Designing Expert Systems

9. Scenario Elicitation: Populating an Ontology with Instances

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Overview

Disciple-COG: Agent for Center of Gravity Analysis

Script-based Scenario Elicitation

Design and Development of Elicitation Scripts

Reading
The center of gravity of an entity (state, alliance, coalition, or group) is the foundation of capability, the hub of all power and movement, upon which everything depends, the point against which all the energies should be directed.

Carl Von Clausewitz, On War, 1832.

The center of gravity of an entity is its primary source of moral or physical strength, power or resistance.


If a combatant eliminates or influences the enemy’s strategic center of gravity, then the enemy will lose control of its power and resources and will eventually fall to defeat. If the combatant fails to adequately protect his own strategic center of gravity, he invites disaster.

Giles and Galvin, USAWC 1996.
The CG-CC-CR-CV Approach to CoG Analysis

Centers of Gravity (CG): Primary sources of moral or physical strength, power or resistance.

Critical Capabilities (CC): Primary abilities which merit a Center of Gravity to be identified as such in the context of a given situation or mission.

Critical Requirements (CR): Essential conditions, resources and means for a Critical capability to be fully operative.

Critical Vulnerabilities (CV): Critical Requirements or components thereof which are deficient, or vulnerable to neutralization, interdiction or attack (moral/physical harm) in a manner achieving decisive results – the smaller the resources and effort applied and the smaller the risk and cost, the better.

Joe Strange,
Critical Capabilities for a Center of Gravity

**Leader**
- Maintain protection
- Stay informed
- Communicate
- Maintain influence
- Be a driving force
- Maintain support
- Be irreplaceable

**People**
- Receive communication from the highest level leadership
- Communicate desires to the highest level leadership
- Support the goal of their force
- Support the highest level leadership
- Maintain positive impact
- Maintain influence

**Military**
- Be deployable
- Exert power
- Be indispensable
- Industrial capacity
- Financial capacity
- Ideology
- External support
- Will of multi member force
## Critical Capabilities and Requirements of a Leader

### National Leader as a Center of Gravity

<table>
<thead>
<tr>
<th>Critical Capability</th>
<th>Critical Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain protection</td>
<td>Have means to be protected from all threats</td>
</tr>
<tr>
<td>Stay informed</td>
<td>Have means to receive essential intelligence</td>
</tr>
<tr>
<td>Communicate</td>
<td>Have means to communicate with the government, the military and the people</td>
</tr>
<tr>
<td>Maintain influence</td>
<td>Have means to influence the government, the military and the people</td>
</tr>
<tr>
<td>Be a driving force</td>
<td>Have reasons and determination for pursuing the goal of the led force</td>
</tr>
<tr>
<td>Maintain support</td>
<td>Have means to secure support from the government, the military and the people</td>
</tr>
<tr>
<td>Be irreplaceable</td>
<td>Be the only leader to maintain the goal</td>
</tr>
</tbody>
</table>
Critical capability to
Maintain protection

Corresponding critical requirement
Have means to be protected from all threats

Means  →  Vulnerabilities

Republican Guard Protection Unit  →  loyalty can be influenced by US-led coalition

Iraqi Military  →  loyalty can be influenced by US-led coalition
  →  can be destroyed by US-led coalition

Complex of Iraqi Bunkers  →  location known to US led coalition
  →  design known to US led coalition
  →  can be destroyed by US-led coalition

System of Saddam Doubles
  →  loyalty of Saddam Doubles to Saddam can be influenced by US-led coalition
  →  can be uncovered by US-led coalition
Disciple-COG at Army War College and Air War College

Center of Gravity Analysis Course

Disciple-COG was taught based on the expertise of the course’s instructor, who used the CG-CC-CR-CV model. Disciple helps military personnel perform center of gravity analyses of scenarios of interest.

Sample Evaluations by Officers (Spring 2007)

The use of Disciple is an assignment that is well suited to the course’s learning objectives.

Disciple should be used in future versions of this course.

A system like Disciple could be used in other Air War College courses.

1) Analyzing the strategic COG of a force is reduced to the tasks of analyzing the COG candidates corresponding to its main elements of power (government, people, economy, military, etc.).

2) Analyzing a COG candidate is reduced to the tasks of analyzing its Critical Capabilities that may make it a COG.

3) Analyzing a Critical Capability is reduced to analyzing its Critical Requirements (i.e. the essential conditions, resources and means needed by the critical capability to be fully operative).

4) Analyzing a Critical Requirement is reduced to determining whether it has any Critical Vulnerability (i.e. deficiency, or vulnerability to neutralization, interdiction or attack in a manner achieving decisive results).

Knowledge Base = Object Ontology + Rules

The **object ontology** is a hierarchical description of the domain objects.

- **governing body**
  - ad hoc governing body
  - established governing body
- state government
- group governing body
  - democratic government
  - dictator
  - deity figure
  - democratic council or board
  - chief and tribal council
- representative democracy
  - parliamentarian democracy
- theocratic democracy
- autocratic leader
- governing body
  - government of Italy 1943
  - represents totalitarian government
  - representative democracy
  - parliamentary democracy
  - theocratic government
- government of US 1943
  - government of Britain 1943
- military dictatorship
- police state
- fascist state
- religious dictatorship
- theocratic democracy
- government of Germany 1943
- government of USSR 1943

- feudal god
- king government
- monarchy
- theocracy
- representative democracy
- parliamentary democracy
- theocratic democracy
- autocratic leader
- deity figure
- democratic council or board
- chief and tribal council
Knowledge Base = Object Ontology + Rules

The rules specify general problem solving steps described with the objects from the ontology.

```
RULE

REASONING TREE

Knowledge Base = Object Ontology + Rules

The rules specify general problem solving steps described with the objects from the ontology.
```
mixed-initiative reasoner

reasoning type: reduction
reasoning mode: solving
plausibility: high

reasoning hierarchy

graphical viewer

report

Test whether President Roosevelt has the critical capability to maintain influence

Q: Which are the critical requirements for President Roosevelt to maintain influence?
A: President Roosevelt needs means to influence the government, means to influence the military, and means to influence the people.

Test whether President Roosevelt has means to influence the government

Test whether President Roosevelt has means to influence the military

Test whether President Roosevelt has means to influence the people
Test whether President Roosevelt has the critical capability to maintain influence

President Roosevelt has the critical capability to maintain influence because President Roosevelt has means to influence the government (President Roosevelt is the head of the government of US 1943), has means to influence the military (President Roosevelt is the commander in chief of the military of US 1943 and President Roosevelt is the head of the government of US 1943) and has means to influence the people (President Roosevelt is a trusted leader using the mass media of US 1943). There is no significant vulnerability.

Test whether President Roosevelt has means to influence the government.

President Roosevelt has means to influence the government (President Roosevelt is the head of the government of US 1943). There is no significant vulnerability.

Test whether President Roosevelt has means to influence the military.

President Roosevelt has means to influence the military (President Roosevelt is the commander in chief of the military of US 1943 and President Roosevelt is the head of the government of US 1943). There is no significant vulnerability.

Test whether President Roosevelt has means to influence the people.

President Roosevelt has means to influence the people (President Roosevelt is a trusted leader using the mass media of US 1943). There is no significant vulnerability.
Center of Gravity Determination: Computational Approach

Given: A situation (e.g. “WW II Europe 1943” World War II in Europe in 1943, at the time of the invasion of Sicily by the Allied Forces).

Determine: The strategic centers of gravity of the opposing forces and their critical vulnerabilities.

- Specification of the Situation
  Assemble data and specify the relevant aspects of the strategic environment:
  - Opposing forces and their strategic goals
  - Political factors
  - Military factors
  - Psychosocial factors
  - Economic factors, etc.

- Identification of COG candidates
  Identify potential primary sources of moral or physical strength, power and resistance from:
  - Government
  - Military
  - People
  - Economy
  - Alliances
  - Etc.

- Testing of COG candidates
  Test each identified COG candidate to determine whether it has all the critical capabilities:
  - Which are the required critical capabilities?
  - Are the critical requirements of these capabilities satisfied?
  - Are the critical requirements vulnerable?
  - Select COG based on analysis.
User – Disciple Collaboration in COG Analysis

- Is guided by Disciple to describe the relevant aspects of a strategic environment.
- Develops a formal representation of the situation.
- Identifies and tests strategic COG candidates.
- Studies the logic behind COG identification and testing.
- Generates a COG analysis report.
- Critiques Disciple’s analysis and finalizes the analysis report.
The student is guided by Disciple-COG to describe the relevant aspects of the situation to be analyzed.
Analysis of center of gravity candidate: President Roosevelt

President Roosevelt is a strategic COG candidate that can be eliminated because President Roosevelt does not have all the necessary critical capabilities (e.g., be irreplaceable).

- President Roosevelt has the critical capability to maintain protection because President Roosevelt has means to be protected (US Secret Service 1943). There is no significant vulnerability.
- President Roosevelt has the critical capability to stay informed because President Roosevelt has means to receive essential intelligence (US Office of Strategic Services 1943, US Navy Intelligence 1943 and US Army Intelligence 1943). There is no significant vulnerability.
- President Roosevelt has the critical capability to communicate because President Roosevelt has means to communicate with the government (executive orders), has means to communicate with the military (military orders and executive orders) and has means to communicate with the people (mass media of US 1943). There is no significant vulnerability.
- President Roosevelt has the critical capability to maintain influence because President Roosevelt has means to influence the government (President Roosevelt is the head of the government of US 1943), has means to influence the military (President Roosevelt is the commander in chief of the military of US 1943 and President Roosevelt is the head of the government of US 1943) and has means to influence the people (President Roosevelt is a trusted leader using the mass media of US 1943). There is no significant vulnerability.
- President Roosevelt has the critical capability to be a driving force because President Roosevelt has reasons to pursue the goal of US 1943 (preserving separate peace by the members of the Allied Forces) and has determination to pursue the goal of US 1943 (the western democratic values). There is no significant vulnerability.
- President Roosevelt has the critical capability to maintain support because President Roosevelt has means to secure support from the government (President Roosevelt is a trusted commander in chief of the military of US 1943 and President Roosevelt is the head of the government of US 1943) and has means to secure support from the people (President Roosevelt is the head of a democratic government with a history of good decisions, and the people of US 1943 are willing to make sacrifices for the unconditional surrender of European Axis). There is no significant vulnerability.

President Roosevelt does not have the critical capability to be irreplaceable because President Roosevelt is not the only leader to maintain the goal of unconditional surrender of European Axis (the goal was established and the country was committed to it). There is no significant vulnerability.
COG candidates in the **WW II Europe 1943 situation**

### 6.3 US 1943 candidates

#### 6.3.1 Candidate: will of the people of US 1943

The will of the people of US 1943 is a strategic COG candidate that cannot be eliminated because it has all the necessary critical capabilities.

**CC: receive communication from the highest level leadership**
The people of US 1943 have the critical capability to receive communication from the highest level leadership because the people of US 1943 have means to receive communication from the highest level leadership (mass media of US 1943). There is no significant vulnerability.

**CC: communicate desires to the highest level leadership**
The people of US 1943 have the critical capability to communicate desires to the highest level leadership because the people of US 1943 have means to communicate desires to the highest level leadership (elected representatives of the government of US 1943). There is no significant vulnerability.

**CC: support the goal of US 1943**
The people of US 1943 have the critical capability to support the goal of US 1943 because the people of US 1943 have means to support the goal of US 1943 (voting, participation in the government).
Overview

Disciple-COG: Agent for Center of Gravity Analysis

Script-based Scenario Elicitation

Design and Development of Elicitation Scripts

Reading
Sample Object Ontology

Disciple-COG has general knowledge about the center of gravity domain, such as the following hierarchy of concepts, but no knowledge about the situation to be analyzed:

- Scenario
- Object
  - Force
    - Single member force
      - Single state force
        - Dominant partner multi state alliance
    - Multi member force
      - Multi state force
        - Equal partners multi state alliance
      - Multi group force
        - Multi state alliance
  - Opposing force
    - Multi state coalition
The student is guided by Disciple-COG to describe the relevant aspects of the situation to be analyzed.
Disciple develops a formal representation of the situation, introducing specific objects and their features into its object ontology, based on the information elicited from the user.
Sample Elicitation Script

Script type: Elicit the feature Has_as_opposing_force for an instance <situation-name>

Question: Name the opposing forces in <situation-name>

Element type: selection list with names control

Answer variable: <first-opposing-force-name>

Ontology actions:

- <first-opposing-force-name> instance-of opposing_force
- <situation-name> has as opposing force <first-opposing-force-name>

Answer variable: <second-opposing-force-name>

Ontology actions:

- <second-opposing-force-name> instance-of opposing_force
- <situation-name> has as opposing force <second-opposing-force-name>
- <first-opposing-force-name> is opposed to <second-opposing-force-name>
- <second-opposing-force-name> is opposed to <first-opposing-force-name>

Script calls:

- Elicit feature is analyzed of the instance <first-opposing-force-name> in new window
- Elicit feature is analyzed of the instance <second-opposing-force-name> in new window
Demo

Disciple COG
Overview

Disciple-COG: Agent for Center of Gravity Analysis

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Reading
Hello, I am Disciple, your assistant to help you choose a PhD advisor. What is your name?
Bob Sharp

We need to
Assess whether John Doe is a potential PhD advisor for Bob Sharp.

Is Bob Sharp interested in the area of expertise of John Doe?
Yes because Bob Sharp is interested in Artificial Intelligence which is the area of expertise of John Doe.

Therefore we need to
Assess whether John Doe is a potential PhD advisor for Bob Sharp in Artificial Intelligence.

Indicate a research area in which you would like to do your PhD:
• Artificial Intelligence
• Information Security

This will be a question asked during Scenario Elicitation when Disciple attempts to elicit the profile of the student.

Ph.D. student
instance-of
Bob Sharp

This is another question that Disciple asks Bob during Scenario Elicitation.

Bob Sharp is interested in Artificial Intelligence
Hello, I am Disciple, your assistant to help you choose a PhD advisor.
What is your name?
Bob Sharp

Nice to meet you Bob Sharp.
I will ask some questions about you, to understand your needs and preferences.

Indicate a research area in which you would like to do your PhD:
• Artificial Intelligence
• Information Security
…
<other questions about Bob>

I will now ask you some questions about potential PhD advisors.
Name the faculty members from your school:
John Doe
Dan Smith
…
Dialog Design

<questions about John Doe>

Who is the employer of John Doe?
George Mason University

Which are the areas of expertise of John Doe?
  • Artificial Intelligence
  • Information Security
...

What type of position does John Doe have?
  • tenured professor
  • tenure track professor
  • visiting professor
  • retired position
...

<questions about Dan Smith>
...
Script Development

Object Browser

Browse repository/PAD-m2o-demo/CS681-demo

- object
  - agent
    - organization
    - person
  - employee
  - student
    - graduate student
    - MS student
    - PhD student
  - undergraduate student

- course
- criterion
- criterion evaluation
- criterion type
- position
- publication
- research area

Script Editor

Script Selection

PhD student scripts: elicit instances of PhD student

- New
- Delete
- Save
- Rename/Move
- Copy
- Go to...

Header

Name: elicit instances of PhD student

Arguments: More

Check: Script is root

Elements

Element type: string input control

Condition: Answer is optional

Control is read-only

Text: Hello I am Disciple, your assistant to help you choose a PhD advisor. What is your name?

Help:

Variable: Name: <student-name>

- Allow multiple values
- Default: new student
- Modifier:

Ontology: <student-name> instance-of PhD student

More

Height: 3

Report: More

Element type: script call

Object: PhD student
Script Development

The image shows a script editor interface for developing educational scripts. The interface includes a browser on the left side with categories such as object, person, student, and course. The main area on the right side is the script editor, with sections for header, elements, and conditions. The header includes fields for script selection, name, and arguments. The elements section allows for editing the script's text content. The image also shows a conditional block with options for script call, object, script name, and person name.
Script Development

Script Editor

Object Browser

Browse repository \ PAD-m2o-demo \ CS681-demo

Script Selection

is interested in scripts: emit interest area

New Delete Save Rename/Mo Copy Go to...

Header

Name: emit interest area

Arguments: <person-name>

More

Script is root

Elements

Element type: selection list control

Condition... Answer is optional Control is read-only

Text: Indicate the domain of interest of <person-name>

Help:

Variable:

Name: <domain>

Allow multiple values

Default:

Modifier:

Values range: Type: range of a feature

Feature: is interested in

Preferred order: More

Allow adding new values to the feature range

Ontology: <person-name> is interested in <domain>

More
Script Development

- Faculty member scripts: elicit instances of faculty member
- Name: elicit instances of faculty member
- Arguments: More
- Element type: string input control
- Text: I will now ask you some questions about potential PhD advisors. Name the faculty members from your school:
- Variable: Name: \textlt{faculty-name}
- Default: new-faculty
- Modifier:
- Ontology: \textlt{faculty-name} instance-of faculty member
- Height: 4
- Report: More
Reading

These Lecture Notes (required).

