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

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### Overview

- 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

Explanatory Hypotheses

What hypothesis would explain these observations?

Probability of each Hypothesis

What is the evidence-based probability of each hypothesis?

Observations

What evidence is entailed by each hypothesis?

Evidence in search of hypotheses

New Evidence

Hypotheses in search of evidence

Big Data

Evidence-driven evidence collection

Multi-INT fusion

Evidentiary testing of hypotheses

Evidence in search of hypotheses

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Computational Theory of Intelligence Analysis

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

Disciple Assistant for Connecting the Dots

Disciple-CD

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

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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*

- 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

Theory of intelligence analysis and evidence-based reasoning

Examples and exercises at each chapter

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

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Cogent: Cognitive Agent for Cogent Analysis

Situation (S): Aum Shinrikyo

Question (Q): Is Aum Shinrikyo a threat? Question (Q): Which is a potential target of Aum Shinrikyo?

Aum Shinrikyo has sarin-based weapons

Aum Shinrikyo has botulinum-based weapons

H

VH

L

develops

buys

H & F

no seller

H

VH

VH

funds

expertise

production material

funds
Support for Hypothesis

Strength

Probability

Belief

Strength Probability Belief

<table>
<thead>
<tr>
<th>F (Full strength)</th>
<th>C (Certain)</th>
<th>TB (Total Belief)</th>
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<tr>
<td>VH (Very High)</td>
<td>AC (Almost Certain)</td>
<td>SB (Strong Belief)</td>
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<tr>
<td>H (High)</td>
<td>VL (Very Likely)</td>
<td>MB (Moderate Belief)</td>
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<tr>
<td>M (Medium)</td>
<td>L (Likely)</td>
<td>WB (Weak Belief)</td>
</tr>
<tr>
<td>L (Low)</td>
<td>NS (Lack of Support)</td>
<td>LB (Lack of Belief)</td>
</tr>
<tr>
<td>VL (Very Low)</td>
<td>NS (Not Set)</td>
<td>NS (Not Set)</td>
</tr>
<tr>
<td>N (No strength)</td>
<td>NS (Not Set)</td>
<td>NS (Not Set)</td>
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On balance function

Disfavoring arguments
Support for negation of Hypothesis

Favoring arguments
Support for Hypothesis

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Attaching evidence to hypothesis

Aum Shinrikyo has sarin-based weapons

Attaching evidence
to hypothesis

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.

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

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?

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

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

5. **Strength of upper-level hypotheses:**

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Situation (S): Al Qaeda

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

Al Qaeda has biological weapons

Hypothesis (H): develops

expertise, production material, funds

Learned patterns

Reuse of learned patterns
## Cogent Documentation

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

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### Requirements and Installation

- Operations to install and uninstall Cogent.

### Analysis Example

- 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

- What to do next.
Future Research

- 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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