A rule-based model of emotion appraisal for narratives

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Abstract

This paper presents a procedural model for the generation of characters' emotions in a narrative. The model is the result of the adaptation of the well-known OCC model for emotion appraisal to the drama context and its encoding into logic clauses that are computationally tractable. The model has been implemented through a standard ontological reasoner, and applied to sample drama fragments through the Drammar ontology encoding of the dramatic incidents.

1 Introduction

There is a limited number of psychological phenomena that can be considered recurrent and pervasive as the emotion in the life of the human being. Emotions characterize almost all the significant events of our daily lives [Smith and Lazarus, 1990], assuming various nature and different intensity: we feel proud when we receive a promotion, we become angry when our companions make fun of us, we are happy at the birth of our children, and we experience deep condolences at the death of a person we loved. Emotions have raised the interest of thinkers since the time of Plato and Aristotle (*Ion* [Leighton, 1982]), followed by the more modern Hume, Kant and Hegel, who have carried out moral reflections on the relationship that binds human being to her/his affective states. Even in the artistic environment, great importance is given to the study of emotions and the way in which these must be expertly communicated to the viewer. A good narrative, whether communicated in literary, theatrical or cinematographic format, is expressly made with the aim of evoking certain emotional states in the audience [Scheff, 1979] Authors use emotional reactions as the manifestations of the motivations and personalities of their main characters, revealing the close relationship between emotions, personality, and cognition [Plutchik, 1980].

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In: A. Jorge, R. Campos, A. Jatowt, A. Aizawa (eds.): Proceedings of the first AI4Narratives Workshop, Yokohama, Japan, January 2021, published at http://ceur-ws.org

In the recent decades, there has been an interest in the computational models of emotions and their potential applications [Sloman *et al.*, 2005], both to clarify the mechanisms of the generation of emotions and to improve credibility and effectiveness of synthetic agents and robots. Hudlicka and colleagues define the computational models of emotions as "software designed to synthesize the operations of the process of elicitation of human emotions based on a specific theory of emotions" [Hudlicka, 1998] [Tsai *et al.*, 2011]

There are three consolidated theoretical perspectives that can be referred to in the construction of a computational model of emotions [Hudlicka, 2011]. Each of these differs from the others in function of the semantic primitives that it believes characterize the procedures of generation of the emotions, that is the founding constituents of the emotional experience that can be modeled and inserted as information within a computational model for the generation of emotions.

- Discrete or categorical theories of emotions emphasize a small number of fundamental emotions, each of which mediated by specific neural circuits [Panksepp, 1998]. The emotional states differ from each other for the different stimuli, the distinct behavioral and physiological expressions, and the different subjective experiences. This theoretical perspective roots in the works of Charles Darwin, who gave rise to an evolutionary perspective by identifying the presence of a discrete group of emotions found both in animals and in humans. Taking up Darwinian theses, Ekman demonstrates the universality of what he considers to be basic emotions, that is joy, sadness, anger, fear, disgust, and surprise [Ekman, 1992].
- Dimensional theories of emotions conceive emotional states as characterized by a small set of underlying dimensions, which define a space within which the human emotions can be distinguished from non-emotions. The most frequent characterization uses mainly two dimensions: valence and excitement [Russel, 2003][Russel and Barrett, 1999]. The valence reflects a positive or negative evaluation and the associated state of pleasure felt (or displeasure), while the arousal defines the general level of activity of the organism, reflecting a general readiness for action.
- Componential theories of emotions emphasize both the cognitive component of the emotion (the cognitive eval-

uation procedure that the individual performs on some situation) and the distinct *dimensions* or *variables* of the cognitive evaluation process called *appraisal of the emotions* [Leventhal and Scherer, 1987]: they include novelty, valence, relevance of the objective, congruence with the objective, and coping ability. These theories assume that a stimulus, be it real or imaginary, elicits an emotion because it is analyzed according to the meaning and consequences that the agent attributes to it. The analysis of the input situation implies the assignment of specific values to the appraisal variables: the number of emotions that can be obtained is quite large, given the large combinations of the possible values assumed by the variables.

From a computational point of view, each theoretical approach tries to bridge the gap between the stimulus that elicits the emotion and the emotion itself: for example, in the discrete/categorical perspective there are no intermediaries since the base emotions themselves constitute the semantic primitives of the ideally calculated emotions, while in the other two perspectives it is the dimensions or the variables of appraisal to act as intermediaries. The best candidates for the formulation of a computational model of emotion for the narrative realm are the appraisal theories, which address the way in which the cognitive evaluation is related to the emotional experience, concluding that the former can be both the cause of the emotion and its consequence: in fact, Roseman and Smith point out how it is possible that, on the one hand, the appraisal of a blameworthy behavior causes anger, but, on the other, such an appraisal is a typical component of the phenomenological experience of proven anger and so, often, a consequence of anger itself [Roseman and Smith, 2001]. In the modular theories of cognitive appraisal, cognition is temporally placed before the experience of emotion and adopted, through specific semantic primitives of emotion, to estimate the emotional experience. According to Lazarus [Lazarus, 1984], the appraisal theorists argue that some form of "analysis of the meaning" of the stimulus situation is needed to elicit an emotion; taking a dramatic narrative sample, one could say that Hamlet cannot react angrily to Ophelia's behavior as long as he does not interpret the fact that she has betrayed him [Smith and Ellsworth, 1985].

Among the appraisal theories, OCC theory [Ortony *et al.*, 1988] has received a great attention for the formulation of a computational model [Marsella *et al.*, 2010], because it represents in an explicit form the appraisal of the situation on behalf of the individual and the calculus for the computation of the emotion types. According to Ortony, Clore and Collins, emotions are basically the result of a mechanism of cognitive interpretation of events, agents and objects in terms of their desirability with respect to the agent's objectives, their coherence in relation to her/his moral standards, and their pleasantness according to the dispositional tendencies of the agent. The individual would tend, for example, to experience a more or less differentiated emotion of hope if s/he appraised an event as desirable for the achievement of her/his goals. The construction of a computational model is supported by OCC theory, since it takes as input the formal representation of the components of the cognitive evaluation procedure and returns as output the development of a calculation algorithm for the computation of the emotions related to them. The representation and calculation of emotions are outlined through the use of practical examples and tree charts, and this makes implementation of the computational model truly immediate.

In this paper, we present a computational model for the emotion appraisal in the context of narratives. The model takes as input the appraisal of the basic elements of some narrative situations and returns as output the emotion appraisal of the characters. The model builds on the narrative elements devised by the Drammar theory [Damiano *et al.*, 2019], which are already formalized as formal ontological entities. In particular, the model is a revised version of the model in [Lombardo *et al.*, 2015], with a simplified account of narrative elements and a novel implementation of model rules. We call this model DrammarOCC model. This model can be useful for the calculation of emotions appraised by characters in a narrative context, and be used for emotion analysis as well as synthesis in the entertainment industry.

2 The DrammarOCC model

In this section, we sketch the Drammar-OCC model, starting from the formal description of the narrative, adapted from the Drammar theory [Damiano *et al.*, 2019]. Going top to bottom in Fig. 1, narratives are split into *units* (concept Unit), grouped into timelines (of one or several units, one preceding the next) and containing a description of the occurring events. The events occurring in the units are motivated by the *action plans* (Action Plan) intended by the *characters* (or Agents) that try to achieve the agents' *goals* (Goal). Goals are triggered by agents' *Values*. By appraising 1) the events occurring in the units of some timeline, 2) the intentional actions of the agents (including themselves), and 3) the pleasantness/liking of objects and agents in the story world, the characters experiences *emotions*, which are conveyed to the audience, in empathy with the characters themselves (if the text is well written, if the staging is effective, ..., depending on the conveying medium). Action plans and goals are central to the work of dramaturgy studies in the analysis and interpretation of a text and by the directors in the creation of a staging and in the direction of the actors, as well as by the actors themselves for the acting job.

As an example, we refer to Brecht's play *Mother Courage and her children* (original title *Mutter Courage und ihre Kinder*, 1938-39). The work, set during the Thirty Years' War in some countries of Central and Northern Europe, tells the misadventures of the vivandière Anna Fierling, who earns a living by selling wares to soldiers, the only people who have money during the war. The war, on the one hand, gets her business, but, on the other, will take her three children away, leaving her alone. Most likely, Brecht wrote it as a protest about the First World War, while feeling its approaching, and about war in general, which deprives Mother Courage of her three children by blurring her maternal instinct, not allowing her to realize that war is bad, not a place for business. To illustrate how modeling takes place, let's take a specific unit as an example, the second of the first scene (Unit 1.2)[1]:

[1]Such a segment is detected through an authoritative critical text

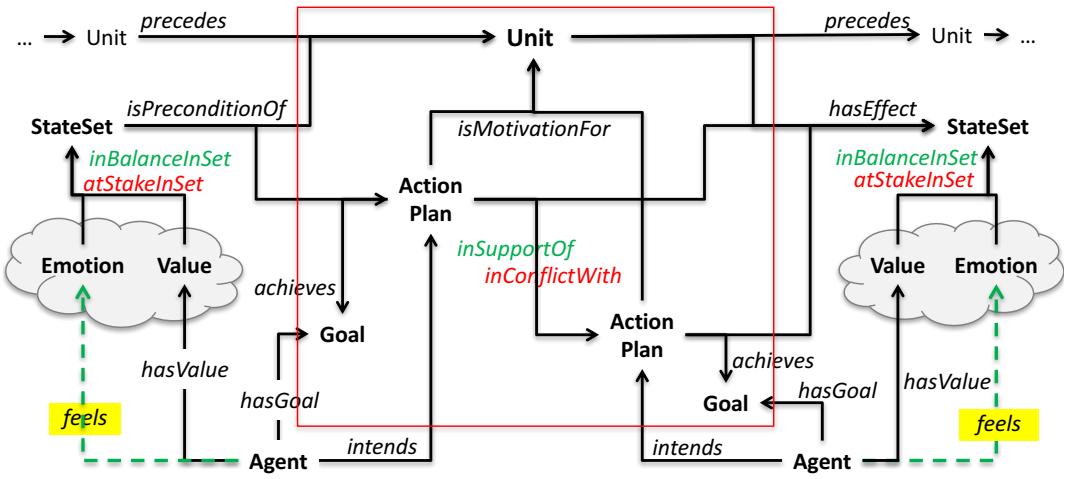

Figure 1: Conceptual schema of the elements of narratives. A narrative is segmented into Units (top); Action Plans, intended by Agents, in conflict or in support of one another, motivate the occurrence of Units and achieve Goals of the Agents. Agents have Values that are at stake or balanced; Values are preconditions of Action Plans. The system computes the feeling of Emotions on behalf of Agents.

> Mother Courage presents her heterogeneous family formed in different theatres of the war to the Brigadier and the Recruiter, who are trying to take her sons away for enlisting them in the army.

Now we see how the logical form of the narrative is expressed as predicates, to be matched with the definite clauses that encode the emotion calculus of the Drammar-OCC model.

Units: incidents, characters, values

The units of events, which are ordered sequentially into timelines (minimal timeline made of one unit):

- concept, monadic predicate $Unit(u)$;
- relation, binary predicate, $precedes(u_1, u_2)$, represents the sequence.

For example, Unit 1.2 is following Unit 1.1 ($precedes(Unit_{1.1}, Unit_{1.2})$). Each unit corresponds to a significant event in the drama; in this representation, unit or timelines embed events; the units or timelines are motivated by the intentions of the characters (see goal and action plans below). Complementary to events, there are states, which represent an existing situation, the result of events, which have effects on the subsequent evolution of the narrative. In this representation, the states are of two types:

1. the mental states of the characters with respect to the facts of the story;
2. an actual state of affairs that holds true at some point in history.

about the narrative at hand, namely a manuscript written by Brecht himself, "Brecht zu Courage", contained in the book "Brecht and Courage", edited by Walter Benjamin, Bernard Dort, Enrico Filippini, Jean Claude Francois, Henning Rischbieter, Bruno Schacherl, Luigi Squarzina, Genoa, Teatro Stabile di Genova, 1970, pp. 40–91. However, we developed an automatic segmentation approach for dramatic text, to be integrated here [Croce *et al.*, 2019].

In particular, the mental states are represented through the values of the characters in a certain unit, which are put at risk (*at stake*) or in safety (*in balance*) by events. The values are part of two sets of states, one preceding and one following the unit, respectively; the unit makes the transition between one set and another, allowing the story to progress. In predicate logic,

- concept, monadic predicate, $StateSet(s)$;
- relationship, binary predicate, $hasEffect(u, s)$, between a unit and a set of states which are effects of the unit;
- relationship, binary predicate, $hasPrecondition(u, s)$, between a unit and a set of states;
- relationship, binary predicate, $atStakeInSet(v, s)$, between a value and a set of states (meaning that the value is at risk in the set);
- relationship, binary predicate, $inBalanceInSet(v, s)$, between a value and a set of states (meaning that the value is safely in the set);

For example, $Unit_{1.2}$ has the effect of putting at stake the value "safety of children", a value of Mother Courage. The representation includes the following elements:

- $ChildrenSafety$: constant representing the "safety of children" value of Mother Courage;
- $Preconditions_{1.2}$: constant that represents the set of values that are valid before Unit 1.2;
- $Effects_{1.2}$: constant representing the set of values that apply after Unit 1.2;
- $StateSet(Preconditions_{1.2})$ and $StateSet(Effects_{1.2})$: monadic predicates that establish the type of the constants together;
- $hasEffect(Unit_{1.2}, Effects_{1.2})$ and $hasPrecondition(Unit_{1.2}, Preconditions_{1.2})$:

predicates that establish the relationship between the unit and the two sets;

- $inBalanceInSet(ChildrenSafety, Preconditions_{1.2})$: predicate that applies to preconditions;
- $atStakeInSet(ChildrenSafety, Effects_{1.2})$: predicate that applies to effects.

The characters and their values

The characters, or agents, are the entities that have goals and intend plans to achieve them:

- concept, monadic predicate $Agent(a)$.

In $Unit_{1.2}$, Mother Courage and Recruiter are Agent ($Agent(MadreCourage)$ and $Agent(Recruiter)$). Each character has values that help determine her/his behavior, since they are brought into play (at stake or in balance) by the events that occur:

- concept, monadic predicate, $ValueEngaged(v)$;
- relationship, binary predicate, $hasValue(a, v)$;
- concept, monadic predicate, $Value(v)$.

As we have seen before, the value of Mother Courage "safety of children" leads her to defend them from recruiting for war; $Unit_{1.2}$, has the effect that Courage's children risk being recruited, i.e. that Courage's value of children safety is put at stake. Another value of Mother Courage is the "business", which leads her to negotiate a sale with the Brigadier in a unit that follows $Unit_{1.2}$; a value of the Brigadier is the "obedience" (balanced), typical of military service; a value of the Recruiter is the "patriotism" (balanced), which leads him to convince people to go to war.

In predicate logic:

- $Value(ChildrenSafety)$: the type of the constant "safety of children" of Mother Courage;
- $Agent(MotherCourage)$: MotherCourage is of type $Agent$;
- $hasValue(MotherCourage, ChildrenSafety)$: predicate that relates Mother Courage and her value.

The characters' goals and the plans to achieve them

The intentions, or plans, of the characters are the engine of the story, used in the deliberation process, when the character decides what actions to uptake. The characters intend to implement action plans and it can be said that a plan motivates the occurrence of an event, that is, of a unit. The motivation can be read in two ways, from the dynamic point of view, considering the point of view of the author and the public, respectively: on the one hand, the events in the unit arise from the action plans of the characters; on the other, the intentions attributed to the characters are the result of the interpretation of the events.

- monadic predicate $ActionPlan(p)$: p is of the category $ActionPlan$;
- binary predicate $intends(a, p)$: agent a $intends$ the action plan p;
- binary predicate $isMotivationFor(p, u)$: the action plan p is a motivation for unit u.

Action plans are used by a character to achieve her/his goals. Plans can be implemented when certain preconditions are met, that is, situations or states that must be verified for the plan to be applied. In our case, as we have seen, the preconditions concern values at stake: on the one hand, the plans are designed to restore values put at stake, that is, the success of the plan has the effect of restoring the value; on the other, plans put at risk values that are in balance until some point. The additional elements needed to represent these aspects are as follows:

- monadic predicate $Goal(g)$: g is a goal (category $Goal$);
- binary predicate $hasGoal(a, g)$: agent a has the goal g;
- binary predicate $achieves(p, g)$: action plan p achieves goal g;
- binary predicate $hasPrecondition(p, s)$: the action plan p has the set of values s as a precondition;
- binary predicate $hasEffect(p, s)$: the action plan p results in the set of values s.

For example, in $Unit_{1.2}$, the interest of officers for Mother Courage's sons jeopardizes the "children safety" value for Mother Courage; that is, the value at stake "children safety" is a precondition of the plan‘ 'to distract the attention of the officers ".

For there to be a real change in value balancing, the characters' plans must succeed, that is, the actions set out in the plan are executed and the plan achieves the goal. However, in narratives, because of conflicts, the agents' plans cannot all succeed; in alternative, a plan could support the realization of another plan, of the same character or of another character. In logical terms:

- $accomplished(p)$: plan p succeeded;
- $unaccomplished(p)$: plan p did not succeed;
- $inConflictWith(p_1, p_2)$: plan p_1 is in conflict with plan p_2;
- $inSupportOf(p_1, p_2)$: plan p_1 supports plan p_2;.

For example, Mother Courage's plan to " distract the officers " fails; instead, the Brigadier's plan to "get the Recruiter contact with Courage's children" is successful; moreover, Mother Courage's plan to "distract the officers" is in conflict with the Brigadier's plan to "get the Recruiter contact with Courage's children", while the Brigadier's plan to "get the Recruiter contact with Courage's children" supports the Recruiter's plan to "recruit soldiers for the army".

3 The emotion-appraisal calculus

The emotions experienced by the characters represent a crucial aspect of the narrative, because the emotional connection allows the audience/reader to fully understand the action that takes place and how the story develops. For example, in $Unit_{1.2}$,, Mother Courage experiences "fear" for her children's fate and "distress" for the failure of her distraction

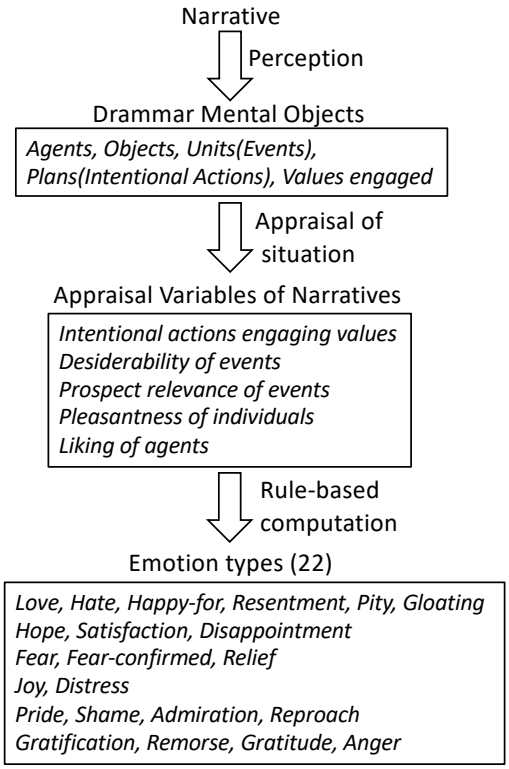

Figure 2: Flow of calculation in the DrammarOCC model.

plan, while the Brigadier feels "hope" for a possible recruitment.

The Drammar-OCC model assumes the flow in Fig. 2. The narrative is encoded through a perception process in the entities of the Drammar model, namely Agents, Objects, Units, Plans, Values; the situation is appraised by the utility rules that compute how plans engage values (making them safe or putting them at stake), the prospect relevance of the events, their desirability, and the pleasantness and liking of objects. Finally, the rules for the computation of emotions (for each agent in the narrative) are applied to compute the emotions types that hold for some agent.

In Fig. 3, we illustrate how Drammar-OCC computes the emotions, with a decision tree representation format: starting from the root, each path in the tree that arrives at some boxed term represents an appraisal rule (multiple rules can fire in parallel, since many emotions can be felt at the same time). The root node sets the Agent a as the one that feels the emotion(s) as a consequence of the rule execution (i.e., of the appraisal). The next level tests whether the emotion is caused by some Unit u that occurred (event appraised emotions), some Object o (can also be an Agent) that can be $Pleasant$ or not and that the Agent $Likes$ or not (object appraised emotions), some Action Plan p carried out by some agent (intentional action appraised emotions).

In the case of the event-appraised branch, 1) if the event is desirable for an Agent b that a likes, a feels $Happy-for$ b; 2) if the event is desirable for an Agent b that a dislikes, a feels $Resentment$ for b; 3) if the event is undesirable for an Agent b that a likes, a feels $Pity$ for b; 4) if the event is undesirable for an Agent b that a dislikes, a feels $Gloating$ for b. Yet in the case of the event-appraised branch, if Agent a appraises the current unit as prospect relevant (i.e., somewhat related to her/him), then 5) if the event is desirable for a, then a feels $Hope$, which, in case the perspective is confirmed, generates 6) $Satisfaction$, otherwise 7) $Disappointment$; 8) if the event is undesirable for a, then a feels $Fear$, which, in case the perspective is confirmed, generates 9) $Fear-confirmed$, otherwise 10) $Relief$. Also, in general, 11) if the event is desirable for a, a feels Joy; 12) if the event is undesirable for a, a feels $Distress$.

In the case of the object-appraised branch, 13) if the object o is generally judged pleasant and is liked by Agent a, then a feels $Love$ for o; 14) if the object o is generally judged unpleasant and is disliked by Agent a, then a feels $Hate$ for o.

In the case of the intentional action-appraised branch, 15) if the intentional action Plan p is intended by the same Agent a and p makes safe a value of the agent put at stake, a feels $Pride$; 16) if the intentional action Plan p is intended by the same Agent a and p puts at stake a value of the agent, a feels $Shame$; 17) if the intentional action Plan p is intended by another Agent b and p makes safe a value of the agent a put at stake, a feels $Admiration$ for b; 18) if the intentional action Plan p is intended by another Agent b and p puts at stake a value of the agent a, a feels $Reproach$ for b.

Finally, there are four compound emotions: 19) if Agent a feels both Joy and $Pride$, then a feels $Gratification$; 20) if Agent a feels both $Distress$ and $Shame$, then a feels $Remorse$; 21) if Agent a feels both Joy and $Admiration$, then a feels $Gratitude$ for b; 22) if Agent a feels both $Distress$ and $Reproach$, then a feels $Anger$ for b.

Now we show some rules for the appraisal of a situation and the calculation of emotions from the example unit above. The encoding of a unit that is relevant in perspective ($ProspectRelevant(u, a, p_a)$) is the following: an event/unit u that is considered relevant in perspective for an agent a because it is in support of or in conflict with a plan p_a of an agent a that can be implemented in the future; that is, for each agent a, for each event u, if the event is motivated by a p plan in support of or in conflict with a p_a plan of a that is not yet realized, then u is relevant in perspective for a, in relation to the p_a plan. In particular, for the conflict case, we have:

$$\begin{aligned} &Agent(a) \ \wedge \ Unit(u) \ \wedge \ Plan(p) \\ &\quad \wedge \ Plan(p_a) \ \wedge \ accomplished(p, true) \\ &\quad \wedge \ isMotivationFor(p, u) \ \wedge \ inConflictWith(p, p_a) \\ &\qquad \wedge \ intends(a, p_a) \ \wedge \ accomplished(p_a, false) \\ &\qquad \Rightarrow ProspectRelevant(u, a, p_a) \end{aligned} \tag{1}$$

The encoding of a unit that is undesirable for the agent ($Undesirable(u, a)$) is the following: an event/unit u that is considered undesirable for an agent a because it conflicts with agent a plan; that is, for each agent a, for each event u motivated by a plan p or for each plan p, if the p plan conflicts with a p_a plan of a, then u is undesirable for a.

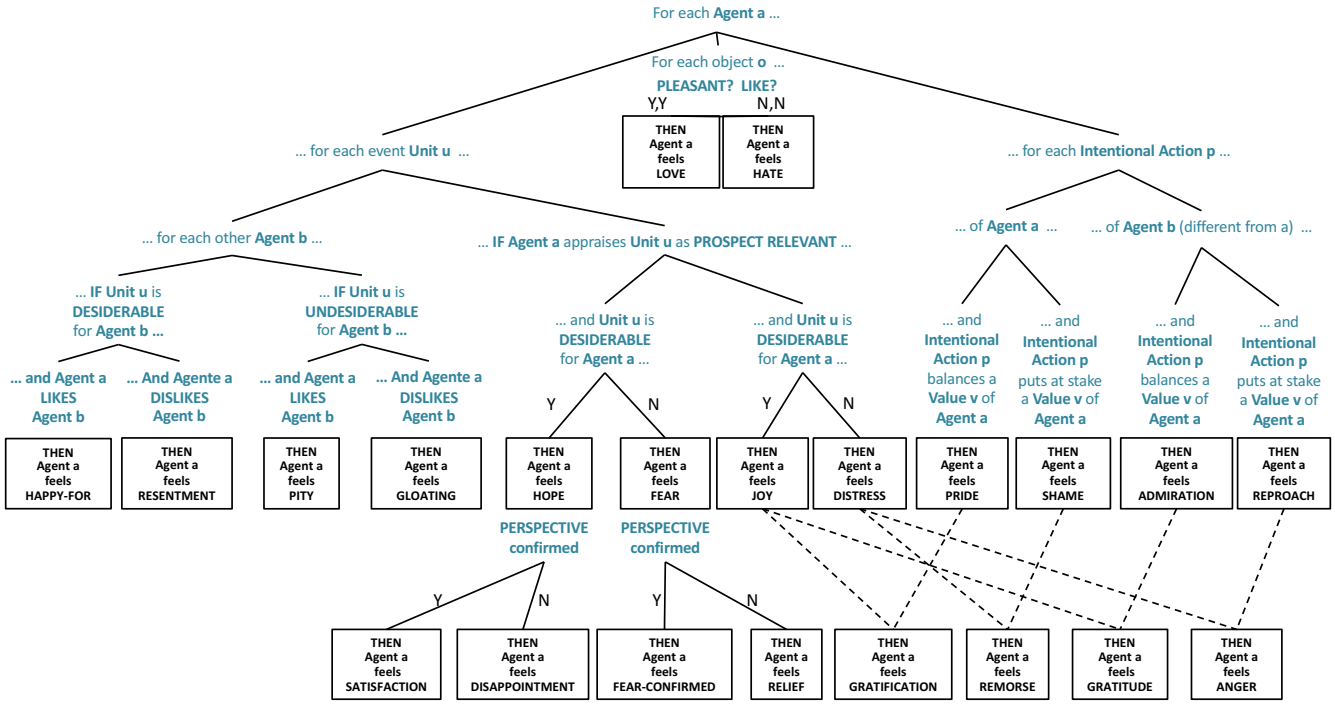

Figure 3: Decision tree-shaped schema for Drammar'OCC model.

$$
\begin{aligned}
&Agent(a) \ \wedge \ Unit(u) \ \wedge \ Plan(p) \\
&\wedge \ Plan(p_a) \ \wedge \ isMotivationFor(p, u) \\
&\wedge \ intends(a, p_a) \ \wedge \ inConflictWith(p, p_a) \\
&\Rightarrow Undesirable(u, a)
\end{aligned} \tag{2}
$$

The calculation of emotion Fear follows from this definition: being sorry, suffering, for the prospect, future occurrence of an event that is NOT desirable for some agent; that is, for each agent a, if the event u, which is relevant in perspective for the agent a given some intentional plan p, which is NOT desirable for the agent a, then a feel the emotion of Fear.

$$
\begin{aligned}
&Agent(a) \ \wedge \ Unit(u) \ \wedge \ Plan(p) \\
&\wedge \ ProspectRelevant(u, a, p) \ \wedge \ Undesirable(p, a) \\
&\Rightarrow Feel(a, Fear)
\end{aligned} \tag{3}
$$

Given the predicates above and the added predicates here below, we can compute the emotion Fear for Mother Courage by applying the Modus Ponens inference.

$$
\begin{aligned}
&Unit(Unit_{1.3MC}) \ \wedge \ Plan(P\_MC\_ContinueOnPath) \ \wedge \\
&inConflictWith(P\_B\_ContactCourageSons, \\
&P\_MC\_ContinueOnPath) \ \wedge \\
&isMotivationFor(P\_MC\_ContinueOnPath, Unit_{1.3MC}) \\
&\wedge \ precedes(Unit_{1.2}, Unit_{1.3MC})
\end{aligned} \tag{4}
$$

The model has been implemented in the Protégé environment, through the SWRL format and executed by the Hermit reasoner. In Fig. 4 we see how the Agent Mother Courage is assigned the emotions Fear and Distress.

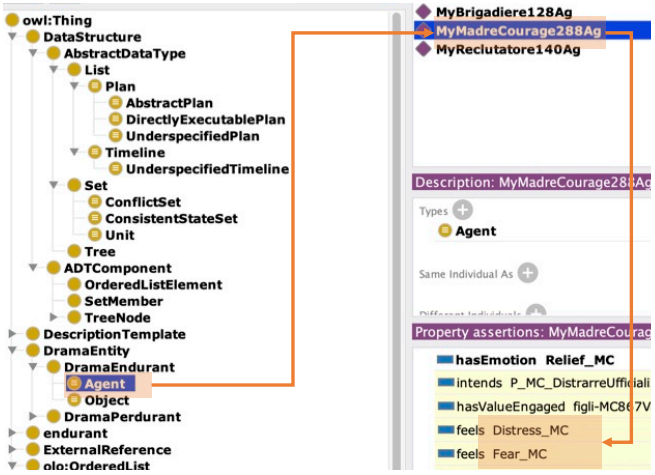

Figure 4: Example encoded .

4 Conclusions

The paper has presented a computational model for the generation of characters' emotions in a narrative. The model descends from the well-known OCC theory of emotion appraisal and its encoded into logic clauses that are implemented through a standard reasoner, and applied to a fragment of a dramatic narrative. We are going to apply the model to a whole narrative (beyond the excerpt limits) and to validate the model with the comparison with human annotations.In particular, we are going to test the knowledge that the participants have of the emotion types.

5 Acknowledgements

The authors like to thank Rossana Damiano for her comments on Beatrice Osella's thesis.

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