

# EmotionML Implementation Report: Web-based EMO20Q Dialog Agent

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## Summary

Emotion twenty questions (EMO20Q) is an experimental framework for studying how people describe emotions in language and how computers can simulate this type of verbal behavior. In EMO20Q, the familiar spoken parlor game of twenty questions is restricted to words that players feel refers to emotions.

In this implementation report, we examine the case where a server-side computer agent plays the role of the questioner and a human plays the answerer via a web browser.

The EMO20Q questioner agent can be decomposed into several components, notably a **vocabulary**, **semantic knowledge**, an **episodic buffer**, and a **belief state**. The vocabulary is a list of 110 emotion words and this vocabulary is expected to grow over time as more data is collected, but remains constant during the agent's instantiation. Semantic knowledge is a large object that remains the same across different agent instantiations and states, while the episodic buffer and belief state are smaller objects that vary over time for each interactive session. Because of the size of the semantic knowledge object, serialization of the agent for each session is not possible. Rather, the episodic buffer and belief states are serialized while the semantic knowledge persists as a static object in the server memory. The belief state is represented as a probability vector indexed by items of the vocabulary.

EmotionML is used to implement the questioner agent's vocabulary and belief state. The agent's vocabulary is implemented using the EmotionML `vocabulary` idiom and the agent's belief state is represented using the `emotion` idiom with a `category` as a child and the `value` attribute to hold numerical probability values.

## EmotionML Test Assertions

**note:** NI stands for Not Implemented

### Document Structure

**100 : All EmotionML documents must validate against the XML schema.**

pass (provided single word emotion names)

**101 : The root element of standalone EmotionML documents MUST be <emotionml>**

pass

**102 : The <emotionml> element MUST define the EmotionML namespace:  
"<http://www.w3.org/2009/10/emotionml>".**

pass

**103 : The <emotionml> element MAY contain one or more <emotion> elements.**

pass

**104 : The <emotionml> element MAY contain one or more <vocabulary> elements.**

pass

**105 : The <emotionml> element MAY contain a single <info> element.**

NI

**110 : The root element of a standalone EmotionML document MUST have an attribute "version".**

pass

- 111 : *The "version" attribute of <emotionml> MUST have the value "1.0"*  
pass
- 112 : *The <emotionml> element MAY contain an attribute "category-set".*  
pass
- 113 : *The "category-set" attribute of <emotionml>, if present, MUST be of type xsd:anyURI.*  
pass
- 114 : *SUB CONSTRAINT: The "category-set" attribute of <emotionml>, if present, MUST refer to the ID of a <vocabulary> element with type="category".*  
pass
- 115 : *The <emotionml> element MAY contain an attribute "dimension-set".*  
NI
- 116 : *The "dimension-set" attribute of <emotionml>, if present, MUST be of type xsd:anyURI.*  
NI
- 117 : *SUB CONSTRAINT: The "dimension-set" attribute of <emotionml>, if present, MUST refer to the ID of a <vocabulary> element with type="dimension".*  
NI
- 118 : *The <emotionml> element MAY contain an attribute "appraisal-set".*  
NI
- 119 : *The "appraisal-set" attribute of <emotionml>, if present, MUST be of type xsd:anyURI.*  
NI
- 120 : *SUB CONSTRAINT: The "appraisal-set" attribute of <emotionml>, if present, MUST refer to the ID of a <vocabulary> element with type="appraisal".*  
NI
- 121 : *The <emotionml> element MAY contain an attribute "action-tendency-set".*  
NI
- 122 : *The "action-tendency-set" attribute of <emotionml>, if present, MUST be of type xsd:anyURI.*  
NI
- 123 : *SUB CONSTRAINT: The "action-tendency-set" attribute of <emotionml>, if present, MUST refer to the ID of a <vocabulary> element with type="action-tendency".*  
NI
- 124 : *The <emotionml> element MAY contain arbitrary plain text.*  
NI
- 150 : *The <emotion> element MAY contain one or more <category> elements.*  
pass
- 151 : *The <emotion> element MAY contain one or more <dimension> elements.*  
NI
- 152 : *The <emotion> element MAY contain one or more <appraisal> elements.*  
NI
- 153 : *The <emotion> element MAY contain one or more <action-tendency> elements.*  
NI
- 154 : *The <emotion> element MAY contain one or more <reference> elements.*  
NI
- 155 : *The <emotion> element MAY contain a single <info> element.*  
NI

**156 : The <emotion> element MUST contain at least one <category> or <dimension> or <appraisal> or <action-tendency> element.**

pass

**157 : The allowed child elements of <emotion> MAY occur in any order.**

pass

**158 : The allowed child elements of <emotion> MAY occur in any combination.**

pass

**159 : The <emotion> element MAY contain an attribute "category-set".**

NI

**160 : The "category-set" attribute of <emotion>, if present, MUST be of type xsd:anyURI.**

pass

**161 : SUB CONSTRAINT: The "category-set" attribute of <emotion>, if present, MUST refer to the ID of a <vocabulary> element with type="category".**

pass

**162 : The <emotion> element MAY contain an attribute "dimension-set".**

NI

**163 : The "dimension-set" attribute of <emotion>, if present, MUST be of type xsd:anyURI.**

NI

**164 : SUB CONSTRAINT: The "dimension-set" attribute of <emotion>, if present, MUST refer to the ID of a <vocabulary> element with type="dimension".**

NI

**165 : The <emotion> element MAY contain an attribute "appraisal-set".**

NI

**166 : The "appraisal-set" attribute of <emotion>, if present, MUST be of type xsd:anyURI.**

NI

**167 : SUB CONSTRAINT: The "appraisal-set" attribute of <emotion>, if present, MUST refer to the ID of a <vocabulary> element with type="appraisal".**

NI

**168 : The <emotion> element MAY contain an attribute "action-tendency-set".**

NI

**169 : The "action-tendency-set" attribute of <emotion>, if present, MUST be of type xsd:anyURI.**

NI

**170 : SUB CONSTRAINT: The "action-tendency-set" attribute of <emotion>, if present, MUST refer to the ID of a <vocabulary> element with type="action-tendency".**

NI

**171 : The <emotion> element MAY have an attribute "version".**

pass

**172 : The "version" attribute of <emotion>, if present, MUST have the value "1.0".**

pass

**173 : The <emotion> element MAY contain an attribute "id".**

NI

**174 : The "id" attribute of <emotion>, if present, MUST be of type xsd:ID.**

NI

**175 : The <emotion> element MAY have an attribute "start".**

NI

176 : *The <emotion> element MAY have an attribute "end".*

NI

177 : *The <emotion> element MAY have an attribute "duration".*

NI

178 : *The <emotion> element MAY have an attribute "time-ref-uri".*

NI

179 : *The <emotion> element MAY have an attribute "time-ref-anchor-point".*

NI

180 : *The <emotion> element MAY have an attribute "offset-to-start".*

NI

181 : *The <emotion> element MAY have an attribute "expressed-through".*

NI

182 : *The <emotion> element MAY contain arbitrary plain text.*

NI

## Representations of emotions and related states

210 : *If the <category> element is used, a category vocabulary MUST be declared using a "category-set" attribute on either the enclosing <emotion> element or the root element <emotionml>.*

pass

211 : *A category element MUST contain a "name" attribute.*

pass

212 : **SUB CONSTRAINT:** *The value of the "name" attribute of the <category> element MUST be contained in the declared category vocabulary. If both the <emotionml> and the <emotion> element has a "category-set" attribute, then the <emotion> element's attribute defines the declared category vocabulary.*

pass

213 : *For any given category name in the set, zero or one occurrence is allowed within an <emotion> element, i.e. a category with name "x" MUST NOT appear twice in one <emotion> element.*

pass

214 : *A <category> MAY contain a "value" attribute.*

pass

215 : *A <category> MAY contain a <trace> element.*

NI

216 : *A <category> MUST NOT contain both a "value" attribute and a <trace> element.*

pass

217 : *A <category> element MAY contain a "confidence" attribute.*

NI

220 : *If the <dimension> element is used, a dimension vocabulary MUST be declared using a "dimension-set" attribute on either the enclosing <emotion> element or the root element <emotionml>.*

NI

221 : *A <dimension> element MUST contain a "name" attribute.*

NI

**222 : CONSTRAINT:** The value of the "name" attribute of the <dimension> element **MUST** be contained in the declared dimension vocabulary. If both the <emotionml> and the <emotion> element has a "dimension-set" attribute, then the <emotion> element's attribute defines the declared dimension vocabulary.

NI

**223 :** For any given dimension name in the set, zero or one occurrence is allowed within an <emotion> element i.e. a dimension with name "x" **MUST NOT** appear twice in one <emotion> element.

NI

**224 :** A <dimension> **MUST** contain either a "value" attribute or a <trace> element.

NI

**225 :** A <dimension> element **MAY** contain a "confidence" attribute.

NI

**230 :** If the <appraisal> element is used, an appraisal vocabulary **MUST** be declared using an "appraisal-set" attribute on either the enclosing <emotion> element or the root element <emotionml>.

NI

**231 :** An <appraisal> element **MUST** contain the "name" attribute.

NI

**232 : SUB CONSTRAINT:** The value of the "name" attribute of the <appraisal> element **MUST** be contained in the declared appraisal vocabulary. If both the <emotionml> and the <emotion> element has an "appraisal-set" attribute, then the <emotion> element's attribute defines the declared appraisal vocabulary.

NI

**233 :** For any given appraisal name in the set, zero or one occurrence is allowed within an <emotion> element, i.e. an appraisal with name "x" **MUST NOT** appear twice in one <emotion> element.

NI

**234 :** An <appraisal> element **MAY** contain a "value" attribute.

NI

**235 :** An <appraisal> element **MAY** contain a <trace> element.

NI

**236 :** An <appraisal> element **MUST NOT** contain both a "value" attribute and a <trace> element.

NI

**237 :** An <appraisal> element **MAY** contain a "confidence" attribute.

NI

**240 :** If the <action-tendency> element is used, an action tendency vocabulary **MUST** be declared using an "action-tendency-set" attribute on either the enclosing <emotion> element or the root element <emotionml>.

NI

**241 :** An <action-tendency> element **MUST** contain the "name" attribute.

NI

**242 : SUB CONSTRAINT:** The value of the "name" attribute of the <action-tendency> element **MUST** be contained in the declared action tendency vocabulary. If both the <emotionml> and the <emotion> element has an "action-tendency-set" attribute, then the <emotion> element's attribute defines the declared action tendency vocabulary.

NI

243 : For any given action tendency name in the set, zero or one occurrence is allowed within an <emotion> element, i.e. an action tendency with name "x" MUST NOT appear twice in one <emotion> element.

NI

244 : An <action-tendency> element MAY contain a "value" attribute.

NI

245 : An <action-tendency> element MAY contain a <trace> element.

NI

246 : An <action-tendency> element MUST NOT contain both a "value" attribute and a <trace> element.

NI

247 : An <action-tendency> element MAY contain a "confidence" attribute.

NI

## Meta-information

300 : The value of the "confidence" attribute MUST be a floating point number in the closed interval [0, 1].

NI

301 : The attribute "expressed-through" of the <emotion> element, if present, MUST be of type xsd:nmtokens.

NI

302 : The <info> element MAY contain any elements with a namespace different from the EmotionML namespace, "<http://www.w3.org/2009/10/emotionml>".

NI

303 : The <info> element MAY contain arbitrary plain text.

NI

304 : The <info> element MUST NOT contain any elements in the EmotionML namespace, "<http://www.w3.org/2009/10/emotionml>".

NI

305 : The <info> element MAY contain an attribute "id".

NI

306 : The "id" attribute of the <info> element, if present, MUST be of type xsd:ID.

NI

## References and time

410 : The <reference> element MUST contain a "uri" attribute.

NI

411 : The "uri" attribute of <reference> MUST be of type xsd:anyURI.

NI

412 : SUB CONSTRAINT: The URI in the "uri" attribute of a <reference> element MAY be extended by a media fragment.

NI

413 : The <reference> element MAY contain a "role" attribute.

NI

414 : The value of the "role" attribute of the <reference> element, if present, MUST be one of "expressedBy", "experiencedBy", "triggeredBy", "targetedAt".

NI

**415 : The <reference> element MAY contain a "media-type" attribute.**

NI

**416 : The value of the "media-type" attribute of the <reference> element, if present, MUST be of type xsd:string.**

NI

**417 : SUB CONSTRAINT: The value of the "media-type" attribute of the <reference> element, if present, MUST be a valid MIME type.**

NI

**420 : The value of the "start" attribute of <emotion>, if present, MUST be of type xsd:nonNegativeInteger.**

NI

**421 : The value of the "end" attribute of <emotion>, if present, MUST be of type xsd:nonNegativeInteger.**

NI

**422 : The value of "duration" attribute of <emotion>, if present, MUST be of type xsd:nonNegativeInteger.**

NI

**423 : The value of the "time-ref-uri" attribute of <emotion>, if present, MUST be of type xsd:anyURI.**

NI

**424 : The value of the "time-ref-anchor-point" attribute of <emotion>, if present, MUST be either "start" or "end".**

NI

**425 : The value of the "offset-to-start" attribute of <emotion>, if present, MUST be of type xsd:integer.**

NI

## Scale values

**500 : The value of a "value" attribute, if present, MUST be a floating point value from the closed interval [0, 1].**

pass

**501 : The <trace> element MUST have a "freq" attribute.**

NI

**502 : The value of the "freq" attribute of <trace> MUST be a positive floating point number followed by optional whitespace followed by "Hz".**

NI

**503 : The <trace> element MUST have a "samples" attribute.**

NI

**504 : The value of the "samples" attribute of <trace> MUST be a space-separated list of floating point values from the closed interval [0, 1].**

NI

## Defining vocabularies for representing emotions

**600 : A <vocabulary> element MUST contain one or more <item> elements.**

pass

601 : A `<vocabulary>` element *MAY* contain a single `<info>` element.

NI

602 : A `<vocabulary>` element *MUST* contain a "type" attribute.

pass

603 : The value of the "type" attribute of the `<vocabulary>` element *MUST* be one of "category", "dimension", "action-tendency" or "appraisal".

pass

604 : A `<vocabulary>` element *MUST* contain an "id" attribute

pass

605 : The value of the "id" attribute of the `<vocabulary>` element *MUST* be of type `xsd:ID`.

pass

606 : An `<item>` element *MAY* contain a single `<info>` element.

NI

607 : An `<item>` element *MUST* contain a "name" attribute.

pass

608 : An `<item>` *MUST NOT* have the same name as any other `<item>` within the same `<vocabulary>`.

pass

## Conformance

700 : All EmotionML elements *MUST* use the EmotionML namespace, "<http://www.w3.org/2009/10/emotionml>".

pass

## Issues

- The the size of the vocabulary we use is larger than most state-of-the-art approaches to affective computing. Nevertheless, the `vocabulary` idiom of EmotionML is adequate to enable our atypical approach. Calling an item of such a large vocabulary a "category" is slightly misleading, but another word that is more appropriate does not come to mind.
- Multi-word vocabulary items, like "let down" are not valid according to `xs:NMTOKEN`
- The producer and consumer of EmotionML in this application is the same program. The use of EmotionML is to persist dyanmic components of the EMO20Q questioner agent's state across HTTP requests. Since the producer and consumer are the same program, a simple serialization of the agent's components would suffice. However, the standardized format will be more useful in planned future developments that will require more heterogeneous system components: logging dialog information, visualization, and the case where the agent is a javascript object communicating via AJAX.