

Exercise # 3

National Cohesive Wildland Fire Management Strategy

Science Analysis Report: Application to the Southeast Region

January, 2014

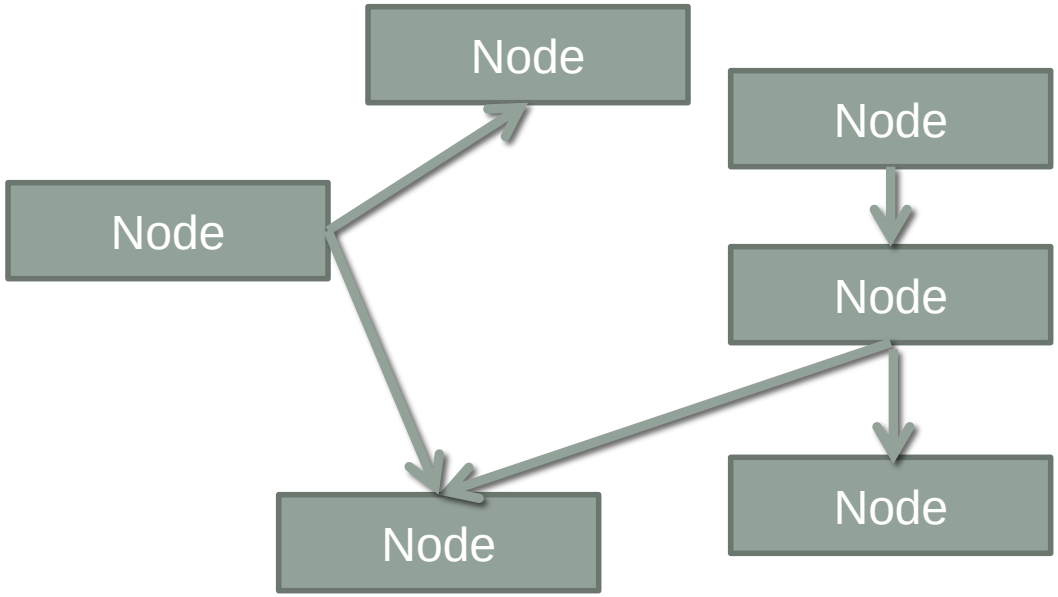
Agenda

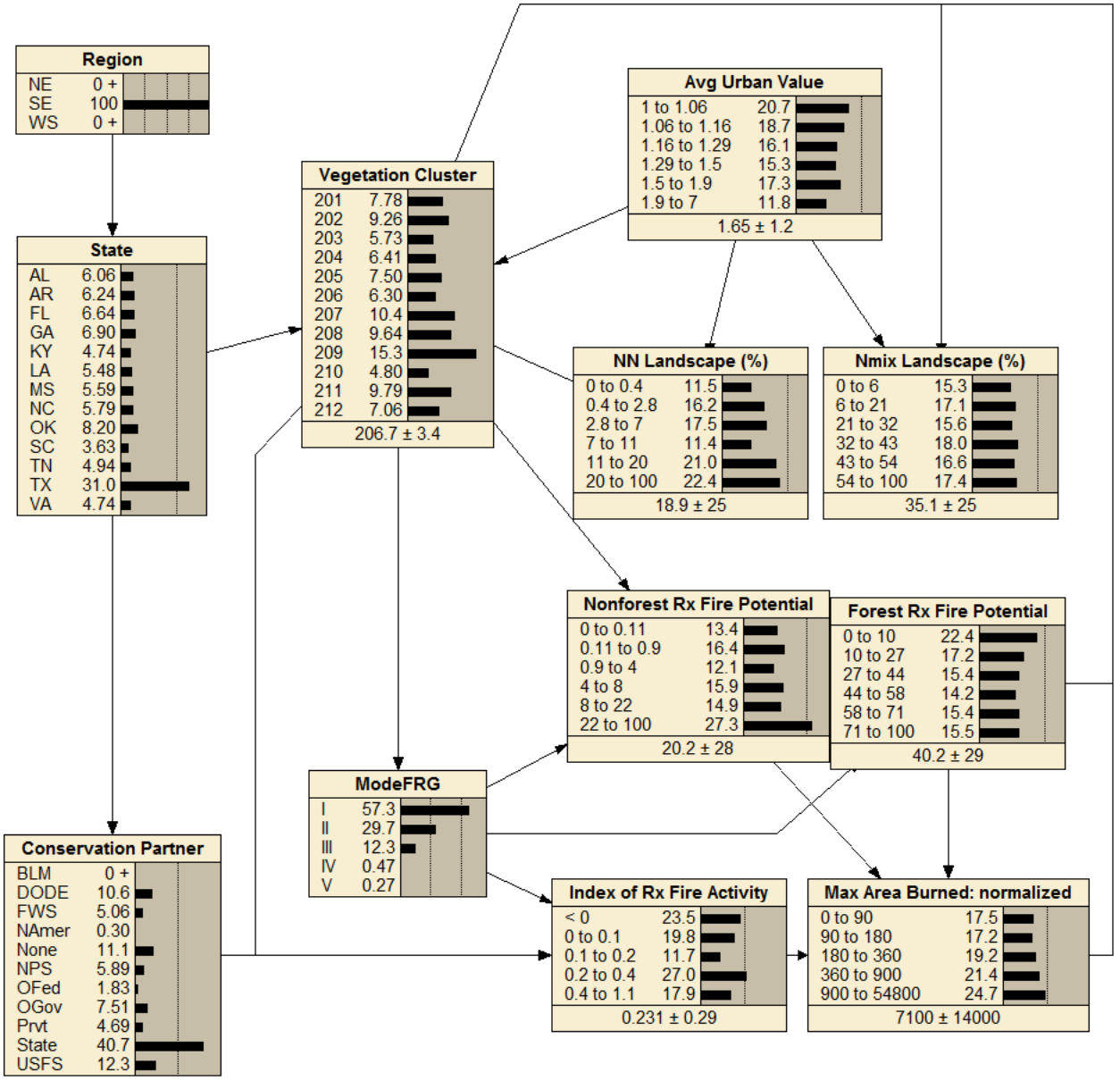
- Yesterday:
  - The National Science Analysis
  - Preparing Data for Analysis
  - Application of Products
  - Basics of Belief Nets
- Today:
  - Exercise #1: Pivot Tables
  - Exercise #2: Naïve Networks
  - Exercise #3: Bayes Networks
  - Wrap-up

A BAYES NETWORK

Cohesive Fire Bayes Network (Prescribed Fire)

- A type of structure for a network
- Assumes that nodes have conditional dependencies on each other that are shown in an acyclic graph. That is, the graph has no cycle or start point.
- There are cause and effect relationships among many nodes

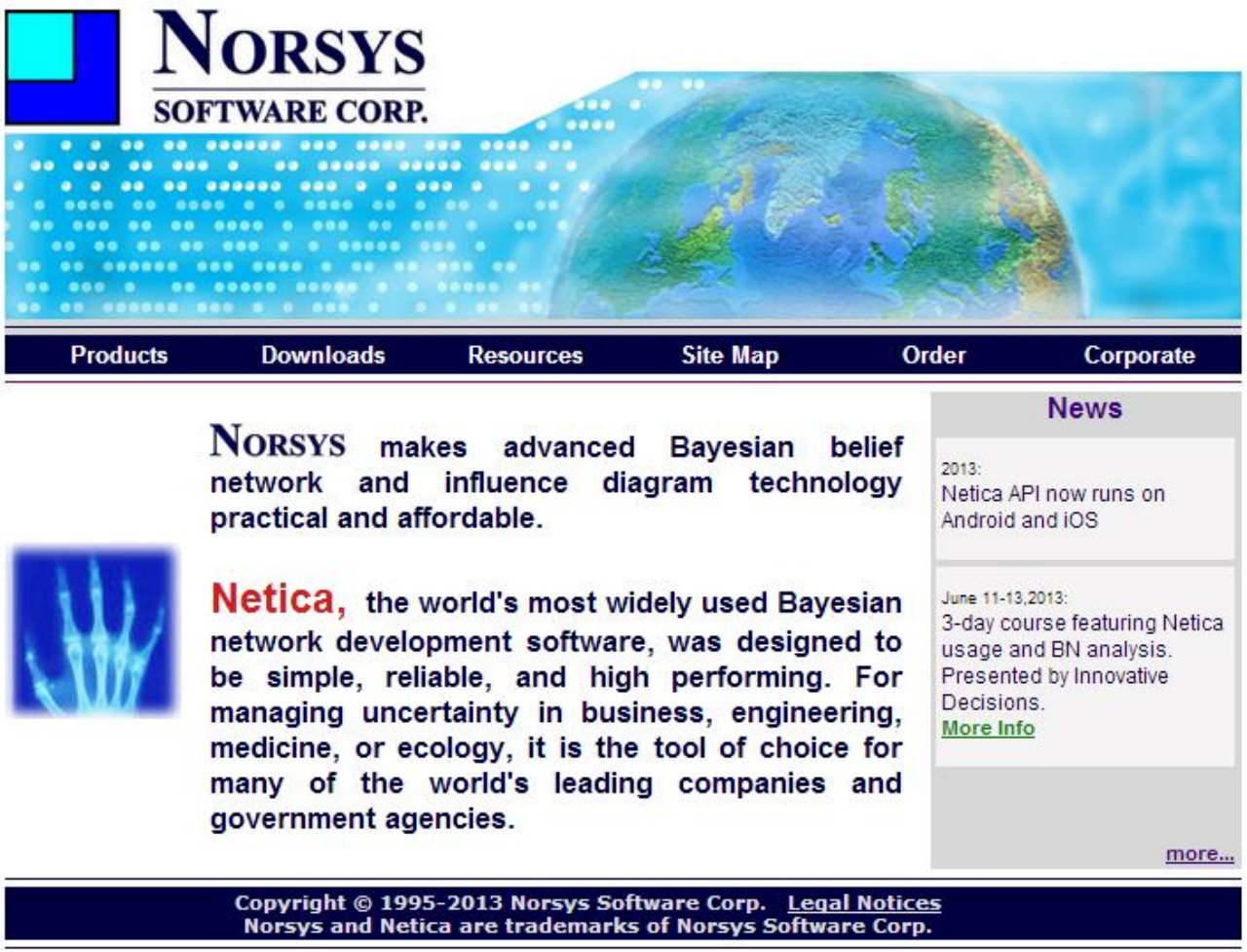



Region
NE 0 +
SE 100
WS 0 +
State
AL 6.06
AR 6.24
FL 6.64
GA 6.90
KY 4.74
LA 5.48
MS 5.59
NC 5.79
OK 8.20
SC 3.63
TN 4.94
TX 31.0
VA 4.74
Vegetation Cluster
201 7.78
202 9.26
203 5.73
204 6.41
205 7.50
206 6.30
207 10.4
208 9.64
209 15.3
210 4.80
211 9.79
212 7.06
206.7 ± 3.4
Avg Urban Value
1 to 1.06 20.7
1.06 to 1.16 18.7
1.16 to 1.29 16.1
1.29 to 1.5 15.3
1.5 to 1.9 17.3
1.9 to 7 11.8
1.65 ± 1.2
NN Landscape (%)
0 to 0.4 11.5
0.4 to 2.8 16.2
2.8 to 7 17.5
7 to 11 11.4
11 to 20 21.0
20 to 100 22.4
18.9 ± 25
Nmix Landscape (%)
0 to 6 15.3
6 to 21 17.1
21 to 32 15.6
32 to 43 18.0
43 to 54 16.6
54 to 100 17.4
35.1 ± 25
Nonforest Rx Fire Potential
0 to 0.11 13.4
0.11 to 0.9 16.4
0.9 to 4 12.1
4 to 8 15.9
8 to 22 14.9
22 to 100 27.3
20.2 ± 28
Forest Rx Fire Potential
0 to 10 22.4
10 to 27 17.2
27 to 44 15.4
44 to 58 14.2
58 to 71 15.4
71 to 100 15.5
40.2 ± 29
ModeFRG
I 57.3
II 29.7
III 12.3
IV 0.47
V 0.27
Conservation Partner
BLM 0 +
DODE 10.6
FWS 5.06
NAmer 0.30
None 11.1
NPS 5.89
OFed 1.83
OGov 7.51
Prvt 4.69
State 40.7
USFS 12.3
Index of Rx Fire Activity
< 0 23.5
0 to 0.1 19.8
0.1 to 0.2 11.7
0.2 to 0.4 27.0
0.4 to 1.1 17.9
0.231 ± 0.29
Max Area Burned: normalized
0 to 90 17.5
90 to 180 17.2
180 to 360 19.2
360 to 900 21.4
900 to 54800 24.7
7100 ± 14000

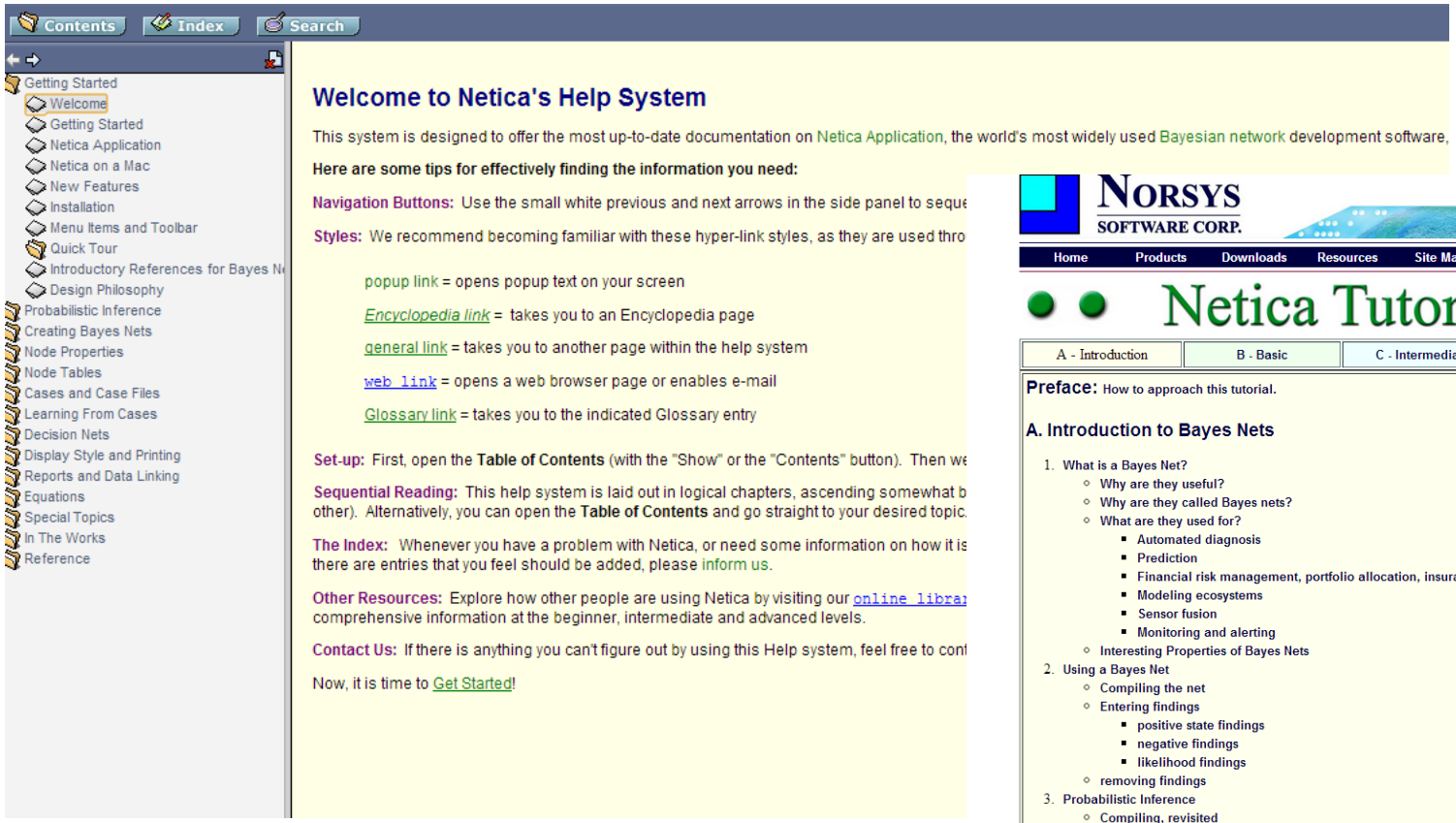
NETICA RESOURCES

Resources

http://www.norsys.com/netica.html



Resources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Creating Bayes Nets
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Display Style and Printing
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Reference
Welcome to Netica's Help System
This system is designed to offer the most up-to-date documentation on Netica Application, the world's most widely used Bayesian network development software,
Here are some tips for effectively finding the information you need:
Navigation Buttons: Use the small white previous and next arrows in the side panel to seque
Styles: We recommend becoming familiar with these hyper-link styles, as they are used thro
popup link = opens popup text on your screen
Encyclopedia link = takes you to an Encyclopedia page
general link = takes you to another page within the help system
web link = opens a web browser page or enables e-mail
Glossary link = takes you to the indicated Glossary entry
Set-up: First, open the Table of Contents (with the "Show" or the "Contents" button). Then we
Sequential Reading: This help system is laid out in logical chapters, ascending somewhat b
other). Alternatively, you can open the Table of Contents and go straight to your desired topic.
The Index: Whenever you have a problem with Netica, or need some information on how it is
there are entries that you feel should be added, please inform us.
Other Resources: Explore how other people are using Netica by visiting our online libra
comprehensive information at the beginner, intermediate and advanced levels.
Contact Us: If there is anything you can't figure out by using this Help system, feel free to cont
Now, it is time to Get Started!
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Netica Tutorial
A - Introduction
B - Basic
C - Intermediate
D - Advanced
Preface: How to approach this tutorial.
A. Introduction to Bayes Nets
1. What is a Bayes Net?
Why are they useful?
Why are they called Bayes nets?
What are they used for?
Automated diagnosis
Prediction
Financial risk management, portfolio allocation, insurance
Modeling ecosystems
Sensor fusion
Monitoring and alerting
Interesting Properties of Bayes Nets
2. Using a Bayes Net
Compiling the net
Entering findings
positive state findings
negative findings
likelihood findings
removing findings
3. Probabilistic Inference
Compiling, revisited
Explaining away
Blocking
4. Basic Decision Making
Utility Nodes
Decision Nodes
Techniques for getting good valuations
References
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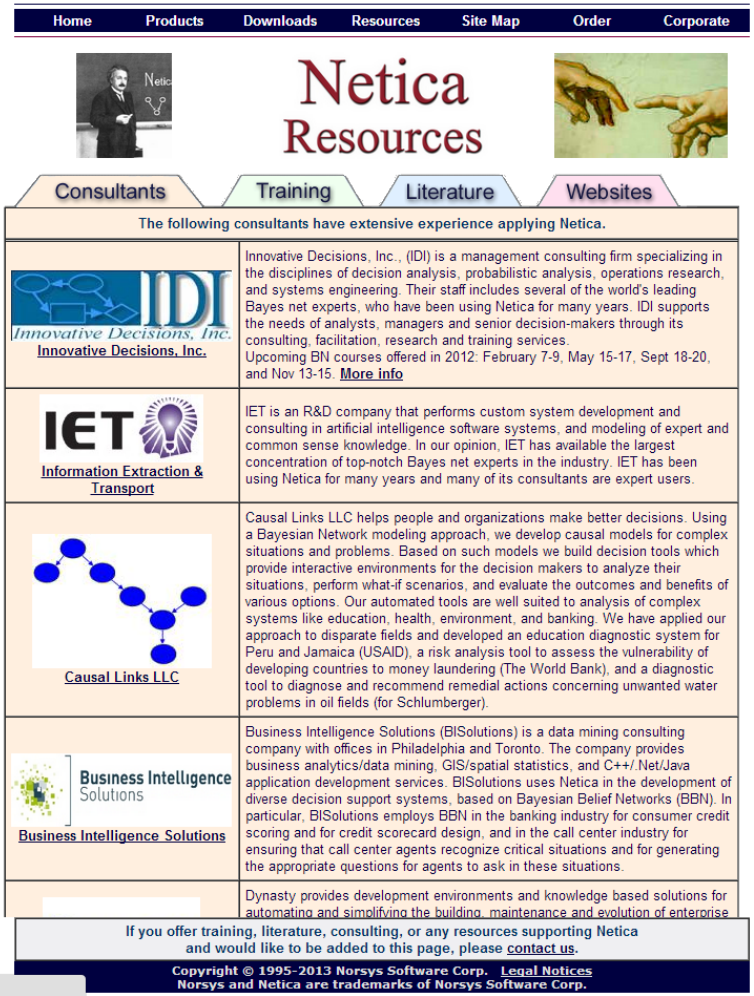
Resources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Websites
The following consultants have extensive experience applying Netica.
Innovative Decisions, Inc.
Innovative Decisions, Inc., (IDI) is a management consulting firm specializing in the disciplines of decision analysis, probabilistic analysis, operations research, and systems engineering. Their staff includes several of the world's leading Bayes net experts, who have been using Netica for many years. IDI supports the needs of analysts, managers and senior decision-makers through its consulting, facilitation, research and training services.
Upcoming BN courses offered in 2012: February 7-9, May 15-17, Sept 18-20, and Nov 13-15. More info
IET
Information Extraction & Transport
IET is an R&D company that performs custom system development and consulting in artificial intelligence software systems, and modeling of expert and common sense knowledge. In our opinion, IET has available the largest concentration of top-notch Bayes net experts in the industry. IET has been using Netica for many years and many of its consultants are expert users.
Causal Links LLC
Causal Links LLC helps people and organizations make better decisions. Using a Bayesian Network modeling approach, we develop causal models for complex situations and problems. Based on such models we build decision tools which provide interactive environments for the decision makers to analyze their situations, perform what-if scenarios, and evaluate the outcomes and benefits of various options. Our automated tools are well suited to analysis of complex systems like education, health, environment, and banking. We have applied our approach to disparate fields and developed an education diagnostic system for Peru and Jamaica (USAID), a risk analysis tool to assess the vulnerability of developing countries to money laundering (The World Bank), and a diagnostic tool to diagnose and recommend remedial actions concerning unwanted water problems in oil fields (for Schlumberger).
Business Intelligence Solutions
Business Intelligence Solutions
Business Intelligence Solutions (BISolutions) is a data mining consulting company with offices in Philadelphia and Toronto. The company provides business analytics/data mining, GIS/spatial statistics, and C++/.Net/Java application development services. BISolutions uses Netica in the development of diverse decision support systems, based on Bayesian Belief Networks (BBN). In particular, BISolutions employs BBN in the banking industry for consumer credit scoring and for credit scorecard design, and in the call center industry for ensuring that call center agents recognize critical situations and for generating the appropriate questions for agents to ask in these situations.
Dynasty provides development environments and knowledge based solutions for automating and simplifying the building, maintenance and evolution of enterprise
If you offer training, literature, consulting, or any resources supporting Netica and would like to be added to this page, please contact us.
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Performance Metrics
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Training
Modeling & Simulation
Bayesian Analysis
Operations Planning
Consulting
Resource Allocation
Strategic Decision Analysis
Program & Budget Development
Source Selection
Decision Conferences
Decision Analysis
Facilitation
Probabilistic Inference
Strategic Planning
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Quantitative Decision & Risk Analysis
IDI provides expert quantitative decision/risk analysis to support agencies' management, organizational and business improvement efforts. We also provides studies, analyses and reports
Planning, Assessment & Decision Process Design
IDI offers planning, assessment, and decision process design services to assist organizations with structuring their decisions processes. Additional services include group collaboration for wicked problems, application of decision support tools, and
RECENT NEWS
IDI Vice President Freeman Marvin Serving as Chair of the Program Committee for 2014 INFORMS Analytics Conference
November 17, 2013 - Freeman Marvin, IDI Vice President and Executive Principal Analyst, is serving as chairman of the program committee for the 2014 INFORMS Analytics Conference to be held in Boston from 30 March - 01 April 2013. The theme of the conference will be "Up the Revolution". For information on registration and details of the event, see this week's blog.
Decision and Risk Analytics (DRA) Course to Be Offered December 16-20, 2013
October 28, 2013 - IDI will host the next running of its Decision and Risk Analytics (DRA) course this December 16-20 at our new Headquarters location. For information and to register, visit the course's page.
IDI to Move to New Headquarters in December
October 14, 2013 - IDI will relocate its headquarters to a new building in Vienna,

EXERCISE #3

Explore Data with Belief Networks (Netica)

Exercise # 3

INTRODUCTION

Similar to Exercise #2, this exercise will expose you to Netica and how it's used, however we will be using a traditional belief network, rather than a naïve network. That is, the structure of the network has more cause and effect relationships between multiple nodes and can be explored differently.

TASK(S)

Your task for this exercise is to work with a partner and complete the activities outlined below. Most activities have a related question, which you should answer and write down in the space provided.

If you have any questions about the software or run into any issues, several facilitators will be walking around the room to answer your questions.

ACTIVITY/PROCESS

Activity #1

1. Open the Netica file called "Rx Fire_Southeast" (File> Open…navigate to desktop)
2. Take a close look at the nodes within the network and notice how the arrows are drawn differently from Exercise #2. Notice the distribution of data without any findings selected.
3. Look at the Index of Prescribed Fire Activity node (called "Index of Rx Fire Activity). Select the state called "<0" and notice the distribution of data in the "Max Area Burned: normalized". Toggle through each state in the "Index of Rx Fire Activity" node and see how the distribution changes.

Activity #2

1. Make sure all findings are removed from the network (click on the "red x" button at the top called "Remove Case (Findings)".
2. Look at the forested prescribed fire potential node (called "Forest Rx Fire Potential"). Select the first state (0-10) and toggle through the others to see how they effect "Max Area Burned: normalized".
3. Now, do the same thing again and notice the number at the BOTTOM of the "Max Area Burned: normalized" node. This is the average Maximum Area burned in acres.
4. **Question: How does this average change? What is the average in "Max Area Burned: normalized" when you select the smallest state (0-10) in the "Forest Rx Fire Potential" node?**

   _____

Activity #3

1. Make sure all findings are removed from the network (click on the "red x" button at the top called "Remove Case (Findings)".
2. Look at the State node. Begin to select each state within the southern region and notice how they

Explore Data with Belief Networks (Netica)

Exercise # 3

affect primary conservation partner ("Conservation Partner"), non-forest prescribed fire potential ("NonFor Rx Fire Potential), forest prescribed fire potential ("Forest Rx Fire Potential"), and the index of prescribed fire activity ("Index of Rx Fire Activity"). Note: You may need to toggle by removing the findings each time.

3. **Question: What interesting relationships do you notice as you toggle through each state in the southern region?** _____

Activity #4

1. Make sure all findings are removed from the network.
2. Now explore the network by selecting Texas from the "State" node and repeat Activities 1-3. Note: Make sure not to remove the findings for Texas in the "State" node for each activity.
3. **Question: Do you see different trends within the data?**

   _____

THINGS YOU WILL NEED

You will need the following items:

- **Personal laptop**
- **Netica file saved on desktop ("Rx Fire_Southeast")**

RESOURCES

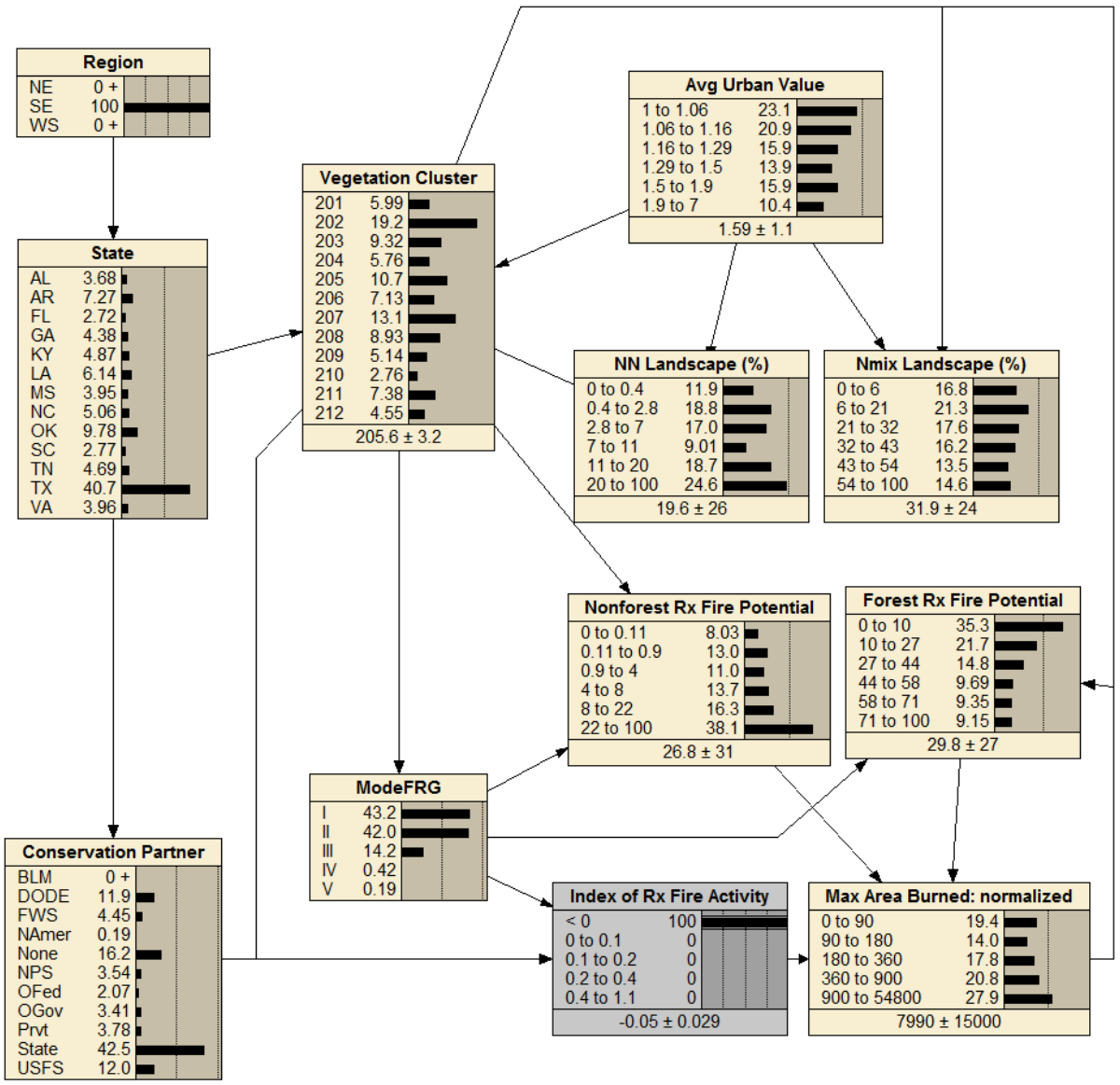
Norsys Netica "Help" section: http://www.norsys.com/WebHelp/NETICA.htm

Tasks and Process

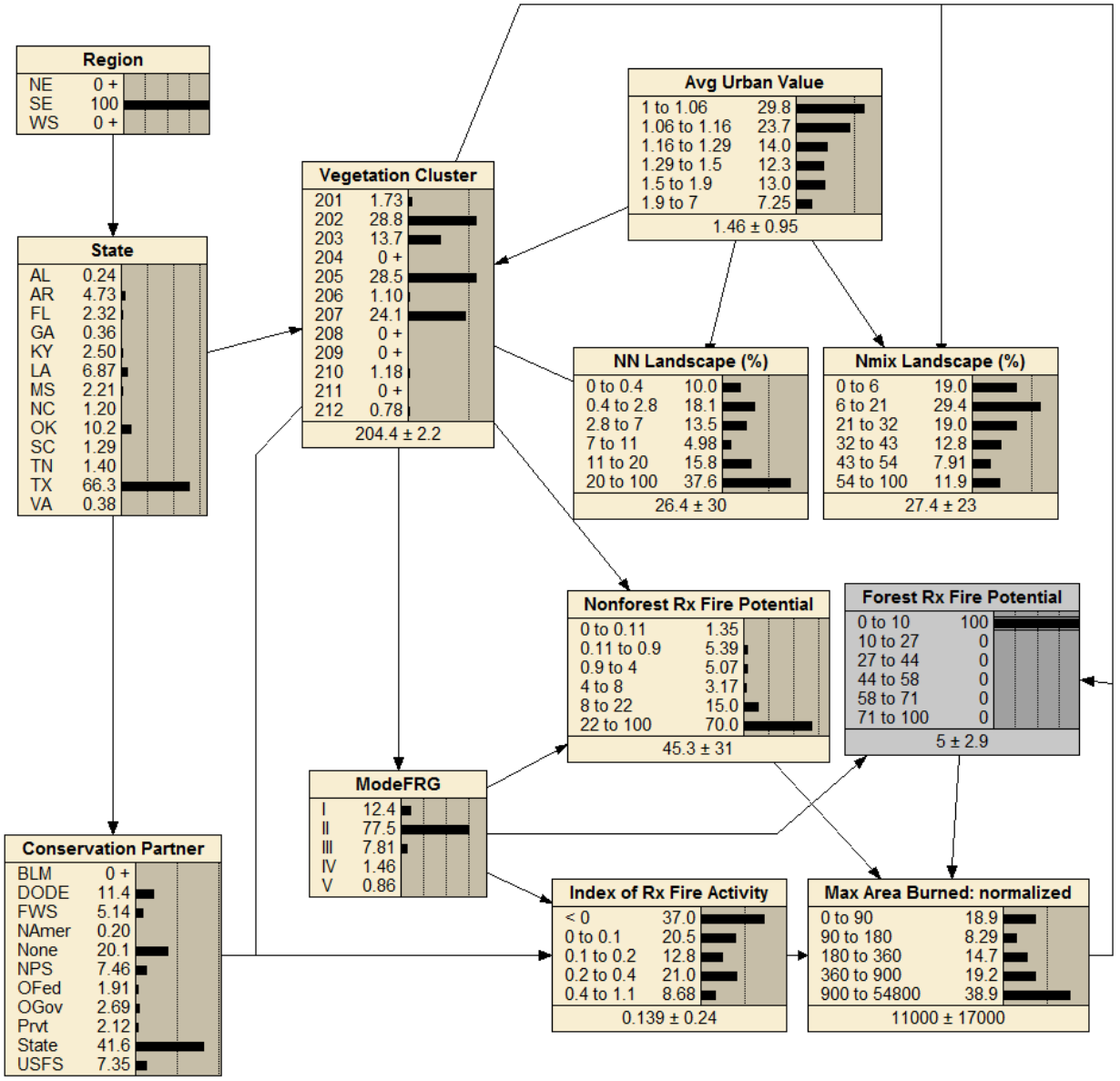
- Everyone will pair up in groups of two
- You will need:
  - NETICA installed on your laptop
  - “county RX Fire Southeast” file
- Go through the FIVE activities outlined in the Exercise Handout
- If you have questions, please raise your hand and someone will assist you…

LET'S GET STARTED

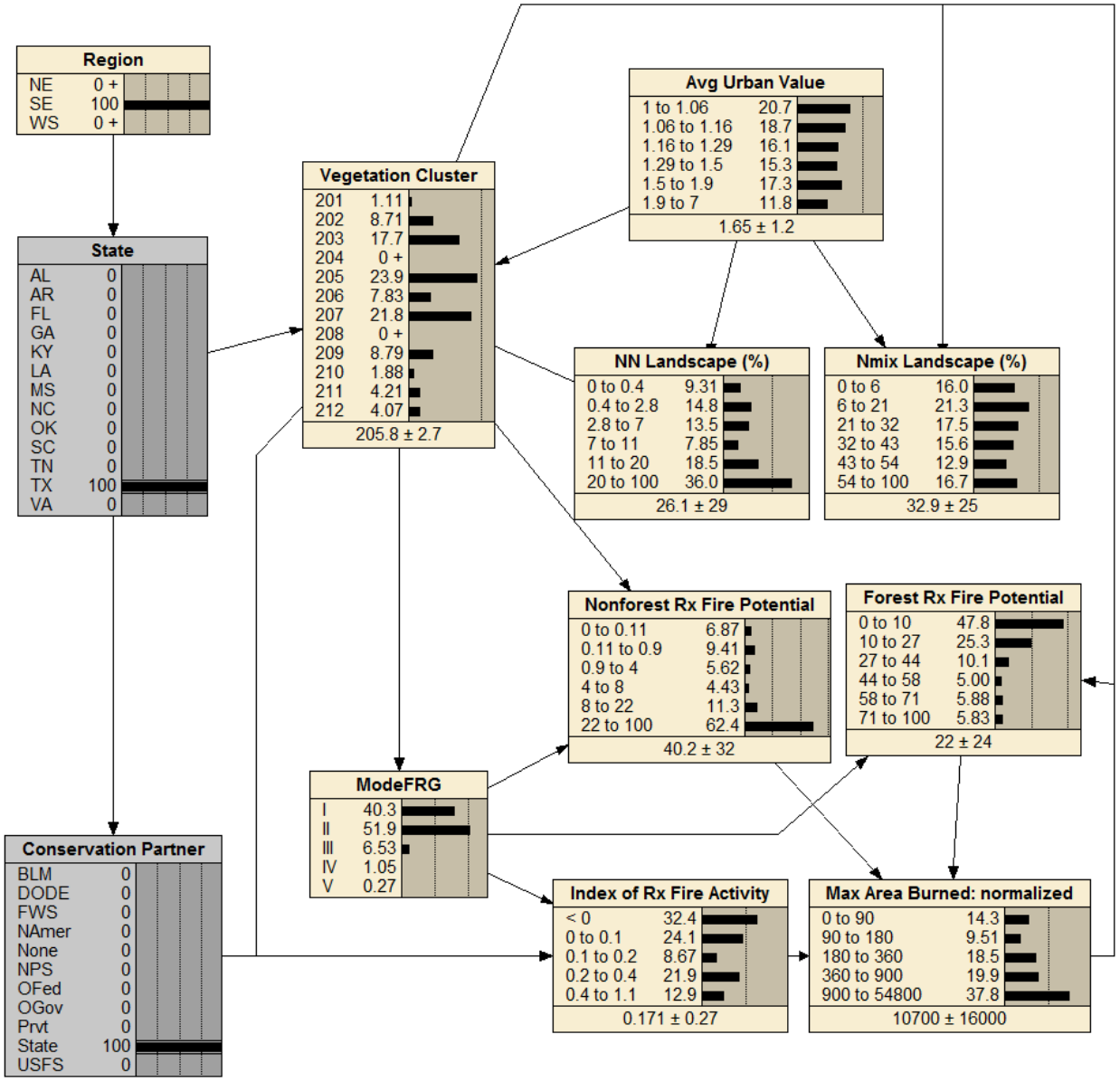
Activity #1


Region
NE 0 +
SE 100
WS 0 +
State
AL 3.68
AR 7.27
FL 2.72
GA 4.38
KY 4.87
LA 6.14
MS 3.95
NC 5.06
OK 9.78
SC 2.77
TN 4.69
TX 40.7
VA 3.96
Conservation Partner
BLM 0 +
DODE 11.9
FWS 4.45
NAmer 0.19
None 16.2
NPS 3.54
OFed 2.07
OGov 3.41
Prvt 3.78
State 42.5
USFS 12.0
Vegetation Cluster
201 5.99
202 19.2
203 9.32
204 5.76
205 10.7
206 7.13
207 13.1
208 8.93
209 5.14
210 2.76
211 7.38
212 4.55
205.6 ± 3.2
Avg Urban Value
1 to 1.06 23.1
1.06 to 1.16 20.9
1.16 to 1.29 15.9
1.29 to 1.5 13.9
1.5 to 1.9 15.9
1.9 to 7 10.4
1.59 ± 1.1
NN Landscape (%)
0 to 0.4 11.9
0.4 to 2.8 18.8
2.8 to 7 17.0
7 to 11 9.01
11 to 20 18.7
20 to 100 24.6
19.6 ± 26
Nmix Landscape (%)
0 to 6 16.8
6 to 21 21.3
21 to 32 17.6
32 to 43 16.2
43 to 54 13.5
54 to 100 14.6
31.9 ± 24
Nonforest Rx Fire Potential
0 to 0.11 8.03
0.11 to 0.9 13.0
0.9 to 4 11.0
4 to 8 13.7
8 to 22 16.3
22 to 100 38.1
26.8 ± 31
Forest Rx Fire Potential
0 to 10 35.3
10 to 27 21.7
27 to 44 14.8
44 to 58 9.69
58 to 71 9.35
71 to 100 9.15
29.8 ± 27
ModeFRG
I 43.2
II 42.0
III 14.2
IV 0.42
V 0.19
Index of Rx Fire Activity
< 0 100
0 to 0.1 0
0.1 to 0.2 0
0.2 to 0.4 0
0.4 to 1.1 0
-0.05 ± 0.029
Max Area Burned: normalized
0 to 90 19.4
90 to 180 14.0
180 to 360 17.8
360 to 900 20.8
900 to 54800 27.9
7990 ± 15000

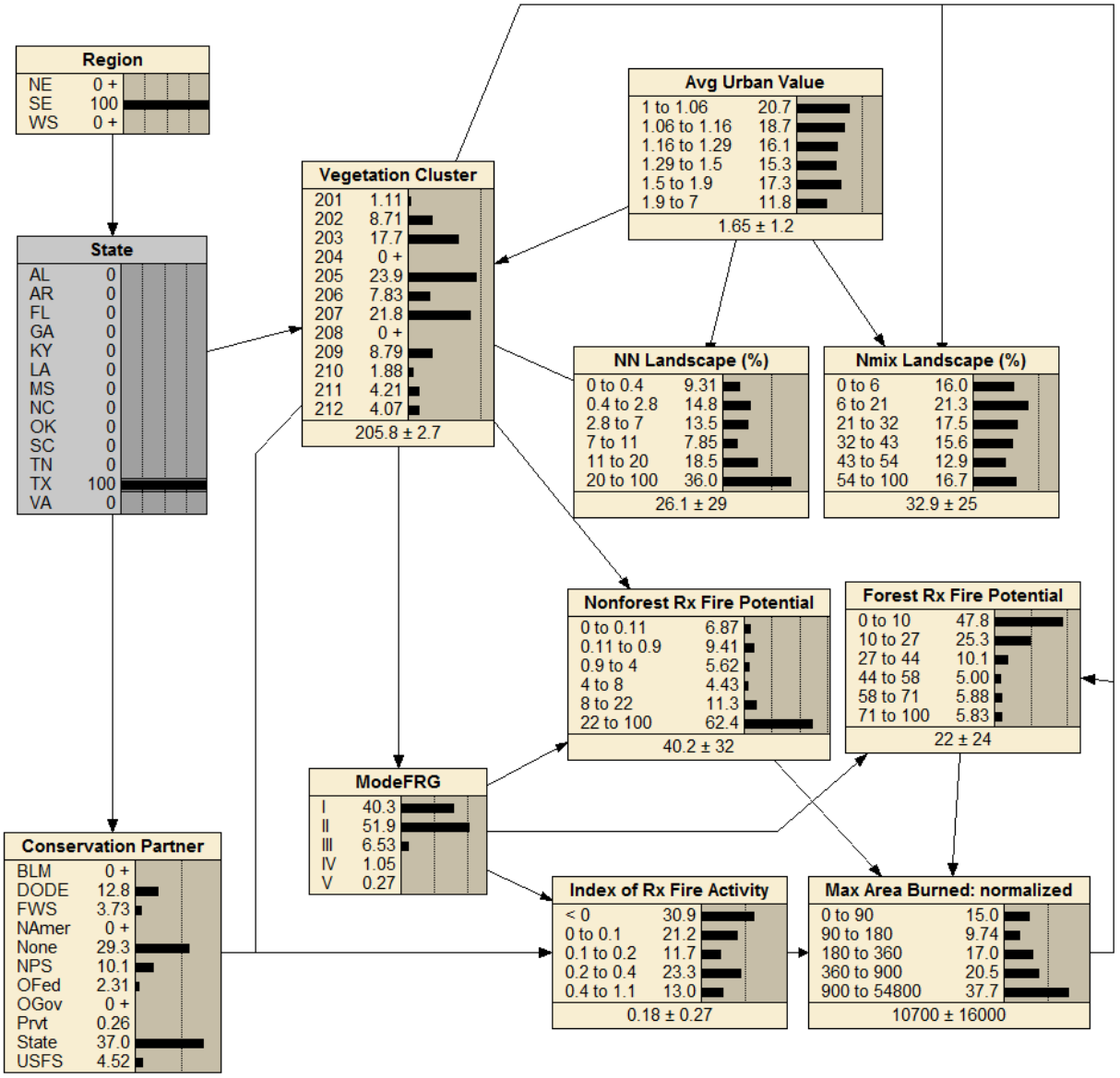
Activity #2


Region
NE 0 +
SE 100
WS 0 +
State
AL 0.24
AR 4.73
FL 2.32
GA 0.36
KY 2.50
LA 6.87
MS 2.21
NC 1.20
OK 10.2
SC 1.29
TN 1.40
TX 66.3
VA 0.38
Conservation Partner
BLM 0 +
DODE 11.4
FWS 5.14
NAmer 0.20
None 20.1
NPS 7.46
OFed 1.91
OGov 2.69
Prvt 2.12
State 41.6
USFS 7.35
Vegetation Cluster
201 1.73
202 28.8
203 13.7
204 0 +
205 28.5
206 1.10
207 24.1
208 0 +
209 0 +
210 1.18
211 0 +
212 0.78
204.4 ± 2.2
Avg Urban Value
1 to 1.06 29.8
1.06 to 1.16 23.7
1.16 to 1.29 14.0
1.29 to 1.5 12.3
1.5 to 1.9 13.0
1.9 to 7 7.25
1.46 ± 0.95
NN Landscape (%)
0 to 0.4 10.0
0.4 to 2.8 18.1
2.8 to 7 13.5
7 to 11 4.98
11 to 20 15.8
20 to 100 37.6
26.4 ± 30
Nmix Landscape (%)
0 to 6 19.0
6 to 21 29.4
21 to 32 19.0
32 to 43 12.8
43 to 54 7.91
54 to 100 11.9
27.4 ± 23
Nonforest Rx Fire Potential
0 to 0.11 1.35
0.11 to 0.9 5.39
0.9 to 4 5.07
4 to 8 3.17
8 to 22 15.0
22 to 100 70.0
45.3 ± 31
Forest Rx Fire Potential
0 to 10 100
10 to 27 0
27 to 44 0
44 to 58 0
58 to 71 0
71 to 100 0
5 ± 2.9
ModeFRG
I 12.4
II 77.5
III 7.81
IV 1.46
V 0.86
Index of Rx Fire Activity
< 0 37.0
0 to 0.1 20.5
0.1 to 0.2 12.8
0.2 to 0.4 21.0
0.4 to 1.1 8.68
0.139 ± 0.24
Max Area Burned: normalized
0 to 90 18.9
90 to 180 8.29
180 to 360 14.7
360 to 900 19.2
900 to 54800 38.9
11000 ± 17000

Activity #3


Region
NE 0 +
SE 100
WS 0 +
State
AL 0
AR 0
FL 0
GA 0
KY 0
LA 0
MS 0
NC 0
OK 0
SC 0
TN 0
TX 100
VA 0
Conservation Partner
BLM 0
DODE 0
FWS 0
NAmer 0
None 0
NPS 0
OFed 0
OGov 0
Prvt 0
State 100
USFS 0
Vegetation Cluster
201 1.11
202 8.71
203 17.7
204 0 +
205 23.9
206 7.83
207 21.8
208 0 +
209 8.79
210 1.88
211 4.21
212 4.07
205.8 ± 2.7
Avg Urban Value
1 to 1.06 20.7
1.06 to 1.16 18.7
1.16 to 1.29 16.1
1.29 to 1.5 15.3
1.5 to 1.9 17.3
1.9 to 7 11.8
1.65 ± 1.2
NN Landscape (%)
0 to 0.4 9.31
0.4 to 2.8 14.8
2.8 to 7 13.5
7 to 11 7.85
11 to 20 18.5
20 to 100 36.0
26.1 ± 29
Nmix Landscape (%)
0 to 6 16.0
6 to 21 21.3
21 to 32 17.5
32 to 43 15.6
43 to 54 12.9
54 to 100 16.7
32.9 ± 25
Nonforest Rx Fire Potential
0 to 0.11 6.87
0.11 to 0.9 9.41
0.9 to 4 5.62
4 to 8 4.43
8 to 22 11.3
22 to 100 62.4
40.2 ± 32
Forest Rx Fire Potential
0 to 10 47.8
10 to 27 25.3
27 to 44 10.1
44 to 58 5.00
58 to 71 5.88
71 to 100 5.83
22 ± 24
ModeFRG
I 40.3
II 51.9
III 6.53
IV 1.05
V 0.27
Index of Rx Fire Activity
< 0 32.4
0 to 0.1 24.1
0.1 to 0.2 8.67
0.2 to 0.4 21.9
0.4 to 1.1 12.9
0.171 ± 0.27
Max Area Burned: normalized
0 to 90 14.3
90 to 180 9.51
180 to 360 18.5
360 to 900 19.9
900 to 54800 37.8
10700 ± 16000

Activity #4


Region
NE 0 +
SE 100
WS 0 +
State
AL 0
AR 0
FL 0
GA 0
KY 0
LA 0
MS 0
NC 0
OK 0
SC 0
TN 0
TX 100
VA 0
Conservation Partner
BLM 0 +
DODE 12.8
FWS 3.73
NAmer 0 +
None 29.3
NPS 10.1
OFed 2.31
OGov 0 +
Prvt 0.26
State 37.0
USFS 4.52
Vegetation Cluster
201 1.11
202 8.71
203 17.7
204 0 +
205 23.9
206 7.83
207 21.8
208 0 +
209 8.79
210 1.88
211 4.21
212 4.07
205.8 ± 2.7
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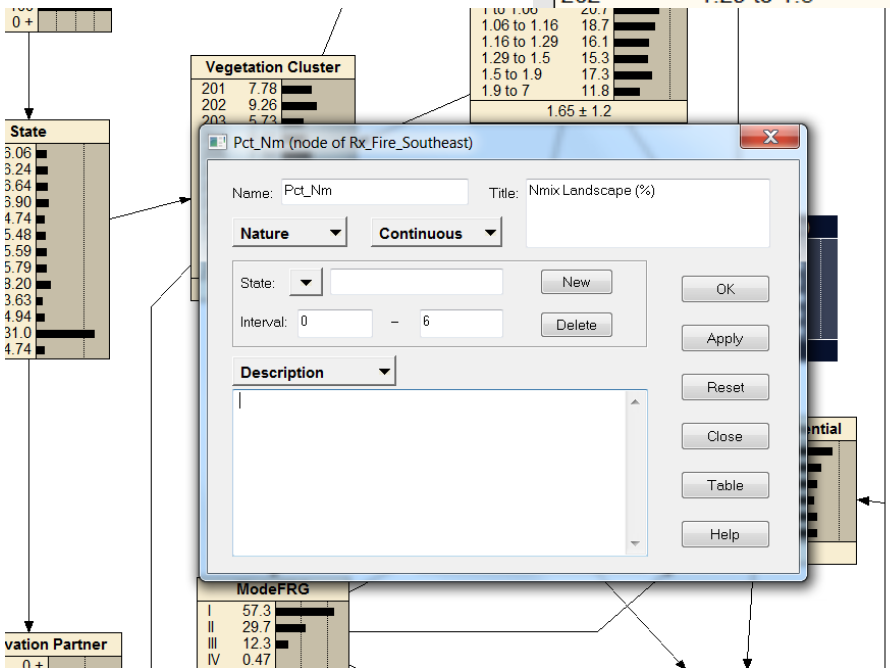
1.16 to 1.29 16.1
1.29 to 1.5 15.3
1.5 to 1.9 17.3
1.9 to 7 11.8
1.65 ± 1.2
NN Landscape (%)
0 to 0.4 9.31
0.4 to 2.8 14.8
2.8 to 7 13.5
7 to 11 7.85
11 to 20 18.5
20 to 100 36.0
26.1 ± 29
Nmix Landscape (%)
0 to 6 16.0
6 to 21 21.3
21 to 32 17.5
32 to 43 15.6
43 to 54 12.9
54 to 100 16.7
32.9 ± 25
Nonforest Rx Fire Potential
0 to 0.11 6.87
0.11 to 0.9 9.41
0.9 to 4 5.62
4 to 8 4.43
8 to 22 11.3
22 to 100 62.4
40.2 ± 32
Forest Rx Fire Potential
0 to 10 47.8
10 to 27 25.3
27 to 44 10.1
44 to 58 5.00
58 to 71 5.88
71 to 100 5.83
22 ± 24
ModeFRG
I 40.3
II 51.9
III 6.53
IV 1.05
V 0.27
Index of Rx Fire Activity
< 0 30.9
0 to 0.1 21.2
0.1 to 0.2 11.7
0.2 to 0.4 23.3
0.4 to 1.1 13.0
0.18 ± 0.27
Max Area Burned: normalized
0 to 90 15.0
90 to 180 9.74
180 to 360 17.0
360 to 900 20.5
900 to 54800 37.7
10700 ± 16000

Activity #5



Node: **Pct_Nm** | Apply | OK | Reset | Close

Chance | % Probab_

VegClusR	Avg Urban Value	0 to 6	6 to 21	21 to 32	32 to 43	43 to 54	54 to 100
201	1 to 1.06	0	19.057	10.205	38.37	27.687	4.681
201	1.06 to 1.16	0	8.589	10.805	49.231	21.104	10.27
201	1.16 to 1.29	4.664	13.054	40.419	35.437	3.205	3.221
201	1.29 to 1.5	5.464	13.486	37.498	36.901	6.65	0
201	1.5 to 1.9	9.173	12.419	33.864	38.898	5.646	0
201	1.9 to 7	32.427	54.048	6.412	7.114	0	0
202	1 to 1.06	19.119	49.855	31.026	0	0	0
202	1.06 to 1.16	32.309	39.72	21.296	6.674	0	0
202	1.16 to 1.29	38.958	47.574	13.468	0	0	0
202	1.29 to 1.5	66.835	33.165	0	0	0	0
		38.29	43.019	18.691	0	0	0
		28.068	71.932	0	0	0	0
		0	16.515	25.505	27.122	19.077	11.781
		0	0	17.743	34.363	13.24	34.654
		0	0	25.743	21.004	31.018	22.235
		0	0	40.097	0	39.447	20.456
		0	0	0	0	100	0
		0	61.59	38.41	0	0	0
		17.295	14.282	0	11.021	31.136	26.266
		30.823	5.614	8.064	0	19.242	36.256
		20.593	3.516	5.624	13.653	15.863	40.751
		6.2	5.752	0	18.926	15.058	54.064
		0	0	14.715	1.722	15.482	68.081
		12.814	0	0	32.21	5.151	49.825
		36.026	31.999	14.361	15.198	2.417	0
		0	40.701	18.313	6.402	16.318	18.265
		0	0	33.497	22.429	0	44.074
		0	0	0	54.7	0	45.3
		0	0	0	0	0	100
		0	0	0	0	0	100
		0	0	0	0	68.947	31.053
		7.5	6.616	17.853	27.989	11.688	28.353
		21.825	4.91	15.021	5.541	16.355	36.349