

*International Technology Alliance
in
Network & Information Sciences*

Controlled English for Effective Communication during Coalition Operations

*18th ICCRTS
June 19-21, 2013*

Stephen Poteet, Ping Xue, Anne Kao
Boeing Research & Technology

David Mott, Dave Braines
IBM UK

Cheryl Giammanco
Army Research Lab



MINISTRY OF DEFENCE



The International Technology Alliance

- Network and Information Sciences International Technology Alliance (ITA) is a collaborative research alliance between the UK Ministry of Defence (UK MoD) and US Army Research Laboratory (US ARL), and a consortium of leading academic and industry partners
- The ITA program started on May 12, 2006; the first phase of the program finished in 2011, and it is now in its second phase (May 2011-May 2016)
- ITA has the strategic goal of producing fundamental advances in information and network sciences
 - to enhance decision making for coalition operations and
 - to enable rapid, secure formation of ad hoc teams in coalition environments and
 - to enhance US and UK capabilities to conduct coalition warfare
- Part of the goal is to address shared understanding and information exploitation in support of decision-making in a coalition environment
- Work presented here is funded under this ITA effort



Challenges for Effective Communication

- Coalition operations involve multi-team and/or multi-nation collaborations
- Various types of linguistic differences exist at various levels of language use between British and American which lead to misunderstanding.
- Cultural differences result in variations in language use even though English speaking nations such as the US and UK share a 'common' English language.
- Linguistic variations and cultural differences often create unexpected challenges for effective communication and pose problems for military operations in a coalition setting



Linguistic Variations and Cultural Differences

- **Use of Acronyms:** acronyms usually originate from a specific technical or culture group and are not known by people outside
- **Use of Slang, Colloquialisms and Jargon:** slang, colloquial expressions and jargon typically belong to a specific community or group
- **Denotation vs. Connotation:** interpretation of the intended/implied meaning is contextually or culturally dependent
- **Misinterpreted Speech Act:** e.g. British officers give commands such as, "You may well wish to ...", which are interpreted by American officers as suggestions.



Ways to Facilitate Communication

- Have coalition partners train together prior to operations (ideal)
 - However, this might be unrealistic due to time and other constraints
- Promote:
 - Use of a standard terminology and language
 - Supported by automated tools that
 - Enable access to standardized terminology
 - Reinforce consistent language use
 - But also allow extensibility in an ever changing situation
- Controlled English (CE) can help in two ways:
 - A common, extensible standard language, supported and reinforced by CE-based tools, and
 - The basis for communication tools (or add-ons to existing tools) that:
 - Recognize potential sources of miscommunication and
 - Alert users to their presence



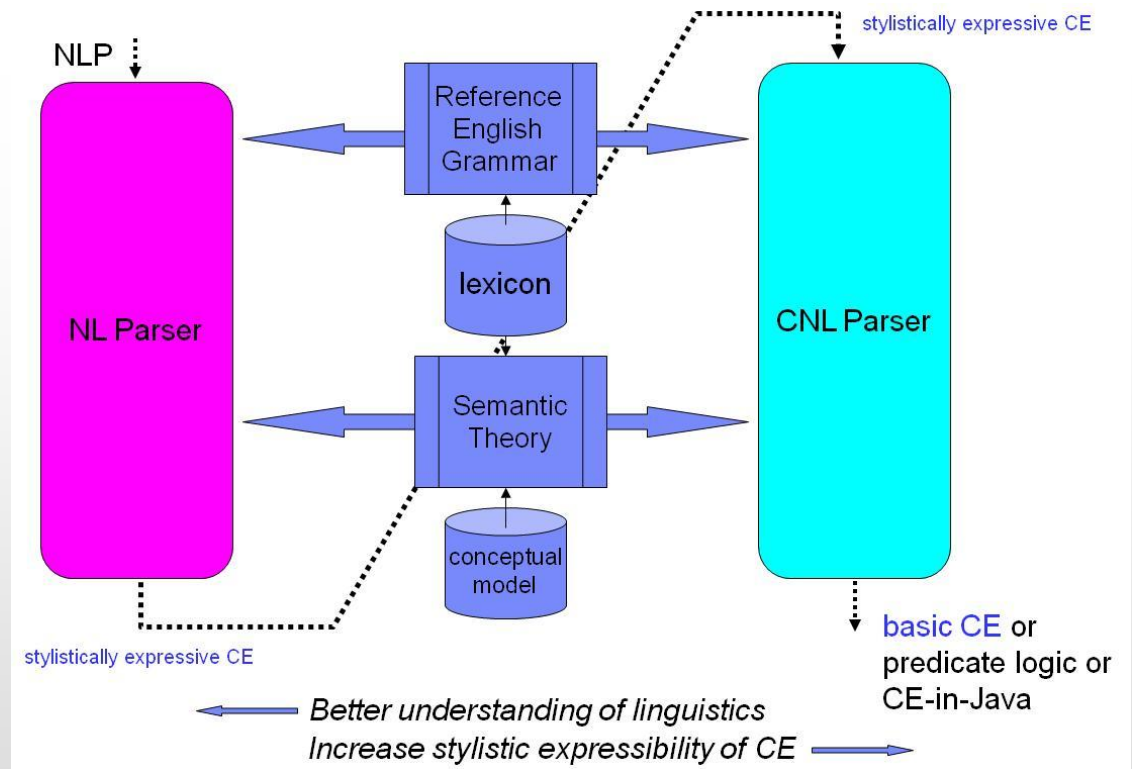
ITAI Controlled English (CE)

- CE is a type of controlled natural language
- A controlled natural language is a subset of a natural language using a restricted set of grammar rules and a restricted vocabulary
- Traditionally, focus was either on improvement for *human readability* or for *machine readability*
- We are concerned with both easy readability for human consumption and unambiguous representation for computer processing
- Challenge: how to balance user-friendliness and computational predictability



CE is Machine Processable

- ITA CE is consistent with First Order Predicate Logic
 - Based on Common Logic Controlled English (Sowa 2007)
- Syntax is compatible with existing ontology modeling languages such as OWL





Statements and Queries in CE

- CE permits a set of plain English sentences for stating propositions referring to entity existence, properties and relations:
 - ***there is*** a person named Fred.
 - the person Fred ***has*** French as language.
 - the person Fred ***is married to*** the person Jane.
- CE also permits meta statements that specify information about propositions such as their truth status or whether they are assumptions:
 - ***it is true that*** there is a person named John.
 - ***it is assumed that*** the person Fred is married to the person Jane.
- CE also allows queries:
 - Example: *For which P1 and P2 is it true that the person P1 is the parent of the person P2.*



Inference and Rationale in CE

- CE also allows statements of logical rules to allow inferencing:
if PREMISES then CONCLUSION
if (the person X has the person Y as brother) and
 (the person Z has the person X as father)
then
 (the person Z has the person Y as uncle)
- ... and statements that can be used to reconstruct the rationale for an assertion or conclusion:
CONCLUSION because PREMISES
the task T1 has the agent A1 as executor
because
the plan P1 has the agent A1 as executor and
the plan P1 contains the task T1.



CE Based Capabilities and Applications

- CE is designed to be easily extensible
- CE encourages a richer interaction and integration between human and machine reasoning capabilities
- CE is most useful in situations that have the following characteristics:
 - A high degree of human interaction, usually involving specialist users with complex needs in non-trivial environments
 - A likelihood of rapidly evolving or uncertain tasks, queries or other knowledge-based activities
 - The need for collaboration, either between different people or teams, and/or across different disciplines



CE Store: A CE-Based Tool Suite

- “CE Store” is a CE-based tool suite to support coalition applications
- It allows one to:
 - Perform basic CE sentence parsing
 - Define and extend any domain concept model
 - Assert any CE sentence conforming to the appropriate conceptual model(s)
 - Define and execute a CE query against a domain model using a combination of a visual query language and written CE
 - Define logical inference rules, in the form of a “query with conclusion clauses”
 - Execute the logical inference rules to infer new CE information and assert it to the knowledge base



CE Store: CE Query Builder (CEQB)

- A visual query drawing tool embedded in the CE Store environment
 - Uses drag-and-drop and contextual (popup) menus
 - Allows the user to draw, execute and save a CE query or rule
- Visual interface for drawing rules assists user in creating CE rules
- Once constructed, a query (or rule) can then be saved, and executed again in the future
- CEQB is a “model aware” component of the CE Store environment and is directly integrated into the CE Store APIs

Constructing a Query in CEQB

CE Store browser - Alpha v1.2 - Mozilla Firefox
localhost:8080/CeStoreWeb/ Boeing Search

Most Visited Latest Headlines Getting Started
CE Store browser - Alpha v1.2

Last transaction (executeCeQuery) took 0.016 seconds. Store contains 272 instances and 742 sentences. Code version=1.2.4587 [refresh the page](#) [login](#)

Concepts
Filters: [\[pri\]](#) [\[s\]](#) [\[nz\]](#) [\[nr\]](#)
[refresh](#)
Showing 10 primary concepts:
[cancer](#) (1, 1)
[cancer scan](#) (1, 1)
[diagnostic test](#) (1) [\[s\]](#)
[disease](#) (1) [\[s\]](#)
[lump](#) (1, 1)
[man](#) (3, 3)
[patient](#) (1, 1)
[person](#) (9, 9) [\[s\]](#)
[symptom](#) (1) [\[s\]](#)
[woman](#) (1, 1)

General information **CE Query Builder (CEQB)** **Lexical information** **Extracted info**

Concept details for **person** below:

| | |
|---------------------------------------|---|
| Name | person [r] |
| parent(s) [all] or [direct] | <ul style="list-style-type: none">primary thingthing |
| children [all] or [direct] | <ul style="list-style-type: none">manwomanpatient |
| creation date | 1369063016762 |
| instances | 9 (simple list) (list details) (exact list) |
| | <ul style="list-style-type: none">age (constant) [c] [r]belongs to (set of things) [c] [r]description (constant) [c] [r]is categorised as (concept) [c] [r]is closely related to (person) [c] [r]is contained in |

for which P1 and P2 is it true that
(the person P1 is the parent of the person P2)

Query/rule name:

- Clear query
- canvas
- Validate query
- Execute as

Actions
Add CE
Search

Errors (0) Warnings (0) Debugs (0) Alerts (0)
No errors were returned in the last request.

Query Results

CE Store browser - Alpha v1.2 - Mozilla Firefox

File Edit View History Bookmarks Tools Help

localhost:8080/CeStoreWeb/ Boeing Search

Most Visited Latest Headlines Getting Started

CE Store browser - Alpha v1.2

Last transaction (executeCeQuery) took 0.016 seconds. Store contains 272 instances and 742 sentences. Code version=1.2.4587 [refresh the page](#) [login](#)

Concepts

Filters: [\[pri\]](#) [\[s\]](#) [\[nz\]](#) [\[nr\]](#) [\[refresh\]](#)

Showing 10 primary concepts:

- [cancer](#) (1, 1)
- [cancer scan](#) (1, 1)
- [diagnostic test](#) (1) [\[s\]](#)
- [disease](#) (1) [\[s\]](#)
- [lump](#) (1, 1)
- [man](#) (3, 3)
- [patient](#) (1, 1)
- [person](#) (9, 9) [\[s\]](#)
- [symptom](#) (1) [\[s\]](#)
- [woman](#) (1, 1)

Actions

Add CE

Search

Errors (0) Warnings (0) Debugs (0) Alerts (0)

No errors were returned in the last request.

General information CE Query Builder (CEQB) Lexical info

Query:

for which P1 and P2 is it true that
(the person P1 is the parent of the person P2)

Results (5 rows):

| # | P1 | P2 | CE |
|---|------------------------|------------------------|--|
| 1 | Bill | John | the person 'Bill' is the parent of the person 'John'. |
| 2 | David | Max | the person 'David' is the parent of the person 'Max'. |
| 3 | David | Nellie | the person 'David' is the parent of the person 'Nellie'. |
| 4 | John | Jean | the person 'John' is the parent of the person 'Jean'. |
| 5 | Maggie | John | the person 'Maggie' is the parent of the person 'John'. |

Entity

Concept details for [person](#) below:

| | |
|---------------------------------------|--|
| Name | person [r] |
| parent(s) [all] or [direct] | <ul style="list-style-type: none"> primary thing thing |
| children [all] or [direct] | <ul style="list-style-type: none"> man woman patient |
| creation date | 1369063016762 |
| instances | 9 (simple list) (list details) (exact list) |
| | <ul style="list-style-type: none"> age (constant) [c] [r] belongs to (set of things) [c] [r] |

Sentences

Sources

Saved queries & rules

Constructing a Rule in CEQB

CE Store browser - Alpha v1.2 - Mozilla Firefox

localhost:8080/CeStoreWeb/

Most Visited Latest Headlines Getting Started

CE Store browser - Alpha v1.2

Last transaction (executeCeRule) took 0.0 seconds. Store contains 274 instances and 748 sentences. Code version=1.2.4587 [refresh the page](#) [login](#)

Concepts

Actions

Add CE

Add CE sentence:

conceptualise the person P1 ~ is the grandparent of ~ the person P2.

[Validate CE sentence\(s\)](#)

[Submit CE sentence\(s\)](#)

General information CE Query Builder (CEQB) Lexical information Extract

Entity

Sentences

Sources

Saved queries & rules

[Refresh saved query/rule list](#)

Queries:

- != test ([load](#), [show](#), [execute](#))
- = test ([load](#), [show](#), [execute](#))
- brother of ([load](#), [show](#), [execute](#))
- brotherless 1 ([load](#), [show](#), [execute](#))
- brotherless 2 ([load](#), [show](#), [execute](#))
- close relation to patient ([load](#), [show](#), [execute](#))
- grandparent ([load](#), [show](#), [execute](#))
- older brothers 30 ([load](#), [show](#), [execute](#))
- older brothers 5 ([load](#), [show](#), [execute](#))
- older brothers 65 ([load](#), [show](#), [execute](#))
- parent ([load](#), [show](#), [execute](#))
- patient lump close relation ([load](#), [show](#), [execute](#))
- patient presents with lump ([load](#), [show](#), [execute](#))
- person suffers from cancer ([load](#), [show](#), [execute](#))
- query1 ([load](#), [show](#), [execute](#))
- temporary ([load](#), [show](#), [execute](#))
- younger brothers ([load](#), [show](#), [execute](#))

[9] the person P1 is the parent of [5] the person P2 [9]

is the grandparent of of [5] is the parent of [9]

[conclusion]

[grandparent]

if (the person P1 is the parent of the person P2) and (the person P2 is the parent of the person P3) then (the person P1 is the grandparent of the person P3)

Clear query canvas

Validate query

Execute as query or rule

Save query

Search

Errors (0) Warnings (0) Debugs (0) Alerts (0)

No errors were returned in the last request.

Rule Execution in CEQB: Rationale

The screenshot displays the CE Store browser interface in Mozilla Firefox. The browser window title is "CE Store browser - Alpha v1.2 - Mozilla Firefox". The address bar shows "localhost:8080/CeStoreWeb/". The page content includes a status bar at the top indicating "Last transaction (executeCeRule) took 0.0 seconds. Store contains 274 instances and 748 sentences. Code version=1.2.4587".

The main interface is divided into several sections:

- Concepts:** A sidebar on the left with "Add CE" and "Add CE sentence:" options. Below "Add CE sentence:" is a text input field containing the sentence: "conceptualise the person P1 ~ is the grandparent of ~ the person P2." Below this are links for "Validate CE sentence(s)" and "Submit CE sentence(s)".
- Query:** A section with tabs for "General information", "CE Query Builder (CEQB)", "Lexical information", and "Extract". The "CE Query Builder (CEQB)" tab is active, showing a query: "[grandparent] if (the person P1 is the parent of the person P2) and (the person P2 is the parent of the person P3) then (the person P1 is the grandparent of the person P3)".
- Results (2 rows):** A table showing two rows of results. The first row is: "1 the person 'Bill' is the grandparent of the person 'Jean' because the person 'Bill' is the parent of the person 'John' and the person 'John' is the parent of the person 'Jean' [grandparent].". The second row is: "2 the person 'Maggie' is the grandparent of the person 'Jean' because the person 'Maggie' is the parent of the person 'John' and the person 'John' is the parent of the person 'Jean' [grandparent].".
- Entity:** A sidebar on the right with tabs for "Entity", "Sentences", and "Sources". Below these is a "Saved queries & rules" section with a "Refresh saved query/rule list" link and a list of queries, each with a "load, show, execute" link.

At the bottom of the interface, there are status indicators for "Errors (0)", "Warnings (0)", "Debugs (0)", and "Alerts (0)". A message states: "No errors were returned in the last request."



A CE Application

- Facilitating Human/Machine Interaction and Analytical Processing
- Aids the intelligence analysts in a multi-agent collaborative operational environment, especially in cases where the agents are a mixture of other human users and machine processes
- Provides for the relations between objects such as assignment of buildings and vehicles to locations on a map
- Supports complex analytical tasks on synthetic data sources
- Enables teams and team members to have shared situation awareness in a collaboration setting



CE Store Provides an Interactive, Extensible, Multimodal Environment

- **Dynamic model:** Generic concepts are used as starting materials and new concepts are added to the conceptual model by using the following CE sentences:
 - conceptualise a ~ building ~ B that is a spatial thing.*
 - conceptualise a ~ ground feature ~ G that is a spatial thing.*
- **Multi-modal interface:** Allows association of photos taken by agents in the field of those objects with icons on the map, and the identification and location of objects extracted from short human generated messages on the map
 - there is a building named b1 that has '51.23' as latitude and has '-1.74' as longitude.*
- **Live environment:** Enables human users to quickly perform information fusion and adapt their situation awareness in a changing environment



Using CE to Quickly Instantiate a Map

Add CE

Add CE sentence:

```
there is a spatial thing  
named 'x' that  
  has '51.61721910' as  
latitude and  
  has '-2.74801318' as  
longitude.
```

[Validate CE sentence\(s\)](#)
[Submit CE sentence\(s\)](#)





Benefits of CE and CE-Based Tools

- Provide a simplified and common form of expression in English
- Provide automated tools to enable access to standardized terminology and reinforce consistent language use
- Provide a method to allow extension of standard terminology
- Provide communication aid tools that encourage human-machine interaction, best leveraging human knowledge and computer processing capabilities
- Provide capabilities to construct and extend knowledge models
- Provide an intuitive, CE-based capability for end users to query information from the available information sources



On-going and Future Work

- Apply CE to support Information Extraction
 - As common language to translate into
 - To express the rules of parsing and interpreting

- Extend the CE lexicon by leveraging publicly available lexical-semantic resources such as WordNet

- Extend CE syntax and semantics to extend its general expressivity

- CE extension will be data driven and based on usability studies and experimentation with real use case scenarios

- Develop more user-friendly functionalities based on assessment of real use case scenarios



The International Technology Alliance

ACKNOWLEDGMENT

This research was sponsored by the US Army Research Laboratory and the UK Ministry of Defence and was accomplished under Agreement Number W911NF-06-3-0001. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the US Army Research Laboratory, the U.S. Government, the UK Ministry of Defence, or the UK Government. The US and UK Governments are authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation hereon.