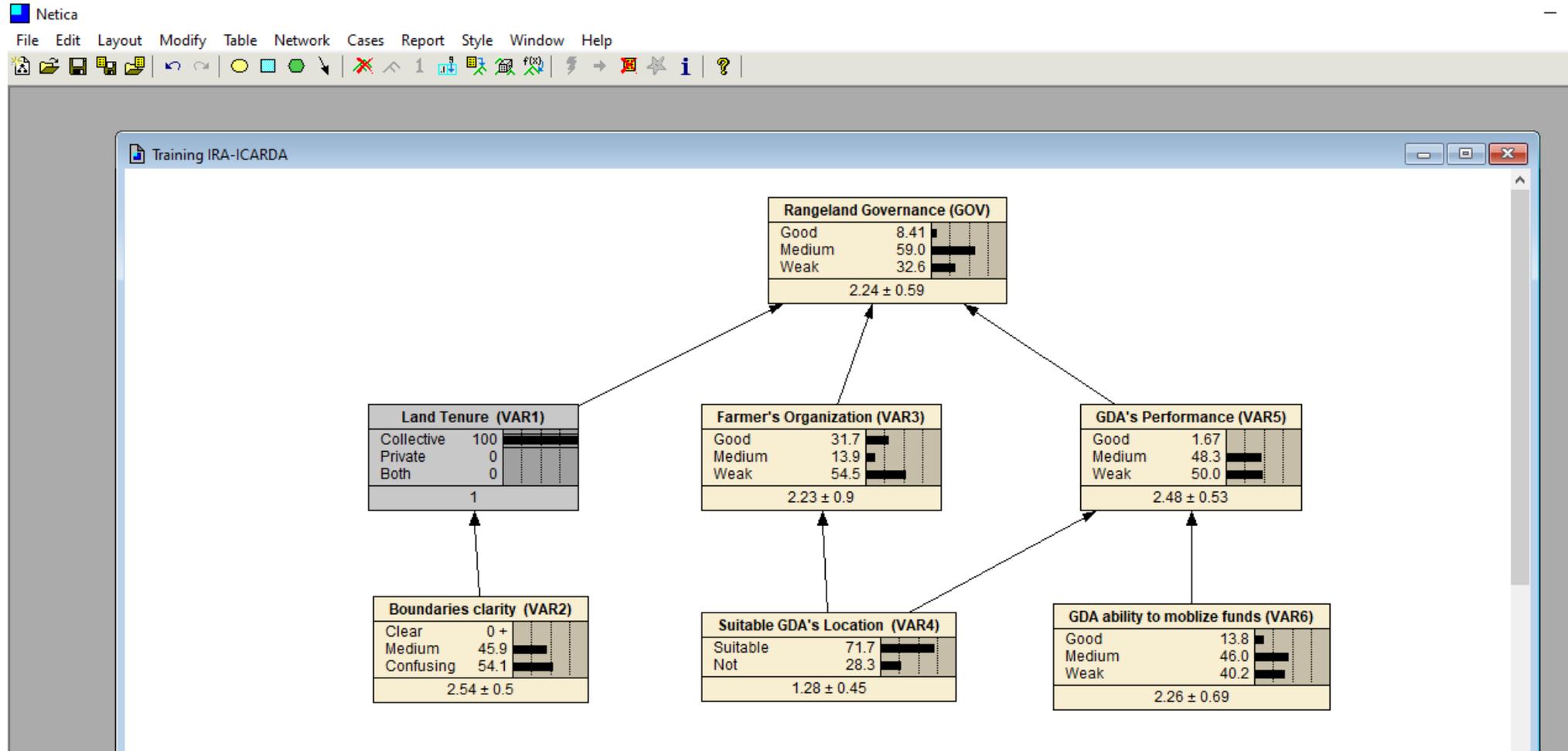
Learn cases : Import data file



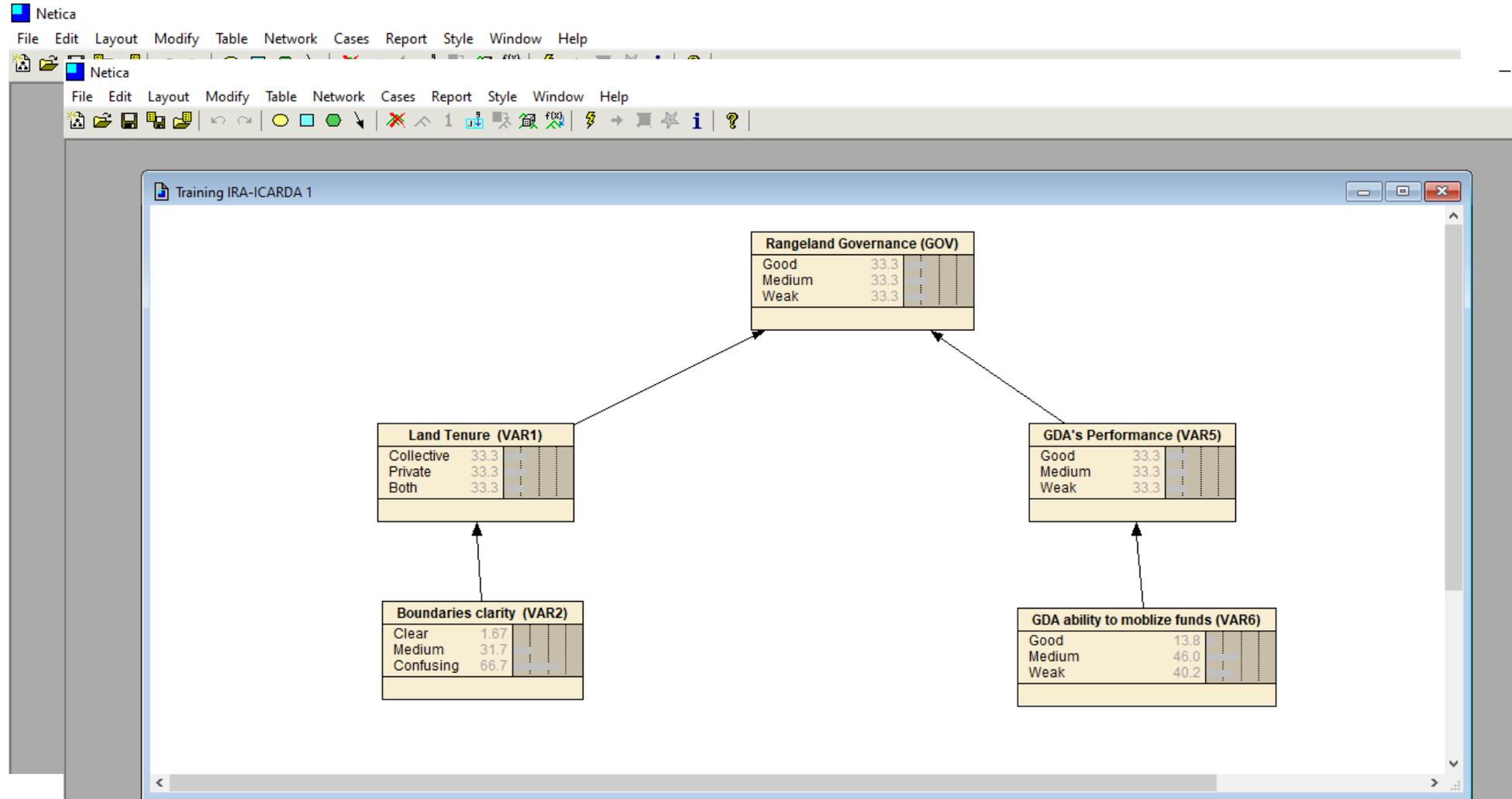
Learn cases : Import data file



Create scenarios



Combine Nets



Combine Nets

Netica

File Edit Layout **Modify** Table Network Cases Report Style Window Help

Modify menu options:

- Add >
- Set NodeSet >
- Add Nodes to Set >
- Remove From NodeSet >
- NodeSet Properties...
- Discretize Nodes
- Add No-Forgetting Links
- Disconnect Links
- Reconnect Links
- Delay Links
- Obfuscate Net
- Reverse Links
- Absorb Nodes
- Decompose Equations
- Combine Nets**

Network Diagram:

- Boundaries clarity (VAR2)**

Clear	1.67			
Medium	31.7			
Confusing	66.7			
- Duration (VAR1)**

33.3				
33.3				
33.3				
- Rangeland Governance (GOV)**

Good	33.3			
Medium	33.3			
Weak	33.3			

Arrows indicate dependencies: Boundaries clarity (VAR2) → Duration (VAR1) → Rangeland Governance (GOV).

Combine Nets

The screenshot shows the Netica software interface. A file selection dialog is open, titled "Choose net to add on to this one:", showing a directory structure with files "Training IRA-ICARDA 1", "Training IRA-ICARDA 2", and "Training IRA-ICARDA". A tooltip for "Training IRA-ICARDA 2" displays: "Type: Bayes Net", "Taille: 1,32 Ko", and "Modifié le: 29/11/2019 21:11".

The background network diagram includes nodes such as "ance (GOV)", "GDA's Perform", and "GDA ability to n".

ance (GOV)	
Good	
Medium	
Weak	

GDA's Perform	
Good	
Medium	
Weak	

GDA ability to n	
Good	
Medium	
Weak	

medium Confusing	
31.7	
66.7	

Combine Nets

The screenshot shows the Netica software interface with a Bayesian network diagram. The network consists of six nodes: Rangeland Governance (GOV), Land Tenure (VAR1), Boundaries clarity (VAR2), GDA ability to mobilize funds (VAR6), and two partially visible nodes (Performance (VAR5) and another). A dialog box is open over the network, prompting the user to enter a degree (experience multiplier) for a selected net. The dialog box contains a text input field with the value '1' and buttons for 'OK', 'Revert', and 'Cancel'.

Netica
File Edit Layout Modify Table Network Cases Report Style Window Help

Training IRA-ICARDA 1 +

Rangeland Governance (GOV)

Good	33.3
Medium	33.3
Weak	33.3

Land Tenure (VAR1)

Collective	33.3
Private	33.3
Both	33.3

Boundaries clarity (VAR2)

Clear	1.67
Medium	31.7
Confusing	66.7

Performance (VAR5)

m	33.3
	33.3
	33.3

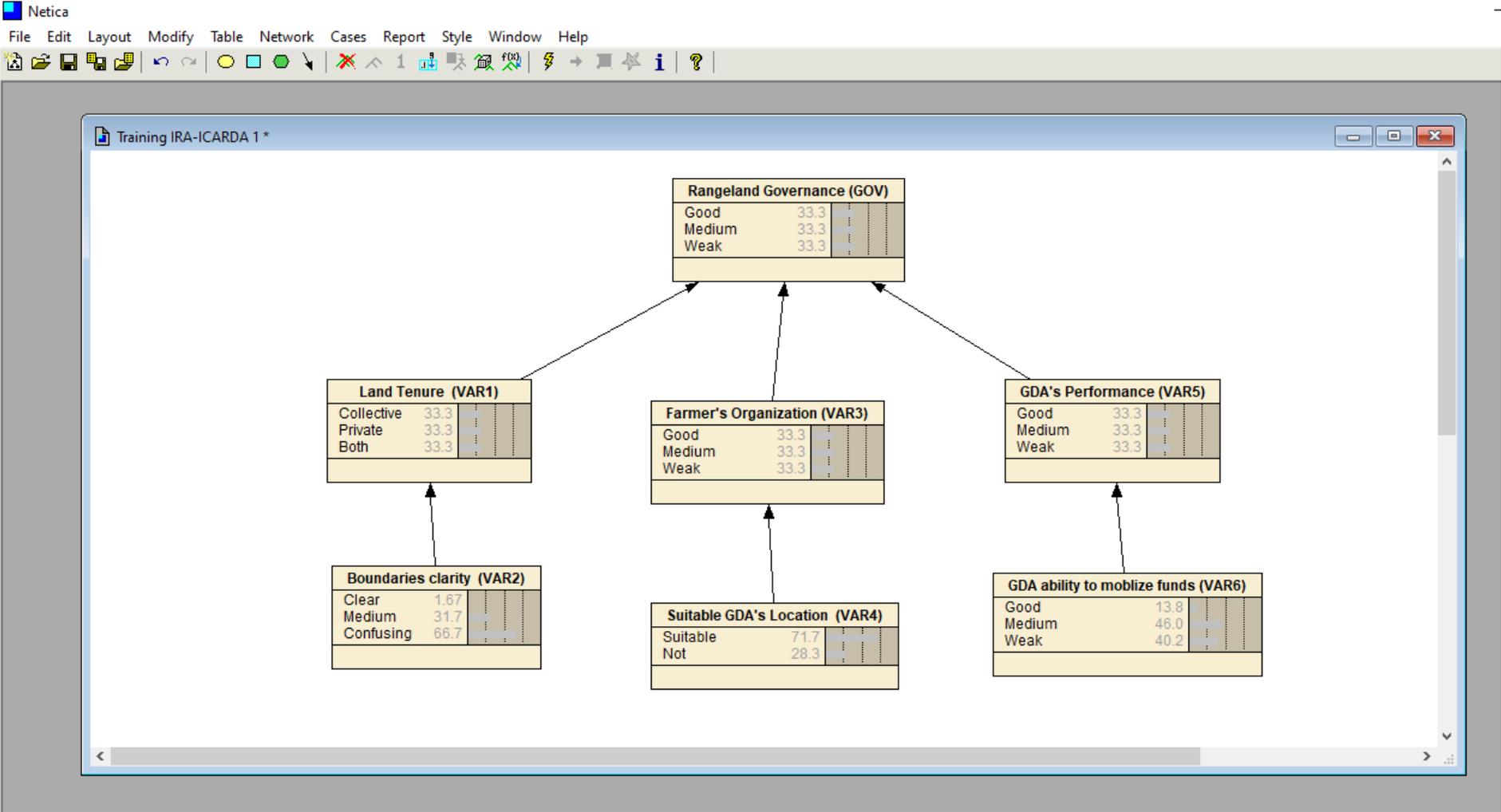
GDA ability to mobilize funds (VAR6)

Good	13.8
Medium	46.0
Weak	40.2

Enter degree [experience multiplier] for that net

OK Revert Cancel

Combine Nets



Export Graph

The image shows a screenshot of the Inkscape website homepage. At the top, there is a navigation bar with links for "English", "Log in", and "Register". A red banner above the navigation bar says "Vote on the About Screen Contest!". The main header features the Inkscape logo and the tagline "Draw Freely." followed by a search bar. Below the header is a dark navigation menu with links for "ABOUT", "DOWNLOAD", "NEWS", "COMMUNITY", "LEARN", "CONTRIBUTE", "DEVELOP", and "SUPPORT US". The "DOWNLOAD" menu is open, showing options for "Current Version", "Upcoming Version (1.0)", "Latest Development Version", and "Extensions". The main content area features a large graphic of a flower and text stating "Inkscape is a professional vector graphics editor for Linux, Windows and macOS. It's free and open source." with a "Download" button. Below this, it says "Current stable version: 0.92.4". A smaller version of the Inkscape logo and tagline "INKSCAPE 0.92 Draw Freely" is also present. At the bottom, there are four columns: "Overview" (What is Inkscape and how can I get it?), "Features" (Find out what Inkscape is capable of), "Gallery" (Showcase of creations from the community), and "Learning Resources" (Resources to help you get the most out of Inkscape). The footer contains three sections: "Users" (A powerful, free design tool), "Developers" (Google Summer of Code 2019), and "Recent News" (Vote for your favorite About Screen for 1.0!).

Vote on the About Screen Contest! ❤️

English Log in Register

Search website

ABOUT DOWNLOAD NEWS COMMUNITY LEARN CONTRIBUTE DEVELOP SUPPORT US

Current Version

Upcoming Version (1.0)

Latest Development Version

Extensions

Inkscape is a professional vector graphics editor for Linux, Windows and macOS. It's free and open source.

Download

Current stable version: 0.92.4

INKSCAPE 0.92 Draw Freely

Inkdrop Diffusion in Water by artelnjeru01

Overview: What is Inkscape and how can I get it?

Features: Find out what Inkscape is capable of

Gallery: Showcase of creations from the community

Learning Resources: Resources to help you get the most out of Inkscape

Users: A powerful, free design tool

Developers: Google Summer of Code 2019

Recent News: Vote for your favorite About Screen for 1.0!

Export Graph

The screenshot shows the Inkscape website's release page for version 0.92.4. The browser's address bar displays the URL <https://inkscape.org/release/inkscape-0.92.4/>. The page features the Inkscape logo and the slogan "Draw Freely." at the top left. A navigation menu includes links for ABOUT, DOWNLOAD, NEWS, COMMUNITY, LEARN, CONTRIBUTE, DEVELOP, and SUPPORT US. A search bar is located on the right side. A prominent banner displays the Inkscape 0.92.4 logo and the slogan "Draw Freely." over a background image of a complex, multi-colored fractal or graph. Below the banner, there are four columns of information: GNU/Linux (Linux based Free Desktop Systems), Windows (Microsoft's Windows Desktop), macOS (Apple's macOS Desktop), and The raw code ready to compile (Source). At the bottom of the page, there are two buttons: "Release Notes" and "Inkscape 0.92.4".

Vote on the About Screen Contest! [English](#) [Log in](#) [Register](#)

INKSCAPE
Draw Freely.

Search website

ABOUT DOWNLOAD NEWS COMMUNITY LEARN CONTRIBUTE DEVELOP **SUPPORT US**

INKSCAPE 0.92.4
Draw Freely

GNU/Linux
Linux based Free Desktop Systems

Windows
Microsoft's Windows Desktop

macOS
Apple's macOS Desktop

The raw code ready to compile
Source

Release Notes

Inkscape
0.92.4

Export Graph

The screenshot shows a web browser window with the URL <https://inkscape.org/release/0.92.4/windows/>. The page features the Inkscape logo and the tagline "Draw Freely." at the top left. A navigation menu includes links for ABOUT, DOWNLOAD, NEWS, COMMUNITY, LEARN, CONTRIBUTE, DEVELOP, and SUPPORT US. A search bar is located on the right side of the header. Below the navigation menu, a breadcrumb trail reads "Home » Releases » Inkscape 0.92 » Inkscape 0.92.4 » Windows". The main content area displays a large, abstract, colorful graphic. Below the graphic, the text "INKSCAPE 0.92.4 Draw Freely" is prominently displayed. At the bottom of the page, there are three download options: "32-bit" (32-bit architecture), "64-bit" (64-bit architecture), and "Windows 10S App Store" (Windows Store). A footer note at the bottom left of the page reads "Always remove/uninstall the previous version before updating!" with a link to <https://inkscape.org/release/0.92.4/windows/32-bit/>.

Export Graph

← → ↻ 🏠 <https://inkscape.org/release/0.92.4/windows/32-bit/> ... 🛡️ 📡 ⭐

Vote on the About Screen Contest! ❤️ [English](#) [Log in](#) [Register](#)

 **INKSCAPE**
Draw Freely. 🔍

[ABOUT](#) [DOWNLOAD](#) [NEWS](#) [COMMUNITY](#) [LEARN](#) [CONTRIBUTE](#) [DEVELOP](#) [SUPPORT US](#)

[Home](#) » [Releases](#) » [Inkscape 0.92](#) » [Inkscape 0.92.4](#) » [Windows](#) » [32-bit](#)

 **INKSCAPE 0.92.4**
Draw Freely

Installer in .exe format ↓ exe	Windows Installer Package ↓ msi	PortableApps.com Format application that runs without installation ↓ portable app	Compressed archive in 7z format (32bit) ↓ compressed (7z)
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<https://inkscape.org/release/inkscape-0.92.4/windows/32-bit/exe/dl/>

Export Graph

Netica

File Edit Layout Modify Table Network Cases Report Style Window Help

New >
Open... Ctrl+O
Open As Text...
Close Ctrl+F4
Save Ctrl+S
Save As...
Recent Files >
Print... Ctrl+P
Printer Setup...
Export Graphics... Ctrl+G
Encryption Password...
Netica Password...
Log Messages
Exit Alt+F4

Land Tenure (VAR1)

Collective	61.7	
Private	35.0	
Both	3.33	
		1.42 ± 0.56

Farmer's Organization (VA)

Good	31.7	
Medium	13.9	
Weak	54.5	
		2.23 ± 0.9

Rangeland Governance (G)

Good	16.3	
Medium	45.2	
Weak	38.5	
		2.22 ± 0.71

Boundaries clarity (VAR2)

Clear	1.67	
-------	------	--

Export Graph

Rangeland Governance (GOV)

Save graphics file as:

Enregistrer dans : BBN

Nom	Modifié le	Type
capture	01/12/2019 13:32	Dossier de fi
Data files	01/12/2019 13:22	Dossier de fi
Downloads	01/12/2019 13:21	Dossier de fi
netica files	01/12/2019 13:22	Dossier de fi
Presentations	01/12/2019 13:34	Dossier de fi
Results	01/12/2019 13:22	Dossier de fi

Nom du fichier : Training IRA-ICARDA

Type : SVG Graphics File (.svg)

Enregistrer

Annuler

Category	Value
Collective	61.1
Private	35.4
Both	3.3
Average	1.42 ± 0.1

Category	Value
Clear	1.67
Medium	31.7
Confusing	66.7

Category	Value
Suitable	71.7

Category	Value
Good	1.67
Medium	48.3
Weak	50.0
Average	2.48 ± 0.53

Category	Value
Good	13.8
Medium	46.0

Export Graph

Rangeland Governance (GOV)

Save graphics file as:

Enregistrer dans : Results

Nom Modifié le Type

Aucun élément ne correspond à votre recherche.

Nom du fichier : Training IRA-ICARDA

Type : SVG Graphics File (.svg)

Enregistrer Annuler

Land Tenure	
Collective	61.7
Private	35.0
Both	3.3
1.42 ± 0.1	

Boundaries clarity (VAR2)	
Clear	1.67
Medium	31.7
Confusing	66.7

GDA's Performance (V)	
Good	1.67
Medium	48.3
Weak	50.0
2.48 ± 0.53	

GDA ability to mobilize funds	
Good	13.8
Medium	46.0
Weak	40.2

Thank you