

# An Operational Semantics for Situated Ideological Systems, with a Religious Conflict as Case Study

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## Abstract

This paper introduces an operational semantics for what, in previous work, we have called *situated ideological systems*: sets of *ways to envisage* concrete social situations (normatively, valuationally etc.) that individuals and social groups may use to direct their choices and actions in such situations. The agent-based social model that we call *Agent Society* is used to computationally construe possible social situations where individual agents and groups of agents may find themselves, and to formally represent ideological systems in ways they can collectively share. As a case study of the proposed semantics, the paper formally presents the *ideological dynamics* underlying the temporal evolution of a paradigmatic situation of religious conflict (between catholics and devotees of African-Brazilian cults), as pictured in the classical Brazilian theatrical play *The Keeper of Promises (O Pagador de Promessas)*. The ideology modeling language TinyIML is used for the computational presentation of the various stages of that ideological dynamics. The syntax and semantics of TinyIML is summarized in an appendix.

**Keywords:** Situated ideological systems. Agent societies. Operational semantics. Ideological dynamics.

## 1 Introduction

Formal models of ideological systems are required to support both the social and political analyses of the ideological aspects of human societies and the computational modeling and simulation of those systems.

The work that has been done concerning *agent-based* computational modeling and simulation of social systems, even though expanding a wide range of topics are either concerned more with the behavioral or mental issues of agents, or with the operational issues of the organizations those agents constitute in given social situations, then with more general socio-cultural issues, like those we are calling *ideological*. Check out, for instance, the main journals of the area, e.g., JAAMAS, at <https://www.springer.com/journal/10458>, and JASSS, at <https://www.jasss.org/JASSS.html>.

The sequence of works to which this paper belongs aims, thus, to elaborate this latter concern. The aim of the present paper is to further that development by introducing an *operational semantics*, and a formal notion of *dynamics*, for ideological systems. The basics of the computational way that it adopts for the modeling of *ideological* issues has been introduced in [4].

The paper is structured as follows. Section 2 gives an overview of the ideological notions considered in the paper, and an account of related works. Section 3 presents, informally, the core concepts of the work. Section 4 reviews the formal definition of the concept of *ideological system* introduced in [4]. Section 5 introduces the *state transition system* aimed to capture, in general terms, the *dynamics* of ideological systems. Section 6 brings a case study. It makes use of ideology modeling language TinyIML to model in detail the ideological system that is at the core of plot of the classical Brazilian theatrical play *The Keeper of Promises (O Pagador de Promessas)* [10]. Section 7 brings the Conclusion. The Appendix presents a formal definition of TinyIML.

## 2 Preliminary Issues

### 2.1 Ideologies and Ideological Systems

The systematic use of the concept of *ideology* seems to have initiated by Marx and Engels's [14] for the characterization of the *conceptual frameworks* underlying political (but also sociological, philosophical, etc.) attitudes and discourses (see, e.g., [8]).

Naturally, then, the concept *ideology* is often assigned, both in academic studies and in public debates, the meaning of a *set of ideas* supporting social and political *revolutionary* attitudes and discourses, from which has been derived the expression: *marxist ideology*.

Curiously enough, and contrary to such understanding, Marx and Engels's original meaning of *ideology* was that of a set of *conservative* ideas, the diffusion of which, among the population of a society, has the intent of *preventing* any social or political transformation of that society. Ideology, in the sense usually intended for expressions like *marxist ideology* is, in fact, what Mannheim latter called *utopia* [13], and (to be faithful to the intended idea) should really be phrased as: *marxist utopia*.

For our purposes here, however, we need a concept of *ideology* that is as neutral as possible regarding political and social biases. We find that Adam Schaff's *functional concept* of ideology [17] serves well as a starting point:

*Ideology is a system of opinions that, by basing itself on a system of admitted values, determines the attitudes and the behaviors of men, regarding desired goals of development of the society, of the social group, or of the agent.*<sup>1</sup>

Nevertheless, Schaff's concept is still linked to the marxian tradition of ideological studies, in the sense that he considers that, in a society, there is in fact just *one* single ideology in operation. We need to generalize his concept, to allow for many ideologies to be in use in any society.

That is [4]:

*An ideology is any system of opinions that, by basing itself on a system of admitted values, determines the attitudes and the behaviors of men, regarding desired goals of development of the society, of the social group, or of the agent.*

So that:

*The ideological system of a given society is the system of ideologies that are in use in that society.*

Clearly, this functional concept of *ideology* involves elements such as *opinions* (beliefs), *values*, *attitudes*, *behaviors*, and *goals*, as well as the *functions* that these elements may realize for societies, their institutions, social groups, and individuals.

We take the *ideological model* of a social situation to be a description of the ideological aspects of that situation, as given by an external observer. Accordingly, we take that any social actor is required to detach itself from the target social situation, and to behave as if were an external observer, whenever it reasons about the ideological system of that situation.

In particular, an ideological model aims to capture:

- the set of *ideological states* of the given social situation (i.e., as explained below, the sets of *ideological frameworks* that are adopted by each agent, or group of agents, present in that situation), at the observation period;
- the *operational semantics* of the ideological system of that social situation (i.e., the *state transition rules* governing the dynamics of the ideological system of that situation).

Thus, an ideological model is taken to be *objective*, relatively to the target social situation, in the sense that it is not conceived to be a part of the society, at the time it is defined, since the observer is considered to be *external* to the society, at that time.

On the other hand, an ideological model is also taken to be *subjective*, in the sense that it aims to capture the ideological (thus, subjective) *envisagements* that the agents and groups of agents, present in the target situation, adopt about that situation.

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<sup>1</sup>Translation and emphases by myself.

## 2.2 Related Works

Roger Schank and Jaime Carbonell seemed to have been the first to investigate issues related to the computational modeling of ideological systems [18], but they restricted their interest to problems of political disputes. Carbonell did the same, in an extended way, in [2].

Those works seem to have set a standard for the modeling of ideological issues in terms of *political goals* and *political plans*. Naturally, subsequent ideological modeling works were also concerned with ideologies in this strictly political sense (e.g., [9, 12, 19]).

Some later works tackled the problem of *general* ideological modeling, but adopting a *quantitative* approach (either algebraic or geometric, sometimes statistical), which we consider inadequate for a proper account of the *qualitative* aspects of ideological issues (e.g., [1, 11]).

Diverging from those works, the approach to the formal modeling of ideologies adopted here is *symbolic*, in the computational sense, and one in which *political goals* and *political plans* are considered to be just *particular types* of ideological elements, not the basic or general ones.

## 3 Conceptual Background

### 3.1 Agent Societies

The particular type of multiagent systems that we are calling *agent societies* is being developed through a series of works, including [7, 6, 5, 3].

In those works, an *agent society* is taken to be a multi-agent system which is:

- *open*: agents can freely enter and leave the system;
- *organized*: agents and sets of agents relate to each other in systematic ways, on the bases of notions of *roles*, *groups*, *organizations*, etc.;
- *persistent*: the organization of the system persists in time, independently of the enterings or leavings of the agents, or of the agents changing their modes of behavior or interaction, or changing their positions or status in the society;
- *situated*: operating in a (real or simulated) material environment.

Figure 1 shows the four basic components of the organization of an *agent society*:

- the *population*: the set of agents that inhabit the society;
- the *organizational structure*: the set of organizational roles, institutions, etc. of the society;
- the *material environment*: the system of material elements (objects, etc.) operationally involved in the conducts (of the agents, organizations, etc.) realized in the society;
- the *symbolic environment*: the system of ideological representations of the publicly (i.e., collectively) developed cultural elements (theories, values, habits, systems of norms, etc.) operationally involved in the conducts (of agents, organizations, etc.) realized in the society.

Structurally, the *ideologies* and the *ideological system* of an agent society are taken as components of the *symbolic environment* of that society. Operationally, they are often tightly *coupled* both to other symbolic systems present in the symbolic environment (such as the symbolic systems of *art*, *law*, *religion*, etc.) and to the other three basic components of the society (population, organizational structure and material environment)<sup>2</sup>.

### 3.2 The Functional Notion of Ideological System

The presence of an *ideological system* in an agent society introduces, thus, important functional features in that society:

- it allows agents and groups of agents to establish *ideological identities* for themselves, on the basis of which they relate to each other in the organization and in the dynamics of the society;
- it allows for agents and groups of agents to behave and interact, in each social situation, in accordance with the *ideology* that corresponds to their respective *ideological identities*;

<sup>2</sup>These *operational couplings* can be clearly seen in the ideologies and ideological system analyzed in the case study (Sect. 6), even though they are not explicitly indicated there.

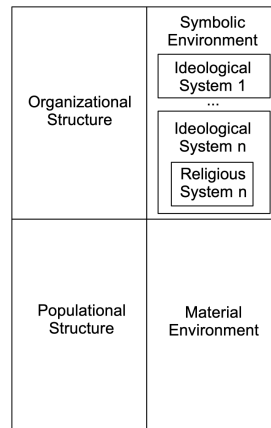


Figure 1: The four basic components of an *agent society*.

- it gives to the agent society itself an ideological identity, through which it can differentiate, both by cultural and by concrete actions, from other societies, and interact with them on the basis of such difference;
- it may support ways through which the agents and groups of agents can interact with each other in order to maintain (or to change) the organization of the society.

Accordingly, a more specific and complete definition of the functional concept of *ideology* may be given, as following:

*An ideology, functionally construed, is a system of values, norms and social ontologies, dedicated to support the social reasoning of a particular group of social actors, in an agent society.*

More precisely, the following core set of concepts, formally construed as *ideological envisagements*, are taken to constitute the basic elements of ideological systems:

- *segmental partitionings* of the population of the society;
- *relative values* that the possible social conducts may have, in that society;
- *relative qualifications* that the envisaged segments of the society may be thought to have, for the performance of those possible conducts;
- *normative regulations* that may seem appropriate for those conducts.

Other ideological envisagements may possibly be added, if required, as extensions, to such core set, e.g., envisagements corresponding to the main concepts of the classical *political* approaches to ideological modeling, namely, *political goals* (individual and social) and the *political plans* (also individual and social) capable of achieving them.

### 3.3 Situated Ideologies and Ideological Systems

We say that a formal model of an ideology or ideological system *situates* that ideology or ideological system in the society where the ideology or ideological system is in use, whenever the connections that such ideology or ideological system has with the components (agents, agent groups etc.) of the society are explicitly taken into account in that model. We say that such formal model accounts, then, for a *situated* ideology or ideological system.

But, notice that *situating* an ideology or ideological system in a given agent society, in a formal way, requires the availability of a formal account of that society (e.g., on the basis of the *Agent Society* model presented in Sect. 3.1, as we do in Sect. 4).

### 3.4 The Concept of Dynamics of a System

We construe *dynamical systems*, in a usual way, as structures with the form  $Sys = (St, Inp, Out, \Delta)$  where:

- $St$  is the set of *states* of  $Sys$ ;
- $Inp$  is the set of elements that can possibly be *input* to  $Sys$ ;
- $Out$  is the set of elements that can possibly be *output* from  $Sys$ ;
- $St \times Inp$  is the set of *input configurations* of  $Sys$ ;
- $St \times Out$  is the set of *output configurations* of  $Sys$ ;
- $(St \times Inp) \times (St \times Out)$  is the set of *configurations* of  $Sys$ , whose elements we denote by  $[(st, inp)/(st', out)]$ ;
- $\Delta \subseteq (St \times Inp) \times (St \times Out)$  is the *dynamics* of  $Sys$ .

The dynamics of  $Sys$  is such that, for any *input configuration*  $(st, inp) \in St \times Inp$ , it happens that  $\Delta(st, inp) \subseteq St \times Out$  is the set of *output configurations* that can be derive from  $(st, inp)$ , so that for each *configuration transition*  $(st', out) \in \Delta(st, inp)$  it holds that:

- $st'$  is the state *reached* by  $Sys$  as a consequence of that transition;
- $out$  is the element *output* from  $Sys$  as a consequence of that transition;

Whenever we have  $(st', out) \in \Delta(st, inp)$ , we say that the structure denoted by  $[(st, inp)/(st', out)]_\Delta$  constitutes an *instance* of a configuration transition (with the index  $\Delta$  possibly omitted, for simplicity, when convenient).

We define a *process* of  $Sys$  to be any *sequence of instances of configuration transitions* of the form:

$$[(st_0, inp_0)/(st_1, out_0)]_\Delta \rightarrow [(st_1, inp_1)/(st_2, out_1)]_\Delta \rightarrow \dots$$

where the arrow “ $\rightarrow$ ” denotes the *temporal sequencing* of configuration transitions.<sup>3</sup>

Whenever the system  $Sys$  is *closed*, with  $Inp = Out = \emptyset$ , instances of configuration transitions are denoted simply by  $[st/st']$  and processes have the simple form:

$$[st_0/st_1]_\Delta \rightarrow [st_1/st_2]_\Delta \rightarrow \dots$$

Notice, however, that we are contemplating systems whose *dynamics* may be *non-deterministic* (since, in general, their dynamics  $\Delta$  is *relational*, not strictly *functional*), so that it is *unpredictable*, in general, which transition will occur, at any given time, in any given process of the system.

## 4 The Formal Model of Situated Ideological Systems

### 4.1 Informal Overview

The basic concept here is that of an *ideological envisagement*, that is, a subjective view of an aspect of a social situation that is independent of the truth of that view. Such subjective view may be held by any active element present in the situation: an agent, set of agents, organization, set of organizations, even a whole agent society. We use the term *social actor* to refer to any one of these elements.

Of the many possible ideological envisagements, we deal with the following ones, in the present paper:

- *segmenting envisagements*: envisagements of the *set of social actors* (so, of the set of agents, organizations, etc.) present in a social situation, to the effect that, from the perspective of the social actors that adopt a given segmenting envisagement, that set of social actors is divided into *segments* (i.e., subsets of agents, subsets of organizations, etc.) that are taken to be similar to each other, in some given respect;
- *normative envisagements*: sets of *norms* regarding obligations, permissions and prohibitions of certain conducts, supposed to be valid for the members of the segments determined by a segmenting envisagement, to the effect that the social actors that adopt those normative envisagements take that the members of those segments behave and interact according to such norms;
- *valuating envisagements*: envisagements of a *set of social conducts* to the effect that these conducts are ordered according to the value that they have for the social actors that adopt such valuating envisagements;
- *qualifying envisagements*: envisagements of the members of the segments determined by a segmenting envisagement, regarding their (supposed) competence for performing certain conducts, to the effect that the social actors that adopt such qualifying envisagements order the members of different segments according to their (supposed) relative competence for the performance of those conducts.

<sup>3</sup>Clearly, this formal presentation of the *dynamics of systems* is a particular application of the concept of *structural operational semantics* proposed in [16].

At any given time, the social actors present in a given social situation may be *adopting* any number of ideological envisagements, of any type, concerning that situation.

An *ideological framework* is a certain way of putting together a set of ideological envisagements, so that they can be adopted in an organized, modular (formally encapsulated) way by a social actor.

The *ideology* of a social actor, at a certain time, is the intersection of the set of ideological frameworks that the social actor is adopting at that time.<sup>4</sup>

The *ideological system* operating in given social situation, at a given time, is the set of ideological frameworks that are adopted by the social actors present in that situation, at the given time.

We say that an ideological envisagement (or ideological framework, or ideology) is *active* in an agent society, at a certain time, if some social actor has adopted it by itself as a basis for taking decisions about the conducts that it realizes, at that time, independently of that adoption being publicly acknowledged or not.

We say that an ideological framework is *assigned* by a social actor to another social actor, at a certain time, if the former considers that the latter is adopting that ideological framework, at that time, independently of that adoption being true or not, at that time, and independently of that assignment being publicly acknowledged or not.<sup>5</sup>

Finally, we take that the *ideological state* of an agent society, at a given time, is a structure composed by at least:

- the set of ideological frameworks that each social actor happens to be adopting, at that time;
- the assignments of ideological frameworks that the social actors are making to each other, at that time;
- the set of operations that the social actors can make use of to change the ideological state, at that time.

## 4.2 Formal Definition

We first review the formal concept of *situated ideological system* introduced in [4]. Then, we formally define the concept of *dynamics* of situated ideological system, introduced above in an informal way.

Notice that those concepts are *situated* in relation to the general model of agent societies presented in Sect. 3.1.

### 4.2.1 Basic Universes

The *basic universes* on which the ideological system of an agent society *AgSoc* is constituted are:

- **SocAct**: the *universe of social actors* of the society;
- **CondType**: the *universe of types of conducts* that social actors may perform in the society.

From the former one immediately derives:

- **Segm** =  $\wp(\text{SocAct})$ : the *universe of segments* of social actors<sup>6</sup>.

### 4.2.2 Ideological Envisagements

We take that, at a minimum, the composition of the *universe of ideological envisagements* is:

$$\text{IdeoEnvis} = \text{SegmEnvis} \cup \text{NormEnvis} \cup \text{ValuatEnvis} \cup \text{QualifEnvis}$$

where:

- **SegmEnvis** =  $\wp(\text{Segm})$  is the universe of *segmenting envisagements*;
- **NormEnvis** is the universe of *normative envisagements*;
- **ValuatEnvis** is the universe of *valuating envisagements*;
- **QualifEnvis** is the universe of *qualifying envisagements*.

<sup>4</sup>Notice, thus, that in the formalization given below, *ideology* is a derived operational concept. The fundamental operational concept is *ideological framework*.

<sup>5</sup>Notice that the *ideological system* that is active in a given social situation is taken to be computationally represented as a component of the *Symbolic Environment* of the agent society in which that situation occurs.

<sup>6</sup> $\wp(X)$  denotes the powerset of the set  $X$ .

to which other universes of ideological envisagements may be added, depending on the application.

We leave formally undefined the structure of the three latter types of ideological envisagements because we assume them to be application dependent. But, notice that while the only basic universe referred to by **SegmEnvis** is the universe of social actors **SocAct** (indirectly, through **Segm**), the other envisagements refer also to **CondType**, the universe of types of conducts.

### 4.2.3 Ideological Frameworks

The *universe of ideological frameworks* is given by:

$$\mathbf{IdeoFrmwrk} = \mathbf{SegmEnvis} \times \mathbf{NormEnvis} \times \mathbf{ValuatEnvis} \times \mathbf{QualifEnvis}$$

and for any ideological framework:

$$ideoFrmwrk = (segmEnvis, normEnvis, valuatEnvis, qualifEnvis) \in \mathbf{IdeoFrmwrk}$$

with  $segmEnvis \neq \emptyset$ .

The envisagement  $segmEnvis$  is said to be the *reference segmentation* of the ideological framework, that is, the *segmentation of social actors* which the other envisagements ( $normEnvis$ ,  $valuatEnvis$  and  $qualifEnvis$ ) refer to.

### 4.2.4 Situated Ideologies

Given any social actor  $sa \in \mathbf{SocAct}$  of  $AgSoc$ , we denote by  $IdeoFrmwrk_{sa}^t$  the *set of ideological frameworks* that  $sa$  is adopting, at the time  $t$ .

For any segmenting envisagement  $se$  of any ideological framework present in  $IdeoFrmwrk_{sa}^t$ , we say that the *segment-bound ideology* of the social actor  $sa$ , regarding the segmenting envisagement  $se$ , is given by:

$$SBIdeo_{sa}^t(se) = (se, \sqcap NE_{sa}^t(se), \sqcap VE_{sa}^t(se), \sqcap QE_{sa}^t(se))$$

where:

- $NE_{sa}^t(se) = \{ne \mid \exists ve, qe : (se, ne, ve, qe) \in IdeoFrmwrk_{sa}^t\}$  is the set of normative envisagements that  $sa$  holds about  $se$  through  $IdeoFrmwrk_{sa}^t$ ;
- $VE_{sa}^t(se) = \{ve \mid \exists ne, qe : (se, ne, ve, qe) \in IdeoFrmwrk_{sa}^t\}$  is the set of valuating envisagements that  $sa$  holds about  $se$  through  $IdeoFrmwrk_{sa}^t$ ;
- $QE_{sa}^t(se) = \{qe \mid \exists ne, ve : (se, ne, ve, qe) \in IdeoFrmwrk_{sa}^t\}$  is the set of qualifying envisagements that  $sa$  holds about  $se$  through  $IdeoFrmwrk_{sa}^t$ ;

and where “ $\sqcap$ ” denotes different *intersection* operations whose precise definitions depend on the particular structures of the envisagements it operates on, so that, here, we leave open the exact definitions of such intersection operations.

Whenever  $\sqcap NE_{sa}^t = \sqcap VE_{sa}^t = \sqcap QE_{sa}^t = \emptyset$ , we say that the segment-bound ideology  $SBIdeo_{sa}^t(se)$  is *empty*.

The *ideology* of the social actor  $sa$  is defined, then, as the *set of segment-bound ideologies* hold by  $sa$ :

$$Ideo_{sa}^t = \{SBIdeo_{sa}^t(se) \mid \exists ne, ve, qe : (se, ne, ve, qe) \in IdeoFrmwrk_{sa}^t\}$$

and, whenever all the segment-bound ideologies in  $Ideo_{sa}^t$  are empty, we say that the ideology  $Ideo_{sa}^t$  is *empty*.

For any set of social actors  $SA \in \wp(\mathbf{SocAct})$ , the *ideology* of  $SA$ , at the time  $t$ , is given by:

$$Ideo_{SA}^t = \sqcap \{Ideo_{sa}^t \mid sa \in SA\}$$

where, again, the *intersection* operation is defined in a component-wise way, but depending on the particular structures of the ideological envisagements that are being considered.

Notice, then, that we use the intersection operations ( $\sqcap$ ) to indicate the strictness implied by the concept of *ideology* of a social actor: it is that *core* set of ideological envisagements that is embedded in every ideological frameworks being adopted by the social actor, at a given time.

#### 4.2.5 Situated Ideological Systems

The *ideological system* of an agent society  $AgSoc$  is a time-indexed structure:

$$IdeoSys_{AgSoc}^t = (SA^t, IdeoFrmwrk^t, AdptFrmwrk^t, AssgnFrmwrk^t, IdeoOper)$$

where, at each time  $t$ :

- $SA^t \in \wp(\mathbf{SocAct})$ :  
is the set of *social actors* of the society, at that time;
- $IdeoFrmwrk^t \in \wp(\mathbf{IdeoFrmwrk})$ :  
is the set of ideological frameworks that are *adopted* by at least one social actor, at that time;
- $AdptFrmwrk^t \subseteq \mathbf{SocAct} \times \mathbf{IdeoFrmwrk}$ :  
is the relation that specifies, for each social actor, the ideological frameworks that it *publicly adopts*, at that time;
- $AssgnFrmwrk^t \subseteq \mathbf{SocAct} \times \mathbf{IdeoFrmwrk} \times \mathbf{SocAct}$ :  
is the relation that specifies the ideological frameworks that each social actor *publicly assigns* to some other social actor, at that time;
- $IdeoOper = \{\text{include, remove, adopt, abandon, assign, retract}\}$   
is the time-invariant *set of ideological operations* that can be performed on the situated ideological system, such that, for any time  $t$ :
  - $\text{include}(IdeoFrmwrk^t, ideoFrmwrk) = IdeoFrmwrk^t \cup \{ideoFrmwrk\}$   
is the operation of *inclusion* of an ideological framework in the current set of adopted ideological frameworks;
  - $\text{remove}(IdeoFrmwrk^t, ideoFrmwrk) = IdeoFrmwrk^t - \{ideoFrmwrk\}$   
is the operation of *removal* of an ideological framework from the current set of adopted ideological frameworks;
  - $\text{adopt}((sa, ideoFrmwrk), AdptFrmwrk^t) = AdptFrmwrk^t \cup \{(sa, ideoFrmwrk)\}$   
is the operation of inclusion of the *adoption* of an ideological framework by a social actor in the current relation of adopted ideological frameworks;
  - $\text{abandon}((sa, ideoFrmwrk), AdptFrmwrk^t) = AdptFrmwrk^t - \{(sa, \{ideoFrmwrk\})\}$   
is the operation of removal of a relationship of adoption of an ideological framework by a social actor from the current relation of adopted ideological frameworks;
  - $\text{assign}((sa, ideoFrmwrk, sa'), AssgnFrmwrk^t) = AssgnFrmwrk^t \cup \{(sa, ideoFrmwrk, sa')\}$   
where  $sa \neq sa'$ , is the operation by which an assignment of an ideological framework is included in the current relation of assigned ideological frameworks;
  - $\text{retract}((sa, ideoFrmwrk, sa'), AssgnFrmwrk^t) = AssgnFrmwrk^t - \{(sa, ideoFrmwrk, sa')\}$   
where  $sa \neq sa'$ , is the operation by which an assignment of an ideological framework is removed from the current relation of assigned ideological frameworks.

With this formal model of *situated ideological systems*, we can formally define the *dynamics* of situated ideological systems.

## 5 The Dynamics of Situated Ideological Systems

To formally characterize the dynamics of situated ideological systems, we define the *ideological configurations* of a situated ideological system in a minimal form, which is just enough to deal with the case study in Sect. 6.

An *ideological configuration* of the situated ideological system:

$$IdeoSys_{AgSoc} = (SA, IdeoFrmwrk, AdptFrmwrk, AssgnFrmwrk, IdeoOper)$$

is a structure:

$$\langle \text{IF}, \text{AdF}, \text{AsF} \rangle \in IdeoFrmwrk \times AdptFrmwrk \times AssgnFrmwrk$$

where:



<p><b>Operation:</b> include(<i>if</i>)</p> <p><b>Transition rule:</b></p> $\frac{ideofrmwrk \in \mathbf{IdeoFrmwrk}}{[\langle \text{IF}, \text{AdF}, \text{AsF} \rangle / \langle \text{IF}', \text{AdF}, \text{AsF} \rangle]}$ <p><b>where:</b> <math>\text{IF}' = \text{IF} \cup \{if\}</math></p>	<p><b>Operation:</b> remove(<i>ideofrmwrk</i>)</p> <p><b>Transition rule:</b></p> $\frac{}{[\langle \text{IF}, \text{AdF}, \text{AsF} \rangle / \langle \text{IF}', \text{AdF}, \text{AsF} \rangle]}$ <p><b>where:</b> <math>\text{IF}' = \text{IF} - \{ideofrmwrk\}</math></p>
<p><b>Operation:</b> adopt(<i>sa, ideofrmwrk</i>)</p> <p><b>Transition rule:</b></p> $\frac{ideofrmwrk \in \text{IF} \quad sa \in SA}{[\langle \text{IF}, \text{AdF}, \text{AsF} \rangle / \langle \text{IF}, \text{AdF}', \text{AsF} \rangle]}$ <p><b>where:</b> <math>\text{AdF}' = \text{AdF} \cup \{(sa, ideofrmwrk)\}</math></p>	<p><b>Operation:</b> abandon(<i>sa, ideofrmwrk</i>)</p> <p><b>Transition rule:</b></p> $\frac{}{[\langle \text{IF}, \text{AdF}, \text{AsF} \rangle / \langle \text{IF}, \text{AdF}', \text{AsF} \rangle]}$ <p><b>where:</b> <math>\text{AdF}' = \text{AdF} - \{(sa, ideofrmwrk)\}</math></p>
<p><b>Operation:</b> assign(<i>sa, ideofrmwrk, sa'</i>)</p> <p><b>Transition rule:</b></p> $\frac{ideofrmwrk \in \text{IF} \quad sa, sa' \in SA}{[\langle \text{IF}, \text{AdF}, \text{AsF} \rangle / \langle \text{IF}, \text{AdF}, \text{AsF}' \rangle]}$ <p><b>where:</b> <math>\text{AsF}' = \text{AsF} \cup \{(sa, ideofrmwrk, sa')\}</math></p>	<p><b>Operation:</b> retract(<i>sa, ideofrmwrk, sa'</i>)</p> <p><b>Transition rule:</b></p> $\frac{}{[\langle \text{IF}, \text{AdF}, \text{AsF} \rangle / \langle \text{IF}, \text{AdF}, \text{AsF}' \rangle]}$ <p><b>where:</b> <math>\text{AsF}' = \text{AsF} - \{(sa, ideofrmwrk, sa')\}</math></p>

Figure 2: A minimal set of transition rules for the dynamics of situated ideological systems.

- $\text{IF} \in \wp(\mathbf{IdeoFrmwrk})$ ;
- $\text{AdF} \in \wp(\mathbf{AdptFrmwrk})$ ;
- $\text{AsF} \in \wp(\mathbf{AssgnFrmwrk})$ .

so that:

- the ideological configurations are constituted only by *state* components, i.e., they have no *input* and *output* components;
- the set of social actors *SA* (as well as the overall organization of *AgSoc*) is taken, here, to be fixed.<sup>7</sup>

For each *ideological operation* of the ideological system  $IdeoSys_{AgSoc}$ , an *ideological transition rule* is defined, specifying the effect of the application of that operation to the current *ideological configuration*.

The *ideological transition rules* of  $IdeoSys_{AgSoc}$  are given by configuration transitions [16] with structure:

$$\frac{Cond_1 \quad \dots \quad Cond_n}{[\langle \text{IF}, \text{AdF}, \text{AsF} \rangle / \langle \text{IF}', \text{AdF}', \text{AsF}' \rangle]}$$

where:

- $Cond_1 \quad \dots \quad Cond_n$  is the (possibly empty) set of conditions that should be true in order for the transition to be applicable;
- $\langle \text{IF}, \text{AdF}, \text{AsF} \rangle$  is the ideological configuration of  $IdeoSys_{AgSoc}$  before the transition has taken place;
- $\langle \text{IF}', \text{AdF}', \text{AsF}' \rangle$  is the ideological configuration of  $IdeoSys_{AgSoc}$  after the transition has taken place.

Figure 2 specifies the details of the ideological transition rules of  $IdeoSys_{AgSoc}$ .

<sup>7</sup>Taking into account the *organizational dynamics* of the agent society requires coupling here an appropriate *societal transition system*, like the one introduced in [5]. That, however, is out of the scope of the present paper.

## 6 Case Study: The Ideological Dynamics in *The Keeper of Promises*

In this case study, we make use of TinyIML to model and analyze the ideological dynamics of *The Keeper of Promises*.

### 6.1 The Play

*The Keeper of Promises (O Pagador de Promessas)* [10] is a theatrical play by the Brazilian playwright Dias Gomes (1922-1999), first staged in 1960<sup>8</sup>. It is a play well suited for a case study in ideological modeling because it deals with an ideological conflict (a religious clash) which is conveniently localized in time and space (one single day, in front of a catholic church), involving a small number of emblematic characters, each representative either of one particular religious faith (catholics, African-Brazilian cult devotees, those that profess both such faiths), or of one typical social or political attitude toward social conflicts (the repressive policemen, the unscrupulous newspaper Reporter).

#### 6.1.1 The Characters

From the point of view of the ideological modeling to be realized in this case study, the following are the important characters of the play:

- Zé-do-Burro<sup>9</sup>, the main character;
- the Priest of the St. Barbara Church, a fictitious catholic church, supposed to exist in the city of Salvador, Bahia;
- the Reporter of a local sensationalist newspaper;
- the local Sheriff;
- the devotees of Iansã, an orisha of the African-Brazilian religion of the Candomblé;
- the devotees of St. Barbara, a saint of the Catholic Church.

#### 6.1.2 The Ideological Setting

The plot is located in the city of Salvador, capital of the state of Bahia, in the northeast of Brazil.

The northeast of Brazil has been, historically, the poorest area of the country, mostly constituted by a semi-desertic area, called *sertão*. The culture of the people of the *sertão* has always been marked by both the dominant ideological influence of conservative sectors of the Catholic Church and a variety of traces of popular European medieval culture, brought to the country by the Portuguese colonizers.

The state of Bahia, however, has got an additional specificity of its own: the quantity of enslaved people brought there, from Africa, was so large that they definitively marked the culture of the area, both extensively and strongly.

Most important among the cultural elements proper to those Africans and their African-Brazilian descendants is the very popular religion called *Candomblé*.

A feature of the Candomblé is that some of its branches explicitly identify (or, at least, make correspond) their *orishas* (in general, deities of nature) to *Catholic saints*. In particular, and of central importance for the play, St. Barbara is identified with Iansã, ruler of the winds and tempests.

#### 6.1.3 The Synopsis

The whole action occurs on the steps of the Catholic Church of St. Barbara, a fictitious church, supposedly located in the center of the city. The year of the action is unspecified, but it happens on the 4th of December, St. Barbara's day.

For the case study, the important details of the plot are the following:

- Zé-do-Burro lived in the *sertão*, working a dry lot of land with his donkey, which he called Nicolau and considered to be his best friend.
- The day Nicolau got sick, Zé-do-Burro tried all kinds of help he could find in the nearby village: called the veterinarian, the local witchdoctor, and others, but no one was able to heal Nicolau.

<sup>8</sup>Filmed in 1961, it won the Golden Palm award for best picture at the Cannes Film Festival, and the Golden Gate Prize, also for best picture, at the San Francisco International Film Festival, both in 1962.

<sup>9</sup>A nickname, not a name. In a literal translation: Joe-of-the-Donkey.

- His last resort was to appeal to St. Barbara, of whom he was a good devotee. But since St. Barbara had no church dedicated to her in the village, Zé-do-Burro went to a Candomblé site that had an image of Iansã. Since, for him, Iansã and St. Barbara were the same, that would do as a place to ask for help.
- As Nicolau heard, Zé-do-Burro attributed the healing to a miracle by the saint. In return for receiving the help that he had asked, Zé-do-Burro promised that he would carry a wooden cross on his shoulders, from his village to the Church of St. Barbara in the city of Salvador, 30 miles away, to place the cross inside the church. Also, he gave part of his property to land workers that were poorer than himself.
- And Zé-do-Burro effectively faced his journey, carrying the cross on his shoulders, accompanied by his wife, arriving in front of the church before dawn, in the Day of St. Barbara (which is the moment at which the play's action starts).
- When the Priest opened the church for the first mass of the day, Zé-do-Burro explained him his intention. Noticing, however, that the promise was made in a Candomblé site, not in a church, and in front of an image of Iansã, not of St. Barbara, the Priest decided not to allow Zé-do-Burro to enter the church. Also, the Priest judged Zé-do-Burro to be, at the same time, too silly, for making such a promise in favor of a donkey, and too pretentious, for trying to imitate Christ's way of sorrows.
- From this point on, the story goes through the interventions of a series of characters (catholic devotees of St. Babara, Candomblé devotees of Iansã, the Sheriff, the Reporter, etc.), each having a strong opinion about Zé-do-Burro's promise and his intention of placing the cross inside the church, and also about the Priest's decision.
- The devotees of Iansã argued that Iansã and St. Barbara are the same. The catholic devotees of St. Barbara, rejected the argument. The Reporter, in an opportunistic attitude, and following the demands of his sensationalist newspaper, tried to exploit the story by producing scandalous headlines in the newspaper he was working for: headlines of religious content, showing Zé-do-Burro as a new Christ, and headlines of political content, showing him as a revolutionary fighting for land reform.
- As the hours pass, the conflict radicalizes, to the point that the Sheriff decides to arrest Zé-do-Burro for promoting social unrest.
- The devotees of Iansã, seeing no reason for the arrest, and being good *capoeira* fighters<sup>10</sup>, enter in confrontation with the Sheriff and his auxiliaries, which were armed with guns. In the fight, Zé-do-Burro is shot to death.
- In a reaction against the situation that ended in such a way, seen as unfair to the faith and the efforts of Zé-do-Burro, both the devotees of Iansã and the catholic devotees of St. Barbara join forces: they take the cross as a stretcher, lay Zé-do-Burro upon it, and invade the church, carrying Zé-do-Burro on the cross (effectively, in Christ's pose), thus allowing him to, at last, bring his cross into the church.

## 6.2 The TinyIML Ideological Model of the Play

### 6.2.1 General Remarks

As the drama exposed in the play is essentially due to the ideological contradiction between Zé-do-Burro and the Priest, it is only natural that theirs are the two most elaborate ideological characterizations given in the play and, thus, theirs are the two most complete ideological models we are able to produce here.

Two secondary characters, the Sheriff and the Reporter, which have an important part in almost turning a religious conflict into a street fighting, are more briefly shown, in the play, as simple allegories of the social roles those types of persons used to have in the society of that time and place, than as fully developed dramatic characters. Thus, there is less to take from them, in terms of ideological modeling, than from the two main characters.

The same happens with the other two secondary characters that have important part in the drama, namely, the mob of Iansã devotees and the mob of catholic St. Barbara devotees, which joint forces to

<sup>10</sup> *Capoeira* is a fight style, commonly practiced by of the African-Brazilian slave descendants, often performed in the form of a dance (under a typical rhythm and sonority, provided by a particular type of musical instrument, the *berimbau*), for ritual, sport or leisure purposes.

place Zé-do-Burro and his cross inside the church, in the end of the play. They are also characterized in even more brief terms, so that we have even less to model about them.

Also, the dynamical modeling proceeds in accordance with the evolution of the plot, on the basis of a logical notion of *time*, with the time variable  $t$  taking, as value, logical time instants  $t_k$ , indexed by  $k = 0, 1, \dots$ . Each  $k$  indicates a moment  $t_k$  in the plot where the ideological configuration is of special relevance,  $t_0$  being the time when the action of the play begins.

With the exception of the (possibly temporary) change in the ideological framework of the saint devotees, which allowed them to join the orishas devotees in the final scene of the play, no character changes the ideological framework it has adopted initially, and no new ideological framework is created during the plot.

That is, the contents of the set  $IF \in \mathbf{IdeoFrmwrk}$  does not change during the play, and  $AdF \in \mathbf{AdptFrmwrk}$  changes only in the last time instants. The changes that mostly occur, during the play, are those in  $AsF \in \mathbf{AsgnFrmwrk}$ , that is, the ideological frameworks that the characters assign to each other.

As a consequence of the quasi-constancy of the first two components of the ideological configurations  $\langle IF, AdF, AsF \rangle$ , we will restrict ourselves, in the following, to account for the dynamics of the ideological system of the play only in terms of changes in assignments of ideological frameworks, that is, only in terms of the occurrences of operations the type  $assign(ag, if, ag')$  and  $retract(ag, if, ag')$ .

Clearly, the occurrences of these operations are due to the interactions between the characters. Thus, in the following, we concentrate on looking in the plot for interactions that produce changes in the  $AsF$  component of the ideological configuration. Each such interaction determines a transition in the ideological configuration of the play, which we indicate by an increase in the index  $k$  of the time variable  $t_k$ .

In fact, the way the assignments of ideological frameworks are made in the plot is the main source of the ideological conflicts that arise among the characters, as shown by the importance of the “public image” of Zé-do-Burro created by the Reporter. That is, most of the drama generated in the plot is due to the way the characters understand each other (or better, intentionally or unintentionally misunderstand each other).

## 6.2.2 The Initial Ideological Model

This subsection presents and comments the initial TinyIML model, that is, the TinyIML model of the ideological frameworks that have been adopted by the characters, and the ideological frameworks that they have assign to each other, at the beginning of the play. The models are presented in the concrete syntax for TinyIML.

### • *The Ideological Frameworks Initially Adopted by Zé-do-Burro and by the Priest*

Figure 3 shows the ideological frameworks initially adopted by Zé-do-Burro and by the Priest. The following comments are in order:

- Zé-do-Burro and the Priest agree on most of their segmentation envisagements. They endorse the same segments of **Individuals** (i.e., **People**, **Saints**, **Orishas**, **WitchDoctors**, **Animals**) and the same segments of **People** (i.e., **StDevotees**, **OrDevotees**, **WitchDoctors**).
- Zé-do-Burro and the Priest disagree, however, about the intersection between the segments **Saints** and **Orishas**, as well as about the intersection between the segments **StDevotees** and **OrDevotees**:
  - Zé-do-Burro takes the intersections between **Saints** and **Orishas**, and that between **StDevotees** and **OrDevotees**, to be non-empty, while the Priest takes them to be empty.
  - This allows Zé-do-Burro to accept that, even though **St.Barbara** is a **Saint** and **Iansã** is an **Orisha**, they are the same (**St.Barbara** = **Iansã**), and so a common member of both segments. The Priest, however, taking that the intersection between the two segments is empty (**Saints**  $\wedge$  **Orishas** =  $\{\}$ ), cannot accept that **St.Barbara** = **Iansã**.
  - Also, Zé-do-Burro can take that: **StDevotees**  $\wedge$  **OrDevotees**  $\neq$   $\{\}$ , while the Priest can only take that: **StDevotees**  $\wedge$  **OrDevotees** =  $\{\}$ .

It is clear that the central ideological disagreement between Zé-do-Burro and the Priest had to erupt about the issue of: **St.Barbara** = **Iansã**.

It is also clear that it is this disagreement that for **Saints**) prevents the Priest from admitting the validity of Zé-do-Burro’s promise. For, even though both Zé-do-Burro and the Priest agree on most of the norms assumed to regulate the behaviors of **StDevotees** and **OrDevotees** (as one can see comparing the

```

ZB = Zé-do-Burro
P = Priest
%-----
SegmEnvis SE_ZB:
  People, Saints, Orishas,
    WitchDoctors,Animals =< Individuals
  Saints /\ Orishas != {}
  StDevotees /\ OrDevotees != {}
SegmEnvis SE_P:
  People, Saints, Orishas,
    WitchDoctors,Animals =< Individuals
  Saints /\ Orishas = {}
  StDevotees /\ OrDevotees = {}
%-----
NormEnvis NE_ZB:
  TypeCndts: Ask-cure-to,Keep-promise-to,
    Pray-for
  permit(OrDevotees,Pray-for(Orishas))
  permit(OrDevotees,Ask-cure-to(Orishas))
  permit(OrDevotees,Ask-cure-to(WitchDoctors))
  permit(OrDevotees,Pray-for(Saints))
  permit(OrDevotees,Ask-cure-to(Saints))
  oblig(OrDevotees,Keep-promise-to(Orishas))
NormEnvis NE_P:
  TypeCndts: Ask-cure-to,Keep-promise-to,
    Pray-for
  permit(OrDevotees,Pray-for(Orishas))
  permit(OrDevotees,Ask-cure-to(Orishas))
  permit(OrDevotees,Ask-cure-to(WitchDoctors))
  permit(StDevotees,Pray-for(Saints))
  permit(StDevotees,Ask-cure-to(Saints))
  oblig(OrDevotees,Keep-promise-to(Orishas))
  oblig(StDevotees,Keep-promise-to(Saints))
  prohib(StDevotees,
    Ask-cure-to(WitchDoctors))
  prohib(StDevotees,
    Ask-cure-to(Orishas))
%-----
ValuatEnvis VE_ZB:
  TypeCndts: Promise
  AnyOther [ Promise
ValuatEnvis VE_P:
  TypeCndts: Promise,ObedienceChurch
  Promise [ ObedienceChurch
  AnyOther [ Promise
%-----
QualifEnvis QE_ZB:
  OrderRel: [Cure
  People [Cure Orishas
  People [Cure WitchDoctors
QualifEnvis QE_P:
  RefSE: SE_ZB
  OrderRel: [Cure
  AnyOther [Cure Saints
%-----
Ideofrmwrk IF_ZB:
  SegmEnvis: SE_ZB
  NormEnvis: NE_ZB
  ValuatEnvis: VE_ZB
  QualifEnvis: QE_ZB
Ideofrmwrk IF_P:
  SegmEnvis: SE_P
  NormEnvis: NE_P
  ValuatEnvis: VE_P
  QualifEnvis: QE_P

```

Figure 3: The ideological frameworks IF\_ZB and IF\_P, respectively adopted by Zé-do-Burro and the Priest, at the beginning of the play.

normative envisagements NE\_ZB and NE\_P), they disagree about the two norms that prohibit StDevotees to ask for cure to both WitchDoctors and Orishas, norms by which the Zé-do-Burro abides, but the Priest does not.

This difference between the two normative envisagements is emphasized by the difference between their respective qualifying envisagements, QE\_ZB and QE\_P:

- Zé-do-Burro takes the two qualifying orders, concerning the power to cure:

People [Cure Orishas and People [Cure WitchDoctors

but no qualifying order between Saints and Orishas, or WitchDoctors.

- The Priest takes the order AnyOther [Cure Saints, which puts the Saints's power to cure above the power to cure of everybody else.

Finally, the valuating envisagements VE\_ZB and VE\_P are those that explain why Zé-do-Burro stick to his promise even when the Priest anathemized him as dominated by the Devil, and also why the Priest anathemized him in such terms:

- For Zé-do-Burro, conducts should be valuated according to the valuating order AnyOther [ Promise, that is, Promise is the most valuable type of conduct, and should be kept at all cost.
- For the Priest, however, the valuating order is:

AnyOther [ Promise and Promise [ ObedienceChurch

that is, ObedienceChurch is the most valuable type of conduct, and should prevail over any Promise.

By sticking to his promise and refusing to obey the Priest, Zé-do-Burro set himself against the Priest and the Church itself. For the Priest, Zé-do-Burro's promise should be dismissed, and he should be restrained from realizing it.

- ***The Ideological Frameworks Initially Adopted by the Sheriff and by the Reporter***

The TinyIML models of the Sheriff's and the Reporter's ideological frameworks are given in Fig. 4. They help to understand why the initial religious conflict between Zé-do-Burro and the Priest turned into a confrontation almost involving a mob in a street fighting.

```

S = Sheriff
R = Reporter
%-----
SegmEnvis SE_S:
  CommonPeople,Policemen,Agitators
    =< Individuals
  CommonPeople /\ Policemen = {}
  CommonPeople /\ Agitators = {}
  Policemen /\ Agitators = {}
SegmEnvis SE_R:
  NewspaperReaders,Personalities,
  Reporters,Politicians =< Individuals
  Politicians =< NewspaperReaders
  Politicians =< Personalities
%-----
NormEnvis NE_S:
  TypeCndts: Agitate,Arrest-Agitators
  prohib(AnyOne,Agitate)
  oblig(Policemen,Arrest-Agitators)
NormEnvis NE_R:
  TypeCndts: Create-sensationalism
  oblig(Reporters,Create-sensationalism)
%-----
ValuatEnvis VE_S:
  TypeCndts: Arrest-Agitators
  AnyOther [ Arrest-Agitators

ValuatEnvis VE_R:
  TypeCndts: Create-sensationalism
  AnyOther [ Create-sensationalism
%-----
QualifEnvis QE_S:
  OrderRel: [Agitate, [Arrest-Agitators
  AnyOther [Agitate Agitators
  AnyOther [Arrest-Agitators Policemen
QualifEnvis QE_R:
  OrderRel: [Create-sensation
  AnyOther [Create-sensation Reporters
%-----
Ideofrmwrk IF_S:
  SegmEnvis: SE_S
  NormEnvis: NE_S
  ValuatEnvis: VE_S
  QualifEnvis: QE_S
Ideofrmwrk IF_R:
  SegmEnvis: SE_R
  NormEnvis: NE_R
  ValuatEnvis: VE_R
  QualifEnvis: QE_R

```

Figure 4: The initial model of the adopted ideological frameworks: the Sheriff and the Reporter.

The main ideological characteristic of the Sheriff is his commitment to avoid what he considers “social unrest”, by promptly arresting anyone he may happen to consider an **Agitator**. The main characteristic of the Reporter is his commitment to create as much sensational headlines as possible, to serve the vending interests of the newspaper for which he works, even at the cost of pushing facts beyond any reasonable limit.

By publishing headlines that made of Zé-do-Burro the motive of a social unrest, the Reporter created a situation where Zé-do-Burro appeared to the Sheriff as an **Agitator**, leading him to decree the arrest of Zé-do-Burro.

- ***The Ideological Frameworks Initially Adopted by the Devotees***

The ideological frameworks of the Orisha and Saints Devotees are given in Fig. 5.

Notice the difference between the normative envisagements of Orisha and Saints Devotees, which implies that, from the start, they are prone to disagree with each other about the rightness of the attitude of Zé-do-Burro: Orishas Devotees supporting him and Saints Devotees condemning him.

Notice also that the normative envisagements of the Orisha and Saints Devotees respectively coincide with those of Zé-do-Burro and the Priest.

- ***The Initial Assignments of Ideological Frameworks***

At the beginning of the play, no assignment of ideological frameworks have been made by any character. The reason is that because the preamble of the play, and the beginning of the play itself, make clear that the characters did not know each other, before the action began. Thus, they could not have assigned ideological frameworks to each other. Such assignments occur while the play goes on.

### 6.2.3 The Ideological Dynamics

- ***General Remarks***

As indicated in Sect. 4, the basic universes of the operational model of ideological systems are the universes of *social actors*, **SocAct**, and the universes of *type of conducts*, **CondType**.

As determined in the above presentation and analysis of the play, we have:

- **SocAct** = {Zé-do-Burro, Priest, Reporter, Sheriff, OrDevotees, StDevotees};
- **CondType** = {Ask-cure-to, Pray-for, Cure, Promise, Keep-promise-to, Agitate, Arrest, Create-sensationalism, Eager-for-sensation}

In the following, we trace the main *transitions* in the ideological configuration of the situation pictured in the play, as the play develops. As stated in Sect. 5, we take tuples of the form  $\langle IF^t, AdF^t, AsF^t \rangle$  to be the ideological configurations constituted, at each time  $t$ , by the dynamics of the ideological system

```

OD = Orisha devotees
SD = Saint devotees
%-----
SegmEnvis SE_OD:
  People, Saints, Orishas,
    WitchDoctors,Animals =< Individuals
  StDevotees,OrDevotees,
    WitchDoctors =< People
  Saints /\ Orishas != {}
  StDevotees /\ OrDevotees != {}
SegmEnvis SE_SD:
  People, Saints, Orishas,
    WitchDoctors,Animals =< Individuals
  StDevotees,OrDevotees,
    WitchDoctors =< People
  Saints /\ Orishas = {}
  StDevotees /\ OrDevotees = {}
%-----
NormEnvis NE_OD,NE_SD:
  TypeCndts: Ask-cure-to,Keep-promise-to,
  Pray-for
  permit(OrDevotees,Pray-for(Orishas))
  permit(OrDevotees,Ask-cure-to(Orishas))
  permit(OrDevotees,Ask-cure-to(WitchDoctors))
  permit(OrDevotees,Pray-for(Saints))
  permit(OrDevotees,Ask-cure-to(Saints))
  oblig(OrDevotees,Keep-promise-to(Orishas))
NormEnvis NE_OD,NE_SD:
  TypeCndts: Ask-cure-to,Keep-promise-to,
    Pray-for
  permit(OrDevotees,Pray-for(Orishas))
  permit(OrDevotees,Ask-cure-to(Orishas))
  permit(OrDevotees,Ask-cure-to(WitchDoctors))
  permit(StDevotees,Pray-for(Saints))
  permit(StDevotees,Ask-cure-to(Saints))
  oblig(OrDevotees,Keep-promise-to(Orishas))
  oblig(StDevotees,Keep-promise-to(Saints))

  prohib(StDevotees,Ask-cure-to(WitchDoctors))
  prohib(StDevotees,Ask-cure-to(Orishas))
%-----
ValuatEnvis VE_OD:
  TypeCndts: Promise
  AnyOther [ Promise
ValuatEnvis VE_SD:
  TypeCndts: Promise,ObedienceChurch
  Promise [ ObedienceChurch
  AnyOther [ Promise
%-----
QualifEnvis QE_OD:
  OrderRel: [Cure
  People [Cure Orishas
  People [Cure WitchDoctors
QualifEnvis QE_SD:
  OrderRel: [Cure
  AnyOther [Cure Saints
%-----
Ideofrmwrk IF_OD:
  SegmEnvis: SE_OD
  NormEnvis: NE_OD
  ValuatEnvis: VE_OD
  QualifEnvis: QE_OD
Ideofrmwrk IF_SD:
  SegmEnvis: SE_SD
  NormEnvis: NE_SD
  ValuatEnvis: VE_SD
  QualifEnvis: QE_SD

```

Figure 5: The initial model of the adopted ideological frameworks: the Devotees.

of the play. Accordingly, we take the configuration  $\langle IF^{t_0}, AdF^{t_0}, AsF^{t_0} \rangle$  to be the *initial* ideological configuration of that situation.

- **Time  $t_0$ : the action begins**

The *initial ideological configuration* is:

$$\langle IF^{t_0}, AdF^{t_0}, AsF^{t_0} \rangle$$

where:

- $IF^{t_0} = \{IF\_ZB, IF\_P, IF\_S, IF\_R, IF\_OD, IF\_SD\}$ ;
- $AdF^{t_0} = \{(Zé-do-Burro, IF\_ZB), (Priest, IF\_P), (Sheriff, IF\_S), (Reporter, IF\_R), (OrDevotees, IF\_OD), (StDevotees, IF\_SD)\}$ ;
- $AsF^{t_0} = \emptyset$ .

with the ideological frameworks  $IF\_ZB, IF\_P, IF\_S, IF\_R, IF\_OD$  and  $IF\_SD$  as given above, in Figs. 3, 4 and 5.

The *initial ideological configuration* tells that:

- $IF^{t_0}$ , the set of all ideological frameworks active in the play, gathers all, and only, the ideological frameworks described in the TinyIML model initially given (Figs. 3, 4 and 5).
- $AdF^{t_0}$ , the initial set of adopted ideological frameworks, is as indicated in the TinyIML model by the naming convention adopted for the ideological frameworks (i.e., Zé-do-Burro adopts  $IF\_ZB$ , etc.).
- $AsF^{t_0}$ , the initial set of assigned ideological frameworks, is empty for the reason explained above.

- **From  $t_0$  to  $t_1$ : First talk between Zé-do-Burro and the Priest**

When Zé-do-Burro and the Priest talk for the first time, they understand each other as devotees of St. Barbara. As a consequence, an ideological transition occurs in the system, to the effect that the following operations occur, at that time:

- $asgn(\text{Zé-do-Burro}, \text{IF\_SD}, \text{Priest});$
- $asgn(\text{Priest}, \text{IF\_SD}, \text{Zé-do-Burro}).$

That is, when they first talked, Zé-do-Burro and the Priest saw each other as devotees of St. Barbara.

As a consequence of the realization of the ideological transitions corresponding to these operations we have (see transition rules in Fig. 7):

- $\text{IF}^{t_1} = \text{IF}^{t_0};$
- $\text{AdF}^{t_1} = \text{AdF}^{t_0};$
- $\text{AsF}^{t_1} = \{(\text{Zé-do-Burro}, \text{IF\_SD}, \text{Priest}), (\text{Priest}, \text{IF\_SD}, \text{Zé-do-Burro})\}.$

• **From  $t_1$  to  $t_2$ : Zé-do-Burro reveals the way his promise was done**

As soon as Zé-do-Burro revealed to the Priest” the conditions in which his promise was made, things changed. The Priest started to see Zé-do-Burro as a devotee of Iansã. That is, the Priest’s assignment of ideological frameworks to Zé-do-Burro change by the operations:

- $rtrct(\text{Priest}, \text{IF\_SD}, \text{Zé-do-Burro})$
- $assgn(\text{Priest}, \text{IF\_OD}, \text{Zé-do-Burro})$

and the ideological configuration becomes:

- $\text{IF}^{t_2} = \text{IF}^{t_1};$
- $\text{AdF}^{t_2} = \text{AdF}^{t_1};$
- $\text{AsF}^{t_2} = \{(\text{Zé-do-Burro}, \text{IF\_SD}, \text{Priest}), (\text{Priest}, \text{IF\_OD}, \text{Zé-do-Burro})\}.$

fixing, for the rest of the plot, their divergence about the segmenting envisagement  $\text{Saints}^{\sim}\text{Orishas} = \{\}$  and, thus, about the truth of  $\text{St.Barbara} = \text{Iansã}.$

• **From  $t_2$  to  $t_3$ : The Reporter and the Sheriff thrust in**

This ideological transition prepares the plot for its tragic ending. The Reporter assigns to Zé-do-Burro the social status of a “new Christ”, a false Messiah aiming to fool the people, while the Sheriff assigns him the social status of a dangerous “agitator”, of which the keeping of the social order imposes immediate imprisonment.

In terms of the religious-oriented ideological frameworks with which we have been describing the plot, we can summarize the assignments of these two social status as the assignment of an ideological framework that denies Zé-do-Burro both the character of Saints Devotee and the character of Orishas Devotee.

Since we have not defined above this latter ideological framework, we denote it here, in an ad-hoc way, with the help of the negation operation “ $\neg$ ”. We have, then, that the ideological transformations that have occurred at this stage of the play can be formally expressed by:

- $assgn(\text{Reporter}, \neg\text{IF\_SD}, \text{Zé-do-Burro});$
- $assgn(\text{Reporter}, \neg\text{IF\_OD}, \text{Zé-do-Burro});$
- $assgn(\text{Sheriff}, \neg\text{IF\_SD}, \text{Zé-do-Burro});$
- $assgn(\text{Sheriff}, \neg\text{IF\_OD}, \text{Zé-do-Burro});$

Thus, the ideological configuration of the play, at the time  $t_3$ , is:

- $\text{IF}^{t_3} = \text{IF}^{t_2};$
- $\text{AdF}^{t_3} = \text{AdF}^{t_2};$
- $\text{AsF}^{t_3} = \{(\text{Zé-do-Burro}, \text{IF\_SD}, \text{Priest}), (\text{Priest}, \text{IF\_OD}, \text{Zé-do-Burro}),$   
 $(\text{Reporter}, \neg\text{IF\_SD}, \text{Zé-do-Burro}), (\text{Reporter}, \neg\text{IF\_OD}, \text{Zé-do-Burro}),$   
 $(\text{Sheriff}, \neg\text{IF\_SD}, \text{Zé-do-Burro}), (\text{Sheriff}, \neg\text{IF\_OD}, \text{Zé-do-Burro})\}.$

One sees that, at time  $t_3$ , the ideological configuration is self-contradictory, with a clear disagreement between both the Reporter and the Sheriff” with both the Priest (about assigning to Zé-do-Burro the ideological framework of an Orishas Devotee) and Zé-do-Burro (about his own initial adoption, at time  $t_0$ , of the ideological framework that characterizes himself as an Orishas Devotee).

But since both the Priest and Zé-do-Burro recognize the authority of the Sheriff (and Zé-do-Burro”, in his naivety, respected the legitimacy of the Reporter), no reason existed, then, for a direct confrontation among them.

Direct confrontation would appear only as a consequence of the last ideological transition in the plot, when the mobs of Orishas Devotees and Saintt Devotees intervene.



- **From  $t_3$  to  $t_4$ : The Orishas and Saints Devotees Intervene**

When the Orishas Devotees and Saints Devotees intervene, the ideological transition that they cause can be formally expressed by:

- $assng(OrDevotees, IF\_OD, Zé-do-Burro)$ ;
- $assng(StDevotees, IF\_SD, Zé-do-Burro)$ ;

and the ideological configuration that results is:

- $IF^{t_4} = IF^{t_3}$ ;
- $AdF^{t_4} = AdF^{t_3}$ ;
- $AsF^{t_4} = \{(Zé-do-Burro, IF\_SD, Priest), (Priest, IF\_OD, Zé-do-Burro), (Reporter, \neg IF\_SD, Zé-do-Burro), (Reporter, \neg IF\_OD, Zé-do-Burro), (Sheriff, \neg IF\_SD, Zé-do-Burro), (Sheriff, \neg IF\_OD, Zé-do-Burro), (OrDevotees, IF\_OD, Zé-do-Burro), (StDevotees, IF\_SD, Zé-do-Burro)\}$ .

With this ideological configuration, the conflict explodes, because of the ideological contradiction among the Orishas Devotees, the Saints Devotees, and the Sheriff, which leads those devotees to become in conflict with the latter about his decision to arrest Zé-do-Burro (taken by the latter to be neither an Orisha Devotee nor a Saint Devotee). And because the ideological identification of the Orishas Devotees Zé-do-Burro justified, for them, their resistance against the arrest.

It is this combination of an ideological disagreement with the Sheriff's decision that leads the conflict to the level of a confrontation between the Orishas Devotees and the policemen, during which Zé-do-Burro is shot to death.

- **From  $t_4$  to  $t_5$ : Zé-do-Burro's Final Victory**

The shock of the death of Zé-do-Burro suddenly ends the confrontation between Orishas Devotees and the policemen. The Saint Devotees, in reaction to his death, decide to ally themselves with the Orishas Devotees, recognizing the sincerity of the Zé-do-Burro's intention and honoring him after his unjust fate.

The the joint mob of Orishas and Saints Devotees enter the church, then, carrying Zé-do-Burro" over his cross, effectively allowing Zé-do-Burro to realize his promise, even if after his death.

From the ideological point of view, this series of events meant the creation of a situation where the the forces that opposed Zé-do-Burro were overcome, as if the ideological assignments they made to him were cancelled, from the practical point of view.

That is, Zé-do-Burro's victory implied the operations:

- $rtrct(Priest, \neg IF\_OD, Zé-do-Burro)$ ;
- $rtrct(Sheriff, \neg IF\_SD, Zé-do-Burro)$ ;
- $rtrct(Sheriff, \neg IF\_OD, Zé-do-Burro)$ ;
- $rtrct(Reporter, \neg IF\_SD, Zé-do-Burro)$ ;
- $rtrct(Reporter, \neg IF\_OD, Zé-do-Burro)$ ;

resulting in the effective ideological configuration:

- $IF^{t_5} = IF^{t_4}$ ;
- $AdF^{t_5} = AdF^{t_4}$ ;
- $AsF^{t_5} = \{(OrDevotees, IF\_OD, Zé-do-Burro), (StDevotees, IF\_SD, Zé-do-Burro)\}$ .

which did not support any more the prohibition imposed by the Priest and the unjustified condemnation by the Sheriff and the Reporter. And that fully allowed the Orishas and Saints Devotees to joint forces and carry Zé-do-Burro and his cross into the church (manifestly syncretized between the two cults, even if temporarily).

### 6.3 Wrapping Up the Case Study

As the confrontation with the policemen lead to the death of Zé-do-Burro, an issue arose for the two religious groups involved in the situation: the issue if Zé-do-Burro would fall defeated alone, in isolation from those two groups, of which he felt to be part of.

The decision of the two religious groups to join forces to invade the church meant their joint embracing of Zé-do-Burro's aim. But such joining of forces required that the Orishas and the Saints Devotees came to a ideological agreement, even if temporarily.

Thus, the question that the ideological analysis of the situation must face is: Why was it possible for the Saints Devotees to adopt a tolerant attitude, putting aside the ideological constraints that were binding them to the Priest and the norms of the Church, thus allowing for their coalition with the Orishas Devotees?

The play leaves that question unanswered.

### 6.3.1 Why the Coalition Between Orishas Devotees and Saints Devotees was Possible?

Perhaps one may guess one possibility for that coalition: a sense of justice to a man that sincerely adopted an ideological framework that is widely adopted in that society (and plainly acceptable for both the Candomblé and the Catholic Church, if they both take a tolerant point of view), and that sincerely fought for the highest value implied by that ideological framework. namely, the keeping of promises made to the saints-orishas of which he was a devotee.

The comparison of those two ideological frameworks show how it was possible for the two groups to finally join forces to take Zé-do-Burro and his cross into the church, in spite of their being initially in opposite standpoints regarding the religious conflict,

It can be seen that:

- The segmenting envisagement of the Orishas Devotees, `SegmEnvis_OD`, coincides with Zé-do-Burro's `SegmEnvis_ZB`, and that the segmenting envisagement of the Saints Devotees, `SegmEnvis_SD`, coincides with the Priest's segmenting envisagement `SegmEnvis_P`. Thus, Orishas Devotees and Saints Devotees disagree, in principle, about the truth of `Iansã = St.Barbara`.
- Other disagreements between Orishas and Saints Devotees are due both to their qualifying envisagements (`QualifEnvis_OD` and `QualifEnvis_SD`), and to their valuating envisagements (`ValuatEnvis_OD` and `ValuatEnvis_SD`), but not to their normative envisagements (`NormEnvis_OD` and `NormEnvis_SD`), which coincide.

Since the disagreement between `QualifEnvis_OD` and `QualifEnvis_SD` is irrelevant for the the conflictual situation, it is in the overcoming of the disagreements between their segmenting envisagements, `SegmEnvis_OD` and `SegmEnvis_SD`, and between their valuating envisagements, `ValuatEnvis_OD` and `ValuatEnvis_SD`, that one should look at for the possibility of their joining forces at the end of the play.

The possibility of Saints and Orishas Devotees joining forces to take Zé-do-Burro and his cross into the church could come only through a change in attitude by the Saints Devotees, since that action was clearly against the determination of the Priest and the principles of the Catholic Church.

The following is what the Saints Devotees had to relax in their ideological beliefs, for the coalition to be possible:

- On one hand, the declaration `Saints /\ Orishas = {}`, in their segmenting envisagement, in order to meet the corresponding opposite declaration in `SegmEnvis_OD`.
- On the other hand, the declaration `Promise [ ObedienceChurch`, in their valuation envisagement, in order to meet the valuation ordering `AnyOther [ Promise` of the Orishas Devotees.

By relaxing their ideological beliefs in such way, the Saints Devotees placed themselves in a position that allowed them to coalize with the Orishas Devotees, in spite of it being against the Priest's and the Catholic Church determinations.

### 6.3.2 Why the Saints Devotees Relaxed their Ideological Beliefs?

The answer to the question of why the Saint devotees relaxed their ideological beliefs and met the Orishas Devotees in their aim to help Zé-do-Burro to place his cross in the church is clearly left to be given by the audience of the play.

The play leaves that reason in the air. In fact, that unsaid reason constitutes the moral lesson the play aims to teach.

Anyone in the audience is free to interpret the play in her own way, finding by herself a reason for the (temporary) change of the ideological beliefs of the Saints Devotees. Accordingly, we also leave that question open, here.

However, one can see that, in a sense, the play is essentially about ideological tolerance and, in a somewhat contradictory way, about the value of enforcing such tolerance.

## 7 Conclusion

In this paper, we have focused on an issue that seems central for the possibility of computer-supported study of the cultural aspects of social systems, namely, representational means for cultural contents. More specifically, we have focused on the issue of the formal modeling of the dynamics of ideological systems.

We have reviewed the formal concept of *situated ideological systems* that have been introduced in [4] and we have provided the elements of dynamical model for such systems.

The elements of such dynamical model were represented in TinyIML, a toy ideology modeling language, whose abstract syntax and direct semantics were formally given in the Appendix.

A case study, concerning an ideological analysis of the theatrical play *The Keeper of Promises (O Pagador de Promessas)*, was developed to show the flavor of a detailed modeling of the dynamics of an ideological system.

Two relevant issues, however, were left out of the case study, concerning the mental operation of social actors:

- How social actors may reason about ideological issues in their social situations, so as to make use of the conclusions of such reasonings in their social interactions?
- How social actors may derive ideological models of other agents, or groups of social actors, from the observation of those situations?

Also, we have not explored, in the case study, other possible uses of the model, besides the ideological characterization of the characters of the play and the dynamics of their ideological conflicts. For instance, the matching of those ideological characterizations and conflicts with the ideological characterizations and conflicts present in other plays, or in reports of some concrete situations, so that *general schemes* for ideological characterizations and conflicts could be evinced, and the possible outcomes of social situations that formally meet such schemes could be systematically forecast.

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## Appendix: TinyIML Formally Defined

The language for ideological modeling that we formally define here, TinyIML, aims to give a simple illustration of the general form that ideological modeling languages may have. It captures in a computational notation just a part of the formal concepts given in the previous section. More specifically, it concerns only ideological envisagements, ideological frameworks, and ideologies.

In Figs. 6 to 9, we define TinyIML in terms of an abstract syntax and a direct semantics that loosely follows the approach adopted by the W3C (World-Wide Web Committee) in the original definition of OWL (Web Ontology Language), see [15]. The concrete syntax of TinyIML, however, is presented only through examples, in an intuitive way, in the case study (Section 6). We omit its formal definition here, for the sake of space.

The following are the basic elements of the concrete syntax of TinyIML. The complete abstract syntax of TinyIML and its semantics are given presently.

The following symbology holds in the concrete syntax of TinyIML:

- =< : the *set inclusion* relation;
- ∧ : the *set intersection* operation;
- ≠ : *not equal*;
- { } : the *empty set*;
- [ : a *value ordering*;
- [X : a *qualification ordering*, regarding the qualification X.

Envisagements are denoted as follows:

- SE\_X: a *segmenting envisagement* adopted by the social actor " X ";
- NE\_X: a *normative envisagement* adopted by the social actor " X ";
- VE\_X: a *valuating envisagement* adopted by the social actor " X ";
- QE\_X: a *qualifying envisagement* adopted by the social actor " X " .

Any statement not explicitly represented has an undefined truth value. And, in the TinyIML models presented in this paper, the universe of agents **Ag** is denoted by **Individuals** .

### 7.1 Abstract Syntax

The abstract syntax of TinyIML is given in Fig. 6.

We use the following notation for sequences:  $a, b, \dots$  for flat sequences;  $l_1; l_2; \dots$  for the sequence of either flat or parenthized sequences;  $(l_1; l_2; \dots)$  for the parenthizing of flat or parenthized sequences. Thus, if: (i)  $l_1 = a, b, c, d$  (ii)  $l_2 = e, f, g$  (iii)  $l_3 = h, i, j, k$  (iv)  $l_4 = (l_1; l_2)$  and (v)  $l_5 = (l_3)$  then:

$$(l_4; (l_1; l_5)) = ((l_1; l_2); (l_1; (l_3))) = ((a, b, c, d; e, f, g); (a, b, c, d; (h, i, j, k)))$$

```

% Rule synt-ideoSys
ideoSys :=
  ideoSysID
  ideoFrmwrk
  [ ideoFrmwrk ]*

% Rule synt-ideoFrmwrk
ideoFrmwrk :=
  ideoFrmwrkID
  segmEnvis
  [ normEnvis ]
  [ valuatEnvis ]
  [ qualifEnvis ]

% Rule synt-segmEnvis
segmEnvis :=
  segmEnvisID
  segmList
  [ segmRangeDecl ]*

% Rule synt-segmList
segmList :=
  universID
  | segmID [ segmID ]* LessEqOP universID

% Rule synt-segmRangeDecl
segmRangeDecl :=
  segmID1 ^OP segmID2 [ ^OP segmIDi ]* =OP
  universEmptSegmID
  | segmID1 vOP segmID2 [ vOP segmIDi ]* =OP
  universEmptSegmID
  | segmID1 ^OP segmID2 [ ^OP segmIDi ]* =OP
  segmIDn
  | segmID1 vOP segmID2 [ vOP segmIDi ]* =OP
  segmIDn

% Rule synt-universEmptSegmID
universEmptSegmID :=
  universID
  | EMPT
  | segmID

% Rule synt-normEnvis
normEnvis :=
  normEnvisID
  typeCondList
  normDecl
  [ normDecl ]*

% Rule synt-typeCondList
typeCondList :=
  typeCondID
  [ typeCondID ]*

% Rule synt-normDecl
normDecl :=
  ProhibOP segmID typeCondID
  | ObligOP segmID typeCondID
  | PermOP segmID typeCondID

% Rule synt-valuatEnvis
valuatEnvis :=
  valuatEnvisID
  typeCondList
  [ valuatDecl ]*

% Rule synt-valuatDecl
valuatDecl :=
  typeCondID
  | typeCondID1 [ typeCondIDi ]*
  LessEqOP typeCondIDn

% Rule synt-qualifEnvis
qualifEnvis :=
  qualifEnvisID
  orderRelDecl
  [ qualifDecl ]*

% Rule synt-orderRelDecl
orderRelDecl :=
  orderRelID

% Rule synt-qualifDecl
qualifDecl :=
  segmID
  | segmID segmID ]* =OP segmID

```

Figure 6: The abstract syntax of TinyIML.

# IDEOLOGICAL SYSTEMS and IDEOLOGICAL FRAMEWORKS:

$$\llbracket \text{ideoSys} \rrbracket = (\llbracket \text{ideoSysID} \rrbracket ; \llbracket \text{ideoFrmwrk} \rrbracket [ , \llbracket \text{ideoFrmwrk} \rrbracket ]^*)$$

$$\llbracket \text{ideoFrmwrk} \rrbracket = (\llbracket \text{ideoFrmwrkID} \rrbracket ; SE; NE; VE; QE)$$

where:

$$SE = \varepsilon \text{ if } [ \text{segmEnvis} ]^* = \varepsilon \text{ in Rule synt-segmEnvis}$$

$$SE = \llbracket \text{segmEnvis} \rrbracket [ , \llbracket \text{segmEnvis} \rrbracket ]^* \text{ if } [ \text{segmEnvis} ]^* \neq \varepsilon \text{ in Rule synt-segmEnvis}$$

$$NE = \varepsilon \text{ if } [ \text{normEnvis} ]^* = \varepsilon \text{ in Rule synt-normEnvis}$$

$$NE = \llbracket \text{normEnvis} \rrbracket [ , \llbracket \text{normEnvis} \rrbracket ]^* \text{ if } [ \text{normEnvis} ]^* \neq \varepsilon \text{ in Rule synt-normEnvis}$$

$$VE = \varepsilon \text{ if } [ \text{valuatEnvis} ]^* = \varepsilon \text{ in Rule synt-valuatEnvis}$$

$$VE = \llbracket \text{valuatEnvis} \rrbracket [ , \llbracket \text{valuatEnvis} \rrbracket ]^* \text{ if } [ \text{valuatEnvis} ]^* \neq \varepsilon \text{ in Rule synt-valuatEnvis}$$

$$QE = \varepsilon \text{ if } [ \text{qualifEnvis} ]^* = \varepsilon \text{ in Rule synt-qualifEnvis}$$

$$QE = \llbracket \text{qualifEnvis} \rrbracket [ , \llbracket \text{qualifEnvis} \rrbracket ]^* \text{ if } [ \text{qualifEnvis} ]^* \neq \varepsilon \text{ in Rule synt-qualifEnvis}$$

$$\llbracket \text{ideoSysID} \rrbracket \in \mathcal{U}_{\text{ideoSys}}$$

$$\llbracket \text{ideoFrmwrkID} \rrbracket \in \mathcal{U}_{\text{ideoFrmwrk}}$$

Figure 7: The direct semantics of TinyIML: Ideological Systems and Ideological Frameworks.

For a sequence with a finite number of occurrences of  $x$  (possibly zero occurrences), we use  $[x]^*$ . For a sequence of zero or one occurrence of  $x$  we use  $[x]$ . For the empty sequence, we use  $\varepsilon$ .

The names of the syntactical categories, adopted in a mnemonic form to shorten the length of the rules, should be easily read and made to correspond to the formal concepts introduced in Sect. 4. The terminal symbols of the abstract syntactical rules are:

- identifiers, given in the form: **xxxID**;
- operators, given in the form: **xxxOP**;
- the emptyset, given in the form: **EMPT**.

## 7.2 Direct Semantics

The direct model-theoretic semantics is given in Figs. 7 to 9. As mentioned above, it is loosely inspired by the direct semantics of the original definition of OWL [15]. It is a set-theoretic semantics, in the sense that it gives a meaning to each syntactical category, each such meaning specified in set-theoretic terms.

The semantical function is denoted by the double square brackets, in the form  $\llbracket \text{syntCat} \rrbracket = \text{semExp}$ , where **syntCat** is an abstract syntactical category and *semExp* is a semantical expression. The semantical expression is:

- either: the characterization of an element of a universe (if the syntactical category is a terminal symbol);
- or: a sequence such that the semantical terms appear in the semantical expression in the same order in which the syntactical terms, to which they correspond, appear in the syntactical expression that defines the syntactical category (if the syntactical category is not a terminal symbol and denotes an element of a universe);
- or else: a logical expression (if the syntactical category is not a terminal symbol and denotes a relation between sets or a property of the elements of some subset of a universe).

Clearly, as the terminal symbols of the abstract syntax are not expressed in a concrete way, the semantical rules responsible for defining their meanings are not concretely given, too, and are just characterized in terms of the universes to which they belong.

Notice that we denote universes by appending their names to “ $\mathcal{U}$ ”, as in  $\mathcal{U}_{\text{Segm}}$ , for the case of the universe of segments.

```

# SEGMENTING ENVISAGMENTS:

[[segmEnvis]] = (segmEnvis ; [[segmEnvisID]] ; [[segmList]])
% if in Rule synt-segmEnvis:
%   [ segmRangeDecl ]* := ε

[[segmEnvis]] = (segmEnvis ; [[segmEnvisID]] ; [[segmList]] ;
                [[segmRangeDecl]] [ , [[segmRangeDecl]] ]*)
% if in Rule synt-segmEnvis:
%   [ segmRangeDecl ]* := segmRangeDecl [ segmRangeDecl ]*

[[segmEnvis]] = (segmEnvis ; [[segmEnvisID]] ; [[segmList]] ;
                [[segmRangeDecl]] [ , [[segmRangeDecl]] ]*)
% if in Rule synt-segmEnvis:
%   [ segmRangeDecl ]* := segmRangeDecl [ segmRangeDecl ]*

[[segmList]] = (segmList ; ε ; [[universID]])
% if in Rule synt-segmList:
%   segmList := universID

[[segmList]] = (segmList ; [[segmID]] [ , [[segmID]] ]* ; [[universID]])
% if in Rule synt-segmList:
%   segmList := segmID [ ‘ , ’ segmID ]* ‘<’ universID

[[segmRangeDecl]] = (segmRangeDecl ; [[segmID]1] ∩ [[segmID]2] [ ∩ [[segmID]i] ]* =
                    [[universEmptSegmID]])
% if in Rule synt-segmRangeDecl:
%   segmRangeDecl := segmID1 ‘^’ segmID2 [ ‘^’ segmIDi ]* ‘=’ universEmptSegmID

[[segmRangeDecl]] = (segmRangeDecl ; [[segmID]] ∪ [[segmID]] [ ∪ [[segmID]] ]* =
                    [[universEmptSegmID]])
% if in Rule synt-segmRangeDecl:
%   segmRangeDecl := segmID ‘∨’ segmID [ ‘∨’ segmID ]* ‘=’ universEmptSegmID

[[segmRangeDecl]] = (segmRangeDecl ; [[segmID]] ∩ [[segmID]] [ ∩ [[segmID]] ]* ⊆ [[segmID]])
% if in Rule synt-segmRangeDecl:
%   segmRangeDecl := segmID ‘^’ segmID [ ‘^’ segmID ]* ‘<’ segmID

[[segmRangeDecl]] = (segmRangeDecl ; [[segmID]] ∪ [[segmID]] [ ∪ [[segmID]] ]* ⊆ [[segmID]])
% if in Rule synt-segmRangeDecl:
%   segmRangeDecl := segmID ‘∨’ segmID [ ‘∨’ segmID ]* ‘<’ segmID

[[universEmptSegmID]] = [[universID]]
% if in Rule synt-universEmptSegmID:
%   universEmptSegmID := universID

[[universEmptSegmID]] = ∅
% if in Rule synt-universEmptSegmID:
%   universEmptSegmID := ‘{ }’

[[universEmptSegmID]] = [[segmID]]
% if in Rule synt-universEmptSegmID:
%   universEmptSegmID := segmID

[[segmEnvisID]] ∈  $\mathcal{U}_{\text{SegmEnvis}}$ 

[[segmID]] ∈  $\mathcal{U}_{\text{Segm}}$ 

[[universID]] ∈  $\mathcal{U}_{\text{Segm}}$ 

```

Figure 8: The direct semantics of TinyIML: Segmenting Envisagements.

```

# NORMATIVE ENVISAGEMENTS:

[[normEnvis]] = (normEnvis ; [[normEnvisID]] ; [[typeCondList]] ; [[normDecl]] [ , [[normDecl]] ]*)

[[typeCondList]] = (typeCondList ; [[typeCondID]] [ , [[typeCondID]] ]*)

[[normDecl]] = (norm ; 'prohib' , [[segmID]] , [[typeCondID]])
% if in Rule synt-normDecl:
%   normDecl := 'prohib(' segmID ' , ' typeCondID ' )'

[[normDecl]] = (norm ; 'oblig' , [[segmID]] , [[typeCondID]])
% if in Rule synt-normDecl:
%   normDecl := 'oblig(' segmID ' , ' typeCondID ' )'

[[normDecl]] = (norm ; 'permit' , [[segmID]] , [[typeCondID]])
% if in Rule synt-normDecl:
%   normDecl := 'permit(' segmID ' , ' typeCondID ' )'

[[normEnvisID]] ∈  $\mathcal{U}_{\text{NormEnvis}}$ 

[[typeCondID]] ∈  $\mathcal{U}_{\text{CondType}}$ 

# VALUATING ENVISAGEMENTS:

[[valuatEnvis]] = (valuatEnvis ; [[valuatEnvisID]] ; [ [[valuatDecl]] ]*)

[[valuatDecl]] ≡  $\neg\exists tc \in \mathcal{U}_{\text{CondType}}(tc \sqsubseteq [[\text{typeCondID}]] \vee [[\text{typeCondID}]] \sqsubseteq tc)$ 
% if in Rule synt-valuatDecl:
%   valuatDecl := typeCondID

[[valuatDecl]] ≡  $\forall tc \in \{ [[\text{typeCondID}_1]] [ , [[\text{typeCondID}_i]] ]^* \} (tc \sqsubseteq [[\text{typeCondID}_n]])$ 
% if in Rule synt-valuatDecl:
%   valuatDecl := typeCondID1 [ ' , ' typeCondIDi ]* '=<' typeCondIDn

[[valuatEnvisID]] ∈  $\mathcal{U}_{\text{ValuatEnvis}}$ 

QUALIFYING ENVISAGEMENTS:

[[qualifEnvis]] = (qualifEnvis ; [[qualifEnvisID]] ; [[orderRelID]] ; [ [[qualifDecl]] ]*)

[[orderRelID]] ∈  $\mathcal{U}_{\text{Segm}} \times \mathcal{U}_{\text{Segm}}$ 

[[qualifDecl]] ≡  $\neg\exists sgm \in \mathcal{U}_{\text{SegmEnvis}}(sgm [[\text{orderRelID}]] [[\text{segmID}]] \vee [[\text{segmID}]] [[\text{orderRelID}]] sgm)$ 
% if in Rule synt-qualifDecl:
%   qualifDecl := segmID

[[qualifDecl]] ≡  $\forall sgm \in \{ [[\text{segmID}_1]] [ , [[\text{segmID}_i]] ]^* \} (sgm [[\text{orderRelID}]] [[\text{segmID}_n]])$ 
% if in Rule synt-qualifDecl:
%   qualifDecl := segmID1 [ ' , ' segmIDi ]* '=<' segmIDn

[[qualifEnvisID]] ∈  $\mathcal{U}_{\text{QualifEnvis}}$ 

```

Figure 9: The direct semantics of TinyIML: Normative, Valuating and Qualifying Envisagements.