Emotional Intelligence in Agents and Interactive Computers

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This character barges into your office when you’re busy. He doesn’t apologize, and doesn’t notice you are annoyed.

He offers you useless advice.
You express more annoyance. He ignores it.

He continues to be unhelpful. The clarity of your emotional expression escalates.

He ignores it.

(this goes on)

Finally you tell him explicitly “Go Away”
He winks, and does a little dance before exiting.
…doesn’t notice you are annoyed.

[Doesn’t recognize your emotion]

You express more annoyance. He ignores it.

[Doesn’t respond appropriately to emotion]

He winks, and does a happy little dance before exiting.

[Not clever about expressing emotion.]
Skills of *Emotional Intelligence*:

- Expressing emotions
- Recognizing emotions
- Handling another’s emotions
- Regulating emotions
- Utilizing emotions

(Salovey and Mayer 90, Goleman 95)
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Emotion is like weather:

Wind velocity, humidity, temperature, barometric pressure, precipitation

Occasionally, a unique combination of these creates a storm, a tornado, a blizzard, or a hurricane.

(adapted from J. Kagan, 1978)
“Emotion recognition”

• Expressions, behaviors
  “Flared nostrils, tightened lips, a quick sharp gesture, skin conductivity=high; probably she is angry”

• Situation, reasoning
  That was an important goal to her and Bob just thwarted it again. She is likely to feel angry toward Bob
Can we teach a chair to recognize behaviors indicative of interest and boredom?  (Mota and Picard)
What can the sensor chair contribute toward inferring the student’s state: *Bored vs. interested*?
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Results (on children not in training data, Mota and Picard, 2003):
9-state Posture Recognition: 89-97% accurate
High Interest, Low interest, Taking a Break: 69-83% accurate
Detecting, tracking, and recognizing facial expressions from video
(IBM BlueEyes camera with MIT algorithms)
Fully automatic computer recognition of six natural facial “action units” (sans calibration or human initialization) (Kapoor and Picard, 2002)
**Fully automatic computer recognition of six natural facial “action units” (sans calibration or human initialization)**
(Kapoor and Picard, 2002)

also: nods, shakes, mouth fidgets
Mouse pressure may change with frustration & stress

(Dennerlein, et al., International Ergonomics Association ’03 links frustration to physical risk factors)
Challenge project:
Automated Learning Companion

The Learning Companion infers and responds to a student’s affective state - “watching especially for signs of frustration and boredom that may precede quitting, for signs of curiosity or interest that tend to indicate active exploration, and for signs of enjoyment and mastery, which might indicate a successful learning experience.”
Future “Learning Companion” agent to sense and respond to affect
14% better than best single mode (Kapoor, Picard, Ivanov ICPR 2004)

Face
Video

Posture
Pressure

Game
Information

Human Coder

Mixture Model & Neural Network

HMM based Classifier

Posture

AU 1

AU 7

Activity

HMM based Classifier

HMM based Classifier

Combine

Game
Status

Game
Level

HMM based Classifier

HMM based Classifier

HMM based Classifier


\[
P(\omega | X) \approx \sum_{\lambda} P(\lambda | X) \sum_{\omega} P(\omega | X, \lambda) P(\omega | \omega, \lambda)
\]

Critics choose the weights of individual modality based on the current input

Noise Model – learnt from the confusion matrices of the training data
Understanding *HOW* something was spoken  
(Fernandez, PhD 2003)

Intonation

Syllables

F0

Tempo

Rhythmicality, ...

Upset Caller

Pauses

Breaths

Extralinguistic Markers
Emotions give rise to changes that can be sensed

<table>
<thead>
<tr>
<th>Distance</th>
<th>Face, voice</th>
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<tbody>
<tr>
<td>Sensing:</td>
<td>Posture</td>
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<tr>
<td></td>
<td>Gestures, movement, behavior</td>
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<tr>
<th>Up-close</th>
<th>Pupillary Dilation</th>
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<tbody>
<tr>
<td>Sensing:</td>
<td>Skin conductivity</td>
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<td>ECG, EEG, Blood pressure</td>
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<th>Hormones</th>
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<td>Sensing:</td>
<td>Neurotransmitters</td>
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Simultaneously examine physiology and behavior for recognizing level of stress: up to 96% accurate, across 12 drivers. (Healey and Picard, IEEE Trans on Intell Transp Sys, to appear)
Driver Stress Demo

Research joint w/Jen Healey and Yuan Qi, incorporating new spectral estimation technique for assessing changes similar to heart rate variability, influenced by cognitive and emotional load
Stress is evident for this person when:
- driving through city
- turning around at toll booth
- hearing siren

New algorithm: analysis of heart-rate variability via real-time spectrum estimation with missing and irregularly sampled data (Qi and Picard, ICASSP 2001)
Voice (in car) that responds to affect of driver improves performance

<table>
<thead>
<tr>
<th>Driver Affect/ Car Voice</th>
<th>Happy/ Enthused</th>
<th>Happy/ Subdued</th>
<th>Upset/ Enthused</th>
<th>Upset/ Subdued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of accidents</td>
<td>2</td>
<td>8.3</td>
<td>9.6</td>
<td>6.3</td>
</tr>
<tr>
<td>Minutes driver spoke</td>
<td>5.8</td>
<td>4.2</td>
<td>3.9</td>
<td>4.7</td>
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</tbody>
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Skills of *Emotional Intelligence*:

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*(Salovey and Mayer 90, Goleman 95)*
“Badday.mpg”
Human – computer interaction is affective

- Four out of five have seen colleagues hurling abuse at their PCs
- Three quarters admit that they swear at their computers.

(Mori survey in UK, 1250 users)
Goal:
Help relieve user frustration

Strategy:
1. Recognize situation as frustrating
2. Is user willing to talk? If so:
   - Practice active listening, with empathy and sympathy
     “Sorry to hear your experience wasn’t better”
     “This computer apologizes to you for …”
   - Allow for repair…

Evaluation:
Build it. Test this “AFFECT-SUPPORT” with 70 subjects against two control conditions: IGNORE and VENT.
How frustrated do you think you got playing the game, all things considered?

- 10 (The most frustrated I have ever felt in my life while playing a game)
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1
- 0 (Absolutely not frustrated at all)
Wow, it sounds like you felt really frustrated playing this game.

Is that about right?
That must feel lousy. It is no fun trying to play a simple game, only to have the whole experience derailed by something out of your control.

This computer apologizes to you for its part in giving you a crummy experience.
Results: responding to user emotion

Subjects receiving AFFECT-SUPPORT showed a significant *behavioral* effect of reduced frustration compared with both the IGNORE and VENT control groups \((p< 0.01)\)

Holds across age, gender, arousability

*(Klein, Moon, Picard, IWC 2002)*
Need: Long-term handling of social-emotional interaction

Idea: **Relational Agent**, a software character that deliberately tries to build a *long-term social-emotional* relationship with you

Experiment: Build a Relational Agent that people interact with ~daily for a month; compare it to “non-relational” agent that otherwise looks and acts the same. (Bickmore & Picard, ToCHI to appear)
Relational Skills include:

- Sensitivity to your affective state
  - Empathy and understanding
- Remembering previous interactions
  - What you liked/disliked, etc.
- Immediacy behaviors
  - Knowing when to move close/away
Significant effects of Relational skills in agent:

- "Laura and I respect each other." (p<.001)
- "Laura and I trust one another." (p<.001)
- "I feel Laura cares about me..." (p<.001)
- "I feel Laura appreciates me." (p=.009)
- "I believe Laura likes me." (p<.001)
- Liking of Laura. (p=.007)
- Desire to continue working with Laura. (p=.001)

Differences held both after 7 days and after 27 days
Empathetic responses
Successful handling of emotion

Klein
“Impacts and ethical implications?”

People interacting with agents vs. with control increased physical activity

Relational agent also increased bonding, sense of “caring”, liking, trust, and desire to keep using
Empathetic responses may facilitate greater use of cognitive resources

- Wentzel et al. “Perceived Caring”
- Riskind “Stoop to Conquer”
- Jonsson & Nass
Concerns (besides privacy)

- Deception, machines that “feel/care”
- People prefer machines to people
- Manipulation vs. support of feelings
- Computational prozac
- Wind out of sails
- Baudrillard, of Lascaux cave paintings:
  “The duplication is sufficient to render both artificial”
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Papers and projects/details:

http://affect.media.mit.edu