



Tools to Support Knowledge Design and Explanation (VISTA update)

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VISTA Goals

- Reduce costs in developing, fielding, and using Human Behavior Representations
 - Approach: provide a generic explanation capability that can be used by various HBRs
 - Specifically: Enhance the ‘explanation’ capability within the existing VISTA system
 - User-driven/interactive
 - Bring to bear multiple knowledge sources in explanation
 - Develop a design paradigm that supports explanation
 - Employ multi-modal explanation

Challenges

- What kinds of explanation are useful?
- What knowledge is available to generate explanations?
- How to reduce burden on system developer to producing explanations?

Approach

- Intelligent User Interface for Multi-Modal Explanations
 - Take advantage of multiple information modalities (e.g., graphics & text) for explanation
 - Use intelligent agent to mediate user interactions and generate contextually-relevant explanations
 - Agent contains domain-independent knowledge for generating explanations, discourse, display, and interaction
 - Agent imports domain-specific knowledge for the performing agent whose actions will be explained
 - Merge multiple knowledge sources to generate different types of explanations for different contexts or different users

Design Tradeoff

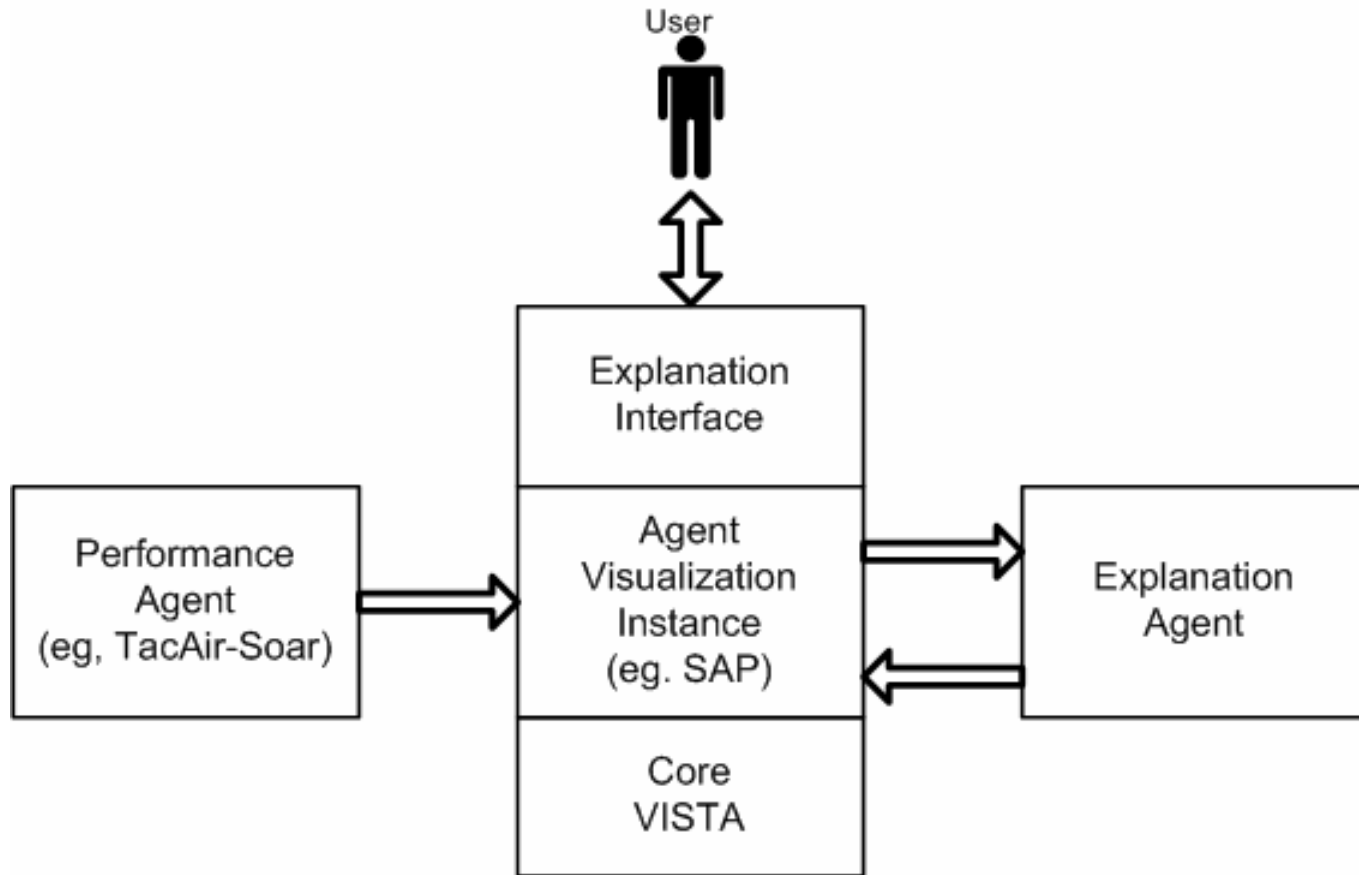
Where to place 'explanation' capabilities?

	Performance Agent	Explanation Agent
Pros	<ul style="list-style-type: none">■ Immediate access to agent knowledge	<ul style="list-style-type: none">■ Generality across agent systems/architectures/domains■ Depends only on general VISTA knowledge representation primitives
Cons	<ul style="list-style-type: none">■ Solution specific to agent and architecture■ Adds extra-task burden on agent	<ul style="list-style-type: none">■ No direct access to performance agent knowledge■ Requires intermediate representation

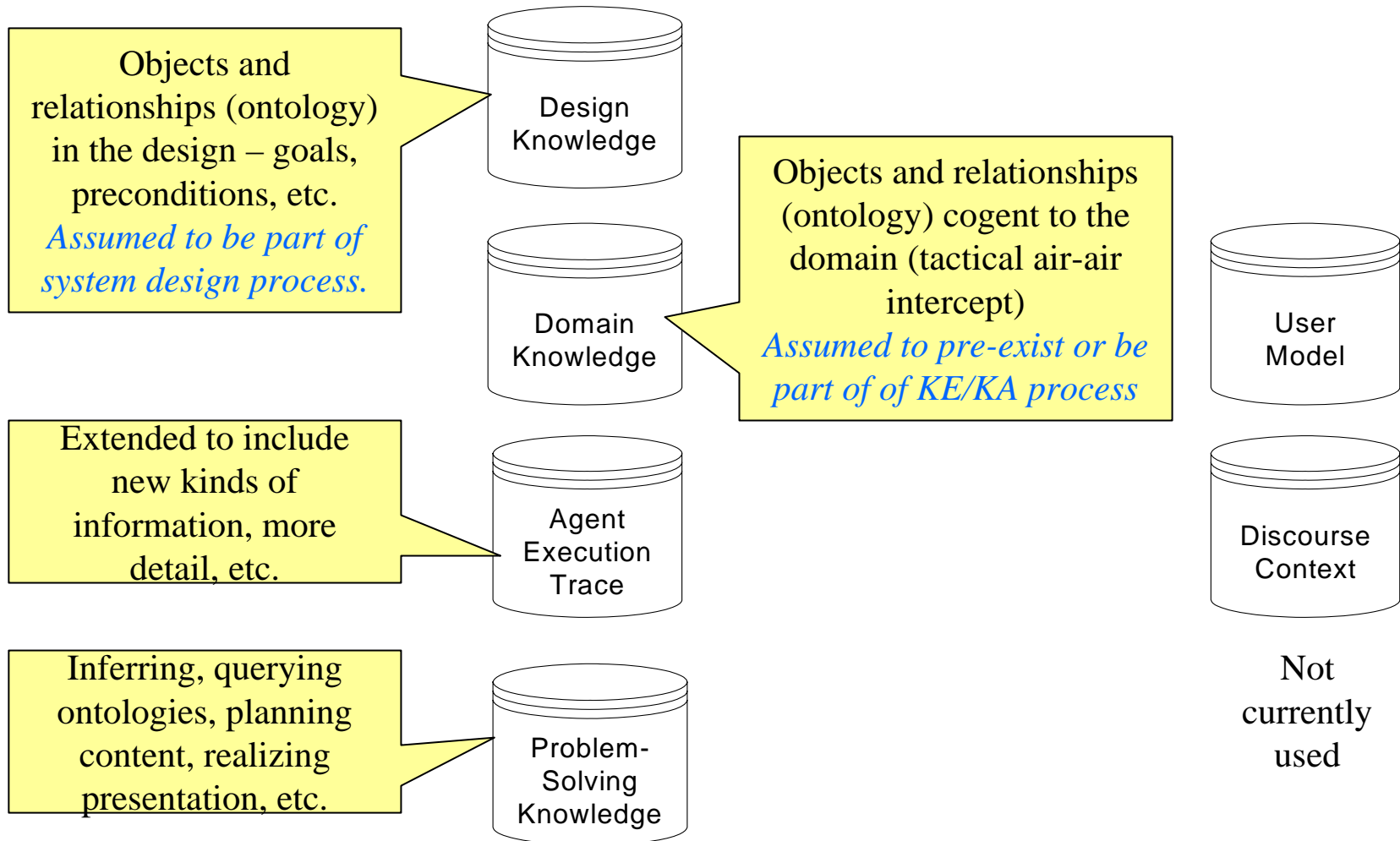
No free lunch

TakeHome: *Generality* of solution is the driving requirement; but efficiency is also important – long-term savings trump short-term

High-level Architecture



What Knowledge is available?



Explanation Knowledge

- Can use ontology information as-is, where supplied
- Can take advantage of special encodings in ontologies for hypertext:
 - GetMissileLarGoal.description = “...such that the sitref:@target is ...”
 - Display: “The purpose of get-missile-lar is to maneuver such that the target is within the launch acceptability region...”
- Some domain-neutral knowledge
 - How to query ontologies
 - How to structure output into a document
- Some domain-specific
 - Distinctions between primitive or domain-specific types (goals, objects)
 - What attributes to use in explanation
 - How to order explanation content

Adding Explanation Capability to HBMs: Process

- Define design, domain as ontologies
- Define decision-making contexts to organize performing agent and question-answering interactions
- Annotate knowledge structures with documentation elements
 - VISTA will automatically generate lower-quality explanatory elements if necessary
- Mark situation knowledge to export from *performance agent*
- If desired, create graphical representations of knowledge elements

How to reduce burden of explanation on developer?

- Re-use of existing knowledge bases
 - From the design and knowledge acquisition processes
 - From extant knowledge bases (SUMO ontology, C2IEDM, etc.)
- Common/standard formats
 - Ontology languages (OWL)
- COTS tools
 - Ontology specification tools, ontology translators, etc.
 - Protégé, Onto2Soar
- API for adding domain-specific knowledge into explanations
- Improved knowledge design tools
 - HERBAL, Contextual Knowledge Editor, HLSR

Knowledge Editor to Build Design Ontologies from Domain Ontologies (Eclipse Plugin)

The screenshot shows the Eclipse IDE with the GoalEditor plugin. The main editor window displays the following code:

```

status of the collision-course computation to the target

CONTEXT-FEATURE proximity-route-heading cc-in-bounds
description 0:
the collision course to the target's relationship to my radar limits

description 1:
the collision course to the target's relationship to my radar limits

description 2:
the collision course to the target's relationship to my radar limits

CONTEXT-RESPONSE proximity-route-heading bearing
target-intent hostile
visual-contact False
radar-contact False
computed-collision False
    
```

The GoalList on the left shows a tree view of goals, with 'proximity-route-heading' selected. The GoalTable at the bottom shows a table of goal instances:

target-intent	visual-contact	radar-contact	computed-collision	cc-in-bounds	Response
friendly	*	*	True	*	lead-p...
*	*	*	False	*	bearing
hostile	True	*	True	*	collision
hostile	*	True	True	True	collision
hostile	False	True	True	False-left	radar-left
hostile	False	True	True	False-right	radar-r...
hostile	False	False	True	*	?

The GoalData editor on the right shows the details for the selected goal 'proximity-route-heading', including its description and a list of values.

VISTA with Explanation Agent

The screenshot displays the VISTA simulation interface and an Explanation Agent window. The VISTA window shows a radar-like display with various aircraft and a base. The Explanation Agent window provides a goal summary and a detailed log of agent actions.

SAP - demo-log.sif

File View Help

ALT 7.82 km
SPD 281.0
HDG 85

Scale 316 km

94.8 km
63.2 km
31.6 km
15.8 km
7.9 km
3.9 km
1.9 km
0.9 km

unkA32
unkA133
Shooter1
Shooter2
Base
Badguy

sparrow 1
amraam 1

GOALS
execute-mission
intercept
employ-weapons
get-missile-lar
cut-to-la
wait

RAZ -48.0
REL -6.0
SAZ 20.0

Time 0:36:18

Set Scale
10000km 1000km 100km 10km 1km 100m 10m

Milestone Display

Milestones

- 0:35:04 Agent A133 is NOT in LAR for amraam
- 0:35:04 Agent A133 is NOT in LAR for sparrow
- 0:35:04 Agent A133 is NOT in LAR for sidewinder
- 0:35:08 Identify contact C1810
- 0:35:48 Identify contact Z121

Replay Controls

0:15:04 0:27:16 0:39:28 0:51:40

Engineering Open_share ...

Explanation Agent

Goal Summary:

I'm pursuing a single thread of goals at time 00:36:18:

- I'm attempting to achieve goal [execute-mission](#), whose purpose is to perform a mission of type [barcap](#)
- I'm attempting to achieve goal [intercept](#), whose purpose is to eliminate the selected [target-group](#)
- I'm attempting to achieve goal [employ-weapons](#), whose purpose is to engage the [target-group](#) with a particular weapon
- I'm attempting to achieve goal [get-missile-lar](#), whose purpose is maneuver my aircraft so the ****target**** is in the ****missile-lar**** of the ****selected-weapon****
- I'm attempting goal [cut-to-la](#)
- I'm attempting to achieve goal [wait](#), whose purpose is to wait for the supergoal ****supergoal**** to complete

vista2-ui-agent Agent Interaction Window

File Show Memory Productions Watch View Commands Demos Help

```
ref></strategy><strategy name='HighlightOnMap' time='2178'><ref>p-G905</ref></st
strategy><strategy name='DeferToAgent' time='2178'><ref>p-G866</ref></strategy><st
strategy name='HighlightOnMap' time='2178'><ref>p-G913</ref></strategy><strategy n
ame='DeferToAgent' time='2178'><ref>p-G901</ref></strategy><strategy name='Defer
ToAgent' time='2178'><ref>p-G906</ref></strategy><strategy name='HighlightOnMap'
time='2178'><ref>p-G866</ref></ref></strategy><strategy name='DeferToAgent' time='217
8'><ref>p-G905</ref></strategy></style></strategy>"
(operator: mark-achieve-generate-situation-summary)
Sending situation summary to VISTA...
(achieved goal: achieve-generate-situation-summary)
... Removing achieved achievement goal: handle-incoming-question-request
... Removing achieved achievement goal: achieve-generate-questions
... Removing achieved achievement goal: handle-incoming-question-request
... Removing achieved achievement goal: achieve-generate-questions
... Removing achieved achievement goal: handle-incoming-question-request
... Removing achieved achievement goal: achieve-generate-questions
... Removing achieved achievement goal: handle-incoming-question-request
... Removing achieved achievement goal: achieve-generate-questions
... Removing achieved achievement goal: handle-incoming-question-request
... Removing achieved achievement goal: achieve-generate-questions
... Removing achieved achievement goal: handle-incoming-question-request
... Removing achieved achievement goal: achieve-generate-questions
... Removing achieved achievement goal: handle-incoming-question-request
... Removing achieved achievement goal: achieve-generate-questions
... Removing achieved achievement goal: handle-incoming-situation
... Removing achieved achievement goal: achieve-generate-situation-summary
```

Step Run Halt Debug TurnDone Search

Synergy

- HERBL
 - Provides user interface for defining domain and some design knowledge, together with mappings to Soar architectural elements
- TRACE
 - Provides low-level architectural ontology which could be used to drive design-knowledge editors and displays
- Architectural abstractions
 - Provides mid-level language for domain and design ontologies
- Contextual Knowledge Editor
 - Provides context-driven engineering of design knowledge at an architecture-neutral level
- HLSR
 - Provides architecture-neutral language for representing domain and design knowledge

Gold

- We have greatly expanded the kinds of information available to a user of HBMs using VISTA
- We have improved the usability/interactivity of getting information from VISTA
- We use multi-modal explanation to take advantage of VISTA graphical channels as well as text-based explanation
- Maintained generality across different agent systems
- Parallel development of a space of related tools and technologies is providing opportunities for the design of agent-oriented Integrated Development Environments to ease development of performing and explaining agents

Coal

- Hard to measure benefit of explanations
- Generating explanations still imposes an additional burden on the model developer
- There are a number of interesting tools and technologies emerging, but they require integration