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Formal Encoding of Drama Ontology.

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Abstract. The goal of this research is to lay the foundations for a formal theory of drama, that abstracts from the procedural and interactive aspects involved in the generation of dramatic content. Based on the structural accounts provided by traditional drama analysis, the theory proposed in this paper exploits an agent-based perspective on characters to provide a goal-based characterization of dramatic qualities.

1 Motivations

Since the advent of digital media, character-based, narrative forms of communication have become commonplace in human-computer interaction, including user interfaces for entertainment, and education [1,2,3,4,5]. The need for autonomous behaviour by these applications has led scholars to adopt the agent techniques developed in artificial intelligence research to define and implement the virtual characters [6]. As applications have evolved into multi-character, interactive systems, the need for a coordinated management of the plot execution has been realized by AI techniques for multi-agent coordination and cooperation [7,8].

While the main effort of system developers has addressed the use of AI techniques in the production of interactive storytelling applications, designers have rarely drawn on the widely acknowledged corpus of drama studies - from Aristotle's investigations to structuralist approaches - to characterize the dramatic qualities of virtual characters. However, there is still lack for computational theory that exploits the concepts of AI to characterize the principles of drama. The aim of this paper is to lay the foundations of a formal theory that systematizes the basic aspects of drama in a computational explicit model, with an immediate integration with agent-based theories. This theory, called *Drammar*, abstracts from the procedural aspects of drama generation, and is intended as the starting point for specifying, implementing and evaluating practical storytelling systems in a principled way.

Drammar is structured into two levels (see Figure 1). The *actional* level accounts for the intentional behaviour of the characters in a plot by enforcing a BDI perspective on the characters as intelligent, goal-directed agents: following Bratman's theory of practical reasoning [9], belief-desire-intention (BDI) agents form goals to pursue them, and, given their beliefs about the world, devise plans to achieve them. This level is augmented with a representation of emotions as provided by the OCC model [10]. The *directional* level accounts for the realization of a direction through the plot, by drawing from the intentionality of the characters through the use of attributes that account for the effect of plot incidents onto the characters' (i.e. agents') mental and emotional states.

Fig. 1. Drammar ontology. The higher level represents the directional level, the lower represents the anchoring of directions in actions, i.e. the actional level.

In this paper we motivate and introduce the directional level of Drammar and apply it to a representative example of dramatic art, a fragment of Hitchcock's *North by Northwest*. The paper first introduces the relevant issues, from the point of view of drama analysis, that are to be encoded in Drammar, and then presents the definition of Drammar. An example and the conclusions close the paper.

2 Drama Analysis

The goal of a drama is to make audience perceive what is intuitively called *plot* by exhibiting the actions of some *characters* (in conflict); actions are organized into a *plot*; the plot moves toward a *direction*. The notions of direction, character (a *dramatis persona*) and plot, pervasive throughout the literature on drama analysis, are the three components of the directional level of Drammar (see figure 1).

The drama direction derives from the notion of "unity of action", originally expressed by Aristotle [11] and clearly stated by Stanislavsky and Styan [12,13]. A more operational account of direction is the notion of *premise*, which takes a tripartite form: $\langle \text{Character's value at stake}, \text{Conflict (or direction of action)}, \text{Results (or goal)} \rangle$ [14,15]. The premise contains a movement caused by a conflict between the character and the environment and/or other characters. Such a movement concerns the moral or emotional value of the character. As we will illustrate, in Drammar, the *direction* is a change function that transforms the initial state of a character into a final state at the end of the drama [14,16]. Such states are defined through

The relationship between the value changes of the rational/emotional state of the characters and the actual actions and events listed in a drama is stated through the notion of *drama goal*. The drama goal is the world state brought about by the actions that realizes the drama direction. In particular, the drama goal is operationally defined as the achievement or the negation of the goal of a character, the *drama protagonist*. In the example above, the drama direction consists in the greedy character losing his self and social esteem; an appropriate drama goal may be the state in which the greedy character is caught in the act of stealing the alms. The other characters, by pursuing the achievement of their own goals, act as to oppose the protagonist (the *opponents*) to help him (the *extras*). The combination of the actions acted by the protagonist and the other characters, together with the environment events, achieve the drama direction. In the example, the goal of the greedy character to steal the alms without being caught is frustrated by the an opposite world state provided by the drama goal: as a consequence, the stealing plan of the greedy character will be opposed by other characters, and they will catch him red-handed.

The drama direction is defined as a rational/emotional state change over the set of attributes that define the character, or *dramatis persona*. This set is divided into sub-sets, in order to combine the rational, Belief-Desire-Intention (BDI) perspective on agents with an emotional component. The rational attributes model the character's knowledge, subdivided into ontological, actional, social and normative, and his motivation, or desires (the agent's long-term goals and preferences), that will translate into the intentions pursued by the agent at the actional level.¹ The emotional component is structured along the lines provided by the Ortony-Clore-Collins (OCC) model of emotions [10], widely employed in interactive drama systems [18]. In this model, emotions basically derive from the appraisal of events, action, and agents, in terms, respectively, of their desirability for the agent's goals, their praise or dispraise according to the agent's moral standards, and their appealing according to the agent's dispositional attitudes. Attributes are valued positively or negatively; a value of an attribute can go from positive to negative or vice versa. In the example of the greedy character introduced above, the drama direction is accomplished by the change of the emotional attribute, *self-satisfaction*, which models an agent's approving (or disapproving) of the consequences of her/his own actions; this attribute turns from positive to negative as a consequence of the failure of the character's goal of stealing the alms.

Concerning the plot structure, it has been a well known convention, dating back to Horace's *Ars Poetica* [20], to segment the list of actions that form a drama into a sequence of units or sections, be it a "sequence of impressions" with a non-specified length or a more clear-cut subdivision [21,22,23,24]. Segmentation has been formalized in semiotic studies in order to mark the discrete advancements of the narration. It is important to notice that such units, despite terminological disparities, are of a recursive nature, so that some authors define drama as a recursive or "fractal" structure.

¹ In drama writing techniques, a similar account of characters as entities articulated by their salient features, classified along personality dimensions, is put forth by Seger [17].

the greedy character, the drama-unit characterized by the drama goal of stealing money contains a smaller drama-unit characterized by the goal of finding money is kept. Following McKee [24] and Elam [26], at the very end of the structure there are the minimal units of the plot, called *beats*, pure actional units by an action-reaction pair. The actual changes of the attribute values occur in every beat is part of a least one drama-unit. Going back to the example of the greedy character, the failed stealing of the alms may be the last unit in a sequence in which the character comes to know about the place where the alms have been hidden (first unit), then conceives the idea of stealing them (second unit), and eventually puts it into action (third unit). In the same way as the emotional change in the character's satisfaction was modelled by the change of the *self-satisfaction* attribute, the change brought about in the character by the first two units can be modelled through other attributes that model the rational connotation of the character: the fact that the character comes to know about the hiding of the alms (a belief) is modelled by the change from negative to positive of the *knows_about_hiding* attribute, and the fact that he conceives the idea of stealing them (an intention) is modelled by the *wants_to_steal* attribute (accompanied by an emotion of *hope*), which takes a positive value.

The description so far implicitly assumes that we are working with linear drama, where a unique list of beats is determined by a unique hierarchy of drama-units. It is worth pointing out here that we do not claim that each drama has a unique interpretation of its plot structure in terms of beats and drama-units, since each individual audience may perceive a different structure, but that each interpretation corresponds to a unique plot structure. So, each interpretation proposed by the literary critic about a specific drama maps to a unique plot structure. In non-linear drama, there is not a unique list of beats, but a multiplicity of plots, licensed by a formal system (e.g., a formal grammar, a constraint-based system, etc.). Non-linear drama generalizes the concept of linear drama by resorting to a meta-system to generate the plot structure: the different lists of beats licensed by the meta-system are alternative realizations of the drama. If a linear structure is a special case that results from a non-ambiguous meta-system, in an interactive version of the greedy character story, the user may decide whether the character is to be caught red-handed or not: keeping the drama direction uncertain, if the character succeeds in stealing the alms, he may for example contract a moral crisis because the alms were infected. Or else, the top level of the plot structure may change to a different one, for example, "ruin leads to redemption", and the character, once in jail, may redeem himself. Notice that the set of the characters' variable attributes associated with the drama-units can be contradictory, since the multiplicity of plots can realize multiple drama directions and different characters' sets. It is a topic for future research to determine what elements should be kept fixed (or unique) to achieve the coherence of the plot.

The units of the drama and their directions are combined in a drama-space progression that is related (via the protagonist's fate) with the emotional engagement of the audience. Dramatic actions in the plot trace a curve related to the fulfilment

in a beat included in some sub-unit of the unit itself. The temporal position of the beat is mapped onto a dramatic value based on the content of the unit, and the succession of values forms a curve, the *dramatic arc*. The drama literature widely recognizes an upside down U-shaped form of the dramatic arc: the first, the highest, and the last dramatic values have received specific names (inciting incident, exposition, rising action, conflict; climax, crisis, or turning point; conclusion or resolution [14,21,22]). If a drama is carefully designed, the dramatic arc reaches its peak towards the end of the plot (some changes may occur later).

3 The Drammar Ontology

The ontology of drama presented here, called Drammar, consists of two levels: a *directional level* that encodes the specific traits of drama illustrated in the previous section and an *actional level* that connects such traits with an agent-based perspective on the actions of the actors. At the directional level, a Drama-unit is a triple of Plot, Direction and Personae. The actional level unfolds the rational and the emotional perspectives on the facts that occur in the Drama-unit, the goal of the Drama-unit, and the traits of the characters. The facts can be either *Actions*, i.e. facts determined by the actions of the actors in pursuit of their aims (*Characters' Goals*) and belonging to the *Character Library of actions*, or incidental *Events*. The beliefs and long-term desires of the characters are encoded in the *Characters' attributes*, which are instances of the rational knowledge (Thought in Aristotle's terms) or of the emotional knowledge (Feeling in Aristotle's terms) types contained in the OCC model respectively.

Each element of the directional level is connected with some element at the actional level through some specific relation. The actions and events represented in the actional level are listed in the Plot only as functional to the accomplishment of the Direction. The Direction, in turn, models the goals of the characters according to a fulfilment/frustration dimension, through which the characters' dramatic qualities (their selection of their overall specification - are affected. The directional level of Drama is encoded in the notion of Drama-unit, which consists of a number of Dramatis personae, a Direction and a Plot (see Figure 1). Drama-units are organized in a hierarchical structure, which accounts for the segmentation of drama. We now present each component of the Drama-unit, then we provide the definition of the overall notion of drama.

The Dramatis persona is a set of $\langle \text{attribute}, \text{value} \rangle$ pairs, where the attribute is a binary-valued $\{+, -\}$. A drama-unit inverts the values of one or more attributes of the characters. Not all of the attributes describing a character at the actional level are affected by the changes carried out by the drama plot. For example, Othello changes his attitude toward Desdemona but does not resign from his military position; Nerissa continues performing her stereotyped married life but does not stop loving her children.

Definition: A dramatis persona *CHAR* is a pair $\langle \text{ATT}, \text{POLARITY} \rangle$, where *ATT* is a subset of *POOL*; *POLARITY* is a set of pairs $\langle x, v_x \rangle$, where $x \in \text{ATT}$.

attributes after the execution of the Plot element of a Drama-unit. So, the domain of the direction function is a State (where a State is a set of Polarities of attributes) and its co-domain is another State. So, let a State be $\bigcup_i CHAR_i.POLARITY$:

$$\mathcal{D} : State_j \rightarrow State_f$$

where we enforce the *Minimal Direction* condition that at least one attribute changes its polarity, i.e. there exists at least one attribute $a_i \in CHAR_i$ such that the assignment of a in the initial state $State_j$ is different from the value assignment in the final state $State_f$.

The drama-plot is the component that carries out the polarity inversions as required by the Direction function. It consists of a list of actions/events grouped in Beats. The value changes required by the Direction function occur within one Beat. Not every Beat may not change any attribute value, but every change does occur within one Beat. The three components above form a drama-unit.

Definition: A drama-unit is a triple $\langle Dramatis_personae, Direction, Plot \rangle$

- *Dramatis_personae* is a finite set of Dramatis_persona $\{DP_1, DP_2, \dots\}$
- *Direction* is a function D defined as above;
- *Plot* is a list of Beats $\langle B_1, B_2, \dots, B_m \rangle$,

and the Minimal Direction condition holds.

A drama-unit represents by itself all the basic aspects of drama, as introduced in the previous section. Drama-units are subdivided into smaller drama-units, until the number of elementary drama-units is reached. The resulting structure is a tree of drama-units whose leaves are directly connected to beats, and whose root is the proper drama-unit for the drama, the highest-level unit that subsumes the entire sequence of beats. For a given drama is the drama-unit that is not dominated by other drama-units.

The dramatic value of a drama-unit is provided by the number of value changes that occur within the unit or in some sub-unit. A drama-unit changes values either directly (that is, in a beat that it includes directly) or through a sub-unit (that is, in a beat that is in a sub-unit). The horizontal (temporal) position of a drama-unit is the beat in which the last value change performed directly by the drama-unit occurs. Given a drama-unit, the dramatic arc of that drama-unit is given by the line formed by connecting the dramatic values of the children units plus the unit itself.

4 An Example

In this section, we apply the formal system Drammar to the well-known Hays and North by Northwest [27], following the analysis reported in [23]. North by Northwest is about a middle-aged advertising executive, Roger Thornhill, who is mis-

he will discover that Eve is an undercover CIA agent and together they will evil gang, on a thrilling sequence on the Mount Rushmore.

ID	Description	Drama Goal	Attribute	Value	Attribute-type
1	R. mistaken for Kaplan and kidnapped by Vandamm's gang	Kidnapped (Roger) True	Distress	+	EMOTION.well-being
2	R. gets aware of mismatch and tries get out of trouble	Involved (Roger) True	Individualism	-	BELIEF.norms
2.1	R. meets Vandamm	Agreement (Roger,Vandamm) False	Disappointment	+	EMOTION.prospect-based
2.1.1	Vandamm addresses R. as Kaplan	Mentioned (Vandamm,Kaplan) True	Distress	+	EMOTION.well-being
2.1.2	Vandamm threatens R. of death	Threatened (Vandamm,Roger) True	Anger	+	EMOTION.well-being/attribution
2.1.3	Vandamm's gang tries to kill R.; R. escapes	Killed (gang, Roger) False	Relief	+	EMOTION.prospect-based
2.2	Nobody believes R.; R. accused of shooting Townsend	Outcast (Roger) True	Isolation	+	BELIEF.world-state
2.2.1	R.'s report not believed by anybody	Discredited (Roger) True	Anger	+	EMOTION.well-being/attribution
2.2.2	R. leaves his mother	Left (Roger.Mother) True	Submission	-	BELIEF.social
2.2.3	R. is believed to have killed Townsend	Falsely_accused (Roger.assassination) True	Disappointment	+	EMOTION.prospect-based
2.3	R. escapes police, meets Eve, seduction, fake appointment	Seduced (Eve,Roger) True	Love	+	EMOTION.attraction
2.3.1	R. runs away by train	Caught (Roger.Train) True	Relief	+	EMOTION.prospect-based
2.3.2	E. hides R. from police in the cabin	Hidden (Roger) True	Gratitude	+	EMOTION.well-being-attribution
2.3.3	R. and E. sleep together	Had_sex (Roger.Eve) True	Satisfaction	+	EMOTION.prospect-based
2.3.4	E. fixes the fake appointment with Kaplan	Deceived (Eve,Roger)True	Hope	+	EMOTION.prospect-based
2.3.5	Airplane tries to kill R.	Meeting (Roger,Kaplan) False	Disappointment	+	EMOTION.prospect-based
2.4	R. calls E.'s bluff and Professor explains	Explain (Professor,Roger) True	Anger	+	EMOTION.well-being-attribution
2.4.1	R. discloses E.	Deceive (Eve,Roger) False	Reproach	+	EMOTION.attribution
2.4.2	R. finds about Vandamm and E.	Unmasked (Roger.Vandamm) True	Anger	+	EMOTION.well-being-attribution
2.4.3	R. arrested and meets Prof.	Meeting (Professor,Roger) True	Truth	+	BELIEF.world-state
2.4.4	E.'s identity revealed	Revealed (Eve's identity,Roger) True	Pity	+	EMOTION.fortune-of-others
3	R. takes revenge	Married (Roger,Eve) True	Family	+	BELIEF.norms
3.1	E. pretends shooting R. at M. Rushmore	Collaboration (Roger,Eve) True	Relationship	+	BELIEF.social
3.1.1	E. fake-shoots R.	Deceived (Roger,Vandamm) True	Satisfaction	+	EMOTION.prospect-based
3.1.2	E. to leave with Vandamm	Coupled (Roger,Eve) True	Love	+	EMOTION.attraction
3.2	Chase and fight at M. Rushmore	Saved (Roger.Eve) True	Gratification	+	EMOTION.well-being/attribution
3.2.1	R. escapes from hospital	Rebellion (Roger,Professor) True	Independence	+	BELIEF.normative
3.2.2	Leonard discloses Eve's secret	Informs (Leonard,Vandamm, Eve's trick) True	Fear	+	EMOTION.prospect-based
3.2.3	R. kills Leonard on M. Rushmore	Killed (Roger,Leonard) True	Relief	+	EMOTION.prospect-based

Fig. 2. Analysis of North by Northwest

standard filmic terminology. For example, Act 1 - being introductory - is not split into smaller units, while Act 2 and 3 consist of 4 and 2 sequences respectively.

The second column, Description, contains an informal description of the unit. The third column, Drama goal, contains the drama goal through which the direction of the Drama-unit is accomplished. The state to be accomplished is always as the state in which a certain predicate is true or false. For example, Act 1 leads to a state in which the moral standards of the protagonist, Roger Thorpe, have been affected, so as to make him more inclined to help the others (the predicate "involved(Roger)" becomes true). This drama goal will be in turn accomplished by the drama goals of the sub-units that compose it: the accomplishment of this information will be carried out by Roger's need to take himself out of a big trouble (opened in Sequences 2.1 and 2.2), together with the seduction operated on him (Sequence 2.3) and the awareness of a conflict between the intelligence service of his country and a group of evil spies (Sequence 2.4).

The last three columns, Attribute, Value and Attribute-type, describe the direction of each Drama-unit. In Drammar, the Direction consists in the change of the value of one or more attributes. For example, in Act 1, Roger falls into distress as a consequence of being kidnapped by Vandamm's gang, setting the emotional attribute "distress" to a positive value; in Act 2, Roger's "individualism", initially set to "-", is set to "+". Although the attributes of the characters affected by changes belong to both the rational and emotional category (individualism and distress are representative of the rational category as reported in the Attribute-type column), most attributes belong to the emotional category, especially in lower-level drama-units. The subtype to which each attribute belongs is expressed by the dot notation: for example, the "BELIEF.norms" expression refers to "individualism" means that this attribute belongs to the normative component of the character's rational connotation. When emotional attributes occur, their subtype refers to the OCC cognitive model of emotional appraisal. For space reasons, the relation between the emotion activation and the character's appraisal is not reported in this table; for each attribute, we only report to which class of emotion it belongs according to OCC classification of emotion types. For example, in Sequence 4 of Act 2 (ID 2.4.1), Roger realizes that Eve, after seducing him, is acting against him: we classify his mental state as dominated by reproach, as a consequence of the moral evaluation of the behavior of Eve, construed as an agent. However, it is important to notice that the same situation could be as well construed as an unpleasant event by Roger, and thus be a source of distress. Finally, the undesirable effect of the blameworthy behavior for Roger may determine Roger's anger.

The last column (Drama value) reports the dramatic value of each drama-unit. For space reasons, we do not report a diagram of the dramatic arc, since its U-shapedness can be appreciated only by considering the temporal position of the beats in which the attribute changes occur.

analysis. Although a number of systems have been developed for the generation of dramatic content, spanning from explicitly drama-oriented systems [28,1] to systems [29,8,30], a formal characterization of the output generated by these systems is still lacking. Based on a broad analysis of traditional literature on drama terms, Drammar accounts for the definition of drama on two levels: a direction level, which specifies the qualifying features of drama in a functional way, and the action level, which models the actions acted by the characters in the plot in an agentive perspective.

The Drammar system provides a language for describing drama as an off-line system, independent of specific applications. It relates the realization of a drama direction to the achievement of a goal at the actional level, but allows the same direction to be realized by different goals, and the same goal to be brought about by different actions of action and events. Interactive drama takes advantage of the non-deterministic accomplishment of the direction, by letting the user navigate the space of available plots. From the off-line, ontological point of view, it does not matter if the choices that determine the final plot are accomplished by the author before the user's fruitive action, or as a collaborative process between the author and the user through a proceduralized interaction.

The description of drama ontology provided in this paper is only a first step towards a comprehensive formal system, that includes a decision procedure for analyzing and generating drama. Several instruments have been proposed to this aim, ranging from story-oriented approaches (rooted in story grammars [31] and scripts [32]) to agent-based systems, in which the story emerges as a result of the interplay of the behavior of multiple agents. In this paper, we have specified the requirements of drama in the context of system design and evaluation, and leave to future research the task of identifying the instruments by which the formal theory may be incorporated into practical applications.

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