Situated Multimodal Interaction
Situation Models - 10 years after CHIL

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IST CHIL Software Reference Model for multimodal services.

- Context Aware Services
- Situation Model
- Sensori-Motor Components
- Logical Sensors, Logical Actuators
- Sensors, Actuators, Communications

Ontology Server, Utilities
IST CHIL Core: Situation Model

Services

Situation Model

Perceptual Components

Function calls

Events

Streams
Situated Multimodal Interaction

Outline

• Situation Models
• Software components
• Learning Situation Models
• Situated Interaction
• Conclusions
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Situation Models: Philip Johnson-Laird

Philip N. Johnson-Laird

PhD Psychology, 1967, University College London
Stuart Professor of Psychology at Princeton Univ.
1973-1989: Laboratory of Exp. Psychology, Univ of Sussex
1989- Applied Psychology Unit, Princeton Univ.

Situation Models are widely used in Cognitive Psychology to describe human abilities for

1) Providing context for story understanding
2) Interpreting ambiguous or misleading perceptions.
3) Reasoning with default information
4) Focusing attention for problem solving

Proposal: Use situation models as a software framework for systems and services that interact with humans
Situation Models: as a theory for context aware services

Services: Communications and Information. Event driven. Non-disruptive
Situation: Describe relevant actors and objects for services, Filter events.
Perception and action: Recognize and model. Perform Tasks
Sensors and actuators: interact with the physical or virtual world.
Situation Models:
as a theory for context aware services

Situation: a set of relations between entities. A State.

Entities: Any relevant observable phenomena
          Ex: People, things, times, places, events

Properties: Attributes that describe entities

Relations: Truth Functions. Boolean or probabilistic predicates

Behaviors: Event-Condition-Action rules
            Behaviors control perception, action, interaction, reasoning and system associated with each state.
**Situation Models:**
as a theory for context aware services

**Situation Graph:** A network of situations with transition conditions
- Each situation specifies: Entities to observe, actions to take,
- Behaviors for sensing, action, interaction, changes to state and context.

**Context Model:**
A specific set of entities, relations, behaviors, situations and transitions.
Examples of situation aware systems constructed at LIG

- Privacy filter for MediaSpace
- Lecture recording system (IST FAME)
- Activity monitoring for assisted living (ANR CASPER)
- Polite, social interaction with robots (Barraquand 08)

Examples constructed in IST CHIL (multi-modal services)

- Memory Jog (non-obtrusive memory prosthesis)
- Context aware Mobile Phone manager
- Meeting minute recording system

Examples in IST Perada ALLOW (Context as flow model)

- Logistics warehouse management System
- Hospital health-care activity monitoring and recording.
Example: Recording Events in a Meeting

Services

Meeting Minutes Recording Service

Events

Situation Model

Events, Queries, Commands

Perceptual Component

Perceptual Component

Perceptual Component

Perceptual Component

Sensors and actuators

Sensor

Sensor

Sensor

Jerome deals Stan a card → Stan Places a bet → Stan Folds

San stays
Example: Recording Events in a Meeting

Entities:
Patrick, Jerome, Sonia and Stan, agenda

Roles:
Moderator, Speaker, Participant, current-agenda-item, etc

Relations:
Moderator(Patrick) speaks-to participants(…)
Participant(Jerome) talks-to Participant(Stan)
Participant(Sonia) looks-at Participant(Patrick)
…
A **role** is a "variable" for entities. (similar to a Skolem Function in Logic)

Roles allow generalizations of situations.
Roles enable learning and reasoning by analogy
More Examples of Applications

1) Event Recording (Startup MeanInFull - 2014)
2) Video Surveillance (Startup BlueEye Video – 2003)
3) Customer monitoring (Start up: HiLabs - 2008)
4) Actimetry and monitoring for Elderly and Handicapped
5) Socially-Aware Human-Computer Interaction
6) Context aware mobile applications (Start up: Situ8ed 2015)
7) Sociable Systems (Startup planned for 2017)
Situ8ed
The right information at the right time

Mobile “component” for apps.
• Monitors Activity 24/7 (driven by initial model of human daily cycle)
• Associates activities with semantic locations and semantic time
• Learns routines (sequence of contexts and situations)
• Predict situations, anticipate needs, proposes information and services
• Learns to predict best situations for interaction.
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The perception action layer can be organized as federations of components for perception and action.
Perceptual Components

Data flow Software Architecture (Shaw-Garlan 96)
Perceptual Components

Supervisor Provides:
Execution Scheduler
Parameter Regulator

• Command Interpreter
• Description of State and Capabilities
Role Assignment

Roles are assigned to entities by “role assignment tests” directed by perceptual behaviors associated with a situation.
Bayesian Track of Face and Hands
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Training Aibo to be polite

Problems:
1) Learn to identify relevant entities and relations (Brdiczka et al 06)
2) Learn network of situations for a context (Zaidenberg et al 06)
3) Learn to appropriateness of behaviours for each situation (Barraquand 12)
Acquiring Situation Models*

Approach:
1) Acquire a simple model with supervised learning
2) Use feedback from users for online supervised learning.
   • Generate new situations as variations of existing situations with different user service actions.
   • Generate new roles and relations as needed to discriminate situations.
3) Use Failure of predictions as feedback for on-line learning
Probabilistic situation models

Developing Situation Models

3 Algorithms*:

**Find-S:** construct the most specific hypothesis for each action based on the role and relation configuration.

**Candidate Elimination:** constructs the most general hypotheses for each action based on the role and relation configuration.

**ID-3:** construct a decision tree that classifies the different actions based on roles and relations. The decision nodes provide the predicates that define situations.

*Thesis of Oliver Brdiczka 2008
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Situated Interaction Theory  
(Suchman 87)

Study of the interaction between an agent and its environment.

Core Concept: Mediation:
• Emphasizes the emergent, contingent nature of activity.
• Includes the environment as part of the cognitive process.
• Asserts that plans are artifacts of reasoning about actions (after the fact explanations, rather than deliberate procedures).

Situated interaction requires awareness
Situated Interaction Requires Awareness

Mica Endsley, Ph.D., P.E.
PhD USC 1990
editor-in-chief of the Journal of Cognitive Engineering and Decision Making
President: SA Technologies
Specialty: Cognitive Engineering
Application Domain: Aviation and critical systems.
A Process Model for Situation Awareness

Attention: Tuning senses for directed sensing
Detection: Directed Sensing of relevant entities
Assimilation: Integrating sensed information into context model
Projection: Prediction of trends, events and situations
Anticipation: Inference of Consequences and possible reactions
Decision: Determination of course action
Situated Observation of Human Activity

Plan

Introduction and Context
Conceptual Framework
The Perception-Action Layer
Developing Situation Models from stereotypical scripts
Conclusions
Some Conclusions

1) Situation models provide an enabling technology for context aware systems

2) Probabilistic Graph Models and Decision trees provide effective techniques for learning and for reasoning with uncertainty

3) Situation models can be acquired by development and adaptation drive by interaction

4) Adaptation requires Robust Perception
   a) Perception is Detection, Tracking and recognition
   b) Robustness through autonomic systems design

5) Situation models can be developed using decision trees (ID3, C4.5, Random Forest)
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Bibliography


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Situated Observation of Human Activity

Contribution from
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Jerome Maisonasse,
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