Anytime Cognition

An information agent for emergency response

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Outline

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- ANTICO Architecture
  - Domain Description Language
  - User Observer
  - Intent Predictor
  - Cognitive Workload Estimator
  - Information Gatherer
  - Information Adapter
  - Information Presenter
- Application Description
- Current Work
**Motivation**

- Planning is challenging:
  - Under time-pressure
  - Relying on uncertain information
- Humans under significant cognitive workload
  - Result in missed deadlines

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**Anytime Cognition concept:**
- Generic information assistant architecture
- Maintains a manageable cognitive workload

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**Without ANTICO**

- Acquire Info \(t_1\)
- Analyse Info \(t_2\)
- Decide \(t_3\)
- Act \(t_4\)

**With ANTICO**

- Acquire \(t'_1\)
- Analyse \(t'_2\)
- Decide \(t'_3\)
- Act \(t'_4\)

**Deadline**
- Missed
- Met
Scenario Description

- Based on the National Planning Scenarios developed by the DHS
- ANTICO focuses on six areas:
  - Emergency Assessment/Diagnosis
  - Emergency Management/Response
  - Incident/Hazard Mitigation
  - Public Protection
  - Evacuation/Shelter
  - Victim Care

- Attack Scenario
  - Based on the nerve agent scenario
  - Deployment of multiple Sarin Gas Canisters into a public building in DC
  - Initial phases of the response are critical
  - Conflicting diagnosis info
  - Potential for additional casualties from first responders
ANTICO Architecture

- **Generic assistance architecture**
  - Integrates multiple AI components
  - Modularized to allow different techniques to be used

- **Main objectives**
  - User activity recognition
  - Unobtrusive assistance
ANTICO Domain Description Language (ADDL)

- Designed to be generic and applicable to various problem domains
- XML-based
  - Human-readable
  - Network friendly
- Domain description includes:
  - User Workflows
  - Information Sources

```xml
<?xml version="1.0" encoding="UTF-8"?>
<anticoDomain>
  <stateVariables>
    <variable name="zip-code" domain type=numeric min=15201 max=15295/>
    <variable name="hazmat-dispatch" domain type=boolean/>
    ...
  </stateVariables>
  <activities>
    <activity name="callHazMat">
      <observations>
        <observation name="dialedXYZ" prob=".5"/>
        <observation name="lookedContacts" prob=".5"/>
      </observations>
      <infoObject>
        <query value="select phone from Contacts where name='HAZMAT' and zip=$(zip-code)$"/>
        <constraints>
          <deadline value="17:00 02-06-2011 GMT"/>
        </constraints>
        <retrieval status="queried" source="Contacts" timestamp="" data=""/>  
        <presentation>zoom-coords=""</presentation>
      </infoObject>
      <effects>
        <variable name="hazmat-dispatch" value="true" prob="0.9"/>
      </effects>
    </activity>
    ...
  </activities>
</anticoDomain>
```
### User Observer

- Obtains and interprets
  - User activities
  - Messages from the field
- Multiple observer objects specialized in specific observation types, e.g.
  - UI activities
  - Input devices
  - External messages
Intent Predictor

- Uses a domain description in ADDL
- Analyzes observations from User Observer
  - Generates a set of information requirements
  - Employs HMM-based intention recognition
Using the information requirements from intent predictor, determines:

- Which information to be gathered
- When to gather information
- How to cope with resource restrictions
Cognitive Workload Estimator

- Calculates cognitive workload
  - Based on the number of tasks executed by user
  - Queuing model for user workload
- Estimates the maximum amount of information to be presented

- ANTICO platform
  - User Observer
  - Intent Predictor
  - Information Gatherer
  - Information Adapter
  - Domain Knowledge Manager
  - Cognitive Workload Estimator
  - Information Object
  - Wrapper
    - Text Summarizer
  - Information Sources
  - Domain Knowledge

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Adapts information before presentation to appropriate level of detail

Level of detail of presented information depends on:
- Cognitive workload
- Time available for user

ANTICO platform

- User Observer
- Intent Predictor
- Information Gatherer
- Information Adapter
- Domain Knowledge Manager
- Cognitive Workload Estimator

Information Sources

Wrapper
Text Summarizer

Information Knowledge
Information Presenter

- Presents information to the user
- Uses current belief state to determine optimal time for presentation
- Monitors when and whether information has been used to improve future presentation

ANTICO platform

User Observer → Intent Predictor → Domain Knowledge Manager → Cognitive Workload Estimator

Information Gatherer → Information Adapter

Information Presenter

Domain Knowledge Manager

Cognitive Workload Estimator

Intent Predictor

Information Gatherer

Information Adapter

Information Object

Information Sources

Wrapper

Text Summarizer

Domain Knowledge

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Application Description

- Timer
- Event Messages Panel
- Map
- Reminders Panel
- Diagnostics Information
- Vulnerable Population Information
- Weather Updates
- Relevant Org. Contact Info
Contributions

- Mitigation of user cognitive workload
- Adaptive presentation of time and context-sensitive information
- Proactive management of information requirements
- Generic XML-based domain description language
- Integration of several AI techniques:
  - Probabilistic plan recognition
  - Constraint optimization
  - Domain independent
Current Work

Current Work by CMU

- Integration of ANTICO with CPOF Sandbox
- Aimed at:
  - Testing of agent assistance for CPOF users
  - Refinements to information assistance in a realistic environment
  - Great potential for technology transition

CPOF Sandbox

- Developed by CERDEC
- Replicates UI functionality of CPOF in a “Sandbox” environment
  - Uses simulated data plus human interaction
  - No access to sensitive data
  - Aimed at usability studies in a controlled environment
Integration with CPOF Sandbox

Evac Plan Data

Schools
