

**REPRESENTING EMOTIONS IN TERMS OF OBJECT
DIRECTEDNESS**

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Representing Emotions in Terms of Object Directedness

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Abstract

A logical formalization of emotions is considered to be tricky because they appear to have no strict types, reasons, and consequences. On the other hand, such a formalization is crucial for commonsense reasoning. Here, the so-called “object directedness” of emotions is studied by using Helen Nissenbaum’s influential ideas.

1 Introduction

“What are emotions, anyway, and what are all the other things we label moods, feelings, passions, needs, or sensibilities? We find it hard to agree on the meanings of words like these, presumably because few of them actually correspond to clearly distinct mental processes.” These words of Marvin Minsky (Minsky 1985: 172), it seems to us, give a particular picture of the essence of human emotions. Most theories acknowledge that an emotion is not a simple phenomenon, viz., it cannot be captured completely by having a person describe his emotional experience (Davitz 1985; Izard 1977). A satisfactory definition should probably include (this is not a complete list):

- the experience or conscious feeling of emotion,
- the processes that occur in the brain and the nervous system, and
- the observable expressive patterns of emotion, e.g., those on the face (Wierzbicka 1993).

We should note, on the other hand, that a practical framework to represent and use commonsense knowledge (e.g., the Cyc project (Lenat et al. 1986; Lenat and Guha 1989; Lenat et al. 1990)) would need a formal theory of emotions at a certain stage. (Caveat: According to John McCarthy—one of the founding fathers of Artificial Intelligence—the preceding assumption is somewhat suspect. In a paper written in 1983, McCarthy observes (Lifschitz 1990: 180):

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“Present machines have almost no emotional qualities, and, in my opinion, it would be a bad idea to give them any. We have enough trouble figuring out our duties to our fellow humans and to animals without creating a bunch of robots with qualities that would allow anyone to feel sorry for them or would allow them to feel sorry for themselves.”

With all due respect, we disagree with McCarthy.)

Here we study the so-called “object directedness” of emotions by applying the influential ideas of Nissenbaum (Nissenbaum 1985). According to Nissenbaum, emotions can be defined as relations between their subjects and other objects in the world. This brings about the concept of object directedness. Our study can be seen as a first attempt at formalizing object directedness in a logical framework. (Although it owes its existence to other considerations, Hayes’ classical study of liquids (Hayes 1985) has provided us with essential methodological inspiration in this regard.)

2 Object Directedness

An essential assumption of this paper is that most emotions are directed:

1. Mary loves Harry.
2. Frank loathes his neighbor.
3. Jane fears a nuclear war.
4. Sue envies her younger sister.

In (1) Harry is the object of Mary’s love. In (2) it is his neighbor that Frank loathes. In (3) nuclear war is the object of Jane’s fear. Finally, in (4) her younger sister is the object of Sue’s envy.

Let us say that an emotion is object directed if it is related to an item in the world in a certain way. According to this outlook, we can distinguish between two possibilities:

- An emotion has an object if there is an item in the world that is related in a certain way to the subject’s having an emotion:

$$em(p) \Rightarrow \exists r \exists q. has(r, p) \wedge obj(p, q)$$

$$em(p) \wedge has(r, p) \Rightarrow subj(r)$$

In the above axioms (cf. Appendix for a legend summarizing the semantics of our predicates), if p is an emotion, then r —the subject of this emotion—has p and also there is an object q to which p is directed. (For example, if p is substituted by love, r is substituted by Mary, and q is substituted by Harry, then we would reach (1) above.) The subject domain contains the human beings. The object domain is more complex because it contains not only human beings but also events, behaviors, imagined things, etc. Therefore, to circumscribe this domain does not look like an easy job. A tentative classification of objects may include individuals (animate and inanimate), properties, events, states of affairs, and relations. Usually, the object of an emotion is considered to be its cause:

$$em(p) \wedge has(r, p) \wedge obj(p, q) \Rightarrow cause(p, r) = q$$

- We might require that the subject and the object be related in an appropriate way in order that the object is considered as the “object” of subject’s emotion. (That is, (1) above shows a relation between Mary and Harry.) That is,

$$em(p) \Rightarrow \exists r \exists q. p(r, q) \wedge subj(r) \wedge obj(p, q)$$

In this formula, p is used in two forms—first as an argument of em , the emotion predicate, and second as a relation name.

Directed emotions are special cases of directed mental states. Directedness is basically oriented toward a feature of the emotional state or experience, not toward an independently existing concrete relatum. In this case, p is the mental emotional state and q is the intensional object. Intensional objects may be imagined, judged, accepted, and rejected objects. Again the same formulas are valid but the domain of the objects changes. Below, the domain of q is the set of intensional objects:

$$intobj(q) \Rightarrow imagined(q) \vee judged(q) \vee accepted(q) \vee rejected(q)$$

An intensional state is one that is directed toward an intensional object. Objects may be propositional or future-oriented:

$$em(p) \wedge equal(p, s) \Rightarrow in(r, s) \wedge menst(s)$$

The disadvantage of this is the introduction of the new concept of intensional objects. These may be mental entities or abstract objects:

$$in(r, s) \wedge menst(s) \Rightarrow \exists q. intobj(q)$$

Linguistic conditions connect the object directedness of emotions to certain structural features of the sentences that describe emotions. For example, instances of several types of emotions are described with sentences in which the emotion is designated by a transitive verb, followed by a grammatical object expression. Hence an emotion sentence is of the form

$$subject + verb + object$$

The emotion verb may contain propositional attitudes such as angry with, worried about, happy for, etc. Accordingly,

$$emsent(e) \wedge em(p) \wedge subj(r) \wedge obj(p, q) \Rightarrow contains(e, parts)$$

where $parts$ satisfies the condition

$$div(parts) \equiv subject(parts) = r \wedge verb(parts) = p \wedge object(parts) = q$$

Objects have an explanatory role with respect to emotion. Take the sentence “Hannah is angry because she was not invited to the party.” To explain Hannah’s anger, the fact that she was not invited to the party is cited. This restricts object directedness, i.e., in citing whatever it is that one identifies to be the object of a directed emotion, one explains the emotion.

Still, while an event’s cause is relevant to explaining the event, the cause does not have to be the object of the emotion always. For example, one may feel happy because of sniffing

cocaine, but this substance is not the object of the emotion. That is, the converse of the formula given in the first condition with *cause* is not always valid (\oplus denotes “exclusive-or”):

$$em(p) \wedge has(r, p) \wedge cause(p, r) = q \Rightarrow obj(p, q) \oplus \exists s.obj(p, s)$$

According to a well-known distinction of Hume (Nissenbaum 1985), the object of the emotion may be “self.” For example, regarding pride or humility, the object of the emotion may be the subject itself, e.g., “Alan is proud of himself.” Here Alan is both the subject and the object.

$$\exists p.em(p) \Rightarrow \exists q.obj(p, q) \wedge has(q, p)$$

According to Kenny (Nissenbaum 1985), emotions are universally object directed. “Universally” here corresponds to all emotions:

$$\forall p.em(p) \Rightarrow \exists q.obj(p, q)$$

Objects may be the cause of the emotion, if they are not future-oriented. While explaining the first condition, we have given the rule about the cause. Now, if this is modified according to Kenny’s view, then we get

$$em(p) \wedge has(r, p) \wedge obj(p, q) \wedge \neg futer(q) \Rightarrow cause(p, r) = q$$

3 Facets of Object Directedness

It will be helpful to individuate a situation or a set of circumstances in which there is an individual having an emotion. This is called an “emotion episode”:

$$emepi(h, p) \Rightarrow \exists q \exists r.em(p) \wedge has(r, p) \wedge obj(p, q)$$

A situation should have a beginning and an end in terms of time and space. It is assumed that the situation includes all the factors relevant to the emotion. This set of factors even includes an event in the subject’s distant past, a character trait of the subject, the subject’s cognitive state, or another individual. Thus, an emotion episode might include factors from several categories that bear on the emotion in a variety of ways. One of the most important and basic factors is spatiotemporal locations. An episode can be defined as a proper temporal part of a “history”. A history differs from a situation since it is restricted spatially and extended temporally:

$$emepi(h, p) \Rightarrow beg(p) < beg(h) \wedge end(p) > end(h) \wedge \forall t.h@t = p@t$$

Here, h is a history and t is a time instant. $h@t$ denotes the “slice” of h at t . This is a state—a spatial entity at a particular time.

Emotion episodes may include a special type of relation between the person having the emotion and the item in the world. An item has been defined previously: it can be a person, a group of people, an inanimate item, an event, or a state of affairs. All of these may be called the “concrete items” of the commonsense world. Items are components of emotion episodes. An emotion and an item are related as a result of the item’s being the emotion’s “focus.”

If $item(q)$ is one of the concrete items of the commonsense world, then it is seen that

$$em(p) \Rightarrow \exists q.focus(p) = q \wedge item(q)$$

$$item(q) \Rightarrow ind(q) \oplus event(q) \oplus group(q) \oplus inanimate(q) \oplus affair(q)$$

For example, the focus of love, hate, anger, and envy is usually an individual. Therefore, we can say that

$$focus(love) = q \wedge ind(q)$$

$$focus(hate) = q \wedge (ind(q) \vee group(q))$$

In case of regret, shame, and embarrassment, a past action is usually the focus:

$$focus(regret) = q \wedge (event(q) \vee affair(q))$$

In almost all of the emotion types mentioned above, the situation involves an item that is the emotion's focus. Certain types of emotions are more likely to involve relations to another individual. This holds for loving, hating, envying, anger, resenting, despising, loathing, fearing, and adoring. Past actions are the focus of another set of emotions: regret, relief, shame, embarrassment, approval, and remorse. Some other emotions are related to events that are not necessarily actions, e.g., being sad about a disaster or being pleased over a victory.

There is another category of factors comprised of items in the real world that enter into an emotion episode but are not the focus of the emotion episode. These are called "explanatory factors". In other words, the set of circumstances contains these factors that can be cited in addition to the focus of emotion:

$$(em(p) \wedge obj(p, q) \Rightarrow \exists e. expl(p, q) = e) \oplus (em(p) \Rightarrow \exists e. expl(p, \emptyset) = e)$$

From the above definition, we can say that we sometimes use just the emotion and its explanation without using the focus of the emotion. This is not valid according to Kenny (Nissenbaum 1985) but in real life we utter sentences which obey this rule. For instance, if we say "Jill was resentful because she was overlooked for promotion," there is no direct object of the emotion, but there is an explanatory factor. Therefore, we used \emptyset above as the object or the focus of the emotion—for there is simply no direct object as the focus of the emotion.

An emotion is directed not (it seems) to the individual but the individual qua possessor of a certain property:

$$em(p) \wedge focus(p) = q \wedge pfoc(q) \wedge has(r, p) \Rightarrow \exists s. prop(s, q) \wedge cause(s, p)$$

Here, $pfoc(q)$ shows that q is not a direct focus. (Rather, it is a property focus.) Also, s is the property of object q and it is the cause of the emotion. For example, while attending a convention, John notices its efficient running and admires the person who is responsible for organization, even though he does not know who this is. Therefore, when he remarks "I admire the person who organized this convention," John wants to draw attention to a special property.

4 Two Theses on Emotions

Consider the following two theses:

1. An emotion is a property of an individual, involving only intrinsic features of the individual having the emotion.

2. In attributing an emotion to a subject, one is attributing to the individual an “occurrent” property.

In attributing an emotion to an individual, one provides information about the individual’s occurrent state, without essential reference to factors outside the individual. In formulating thesis (1), a distinction should be made between predicates that are relational and predicates that designate pure properties. “Pure” properties may be identified without reference to another individual:

$$prop(s, q) \wedge pure(s) \Rightarrow \neg(\exists t.ref(s) = t \wedge item(t))$$

Predicates involving intransitive verbs often constitute cases of “non-relational” predicates.

If an occurrent property is attributed to a subject then one is indicating a feature of the subject that may be identified concurrently with the attribution. Here, a distinction between occurrent and “dispositional” properties needs to be made. Take the statement “Abby is singing.” Its subject has the occurrent property, but in the sentence “This vase is fragile,” the subject has the dispositional property. The characteristics of these properties are independent. Properties that are non-relational and non-occurrent are dispositional.

When expressing relational properties, transitive verbs are used, but to express non-relational ones, intransitive verbs are needed:

$$prop(s, q) \Rightarrow (nonrel(s) \oplus rel(s)) \vee (disp(s) \oplus occ(s))$$

$$disp(s) \Rightarrow nonrel(s) \wedge \neg occ(s)$$

$$occ(s) \Rightarrow (rel(s) \wedge \neg disp(s)) \vee (nonrel(s) \wedge \neg disp(s))$$

Hence, occurrent and dispositional properties cannot occur together.

It can be seen that transitive verbs designate occurrent properties. Examples:

- Dispositional: “This vase is fragile.”
- Non-relational, occurrent: “Sally is in pain.”
- Relational, occurrent: “Abby is envying her younger sister.”

According to thesis (1) above, an emotion involves the subject alone. The subject may be characterized just by reference to the intrinsic features of the subject. For example, if it is said “Dennis is angry,” then there is no need to look further than Dennis, the subject of the emotion. Thus, in thesis (1)—that emotions are pure properties, like pain—the intrinsic features of the subject are all that is involved in an emotion. In thesis (2)—that emotions are occurrent—it is dictated that there is currently something that identifies one’s emotion. Accordingly, there should be something that identifies Dennis as angry in the last example.

Emotions in general obey the rules of either theses (1) or (2). However, there is significant subset of emotions that are non-occurrent and relational (e.g., depression):

$$em(p) \wedge has(r, p) \wedge subj(r) \Rightarrow \exists s.prop(s, r) \wedge (pure(s) \oplus occ(s) \oplus (\neg occ(s) \wedge rel(s)))$$

According to Nissenbaum, there are non-occurrent, relational emotions that challenge these two theses. There is a significant class of emotions that may not be distinguished as particular types of occurrent features of the individual having these emotions: love, hatred,

anger, loathing, envy, and shame. These are called “active emotions” (Nissenbaum 1985). Deciding whether a given emotion is active or not depends on linguistic concepts. It is possible to designate the emotion by a transitive verb in the active voice. Furthermore, the subject of the verb should refer to the individual that we think of as the one having the emotion.

A new paradigm arises once we start to see emotions as patterns of episodes. For active emotions this will usually be a pattern of interactions. A particular emotion is characterized by a complex pattern. It covers a sequence of episodes, all of which fit this pattern, and is a complex, structured interaction between an individual who is the subject of the emotion and another individual or part of the world. An emotion spans several episodes.

$$pat(u) \Rightarrow \exists e_1 \dots \exists e_n. cont(u, emepi(e_1, h)) \wedge \dots \wedge cont(u, emepi(e_n, h))$$

Patterns are at a higher level of abstraction than emotion episodes. Consider a previous example. If Jill envies Pam over job standing, one can describe more abstractly a pattern of interactions that characterizes their relationships. Certain sequence of episodes of the envy pattern of Jill may be:

1. Jill is becoming furious on hearing that their boss is praising Pam.
2. She is resentfully acknowledging the inferiority of her working conditions.
3. She is experiencing unpleasant feelings whenever she sees or thinks about a particular success that Pam has achieved.

In the above example (1), (2), and (3) are the pieces of the pattern “Jill envies Pam.” Consequently, we can say that an emotion is a pattern of events. There are a number of factors that determine the nature of the pattern in a given instance of emotion. The type of the emotion determines the types of the events comprising the pattern. The frequency and concentration of certain types of events are other definitive factors.

4.1 An Example: Envy

“Comparison” is the core of envy. The envier focuses on a particular feature of the envied individual and compares himself to the envied. The problem here is that of inequity; this strikes the envier as an undesirable and discomforting situation.

Envy defines three central roles: that of the envier, the envied, and a feature or possession of the one envied. If we go back to Jill’s case we simply have:

$$em(envy) \wedge has(Jill, envy) \Rightarrow subj(Jill)$$

$$subj(Jill) \Rightarrow ind(Jill)$$

In the relational case, if we substitute the object and the subject of the emotion as Pam and Jill respectively, then we obtain:

$$em(envy) \Rightarrow envy(Jill, Pam) \wedge subj(Jill) \wedge obj(envy, Pam)$$

Clearly, here Pam should have some features that Jill does not have, so that envy occurs.

In fact, we need some kind of generalization of envy, because we said that it is a dispositional emotion. Therefore, there should exist some general facts. In the case of Jill’s envy, some of these facts may be:

- In all situations in which information is present, relevant to the relative standings in the firm of Jill and Pam, Jill notices it.
- In all situations in which Jill is faced with Pam’s success in her job, she becomes unpleasantly aroused.
- In all situations in which Jill has a reasonable chance of blocking Pam’s progress, she takes it.

According to Nissenbaum, our emotion concepts (active emotion cases) are general concepts, the particulars being events. Emotions are both patterns of episodes and they are dispositional.

$$activem(p) \Rightarrow \exists u \exists s. disposition(s, p) \wedge pat(u)$$

Here s is the subject and related to emotion p by a disposition, and u corresponds to a pattern.

5 Events of Patterns

A speculation, developed by Nissenbaum, is that the events of an emotional relation fall into three categories: thinking, acting, and feeling.

$$event(p, x) \wedge em(p) \Rightarrow thinking(x) \oplus acting(x) \oplus feeling(x)$$

Events are relevant to emotions in two ways: being pieces of a pattern and by instantiating the emotions. The first one is formulated as:

$$emepi(h, p) \Rightarrow \exists x. event(p, x)$$

Given an emotion p , an instance of this emotion e occurs in a context. The context consists of the subject of e , any individual related by e to the subject, i.e., the object of e , and the setting of e . The setting of e is the location of e defined in terms of spatial or temporal variables, or with markers that are more descriptive. Thus, emotional episodes are partitioned in a special way.

$$activepi(h, p) \Rightarrow \exists r \exists q \exists l \exists t. subject(r) \wedge object(q) \wedge spatem(l, t)$$

In the case of Jill’s envy, the context includes Jill, the object Pam, their relative job status, and a setting. The setting can be defined in terms of date and place or more descriptive markers such as “the office of Luby & Heinz law firm”.

Let us now examine thinking, acting, and feeling more closely.

Thinking Here thinking is used to cover a broad range of mental activities like remembering, calculating, deciding, noticing, interpreting, and so on. Thinking enters into an analysis of emotion in that events involving the subject in certain forms of thinking are frequently pieces of a pattern, and are constrained by the conditions. Nissenbaum limits thinking to “real time” phenomena. She focuses on events in which the subject is currently engaged in thinking.

$$thinking(x) \wedge em(p) \Rightarrow \exists u. pat(u)$$

One may associate certain ways of thinking with certain types of emotion. An instance of hatred may involve the subject's thinking about the individual he hates, thinking about the despicable characteristics of the hated individual, or something similar.

Of course, thinking alone cannot determine the existence and the type of an emotional relation. Nissenbaum's approach introduces an additional dimension to the identification of an emotion, viz., the pattern. There is no single episode that constitutes an active emotion. The concentration and frequency of certain ways of thinking about another individual determine the presence of an emotional relation as much as the context of the thoughts. Certain trains of thought characterize the state of mind of the individual who is the subject of the emotional relation.

Acting Acting is similar to thinking in terms of definition, that is, the pattern of an emotional relation includes episodes with the subject as an agent in much the same way as it involves the subject engaged in thinking.

Certain types of actions are characteristics of certain emotional relations.

$$acting(x) \wedge em(p) \Rightarrow \exists u.pat(u)$$

For example, one is not surprised to see a lover act to protect the loved one from a possible danger.

Feeling The pattern of events fitting an emotion label usually includes events in which the subject experiences feeling:

$$feeling(x) \wedge em(p) \Rightarrow \exists u.pat(u)$$

To establish a connection between feeling and emotion, one possibility is that emotion is a type of feeling, a subspecies of feeling. However, Nissenbaum develops a different hypothesis about feeling. She lists some of the characteristics that are frequently associated with feeling:

- Feelings are elements of conscious experience, identifiable by introspection.
- Feelings are not under direct voluntary control.
- Feelings are non-representable.
- The identification and description of feeling is based on a subjectively recognized phenomenological quality. One employs metaphors to describe the quality.
- Feelings differ from one another not only in quality but also in degree.
- Feelings are mental events occurring within the causal order. That is,

$$feel(s, u, e) \wedge pat(u) \Rightarrow \exists c.cause(e, c)$$

In the last formula, s is the emotion's subject, u is the pattern, and e is the feeling event.

The general framework for feeling episodes in emotional relations is no different from the one described for both acting and thinking. The pattern of an emotional relation includes events in which the subject experiences the appropriate feelings. The type of the

emotional relation is determined by two features of the feeling episodes. First, certain types of emotions are associated with certain qualities of feeling. Second, the emotion type is associated with a systematic correlation between the quality of feeling and context arousal. This second factor is a key to the solution of many persistent problems, e.g., is there a one-to-one connection between feeling and emotion? Distinct emotions in which feeling episodes are qualitatively identical are distinguished by the uniqueness of the context of arousal of the feelings.

For the case of envy, one intends to cover several feeling episodes, in applying the term envy to the relation between Jill and Pam. For example, this includes Jill's feeling

- agitated when she thinks about the possibility of losing a really important case to Pam
- bitter when Pam is awarded a prize for distinguished service
- self-satisfied when Pam's proposal is voted down at a meeting
- pleased when a superior scolds Pam harshly

It is seen that quality of feeling is an important factor but it cannot tell the whole story about emotion. Contexts of arousal of the subject's feelings determine the emotion:

$$em(p) \Rightarrow \exists x \exists h. feeling(x) \wedge emepi(h, p)$$

6 Emotional Relation and Salience

An emotional relation says that certain objects and features are salient to the emotion's subject. An emotion causes a change in the subject's pattern of attention. According to Nissenbaum, the fact that certain phenomena are salient to certain individual partially constitutes the fact that the individual is emotionally related to the phenomena:

$$em(p) \wedge subj(s) \Rightarrow \exists t. salient(s, t)$$

Let us summarize what we said up to now by using Nissenbaum's ideas. By applying an emotion concept to an individual, one picks out the structured interaction between the individual and an item in the world. This interaction is characterized by not only the types of the events but by the nature of the pattern of occurrence that these events follow. This is the reason for using the term "pattern of events". Three categories of events are suggested: thought, action, and feeling. Events involve the subject of the emotion in thinking, acting, and feeling.

According to Nissenbaum, "the emotion is a relation, because it is an abstraction over a pattern of events that are themselves relational." The picture to fix in one's mind is the picture of an array of events conceptually identified by the type of the emotion and tied together by the persistence of at least two items: the subject and the object (individuals or other items).

Most emotional relations are not commutative, so it matters which individual fills which role in the succession of episodes. The subject systematically takes the role of subject in the episodes that constitute an emotional relation. He is the agent, the one who is thinking and feeling. In every emotional relation there is a subject role filled by the subject of

the emotion. The label “focus of emotion” applies to another individual who features throughout the pattern of episodes.

Nissenbaum adds a new dimension by suggesting that an emotion is a pattern that is comprised of a number of distinct occurrences. Even though emotions are nonuniform phenomena, they are attributed sufficient structure to account for many of the features we typically associate with emotions. Emotions involve thought, feeling, and action. The pattern is determined by the emotion, features of the subject and of other central participants, and the nature of the context.

7 Conclusion

This paper is only an introduction—a rather premature one, in fact—to a logical representation of emotions. While treating the details, auxiliary concepts and new arguments (Reilly and Bates 1992) will no doubt appear and the formalization will become more complex. Also, the special cases that need attention will increase. To cover all special cases is highly unlikely; besides placing them into the appropriate categories may be a difficult task. However, only further and deeper work a la Nissenbaum may render better and more improved formalisms.

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8 Legend

accepted(q): q is an accepted thing
acting(x): x is an acting
activem(p): p is an active emotion
activepi(h, p): h is an episode of the active emotion p

beg(p): beginning of the pattern p

cause(p, r) = q: cause of r 's having emotion p is q
cont(u, h): pattern u contains h
contains(e, parts): sentence e contains $parts$

disp(s): s is a dispositional property
disposition(s, p): p is the disposition of the subject s
div(parts): division of parts

em(p) : p is an emotion
emepi(h, p): h is an emotion episode of emotion p
emsent(e): e is an emotion sentence
end(p): ending of pattern p
envy(s, r): s is envying r
equal(p, s): p is equal to s
event(p, x): x is an event of the emotion p
expl(p, q) = e: explanation of p , where the object is q , is e

feel(s, u, e): subject s is feeling emotion e in the pattern u
feeling(x): x is a feeling
focus(p) = q: the focus of the emotion p is q
futor(q): q is future-oriented

has(r, p): r (the subject) has the emotion p

imagined(q): q is an imagined thing
in(r, s): r is the subject and s is the mental state of r
ind(s): s is an individual
intobj(q): q is an intensional object
item(t): t is an item

judged(q): q is a judged thing

menst(s): s is a mental state

nonrel(s): s is a non-relational property

obj(p, q): q is the object of the emotion p
object(parts) = q: object of $parts$ is q
occ(s): s is an occurrent property

pat(u): *u* is a pattern
prop(s, q): *s* is the property of object/subject *q*
pfoc(q): *q* is a property focus
pure(s): *s* is a pure property

ref(s) = t: reference of *s* is an individual *t*
rejected(q): *q* is a rejected thing
rel(s): *s* is a relational property

salient(s, t): *t* is salient to the subject *s*
spatem(l, t): *l* is the location and *t* is the time instant
subj(r): *r* is the subject of the emotion
subject(parts) = s: subject of *parts* is *s*

thinking(x): *x* is a feeling

verb(parts) = p: verb of *parts* is emotion *p*

AUTHORS' SHORT BIOGRAPHIES

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