

# Cognitive Assistants for Intelligence Analysis: Theory, Textbooks, and Tools

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**NGA Grant #HM1582-09-1-0049**  
**National University Research Initiative (NURI)**  
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**2014 NGA Academic Research Program (NARP) Symposium and Workshops**

**9 - 11 September 2014**  
**The National Academy of Sciences Keck Center**  
**Washington, DC**

# Overview

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Computational Theory of Intelligence Analysis

From Tiacritis to Disciple-CD and to Cogent

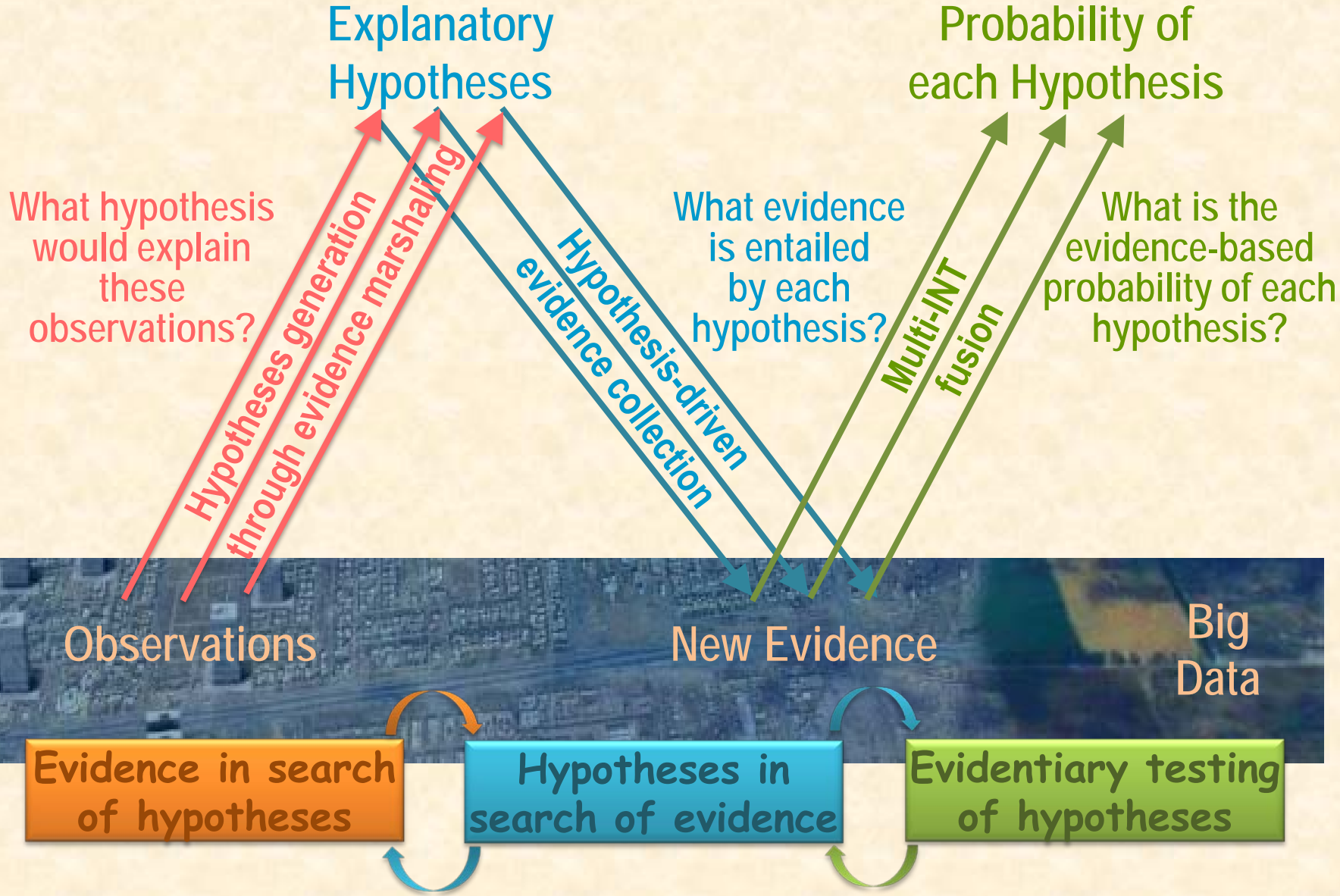
“Knowledge Engineering” Textbook and Disciple-EBR

“Connecting the Dots” Textbook and Disciple-CD

Cogent: Cognitive Agent for Cogent Analysis

Future Research

# Computational Theory of Intelligence Analysis



# Computational Theory of Intelligence Analysis

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## Key Elements

- Developed in the framework of the scientific method.
- Systematic approach to evidence-based reasoning through a synergistic integration of abductive, deductive, and inductive reasoning.
- Computational models for essential analytical tasks ( e.g., evidence marshaling, hypothesis-driven evidence collection, multi-INT fusion, detection and mitigation of bias).
- General analysis structure with favoring and disfavoring arguments for competing hypotheses.
- Intuitive system of Baconian probabilities with Fuzzy qualifiers, allowing customizable assessment scales.
- Substance-blind ontology of evidence.
- General procedures for credibility/believability assessment.

# Advanced Tools for Intelligence Analysis: From TIACRITIS to Disciple-CD and to COGENT

## Improvements over TIACRITIS

- Probability system
- Argument development
- Evidence-based reasoning
- Knowledge base management
- Usability
- Scalability
- Reliability

Version 1

(Summer 2014)

Cognitive Agent for  
Cogent Analysis

**COGENT**

2012-2016

Disciple Assistant for  
Connecting the Dots

**Disciple-CD**

2011-2014



## New Generation Tool

- Easy to use
- Enforcing cogent analyses
- Learning and reuse
- Collaborative analysis
- Enabling fast analyses
- Customizable scale

Teaching Intelligence  
Analysts Critical  
Thinking Skills

**TIACRITIS**

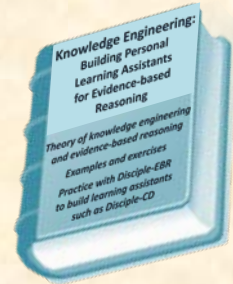
2009-2011



# Knowledge Engineering Textbook (with Disciple-EBR)

## **KNOWLEDGE ENGINEERING:** *Building Personal Learning Assistants for Evidence-based Reasoning*

- Introduction
- Evidence-based Reasoning: Connecting the Dots
- Methodologies and Tools for System Design and Development
- Modeling the Problem Solving Process
- Ontologies
- Ontology Design and Development
- Reasoning with Ontology and Rules
- Learning for Knowledge-based Systems
- Rule Learning
- Rule Refinement
- Abstraction of Reasoning
- Disciple Agents (Disciple-WA, Disciple-COA, Disciple-COG, and Disciple-VPT)



**Theory of knowledge engineering and evidence-based reasoning**

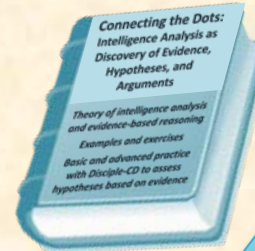
**Examples and exercises at each chapter**

**Practice with Disciple-EBR to build learning assistants such as Disciple-CD**

# Intelligence Analysis Textbook (with Disciple-CD)

## Connecting the Dots:

### *Intelligence Analysis as Discovery of Evidence, Hypotheses, and Arguments*



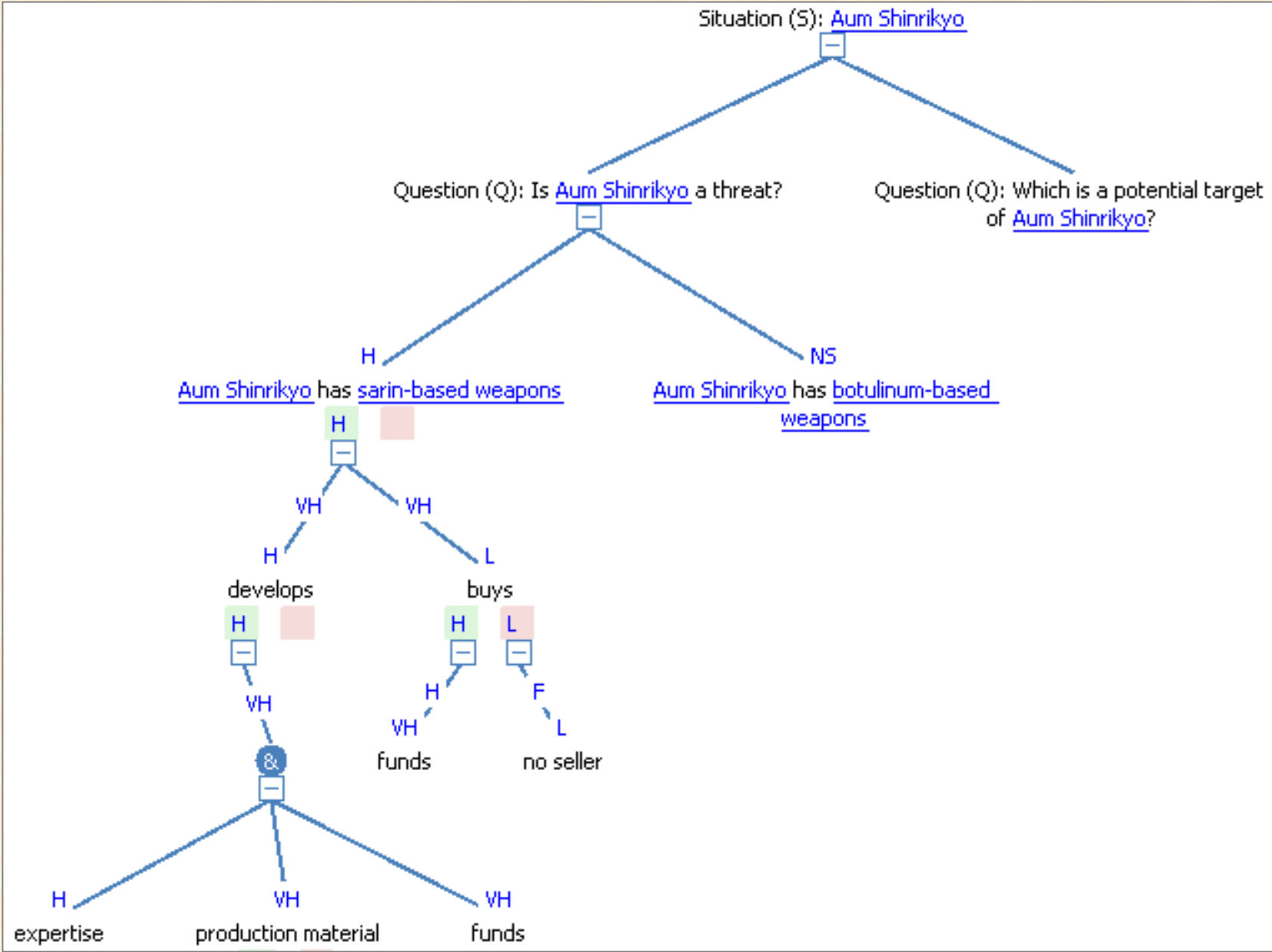
**Theory of intelligence analysis and evidence-based reasoning**

- Intelligence Analysis: “Connecting the Dots”
- Marshaling Thoughts and Evidence for Imaginative Analysis
- Disciple-CD: A Cognitive Assistant for Intelligence Analysis
- Evidence
- Divide and Conquer: A Necessary Approach to Complex Analyses
- Assessing the Believability of Evidence
- Chains of Custody
- Recurrent Substance-blind Combinations of Evidence
- Major Sources of Uncertainty in Masses of Evidence
- Assessing and Reporting Uncertainty: Some Alternative Methods
- Analytic Bias
- Appendices

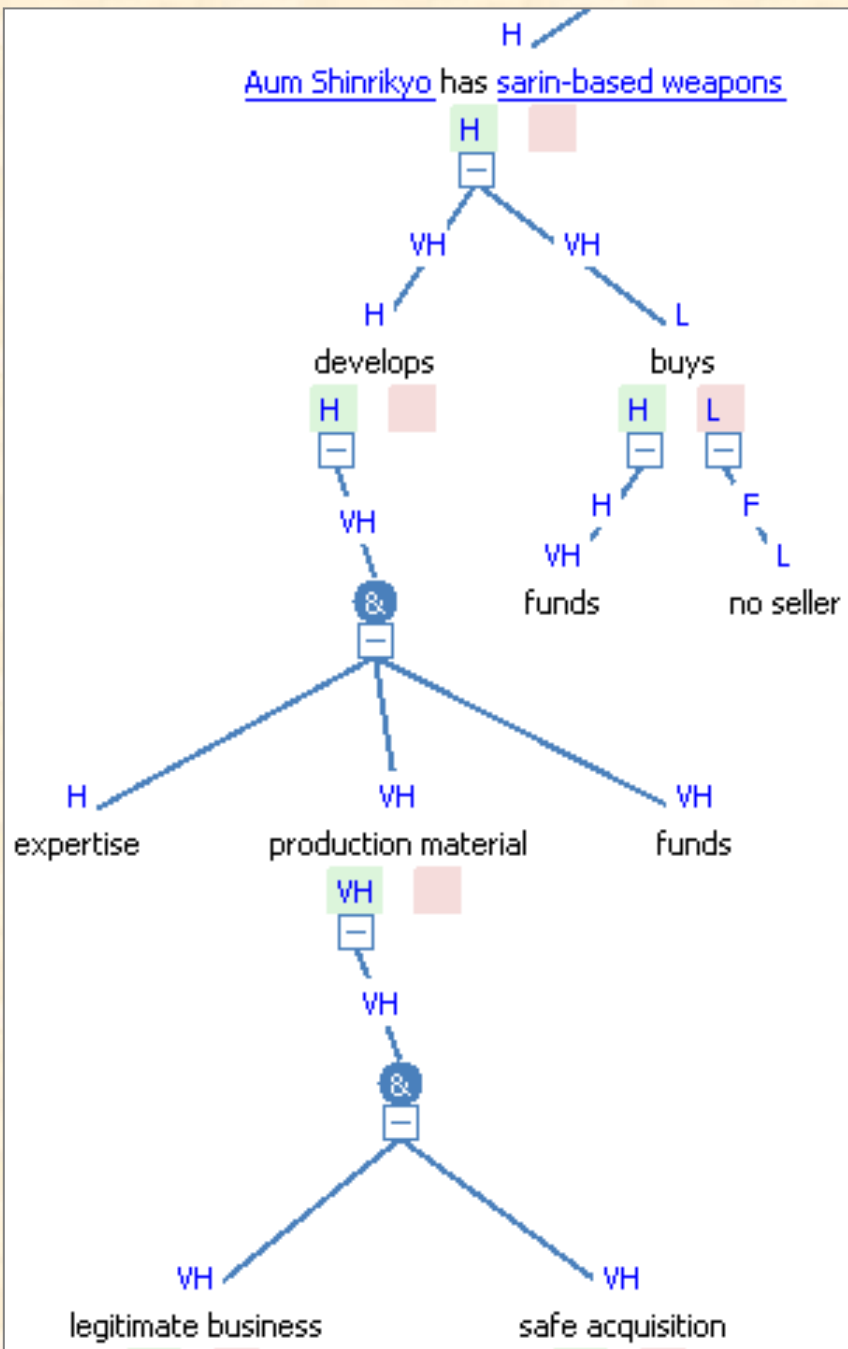
**Examples and exercises at each chapter**

**Basic and advanced practice with Disciple-CD to assess hypotheses based on evidence**

# Cogent: Cognitive Agent for Cogent Analysis







## Customizable assessment scale

Strength	Probability	Belief
F (Full strength)	C (Certain)	TB (Total Belief)
VH (Very High)	AC (Almost Certain)	SB (Strong Belief)
H (High)	VL (Very Likely)	MB (Moderate Belief)
M (Medium)	L (Likely)	WB (Weak Belief)
L (Low)	LS (Lack of Support)	LB (Lack of Belief)
VL (Very Low)	NS (Not Set)	NS (Not Set)
N (No strength)		
NS (Not Set)		

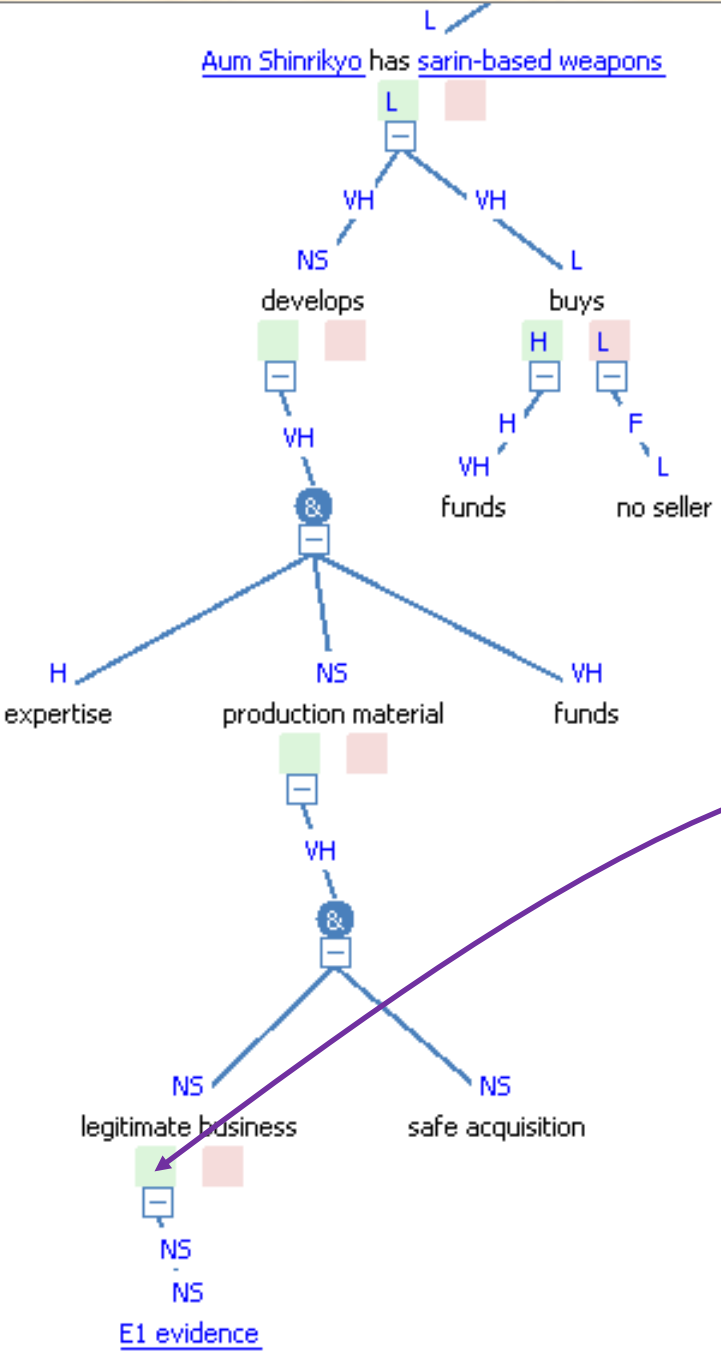
## On balance function

Disfavoring arguments  
Support for negation of Hypothesis

Strength of Hypothesis	N	VL	L	M	H	VH	F
F	F	VH	H	M	L	VL	N
VH	VH	H	M	L	VL	N	N
H	H	M	L	VL	N	N	N
M	M	L	VL	N	N	N	N
L	L	VL	N	N	N	N	N
VL	VL	N	N	N	N	N	N
N	N	N	N	N	N	N	N

Favoring arguments  
Support for Hypothesis

Attaching evidence to hypothesis



Argument
Evidence
E1 <u>evidence</u>
Description
To purchase the required technical equipment and substantial amounts of chemicals, Aum created two dummy companies - both run by Niimi - under Hasegawa Chemical, an already existing Aum shell company.
Save
Delete

As Nakagawa recalls, Murai, [Kazuyoshi] Takizawa and Tsuchiya started the design of the plant which was expected to produce 70 Tjens of) sarin in the building of Saiyan 7 that had already been built. They also began to buy a great amount of chemicals for 70 Tjens of) sarin in August 1995.<sup>114</sup>

To purchase the required technical equipment and substantial amounts of chemicals, Aum created two dummy companies - both run by Niimi under Hasegawa Chemical, an already existing Aum shell company.<sup>115</sup>

Work proceeded around the clock. By September 1995, the production facility at Saiyan 7 was declared ready for occupancy.<sup>112</sup> However, this readiness appears to have been overstated. Perhaps because of the haste with which it was built, Saiyan 7 never came close to the stated goal of 70 tons of sarin. As described below, it was capable of producing some 40 or 50 liters (that is, approximately 800 pounds) of the chemical. It occasionally employed 500 Aum members and was equipped with 30-liter flasks with mixing and temperature control capabilities with enclosed protective hoods.<sup>113</sup> The photograph on the right conveys a sense of Saiyan 7's size. A subsequent United Nations report estimated that the building and its contents cost 30 million dollars.<sup>114</sup>

**Sarin Expanded Production and Dissemination**

In October 1995, while Saiyan 7 was coming online, Tsuchiya was ordered to produce one kilogram of sarin. Murai assigned four trusted residents to work with Tsuchiya: Nakagawa, Kageko Sasaki (Nakagawa's girlfriend), Murai's wife and a bodyguard. Tsuchiya says that he could not refuse because his helpers entrained him in the organization.<sup>115</sup>

By mid-November 1995, Tsuchiya managed to produce 660 grams of sarin, and by December

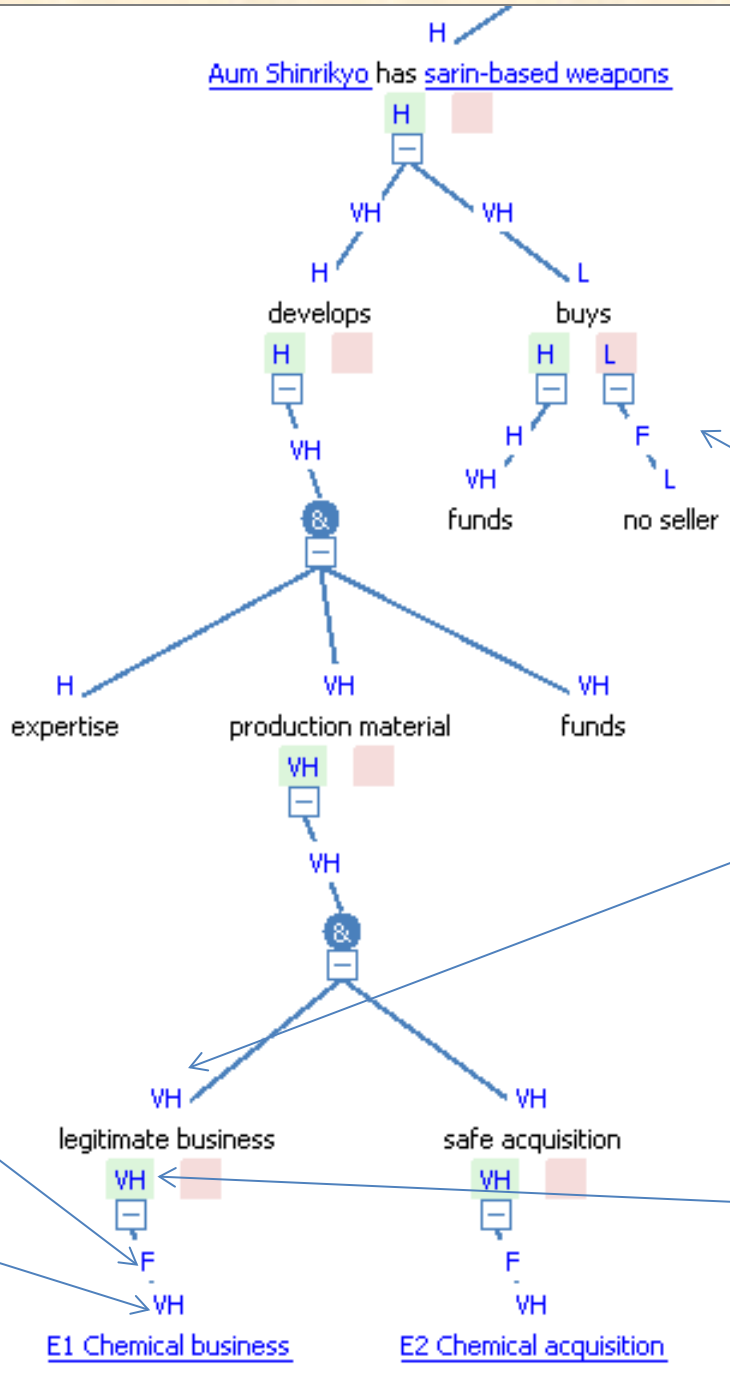
## Analyst assessments

2

**Strength of link:** How strong is the link between what the evidence states and the hypothesis? That is, assuming that Aum has indeed created the two dummy chemical companies, how strong is the hypothesis that it has a legitimate business which is justified to acquire sarin?

1

**Credibility of evidence:** How high is the credibility of E1 (i.e., that Aum has indeed created two dummy chemical companies)?



## Cogent assessments

5

**Strength of upper-level hypotheses**

4

**Strength of hypothesis** (based on both favoring and disfavoring arguments)

3

**Strength of favoring argument:** What is the strength of the favoring argument for the "legitimate business" hypothesis, based only on E1?

Situation (S): Al Qaeda



Question (Q): What are the capabilities of Al Qaeda?



NS

Al Qaeda has biological we

### Argument

- hypothesis
- question
- ... has ... (...)
- buys (...)
- develops (...)
- production material (...)

Learned patterns

Situation (S): Al Qaeda



Question (Q): What are the capabilities of Al Qaeda?



NS

Al Qaeda has biological weapons



NS

NS

Hypothesis (H): develops



VH

&

NS

expertise

NS

Hypothesis (H): production material

NS

funds

### Argument

Close

develops



VH

&

expertise

production material

funds

Reuse of learned patterns

# Cogent Documentation

**Getting Started with Cogent**  
 (for the strength scale and  
 for the probability scale)

**Requirements and Installation** ..... 3  
*Operations to install and uninstall Cogent.*

**Analysis Example** ..... 5  
*Theory and operation of Cogent through a complete analysis example, ending with operations of saving the developed argumentation, creating a new knowledge base, and loading it to develop a new argumentation.*

**Next Steps** ..... 18

**Introduction** ..... 4  
*Determining the probability of a hypothesis and operations description.*

**Assistants** ..... 7  
*Operations to open and close Cogent assistants.*

**Building an Argument** ..... 10  
*Basic operations for building an argument.*

**Assessments and Assumptions** ..... 23  
*Operations to assess the credibility and strength, and to make assumptions.*

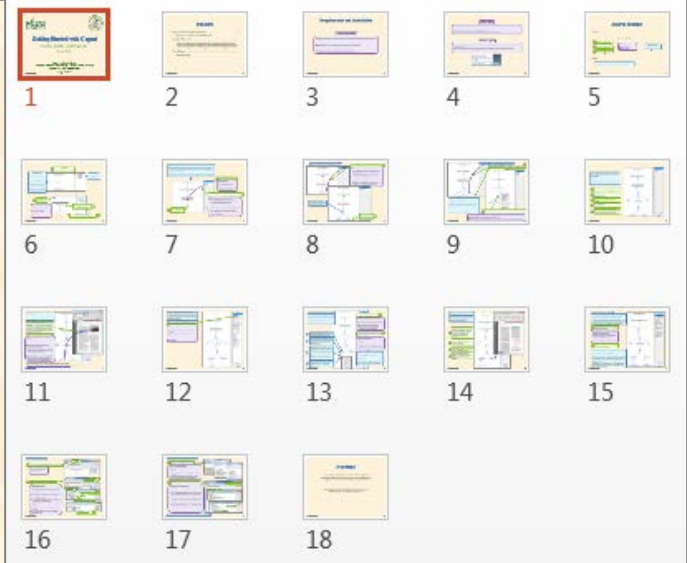
**Local Evidence** ..... 31  
*Operations to define, update, and delete evidence in the local repository.*

**Updating an Argument** ..... 36  
*More complex operations to update an argument.*

**Learning and Reuse** ..... 42  
*Learning patterns from an argument and reusing them.*

**Knowledge Repository** ..... 47  
*Operations to create, select, save, close, and transfer knowledge bases.*

**Requirements and Installation** ..... 53  
*Operations to install and uninstall Cogent.*



**Cogent: Operations**  
 (for the strength scale and  
 for the probability scale)



# Future Research

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- Advanced analytic capabilities:
  - Detection and mitigation of cognitive bias;
  - Evidence marshaling for hypotheses generation;
  - ACH-like visualization and browsing;
  - Key evidence and assumptions; etc.
  
- Advanced learning capabilities
  
- Collaborative analysis
  
- Analysis advisor
  
- Automatic report generation
  
- Cogent-based textbook
  
- Transition to IC and DOD

# Questions

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