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(Article begins on next page)

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 from 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, entertainment, and education [1,2,3,4,5]. The need for autonomous behavior required 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 centralized 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 relied upon the widely acknowledged corpus of drama studies - from Aristotle's investigations to structuralist approaches - to characterize the dramatic qualities of virtual narratives. However, there is still lack for computational theory that exploits the conceptual tools 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 direct and explicit model, with an immediate integration with agent-based theories. The 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 models the intentional behaviour of the characters in a plot by enforcing a BDI perspective on characters as intelligent, goal-directed agents: following Bratman's theory of practical reasoning [9], belief-desire-intention (BDI) agents form goals to pursue their desires, 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 abstracting from the intentionality of the characters through the use of attributes that model the effect of plot incidents onto the characters' (i.e. agents') mental and emotional state.

signed to a number of *attributes*, or dramatic qualities of the characters. For example, given a premise according to which “greed leads to ruin”, the *self-satisfaction* attribute of a greedy character may change its value through a sequence of actions.

The relationship between the value changes of the rational/emotional states 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 plot, that realizes the drama direction. In particular, the drama goal is operatively specified 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 loosing 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 acting for the achievement of their own goals, act as to oppose the protagonist (the *opponents*), or 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 goal. For example, the goal of the greedy character to steal the alms without being caught will be 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, who may catch him red-handed.

The drama direction is defined as a rational/emotional state change over a set of attributes that define the character, or *dramatis persona*. This set is divided into two sub-sets, in order to combine the rational, Belief-Desire-Intention (BDI) perspective [9] on agents with an emotional component. The rational attributes model the character’s knowledge, subdivided into ontological, actional, social and normative, and her/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) cognitive model of emotions [10], widely employed in interactive drama systems [18,19,8]. In this model, emotions basically derive from the appraisal of events, action, and objects in terms, respectively, of their desirability for the agent’s goals, their praiseworthiness 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 change 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 an 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 number of units or sections, be it a “sequence of impressions” with a non-specified length [13] 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 [25,26]. It is important to notice that such units, despite terminological disparities, are of the same nature, so that some authors define drama as a recursive or “fractal” structure [23]. We

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

call the units of this recursive structure *drama-units*, and define drama as a drama-unit that is not included in any other unit. In parallel with the inclusion of drama-units in larger drama-units, the same relation holds between drama goals: in the example of the greedy character, the drama-unit characterized by the drama goal of stealing the money contains a smaller drama-unit characterized by the goal of finding where the money is kept. Following McKee [24] and Elam [26], at the very end of the recursive structure there are the minimal units of the plot, called *beats*, pure actional units formed by a action-reaction pair. The actual changes of the attribute values occur in beats, and 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 through 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 goes into action (third unit). In the same way as the emotional change in the character's self-satisfaction was modelled by the change of the *self-satisfaction* attribute, the changes brought about in the character by the first two units can be modelled through specific attributes that model the rational connotation of the character: the fact that the greedy 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 *want_steal_alms* 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 in the audience may perceive a different structure, but that each interpretation corresponds to a unique plot structure. So, each interpretation proposed by the literary criticism 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 case of linear drama by resorting to a meta-system to generate the plot structure: the possible lists of beats licensed by the meta-system are alternative realizations of the drama, and 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-hands or not: keeping the drama direction unchanged, if the character succeeds in stealing the alms, he may for example contract a mortal illness because the alms were infected. Or else, the top level of the plot structure itself 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 matter of future research to determine what elements should be kept fixed (or unique) in order to achieve the coherence of the plot.

The units of the drama and their directions are combined in a drama-specific 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 of the

direction. Each drama-unit, with its goal, has both a temporal position and a *dramatic value* within the plot. The dramatic value of a drama unit is given by the number of value changes that occur within the unit, either in a beat directly included by the unit or in a beat included in some sub-unit of the unit itself. The temporal position of each unit is mapped onto a dramatic value based on the content of the unit, and the resulting succession of values forms a curve, the *dramatic arc*. The drama literature widely acknowledges 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, or rising conflict; climax, crisis, or turning point; conclusion or resolution [14,21,22,23,24]. 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 characters. At the directional level, a Drama-unit is a triple of Plot, Direction and Dramatis Personae. The actional level unfolds the rational and the emotional perspective in terms of the facts that occur in the Drama-unit, the goal of the Drama-unit, and the attributes of the characters. The facts can be either *Actions*, i.e. facts determined by the characters in pursuit of their aims (*Characters' Goals*) and belonging to the *Characters' Library of actions*, or incidental *Events*. The beliefs and long-term desires as well as the emotions of the characters are encoded in the *Characters' attributes*, which in fact are instances of the rational knowledge (Thought in Aristotle's terms) or of the emotion 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 drama at 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 - a selection of their overall specification - are affected. The directional level of Drammar 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; 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 attributes are binary-valued $\{+, -\}$. A drama-unit inverts the values of one or more attributes of some characters. Not all of the attributes describing a character at the actional level will be 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; Nora stops 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 $x \in \text{ATT} \text{ e } v_x \in$

$\{+, -\}$. All the attributes in ATT are assigned a value in $POLARITY$ and for each attribute only one assignment is permitted.

The Direction is a function D that specifies the value changes of the characters' 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 the 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 inverts its polarity, i.e. there exists at least one attribute $a_i \in CHAR_i$ such that the value assignment of a in the initial state $State_j$ is different from the value assignment of a in the final state $State_f$.

The drama-plot is the component that carries out the polarity inversions as described 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. Notice that some Beat may not change any attribute value, but every change does occur in some Beat. The three components above form a drama-unit.

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

- *Dramatis_personae* is a finite set of *Dramatis_personae* $\{DP_1, DP_2, \dots, DP_n\}$;
- *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 level 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 properly called drama, the highest-level unit that subsumes the entire sequence of beats. Formally, a 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 included in a sub-unit). The horizontal (temporal) position of a drama-unit is the beat where 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 all 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 Hitchcock's North by Northwest [27], following the analysis reported in [23]. North by Northwest is about a middle-aged advertising executive, Roger Thornhill, who is mistaken for

a government agent George Kaplan by a gang of spies lead by Mr Vandamm. He gets involved in a series of misadventures and is pursued across the States by both the spies and the government whilst being helped by a beautiful blonde Eve Kendall. Eventually he will discover that Eve is an undercover CIA agent and together they will defeat the evil gang, on a thrilling sequence on the Mount Rushmore.

ID	Description	Drama Goal	Attribute	Value	Attribute-type	Dramatic Value
1	R. mistaken for Kaplan and kidnapped by Vandamm's gang	Kidnapped (Roger) True	Distress	+	EMOTION.well-being	1
2	R. gets aware of mismatch and tries get out of trouble	Involved (Roger) True	Individualism	-	BELIEF.norms	20
2.1	R. meets Vandamm	Agreement (Roger,Vandamm) False	Disappointment	+	EMOTION.prospect-based	4
2.1.1	Vandamm addresses R. as Kaplan	Mentioned (Vandamm,Kaplan) True	Distress	+	EMOTION.well-being	1
2.1.2	Vandamm threatens R. of death	Threatened (Vandamm,Roger) True	Anger	+	EMOTION.well-being/attribution	1
2.1.3	Vandamm's gang tries to kill R.; R. escapes	Killed (gang, Roger) False	Relief	+	EMOTION.prospect-based	1
2.2	Nobody believes R.; R. accused of shooting Townsend	Outcast (Roger) True	Isolation	+	BELIEF.world-state	4
2.2.1	R.'s report not believed by anybody	Discredited (Roger) True	Anger	+	EMOTION.well-being/attribution	1
2.2.2	R. leaves his mother	Left (Roger.Mother) True	Submission	-	BELIEF.social	1
2.2.3	R. is believed to have killed Townsend	Falsely_accused (Roger.assassination) True	Disappointment	+	EMOTION.prospect-based	1
2.3	R. escapes police, meets Eve, seduction, fake appointment	Seduced (Eve,Roger) True	Love	+	EMOTION.attraction	6
2.3.1	R. runs away by train	Caught (Roger.Train) True	Relief	+	EMOTION.prospect-based	1
2.3.2	E. hides R. from police in the cabin	Hidden (Roger) True	Gratitude	+	EMOTION.well-being-attribution	1
2.3.3	R. and E. sleep together	Had_sex (Roger.Eve) True	Satisfaction	+	EMOTION.prospect-based	1
2.3.4	E. fixes the fake appointment with Kaplan	Deceived (Eve,Roger)True	Hope	+	EMOTION.prospect-based	1
2.3.5	Airplane tries to kill R.	Meeting (Roger,Kaplan) False	Disappointment	+	EMOTION.prospect-based	1
2.4	R. calls E.'s bluff and Professor explains	Explain (Professor,Roger) True	Anger	+	EMOTION.well-being-attribution	5
2.4.1	R. discloses E.	Deceive (Eve,Roger) False	Reproach	+	EMOTION.attribution	1
2.4.2	R. finds about Vandamm and E.	Unmasked (Roger.Vandamm) True	Anger	+	EMOTION.well-being-attribution	1
2.4.3	R. arrested and meets Prof.	Meeting (Professor,Roger) True	Truth	+	BELIEF.world-state	1
2.4.4	E.'s identity revealed	Revealed (Eve's identity,Roger) True	Pity	+	EMOTION.fortune-of-others	1
3	R. takes revenge	Married (Roger,Eve) True	Family	+	BELIEF.norms	8
3.1	E. pretends shooting R. at M. Rushmore	Collaboration (Roger,Eve) True	Relationship	+	BELIEF.social	3
3.1.1	E. fake-shoots R.	Deceived (Roger,Vandamm) True	Satisfaction	+	EMOTION.prospect-based	1
3.1.2	E. to leave with Vandamm	Coupled (Roger,Eve) True	Love	+	EMOTION.attraction	1
3.2	Chase and fight at M. Rushmore	Saved (Roger.Eve) True	Gratification	+	EMOTION.well-being/attribution	4
3.2.1	R. escapes from hospital	Rebellion (Roger,Professor) True	Independence	+	BELIEF.normative	1
3.2.2	Leonard discloses Eve's secret	Informs (Leonard,Vandamm, Eve's trick) True	Fear	+	EMOTION.prospect-based	1
3.2.3	R. kills Leonard on M. Rushmore	Killed (Roger,Leonard) True	Relief	+	EMOTION.prospect-based	1

Fig. 2. Analysis of North by Northwest

The table in Figure 2 contains the translation of North by Northwest in Drammar terms. The first column, ID, reports the hierarchical structure of Drama-units; the levels of the hierarchy correspond (in decreasing order) to acts, sequences and scenes in the standard filmic terminology. For example, Act 1 - being introductory - is not subdivided 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 Drama-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 described as the state in which a certain predicate is true or false. For example, Act 2 (ID 2), leads to a state in which the moral standards of the protagonist, Roger Thornhill, 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 through the drama goals of the sub-units that compose it: the accomplishment of this transformation will be carried out by Roger's need to take himself out of a big trouble (developed in Sequences 2.1 and 2.2), together with the seduction operated on him by Eve (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 a "+". Although the attributes of the characters affected by changes belong to both the rational and emotional category (individualism and distress are representative of the two, as reported in the Attribute-type column), most attributes belong to the emotional type, 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 referred to "individualism" means that this attribute belongs to the normative component of the character's rational connotation. When emotional attributes occur, their classification 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 explicitly represented in this table; for each attribute, we only report to which class of emotions it belongs according to OCC classification of emotion types. For example, in Scene 1 of 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 an effect 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 undesirable event by Roger, and thus be a source of distress. Finally, the undesirable effects of Eve's 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-shaped form can be appreciated only by considering the temporal position of the beats where the attribute changes occur.

5 Conclusions and Future Work

In this paper we have provided the foundations for devising a formal theory of drama analysis. Although a number of systems have been developed for the generation of dramatic content, spanning from explicitly drama-oriented systems [28,1] to narrative 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 cast in AI terms, Drammar accounts for the definition of drama on two levels: a directional level, which specifies the qualifying features of drama in a functional way, and the actional level, which models the actions acted by the characters in the plot in an agent-based perspective.

The Drammar system provides a language for describing drama as an off-line object, 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 courses of action and events. Interactive drama takes advantage of the non-determinism in the accomplishment of the direction, by letting the user navigate the space of alternative 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 fruition or by a collaborative process between the author and the user through a procedural system.

The description of drama ontology provided in this paper is only a first step toward a comprehensive formal system, that includes a decision procedure for analyzing or generating drama. Several instruments have been proposed to this aim, ranging from story-oriented approaches (rooted in story grammars [31] and scripts [32]) to character-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 a perspective 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 systems.

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