

# Lecture 5 - Psychological Theories (I : Appraisal)

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## Readings:

- Jonathan Gratch and Stacy J. Marsella *A domain independent framework for modeling emotion* Cognitive Systems Research, Vol. 5, pp.269-306, 2004

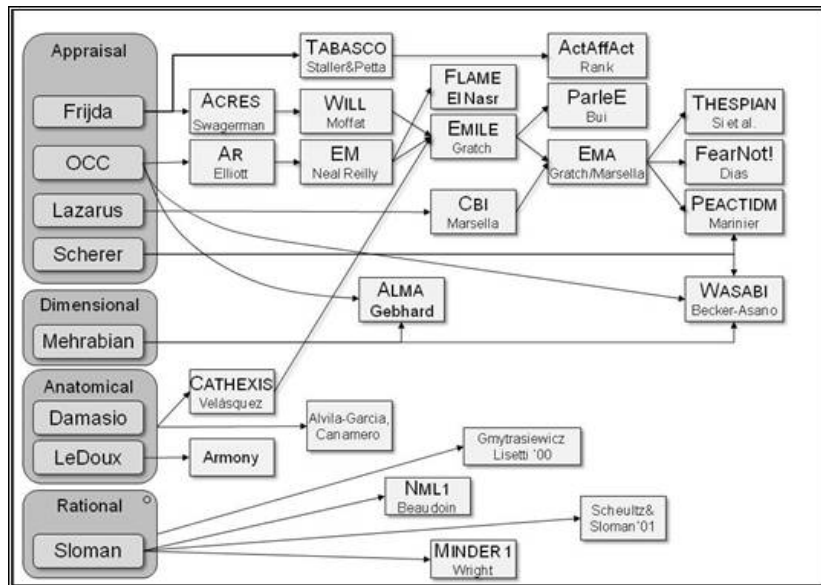
- Emotion helps AI applications
  - ▶ Disaster recovery
  - ▶ Military training
  - ▶ Economic forecasting
  - ▶ Psychotherapy
  - ▶ Tutoring systems
  - ▶ Marketing
- Emotion is key to behaviour in general
  - ▶ Damasio (neuropsychological)
  - ▶ Lisetti (decision making)

## Claims made:

- Use *appraisal* and *coping* as key concepts for building general emotionally intelligent systems
- looks at relationship between cognition and appraisal
- first computational model of coping
- integration of perception, planning, dialogue
- build a complete real-time working system

- focus on “*broad agents*” that:
  - ▶ have emotions and use them
  - ▶ do symbolic reasoning (planning, acting, natural language, user modeling)
- Psychology: emotion to cognitive processes tightly linked
- AI: emotion and symbolic reasoning tightly linked
- Emotions have adaptive functions
- Build virtual humans

# Models of Emotion used in Affective Computing



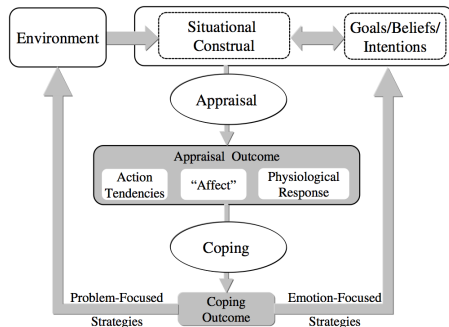


Fig. 1. The cognitive-motivational-emotive system. Adapted from Smith and Lazarus (1990).

Note that (1) there is no fully connected pathway from/to the environment that is not “appraised” and (2) appraisal may happen prior to situational construal and the system still works

# Appraisal theory

1. Cognitive processes build up an interpretation of the *person-environment relationship* in terms of the agent's *goals*, *beliefs* and *intentions*
2. Appraisal computes abstract features based on the interpretation
3. These features describe how external events relate to goals and desires
4. *Coping* recruits resources to repair or maintain this relationship
5. Coping draws on appraisals to motivate actions (internal or external)
6. These actions alter the person-environment relationship by
  - ▶ Changing the environment *problem-focused*
  - ▶ Changing the interpretation *emotion-focused*
7. Cognitive processes implement the coping strategy
8. Coping strategy implementation changes the interpretation (back to step 1)

For example

1. Agent A *intends* to *achieve* a *goal*, and *believes* it can do so
2. Appraisal computes that A feels *hope*
3. Coping makes A work towards the goal

then, say Agent B does something

1. Agent A interprets this as preventing it from reaching its goal
2. Appraisal computes that A feels *frustration* or *dissapointment*
3. Coping makes A abandon the goal, or do something to B, etc...



## Appraisal:

- Reflexive assessment of the current mental state
- May or may not be deliberately arrived at
- Rapid (pre-cognitive) or
- Slow (cognitive, deliberate)

*Significance* ← *interpretation* of event in context of:

- beliefs
- desires
- intentions
- abilities

## Criteria along which the significance of events can be judged.

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Relevance		requires reaction?
Desirability		assist or thwart?
Attribution	agency	what agent was responsible?
	blame/credit	should the agent be blamed/credited?
Likelihood		how likely is outcome/event?
Coping	Controllability	influence?
	Changeability	exogenous change
	Power	power of agent to control
	Adaptability	can agent live with the consequences?
Unexpectedness		predictable?
Urgency		will delay worsen things?
Ego		impact on self (moral values, social esteem)

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- Problem-focussed coping: directed externally
  - ▶ active coping: doing things
  - ▶ planning strategies of action to cope
  - ▶ seeking support/assistance
- Emotion-focussed coping: directed internally
  - ▶ suppress other projects
  - ▶ disengage/hold back
  - ▶ seeking support emotionally
  - ▶ reinterpretations
  - ▶ acceptance
  - ▶ religion
  - ▶ escape/drugs
  - ▶ vent frustration
  - ▶ denial

# Requirements for Appraisal models

- representation: knowledge/interpretation
- reason about relevance and desirability
  - ▶ preferences: goals, utility
- causal attribution: past and future, other agents
  - ▶ logics of intentions/beliefs
- likelihood, unexpectedness, changeability
  - ▶ probability/Bayesian networks
- urgency, temporal constraints
  - ▶ temporal logics
- controllability/influence/social power
  - ▶ planning
- adaptability/re-interpretation
  - ▶ subjective beliefs, higher-order logics
- identity and self-concept

## Decision Theoretic Reasoning

- ✓ preferences
- ✓ time
- ✓ probability
- ✗ commitment to belief/intention: blame/credit is not somehow “implicit” in decision theory?

## Beliefs, Desires, Intentions

- ✓ blame/credit
- ✓ significance to others
- ✗ probability
- ✗ time
- ✗ preference

# Summary of Model

plans, beliefs, desires, intentions, probabilities and utilities: *causal interpretation*

- in AI: mental state
- in Psychology: construal of the person-environment relationship

Events:

- physical action in the causal interpretation
- that facilitates or inhibits some state with non-zero utility

Appraisal:

- A mapping from domain-independent features of causal interpretation to individual appraisal variables

Coping directs control signals to auxiliary reasoning modules:

- to overturn or maintain features of the causal interpretation
- that lead to individual appraisals

# Revised Appraisal model

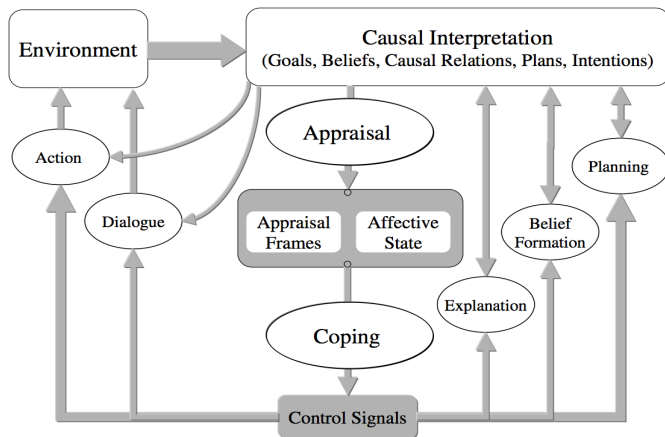


Fig. 2. Our computational instantiation of the cognitive-motivational-emotive system.

# Revised Appraisal model

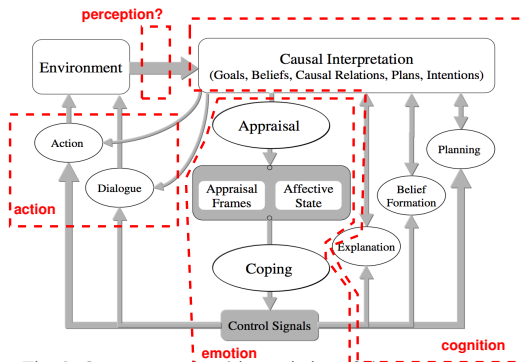
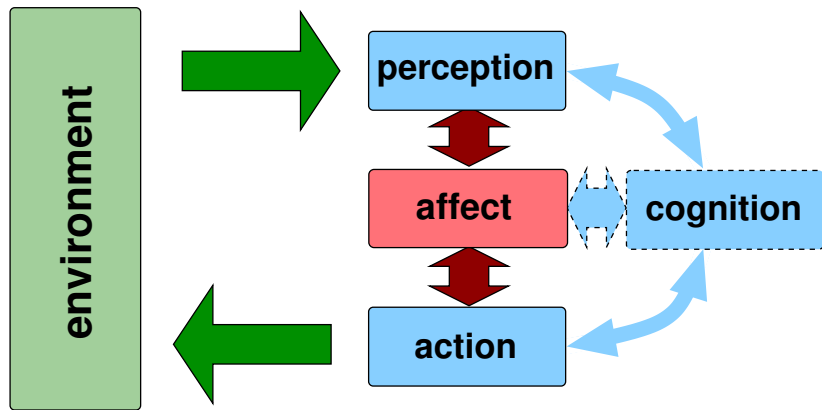


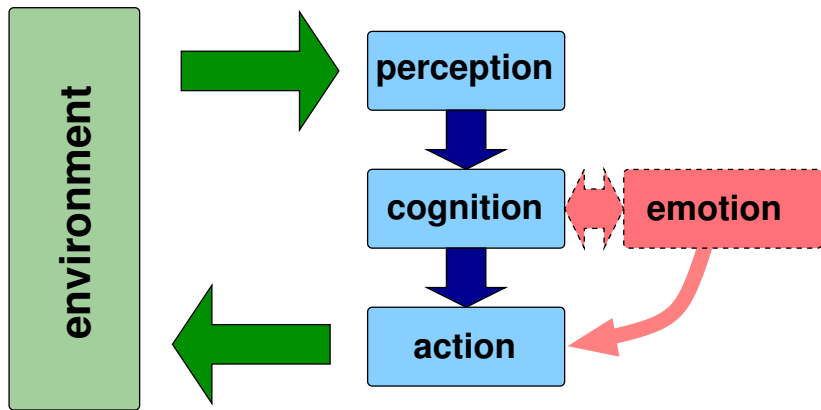
Fig. 2. Our computational instantiation of the cognitive-motivational-emotive system.

Now, note that there is pathway that is **not appraised**





Original Appraisal Theory



Revised Appraisal Theory

## Key difference

*“...this configuration of beliefs, desires, plans, and intentions represents the agent’s current view of the agent-environment relationship, an interpretation that may subsequently change with further observation or inference.”* (from p.278)

Consider a group of 10 of your friends

- how many complete sets of **beliefs, desires, plans and intentions** do you need for your ten friends?
- but you also need a set of beliefs, desires, plans and intentions for their **relationship** with you
- These ten friends, they presumably know each other, therefore you need more beliefs, desires, plans and intentions for **all those relations**
- these computational appraisal theories claim that all this must occur **prior** to emotion being felt or action being considered.
- as we have seen, this is contrary to much evidence about human brain function

EMA is a compromise between

- pragmatic constraints of building a general-purpose agent
- theoretical requirements of emotions models

Implementation:

- evolving current state of world
- actions have duration and can fail
- Soar cognitive architecture (Newell 1990)
- STRIPS representation of actions

Operation:

1. construct and maintain causal interpretation: beliefs, desires, plans, intentions
2. compute appraisal frames based on causal interpretation
3. map appraisal frames to emotions
4. aggregate emotions
5. adopt coping strategy based on aggregate emotional state

- degree of belief: subjective Bayesian view
- preferences = utilities (arbitrarily chosen?)
- intentions: “intend-to” and “intend-that”
- intention  $\neq$  utility: an agent can intend to do something that it does not desire.
- this can be due to lack of information, commitments, resource bounds, etc.
- *Cognitive operators* (100ms scale)
  - ▶ planning: add a planstep, add an intention,...
  - ▶ dialogue: input/output speech, update speech state
  - ▶ execution and monitoring: initiate action, monitor effect
- Perspectives: of self and other agents
  - ▶ for preferences only

# Appraisal Variables

- **Relevance:** significance of an event = magnitude of utility
  - ▶ if  $|utility| > 1.0$
- **Desirability:** valence of an event
  - ▶ if  $utility > 0.0$
- **Likelihood:** certainty of an event
  - ▶ probability  $> 0.5$  gives binary likely/unlikely
- **Causal attribution:** who did it and was it good/bad = credit/blame
  - ▶ you did it and it was *good* for me → praise
  - ▶ you did it and it was *bad* for me → blame
- **Controllability:** can the agent change things?
  - ▶ maximum of likelihood of change over all actions
- **Changeability:** will things change on their own?

# Appraisal Variables and Emotions

Desire	Likely	Attribution	Emotion	Intensity
$> 0$	$< 1.0$		Hope	Desirability*Likelihood
$> 0$	$= 1.0$		Joy	Desirability*Likelihood
$< 0$	$< 1.0$		Fear	Desirability*Likelihood
$< 0$	$= 1.0$		Distress	Desirability*Likelihood
$< 0$		blame	Anger	Desirability*Likelihood
$< 0$ (other)		blame	Guilt	Desirability*Likelihood

- Emotions are brought into **focus** by cognitive interpretation
  - ▶ any cognitive operator  $\rightarrow$  appraisal frame in focus
  - ▶ like **spreading activation** in ACT-R : working memory
  - ▶ Coping can make use of this by ensuring certain operators are not used (e.g. by changing location/setting)
- Mood (per emotion type) is an **aggregate** (sigmoid-squashed sum) of all elicitors of each emotion
- Mood aggregate is added back to the emotions to determine which one the agent will “feel” (the strongest one)

$$\text{sigmoid} \left[ \left( \sum_{\text{elicitor} \in \text{causal interp.}} \text{mood}_{\text{emotion}}(\text{elicitor}) \right) + \text{emotion}(\text{cognitive operator}) \right] = \text{emotion strength}$$



*“...the psychological literature defines coping strategies in a somewhat nebulous fashion.”*

- Coping is not just about negative states: e.g. positive action to make needed change
- Coping is cast as the inverse of appraisal
- Bring coping strategies into focus based on current cognitive interpretation and strongest emotional appraisal
- Choose a coping strategy based on coping potential (how likely is it to work)
- Apply multiple strategies sequentially

# Coping Process

1. **identify** a coping opportunity,
  - ▶ intensity of max appraisal  $>$  some “constant”
2. **elaborate** coping situation,
  - ▶ situational factors added
3. propose **alternative** coping strategies,
  - ▶ identify preconditions and effects
4. assess **coping potential** , and
  - ▶ predict **effects** of application
5. **select** a strategy to apply.
  - ▶ multiple strategies applied sequentially in order of preference

# Coping Strategies and Process

- **Planning**: forming intentions and computing plans to achieve desirable states.
- **Positive reinterpretation**: raising utilities
- **Disengagement**: lowering utilities “oh well that wasn’t really so good after all”
- **Acceptance**: drop trying to achieve a state
- **Denial**: change probabilities
- **Shift**: blame

Coping Strategies can **combine** as well, but the combinations must be **consistent**

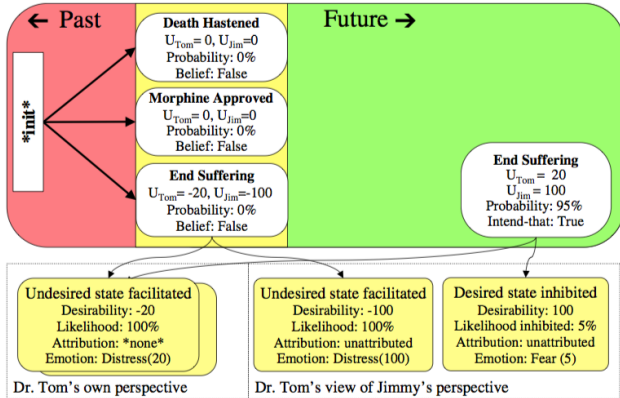
# Coping Process - difficulties

- **Theoretical** underpinnings lacking
- Probabilities/utilities raised/lowered **arbitrarily**
- Coping is an ad-hoc **alternative calculus** for probabilities and utilities based on arbitrarily defined increments and thresholds.
- This alternative calculus **breaks** decision and probability theory,
- Claim to just **break it in small amounts** and so this makes it O.K.

## Running example (Dr. Tom)

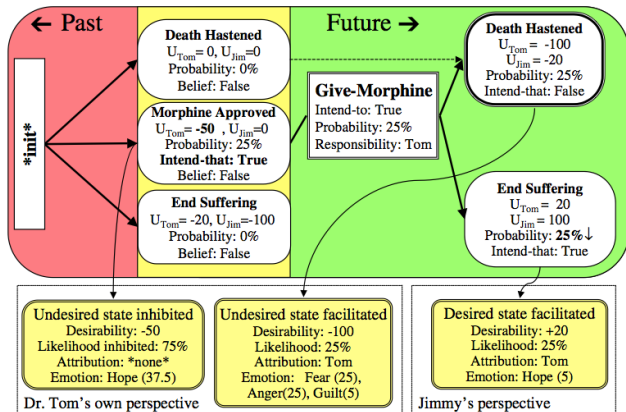
- Dr. Tom, Jimmy (11 year old with cancer in pain), Jimmy's mother
- Morphine can reduce suffering but may hasten death
- Dr. Tom advises Jimmy's mother on morphine
- Jimmy's mother ignores Dr. Tom
- Dr. Tom feels anger
- Dr. Tom copes by denial

# Example: Dr. Tom



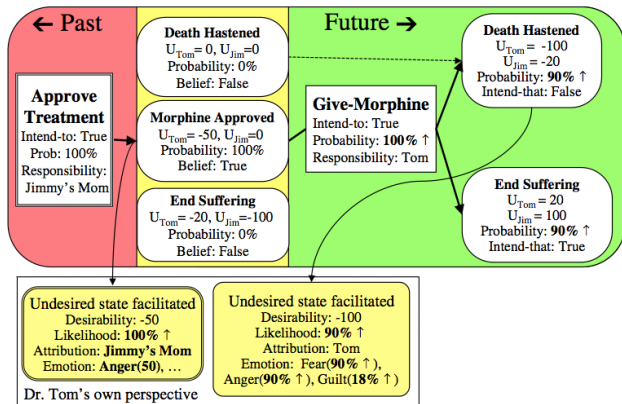
- **initial state** encodes the problem setup
- Dr. Tom's perspective (a virtual agent)
- Mother request to **end suffering** (in future) has no plan so has probability 0% in current state
- **Distress/Fear** causes agent (Tom) to plan

# Example: Dr. Tom



- planned **intention** is to approve morphine - emotion of **hope**
- plan reveals **unintended consequences** (*death hastened, very negative* for doctor)
- coping** is to use **dialogue** with mother

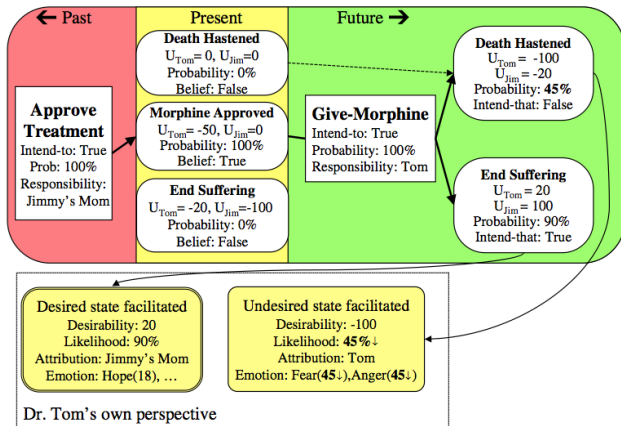
# Example: Dr. Tom



- Mother **approves** treatment (blameworthy)
- death hastened probability goes up
- emotion is **anger** - coping is **denial**



# Example: Dr. Tom



- probability of death hastened **drops through denial**



Fig. 9. A scene from the Mission Rehearsal Exercise.

- Teach soldiers cultural engagement
- emotions are key
- cultural effects not modeled (what “coping” strategies do Iraqis use?)

- Appraisal Theories (II)
  - ▶ Elliott
  - ▶ OCC
  - ▶ Scherer
- Dimensional Theories
- ... Affect Control Theory