

Features of Emotional Planning in Software Agents

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The Idea

Analysis of interactions and commonalities
of emotional and planning processes
in software agents

- Situated resource-bounded agents
- Complex environments:
rich, social, dynamic, and partially observable
- Planning as a resource

Outline

- 1 Planning for Dynamic Environments
- 2 Emotions
- 3 Emotional Planning Architectures
- 4 Planning vs. Emotion

- 1 Planning for Dynamic Environments
 - Decision Theory, Dynamic Environments, and Beyond
 - Planning as Module
 - Planning Module Interface: Parameters and Management
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Decision Theory

- **Utility** (U): preference function over outcomes
 - **Probability** (P): distribution of expected action outcomes
- **Expected Utility** (EU):

$$EU(A|E) = \sum_i P(\text{Result}_i(A)|\text{Do}(A), E) * U(\text{Result}_i(A))$$

A...action, E...evidence

- Goal: **Maximise Expected Utility**

Challenges of Complex Environments

- Uncertain knowledge
- Nondeterministic actions
- Many and conflicting goals
- Interleaved or concurrent execution
- Worth-oriented domains (partial goal achievements)
- Goal types:
 - Achieve, maintain, avoid, verify, improve upon, . . .

Uses of Plans in Complex Environments

Use/execution of plans dominates over planning:

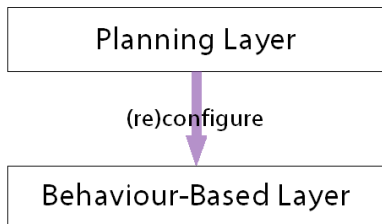
- **Plans-as-routines**
 - basic building blocks
- **Plans-as-commitments**
 - limit further reasoning
 - influence monitoring of the environment for options and the cost of new options
- **Plans-as-communication**
 - cannot be executed directly
 - require interpretation in context

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Planning as Module

Who is in control?

- Situatedness
⇒ coordination of influences by “self” and environment
- Continuous planning requires partial plans and plan adaptation



Planning as Option:

- Vertical modularisation with supporting layers
- **Hybrid systems**
- What provides control/guidance for planning activity?

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Planning Module Interface

Parameters:

- Goals, beliefs
- Utilities & costs of activities
- Heuristics, success criteria

Outputs:

- Plans (partial, partially ordered, skeletal)
- Abandoned options
- Profiling information
(e.g. number of options, level of detail, planning effort)

Management:

- Start, stop, resume, discard, elaborate partial plans

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 - Cognitive Appraisal Theories
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The Role of Emotion

- Cognitive appraisal theories describe emotions as a **process** (vs. dimensional and categorical models):
the emotional subsystem monitors the environment (including itself) for events (changes) of subjective relevance and proposes lines of reactions
- Situated/bounded view on emotions: delimitation of scope
- Emotions as crucial for dealing (successfully) with and sustaining complex social environments
- **Appraisal criteria**: central dimensions used during the process
- **Appraisal effects**: action tendencies and coping activities

Appraisal Criteria

Major Dimensions of Emotion Eliciting Stimuli [Ellsworth & Scherer 2003]

- Novelty, pleasantness
- Conducive/obstructive to needs/goals/concerns
- Coping potential: control and power
- Social dimension: norms and values

According to [Frijda 1986] appraisal criteria are **coding categories**: possible components of **situational meaning structures** that characterise the subjective experience of a situational change

Appraisal Effects

Main outputs of the emotion process:

- **Action control precedence signals** such as interrupts
- Internal awareness and overt manifestations of **action tendency changes**
(facial expressions, iconic and ritual gestures, display rules)

Action tendency: readiness to achieve/maintain/end/avoid/...
a specific subjective relation to the environment

Emotional behaviours:

- Strategies of **coping** with the challenge posed by the subjective appraisal of the stimulus
- Denial, positive reinterpretation, social support, planning, ...



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Emotion Module Interface

Situational parameters:

- Needs/goals/concerns, situational changes

Dispositional antecedents:

- Coding categories (aspects of situational change)
- Response thresholds and modes (antagonistic, protective, ...)
- Previous experiences with an event (type)

Outputs:

- Situational meaning structures
- Expressiveness of behaviour and preliminaries for action readiness change
- Influence on action control and control precedence

Management:

- Regulation

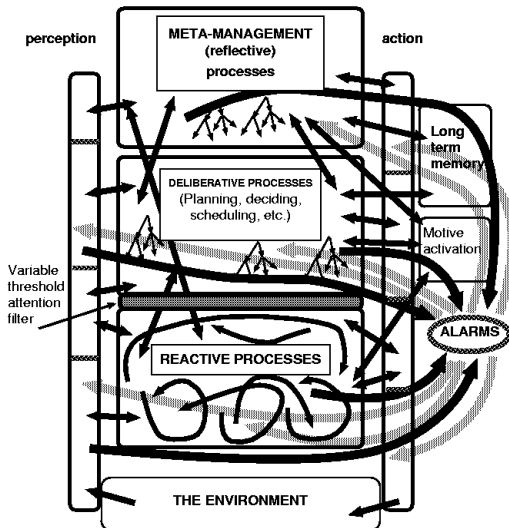
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APOC (Activation, Priority, Observer, Component)

APOC architecture framework [Scheutz 2001]

- Typed links between nodes of the architecture
- Evolutionary values of affective and deliberative control as additions to a purely reactive architecture are compared
- Simplified affect: state variables
- In simple environments, affect may outperform deliberation
- Impact of environmental characteristics

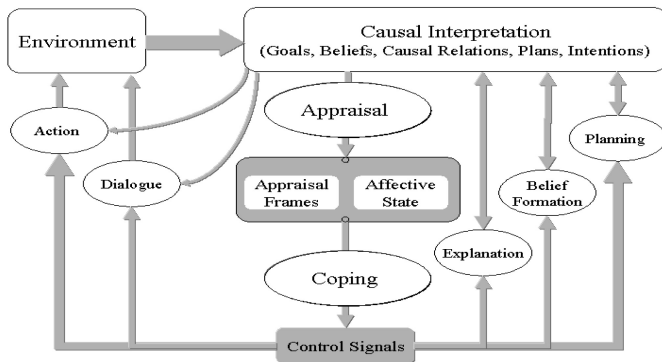
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- One of Aaron Sloman's aims is to define emotional concepts starting from architectural ones, such as layering and arbitration mechanisms

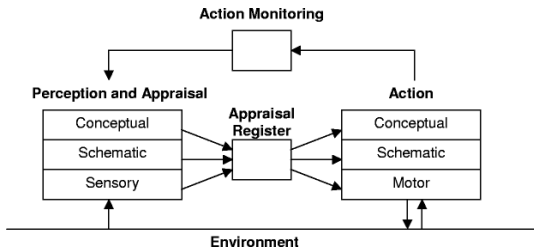
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EMA



- Domain-independent structural analysis of plans
- Mapping emotional concepts onto a deliberative architecture
- Current focus on coping strategies [Gratch & Marsella 2004]

TABASCO & ActAffAct



- Starting point are psychological theories about the emotion process
- Search for a principled way of generating expressive behaviour
- ActAffAct as implementation of a simplified model for dramatic environments

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 - Relations of Planning and Emotion
 - Conclusion

Planning vs. Emotion: Comparison of Basic Concepts

- Goals vs. needs/goals/concerns
- Representation of a situation:
world facts vs. components of subjective meaning structures
- Utilities vs. pleasantness, conduciveness, coping potential
- Costs vs. response thresholds and impulse strength
- Heuristics vs. response modes, history of experience
and action tendencies
- Appraisal uses the **social dimension** as basic category

Influencing Factors in Both Directions

Control and Guidance of Planning:

- Action control precedence
- Action tendencies
- Coding categories (may influence search and utilities)
- Plan-related coping strategies

Conditions of the Appraisal Process:

- Response modes and thresholds
(influenced by current plan profiling and intentions)
- History of experience
(including plan success/failure and abandoned options)
- Expectations about situational change





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Conclusion

- Situated agents can profit from both the more abstracted and objectified perspective of planning and the subjectively grounded current evaluations of the emotion process
- Combining them calls for consolidation and integration of overlaps in functionality
- Current work:
principled integration of deliberative capabilities into a computational model of emotion, in cooperation with other emotion researchers within the EU FP6 NoE Humaine

Thank You for Your Kind Attention!

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