Perception for Social Interaction

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Equipe Projet PRIMA

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Perception for Social Interaction

Plan

- Social Interaction with Smart Objects and Spaces
- A Theory for Situation Perception and Awareness
- Perception of Affection
- Learning for Social Interaction
- Conclusions

Affective Communicating Objects

Nabastag

AIBO

NAO

- Small, autonomous, “cute” devices
- With embedded Perception, Action, Computation and Transmission.
- Using speech, vision, gesture, lights and other modes for interaction
- Wireless Net communications (devices are on the internet)

Aladbaran's NAO Robot

QuickTime™ and a
decompressor
are needed to see this picture.


NEWS
DAVID
Leaving work. Home in 45 min.
Sophia comes to dinner at eight
HOME
DAVID
NEWS
HOME
Waiting for my master!
FLOWER
CAR
HOME

Perception for Social Interaction

Challenge:

Provide a technology for smart objects and spaces to act and interact in a manner that complies with social rules, norms and customs

Two related challenges

1) Social Interaction between objects and people.
2) Mediated interaction between people at a distance.

Common Requirement:

Perception and Awareness of Social Situation

Situated Social Common Sense

Common sense: The collection of shared concepts and ideas that are accepted as correct by a community of people.

Social Common Sense: shared rules for polite, social interaction that govern behavior within a group

Situated Social Common Sense: Social common sense governed by a model of social situation

Situated Social Common Sense

Situated Social Common Sense requires

1) Awareness of Social Situation
2) Knowledge of correct actions for each situation.

Social Common Sense varies over individuals and groups.

$\Rightarrow$ Social Common Sense must be learned

$\Rightarrow$ learning Social Common Sense requires a theory

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A Theory of Perception and Action

Awareness

- Vigilance against danger or difficulty.
- Having knowledge of something.
- The ability to perceive, to feel, or to be conscious of events, objects or sensory patterns.
- Conscious of stimulation, arising from within or from outside the person

Models of awareness have been studied and applied for human factors in aviation since at least 1914.

Human Factors: Mica R. Endsley

QuickTime™ and a
decompressor
are needed to see this picture.

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.

QuickTime™ and a
decompressor
are needed to see this picture.

QuickTime™ and a
decompressor
are needed to see this picture.

Endsley's Model of the Dynamic Decision Making Process.
Figure 2 from (Endsley 2000)

Levels in Situation Awareness

Situation Awareness (Endsley): The Perception of [relevant] elements of the environment in a volume of space and time, the comprehension of their meaning and the projection of their status in the near future.

Levels in Situation Awareness

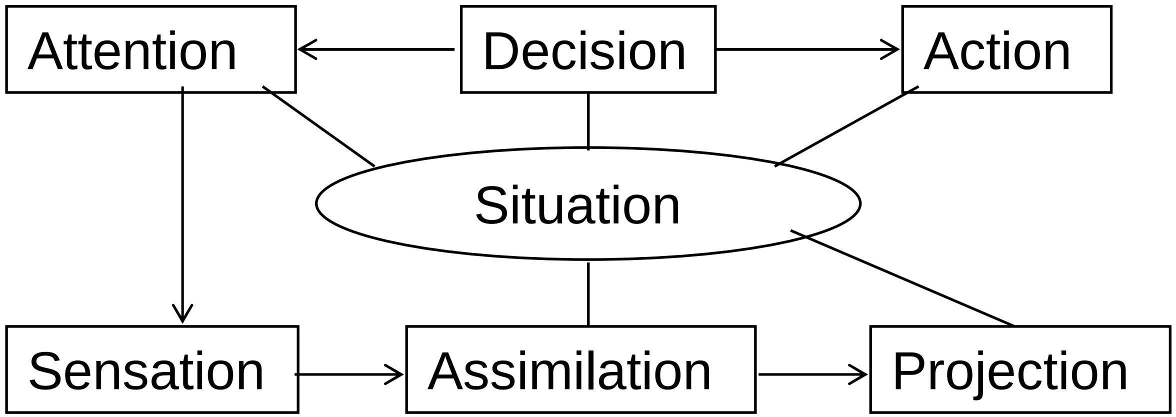
1: Sensation: Sensing of entities relevant to task

2: Assimilation: association of percepts with models that predict and explain.

3: Projection: Forecast events and dynamics of entities

To use Endsley's model for artificial systems we need a programmable theory for perception, assimilation and projection.

A Theory of Perception and Action



Attention: Tuning senses for directed sensing

Sensation: Directed Sensing of relevant entities

Assimilation: Integrating sensed information into context model

Projection: Prediction of trends, events and situations

Decision: Generation of actions

Cognitive Science: Philip N. Johnson-Laird

QuickTime™ and a
decompressor
are needed to see this picture.

Philip N. Johnson-Laird

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are needed to see this picture.

PhD Psychology, 1967, University College London

Stuart Professor of Psychology at Princeton Univ.

1971-1973: Inst. of Advanced Study, Princeton U.

1973-1989: Laboratory of Exp. Psychology, Univ of Sussex

1989- Applied Psychology Unit, Princeton Univ.

Situation Models:
A model for human cognitive abilities

P. Johnson-Laird 1983 – Mental Models.

A model to describe human cognitive ability to

1) Provide context for story understanding
2) Interpret ambiguous or misleading perceptions.
3) Reason with default information
4) Focus attention in problem solving

Situation Models:
A model for human cognitive abilities

P. Johnson-Laird 1983 - Situation Model

An analytical tool to allow Human Psychologists to model human to human interaction.

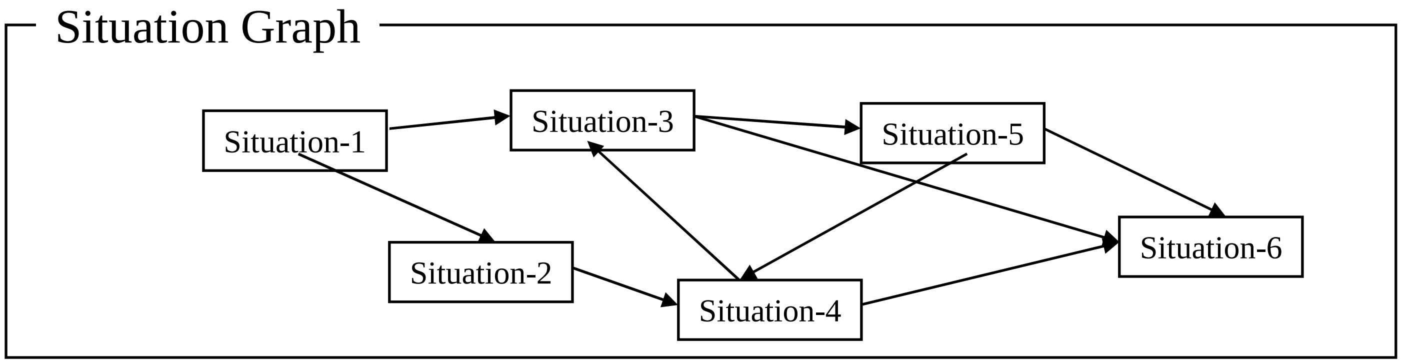
Situation: Relations between entities

Entities: People and things;

Relations: An N-ary predicate (N=1,2,3 …)

Example: John is facing Mary. John is talking to Mary.

Situation Graph



A situation graph encodes a state space of situations about a set of entities
Each Situation provides information for:

- Default information (Context)
- Predictions about possible next situation
- Possible actions (prescribed, allowed or forbidden)
- Focus of Attention: entities and relations for the system to observe

A Situation Graph provides context for perception and action

Situation Models:
A model for perception and action by objects and spaces

Situation Models drive Perception and Action

Situation: A configuration of relations between entities,

A situation encodes:

- Assimilation: interpretation for entities, relations and events
- Projection: Transition probabilities for possible next situations
- Decision: Appropriateness or inappropriateness of actions.
- Attention: Relevant entities and properties to perceive

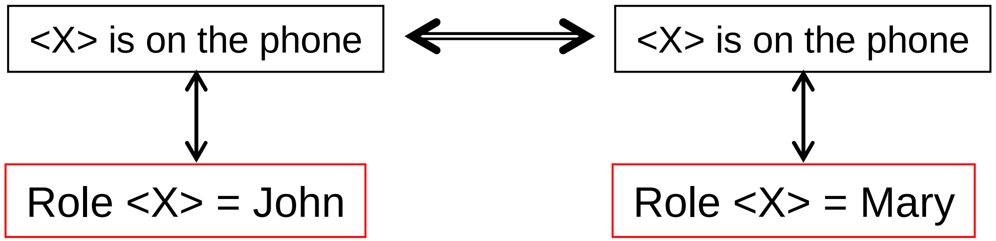
Situated Perception and Action

John is on the phone	⟷	John is facing Mary	⟷	John is talking to Aibo
AIBO Behaviours		AIBO Behaviours		AIBO Behaviours
Be Quite (10)		Be Quite (5)		Be Quite (-10)
Play (-5)		Play (0)		Play (5)
Talk to John (-10)		Talk to John (-5)		Talk to John (10)
Dance (-10)		Dance (-10)		Dance (5)
Sing (-20)		Sing (-20)		Sing (-5)

A situation encodes:

- Assimilation: interpretation for entities, relations and events
- Projection: Transition probabilities for possible next situations
- Decision: Appropriateness or inappropriateness of actions.
- Attention: Relevant entities and properties to perceive

Roles and Situations



A <u>role</u> is a "variable" for entities.

Roles allow generalizations of situations.

Roles enable <u>learning by analogy</u>

Situation Models for Social Interaction

Situation models drive perception and action

Situation:

A configuration of relations between entities,

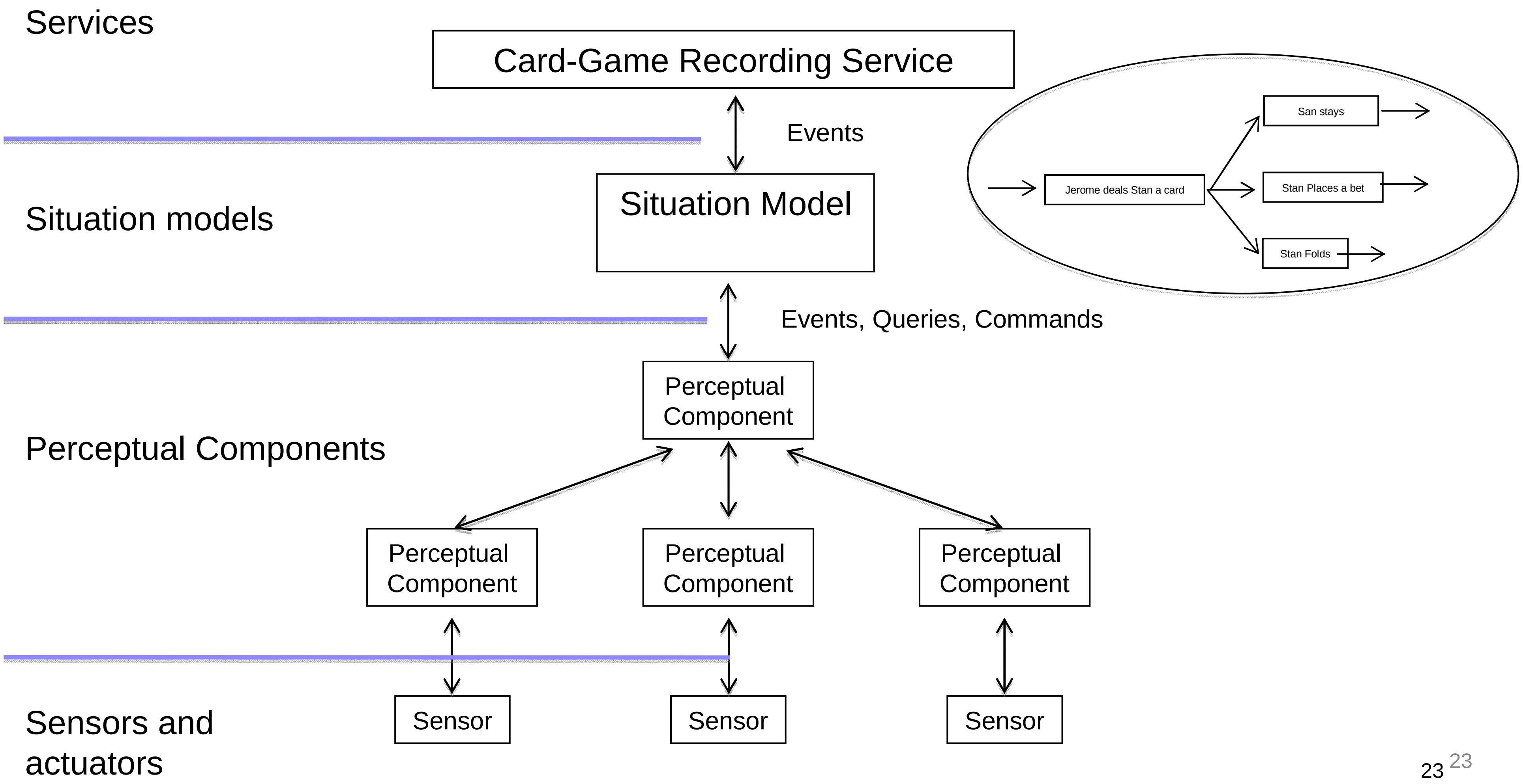
The appropriateness of actions for the situation.

Context:

A situation network composed from

A set of entities, relations, actions, and situations

An example:
Recording events in a card Game



An example:
Observing a card Game

Actors:

- Jerome, Sonia and Stan

Objects:

- Card table, cards

Roles:

- Dealer, player

Relations:

- <Dealer> deals to <player>
- <player> talks to <player>
- <player> Folds
- <player> makes a bet
- <player> talks to <x>

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Perception of Affection

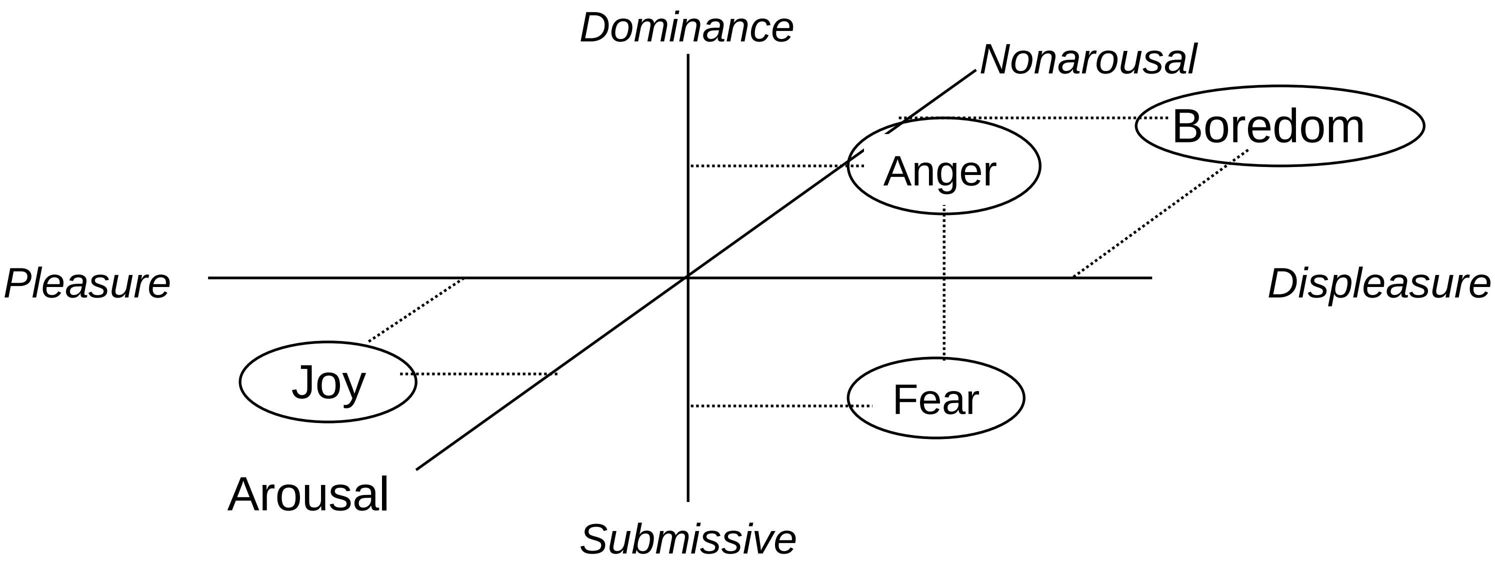
The PAD (Pleasure, Arousal, Dominance) model

J. A. Russell , A. Mehrabian, "Evidence for a three-factor theory of emotions", Journal of Research in Personality Vol. 11(3), pp 273-294, Sept 1977.

Three Dimensions of affection:

1) Pleasure - Displeasure: Valence of an emotion
2) Arousal - Nonarousal: Intensity, physiological excitation
3) Dominance - Submissive: Disposition to assert control.

Pleasure, Arousal, Dominance



Perception of Affection

Measurements for Affection:

Pleasure: Facial Action Units, Prosody

Arousal: Blood Pulse Volume, Motion activity, Skin conductivity

Dominance: Facial Action Units, Prosody, motion activity.

Blood Pulse Volume

QuickTime™ and a
decompressor
are needed to see this picture.

Developped by R. Piccard (MIT Media Lab)

Real time blood pulse waveform from web cam.

(Commercialised by Affectiva)

FACS: Facial Action Coding System

QuickTime™ and a
decompressor
are needed to see this picture.

Image provided by UCSD Machine Perception Lab

Facial Action Coding System (FACS) : A system to label human facial expressions, developed by P. Ekman and W. V. Friesen, 1978)

A common standard for recognizing physical expression of emotions

Code available from J. Movellan and M. Bartlette UCSD Machine Perception Lab

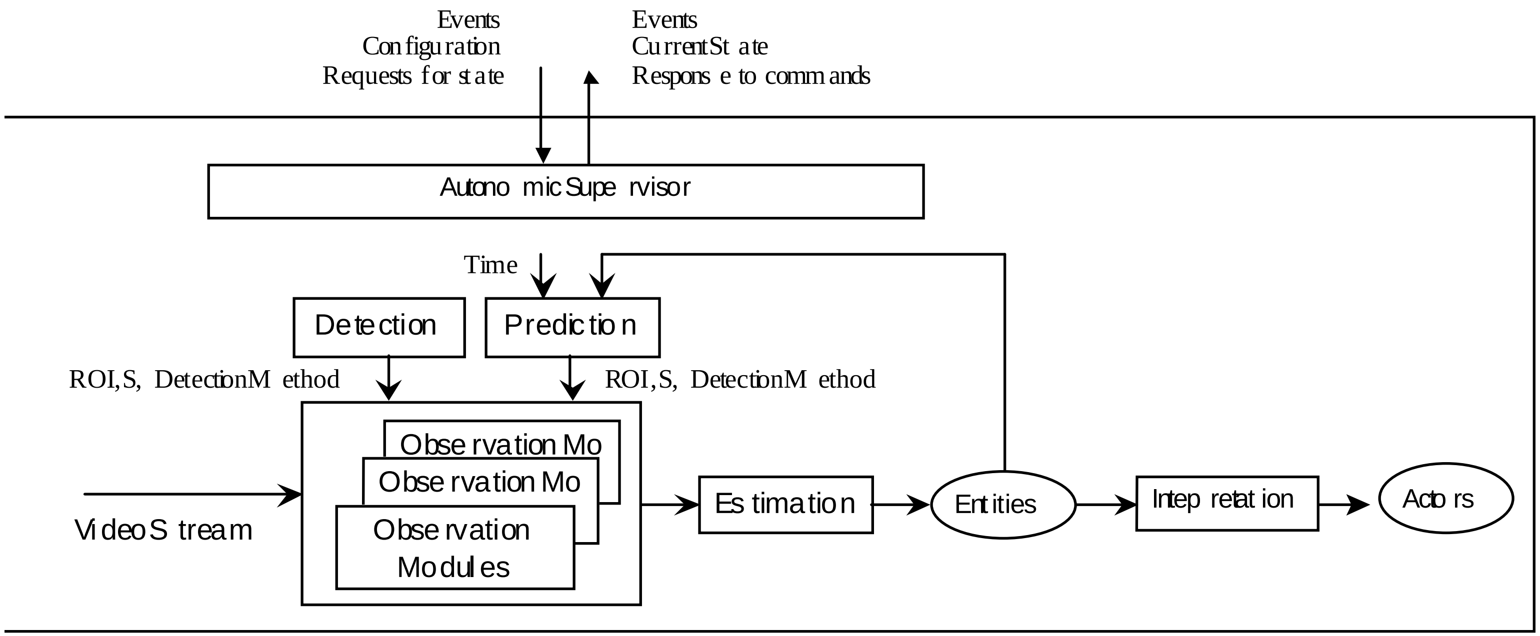
Ekman’s Seven Basic Emotions

Emotion	**Action Units**
Happiness	6+12
Sadness	1+4+15
Surprise	1+2+5B+26
Fear	1+2+4+5+20+26
Anger	4+5+7+23
Disgust	9+15+16
Contempt	R12A+R14A

Tracking Faces Hands and Bodies

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

Autonomic Perceptual Components

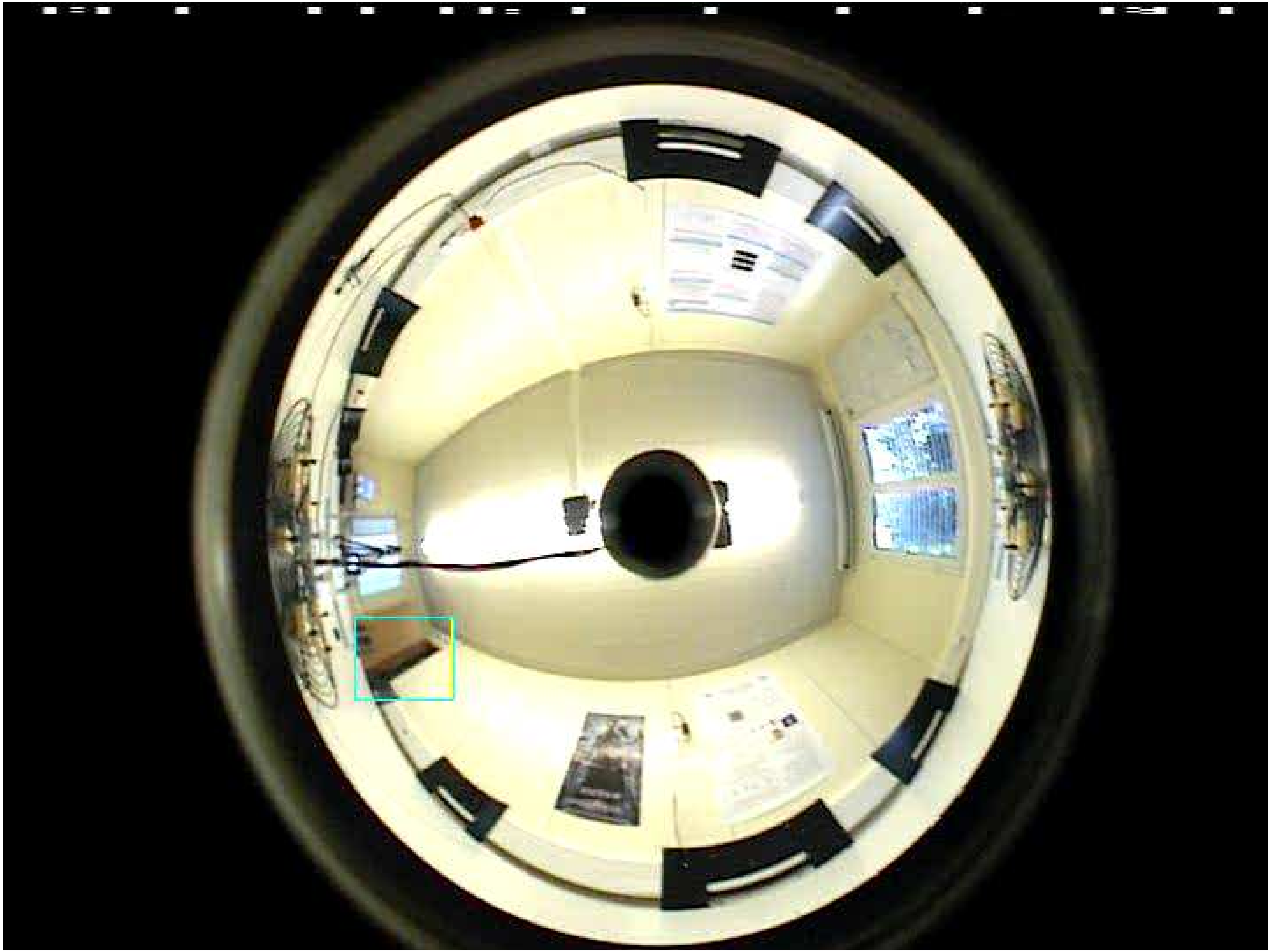


Supervisor Provides:

- Execution Scheduler
- Parameter Regulator
- Command Interpreter
- Description of State and Capabilities

Face Detector

QuickTime™ and a
H.264 decompressor
are needed to see this picture.



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Situation Models for Social Common Sense

Fundamental Problem

The Knowledge Barrier:

The extreme complexity of human activity and individual preferences

Proposed Solution

Machine Learning

Off-line: Learning of prototype scripts

On-line: Adaptation of scripts to accommodate preferences

Learning Polite Behavior with Situation Models*

Rémi Barraquand and James L. Crowley

Project-Equipe PRIMA

INRIA Grenoble Rhône-Alpes Research Centre

Montbonnot, France

Presented at HRI'08, Amsterdam, Sept 2008.

Experimental Set Up
Smart Environments Experimental Facility

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

AIBO Robot:

- Large library of behaviors in the Sony SDK
- Positive Reward: <u>Caress back</u>
- Negative Reward: <u>Tap head</u>
- Situation awareness is provided by the environment.

Learning for Social Interaction

<u>Four Learning Problems</u>

Learning Behaviour

⇒ Supervised on-line Learning

Learning Situations Graphs

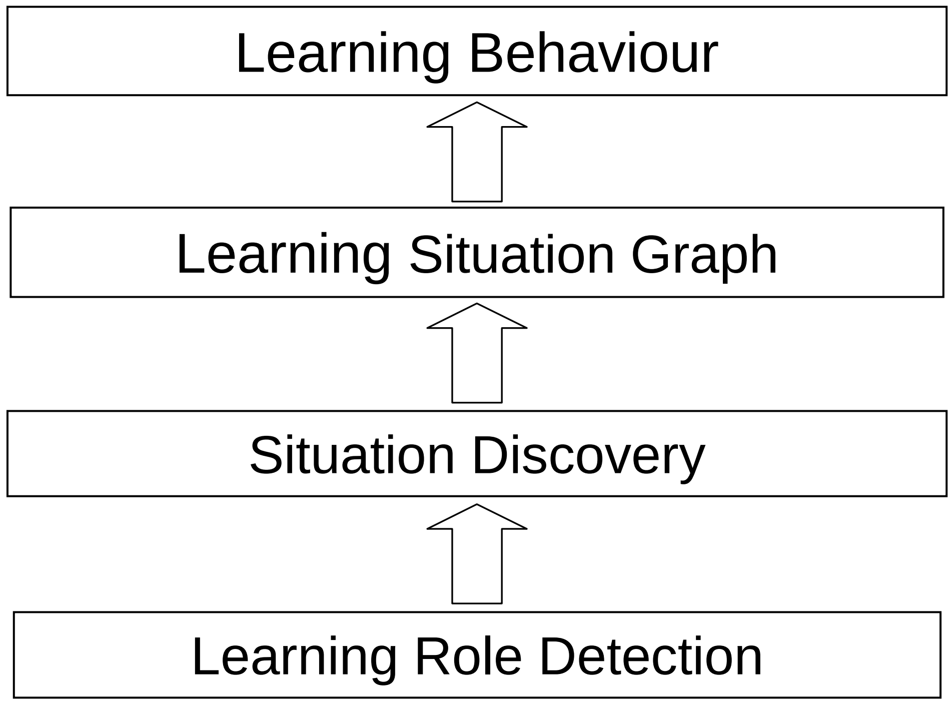
⇒ Supervised off-line Learning

Situation Discovery

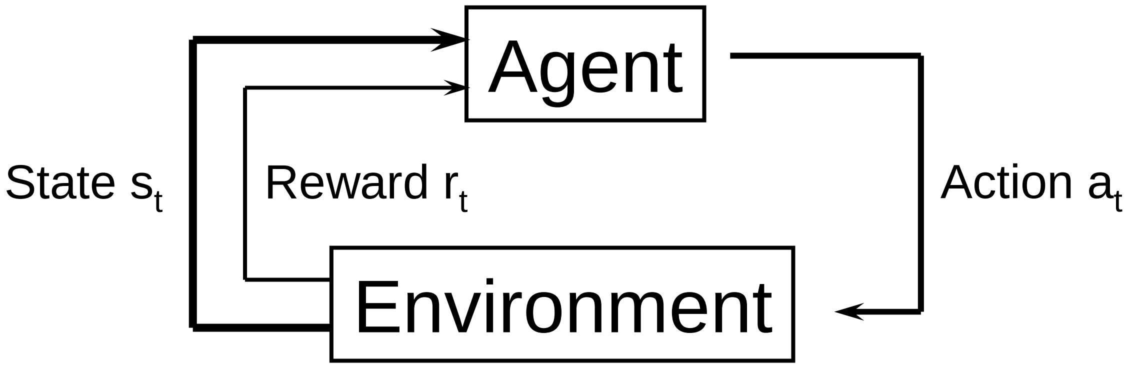
⇒ Unsupervised off-line Learning

Role Detection

⇒ Off-line Statistical Learning



Learning Behaviour: Reinforcement Learning



Algorithm to learn a policy π: *situation* $\rightarrow$ *action*

Q-Learning [Watkins 89] :

- Learns policy and Q-Value at the same time
- Based on temporal different and learning rate.

Why is Social Learning hard?

Learning rate should depend on many social factors:

- Social Context
- Time of Day
- Emotional stimulation
- Motivation,
- Attention
- Nature of reward
- Temporal dependence
- Advice
- Surprise

Conclusions About learning

1. Social common sense can be captured by learning appropriateness for behaviours conditioned on social situation
2. Absence of positive feedback is NOT punishment
3. Social factors can be used to control learning rate
4. Proper delay required for credit assignment
5. Roles enable learning by analogy.

Conclusions about Social Interaction

1. Socially mediated interaction requires awareness of social situation
2. Perception is more than recognition. Perception is a process of sensation-assimilation-projection-attention
3. Situation model can provide scripts for social perception and socially correct action and interaction
4. Many challenges remain ….

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