Towards Context Aware Emotional Intelligence in Machines:

Computing Contextual Appropriateness of Emotions

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Presentation Outline

I. Introduction
II. Emotional Intelligence
III. System features – main assumptions
IV. Emotion detector
V. Contextual Appropriateness of Emotions
VI. Emotion verifier
VII. Verifying procedure
VIII. Evaluation Experiment
IX. Results
X. Conclusions & Future Work
Introduction

We are all busy people

Too much work

Annoying coworkers

Over-time

Need someone to talk to

An intelligent agent-companion

A companion available 24/7/365
Introduction

When do we need to talk?

• Upset
• Heart-broken
• Bored
• Happy
• etc.

Emotional

What do we expect?

• Sympathy / Empathy
• Consolation
• Cheer
• Praise
• Counsel
• etc.
Introduction

When do we need to talk?

What do we expect?

We need conversational agents to be emotionally intelligent!
Emotional Intelligence

Intelligence – one or many?


(Theory of multiple intelligences)
There are many kinds of intelligence: logical, linguistic, spatial, musical, kinesthetic, naturalist, intrapersonal and interpersonal...

1990. Peter Salovey & John D. Mayer – Emotional Intelligence

The ability to recognize, monitor one's own and others' emotions, to discriminate among them and to use this information to guide one's thinking and actions.

Emotional Intelligence Framework

I Perception, appraisal, and expression of emotion
• Ability to recognize emotion in one’s physical and psychological states, in other people and objects.
• Ability to discriminate between accurate and inaccurate, appropriate and inappropriate, honest and dishonest, expressions of emotions.
• Ability to express emotions accurately, and to express needs related to them.

II Emotional facilitation of thinking
• Ability to redirect and prioritize one's thinking based on the feelings associated with objects, events, and other people.
• Ability to generate or emulate vivid emotions to facilitate judgments and memories concerning feelings.
• Ability to capitalize on mood swings to take multiple points of view; ability to integrate these mood-induced perspectives.
• Ability to use emotional states to facilitate problem solving and creativity.

III Understanding and analyzing emotional information; employing emotional knowledge
• Ability to understand how different emotions are related.
• Ability to perceive the causes and consequences of emotions.
• Ability to interpret complex emotions, such as emotional blends and contradictory feeling states.
• Ability to understand and predict likely transitions between emotions.

IV Regulation of emotion
• Ability to be open to feelings, both those that are pleasant and those that are unpleasant.
• Ability to monitor and reflect on emotions.
• Ability to engage, prolong, or detach from an emotional state, depending upon its judged informativeness or utility.
• Ability to manage emotion in oneself and others.

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Manage emotion in oneself and others.

Emotion management is the final ability!

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- Ability to **manage emotion in oneself and others.**

It’s time to go one step further!
Emotion management is the final ability!

Appropriateness of Emotions

One of the abilities of intelligence

Ability to determine whether an expression of emotion is appropriate for a certain context and react adequately

Know the present emotional state

Know the emotions appropriate for the context

Intelligent conversational agent
This should be done as a language processing task (affect analysis).

The semantic and pragmatic diversity of emotions is best conveyed in language*.

1. We need to know what the expressed emotions are.

2. We need a list of emotions appropriate for the context.

3. We need a verifying procedure.


Specificities of the Japanese language

Agglutinative language

• Morpheme: the smallest linguistic unit with semantic meaning
• Sentences are formed by joining morphemes together
• Syntax and semantics are closer than in, e.g. English
Emotion Detector

• Usual approach to affect analysis:
  – One database of emotive words*
  – Processing (Matching input using Web mining, word statistics, etc.)
  – Example: “John is a nice person.”
    Emotive expression: “nice” emotion: liking, fondness
    ...but that’s just a declarative sentence.
    In a real conversation:
    “Oh, but John is such a nice person!”

Emotion Detector

• Our approach to affect analysis:
In language there are:

1. Emotive expressions*

“Oh, but John is such a nice person!”
“Oh, but John is such a rude person!”

**) M. Ptaszyński, Moeru gengo - Intānetto kei-jiban no ue no nihongo kaiwa ni okeru kanjōhyōgen no kōzō to kigörontekikinō no bunseki – “2channeru, denshikeijiban o rei toshite –(Boisterous language. Analysis of structures and semiotic functions of emotive expressions in conversation on Japanese Internet bulletin board forum - 2channel -),
UAM, Poznań (2006)
Michal Ptaszynski, Pawel Dybala, Rafal Rzepka and Kenji Araki. Affecting Corpora:Experiments with Automatic Affect Annotation System - A Case Study of the 2channel Forum - , The Conference of the Pacific Association for Computational Linguistics (PACLING-09), September 1-4, 2009, Hokkaido University, Sapporo, Japan
Emotion Detector

Gathered manually (907 items)

- emotems DB
  - exclamatives
    - すげえ sugee (great!)
    - うぉ wooo (whoa!)
  - mimetics (gitaigo)
    - ワクワク wakuwaku (heart pounding)
    - ドキドキ dokidoki (go pit-a-pat)
  - vulgarities
    - ふざける yageru (fu**ing do sth)
    - くそ kuso (shit)
    - 鳴々 baka (stupid)
  - hypocorystics
    - ちゃん chan (name suffix)

- emotive expressions DB
  - nouns
    - 愛情 aijou (love)
    - 安心 anshin (relief)
    - 恐怖 kyofu (fear)
  - verbs
    - 喜ぶ yorokobu (be glad)
    - 悲しむ kanashimu (feel sad)
    - むかつぐ mukatsuku (get angry)
  - phrases / idioms
    - 虫酸が走る mushizu ga hashiru (give one the creeps)
    - 心が解ける kokoro ga tokuru (one’s heart is melting in relief)
    - 歓天喜地 kantenkichi (delight larger than Haven and Earth)
  - adjectives
    - 嬉しい ureshii (happy)
    - 悔しい kuyashii (mortifying)
    - 怖い kowai (scary)

Nakamura’s dictionary (2100 items)

10-type emotion classification:
1. Joy, delight
2. Anger
3. Sorrow, sadness, gloom
4. Fear
5. Shame, shyness, bashfulness
6. Liking, fondness
7. Dislike, detestation
8. Excitement
9. Relief
10. Surprise, amazement
Emotion Detector

コンピュータは面白いですね!
Konpyuuta wa omoshiroi desu ne!
Oh, computers are so interesting!

Found emotems: *ne, !*
(for English: *oh, so-., !*)
Utterance is: emotive
Found emotive expressions: *omoshiroi*
(interesting)
Conveyed emotion types: joy
Contextual Appropriateness of Emotions

- Contextual Appropriateness:
  - Positive vs. negative is not enough
  - Is this particular “positive”/“negative” appropriate for this context?
    - John was in a bad mood during the party last night...
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- John was in a **bad mood** during the party last night because he was given the sack and his girlfriend left. (Negative, but appropriate)
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    • Mary looks **happy**...
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  - Mary looks **happy** because she left John for a richer boyfriend and managed to steal John’s project. (Positive, but inappropriate)
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[Expression of emotion] [causal form] [cause of the emotion]
Japanese tend to express emotions after expressing the cause.

今日は彼女とデートに行って楽しかった！Kyo wa kanojo to deeto ni itte tanoshikatta!
“Today I went on a date with my girlfriend – it was fun!” or
“I had so much fun because I went on a date with my girlfriend today!”

Emotions are often expressed after morphemes of causality

Causality morphemes in Japanese: -kara, -node, -te, -to, -tara (90% of all), -ba, -nara, -noga, -kotoga, -kotowa, -nowa

Emotion Verifier

Assumption:

- On the Internet there are many sentences.
- There are many people with similar experiences.
- People express their emotions for those experiences.
- The most frequent emotions are the most natural and appropriate for the context.
I’m depressed because I was given the sack and my girlfriend left...

“to be given the sack and be left by a girlfriend”
“to be given the sack and be left by”
“to be given the sack”
“to be left by a girlfriend”
Emotion Verifier

I’m depressed because I was given the sack and my girlfriend left...
“because I was given the sack and was left by a girl”
“because I was given the sack”
“if I was given the sack”
“since I was given the sack”
“because I was left by a girl”
“since I was left by a girl”
“If I was....”

causality morphemes in Japanese:
-te, -to, -node, -kara, -tara

Causality forms in English:
If-, because-, since-, -so, -therefore...
I’m depressed because I was given the sack and my girlfriend left:

“because/since/if I was given the sack”: [sadness, surprise]
“because/since/if I was left by a girl”: [sadness, depression, fury…]

List of emotions most natural / appropriate for the context
### Verifying Procedure

<table>
<thead>
<tr>
<th>Konpyuuta wa omoshiroi desu ne!</th>
<th>Oh, computers are so interesting!</th>
</tr>
</thead>
</table>

**ML-Ask:**
- Joy

**Web-mining (list of natural emotions):**
- Joy
- Surprise
- Excitement...

**1. If an emotion type specified by ML-Ask appears on the list, it is appropriate.**
Verifying Procedure

駄洒落がすきなんですね

Dajare ga suki nan desu ne.

Oh, so you like puns, don’t you?

ML-Ask:

• Liking

Web-mining (list of natural emotions):

• Joy
• Surprise
• …

What if they don’t match perfectly?
Verifying Procedure

- **2-dimensional model of affect**

  "All emotions can be described in a space of two-dimensions: valence polarity (positive / negative) and activation (active / passive)."

Nakamura’s emotion types mapped on Russell’s model (all possibilities)


Verifying Procedure

Dajare ga suki nan desu ne.
Oh, so you like puns, don’t you?

<table>
<thead>
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<th>ML-Ask:</th>
<th>Web-mining (list of natural emotions):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Liking</td>
<td>• Joy</td>
</tr>
<tr>
<td></td>
<td>• Surprise</td>
</tr>
<tr>
<td></td>
<td>• …</td>
</tr>
</tbody>
</table>

2. If in the same Russell space then appropriate.
### Verifying Procedure

<table>
<thead>
<tr>
<th>Negative</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appropriate</strong></td>
<td><strong>Inappropriate</strong></td>
</tr>
<tr>
<td>User: I hate him for making a fool of me in front of everyone.</td>
<td>User: I’m so happy I passed the exam!</td>
</tr>
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<td><strong>ML- Ask:</strong> dislike; <strong>Web mining:</strong> anger, dislike</td>
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</tr>
<tr>
<td>Agent: Yeah, you have a reason to be angry.</td>
<td>Agent: Yeah! That’s great!</td>
</tr>
<tr>
<td></td>
<td><strong>[empathy]</strong></td>
</tr>
<tr>
<td>User: I’d be happy if that bastard was hit by a car!</td>
<td>User: I won the Loebner prize, but I feel so bored.</td>
</tr>
<tr>
<td><strong>ML- Ask:</strong> joy; <strong>Web mining:</strong> fear, sadness</td>
<td><strong>ML- Ask:</strong> dislike, depression; <strong>Web mining:</strong> excitement, joy</td>
</tr>
<tr>
<td>Agent: Is that what you really feel?</td>
<td>Agent: You should be happy!</td>
</tr>
<tr>
<td></td>
<td><strong>[counsel]</strong></td>
</tr>
</tbody>
</table>

*Every case can be considered as one of 4 situations*
Verifying Procedure


...Or in 8
Verifying procedure

Emotions that appeared (expressed)

...Or in 100
## Verifying procedure

<table>
<thead>
<tr>
<th>Appropriate <strong>hate</strong></th>
<th>Appropriate <strong>joy</strong></th>
</tr>
</thead>
</table>
| **User:** *I hate him for making a fool of me in front of everyone.*  
**ML-Ask:** dislike;  
**Web mining:** anger, dislike  
**Agent:** *You have a reason to be angry.*  
[empathy] | **User:** *I’m so happy I passed the exam!*  
**ML-Ask:** joy;  
**Web mining:** joy, excitement  
**Agent:** *Yeah! That’s great!*  
[sympathy] |
| **Inappropriate **joy** | **Inappropriate **boredom/dislike** |
| **User:** *I’d be happy if that bastard was hit by a car!*  
**ML-Ask:** joy;  
**Web mining:** fear, sadness  
**Agent:** *Is that what you really feel?*  
[counsel] | **User:** *I feel so bored for winning the prize.*  
**ML-Ask:** dislike, depression;  
**Web mining:** excitement, joy  
**Agent:** *You should be happy!*  
[consolation] |
Evaluation experiment

- 13 user-participants
- 2 conversational agents
  - Modalin: modality¹
  - Pundalin: modality + puns²
- 10-turn conversation
- 26 conversations (6 had no specified emotions)
  -> 20 conversation sets
- affect analysis, verification

Evaluation experiment

• Results of verification procedure – evaluated by a questionnaire

• Questionnaire:
  – Are the emotions positive / negative?
  – What were the emotion types?
  – Were the emotions appropriate for the situation?

• 20 sets / Every set evaluated by 10 people (≠users)

• Overall 200 different evaluations
Results

• Number of people who agreed with the system per case.

• Evaluated items:

A) Emotion valence recognition by ML-Ask
B) Emotion type recognition by ML-Ask
C) Appropriateness verification of emotion types
D) Appropriateness verification of emotion valence
Results

- A perfect “10” is hard, but...

1. If at least 1 person agrees – it’s already a human level (often in affect analysis research)\(^1, 2, 3\)

2. If 4 people out of 10 agree it’s a considerable common-sense

3. For 10 people = 10 points, 0 people = 0 points

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<table>
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<tr>
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<th>Pundalin</th>
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<tbody>
<tr>
<td></td>
<td>10–7 ppl.</td>
<td>6–4 ppl.</td>
<td>3–1 ppl.</td>
<td>0 ppl.</td>
</tr>
<tr>
<td>A</td>
<td>5</td>
<td>3</td>
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<tr>
<td>B</td>
<td>4</td>
<td>5</td>
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<td>0</td>
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<tr>
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Overall results

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<tr>
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<th>Rigorous (10–4 ppl.)</th>
<th>Optimistic (10–1 ppl.)</th>
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<tr>
<td>A</td>
<td>75%</td>
<td>95%</td>
</tr>
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<td>B</td>
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<td>90%</td>
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<td>C</td>
<td>45%</td>
<td>85%</td>
</tr>
<tr>
<td>D</td>
<td>50%</td>
<td>80%</td>
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## Results

### 1. Optimistic (1 person)
- **A)** 95%
- **B)** 90%
- **C)** 85%
- **D)** 80%

### 2. Rigorous (4 people)
- **A)** 75%
- **B)** 75%
- **C)** 45%
- **D)** 50%

### 3. Points
- **A)** 63%
- **B)** 55%
- **C)** 36%
- **D)** 45%

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Conclusions

Presented method uses:

- Affect analysis system to recognize user’s emotions...
- Web mining technique to verify their contextual appropriateness

Computing contextual appropriateness of emotions is a feasible task.
Conclusions

- Agent equipped with our system can determine what communication strategy is the most desirable

- Applications
  - Personal conversational agent (free counselor for stress management, 24h/7/365)
  - Toy-companion for kids (as a part of education & safety application)
Future Work

• Improve ML-Ask
  – Add Contextual Valence Shifters (see ARCOE-09)
  – Enlarge databases
  – Disambiguate emotive type affiliation of emotemes

• Improve Web mining
  – Mine only specified areas (blogs, forums)

• Experiments on different corpora
  – natural conversations, forums, chat-room logs

• Implementation in conversational agent
  – specify the conversational strategies for each case
Future Work

Implement other abilities from the Emotional Intelligence Framework:

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• Ability to manage emotion in oneself and others.
Thank you for your attention!

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## Emotion Verifier

**Diagram:**
- **Input:** phrase extraction → phrase adjusting → querying → emotion association extraction → output

**Table:**
<table>
<thead>
<tr>
<th>Original utterance</th>
<th>Aa, pasokon ga kowarete shimatta... (Oh no, the PC has broken...)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longest n-gram</td>
<td>Aa pasokon ga kowareru te shimau [interjection] noun particle verb verb connector perfect form</td>
</tr>
<tr>
<td>(here: hexagram)</td>
<td></td>
</tr>
<tr>
<td>Pentagram</td>
<td>pasokon ga koware te shimau</td>
</tr>
<tr>
<td>Tetragram</td>
<td>Aa, pasokon ga kowareru</td>
</tr>
<tr>
<td>Trigrams</td>
<td>pasokon ga kowareru koware te shimau</td>
</tr>
</tbody>
</table>
### Emotion verifier

#### Morphemes of causality:
- te, -to, -node, -kara, -tara

#### Table: n-gram phrase adjusting (morpheme modification)

<table>
<thead>
<tr>
<th>n-gram</th>
<th>Original phrase</th>
<th>Adjusted phrases</th>
</tr>
</thead>
<tbody>
<tr>
<td>pasokon ga koware te shima*te</td>
<td>/-te/</td>
<td>pasokon ga koware te shima-te</td>
</tr>
<tr>
<td></td>
<td>/-to/</td>
<td>pasokon ga koware te shima-to</td>
</tr>
<tr>
<td></td>
<td>/-node/</td>
<td>pasokon ga koware te shima*node</td>
</tr>
<tr>
<td></td>
<td>/-kara/</td>
<td>pasokon ga koware te shima*kara</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

#### Diagram:
- Input phrase extraction
- Phrase adjusting
- Phrase querying
- Emotion association extraction
- Output
Take only 50% of results

Emotion verifier

Emotion verifier

Sentence: An, pasokon ga kowarete shinatta... (Oh no, the PC has broken.)

Extracted emotion type:

Type extracted / all extracted types: 21/133

Ratio: 0.1576923076923077