



Cognitive Emotion Models: some thoughts on their tuning and use in communication processes

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- 1. Statement of the problem*
2. Outline of a solution for modeling emotion activation
3. Extending the model to emotion interpretation
4. Tuning the model
5. Cooperation perspectives

Emotions in Dialogic Communication

What characterizes this application domain?

Need, for both the participants in the dialog, to keep *a image of the other's mind*

which, together with own goals and plans, implies decision of *what to say* at every dialog step,

by insuring *behavior coherence and time consistency* but also *ability to adapt to evolving situations*.

Role of Cognitive Emotion Models

Let: A_1, A_2 be the agents involved in the dialog and
 $t_1, t_2, \dots, t_i, \dots, t_n$ be the various dialog turns.

Let us assume that we are in dialog turn t_i
and that A_1 'moved' at t_{i-1} , with $\text{Move}_1^{(i-1)}$.

The following forms of reasoning about emotions
can be made by A_2 :

- a. Interpreting 'emotional and non emotional' aspects of the previous move $\text{Move}_1^{(i-1)}$.*
- a. Guessing the possible (emotional and non emotional) impact of next move $\text{Move}_2^{(i)}$.*

Interpreting the previous move $\text{Move}_1^{(i-1)}$.

(a kind of 'diagnostic reasoning')

Given some sign of emotional state (of any kind)
displayed by A_1 , which might be its *causes*?

Which combination of beliefs, desires, intentions of A_1
might have produced it?



Updating of A_2 's image of the mental state of A_1

Guessing the possible impact of next move $\text{Move}_2^{(i)}$.

(a kind of 'prognostic reasoning')

Which might be the emotional consequences of my
next move ('induced emotions'),
given my knowledge of A_1 ?

Are these consequences of any help in enabling me to
achieve my own goals/plans?



Updating of A_2 's goals and plans

Notice that
after move $\text{Move}_1^{(i+1)}$

A_2 will also check how effective was his move:
whether it succeeded or not
in enabling him to achieve his own goal
and why it eventually failed.

A Small Fragment of An Example Dialog

User: *"So what?"*
(with a light smile)

Move_U⁽ⁱ⁺¹⁾

Prognostic reasoning:
Decision to apply the persuasion schema of 'appeal to negative consequences' and goal 'avoid skin ageing'



Move_A⁽ⁱ⁾

Agent: *"Do you know that smoking increases considerably the risk of skin ageing?"*

Diagnostic reasoning:
Why does the user seem to be indifferent to my persuasion attempt?
Some candidate explanations:
• she does not give *value* to avoid skin ageing or
• she does not *believe* in the action-effect relation,
• she is not a '*apprehensive*' person.


Coherent and (time) Consistent Reasoning

A_2 should integrate in a consistent way rational and emotional aspects of his image of A_1 's mind.

This means that the (presumed) system of BDIs of A_1 should be 'compatible' with her emotional state.

We should therefore define *consistency -in time- between rational and a-rational components of an agent's mind* and

build models which represent interpretation and induction of emotional states with this concept of consistency.

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Which Variables to Include in the Model?

Intrinsic variables:

likelihood that event will occur

its desirability/undesirability

its time of occurrence (past, present, future)

person involved (myself, the other)

.....

Influencing factors:

Personality (and therefore)

values

goal weights

propensity to feel emotions (threshold effect)

emotion persistence (time decay)

Social context (e.g. relationship with the interlocutor).

Role of uncertainty

Two Prevailing Approaches to Emotion Modeling

- to represent intensity of emotion as a function of a number of variables; usually, a function of the type:

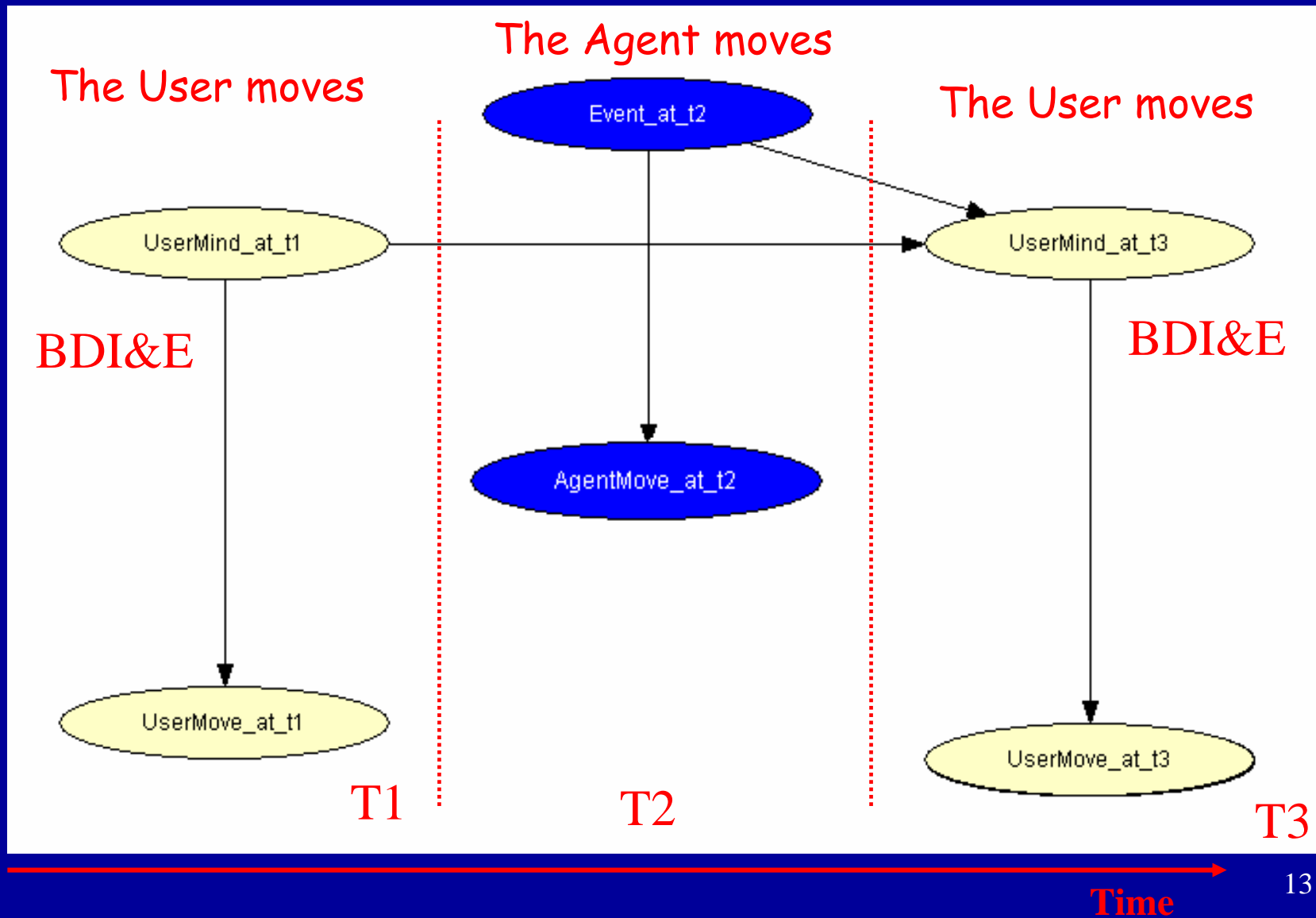
$$\log \sum a_i e^{-b_i x_i}$$

(by following the line traced by Ortony in 1988 and developed in EM, Affective Reasoner, Cathexis.

- by employing Hidden Markov Models.
Dynamic Bayesian Networks are models of this type

(work performed in the scope of MAGICSTER)

Why Dynamic Bayesian Networks



Outline of Our Cognitive Models

The user's mind at time $T+1$ depends on:

- her mind at time T
- the event(s) occurred in the interval $(T, T+1)$.

The 'feeling of emotions' is a function of

- these events,
- the user's (presumed) *personality*,
- the *context* in which the dialog occurs.

Cognitive Ingredients of Emotions

whose representation is essential to coordinate the emotional and rational components of an agent's mind.

Example: *U envies A because of x when:*

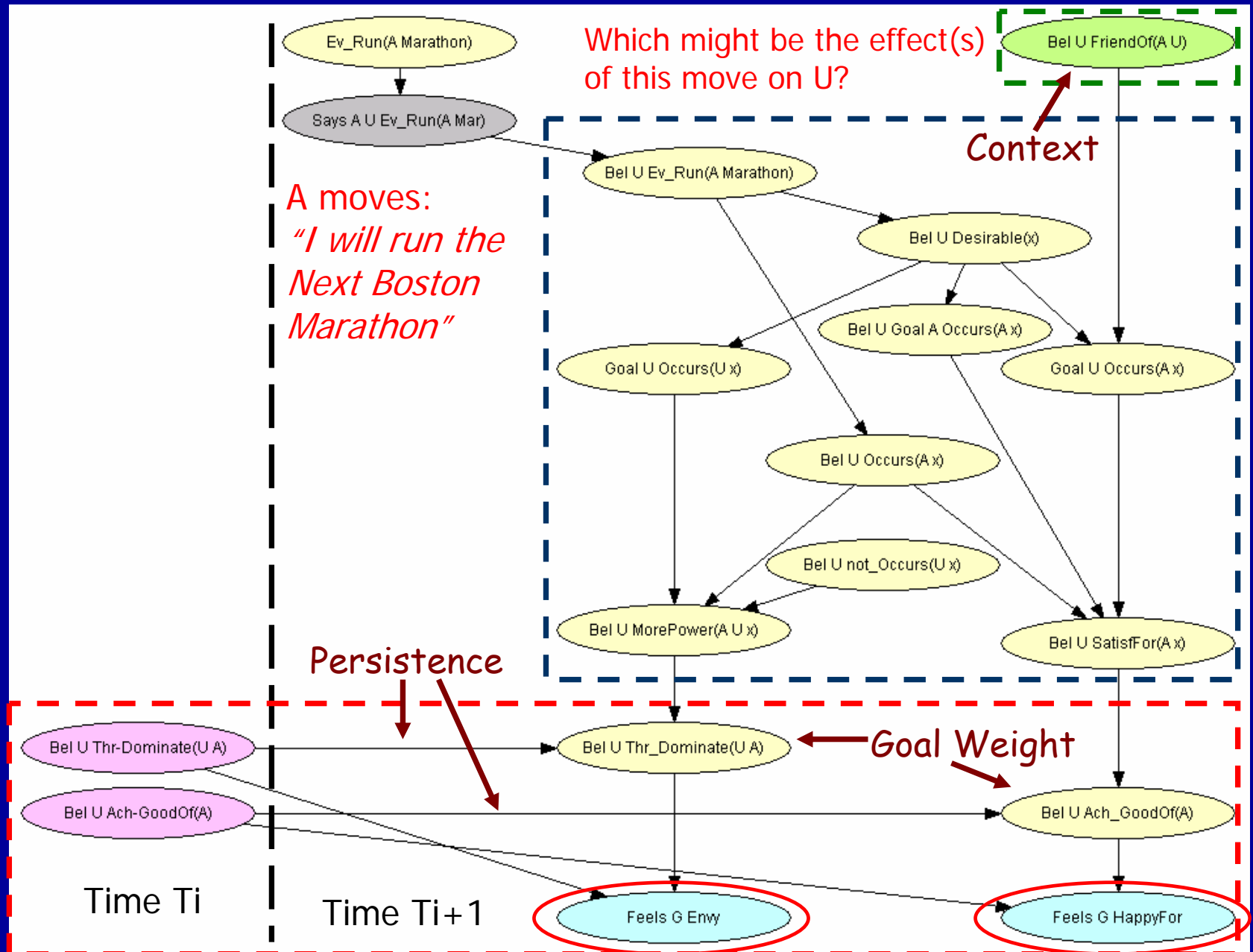
- U believes that x occurred or is going to occur to A:
Bel U (Has A x) or Bel U (CanHave A x)
- U believes that x is 'desirable', to both A and self and therefore:
Goal U (Has U x) and Bel U Goal A (Has A x)
- U believes that he cannot have x: **Bel U not(CanHave U x)**

Consequences:

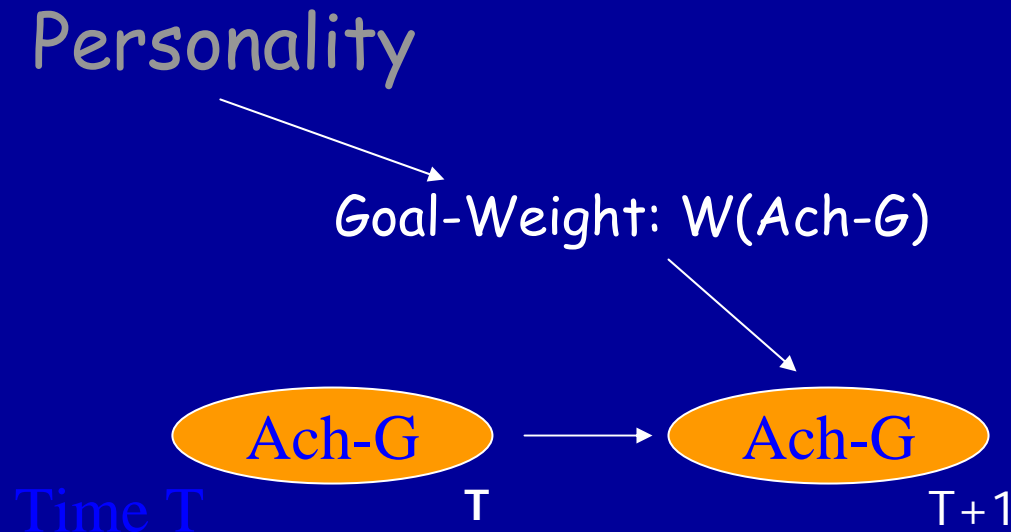
- U believes that this situation increases A's power over U:
Bel U (MorePowerful A U x) and
- U's goal of 'dominating others' (in particular, A) is threatened:
Thr-Goal (Dominates U A)

(Castelfranchi, 2000) 15

The DBN for Induction of Envy & HappyFor



Effect of Personality on Emotion Induction



Triggering of Em:

$F = f(\text{Prob}(\text{Ach-G}(T+1)) - \text{Prob}(\text{Ach-G}(T)))$
(with a 'threshold effect')

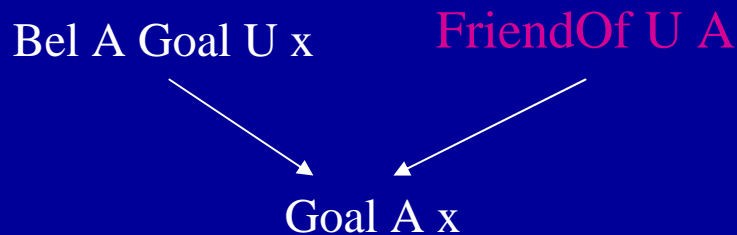
*Variation of Intensity of Em
from T to T+1:*

$$\Delta E = W(\text{Ach-G}) * F$$

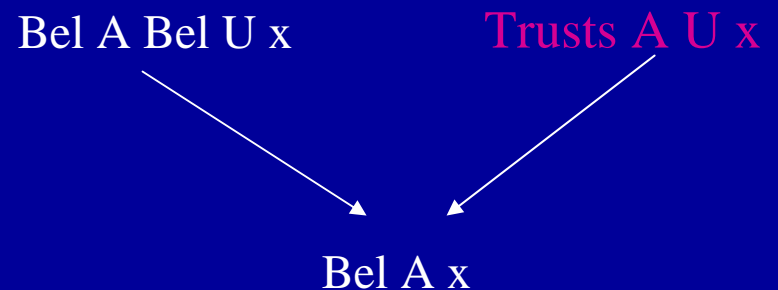
Effect of Context (Relationship Between the two Interlocutors)

Context may influence emotion triggering through an indirect influence on the subject's beliefs and goals.

Two examples:

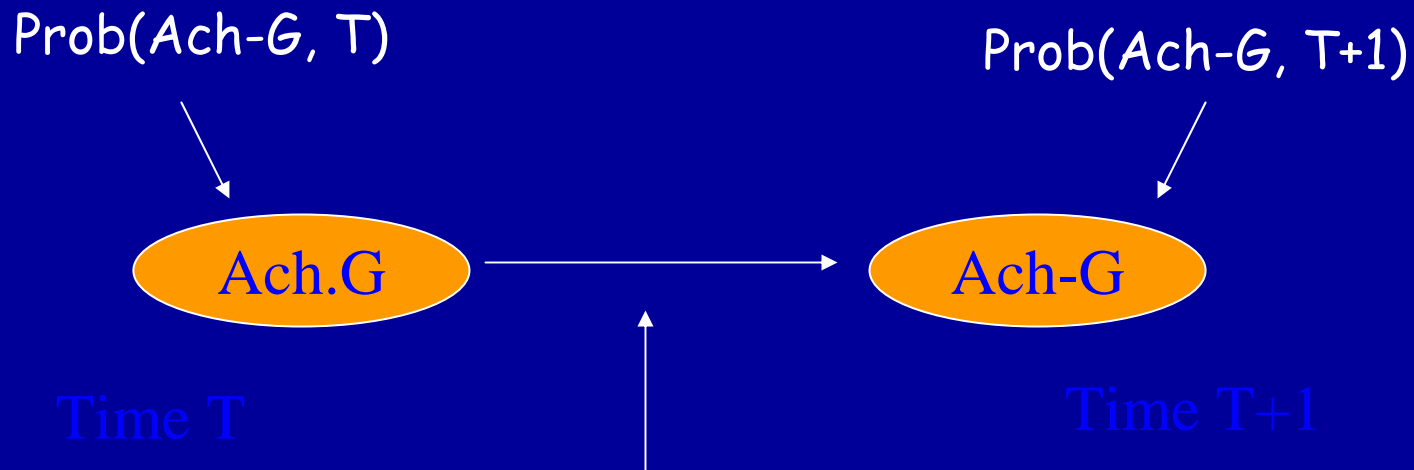


*(Adoption
of Friends' Goals)*



*(Sharing of Beliefs
in Trusting Conditions)*


Effect of Emotion Persistence



The probability table associated with this link
may be varied

so as to simulate a *fast decay* (for positive emotions)
or a *slow decay* (e.g., for negative emotions)

and the effect of another personality trait (*Neuroticism?*)

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Integrate Interpretation, Guessing & Validation

Interpretation
of $\text{Move}_U^{(i-1)}$



The Agent's
image of the User
is updated

Forecast of impact
of $\text{Move}_A^{(i)}$



The Agent's
Goals and plans
at time i are updated

Validation of
forecast at time i



The Agent's
image of the User
is updated

T_{i-1}

$\text{Move}_U^{(i-1)}$

T_i

$\text{Move}_A^{(i)}$



T_{i+1}

$\text{Move}_U^{(i+1)}$

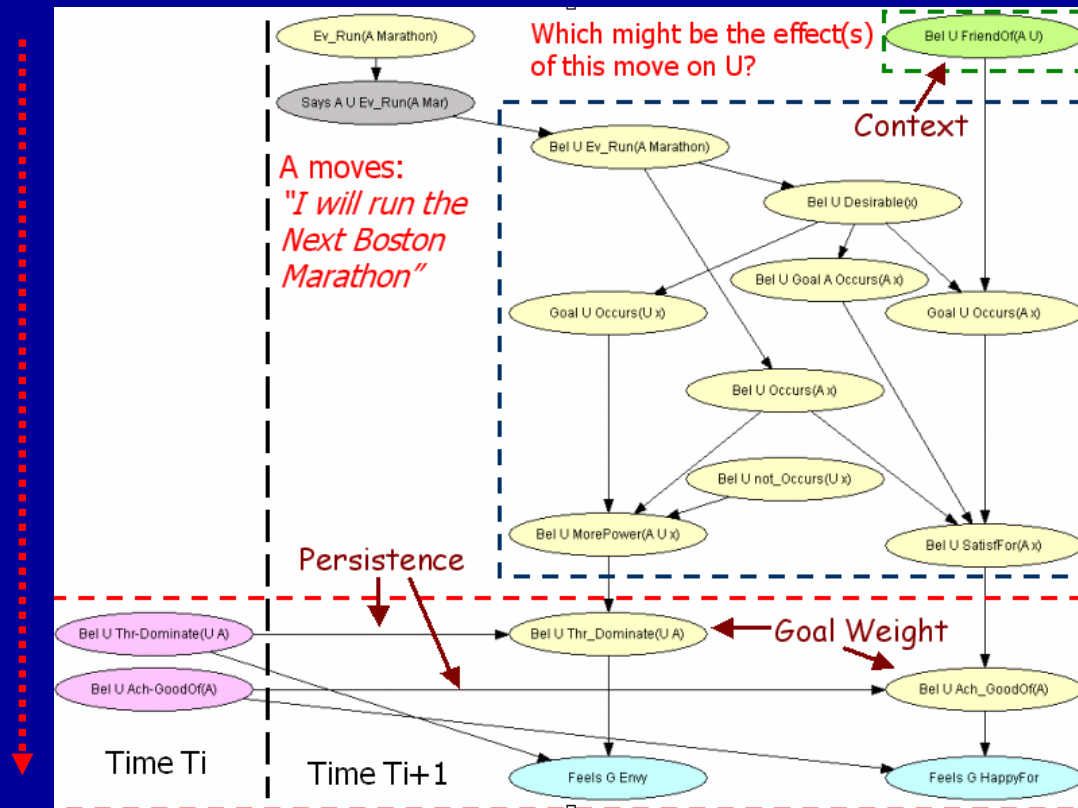
T_{i+2}

$\text{Move}_A^{(i+2)}$



Work in the scope of HUMAINE:

study how the model built to represent emotion induction may be employed to represent how to 'interpret' a communicative act



prognostic reasoning:

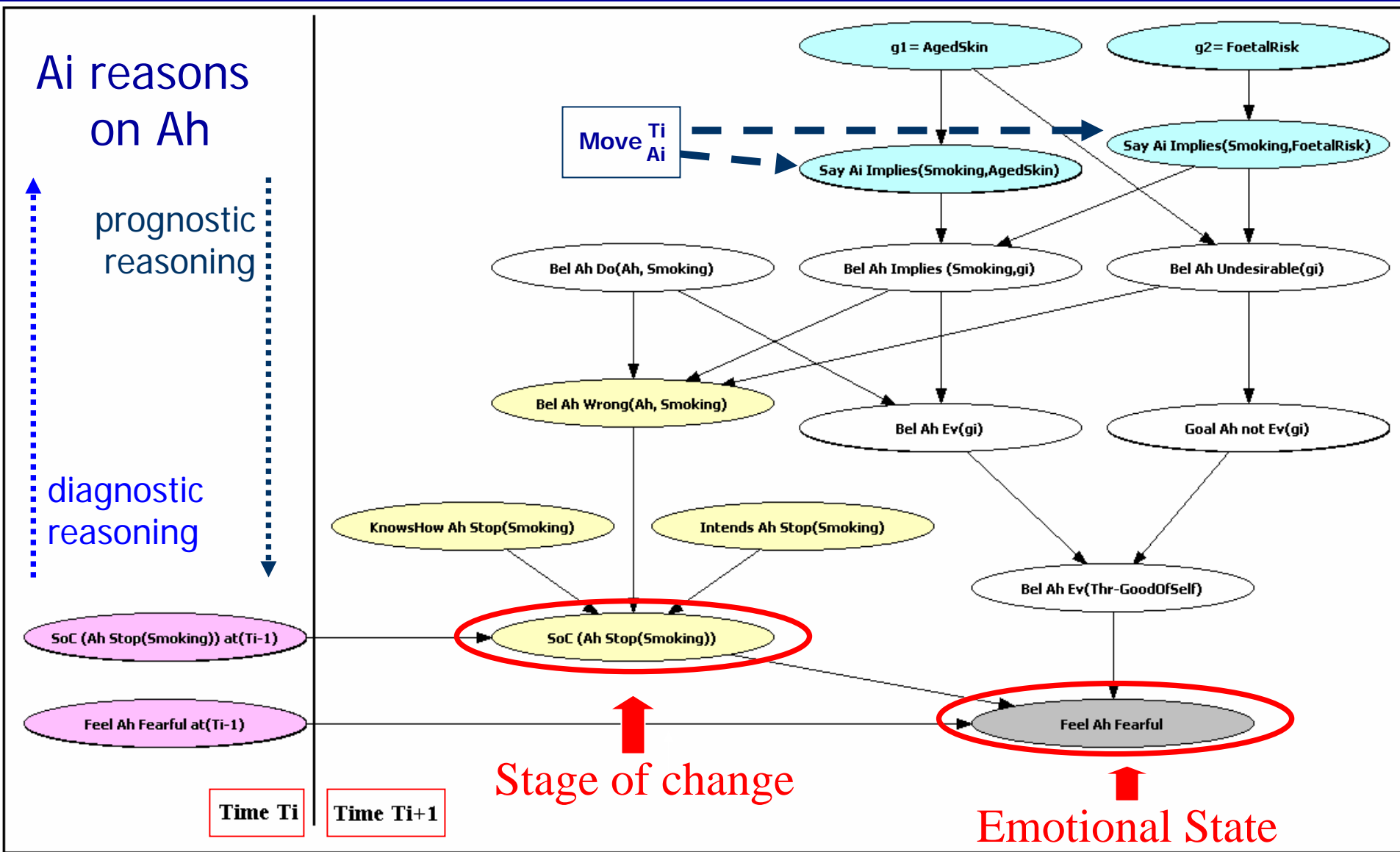
From beliefs desires and intentions to emotions

diagnostic reasoning:

from emotions to beliefs, desires and intentions

... by insuring consistency between rational and emotional aspects of the interlocutor's mind

An Example of Consistent Knowledge in Health Promotion Dialogs



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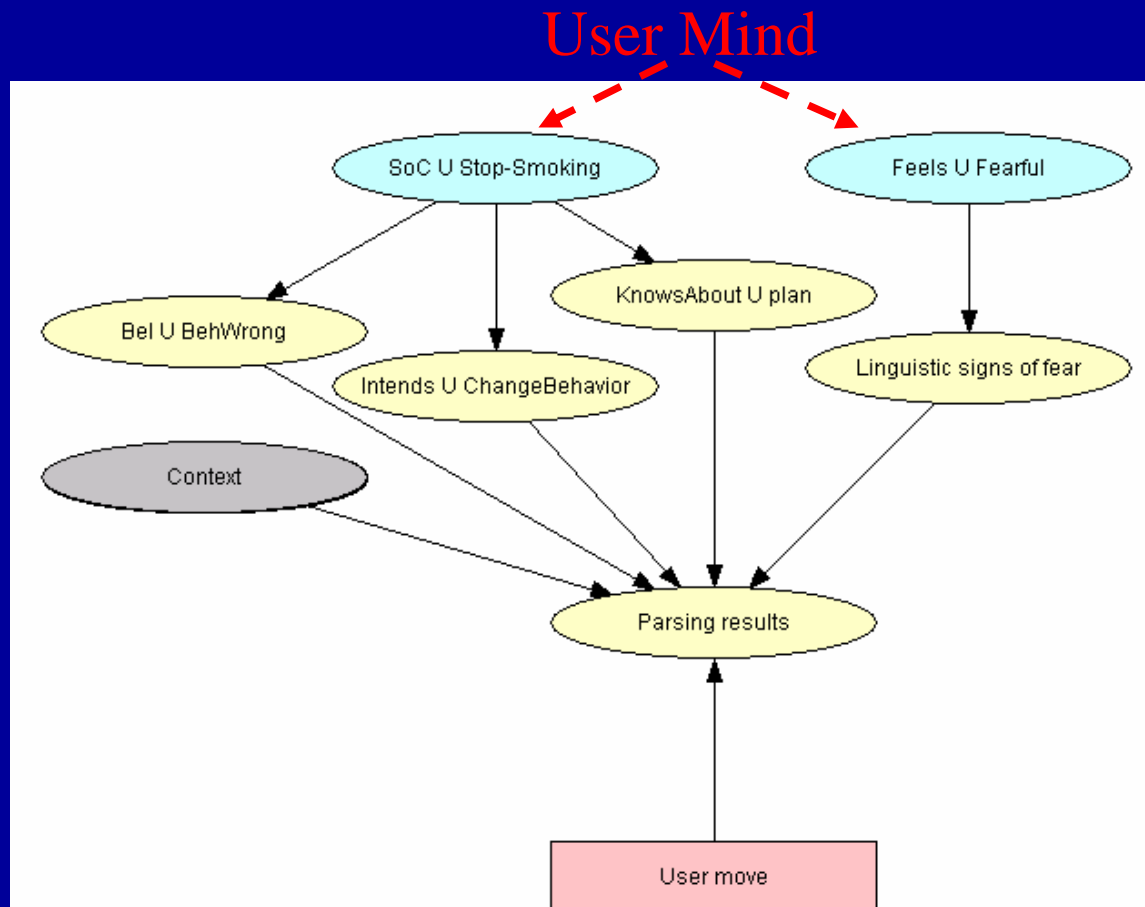


How we plan to use these models in HUMAINE

1. In the context of *persuasion dialogs* (-> WP8).
System = persuader, User = persuadee
application domain: healthy eating
intention to be induced: to eat vegetables
rational and emotional persuasion strategies may
be combined.

How we use these models in HUMAINE

2. In integrating context-based recognition (from parsing of the user move) with interpretation (WP4).



Problems in building DBNs

The 'qualitative' part of the model (its structure) may be defined according to emotion activation theories (OCC, Ekman, Oatley and Johnson-Laird, Castelfranchi,...).

The 'quantitative' part (parameters) is more tricky.

DBNs require a large number of parameters, which may be evaluated (in general) by applying a *frequentist* approach (learning from a dataset) or a *subjectivist* one (from experts).

The frequentist approach cannot be applied to cognitive emotion models: difficult to get reliable data on *'what were subjects thinking when (or immediately before) they felt a given emotion'*.

Therefore, the subjectivist approach must be applied. However, humans are not always good at estimating probabilities (Tversky and Kahneman, 1980).

Hence, models need to be tuned and validated!!

Two forms of evaluation

a. Robustness of the model

How the model output (emotion intensities) varies when

- All the parameters are varied simultaneously (*uncertainty analysis*) or
- One of the parameters is varied (*sensitivity analysis*).

b. Predictive value of the model

Does the dynamic behavior of the model reflect what an external, independent (and competent) source would expect?

Sensitivity Analysis

Alternative to 'brute force' early methods:

Given:

- a *node of interest*
- a set of *observed nodes*

a *sensitivity set SS* of nodes is found (those who influence the node of interest).

For every node in SS, the effect of variations in the value of parameters associated with the node on the probability of the node of interest is plotted.

This probability may be expressed as a ratio of two linear functions of the studied parameter.

In the case of cognitive models of emotions

If used in a *prognostic* mode:

Node of interest: (Feel Ag em)

Observed nodes: an appropriate combination of:
emotional state at time $i-1$
social relationship between the two agents
desirability of the event

If used in a *diagnostic* mode:

Node of interest: a belief or goal node which is of potential interest to select the plan to apply next

Observed node: (Feel Ag em)

Validation of the predictive value

Which kind of error should be avoided?

Is a low *sensitivity* in recognizing emotions a more serious kind of error than a low *specificity*, or the inverse?

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Exemplars for HUMAINE

What we can give to other partners:

- *A domain-independent tool* (Emotional-Mind) to simulate emotion activation by varying the agent personality traits and the social context: output in tabular, graphical or ECA form.
- *A dll version* to include the model in any application.

The Graphical Interface of Emotional-Mind

Setting a personality set and a context set

Selecting a context and a personality

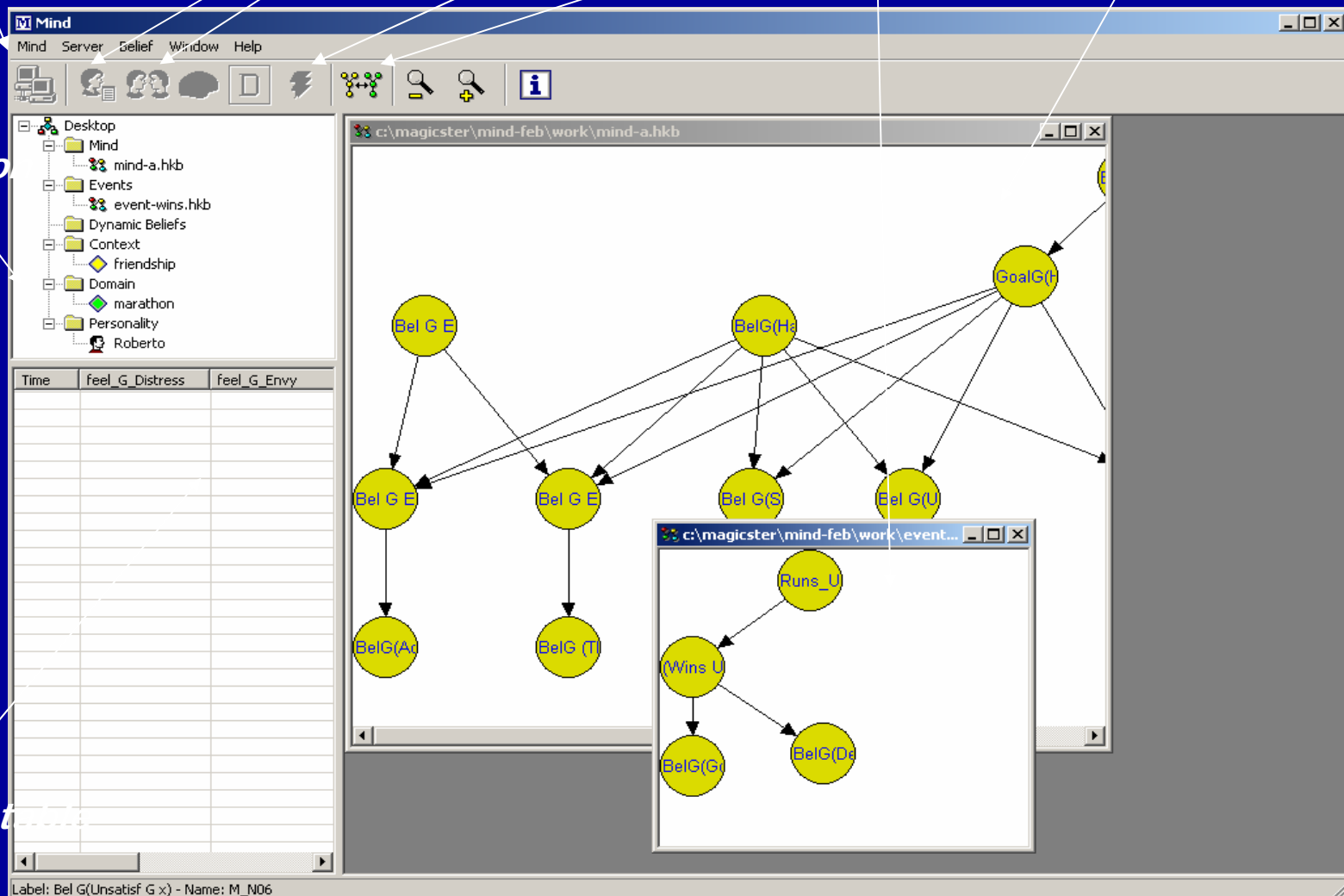
Selecting an event

Firing the event

Mind at T_0

Simulation history

Dynamic Emotion table



Output also as an ECA expression

The screenshot displays the MagiCster software interface. The title bar reads "MagiCster - Mind - [c:\mind\work\normal\mind_tpo.hkb]". The menu bar includes "Mind", "Belief", "View", "Debug", and "Help". The toolbar contains various icons for client interaction, mind bar, and analysis. A "Threshold" slider is set to 3%.

The left sidebar shows a "Workspace" tree with the following structure:

- Context
 - friendship.cfg
- DBN
 - mind_tpo.hkb
- Domain
 - disorder
- Event
 - eating_disorder.hkb
- APML
 - eating_disorder.xml
- Mind
 - mind.hkb
- Personality
 - other-centeredSoptimistic.cfg

The main workspace contains a cognitive network diagram with nodes and directed edges. The nodes are labeled as follows:

- BelG(Des) (yellow)
- BelG(Frie) (red)
- GoalG(Ha) (yellow)
- BelG(Goa) (yellow)
- GoalG(Ha) (yellow)
- BelG(Hes) (yellow)
- BelG(Uns) (yellow)
- Bel G Ev() (yellow)
- BelG(Thr-) (yellow)
- BelG(MPo) (yellow)
- BelG(Sat) (yellow)
- BelG(Thr) (yellow)
- BelG(Ach) (yellow)
- BelG(Thr) (yellow)
- BelG(Ach) (yellow)

The diagram shows a complex network of relationships between these belief and goal nodes. A 3D female avatar is visible in the bottom-left corner of the interface.

But:

we look forward to cooperating with
other partners working on dialogs!