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METAPHORS OF EMOTIONS: TOWARDS A DATA-DRIVEN FORMALIZATION

Abstract

Formalization of natural language metaphors is a notorious problem in artificial intelligence and in other overlapping domains. It is semantic vagueness that makes metaphors resistant to formulaic or algorithmic descriptions. Great effort has been invested into modeling metaphors computationally but the issue remains methodologically uncertain and needs further research. This paper works on a practical solution to the problem how metaphorical meaning can be represented in a way suitable for computation. The research agenda of this paper is interdisciplinary; it brings together an algebraic heuristic-driven theory for metaphors developed in artificial intelligence and an applied theory of meaning that comes from cognitive linguistics. This agenda postpones theoretical speculation and argument and is solely solution-focused, which contributes to the value of this paper's attempt to bridge the cognitive science disciplines whose compatibility, though declared, is seldom demonstrated in a piece of practical research.

This paper works with metaphors of human emotions that are linguistically manifested in modern English discourse. Emotions by virtue of their ineffability as qualia are rich in metaphorical conceptualizations and serve the research agenda well. This paper in a meaningful way exposes and ranks designated properties of the FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY concepts and arranges these properties into general-purpose ontologies that explicitly specify metaphorically preferred emotion conceptualizations and are good candidates for computation. In prospect, this paper will account for some theoretical aspects of the research and probe the algorithmic and repetitive nature of schemas that license metaphorical expressions in natural language.

Keywords: artificial intelligence, cognitive linguistics, formal representation of metaphors, human emotion, intensional definition, ontology, schema.

Анотація

У статті представлено результати практичної розвідки, виконаної на перетині теорії штучного інтелекту та когнітивної лінгвістики – дисциплін у складі когнітивної науки, чия методологічна комплементарність, хоча й проголошується, досі має недостатнє унаочнення в практичних дослідженнях. Ця робота присвячена питанню створення формальної моделі метафори. Обчислення метафор протягом тривалого часу залишається однією з невіршених проблем у царині штучного інтелекту й низки суміжних дисциплін. Перешкодою до подолання зазначеної проблеми є семантична невизначеність метафор, що її неможливо вивірити за допомогою формул та алгоритмів. Мета статті полягає в демонстрації того, як за використання методологічного інструментарію когнітивної лінгвістики, а саме доробку семантики лінгвальних мереж, метафоричне значення може бути репрезентоване в такий спосіб, який постане придатним для обчислення в системах штучного інтелекту. Матеріалом дослідження послуговували метафоричні вирази, які маніфестують у сучасному англomовному дискурсі концепти емоцій страху, смутку, щастя та безтурботності. Емоції як квалія є особистим досвідом, що його можливо словесно описати переважно за допомогою метафор. Це дає багатий матеріал та підкреслює практичну значущість дослідження, адже емоції, як і метафора, є складними для математичного моделювання сутностями.

За точку відліку в статті взято алгебраїчну теорію метафори, керовану евристичним пошуком. Саме ця теорія спрямувала дослідження на послідовне розв'язання двох практичних завдань. По-перше, у статті у вигляді інтенціональних дефініцій визначено та впорядковано за ступенем промінантності парадигматичні властивості концептів FEAR, SADNESS, HAPPINESS та RELAXATION/SERENITY. По-друге, ці властивості для кожного концепту організовано у вигляді онтології – моделі репрезентації

знань, що її можна обчислити математично та описати за допомогою спеціалізованих мов програмування. Онтології експлікують метафоризовані властивості концептів емоцій у їхньому взаємозв'язку з урахуванням ступеня промінантності.

Ключові слова: емоції, інтенціональне визначення, когнітивна лінгвістика, онтологія, схема, теорія штучного інтелекту, формалізація метафор.

1. Introduction

Metaphor is a natural language phenomenon whose semantic vagueness furnishes its formal representation with considerable methodological uncertainty and guesswork. An algebraic theory that in a rather straightforward manner spells out semantics of natural language metaphors is suggested by Gust et al. (2006) who use many-sorted first-order logic and syntactic generalization in order to compute different types of metaphors, including creative concepts, which is a very non-trivial task for artificial intelligence (hereinafter referred to as AI) (see also Besold et al., 2017; Eppe et al., 2018; Schmid et al., 2003). The theory is heuristic-driven; it gives a structural description of the source and target in a metaphor and specifies the connection between these. There has however been left a vacancy in the theory that needs to be closed from outside the AI domain (Gust et al., 2006, p. 116):

"What is needed for an appropriate modeling of metaphors is a list of designated properties of the involved concepts. Such a list must contain relevant information concerning possible properties of concepts that can play a role in metaphors. Furthermore, it seems to be reasonable to rank these properties according to their importance. Clearly, this is a purely empirical problem, but it is necessary to get the correct input for the machinery".

1.1 Aim, methods, and material

This paper has an interdisciplinary objective to bridge the domains of AI and of cognitive linguistics in a piece of practical research. It **aims** to suggest a way how the computable input for metaphor might be tailored using the cognitive linguistic **methodologies** of semantics of lingual networks (see Жаботинська, 2019). The research agenda of this paper postpones theoretical speculation and argument and appears to involve two items that are solely solution-focused (Prof. Dr. phil. Kai-Uwe Kühnberger, personal communication, September 2019). The first item is to expose and rank in a meaningful way the designated (= paradigmatic, or sortal) properties of metaphorical concepts manifested in natural language; the second one is to pertinently arrange these properties in a knowledge representation model suitable for computation. Among the available models of this kind, Gust et al. (2006) place their preferences upon ontologies, which makes an ontology a reasonable pick for this paper as well. The **data** for analysis in this paper come from a fragment of modern English discourse on human emotion. Because of their metaphorical abundance, emotions answer the purposes of this paper well.

1.2 Literature review

This paper treats *emotions* as basic irreducible intentional reflective states induced in experiencers by external and internal stimuli (Scherer, 2005). Emotions evoke in the array of organismic subsystems immediate and various responses but by their qualia nature are ineffable. Verbal report on emotions is generally metaphorical. This paper sticks to G. Lakoff and M. Johnson's conceptual metaphor theory and understands *metaphor* as experiencing one concept in terms of another concept, where these concepts are the target and the source respectively with a set of systematic correspondences between them (see Vakhovska, 2017b for an overview of the theory). Individual emotions have valence and are characterized as positive, negative, or ambivalent in its terms. Valence is not an intrinsic property of emotions; it is contextually assigned to them in acts of awareness and interpretation. Emotion concepts show to be unevenly distributed within a four-dimensional emotion space

(Scherer, 2005) whose scales are valence (positive vs. negative), organismic arousal (passive vs. active), and appraisal of goal relevance (conductive vs. obstructive) and of coping potential (high vs. low control/power).

This paper singles out the FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY concepts from the emotion space. These concepts come each from one of the four regions within the space and sit on its opposite poles: FEAR is negative-active, SADNESS is negative-passive, HAPPINESS is positive-active, and RELAXATION/SERENITY is positive-passive, which safeguards for this paper a span over the entire emotion space. The four emotion *concepts* lend their *names* to cognitive linguistic analysis and in this paper are exposed as *lexical meanings* of these names (here and below, see Vakhovska, 2017a for an overview of the linguistic terms and their definitions). The analysis is fueled by a direct sample from the British National Corpus. From there, 4000 discourse fragments have been recruited, with the *fear*, *sadness*, *happiness*, and *relaxation/serenity* English nouns manifesting FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY respectively. The sample was randomly selected; this was a simple random sample for each of the four nouns naming their respective emotion concepts. There are 1000 items in each emotion concept's data set.

Lexical meaning is a mental construal. Representation of lexical meaning is a *semantic network* structured by a set of *schemas*. Each set of schemas accommodates a list of *designated properties* of the respective emotion concept. These properties capture the *intensional definition* of the concept. Each schema in a set highlights a distinct designated property and has a different iteration rate in the data. This rate indicates how *prominent* a property is; prominence distinguishes cognitively preferred designated properties and is a way of their ranking.

Semantic networks for FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY are treated in this paper as structures of ontological knowledge about respective emotions. This knowledge is common-sense, naïve, and non-specialist. However, it is this very knowledge that is crucial for computing natural language metaphors (Gust et al., 2004, 2007). *Ontologies* for FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY hold their concepts' designated properties in their relations and allow interpretation and extraction of knowledge about respective emotions.

With this in mind, I give the intensional definitions for FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY in **Subsection 2.1** of this paper, and lay the respective ontologies open in **Subsection 2.2**. **Section 3** is a conclusion to this paper and an outline of prospects for further research.

2. Results and discussion

2.1 Intensional definitions for the FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY emotion concepts

From the AI perspective, mapping between the structured target and source in a metaphor produces a set of systematic semantic correspondences, which is captured by a schema and stored as an abstracting generalization. It is this generalization that is computed once at hand (Gentner & Forbus, 2011). Schemas define attributes and relations on conceptual entities. Schema is a generalized knowledge structure; the term is of wide application across many scientific domains where it has a more or less shared understanding. In cognitive linguistic view, *schemas* "can be used to produce and understand linguistic expressions. Linguistic expressions are categorized by schemas in production and comprehension; in other words, they are licensed to occur by those schemas. In this way expressions are linked to the knowledge structures that produce them and make them interpretable" (Kemmer, 2003, p. 70). Schematic representations enable data extraction, data interpretation, and learning in both human and artificial agents (Gentner & Forbus, 2011).

Intensional definitions for FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY prove largely metaphorical because of ineffability of emotion qualia *per se*. Each schema in the definition captures a particular (metaphorical) conceptualization of the emotion. In the mappings,

information from various source concepts is transferred to the targets and hypothetical world knowledge is introduced into FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY. Sets of schemas for the emotion concepts are given below. The nomenclature of schemas for this paper is adopted from Zhabotynska (Жаботинська, 2019). Represented as [a numerical value] is the number of linguistic expressions in the data set that are licensed by the respective schema; the bigger the number, the more prominent the schema in terms of ranking:

FEAR

- The possession ownership schema [61] "O^W_{owner} *has* O^D_{owned}-FEAR"
- The possession inclusion schema [21] "C^R_{container}-FEAR *has* C^T_{content}"
- The being locative schema [33] "FEAR *is* T^H_{ERE}-L^C_{locative}"
- The being qualitative schema [5] "FEAR *is* S^U_{CH}-Q^U_{ALITY}"
- The identification classification schema [38] "I^D_{identified}-FEAR *is* C^L_{classifier-type}"
- The action contact schema¹ [30] "A^G_{agent-experiencer} *feels / does not feel* P^T_{patient}-FEAR"
 - The action contact schema¹ + L^C_{locative} [20] "A^G_{agent-experiencer} *feels* P^T_{patient}-FEAR T^H_{ERE}-L^C_{locative}"
 - The action contact schema¹ + T^M_{temporative} [6] "A^G_{agent-experiencer} *feels* P^T_{patient}-FEAR T^H_{EN}-T^M_{temporative}"
 - The action contact schema¹ + C^S_{cause} [411] "A^G_{agent-experiencer} *feels / does not feel* P^T_{patient}-FEAR *because of* C^S_{cause}"
- The action contact schema² [23] "A^G_{agent-experiencer} *exhibits / does not exhibit* P^T_{patient}-FEAR"
 - The action contact schema² + M^D_{mediator} [52] "A^G_{agent-experiencer} *exhibits* P^T_{patient}-FEAR *with the help of* M^D_{mediator}"
- The action schema³ [35] "A^G_{agent}/C^R_{causer} *makes* F^T_{factitive}-FEAR"
 - The action schema⁴ [50] "A^G_{agent}/C^R_{causer-experiencer} *acts / acts upon* P^T_{patient}, A^F_{ffective} / *makes* F^T_{factitive} *with/without* A^T_{TENDANT}-FEAR"
 - The action schema⁵ [26] "A^G_{agent}/C^R_{causer} *acts / acts upon* P^T_{patient}, A^F_{ffective} / *makes* F^T_{factitive} *with/by* I^N_{STRUMENT}-FEAR"
 - The action schema⁶ [1] "A^G_{agent}/C^R_{causer-experiencer} *acts / acts upon* P^T_{patient}, A^F_{ffective} / *makes* F^T_{factitive} *despite* P^R_{EREQUISITE}-FEAR"
 - The action schema⁷ [65] "A^G_{agent} *acts upon* P^T_{patient}-FEAR"
 - The action schema⁸ [66] "A^G_{agent}/C^R_{causer-experiencer} *acts / acts upon* P^T_{patient}, A^F_{ffective} / *makes* F^T_{factitive} *because of* C^S_{cause}-FEAR"
- The comparison likeness schema [57] "FEAR *is as if* S^M_B/S^M_{TH}-A C^O_{RRELATE}"

SADNESS

- The possession ownership schema [89] "O^W_{owner} *has* O^D_{owned}-SADNESS"
- The possession inclusion schema [19] "C^R_{container}-SADNESS *has* C^T_{content}"
- The being locative schema [147] "SADNESS *is* T^H_{ERE}-L^C_{locative}"
- The being qualitative schema [14] "SADNESS *is* S^U_{CH}-Q^U_{ALITY}"
- The identification classification schema [78] "I^D_{identified}-SADNESS *is* C^L_{classifier-type}"
 - The action contact schema¹ [150] "A^G_{agent-experiencer} *feels* P^T_{patient}-SADNESS"
 - The action contact schema¹ + L^C_{locative} [35] "A^G_{agent-experiencer} *feels* P^T_{patient}-SADNESS T^H_{ERE}-L^C_{locative}"
 - The action contact schema¹ + T^M_{temporative} [30] "A^G_{agent-experiencer} *feels* P^T_{patient}-SADNESS T^H_{EN}-T^M_{temporative}"
 - The action schema of contact¹ + C^S_{cause} [158] "A^G_{agent-experiencer} *feels* P^T_{patient}-SADNESS *because of* C^S_{cause}"

The action contact schema² [34] "AG^{agent}-experiencer *exhibits / does not exhibit* PT^{patient}-SADNESS"
 The action contact schema² + MD^{mediator} [78] "AG^{agent}-experiencer *exhibits* PT^{patient}-SADNESS
with the help of MD^{mediator}"
 The action schema³ [17] "AG^{agent}/CR^{causer} *makes* FT^{factive}-SADNESS"
 The action schema⁴ [63] "AG^{agent}/CR^{causer}-experiencer *acts / acts upon* PT^{patient}, AF^{affective} / *makes*
 FT^{factive} *with/without* ATTENDANT-SADNESS"
 The action schema⁵ [14] "AG^{agent}/CR^{causer} *acts / acts upon* PT^{patient}, AF^{affective} / *makes* FT^{factive}
with/by INSTRUMENT-SADNESS"
 The action schema⁶ [45] "AG^{agent} *acts upon* PT^{patient}-SADNESS"
 The action schema⁷ [3] "AG^{agent}/CR^{causer}-experiencer *acts / acts upon* PT^{patient}, AF^{affective} / *makes*
 FT^{factive} *because of* CS^{cause}-SADNESS"
 The comparison likeness schema [26] "SADNESS *is as if* SMB/SMTH-A CORRELATE"

HAPPINESS

The possession ownership schema [143] "O^{wowner} *has* O^{downed}-HAPPINESS"
 The possession inclusion schema [27] "CR^{container}-HAPPINESS *has* CT^{content}"
 The being locative schema [63] "HAPPINESS *is* THERE-LC^{locative}"
 The being qualitative schema [41] "HAPPINESS *is* SUCH-QUALITY"
 The identification classification schema [172] "ID^{identified}-HAPPINESS *is* CL^{classifier-type}"
 The action contact schema¹ [11] "AG^{agent}-experiencer *feels* PT^{patient}-HAPPINESS"
 The action contact schema¹ + LC^{locative} [17] "AG^{agent}-experiencer *feels* PT^{patient}-HAPPINESS
 THERE-LC^{locative}"
 The action contact schema¹ + TM^{temporative} [36] "AG^{agent}-experiencer *feels* PT^{patient}-HAPPINESS
 THEN-TM^{temporative}"
 The action schema of contact¹ + CS^{cause} [62] "AG^{agent}-experiencer *feels* PT^{patient}-HAPPINESS
because of CS^{cause}"
 The action contact schema² [8] "AG^{agent}-experiencer *exhibits* PT^{patient}-HAPPINESS"
 The action contact schema² + MD^{mediator} [32] "AG^{agent}-experiencer *exhibits* PT^{patient}-HAPPINESS
with the help of MD^{mediator}"
 The action schema³ [54] "AG^{agent}/CR^{causer} *makes* FT^{factive}-HAPPINESS"
 The action schema⁴ [2] "AG^{agent}/CR^{causer}-experiencer *acts / acts upon* PT^{patient}, AF^{affective} / *makes*
 FT^{factive} *with* ATTENDANT-HAPPINESS"
 The action schema⁵ [2] "AG^{agent}/CR^{causer} *acts / acts upon* PT^{patient}, AF^{affective} / *makes* FT^{factive}
with/by INSTRUMENT-HAPPINESS"
 The action schema⁶ [161] "AG^{agent} *acts upon* PT^{patient}-HAPPINESS"
 The action schema⁷ [3] "AG^{agent}/CR^{causer}-experiencer *acts / acts upon* PT^{patient}, AF^{affective} / *makes*
 FT^{factive} *for* GL^{goal}-HAPPINESS"
 The comparison likeness schema [166] "HAPPINESS *is as if* SMB/SMTH-A CORRELATE"

RELAXATION/SERENITY

The possession ownership schema [22] "O^{wowner} *has* O^{downed}-RELAXATION/SERENITY"
 The possession inclusion schema [11] "CR^{container}-RELAXATION/SERENITY *has* CT^{content}"
 The being locative schema [104] "RELAXATION/SERENITY *is* THERE-LC^{locative}"
 The being qualitative schema [19] "RELAXATION/SERENITY *is* SUCH-QUALITY"
 The identification classification schema [97] "ID^{identified}-RELAXATION/SERENITY *is* CL^{classifier-type}"
 The action contact schema¹ [107] "AG^{agent}-experiencer *feels* PT^{patient}-RELAXATION/SERENITY"
 The action contact schema¹ + LC^{locative} [308] "AG^{agent}-experiencer *feels* PT^{patient}-RELAXATION/
 SERENITY THERE-LC^{locative}"

The action contact schema¹ + TM^{temporative} [59] "AG^{agent}-experiencer *feels* PT^{patient}-RELAXATION/SERENITY THEN-TM^{temporative}"

The action contact schema² [22] "AG^{agent}-experiencer *exhibits* PT^{patient}-RELAXATION/SERENITY"

The action contact schema² + MD^{mediator} [41] "AG^{agent}-experiencer *exhibits* PT^{patient}-RELAXATION/SERENITY *with the help of* MD^{mediator}"

The action schema³ [159] "AG^{agent}/CR^{causer} *makes* FT^{factitive}-RELAXATION/SERENITY"

The action schema⁴ [13] "AG^{agent}/CR^{causer}-experiencer *acts / acts upon* PT^{patient}, AF^{affective} / *makes* FT^{factitive} *with/without* ATTENDANT-RELAXATION/SERENITY"

The action schema⁵ [3] "AG^{agent}/CR^{causer} *acts / acts upon* PT^{patient}, AF^{affective} / *makes* FT^{factitive} *with/by* INSTRUMENT-RELAXATION/SERENITY"

The action schema⁶ [22] "AG^{agent} *acts upon* PT^{patient}-RELAXATION/SERENITY"

The action schema⁷ [1] "AG^{agent}/CR^{causer}-experiencer *acts / acts upon* PT^{patient}, AF^{affective} / *makes* FT^{factitive} *because of* CS^{cause}-RELAXATION/SERENITY"

The comparison likeness schema [12] "RELAXATION/SERENITY *is as if* SMB/SMTH-A CORRELATE"

Iteration rates guide the distribution of designated properties into the intension or into the implication of meaning of respective emotion names. Properties in the *intension of meaning* are stable, formative, and obligatory for this emotion concept by virtue of its name. Intensions are distilled into dictionaries as the signified meanings of words. The *implication of meaning* embraces unstable properties distributed into different regions: the strict implication includes the most probable associates of the intension but their absence however does not rule the concept out of its category; properties in the weak implication are free, their association with the intension is equally probable or improbable depending on the grounds of categorization. Strict and weak implications are fuzzy sets of properties. Whereas the intension of meaning results from constructivization of reality and is a deterministic abstraction from the infinity of referents and their relations, the implication of meaning reflects the probable, indeterministic nature of the world (see Никитин, 2007, pp. 102-135). Each emotion name therefore carries in its meaning an obligatory and invariable semantic core and an optional and variable periphery of an infinite size. Levels of generalization to which the periphery is pruned depend on particular research objectives and are generally common-sense.

In this paper, distribution of the designated properties of emotion concepts into the intension and various regions of the implication is conditioned by prominence that is measured quantitatively. The intension and implication are peculiarly boldfaced in the definitions; the numerical thresholds for the strict, highly probable, and weak implication are arbitrary with reference to the size of the data set. The thresholds are the following:

the signified and ***the intension of meaning***

strict implication – more than 50 linguistic expressions that are licensed by a schema,

highly probable implication – 20-50 expressions,

weak implication – less than 20 expressions.

The data set has been formed, systematized, and analyzed. Based on this analysis, for each of the emotion concepts an intensional definition is suggested that captures the designated properties for this concept ranked and marked according to their prominence. Represented as [a numerical value] in the definitions is the number of linguistic expressions that manifest respective properties. The intensional definitions for the emotion concepts are given below:

The intensional definition for FEAR with its ranked designated properties

Fear is an emotion [22] evaluated as a negative one [5] but that can also be deemed positive [2], and is a reaction, a response [9]. ***It is human [48] and non-human [13] experiencers:*** horses [4], birds [3], dogs [2], cats [1], foxes [1], rabbits [1], and androids [1], ***who have fear.*** Experiencers can have fear in the mind [18],

in their whole selves and bodies [9], in their hearts [5] and eyes [1]. Fear can be outside and envelope experiencers [19]. Experiencers are usually aware of their fear [26] but can also be unaware of it [4]. They can feel fear at a certain time [6] and in a certain place [17], in the Third Reich [1], in the Soviet Union [1], and in London [1]. Fear can have some forms [2]. Fear can be rational [1] and irrational [3], and also unnatural [1].

Fear has a cause [411] that triggers it. Fear is induced in experiencers by thoughts about, or arrival, possibility, existence, etc. of death [23] and of illness [13]. Fear is generated by an impending danger [7] and by violence and bodily harm [87]. It can be triggered by weather cataclysms [4], by water [3], fire and light [3], and by imminent starvation [1]. Cats [9], dogs [3], wolves [3], poisonous snakes [3], and birds [1] can give fear to human experiencers. Fear can be that of flying a plane [6] and driving a vehicle [4], and also of finding oneself in a closed space [1]. Female experiencers have fear of an unplanned pregnancy [6], of childbirth [3], and of sexuality [1]. Male experiencers have fear of dominant women and feminism [9] and of castration [1]. Fear can also come about because of unemployment [17], financial risks and money waste [10], money penalties [10], costs [4], home loan debts [2], and inflation [2]. Lawyers [1], crimes [14] and punishments [4] can also cause fear. Fear is induced in experiencers by God [8], by the unknown [30] and by the truth [1], and by fear itself [4]. Fear can occur because of an inappropriate social distance [29] and might be experienced because of rejection, loneliness, or, on the contrary, excessive closeness. Attention, the others' opinion and disapproval [35] can cause fear. Losses [18] and failures [18] are also fear elicitors. Fear can be provoked by the Jews [1], by the Soviet Union and Russia [3], by Bolshevism and Communism [2], and by Iraq [1]. Fear is incited by terrorism [3] and by imminence of a nuclear war [2].

Experiencers can exhibit their fear [19] or not [4]. **There are signs that indicate fear [52]. In humans, fear is expressed through certain motor expressions [22], physiological symptoms [4], and action propensities [1].** Motor indicators for fear in humans are facial signs: mimics, mouth twitching, eye movement and expression, and tears [5]; voice: experiencers cry, scream, squeak, and quack in fear [6]; and gestures and body motion: shivering, shaking, trembling, drumming one's heels, chaotic movement [8], and also cowering and cringing [3]. Physiological symptoms for fear are broken breath and heart beat patterns, sweating palms, and nausea [4]. An action propensity in fear is running [1]. In fear, humans experience frustration, joylessness, altered states of consciousness, apathy, and nervousness [5]; they can also lose the ground under their feet and feel numb and paralyzed [6]. They can indulge into verbal offences [2] and express their fear in written texts [5]. In animals, fear is mediated through cowering, jamming and hanging the tail, animation, barking, running and pulling away, and aggressive behavior [7].

Fear drives experiencers towards or away certain intentions, and is the cause for their (in)action [66]. Experiencers can act despite their fear [1]. Fear can accompany certain states, processes, and actions or be absent from them [50]. Experiencers can cause fear in themselves or in the others [35], can act upon their fear by transforming, reducing or magnifying it, can think of fear or describe it [65], and can also use the others' fear as a means to achieve certain goals [26].

The intensional definition for SADNESS with its ranked designated properties

Sadness is an emotion [54] evaluated as a negative one [12] but that can often be deemed positive [8], and is a reaction, a response [4]. Sadness is ambivalent. **It is human experiencers who have sadness [85]** but dogs [1], monkeys [2], and lions [1] can also experience this emotion. Humans can have sadness in their eyes [20], in their whole selves and bodies [20], in their hearts [15], voices [10] and faces [5], in their spirit [2] and the mind [2], and in their lives [4]. Experiencers may situate their sadness in texts [16], poems [5] and books [2], and in metaphors [2], words [1] and style of writing [2]. Music [11] and songs [2], paintings [2], ballet performances [1], TV broadcasts and films [2] can also be locations for sadness. Sadness is in the world and universe [7], in Berlin [1] and in England [1]; it fills events [2], visions [1], air, atmosphere and one's aura [10], and is also found in Socialism [1]. Sadness can be outside and envelope and consume experiencers [18]. **Experiencers are aware of their sadness [150]** if they have it. They can feel sadness at a certain time [25], at Christmas [1] and at Easter [1], and after a coitus [3]; they can feel sadness everywhere, there, and in a certain place [35]. Sadness can have some forms [1]. It can be great, consuming, the only, special, tremulous, overwhelming, and small; there is pierrot's sadness and sadness of deck chairs on a rainy beach [14].

Sadness has a cause [158] that evokes it. Sadness is induced in experiencers by thoughts about, or arrival, possibility, existence, etc. of death and by funerals [80], by departures and farewells [49], and by illness [9], aging [2] and childlessness [1]. Sadness is elicited by news [4], crimes [4], losses [4] and failures [1], and by whores [1], prejudice [2], and the holocaust [1].

Experiencers can exhibit their sadness [24] or not [10]. **The indicators for sadness in humans are certain motor expressions [71]** and action propensities [1]. Motor indicators for sadness are facial signs: face expression and mimics, e.g., faint smiles and lines around the mouth [26], tears, eye movement and expression, e.g., eyes enlarge and widen, grow chill and become dim with sadness, their look is a gaze [31]; voice: experiencers cry, call, shriek, and scream in sadness [4], they sigh [1] and have a modulated voice tone [5]; and gestures and body motion [4]: fluttering, slow palm-up gestures, slight head shakes, and sadly bent knees. An action propensity in sadness is turning away [1]. In sadness, humans experience frustration, apathy and altered states of consciousness [3]. They can express their sadness through words [1] and in Psalms [1] and also mediate their sadness through art [1].

Sadness can drive experiencers towards certain intentions, and is the cause for action [3]. **Sadness accompanies certain states, processes, and actions or is, although infrequently, absent from them [63]**; it may also be used to trigger these in experiencers [14]. Sadness can be brought to experiencers, caused or evoked in them; experiencers can be moved to sadness, and sadness can be born from knowledge or can result from the need that humans naturally have for it [17]. Experiencers can act upon their sadness [45] sharing it with others, knowing, remembering, measuring, sorting out, capturing, confronting, relieving, controlling, easing, complicating, and stopping it; they can attach sadness to something, think of their sadness and describe it verbally, can replace sadness with another, positive or negative, emotion that outweighs it.

The intensional definition for HAPPINESS with its ranked designated properties

Happiness is an emotion [142] evaluated as a positive one [23], and is a basic need [1] and a response [5]. Happiness can only scarcely be deemed negative [1]. It is God [8] and **human experiencers [132] who have happiness** but horses [3] can also experience this emotion. Humans can have happiness in their mind [3], in their whole selves and bodies [5], in their heart [3] and soul [1], and in their lives [15] and memories [1]. Experiencers may situate their happiness in texts [4] written by them. Christian faith [20] and art [1] can also be locations for happiness. Happiness is in the heaven [3], in this world [5] and in the other world [2]. Happiness can be outside and envelope experiencers [20].

Experiencers are aware of their happiness [11] if they have it. They can feel happiness at a certain time [16], in the day- [1] and nighttime [1], in the afternoon [1] and in the evening [1], at Christmas [2], and in the past [2] and in the future [9]. Happiness lasts a moment [3]. Experiencers can feel happiness in a certain place [5], at home [10] and in a house [1], and in Italy [1]. Happiness can have some forms [6] and there is a complexity in it [1]. Happiness can be of different quality [41]. It can be great, everlasting, fleeting, ephemeral, short-term, true, real, perfect, spiritual, transforming, moderate, mild, extreme, unlooked-for, sudden, lost, high-tech, unique, special, fatal, corrupted, and vain; there is Christian happiness and happiness that is childlike or paper thin.

Happiness is the result of causation [54]; it is given to experiencers, is achieved by them and has causes [62] that elicit it. Happiness is induced in experiencers by marriage [17], family life [1], and children [1]. Men find happiness in their marriage proposals accepted [2]; women find happiness in a work-life balance [1]. Happiness is elicited by acts of giving and by caring about the others [6], Christian faith [3], freedom of mind and creativity [2], and by self-fulfillment [1]. Money [5], alcohol [3], a good job [2], reading [1], music [1], leisure [1] and cocaine [1] can also give happiness to humans. Experiencers find happiness in sex and desire [2] and in relationships [1]; men are happy with women [1], and women are happy with men [1]. Laughter [1], beauty [1], smiles [1], success [2], and somebody else's happiness [1] can also give happiness to humans. Happiness can be in elections of a king [1]. Happiness may be brought by Zashiki-Warashi [1] and may be achieved through a ritual [1].

Experiencers exhibit their happiness [8]. **The indicators for happiness in humans are certain motor expressions [29]**. Motor indicators for happiness in humans are facial signs: face expression, mimics, and a smile [7], eye expression and tears [7]; voice: experiencers sigh [1], cry [3], weep [3] and laugh [3] with happiness; and gestures and body motion: agitation, restless movement, wriggling the toes [3], stretching the hand out [1], and dancing [1]. In happiness, humans can experience altered states of consciousness [3].

Happiness drives experiencers towards certain intentions, and is the cause for their action [3]. Happiness can accompany certain states, processes, and actions [2], and can tinge these [2]. **Experiencers can act upon their happiness and that of others [161]** completing, sharing, increasing it; expecting, looking for and finding it; knowing, contemplating, understanding, describing and wishing it; remembering and forgetting it; substituting and associating it with something; shattering, spoiling and destroying it; etc.

The intensional definition for RELAXATION/SERENITY with its ranked designated properties

Relaxation/serenity is an emotion evaluated as a positive one [22]; it is abatement from bodily or mental effort [48] and is a state or quality of being tranquil [27]. It is Christ [2], human [18] and non-human [2] experiencers who have relaxation/serenity: horses [1] and swans [1]. Human experiencers can have relaxation/serenity in the mind [9], in their voice [4] and spirit [5], and in their lives [12]. They find relaxation/serenity in music [18] and the art [4], in paintings [4] and theatrical plays [1], and may put their relaxation/serenity in impressions [1] and letters [2]. Relaxation/serenity is in religious faith [4], at cemeteries [2] and in the grave [1]; it can be found in the world [4], in the sky, above the clouds and material things [4], in the Sahara [1] and on the Moon [2], and also in an aquarium [1]. **Relaxation/serenity fills atmosphere, air and one's aura [24]**, and is in the weather [1]. Relaxation/serenity can be outside and envelope experiencers [4].

Experiencers are aware of their relaxation/serenity [107] if they have it. **They can feel relaxation/serenity at a certain time [36]**, in the morning and daytime [7], in the evening and nighttime [12], on Sundays [1] and in summer [1], during a siesta [1] and in their old age [1]. **They can feel relaxation/serenity in a certain place [36], in the countryside [61], at water, rivers, lakes and seas [55], at nature and the scenery [39], at hotels [37], in dwellings [17] and in rooms [4], in gardens [17], on islands [11], at spa resorts [6] and in relaxation centres [6], in the mountains [5], in Italy [5], in churches [4], parks [2], cafés [1], and at grammar school [1]. Men feel relaxation/serenity on a woman's bosom [1]. Relaxation/serenity can have some forms [7] and can be of different qualities [19]. It can be subtle, quiet, false, Greek and classical, monastic and angelic; there is the dignified serenity of an elephant trundling off to its ancestral graveyard and there is the serenity of a chain saw; one can feel serene as a steel engraving and as Renoir.**

Experiencers exhibit their relaxation/serenity [22] through motor indicators [41]. These are face expression and a tranquil smile [34], and eye expression [7].

Relaxation/serenity is the result of causation [159]; it is given to experiencers and is achieved by them [4]. **Relaxation/serenity is induced by comfort [38], alcohol and drinks [23], sun [5], travelling [4], psychiatric medicines [2], music [1], coffee [2] and conversation [1], and by humor [1]. Humans achieve relaxation/serenity through sex [3], massage [5] and aromatherapy [6], a bath [4], acupuncture [1], meditation [1] and yoga [1], and through sleep [1] and food [1]. Certain techniques and exercises [31], hobbies and pastime [23] also bring relaxation/serenity to humans. An elicitor for relaxation/serenity is a victory [1].**

Relaxation/serenity drives experiencers towards certain intentions, and is the cause for their action [1]. Relaxation/serenity can accompany certain states, processes, and actions or be absent from them [13]. **Experiencers can act upon relaxation/serenity [22]** completing, increasing and enhancing it, concentrating on and learning it, permitting and affecting it, shattering, threatening or disturbing it. They can also use relaxation/serenity as a means to achieve certain goals [3].

These intensional definitions read as narratives, which makes them good candidates for computational storytelling, and adds practical value to this paper although the subject is outside of the scope of research. Intensional definitions comprise those designated properties of emotion concepts that formalization of metaphors ultimately seeks. The definitions are to be represented at the ontological level now.

2.2 Ontologies for FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY

An ontology is a knowledge engineering artifact that specifies objects/concepts with their attributes and relations within a domain (Peters & Shrobe, 2003). Representing these domains is called ontological engineering. There are a number of ways to construct and populate ontologies, the choice depending on particular research objectives. Figures 1, 2, 3, and 4 below set the relevant common-sense knowledge about FEAR, SADNESS, HAPPINESS, and RELAXATION/SERENITY in ontologies. These are general-purpose ontologies that organize and hold together the various specific fragments of knowledge about the emotions. The facts that the ontologies contain are generally translatable into formal ontology language for AI.

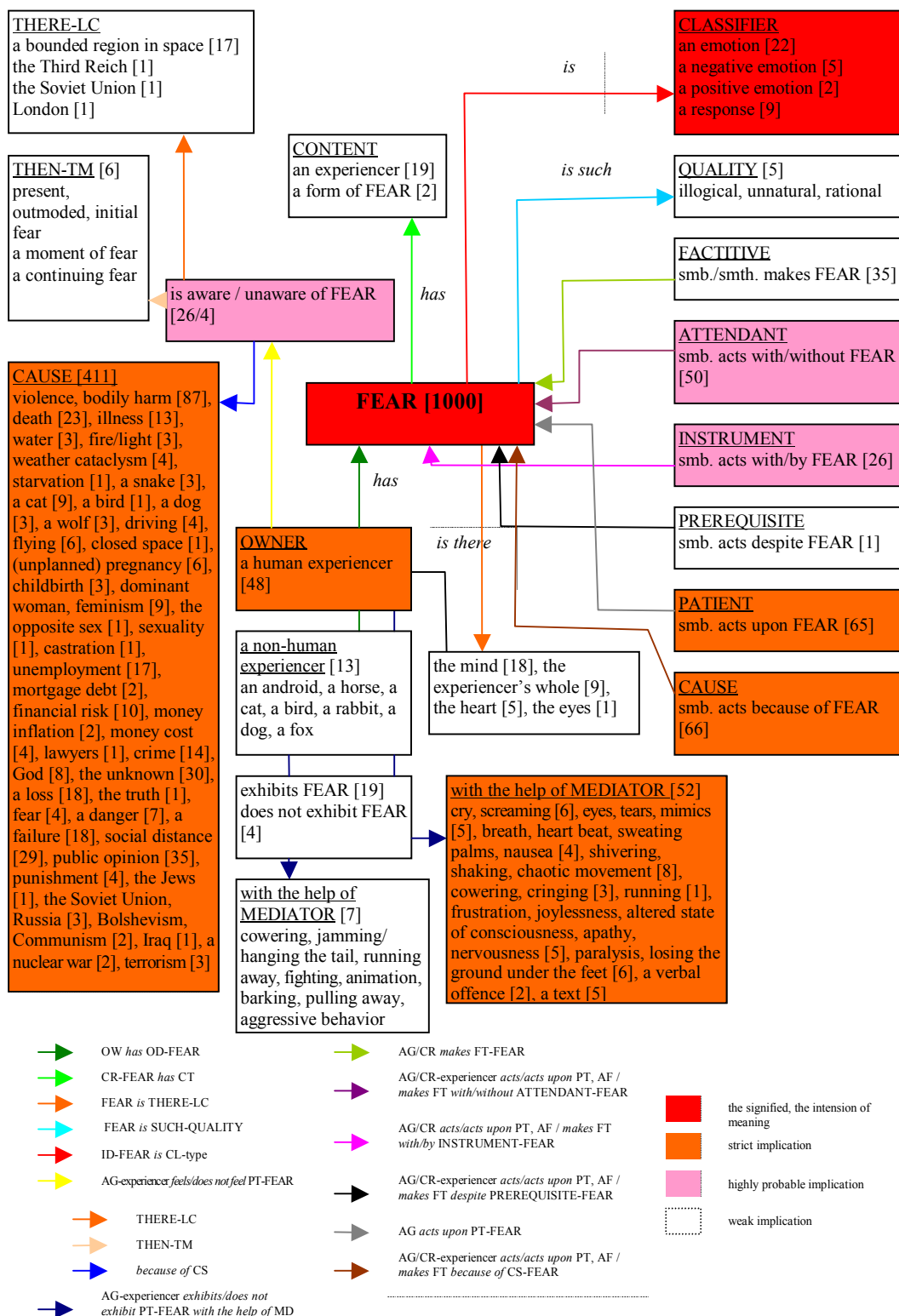


Fig. 1. A possible ontology for FEAR

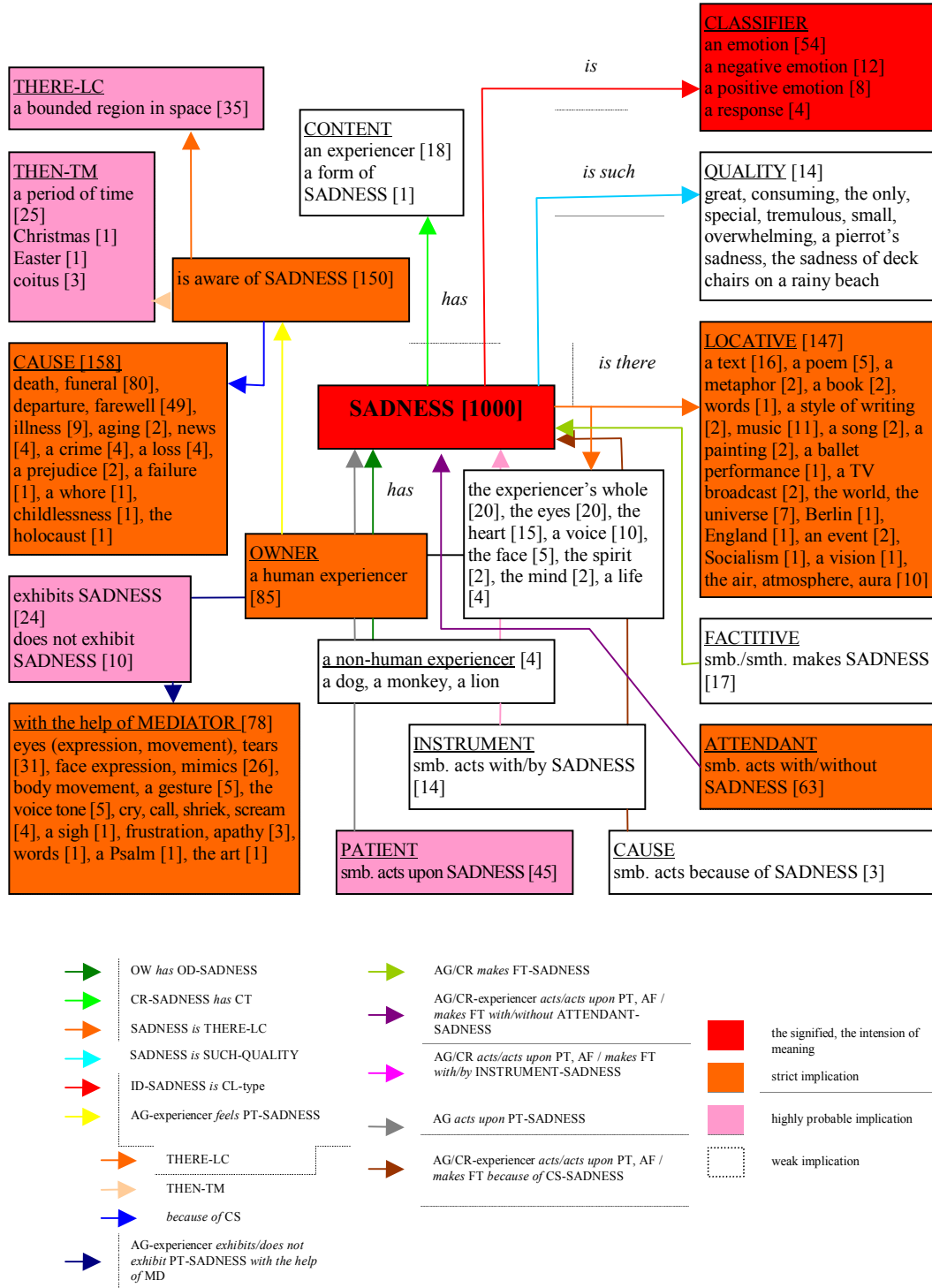


Fig. 2. A possible ontology for SADNESS

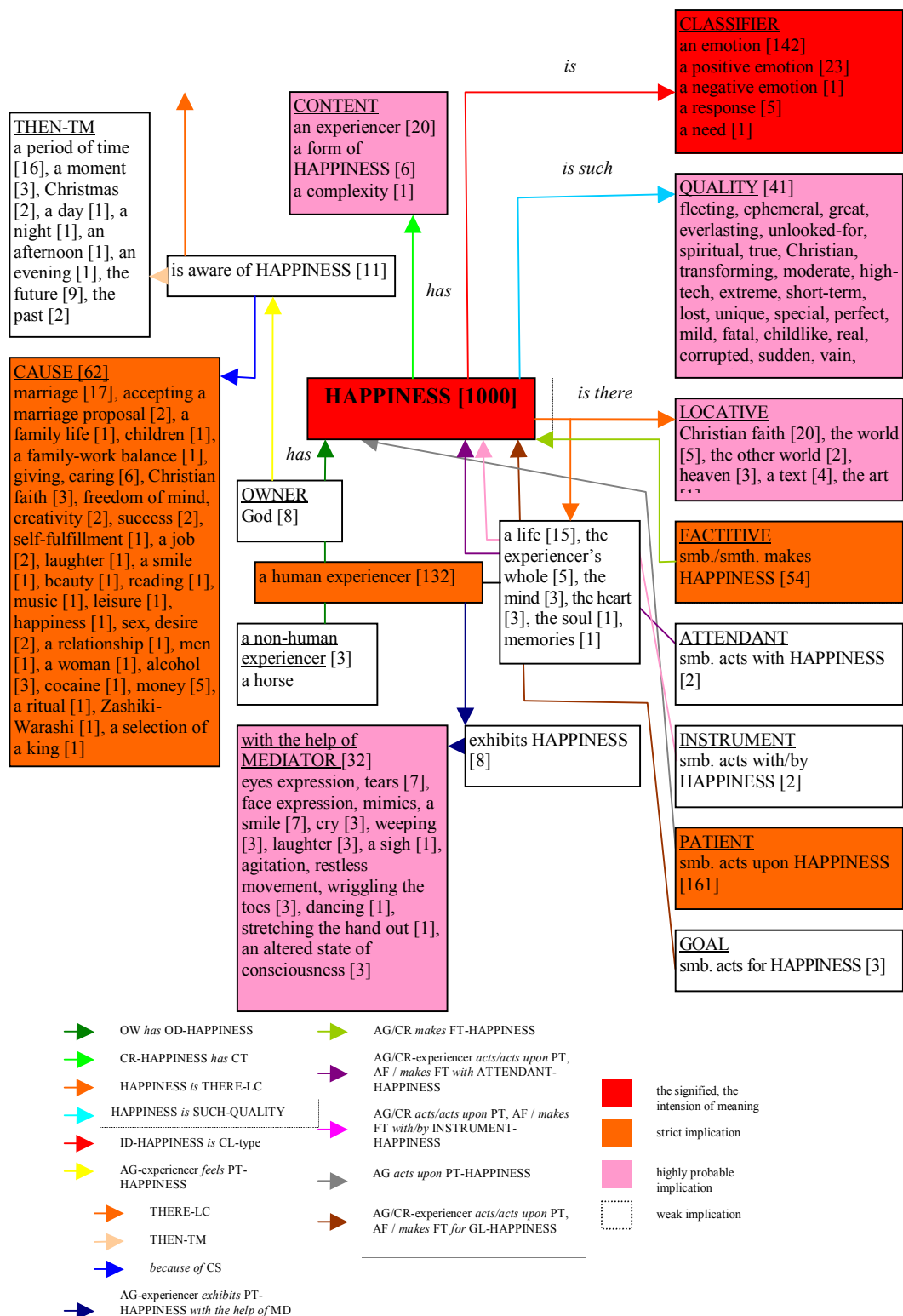


Fig. 3. A possible ontology for HAPPINESS

By way of different colors, the figures show relations between concepts within the ontologies and their prominence. These ontologies are explicit specifications of conceptualization for the emotions of fear, sadness, happiness, and relaxation/serenity in the British worldview.

3. Conclusions and further research

This paper has attempted to bring cognitive linguistics and AI together in an interdisciplinary study of metaphor. It has used big corpus data and trusted cognitive linguistic tools to expose and rank designated properties of major emotion concepts and to arrange these properties into general-purpose ontologies. As explicit specifications of metaphorically preferred emotion conceptualizations, the ontologies that this paper suggests make good candidates for computation in ontology languages for AI.

The research agenda of this paper has been practical and solution-based, with some theoretical issues postponed. One of these issues is metaphor itself with regards to where it is to be terminologically located within the proposed methodological framework. In other words, what conceptual entity exactly is to be considered and termed a metaphor here? Emotions by virtue of their ineffability as qualia are conceptualized metaphorically, and this paper has been clearly operating on metaphors that conceptualize the emotions of fear, sadness, happiness, and relaxation/serenity. The practical value of the solution that this paper suggests for AI does not depend on terminological speculations, still the proper location for the term "metaphor" in the framework will make this solution theoretically immune.

Semantics of lingual networks (Жаботинська, 2019) that this paper adopts is a theory of meaning inspired by frame semantics. The theory, to the best of my knowledge, reserves for metaphor one schema only. It is the comparison likeness schema "SMB/SMTH *is as if* SMB/SMTH-A CORRELATE" that is assumed to license metaphorical expressions in natural language. In this light, linguistic manifestations that need to be exclusively considered metaphorical for HAPPINESS, for example, are only those 166 expressions in the data set that are licensed to occur by the schema "HAPPINESS *is as if* SMB/SMTH-A CORRELATE", e.g., *happiness is paper-thin*, where the mode is fictitious (the wordage for the mode is by Immanuel Kant). However, the mode is equally fictitious for such expressions in the data set as *money gives them happiness* (the HAPPINESS *is* A PHYSICAL OBJECT metaphor), *there is so much happiness in the community* (the HAPPINESS *is* CONTENT INSIDE A CONTAINER metaphor), etc. These expressions are licensed to occur by other schemas but are metaphorical (at least in terms of the conceptual metaphor theory in its standard version, see Vakhovska, 2017b for an overview), which overrides the initial expectation. Cf. also: these other schemas license non-metaphorical expressions, e.g., *the teacher gives them a book* and *there is so much water in the vase*; these expressions manifest concrete concepts, and indeed the mode here is actual. Therefore, for abstract concepts like HAPPINESS a lot more schemas need to be treated as those that license metaphorical expressions but not the comparison likeness schema alone, which generally has been shown by this paper's data set.

There is another issue in this train of thought. Could schemas be termed metaphors if they are conceptual structures that license metaphorical expressions? From the conceptual metaphor theory perspective, the answer is presumably yes, although this does not resonate with the methodology and is counter-intuitive. The theory naturally and traditionally handles metaphorical concepts but not metaphorical schemas. Yet, schemas do have their say in the mind's operation, and there are opinions that schematicity interlaces metaphorical concepts and is their central property (see Kövecses, 2017). This schematicity is that of the metaphorical sources that can come from different levels of abstraction and thus be of different degrees of schematicity, e.g., HAPPINESS *is* A PRECIOUS POSSESSION and HAPPINESS *is* A JEWEL. Should then the HAPPINESS *is* A PRECIOUS POSSESSION metaphorical concept be considered less schematic than the "O^wowner *has* O^downed- HAPPINESS"

schema? This however is an implausible juxtaposition of entities of different order. Therefore, the terminological refinement for this paper, if aimed at, requires a deeper insight into methodologies and is a **prospect** for further research.

Another research opportunity is the algorithmic and repetitive nature of schemas that license metaphorical expressions for the emotion concepts. There are schools of thought in AI that with the purpose of computation explore productive aspects of metaphors and of creative metaphors in particular. The intensional definitions and ontologies from this paper make valid input for a metaphor generator. Potential metaphORIZATIONS of fear, sadness, happiness, and relaxation/serenity are infinite, which is generally the case for any metaphORIZATION thinkable until combinatorial explosion (Prof. Dr. phil. Kai-Uwe Kühnberger, personal communication, September 2019), and what this paper has achieved is cataloguing the regularities of these combinations.

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List of abbreviations

AI – artificial intelligence

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