



## AN ONTOLOGY OF BOARD GAMES BASED ON THE MDA FRAMEWORK

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Orientador: Geraldo Bonorino Xexéo

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*To my first fan  
Mom*

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Março/2020

Orientador: Geraldo Bonorino Xexéo

Programa: Engenharia de Sistemas e Computação

Esta dissertação utiliza de teorias muito bem fundamentadas na literatura para dar um primeiro passo na criação de uma base de conhecimento sobre jogos de tabuleiro. Produzindo assim uma ontologia fundamentada sobre o framework MDA HUNICKE *et al.* (2004) e criada sobre os preceitos da UFO GUIZZARDI (2005). Para isso se investiga de forma mais profunda o que são mecânicas, dinâmicas e estéticas, utilizando tanto conhecimento prático de pessoas envolvidas quanto bases teóricas fortes como EKMAN (1992) e DILLON (2010). Finalmente produzindo um artefato a ser utilizado para melhorar o entendimento de jogos de tabuleiro.

Abstract of Dissertation presented to COPPE/UFRJ as a partial fulfillment of the requirements for the degree of Master of Science (M.Sc.)

UMA ONTOLOGIA DE JOGOS DE TABULEIRO FUNDAMENTADA NO  
FRAMEWORK MDA

Joshua Silveira Kritz

March/2020

Advisor: Geraldo Bonorino Xexéo

Department: Systems Engineering and Computer Science

This dissertation uses theories highly recognized in the literature to take a first step in creating a knowledge base about board games. Thus producing an ontology based on the MDA framework HUNICKE *et al.* (2004) and created upon the precepts of UFO GUIZZARDI (2005). For this it investigates more deeply what mechanics, dynamics and aesthetics are, using as much practical knowledge of the people involved as strong theoretical basis such as EKMAN (1992) and DILLON (2010). Finally producing an artifact to be used to improve the understanding of board games.

# Sumário

<b>Lista de Figuras</b>	<b>xi</b>
<b>Lista de Tabelas</b>	<b>xii</b>
<b>1 Beginnings</b>	<b>1</b>
1.1 Why games? . . . . .	1
1.2 Research Problem . . . . .	3
1.3 Concepts . . . . .	3
1.4 Structure of this work . . . . .	4
<b>2 What we know so far</b>	<b>6</b>
2.1 Game ontologies . . . . .	6
2.2 MDA framework . . . . .	7
2.3 Background knowledge of games . . . . .	10
2.4 Emotions . . . . .	12
2.4.1 Basic emotion models . . . . .	12
2.4.2 The Atlas of Emotions . . . . .	13
2.4.3 The 6-11 model . . . . .	15
2.5 What is an ontology? . . . . .	17
2.5.1 Modeling languages and conceptualization . . . . .	17
2.6 UFO: a non-alien ontology . . . . .	19
2.6.1 The Universal . . . . .	19
2.6.2 The wholes with parts . . . . .	22
2.6.2.1 Principle of unity . . . . .	22
2.6.2.2 Secondary characteristics . . . . .	23
2.6.2.3 Shareability . . . . .	23
2.6.2.4 Separability . . . . .	24
2.6.3 Restrictions . . . . .	24
<b>3 Crafting an Ontology</b>	<b>26</b>
3.1 Thinking of UFO . . . . .	26
3.1.1 OntoUML . . . . .	27



3.2	How to model board games . . . . .	28
3.3	Mechanics . . . . .	29
3.4	Dynamics . . . . .	29
3.4.1	The focus group . . . . .	30
3.4.2	Survey on dynamics . . . . .	31
3.4.3	Developing the ontology . . . . .	32
3.5	Aesthetics . . . . .	33
3.5.1	The modeling of emotions . . . . .	33
3.6	Using the ontology . . . . .	34
3.7	Scope delimitation . . . . .	35
<b>4</b>	<b>Dynamics: research results and analysis</b>	<b>36</b>
4.1	Focus group . . . . .	36
4.1.1	Curious cases . . . . .	38
4.2	Survey data . . . . .	39
4.3	Statistical analysis of survey answers . . . . .	41
4.3.1	Using ANOVA . . . . .	41
4.3.2	Analyzing the output . . . . .	41
4.4	To the survivors, the spoils! . . . . .	42
<b>5</b>	<b>OntoBG: An ontology of boardgames</b>	<b>45</b>
5.1	What about cause and consequence? . . . . .	45
5.1.1	Formalizing cause and consequence relationship . . . . .	46
5.2	It's Alive! . . . . .	47
5.3	OntoBG-M : mechanics unbound . . . . .	48
5.4	OntoBG-D : dynamics uncovered . . . . .	49
5.4.1	The expected . . . . .	50
5.5	OntoBG-A : aesthetics unearthed . . . . .	51
5.5.1	Ekman to UFO . . . . .	51
5.5.2	Dillon to UFO . . . . .	52
<b>6</b>	<b>Prolog implementation</b>	<b>53</b>
6.1	Motivation . . . . .	53
6.2	Translating OntoBG to Prolog . . . . .	54
6.3	Creating games and asking them questions . . . . .	55
6.3.1	Game validity . . . . .	55
6.3.2	Finding the error . . . . .	56
6.4	Enhancing the model . . . . .	58
6.4.1	Creating relationships . . . . .	59
6.4.2	Creating concepts . . . . .	60

6.4.3	Hit the nail in the head . . . . .	61
<b>7</b>	<b>Finale</b>	<b>63</b>
7.1	OntoBG: ontology of boardgames . . . . .	63
7.2	Theories . . . . .	64
7.2.1	Preliminary work on dynamics . . . . .	64
7.2.2	Aesthetic values in perspective . . . . .	65
7.2.3	Mechanics and praxis . . . . .	65
7.3	Program of the model . . . . .	65
7.4	The issue of validation . . . . .	66
7.5	At the end... . . . .	66
	<b>Referências Bibliográficas</b>	<b>68</b>
<b>A</b>	<b>Surveys submitted</b>	<b>73</b>
A.1	English survey . . . . .	73
A.2	Portuguese survey . . . . .	86
A.3	OntoBG-M diagram . . . . .	99
A.4	OntoBG-D diagram . . . . .	100
A.5	OntoBG-A diagram . . . . .	101
A.6	Building Blocks analysis . . . . .	103

# Lista de Figuras

2.1	MDA diagram . . . . .	8
2.2	Dynamics example . . . . .	10
2.3	Emotional States intensity . . . . .	14
2.4	6-11 model Diagram . . . . .	16
2.5	Modeling Diagram (GUIZZARDI, 2005) . . . . .	18
2.6	Universal classification Diagram (GUIZZARDI, 2005) . . . . .	21
5.1	Game Diagram . . . . .	48
A.1	Mechanics ontology Diagram . . . . .	99
A.2	Dynamics ontology Diagram . . . . .	100
A.3	Aesthetics ontology Diagram top section . . . . .	101
A.4	Aesthetics ontology Diagram bottom section . . . . .	102

# Lista de Tabelas

2.1	MDA components description (HUNICKE <i>et al.</i> , 2004) . . . . .	8
4.1	Averages of answers . . . . .	40
4.2	Analysis of Variance . . . . .	42
4.3	Model Summary . . . . .	42

# Capítulo 1

## Beginnings

This chapter presents this dissertation's proposal and introduces the main ideas that will be used along its construction. It contains the motivations as well as a broad spectrum view of this work, while introducing core concepts that will be used .

### 1.1 Why games?

Nowadays we live surrounded by games. There are games in smart-phones that are played while we come and go to our everyday tasks, games in our houses, in computers and even where there seems to be no games, there are people talking about games.

Financially, games are a big industry. The revenue of many video game companies are in the score of billions of dollars. BABB & TERRY (2013) evaluates diverse companies and games, giving a good illustration of this big industry. Only the US video game market is worth over 20 billion dollars. A single game, World of Warcraft, had almost 1 billion dollars revenue by itself. All of this before 2011, when today this market has only increased as analyzed by MÄÄTTÄ (2019). This shows how big games are in the modern world, which enforces why we should study them deeply.

Games are also becoming present on education. Game-based learning became a very popular approach to teaching in many levels of education. In HAINEY *et al.* (2016) the sheer amount of practical experiences found is enough to show that games are a part of education in the twentieth century.

One can guess that, if games are so entwined in our daily lives, there will be a great understanding of them, of what games are, how games are made, what means to play a game. Surprisingly that is not true. Studies in games have a great amount of disagreement. Many aspects of games are met with different opinions among scholars. To begin with, there is no commonly accepted definition of the term game.

Many researchers addressed the problem of finding a definition (CRAWFORD, 1984; JÄRVINEN, 2009; JUUL, 2010; SALEN & ZIMMERMAN, 2004; SCHELL, 2014) but they could not agree on a single definition. Each of them pursued very different paths in their search for understanding, thus each defined games in their own way. Although there is some common ground between some of those definitions. SALEN & ZIMMERMAN (2004) systematically compared most definitions from previous works and concluded there was no true agreement between them. WITTGENSTEIN (2009) went further to state that there is no possible definition, “game is a concept with blurred edges”. Such is the hardship of finding a definition for games.

Other aspects of games share this multitude of opinions. Game design or how to make games is a subject that presents a variety of ideas and models for its understanding. Although there are more common parts and shared ideas through many researches this subject is far from a global complete knowledge. There are many other questions pertaining games that remain without a completely accepted answer. Such as ‘why do people play games?’, ‘how do people react to games?’, ‘how do people behave in games?’.

In light of such confusion and dissent. The purpose of this work is to extend current understanding of what games are made of, of which parts compose this complex and intriguing whole. Hopefully, this will bring us closer to completely understanding games. At least it should provide a tool for researchers and designers that wish to adventure in the games domain to start to understand what it is. Therefore, this is an attempt to create a boardgame ontology using the ontological principles of UFO (GUIZZARDI, 2005). UFO will provide the foundation for a human oriented ontology. This ontology is structured upon the MDA framework (HUNICKE *et al.*, 2004) as it is simple and widely accepted in the academic community.

This dissertations focus its efforts in boardgames, this is due the author’s experience, but also because the boardgame industry is increasing rapidly over the past decade and becoming a very expressive part of the daily lives in many countries. In a market report, done by Grand View Research <sup>1</sup>, the boardgame market size was almost 12 billion dollars, with an expected increase of 8,79% over the next six years. It still does not compete with video games, but this growth implies that boardgames are becoming more and more important and prominent over the years and must be addressed accordingly.

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<sup>1</sup><https://www.grandviewresearch.com/industry-analysis/playing-cards-board-games-market> Accessed in 12/03/2020

## 1.2 Research Problem

The research problem addressed in this dissertation is represented by the following research questions:

1. What work has been done about game ontologies?
2. What means are there to describe the boardgame domain using an ontology?
3. In what ways can an ontology be composed to better represent the challenges on board game domain?
4. How to create a domain ontology of boardgames focused on humans rather than machines?
5. Does this ontology provides better understanding of the boardgames domain?

## 1.3 Concepts

In this section some important concepts used in this work are exposed and explained according to their meaning to this dissertation. To be clear about what they mean whenever they are used. It is not in the scope of this work to define games so there will be no rigid definition of the word Game. When looking into the definitions given by the many authors mentioned in section 1.1 that are the background knowledge of the author as stated in section 2.2 it is possible to understand what a game is to this work.

**Boardgame** is used with the idea of a non-digital game. It does not need to have a board, it can be a game made of only cards or even a mimics game with no object, only the rules. The scope of this work does not include video games. We use the word boardgame, instead of game, throughout this dissertation to emphasize this.

The terms **mechanics**, **dynamics** and **aesthetics** are used according to their definition in the MDA framework, which is explained in the next chapter.

**Magic Circle** is a notion first introduced in HUIZINGA (2014). Although HUIZINGA did not name it so, many scholars that further developed the concept name it as Magic Circle. BATEMAN (2015); SALEN & ZIMMERMAN (2004) are only a few examples. This concept develops on the idea that there is a certain boundary in reality in which the play of a game takes place and this boundary prohibits some aspects of reality to affect the game space, in other words it protects the game from the real world. The Magic Circle became very important to the studies of games and whenever mentioned throughout this work the Magic Circle significance is in accordance to the understanding given by SALEN & ZIMMERMAN

(2004). Which is that the Magic Circle is the reality where the game takes place, and it sets the boundaries that separate the game from real world.

**World** is addressed in the modeling concept of the real world. A given world is a possible reality of facts and beings that are part of the modeled domain. In other words a world is a possible existence. An example, say that a model of families exist. One world is that Carlos, Mandy and Bob form a family while Eduardo, Sandra and Charlie form another. A second possible world is that Carlos, Eduardo and Bob from the first family while the others form the second one.

## 1.4 Structure of this work

This first chapter is used to introduce the general idea of this dissertation as well as some important concepts that are used throughout it.

Chapter 2 will present a literature review, which will cover the topics of this dissertation. First it presents works that are similar to some degree to the one that will be done here. Ontologies made about the game domain, including some that were not about game specifically but about specific aspects of games. Then it establishes references used as foundation knowledge for this work, such as books, theories and ideas that were fundamental to the author's understanding of the area. Finally it introduces a review of the subjects nested in the MDA framework. That is, provides a review of works done with respect to mechanics, dynamics and aesthetics that were in accord with their definition.

The third chapter will discourse about the methodology chosen for this work, presenting and explaining the UFO and OntoUML and how they will be used to bring fruition to this ontology. It will explain the ideas of UFO and the reasoning behind choosing it. Also about why this is different from other attempts on building ontologies in the games domain. Furthermore it shows why OntoUML is a natural choice when describing an ontology founded in UFO.

Following the methodology, chapter 4 presents the results of the research on dynamics. Using these results a vocabulary of dynamics is also established, which is used to create the dynamics section of this ontology.

Using the background built until then, the fifth chapter summarizes the proposal of this dissertation. Thoroughly explaining what is to be done in the creation of the ontology of boardgames and why it is done so. It provides the theoretical foundation of the ontology, the core modeling choices made, their explanation and reasoning and how to use the OntoUML language to represent the concepts contained in the ontology.

Chapter 6 will then contain the implementation of the ontology in the prolog language. This is the computable form of the ontology, the part which users can



manipulate and change the ontology by themselves and describe games through the model. This chapter covers its creation as well as functionalities and how to use it. Also covering how to evaluate improvements to this ontology.

Finally, chapter 7 concludes this work discoursing and summarizing what was done here. Also exposing how future works can improve the line of research and even create new ones.

# Capítulo 2

## What we know so far

This chapter aims to present the knowledge and ideas used as foundation for this work, looking into similar perspectives, theory about games and presenting knowledge pertaining the methodology chosen.

### 2.1 Game ontologies

The whole idea of creating an ontology about games is not a novelty. There are many attempts to create such an artifact, although not specifically about boardgames, each of them with their own purpose. The most known of those attempts is the Game Ontology Project (GOP) (GAMEONTOLOGY, 2015), “a framework for describing, analyzing and studying games” (ZAGAL & BRUCKMAN, 2008). It provides a structure to study game elements based on four top-level elements: interface, rules, entity manipulation and goals. It is a collaborative work, open to contributions, although as of 11/11/2019 its development is stalled. Some of its elements can be identified in the ontology proposed in this work. Most of it in the Mechanics ontology. Those resemblances are further covered in (KRITZ *et al.*, 2017). Roman, Sandu, and Buraga constructed an ontology for role-playing games (RPG) in a work inspired by GOP (ROMAN *et al.*, 2011). That work uses the OWL language to describe the ontology and intends to facilitate designers’ activities like character creation, NPC generation, simple battle system configuration, etc. A slightly more comprehensive ontology was created in the realm of RPG (ĐURIC & KONECKI, 2015). Although using a specific game, THE MANA WORLD, as the source of concepts, the authors claim that the resulting ontology is applicable to massively multiplayer online role-playing games (MMORPG).

More recently, GOP and MDA were also used to provide a model for innovation in digital games (CALADO *et al.*, 2015). Three Hundred Mechanics is a video game oriented catalog of game mechanics, with examples (HOWARD, 2014). It is very comprehensive and provides five collections: Comp-grid, Procedural, Tactics,

Tiny Crawl and Misc. It is maintained by a single person, but also seems to have ceased to evolve, as of 2019. In LEÓN Z & SÁNCHEZ L (2010) a Mobile games ontology is developed while investigating the use of UML and OCL for ontology representation. Another recent work focused in video games is PARKKILA *et al.* (2017), in which the authors claim that can enable interoperability between games. A Game Character Ontology developed in SACCO *et al.* (2017) provides tools to be used in the creation of game characters.

In the realm of Serious Games there are some other attempts on ontology creation. A group of researchers at Aristotle University of Thessaloniki created an ontology for exergames proposing a "unified model for the semantic representation of exergames"(BAMPAROPOULOS *et al.*, 2016) with the objective to propose standards for the research on exergames. In a different approach Tang and Hanneghan created the Game Content Model (GCM) (TANG & HANNEGHAN, 2011), which is an ontology about documenting serious game design. It focus on helping new game designers with methods and game design models. Although the main subject of GCM is not exactly the game, but game documentation, it provides great insight in taking the player into account in its model. More specifically for games in education GHANNEM & KHEMAJA (2011) created a ontology for integrating games and learning processes.

Each of these attempts and examples are focused on video games. Although some of them do not directly establish this focus the creation of the ontologies were made using knowledge, examples and experience of video games. This work proposes a different approach creating an ontology specific to boardgames using knowledge examples and experience from boardgames.

## 2.2 MDA framework

The MDA framework, used as a foundation for this work, is a widely accepted model for understanding and studying games, featuring over 2000 citations as of February of 2020 in Google Scholar.

It's name is an acronym for Mechanics, Dynamics and Aesthetics, which are the three conceptual components games are made of. The framework also presents a causal relationships between those components which is the most interesting contribution of this model. The MDA framework was created to help designers, scholars and researchers, providing a tool for decomposing games in smaller parts, that are easier to manage and understand.

The components of the framework are defined as Tabela 2.1 illustrates:

Those definitions, proposed by the authors, are fitting for the their model, but if we want to apply the model thoroughly in both game design and research, deeper

Tabela 2.1: MDA components description (HUNICKE *et al.*, 2004)

Mechanics	The particular components of the games, at the level of data representation and algorithms.
Dynamics	The run-time behaviour of the mechanics, acting on player inputs and each others' outputs over time.
Aesthetics	Emotional responses evoked in the players.

understanding of each of these concepts will be very useful. Hence this work intends to create an ontology for each of them, providing a tool that increases the usability of the MDA model for Boardgames. Even with a simple ontology and the foundations for a knowledge base, the use of each component of the MDA framework will be much clearer. As of today there is a lot of controversy about mechanics and aesthetics and for dynamics there is almost no information at all. This work intend to deliver not only a better understanding of each component but also a coherent connection between them.

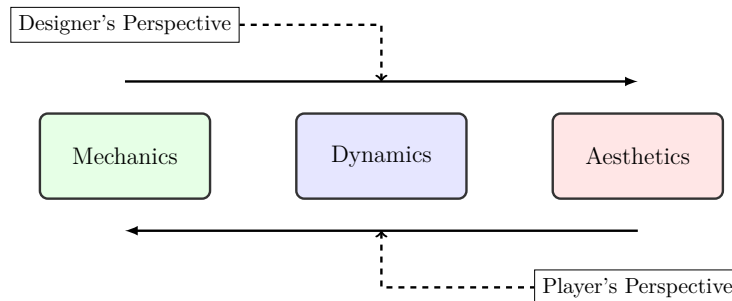


Figura 2.1: MDA diagram

How each component of this model relates to each other can be understood through the diagram at Figura 2.1. There are two agents of importance in this model, the player, who experiences the game and the designer who crafts the game each with a different perspective of the game. Those perspectives are of great importance to the MDA model, as they represent how the different agents involved in the game perceive it.

The designer's perspective explains the reasoning used in the creation of the game, that is, how the design choices affect the game. Starting with the mechanics the designer chooses to include, he creates the artifact of the game. At this point the designer has full control of the artifact and knows exactly what is there and what is not. From the mechanics instanced in the game emerges dynamics, which depends

on how the player will interact with those mechanics. Because of this dependence the designer does not have the same power of control as with the mechanics, though it can still predict what dynamics can appear with some level of accuracy. The farthest point from the designer is aesthetics which means it is the component over which the designer has least control. Representing the emotions experienced in gameplay, aesthetics are heavily dependent on the dynamics that happened in the game but even more on the player itself. Leaving the designer with just the expectation of what will happen in most cases, but not allowing the determination of a precise aesthetic response.

The player's perspective addresses how the player experiences the game and how he interacts with each component of the game. The most important experience for the player is the aesthetic response it gets through playing a game. The player still has a certain responsibility for her aesthetics responses. She brings to the game her previous experiences, opinions and values, and is how she evaluate the gameplay that brings such responses. This is the component that has greater influence over the player judgment, it defines her opinions of the game, whether she likes it or not and how she feels about playing. Dynamics, to the player, is how gameplay develops, how she interacts with other players and the game artifact. Such interaction is affected by the aesthetics experienced by the player throughout the gameplay and limited by the mechanics of the game. In mechanics the player withstands the set of rules and norms she has to oblige in order to play the game, in other words she sees them as the limitations and possibilities of the game. The player thus relates to the mechanics as a tool which allows her to interact with the game and as the rules that govern this interaction.

There is a practical example to illustrate such relationships. A said dynamic *Run away* is an impulse created by the aesthetic *Fear*, the player thus run because he is afraid. The player can only run because there is a mechanic *Movement* that allows him to do so. At the same time this same movement mechanic could be used in a *Charge* dynamic when it is related to the aesthetic of *Fury*. It is important to note that such relationships are not always reflective. In our example, run is caused by fear, but running does not inspire fear, another dynamic *Find monster* is responsible to inspire this fear.

There is then a relationship between Mechanics and Dynamics as well as between Dynamics and Aesthetics that will feature in the boardgame ontology as relationships between the each particular ontology.

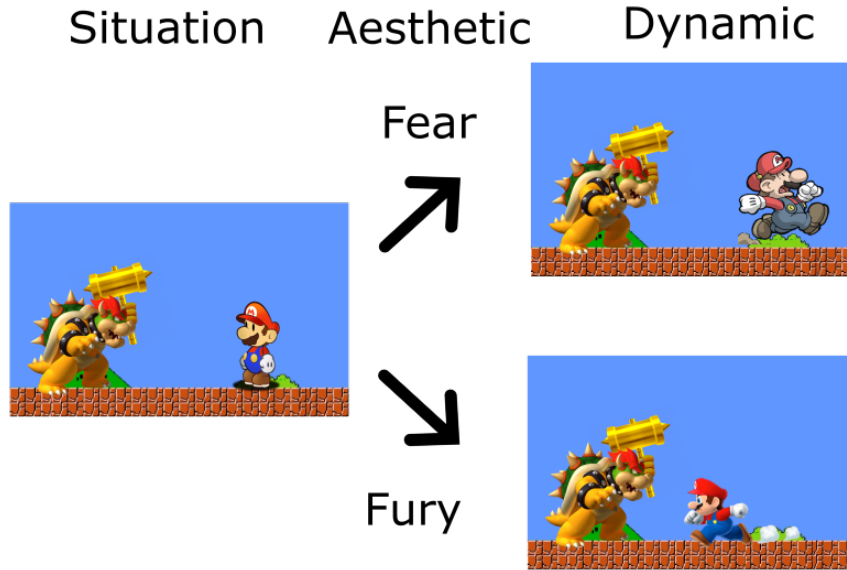


Figura 2.2: Dynamics example

## 2.3 Background knowledge of games

Although not defining the term game, it is important to be clear about how we understand games. About what are the paving stones for the knowledge used in this work. In such light this section reviews many authors and their works, which compose the foundation of the view of games domain. First it is important to note that most of the references mentioned here are not specific about boardgames, some are even exclusively about video games, but nonetheless they are important to clarify the way this work looks and delves into boardgames. As most of the knowledge in such references are about games in general their ideas are completely valid for boardgames. Although the specifics of how to fit these ideas in this domain was brought mostly by experience.

The most notable foundation is the MDA framework HUNICKE *et al.* (2004), chosen as the core structure of this dissertation. It will be explained in a section of its own given how important it is to this work.

Close to the MDA framework, but different in the way it relates the game components, is SCHELL (2014) framework. He defines mechanics much like the MDA and aesthetics in a different but similar way. It includes the visual and sensory aspects of the game. But he does not define the emotions as aesthetics and actually relates them as cause-effect. Schell does not include the dynamics in his framework, but he introduces two components, Story and technology. The former is important to understand how the narrative and the reasoning behind mechanics impact the game. Technology is of great importance here. In Schell's framework it is the actual choice of implementation of the game. How it exists as an artifact, if it is paper and

plastic objects, a book, code and data in a digital setting. The importance of it to games is that it imposes limits to the game. An example, for a game to be created for a mobile platform, it cannot have the same quality of graphics and sound as if it was to be played in a desktop computer. In a more complex comparison, Role Playing Games, which are written in books, can have a flexible set of rules, most of the time the rules are dictated by a game master and aren't even written on the book. Such characteristic is difficult to obtain in digital games, as these rules need to be pre-coded. This distinction given to the choice of technology is definitive for this work, as it is why I think it is worth to study a specific type of technological limitation, of physical papers and plastic objects and a rulebook. This scope allows to better enlighten these limitations and advantages of a specific technology.

When studying games there are many facets that can be persecuted, SALEN & ZIMMERMAN (2004) acknowledge it in their work and even used this in their framework. They termed this process of focusing in a specific facet as framing the game. According to SALEN & ZIMMERMAN (2004) there are three possible ways to frame games, as Rules, Play and Culture, each of them focus on certain specific aspects of a game in detriment of other ones. To frame games as Rules means looking into the game as in and of itself without considering who plays the game, neither in what circumstances it happens. According to the authors "Rules is a *formal* primary schema, and focuses on the intrinsic mathematical structures of games" (SALEN & ZIMMERMAN, 2004). The Rules frame focus on the mechanics of the games. Increasing the scope of the frame there is Play, this frame begins to take into account the player of the game, what he does and how he behaves, as the authors state "Play is an *experiential* primary schema and emphasizes the player's interaction with the game and other players." SALEN & ZIMMERMAN (2004). In accord with the MDA, the Play frame focus on Dynamics and the Aesthetics of the game. The broader scope of this framing is Culture, it goes beyond the game and its players to look into the social behaviour and culture surrounding the game, to the authors "Culture is a *contextual* primary schema, and highlights the cultural contexts into which any game is embedded." SALEN & ZIMMERMAN (2004). This framing is not encompassed by the MDA framework, it focus on the environment in which the game exists and how it interacts with the game, not with the game itself as does the MDA. This is an important distinction, for it provides a clear understanding of one of the boundaries of this work's scope. By using the MDA as our foundation we abide to remain in its frame, which means this work frames games in a conjunction of the Rules and Play frames.

These are the most prominent foundations for the academic knowledge of the author. They assisted in creating the notion of game and the foundations of its

understanding for the author. Together with the MDA framework they establish the academic baselines of this work.

## 2.4 Emotions

An important subject in the study of games is the emotions felt by the players. In MDA they feature as one of the three fundamental components of games. Emotions are traditionally a subject of psychology, but there are many studies focusing on emotions for games such as BATEMAN (2015, 2014); DILLON (2010); KARPOUZIS (2016). This section covers baseline studies, on both games and psychology, meant to understand such a complex subject and provides structure to this ontology.

There is no single line of research for emotions in psychology, however there are two major ways of studying them. One is called *appraisal theory*, which considers emotions generated by appraisal and arousal, a valenced reaction to such appraisal (ORTONY *et al.*, 1990; SCHERER *et al.*, 2001). The other studies emotions as intrinsic manifestations, that is, there are a set of emotions understood as basic emotions which are natural to humans and independent of cultures and backgrounds, henceforth named *basic emotion theory* (EKMAN, 1992, 2016).

It is not within the scope of this work to discuss different psychological theories of emotions, or why and how they happen. What is of interest to this work is some structural model which exposes and classifies emotions that can be used as a basis for this ontology. That said, the appraisal theory models are more difficult to comprehend as they delve deeper in the terms of psychology and cognition. Whilst the basic emotion ones are simpler, much of this is due to the fact that appraisal theories are not about emotion words, that is, they do not intend to define emotion as they are used in common language. On the other hand, basic emotion theories study emotion from a perspective which focuses on how the person interprets their own emotions and thus naturally it is defined in emotion words.

The intention of this ontology is to be used by game designers and other people interested in games, who do not necessarily have a deep knowledge of psychology. Basic emotions were then chosen as the theoretical foundation for the ontology of aesthetics because of their simplicity. The remainder of this section addresses two different models of basic emotions.

### 2.4.1 Basic emotion models

The following sections evaluates two different perspectives in basic emotion theory. One, built by DILLON (2010), is focused in the study of games, and therefore of great interest to this work. The other one is a widely accepted and central theory



created by EKMAN (1992). Dillon's theory is not incompatible with Ekman's, actually he uses the psychological theories of emotion created by many authors which agree with Ekman, and even use his theory. Thus this section analyzes two different takes on emotions studies, one purely psychological and the other applied to games, to find out how they can contribute to understanding emotions in games.

Also, it is important to make a clarification on basic emotions. This classification of an emotions in basic ones, is not in the sense that they are elements combined to create a more complex emotion, it denotes emotions which have a biological basis. The meaning behind this biological basis is that "emotions are a product of our evolution"EKMAN (1992).

## 2.4.2 The Atlas of Emotions

Ekman created an atlas to illustrate his model which can be accessed at <http://atlasofemotions.org/> as of december 2018, it is the amalgamation of many years of research in emotions. This theory created by Ekman stands upon the assertion that emotions can be associated with physical reactions, to him, facial expressions.

The atlas identifies five basic emotions, anger, fear, disgust, sadness and enjoyment. Inside each basic emotion there are several emotional states, which are the ways a given person experiences this emotion. Each emotional state has its own intensity zone of the basic emotion to which it is related, this is illustrated by Figura 2.3. This zone represents how intense the emotion must be for the emotional state be manifested. Some of those states have zones that overlap, and can be felt at the same time. It is this conjunction of emotional states that represents the complexity of human emotion.

Common responses in each emotional state are also identified in Ekman's model. They evaluate the usual reactions a person express when feeling a particular emotion state. The notion of mood also present, a mood is a mental state which causes a particular emotion to be more likely felt. They last longer than the emotions themselves and can span through any other emotional states.

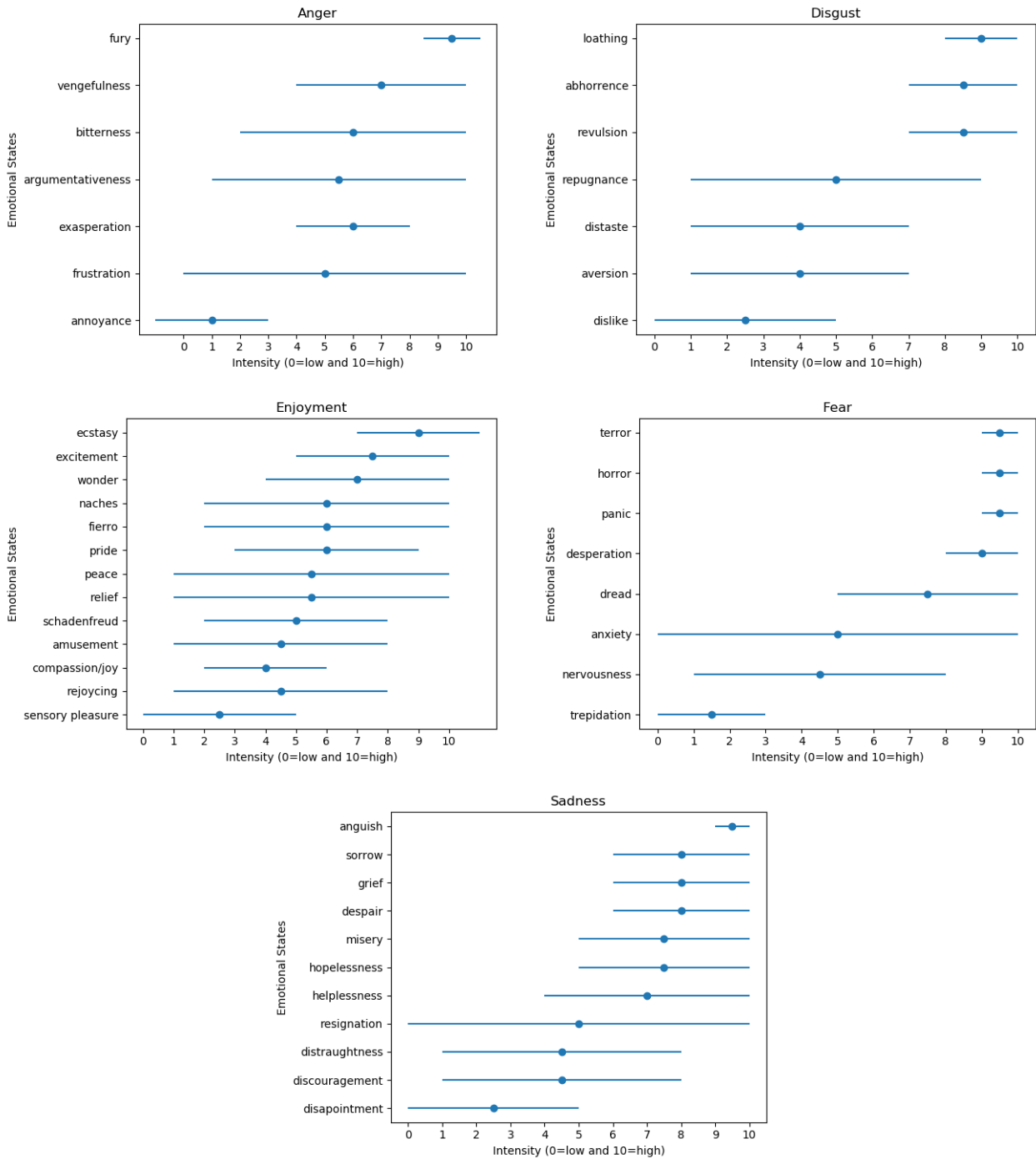


Figure 2.3: Emotional States intensity

### 2.4.3 The 6-11 model

In his book *On the way to fun* DILLON tackles the challenge of studying game design using emotions as his main perspective. His work consists of looking at successful games, that is, games which had a great acceptance of the public and received lots of positive criticism analyzing the emotions those games evoke. With this analysis Dillon creates a framework to understand how emotions behave in games, which is called 6-11.

6-11 stands as the name of the framework because this model is structured around 6 basic emotions and 11 instincts. The 6 emotions are fear, anger, pride, excitement, sadness and joy and the 11 instincts, survival, identification, collecting, greed, aggressiveness, revenge, competition, protection/care, curiosity, communication, color appreciation are related as according to the framework diagram in Figura 2.4. The solid lines relate emotions to instincts they evoke and dashed lines instinct to the emotions they cause. Relationships between emotions and between instincts appear in Dillon's book, but are not thoroughly explored by him. The only relationship between emotions is from Pride to Joy. Most important are the relationships between emotions and instincts. Thus for clarity of information relationships between concepts of the same kind were left out of the diagram.

Differently from the Atlas of emotions, Dillon's identifies 6 basic emotions. Some of them very akin o those of the atlas while others even feature in the atlas as emotional states. That said, the emotions side of the 6-11 framework is very similar to the emotions proposed by Ekman and there is no new remark to be made.

Instincts concepts are adopted by this model. Dillon does not give a precise definition of instincts as "the analysis of instincts can spur disagreement among sociologists and psychologists"(DILLON, 2010). Instead he provides some common accepted characteristics of instincts:

- Are automatic
- Are irresistible
- Occur at some point in development
- Are triggered by some event in the environment
- Occur in every member of the species
- Cannot be modified
- Govern a behavior for which the organism needs no training

Upon this, he states that for this model's purpose the focus lies upon the fact that instincts are triggered by some event in the environment and that "we can

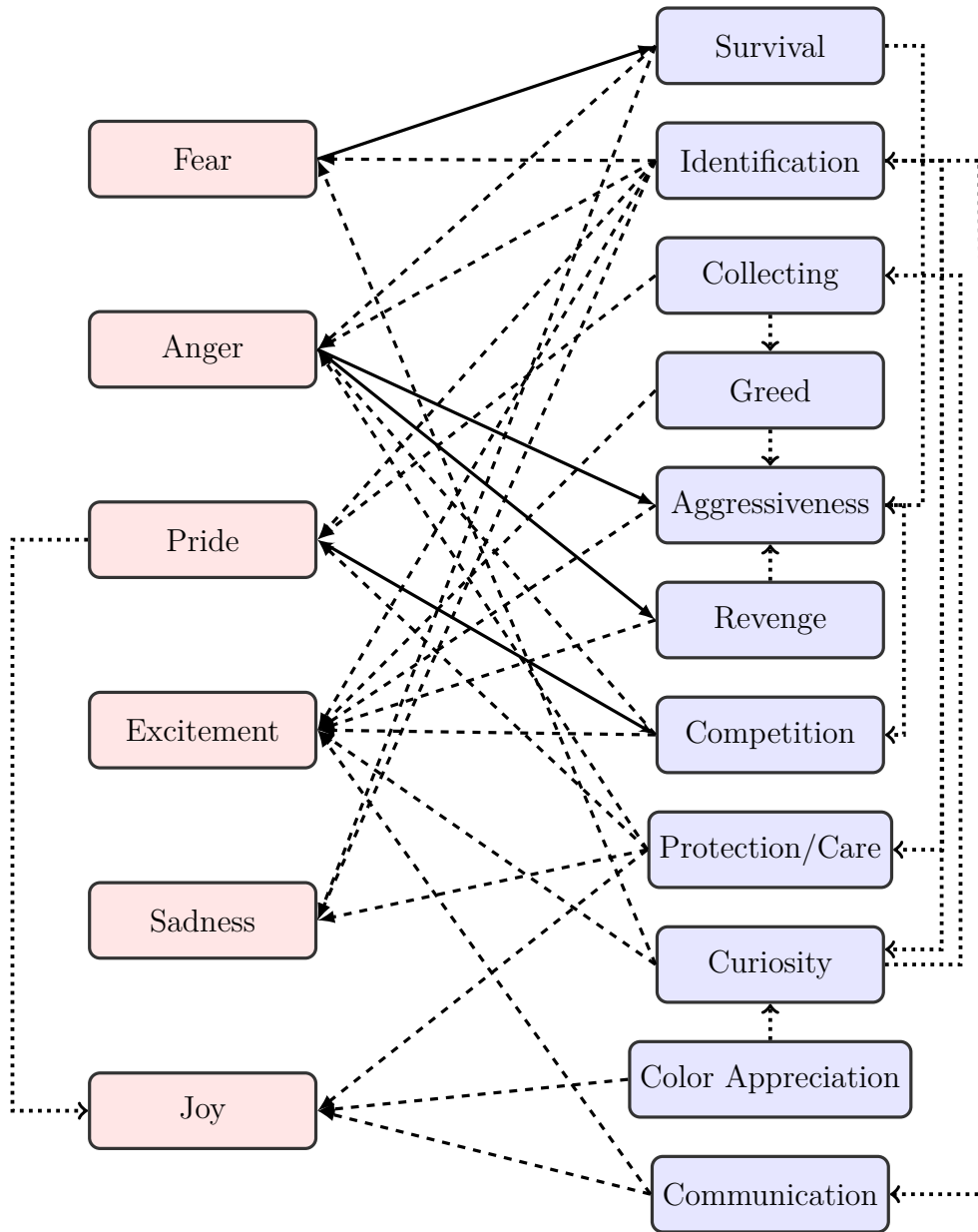


Figura 2.4: 6-11 model Diagram

simply take the others for granted and let sociologists debate over them.” (DILLON, 2010). Which means that the framework models not what or why such instincts are present in games, but how they happen.

The last part of the 6-11 framework is how each emotion relates to each instinct. This is a causal relationship, when a given emotion evokes a certain instinct or an instinct triggers a particular emotion. The purpose of this relationship is to be possible to analyze how those two concepts interact within a game. How a given emotion is felt by the player and what is responsible for this feeling, and which consequences this emotion bring to him.

## 2.5 What is an ontology?

The term ontology is used both in computer sciences and philosophy, but not with the exact same purpose. Both are areas of study that focus on representing entities, ideas and events and their relationships and properties. The difference lies in the fact that computer science mostly studies how to create ontologies (ontology engineering) about specific domains and to use them in computer systems (GRUBER, 2009). Whilst philosophy focus on understanding the nature of ontologies, of the being and what exists, that is studying more abstract subjects of ontologies and also providing classification for ontological concepts (GUIZZARDI, 2005).

In regards to ontology engineering there are different types of ontologies according to their level of generalization. The most generic type is *top-level ontologies* which describe concepts that are independent of a problem or domain, as such it defines concepts like events, actions, objects, spaces, time, etc. Next there is the specialization of the top-level ontology, which are *domain ontologies* or *task ontologies*, respectively, when describing a domain or problem. Such ontologies are presented by specifying the concepts presented in a top-level ontology, which means they present the vocabulary of their subject domain or problem. At last there is *application ontologies* which merge a domain ontology and a task ontology, it presents concepts which relate to a specific problem of a domain (GUARINO, 1998).

The main objective for creating an ontology is, in computer science, mainly to use them in an application. There are three areas that are mostly responsible for the demand for such applications of ontologies, database and information systems, software engineering and artificial intelligence (SMITH & WELTY, 2001). For database and information systems ontology is mostly used as a theoretical basis to better model reality or to evaluate existing models. To software engineering ontologies became very important as a tool to be used in domain engineering. The study of ontologies became important in addressing how intelligent systems acquire and model knowledge.

### 2.5.1 Modeling languages and conceptualization

In GUIZZARDI (2005) there is an important clarification about some concepts surrounding a model. First of all, a model in and by itself is an abstract entity as it is an abstraction of a given subject. The concrete form of a model is given by a specification, which is a set of concepts, relationships and rules that translate the model. The specification needs to be written using a modeling language, that has the syntax and vocabulary needed to express the specification. A conceptualization is an abstraction of the world's concepts, that is, it contains the ideas and possibilities of the world. This is what defines the modeling language, giving fruition to its voca-

bulary and meaning to the syntax. The model needs a fitting conceptualization to be created. So the choice of specification, modeling language and conceptualization are heavily entwined with the idealized model.

In the diagram of Figura 2.5 there is a visual representation of those concepts:

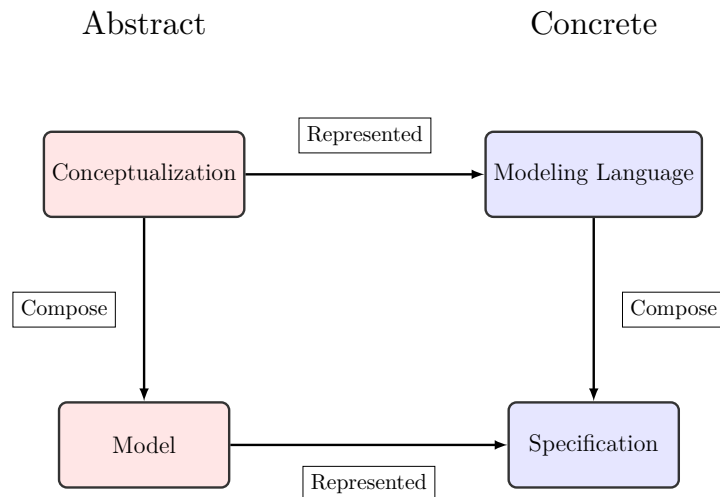


Figura 2.5: Modeling Diagram (GUIZZARDI, 2005)

It is duly noted that the distinction made is between abstract and concrete ideas. The concrete are defined as such because they have a material form with which one can interact. On the other hand the abstract concepts withhold the meaning conveyed by the concrete entities.

From the perspective of this work the model is the objective, so we center it on the interpretation of the diagram. That said, the model is an abstraction of a particular idea which resides in the world. So although it is the conceptualization that allows us to compose a model, the target models need to have compatible conceptualization. An example, one cannot correctly create a model of soccer games using a conceptualization of politics. This is called “conceptualization appropriateness” GUIZZARDI (2005).

The conceptualization comes with a modeling language to express its ideas. With this language it is possible to create a specification that represents a given model. But this specification must be according to the abstract model, otherwise it is no specification at all.

Lastly, it should be noted that the relationships between the concepts are double-sided. Whilst a model is represented by a specification it is also interpreted from it. And while a conceptualization is used to compose a model, the model is an instance of that conceptualization.

Perhaps more important than these ideas is how they limit each other. And thus they need to be carefully accounted when modeling. This work thus abides to the conceptualization and modeling language provided by the Universal Foundational Ontology and OntoUML.

## 2.6 UFO: a non-alien ontology

If the objective is to engineer an ontology there are many ways to take on this challenge. When the ontology to be engineered is of the domain or task type, a top-level, or more commonly named, foundational ontology is needed as basis for the new model. Altogether, an application ontology needs both a domain and a task ontology as a basis. How to address the creation of a top-level ontology is a complicated work and not within the scope of this text. It suffices to say that they are needed to build the other ontologies. In other words, domains and tasks are modeled using a foundational ontology and applications are modeled combining a domain ontology and a task ontology.

Before delving deeper in UFO modeling specifications and concepts it is important to expose the perspective it uses to model the world. First it is necessary to understand what endurants and perdurants are. Such concepts are introduced and studied in philosophy. They divide the being, or that which exists, in two possibilities, either it is an endurant or a perdurant. The former is a being that exists in time, it can be analyzed independently of the time. The latter is a being which happens over time, and it needs that time-span to exist, thus is not independent of it. In a more simplistic manner one can say that perdurants are events and endurants are everything else.

UFO or Universal Foundational Ontology created by GUIZZARDI (2005), is one of the most complete and used foundational ontologies in computer sciences. It leans on a heavy philosophical background and precise logical structure to provide a most complete modeling language. It is divided into different specifications UFO-a for endurants and UFO-b for perdurants. This work utilizes UFO-a because it is an ontology of an endurant and does not use UFO-b specifications. As such this section focuses on UFO-a only. For simplicity whenever it is written UFO it is addressing UFO-a only.

### 2.6.1 The Universal

Central concept of the UFO is that of an *universal*, meaning the common proprieties found in different individuals. The concept is akin to a class or type in many

of the modeling languages. It provides the common characteristics of a group of individuals.

There are diverse types of universals which are classified according to how they deliver meaning to an individual. The first classification to be remarked is the distinction between sortal and dispersive. “... a Sortal Universal, which provides a *principle of individuation* and *identity* to the particulars it collects” (GUIZZARDI, 2005). A dispersive universal embraces many concepts with different identities and thus do not convey a principle of individuation for its instances.

Sortal is a term coined by John Locke in LOCKE (1841). A technical philosophical term which was further developed by other authors. This notion is central to the discussion of things. A **sortal** has three main characteristics according to GRANDY (2016):

- Tells us what the essence of a thing is
- Tells us how to count things of that kind, which requires knowing which things are different and which are the same
- Tells us when something continues to exist, and when it goes out of existence

Thus a **sortal** is what individualizes different things and their specifics. It allows us to discuss about those things accounting for all its proprieties. It answers the question of “What is it?”.

Rigidity of a universal provides another differentiation quality. “A rigid universal is one that applies to its instances necessarily, i.e. in every possible world”(GUIZZARDI, 2005). For example, if there is a universal for *Man* which specifies *Person* in any possible world a given real person is identified by the person concept. While if it is a man it provides further identification, it is not a woman, and it remains a man in every possible world. A universal can also be *non-rigid* which is the logical negation of rigid or *anti-rigid* which is a more constrained form of non-rigid. Non-rigid means that the universal do not apply to at least one of its instances in some possible world. Anti-rigid are universals that in every possible world do not apply to one of its instances. The difference between them is that the anti-rigid must have an instance to which he does not apply, while the non-rigid might apply to all instances in a specific world.

A universal which does not apply necessarily to at least one of its instances is non-rigid. *Seatable* provides a nice example, suppose its instances are a given chair and a crate. The chair is necessarily seatable in every world whilst the crate can become unsteable and still be the same crate. Anti-rigid restricts that for every instance of the universal there must exist a world where it does not apply to that instance. Following the person example, a given man could be specified by the



universal *Child*, but it is only a child in his early years of life, in all other worlds he is no longer a child but an adult or elder.

Upon this classification GUIZZARDI brought together a typology for universals. This typology classifies and names the types of possible universals in UFO. This structure is depicted in Figura 2.6. Each of its leaves is a final classification for universals which are very important concepts for conceptual modeling. Those are defined and explained in the remainder of this section.

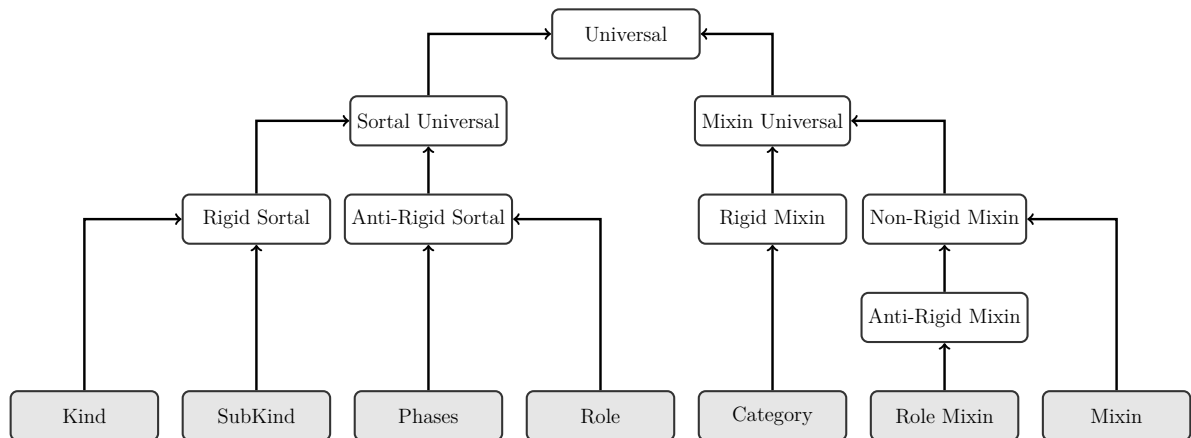


Figura 2.6: Universal classification Diagram (GUIZZARDI, 2005)

Gray nodes at the bottom of the diagram are the types of universals present in UFO. Each contains the fundamental characteristics that define the concepts of the model. The arrows forms the specification path from which that type comes. Kind is a rigid sortal, which is a sortal universal that is a universal, and so on. In any way each leave has its own meaning and definition that allows the modeler to stereotype each concept representing a universal.

“«kind» represents a *substance sortal* that *supplies* a principle of identity for its instances” (GUIZZARDI, 2005). The kind is then the representation of what is a rigid sortal, that is, in a given model all concepts which are rigid sortals are kinds. Subkinds are just specializations of kinds and can be omitted from a model without any loss. Any object in a UFO specification must be an instance of a kind, directly or indirectly.

Phases are a specification of kinds, and represent the different states that a kind has along the time of its existence. It is important that, when modeled, the phases of a kind constitute all of the phases it has in the world. That is, when modeling a person, and including his *adult* and *elder* phases, it would be incorrect without a *child* phase. Phases then form a partition of a given kind’s existence.

Roles determine how a given entity plays a role in a certain context. Differently from phases, which depend solely on intrinsic proprieties, roles depend on external proprieties, that is, how the entity relate to the other entities. Roles, then, need

to be connected by a relationship to an external kind. Using the person example, the kind person can be related to roles such as *student*, but it does need to have a relationship, say *enrollment*, with a *school* kind.

Mixin universals represent the dispersive concepts discussed before. Category is a collection of kinds, it is an abstract entity which unites common characteristics of the kinds it generalizes. The same is valid for Role Mixin, which is an abstraction of proprieties common to multiple Roles.

The type defined as Mixin is basically everything else, it comprehends all non-rigid dispersive universals. Whatever fails to have the characteristics of the other types is a mixin. They represent properties which are essential to some instances but happens accidentally to the other ones. The best example to illustrate it is the seatable examples used previously, which is essential to the chair but accidental to the crate.

Those classifications have a complete logical formal definition. Their descriptions can be found in GUIZZARDI (2005).

## 2.6.2 The wholes with parts

Mereology is a very important component of ontologies. It is the theory which relates the parts that compose a whole and how those parts relate to the whole. Simple as it may seem it is a very useful tool for accurately modeling complex wholes.

Defining parts and wholes in a very simple way may seem easy. Wholes are any concepts which have one or more parts and the concepts that together make up another one are parts. But this is not quite true for UFO, as it presents a *principle of unity* in its mereology. For this principle to hold the parts of a whole need to be related among themselves, not only to the whole. Another differentiation of this mereology is the existence of *secondary characteristics of parts*. This defines the role a part plays within the aggregate it belongs, i.e whether objects can share parts, or if an object can only exist if an specific part exists.

Following is a further explanation of those important notions pertaining the theory of parts and wholes of UFO.

### 2.6.2.1 Principle of unity

The prime reason for this principle is to deal with a conceptual problem very common in many mereologies. That using these theories purely can lead to very weird compositions which are not cognitively acceptable. Think of a set of parts and two wholes composed by these same set of parts. Most simple theories state that these wholes are identical, which is not necessarily true. It is easy to think of a band as a

whole composed of its musicians but they can also be part of a group of friends or even a family.

Integral wholes is the name given to a set of parts that have this principle. In other words, which have a unifying condition which bonds them in a specific way. Such connection should be not only a simple relation of any kind, it needs to tie the parts together in a way that changes their history. A good example is given by a molecule of a mass of water that is  $H_2O$ . While it is composed of H and O atoms if they didn't have a molecular bonding between them, the sharing of electrons, they wouldn't be a molecule of water.

### 2.6.2.2 Secondary characteristics

Parts convey a lot of meaning to its wholes, and the secondary characterization focus on explicitly understanding and classifying this meaning. There are two types of roles for parts, intimately related to how they behave in respect to the whole. If a part can be shared by multiple wholes, it is a characteristic named *shareability*, or if it is separable from its whole, name it *separability*.

Terming them secondary is done to emphasize that not all relationships of this type have this propriety. That is, a part-whole relationship might not feature such characteristics, but when they do, they expresses more meaning into the conceptual relationship.

### 2.6.2.3 Shareability

Shareability defines characteristics that address if a given part can be shared between different wholes. That is, if something can be a part of two different entities at the same time. With this it suffices to define a single type of part.

The exclusive part, is a part-whole relationship that states that it's a part of its related individual or it's a part of something else that is by itself a part of the related individual or the opposite, it is part of something of which the related individual is also a part. In other words if a given engine is an exclusive part of a car, it can be a part of the chassis which is part of that car, but never part of a museum which is not a whole with the car as a part. It might seem confusing but the exclusive is a good name, and its meaning is well applied in this concept.

This concept can be extended from individuals to universals creating the general exclusive part-whole relationship. It is the same idea but relating universals instead of individuals, an universal A is a general exclusive part of an universal B, if every instance of A is exclusive part of some instance of B.

#### 2.6.2.4 Separability

Understanding separability requires us first to learn about ontological dependence. Existential dependence comes in a very intuitive way. If  $x$  is an individual existentially dependent of  $y$ , than necessarily  $y$  exists whenever  $x$  exists. Which can also be extended to universals creating the generic dependence. Individual  $z$  is generic dependant of the universal  $A$ , if whenever  $z$  exists some instance of  $A$  must exist.

Simply using the concept of dependence leads to a very intuitive secondary characteristic. Whenever there is an individual  $x$  and another one  $y$ , if  $y$  is existentially dependent of  $x$  and  $x$  is necessarily a part of  $y$  we say that  $x$  is an essential part of  $y$ . It is simply a part without which there is no whole, a good example is that one cannot have a living person without a brain, so brain is an essential part of living person.

With this comes a notion of the extensional individual, that is, the individual which all of its parts are essential. That is, it needs all of its parts to exists, it cannot have some of them, it needs all of them.

Using the other side of existential dependence one can introduce the concept of inseparable part. This is a part which is existentially dependent of its whole. Important distinction comes from this notion, an essential part is not necessarily an inseparable part. When inseparable a part's lifespan of existence is completely tied to the whole that contains it. Whilst the essential part can exist without the whole. I.e, a chassis is an essential part of a car, but the chassis existed a long time before the car does, while a brain is an inseparable part of a living person its existence is tied to the lifespan of the living person.

Lastly the concept of inseparable part can be generalized using the generic dependence of the part to a whole. We say that a mandatory whole is the individual instantiating an universal from which the part is generic dependent. An example is the heart of a living person, it can exist before a specific person, but it needs a person to exist. It can change the instance of person it is part of through a transplant, but some person is mandatory for its existence.

### 2.6.3 Restrictions

Restrictions are the name of some logical rules that bind the ontology. Their importance comes from expressing some imitating concepts from the world within the modeling language. GUIZZARDI (2005) does not address this feature in his theoretical basis. Nonetheless it is necessary for the development of ontologies and is included in OntoUML specification, where it is presented as OCL scripting. (GUIZZARDI *et al.*, 2004)

Logical sentences form those rules. They bind the cardinality of certain relationships, the possibilities of generalization or even invalidate specific connections between some concepts. Restrictions like these have the purpose of impeding absurd representations of the modeled reality. In example, if in a model of persons we have a specification of man, an adult man, and it has a variable age. Without restrictions one could model an adult man with 10 years of age, which is an absurd. To correct this would be to add a restriction that for the adult man his age should be within 21 to 60 years.

Bureaucratic as they seem, restrictions are essential to model ontologies. They provide means to express some limitations which can be hard to convey using the other ontological methods. Providing a way to introduce a logical reasoning inside the conceptual model, the rules, become a tool for the modeler to state how that reality works and behaves. For the matter, in a given model it is possible to have a greater appropriateness using rules. That is, increasing the specificity of the model being able to be use abstraction about the reality intended.

# Capítulo 3

## Crafting an Ontology

This chapter covers how a domain ontology about boardgames was built, the methodology of its creation. The ontology, henceforth called OntoBG, is composed of 3 blocks and constructed upon the theoretical framework of the Universal Foundational Ontology or UFO (GUIZZARDI, 2005), using the OntoUML modeling language as described in GUIZZARDI (2005); GUIZZARDI *et al.* (2004, 2015).

The purpose of separating the ontology into three sub-ontologies is to put together the three ontologies of mechanics, dynamics and aesthetics in a coherent and understandable single ontology, this will expose the structure of the MDA framework used as theoretical principle of this thesis. Each of those sub-ontologies is assembled using a specific methodology. The particulars of their creation will be further explained in the following sections.

For clarity purposes, these three sub-ontologies of the ontology are named OntoBG-M, OntoBG-D and OntoBG-A, respectively for the mechanics, dynamics and aesthetics.

Before introducing the specifics for each sub-ontology of the OntoBG it is important to specify how it can be used to model this particular domain. Due to the broad philosophical foundation of UFO, this subject will be split in two sections. The first addressing this philosophical theory and the general concepts in this model, afterwards it is addressed how it will be applied in the domain of boardgames to give fruition to OntoBG.

### 3.1 Thinking of UFO

Games are endurants as far as this ontology is concerned. So UFO-a is used in this work to model such endurant. The interest, then, is to look up to its characteristics as an endurant not a perdurant. There is some aspects of games that can be seen as perdurants, a specific match, the social interaction of games and other ones. But for the MDA framework games are studied as endurants, static things that exist.

First and foremost, an ontology is founded upon concepts of a given domain. To build it we need to acknowledge and understand the reality to be conceptualized. In this case, the more abstract concepts comes from the MDA framework definitions: games are mechanics, dynamics and aesthetics. For the specifics, each will have a different approach, as they are very different in nature. For mechanics it was possible to build the reality to be modeled perusing many authors on game studies as well as widely accepted knowledge bases of board games. Dynamics proved a more difficult subject, it was needed to use research methods to uproot the reality, as there are little specific literature in the area. Emotion models were studied to bring about the aesthetics reality and become a basis for this work's ontology.

Reality provided through the MDA definition of each part implies that mechanics, dynamics and aesthetics are all kinds. Clearly they are sortals, given they provide identity to all parts of the game. Rigidity comes from the necessity of games to have those parts. MDA understands that games are composed of three components, and they are necessary to all games, they define the game. With a big number of kinds in the ontology, for simplicity all are stereotyped as kinds and never as subkinds.

Featuring a big number of concepts, if OntoBG had all possible relationships among those concepts it would become useless, as nobody could understand it. With this in mind, many of such relationships are omitted. But the ones that are in the ontology will be examples of how to express an information in the ontology. Should then be seen as templates to be extended to any other concepts it seems to fit. To help this simplification, the logical restrictions of the model will express how to relate two concepts. More specifically how one cannot relate two individuals or about the correct cardinality for some relationships.

### **3.1.1 OntoUML**

OntoUML is a language created to express the ontologies created using UFO. It's specification is perfectly matched to UFO-a definitions and concepts, which means it is a language to model endurants. It is made similar to UML, hence the name, because of the proximity of UFO and UML standards. Many concepts well established in UML are in accord with UFO, only needing some specifications to be correct. Thus OntoUML is a heavyweight extension to UML to allow UFO standards to be written in UML.

To make use of this language, this work uses Menthor, a free application developed by GUIZZARDI. Menthor was created through the specifications of OntoUML, it uses these standards to be a tool for creating domain ontologies from UFO. Similarity to UML makes it familiar and easy to use. Restrictions are scripted in OCL.

Overall, it is a powerful yet simple tool to create ontologies. Thus its appropriateness for this work is undeniable.

Used to provide visual representation of the model, OntoUML is of great use to understand the data representation and modeling. Thus it is used mainly as a way to convey the structure of OntoBG keeping it understandable and readable.

## 3.2 How to model board games

The perspective of modeling board games in accord with UFO is not unique neither simple. As with any modeling activity, there are many possible interpretations of the concepts of the domain, which means that a focus is needed. This focus is to make the choices of interpretations giving more importance to certain aspects of the concepts, with some specific goal in mind. As example, one could model board games as a social activity, focusing on player interactions and consequences of play, another perspective is to model the physical artifact, focusing on the materials and forms used in board game elements.

This ontology focus its lenses in a MDA model perspective, that is, it looks to board games as composition of 3 concepts. That gives a broader spectrum for the perspective of OntoBG, which means it comprehends the artifact, the play of the game as well as the consequences of play. But most important is that MDA looks into games as a construct, that is, it focuses on the fact that it is made with intention, during the games' design. Even when looking on the play of the game or the aftereffects of it, it does so considering them as part of the constructed entity. That said, it is important to note that all the modeling choices done in this work take this perspective into account to be faithful to the MDA basis.

Addressing the modeling directives used to create this ontology is important to be sure that all the choices are reasonable with each other. This should clearly state the view of the world represented by this model. OntoBG uses the following directives for modeling board games:

- Mechanics, dynamics and aesthetics are viewed as kinds, as well as mandatory parts of board games
- Concepts to be included need to be present on a given board game, that is, concepts exclusive of digital games are not included
- Relationships between mechanics and dynamics or dynamics and aesthetics maintain the same meaning as the MDA framework
- Concepts that are neither a mechanic, dynamic or aesthetic cannot feature in the ontology



OntoBG will be created as a lightweight ontology. That means it does not provide an axiomatization of the domain. Not being strict on concepts definitions is essential when creating such a preliminary work. Especially when addressing a domain such as games, which are defined through common knowledge rather than scientifically. This also increases the possibility for contribution on expanding the ontology as any one with experience can provide valuable ideas. Not being comprehensive, this work's ontology needs to be enhanced through peer contributions to cover more thoroughly the board game domain.

### 3.3 Mechanics

The mechanics ontology will be a restructuring of the board game mechanics ontology created previously in KRITZ *et al.* (2017). Although it was created using a different methodology it will be used as a foundation for this mechanics ontology. There is a necessity to adapt this ontology and its description to fit in the UFO standards. It will not change much of the structure of the ontology, and the main idea will remain untouched. But this will enrich naturally the ontology as the UFO provides a much larger semantic value than the previously used methodology.

To access the situation, all of the nodes in the original ontology will be translated as kinds and subkinds. The is-a relationships between the nodes will become generalizations as in the OntoUML specifications they are semantically equal. This translation does not degrade the significance of the model. Is-a relationships are semantically equivalent to generalizations. Also, the idea behind the node of the other methodology is the same of a kind stereotype.

### 3.4 Dynamics

Dynamics might be the most complicated domain to model in this ontology. Using the definition provided by the MDA framework dynamics become almost about everything. In an essay LEBLANC (2006), one of the creators of MDA, states “When we view a game in terms of its dynamics, we are asking, ‘What happens when the game is played?’” and the complete answer to this question when we are looking into the whole domain of board games becomes overwhelming as there is a multitude of things happening during a single gameplay, there is even more about all possible plays of all possible games.

Another difficulty found is the lack of specific research on dynamics of games. Although many authors acknowledge and speak of dynamics they do so when focusing their efforts in other aspects of games. So they do not convey a definition of the term neither a good pool of examples. With this there is nowhere to find a big

set of terms and concepts with a structure in dynamics of games like it was done with mechanics and aesthetics.

To workaroud this troublesome situation this work brings about a quantitative and qualitative research to provide an initial knowledge of dynamics of board games. This is done by using a focus group composed of game designers to evaluate on names and concepts of dynamics. Following with a survey applied more widely to validate the results of the focus group and provide more suggestions. The resulting set of concepts will be then evaluated through the survey results and pruned when needed, after such filtering they will be used to compose the ontology of dynamics.

### 3.4.1 The focus group

A focus group is a method to generate data based on individual experience and the discussion of such individuals on those experiences. Those individuals should have common expertise in the topic to be addressed in the experiment. Even better is if the participants have a good amount of knowledge and experience on the subject. According to KITZINGER (1994) the most important data of a focus group is provided by the interaction and discussion of the individuals. Nonetheless, a focus group have to remain focused on the topic to be addressed and thus need to be directed correctly to provide better quality data for the reasearch. (KITZINGER, 1994; LIAMPUTTONG, 2011; RABIEE, 2004)

The selection of individuals for this focus group should, of course, be composed of the target users of this methodology, designers of board games. Also it intends to collect data on dynamics, which happens during the play of the game. Thus long time players of board games should also be able to provide valuable insight, and are included in this selection.

Designers and play-testers of the *Casa do Goblin*<sup>1</sup> collective agreed to be our focus group and will participate in this endeavour. They all have experience in the board game domain and have interest in OntoBG as a creation or analysis tool. The participating designers were also both new and experienced ones. The ten participants were composed of 5 men and 5 women, from 23 to 40 years old.

Although experts in board games, the participants have differing notions of dynamics or no understanding at all of the specifics. As such it is needed to thoroughly explain the dynamics concept of the MDA to them. Then designers participants will brainstorm on names or terms of dynamics they believe pertain to board games. Afterwards they will discuss what was proposed on the brainstorm to filter unfitting concepts and to further develop the ones that require extra atention.

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<sup>1</sup>[www.casadogoblin.com](http://www.casadogoblin.com)

*Casa do Goblin*'s participants will be introduced to the dynamics concept using the definition in the MDA model, as well as further explaining of the notion according to this work's fundamentals. To clearly illustrate the concept, the example of *movement - run - fear* is used. Also they will be encouraged to compose generic and simple examples like this one to be sure they grasped the meaning.

The discussion will be directed towards generating words for dynamics, that is, to explain concepts they believe to be dynamics into simple words. To provide an anchor from where to start the mechanics featured in this OntoBG-M will be fixed on a board in everyone's sights. The purpose of the mechanics will be to be used as basis for thinking of dynamics they found in games, that is, looking to the mechanics and thinking which dynamics emerge from each of them.

Provided the initial basis of words and concepts the group then will review the words generated and discuss what they mean, how they present themselves in games and whether it is or not a dynamic. If needed, little adjustments should be made and the words will become concepts to be used in OntoBG-D, that is, become names of dynamics.

Discussion made during the whole process will be acknowledged as possible concepts and relationships that are not dynamics names. In example abstract concepts used to structure the dynamics, connections between types of dynamics, maybe even part-whole relationships.

### **3.4.2 Survey on dynamics**

At the beginning of the survey there will be a short explanation of what is a dynamic of board game according to the MDA. This is to be sure all subjects are on the same terms as to what is the concepts. Also for statistical purposes and further analysis there are questions about their relation to the board game world (designer, producer, hobbyist) and how long have they known and played board games. This distinction comes from the proposal of MDA that the player of the game and the designer have different perspectives of the game, which can lead to a significant difference in their opinions about dynamics.

The survey will be composed of questions based on the results of the focus group. For each term created the survey will have a 5 point traditional likert scaled questions. Surveyed subjects answer how much they agree or not with the term as a dynamic that actually happens in games. One of its advantages was having the neutral option between agreement or disagreement, what would allow for answers such as not knowing or not understanding. For verification purposes, before the actual questions are made the survey requires some information about who is filling

it. These questions inform of how the subjects are related to board games and how frequently they play board games. (DEVELLIS, 2016)

To establish the concepts that would feature in the survey, a trimming was necessary. Fifty seven concepts, resulting in 57 questions, would lead to a large survey. Large surveys with obligatory questions are less likely to receive answers which could lead to insufficient number of answers. To adjust this the 57 concepts obtained from the focus group will be narrowed. The redundant concepts, which are contained in one another, will be removed. Keeping only the more generic ones. Also, similar concepts which can together be abstracted into a new one that does not feature in the list will be removed as well. Favoring the more general concept. (MALHOTRA, 2012)

Furthermore, if the subject wanted it could suggests new dynamics he felt were missing, and also provide an e-mail address to be further informed about this research if he was interested.

The actual survey submitted to the public can be found in Seção A.1 the Portuguese version and in Seção A.2 the English version. It was made and submitted in both languages to achieve a greater number of answers which leads to greater diversity of opinions. The survey was created using Google Forms and conveyed through Facebook and Whatsapp groups with board game interests as well as in the board gameGeek forum. The results will be considered closed after a week of being released.

The results collected are expressed and analyzed in chapter 4. There will be some statistical testing on the data. The intent is to decide the best way of using it, whether simply merging the answers from all groups or putting different weights in each. This will be decided through an ANOVA test, which will determine if the data from different groups have any significant discrepancy. If none is found, all answers will be considered equally, in the other case the professionals should be considered to be better quality data, thus given a bigger weight. After this decision the final value for each concept will be evaluated.

Finally, the concepts that will be used to create OntoBG-D will be the ones with a value greater than 3. Those are the concepts which majorly had answers agreeing with them.

### **3.4.3 Developing the ontology**

After acquiring and processing the data it will be used as a baseline for the concepts of the OntoBG-D, grouping them together, by similarity, or by generalization characteristics. This ontology will bring up a starting notion of how to address dynamics in board games. As any part of this ontology it does not intend on being

comprehensive or complete. It does then provide some insight on different ways to understand the dynamics collected. That is, the final classification and relationships present in the ontology should be viewed as suggestions.

Correlating and classifying the concepts featuring in the OntoBG-D will be done in accordance to the author's experience as well as the discussions made during the focal group, remaining truthful to the idea of comprising the ontology with experience, making it tune in with the designers' needs.

## **3.5 Aesthetics**

The aesthetics ontology domain is centered on emotions, as such this ontology is created with foundation in emotions theories. In this light this ontology is based in two theories, the DILLON (2010) 6-11 model, which is a theory of emotions in games, and the one presented in EKMAN Atlas of Emotions. This last theory was built in a psychological view with no direct relation to games. The objective of using both theories in union is to benefit from the detailed perspective of Ekman's approach, which brings a rich understanding of how emotions behave, while using Dillon's simpler approach to appropriately connect the whole theory into the games domain.

Fusing both theories is not inconceivable because both precepts the existence of basic emotions. Their understanding of basic emotions although slightly different have a lot of overlaps and are totally compatible. That said, Ekman's model is adopted for the emotions, as it is far more detailed and complete, in detriment of the 6-11 model. From Dillon's model we harness the instincts section, it provides insight in how emotions behave in games.

Established those directives, the particular method for modeling emotions and instincts is broadly described in the following subsections.

### **3.5.1 The modeling of emotions**

OntoBG-A is centered around the five basic emotions found in the Atlas of Emotions. The goal of OntoBG is to express boardgames in a way that designers can expand their knowledge about their games. As such this ontology features the emotions states of the atlas as subkinds of the basic emotions. This is due to some advantages these concepts introduce in the ontology. First when analyzing games, the broadness of the emotions can create confusion or ambiguity whilst using emotional states specificity provides more clarity in how the game affects the player. It is due to this specificity of the states that when relating to instincts the user of the model can pinpoint more precisely how that instinct interacts with the game. Also emotional

states not being exhaustive abides to one of the goals of OntoBG, which is to be expandable according to the needs of the designer. Opposing the emotions that are static for the theory, thus using only them the model would become static as well. With this the designer can include new emotional states he identifies in his game giving him the tool he needs to understand the emotions behaviour in his game.

Composite emotions are acknowledged in the Atlas of Emotions as it is possible for a given person to feel different emotions simultaneously (EKMAN, 1992). When this event occurs the union of emotions provokes different reactions and thus it is useful to include such concept in OntoBG-A. But Ekman's model does not explicate any composite emotion thus the inclusion of this concept in this model come as a category with no kind as an example. With this the user of the model that needs to analyze a particular composite emotion can introduce it as a specification of this category and identify which emotions compose it by parthood relationships.

Instincts feature as kinds connected to the emotions according to DILLON, using the needed adaptations of disposed emotions. Relationships from instincts to emotions should not be viewed as unique and static, as relating instincts to emotional states is also possible and encouraged. But for simplicity we stick to the theoretical framework used as basis.

### 3.6 Using the ontology

The main objective of OntoBG is to help designing and analyzing games. To achieve this it was created a Prolog program implementing the data model, containing the rules for describing games using the OntoBG specification, thus allowing a user to have a database of games. From such database one can extract information he needs from the ontology using the rules in the program.

Prolog was chosen as it is a logical language that is widely used and have great support. Logic is used to express the rules of the ontology. Rules that provide a reasoning which match the knowledge contained in OntoBG. In other words, the rules explain the inherent data of the ontology in system. This system is then used to actual manipulation on the ontology and associated database.

Querying the base of games can be made using the Prolog commands. Those will bring some information required. Such as, if a game is already in the database, if there is a similar game or even to suggest a variation of a game. By manipulating the data modeled through this program, the user can find useful information to his work.

## 3.7 Scope delimitation

Important reminder is that OntoBG is not comprehensive and do not claims to become so. To map all possible ramifications of games might be impossible. So this ontology shall be seen as a preliminary work towards understanding and modeling the nature of board games. This scope delimitation is not about removing, it is about gaining. With this, OntoBG can be flexible to attain the most simple needs of a researcher or designer while still being able to grow more complex. Reducing it also turns it more palatable for anyone, not familiar with modeling or ontologies in general, to use.

Fixing the scope on board games is important to lean this work. This is important to achieve the objectives of OntoBG. It permits that the ontology can be increased with ease and simplicity. Also bringing consistency to the knowledge it represents, guaranteeing that OntoBG is easy to understand and use.

# Capítulo 4

## Dynamics: research results and analysis

This chapter comments and exposes the data obtained in the focus group and in the survey of dynamics. After explicating the contents of the results it uses a statistical method to evaluate the data and decide how to use it. Lastly it makes some worthy appointments noted throughout the experiment, which might be of great use in expanding it in the future.

### 4.1 Focus group

Results from the focus group were used to create a basis of knowledge on board game dynamics. This knowledge was represented in form of 57 ideas which were proposed and discussed by the group. Analyzing the collected ideas and comprising them into a more compact list was done shortly after, which was important to do before this ideas could be used in the subsequent tasks.

Primarily the group proposed ideas of dynamics. It developed several concepts, which were then discussed and checked whether they were dynamics or not. Many concepts were mentioned by more than one person even if in different terms. This means the group was well aligned in how they understand the dynamics. Other concepts caused a big dissension on whether they were dynamics or not. Further studies should be made to evaluate this, thus they were excluded from this work. The group could not associate some ideas, which seemed dynamics, with a proper mechanic. Without such connection they were not included in this ontology. Discussing the concepts proved to be most valuable. Some of them did not appeared to be dynamics in a first glance. But in another perspective or situation they were dynamics.



Apart from the dynamics concepts created the discussion featured their relationships to mechanics and aesthetics. As a group, the participants related many dynamics to the other concepts when explaining them or trying to understand. Also sometimes relating dynamics to each other. Establishing that some are incompatible with each other, as well as generalizations between them.

Finally a list of 40 dynamics was comprised. They can be found in the following list. Those were used to form the questions of the survey.

- 1 - Do an action to reduce other players options
- 2 - Collateral effect: do A resulting in B intending C.
- 3 - Use an action to discover information, see other players reaction.
- 4 - Block another player
- 5 - Use an action to force a change in the game state (phase, turn, etc)
- 6 - One versus all, one player decides to attack all others
- 7 - All versus one, players uniting against one
- 8 - Ally with another player
- 9 - Pursue another player
- 10 - Survive, play to evade elimination
- 11 - Chain automatic effects (combo)
- 12 - Reduce or render useless a resource
- 13 - Defend from a player using another one
- 14 - Parallax: Change a point of view to create a better result for himself
- 15 - Avoid to acquire points to get some other benefit (playing early next round)
- 16 - Camping, in a position or terminate action
- 17 - Stop the progress of the game, delay the endgame
- 18 - Play accounting to your next actions, plan a series of actions.
- 19 - Alpha player: Player that forces the others to play as he wants
- 20 - Protect an specific position or pieces
- 21 - Play safely, do not take on risks only play on certainty
- 22 - Rituality: Repeat the same way of playing looking for the same results as before
- 23 - Counting cards, tokens and other resources
- 24 - Play riskily, pursue greater risks for greater gain

- 25 - Pursue self defined objective instead of the game objective
- 26 - Accelerate the end of the game
- 27 - Do a sacrifice for greater gains
- 28 - Distraction: Use an action to change other players attention from your real intention or objective
- 29 - Change strategy because of the game state
- 30 - Deduce hidden information through open information
- 31 - Communicate with allies indirectly so other players do not notice
- 32 - Forfeit the game
- 33 - Cheating: break the game rules
- 34 - Trolling: play to annoy other player rather than win the game
- 35 - Intimidate: use a stronger position to force another player to play as you want
- 36 - Bluffing: relay false information to manipulate other players actions
- 37 - Convince the other players
- 38 - Confuse a player to induce a bad play
- 39 - Excluding another player
- 40 - Small talk: talking all the time to distract other players

#### 4.1.1 Curious cases

Some concepts which arose during the focus groups discussions were very interesting although they did not reached the final list. This was because they were very complicated cases. But the fact that they were brought to discussion, is by itself a great contribution.

One was Chaos, meaning a condition of disorder in the game, that is, chaos made by the players. It was very surprising to most, and through discussion they couldn't agree whether it is or not a dynamic. The most interesting factor on this discussion, however, is that if it is a dynamic, other possible conditions, like funny, tense and ordered, would also be dynamics. On the other hand, it is also possible that those concepts are actually part of Aesthetics, as defined in the MDAHUNICKE *et al.* (2004) since they could be associated to emotional states.

Another case is the change of rules during the game. This situation can happen in gameplay in some situations, more notably when players notice a confusion or wrong interpretation of the rules. It could also happen when players find something broken while creating games, and it is common on children's play. The first case always rise the question "does we keep playing wrong to avoid changing the game as it is now, or from now on we play correctly?". Hence the possibility of being a

dynamic, since it comes from the decisions the players make. However, since it is not part of the gameplay itself, it can be considered a meta-game event.

The focus group also detected another common situation in board games that can be considered a meta-game action: a player needing or wanting to undo his last move or play, including the case that it was impossible to be made with the correct rules.

All of those situations are left unanswered in this work. They push way through the boundaries of our scope of preliminary work, requiring more study and thought, and were left for future development.

## 4.2 Survey data

Answers to the survey were collected for one week time, from 12/13/2018 to 12/20/2018. Featuring a total of 196 answers, which were divided in two groups: consumers with 174 replies and industry totalling 22 answers. Then the average value for each question in each group was computed. Those values are represented in Tabela 4.1. The number of the question is the order in which it appears in the survey.

Looking for the concepts which were mostly agreed by the subjects, that is, with average equal or higher then 3, becomes possible to observe an interesting phenomena. The industry group had 32 of the concepts in this level, on the other hand the consumers group had 29. It is important to note that the 29 of the consumers are present in the 32 from industry. This is, the consumers disagree only on three concepts from the industry, which lead to the belief that their opinions are similar or equal. Disagreeing with our previous assumption that they would have different opinions. Analyzing the concepts with even more average, those with a value greater or equal than 4, there is almost the same situation. With 14 concepts for industry and 9 for consumers we note a bigger difference in the quantity of higher values. Also of the consumers' 9, only one of them is not contained in the 14 from industry. Although it still poses a good evidence that the groups opinion are in accord, it also point some doubt in this assertion. To enlighten this doubt this work uses the ANOVA test to state if the groups have significantly different results.

Tabela 4.1: Averages of answers

Question	Hobbyists	stdev	Professionals	stdev
1	4,07	1,05	4,23	0,92
2	3,90	1,08	3,82	0,91
3	3,92	1,11	4,36	0,73
4	4,16	1,12	4,32	0,89
5	4,04	1,14	4,50	0,74
6	3,21	1,33	3,50	1,47
7	3,35	1,48	3,68	1,32
8	3,72	1,21	3,73	1,08
9	2,62	1,48	2,55	1,65
10	3,48	1,27	3,50	1,30
11	4,16	0,98	3,86	1,28
12	3,41	1,30	3,64	1,00
13	3,17	1,31	3,18	1,47
14	3,57	1,19	4,05	0,90
15	3,75	1,21	4,00	0,98
16	3,01	1,35	3,27	1,35
17	2,94	1,47	2,55	1,53
18	4,44	0,87	4,55	0,80
19	2,68	1,49	2,86	1,64
20	3,93	0,99	4,00	0,98
21	3,46	1,17	3,45	1,18
22*	2,88	1,32	3,09	1,23
23	3,75	1,28	3,68	1,21
24	3,07	1,41	3,32	1,21
25	3,78	1,19	4,00	1,02
26	4,06	1,02	4,32	0,65
27	4,11	1,02	4,45	0,74
28	4,34	0,86	4,41	0,80
29	4,06	1,00	4,14	1,13
30*	2,63	1,41	3,14	1,49
31	1,88	1,24	2,18	1,47
32	1,76	1,19	2,09	1,54
33	2,27	1,36	2,50	1,60
34	3,06	1,45	3,14	1,21
35	3,71	1,22	4,00	1,11
36	3,82	1,04	3,82	0,96
37*	2,93	1,47	3,00	1,48
38	2,07	1,34	2,18	1,47
39	2,26	1,26	2,27	1,45
40	3,91	1,01	3,77	1,27

\* - differences between hobbyists and professionals

stdev = standard deviation

## 4.3 Statistical analysis of survey answers

ANOVA, also known as, analysis of variance, was used to test the hypothesis that the different surveyed groups had different opinions. A similar use to this work‘ approach is found in ISMAIL AL-ALAWI *et al.* (2007). They used ANOVA to analyze the results of a survey with three different groups of knowledge. This analysis has only two groups, but it does not imply in a big change to the model.

The sole purpose of ANOVA is to test the hypothesis that different groups of samples for the same factor have a statistically significant difference in results. This will give the information needed to establish the correct average values for the concepts. Subsequently determining the dynamics which will compose OntoBG-D.

### 4.3.1 Using ANOVA

As with any model, we need to be inside it’s constraints to be able to use it. One-way ANOVA has only one crucial constraint, the variances of the residues must be equal. Testing it, with a proper method, is very simple and provide a probabilistic answer. Using a standard significance level of  $\alpha = 0.05$  provide a good perspective on the similarity of the variances.

Using equal variances test in our data provided us with a 95,8% of certainty that the variances are equal, according to the multiple comparisons test. This test takes into account the intervals of each sample variances. When they do not overlap there is a significant difference in the variances. Levene’s test provided a P-Value of 0,971, meaning there is a 97,1% chance of the variances being equal.

Using two different tests and producing a positive result on both of them, we are now assured that we can use one-way ANOVA. Albeit a probabilistic result, over 95% chance is more than enough to justify using the test in this work.

### 4.3.2 Analyzing the output

Completing the analysis provided plenty of information regarding our study. First and foremost the model did not refute the hypothesis that the averages are equal. Meaning that both groups of subjects have no meaningful differences in their average answers. Therefore, there is evidence that our initial guess is correct.

It also allows us to look at the data of both groups together. That is, to average all the answers without concern for the group it came from. Allowing us to present a more trustworthy average value for each dynamic.

Raw results of the test are shown in 4.2. Those results have many parts, the main result of the model calculations and the model adequacy measurements it also present some info regarding the data. Resulting calculations of the model under the

Source	DF	AdjSS	Adj MS	F-Value	P-Value
Factor	1	0,4147	0,4147	0,83	0,366
Error	78	39,1889	0,5024		
Total	79	39,6036			

Tabela 4.2: Analysis of Variance

S	R-sq	R-sq(adj)	R-sq(pred)
0,708817	1,05%	0,00%	0,00%

Tabela 4.3: Model Summary

Analysis of Variance, shows us the value of the sums of squares and sum of means squares. With them the model evaluates the F- Value, of 0,83, and P-Value, of 0,366. Both of them do not reject the null hypothesis of the model, as the p-value is way over our alpha.

Adequacy is shown as model summary at 4.3, S is the distance between the data and model, R2 is the percentage of variability in the results presented by the model.

Model summary shows an almost perfect result, meaning that this data fit perfectly in the model. This rises a few questions as one should doubt whenever data fit perfectly. What lies in doubt here is if the model taught us anything useful at all, we used a model which assumes that the populations produces equal results and tries to prove the opposite. In this situation it could not, because the data fit to the model and it was really similar. What would happen if it was the other way around, that is, using a model that assumed data to be significantly different? Such questions and their possible answers are out of this work's scope, therefore we leave them to future works.

## 4.4 To the survivors, the spoils!

After consideration on the analysis' result we concluded that averaging both our populations as equals was the best course of action.

With this, a final average level for each concept was calculated. The goal was extracting from the original list the core game dynamics experienced in boardgames, making the assumption that they are represented by concepts mostly agreed upon on the survey.

Those with average equal to 3 or higher formed this first vocabulary. To put concepts together in this effort they also needed to be synthesized in a word, since vocabularies are made of words that are linked to a meaning. With that in mind, here is the vocabulary created, composed of 29 of the 40 concepts featured in the survey:

- Sacrifice: Sacrifice a piece or position for greater gains
- Indirect Effect: Execute something when wanting a consequence of its events
- Acquire information: Use an action to discover
- Reduce Options: Using an action to reduce other players options
- Resource Extinction: Reduce the source of a limited resource or make it useless
- Deduction: Use open information to discover hidden information
- Game state Change: Use an action to purposely provoke a change in the game
- Combo: Chain automatic effects of the game
- Blocking: Block another player's action, strategy, progress
- One versus all: When one player attacks all the other simultaneously
- All versus one: All players of the game, but one, join forces to defeat the other player
- Alliance: When players join forces to achieve mutual benefit
- Forceful interpretation: Use a particular point of view to create better benefits for himself
- Self objective: Pursue a self appointed objective other than the game's objective
- Play safe: Not taking risks, playing only on certainty
- Risk play: Accept greater risks seeking greater rewards
- Survival: Play only with to avoid elimination
- Camping: Stick with a position or action through a lot of time
- Protectionism: Protect a specific position or pieces
- Action planning: Play accordingly to your next actions, plan a series of actions.
- Rush the game: Accelerate the end of the game
- Flexible strategy: Change strategy because of the game state
- Reject objectives: Intentionally not achieving a game's objective to attain some advantage.
- Intimidate: Use of a stronger position to force another player to play as you want
- Distraction: Use an action to change other players's attention from your real intention or objective
- Small talk: Talking all the time to distract other players

- Count resources: Use previous knowledge of the available resources to count them and achieve advantage
- Bluffing: Relay false information to manipulate other players actions
- Convince: Convince other players

Of course it is not comprehensive on boardgame dynamics, even more in general game dynamics. Nonetheless it is a starting point, and feature some obvious dynamics as well as non intuitive ones.



# Capítulo 5

## OntoBG: An ontology of boardgames

This chapter covers the OntoBG ontology in detail: its specification, diagrams and restrictions, and also reviewing some important conceptual points of the model. It also provides insights on how to use it for different modeling purposes. The diagrams of the model were made using Menthor, the file and program can be found in GitHub<sup>1</sup>.

Following the scope delimitation of this work, it does not cover all the possibilities of board games. It aims to provide new insight on board game modeling and study, not thoroughly explain the domain.

The ontology is represented as four diagrams. One that provides an overview of the MDA structure throughout the ontology, and three others that convey the understanding of each part of the MDA, which are: OntoBG-M, OntoBG-D and OntoBG-A. The following sections, present and explain each of them. At the end of the chapter, an overall perspective of the ontology is given.

But before understanding the model, there is one more concept to be created: the relationship of cause and consequence. Why it is necessary is fully explained in the next section.

### 5.1 What about cause and consequence?

Considering how different ideas relate to each other, the MDA model comprises a notion of cause and consequence between its concepts, stating that each part of the game spectrum is cause and consequence of each other. DILLON (2010) also uses this relationship to explain how emotions and instincts relate to each other, even when addressing the interconnection between two instincts, or two emotions.

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<sup>1</sup>[https://github.com/HuntedSouls/ONTOBG\\_Repos](https://github.com/HuntedSouls/ONTOBG_Repos).

It is important that this relationship has a reading direction. That is, when two concepts are related by cause and consequence, one of them is cause and the other is consequence, and the cause brings about the consequence, never the other way around. Both aforementioned models clearly use this propriety.

However, even though it is directional, it does not mean that a different relationship in the reverse direction cannot exist. But, when it does exist, it does so with a different meaning. MDA uses it to differentiate its model reading direction, even attributing each reading direction to different characters, one for the player of the game and the other to the game designer. Dillon have few examples where the inverse exists. He does not specifically state the difference in them, but in his comprehensive model explanation the difference in meaning is clear.

UFO does not have a theoretical basis for cause and consequence relationships. When looking to its relationship stereotypes, none of them quite allow the introduction of this relationships. Although it could be stated as a simple association, its importance to each of the models implies necessity of a stronger theoretical basis. OntoBG absorb this importance from the participation of these models. Moreover, its greatest contribution is to establish the relationships between mechanics, dynamics and aesthetic concepts directly. Hence, this work needs the structuring of a precise relationships stereotype for cause and consequence.

### **5.1.1 Formalizing cause and consequence relationship**

Making a formal introduction to the cause and consequence relationship first requires an analysis of this idea in our context. The prime sources of meaning are the 6-11 and MDA models. As this dissertation is translating their respective conceptualizations to the UFO modeling language, it is important to maintain the original meaning intended for this relationship. Luckily both models introduce cause and consequence very clearly in their structure.

Dillon explains his model very briefly, not addressing the details and formalities of definitions, but he does make his ideas clear through examples. In those examples lie his understanding of relationships between his concepts of emotions and instincts. With this, creating a formal definition for such relationships should also drawn from those examples. Dillon construct his connections between concepts as a sequence, stating that the presence of a given instinct or emotion results in another one that by itself bring another, and so on. The idea of sequence of events is naturally linked to cause and consequence. He even reinforces this using phrases like “survival instinct will provide new excitement” (DILLON, 2010, p. 13) or “It[Aggressiveness] can be triggered by survival and greed instincts” (DILLON, 2010, p. 14). Provide and trigger are words which convey the meaning of cause and consequence, e.g.,

trigger as verb explicitly means to cause something. When explaining his model, DILLON (2010) mostly uses these constructions and thus heavily conveys the idea that emotions and instincts are entwined by cause and consequences.

MDA greatest distinction is its double sided view. The designer's perspective which goes from left to right and the player's one following the opposite way. When describing the difference in both views the authors make this statement:

From the designer's perspective, the mechanics give rise to dynamic system behavior, which in turn leads to particular aesthetic experiences. From the player's perspective, aesthetics set the tone, which is born out in observable dynamics and eventually, operable mechanics. HUNICKE *et al.* (2004)

For the designer's perspective they use an expression, "give rise", and a word, "leads". Both of them have cause and consequence meaning. The other way around is less explicit. From aesthetics to dynamics they employ "born out" when addressing the *tone*, a consequence, of aesthetics. This expressions have the meaning that the observable dynamics comes from the tone. Which in turn is made by aesthetics, thus aesthetics become a cause of dynamics.

Dynamics to mechanics becomes more complicated. The MDA description does not explicitly state this relationship. They envelop it as a part of the first relationship. Throughout their work, dynamics are more discussed with respect to aesthetics than mechanics. I believe this comes from the focus on the experience part of the game in the model, but there is something to be harnessed from their description: that mechanics become operable. What this means is, although not directly, dynamics influence mechanics, not their essence but their perceptiveness. Dynamics that happen during a game influence how the players perceive their possibilities of interaction with the game. That is, imagine a player that experiences a dynamic that arise from a different use of a given mechanic. If that situation provide different results from the traditional use of this mechanic, he surely will change the way he uses this mechanic in the future. In other words, the dynamics allows the player to understand how to operate the mechanics of the game, hence we found a causal relationship from dynamics to mechanics.

## 5.2 It's Alive!

Translating the MDA framework into UFO led to a simple diagram with important information. Although simplistic, MDA has a lot of nuances. When addressed in a more complex modeling language this nuances need careful analysis to be correctly modeled. The diagram features in Figura 5.1 and its information detailed in sequence.

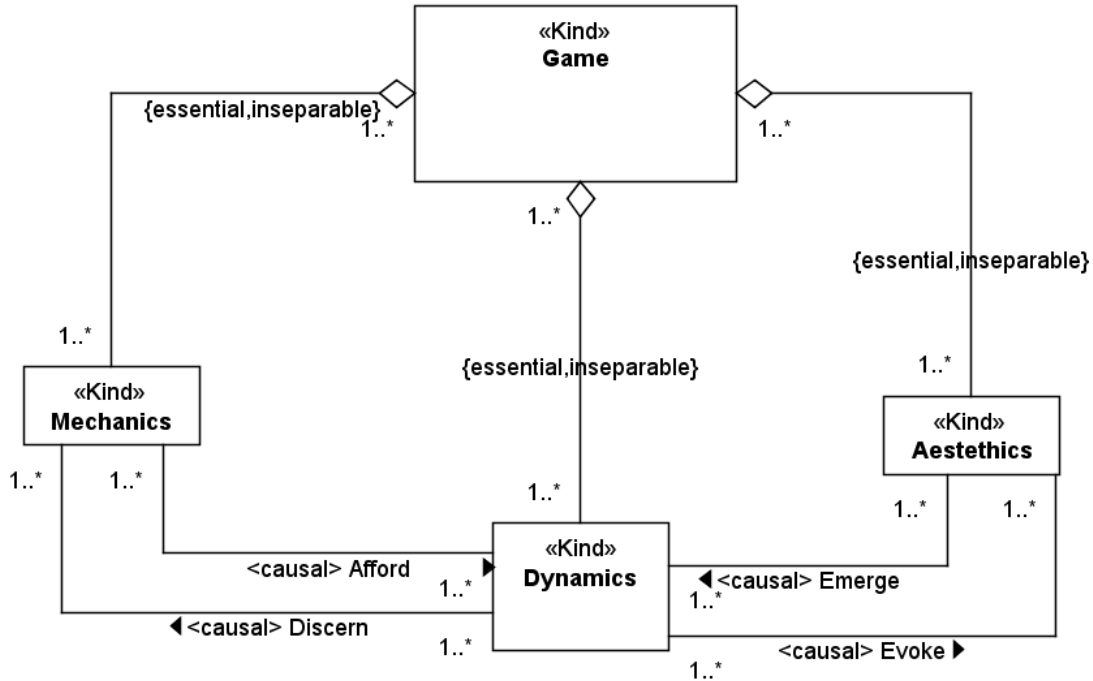


Figura 5.1: Game Diagram

This diagram illustrates the main idea of the MDA. The game is made of three different parts: mechanics, dynamics and aesthetics. They are inseparable and essential because a game must have all of them and they are intrinsic parts of games.

Addressing the designer and player different perspectives in MDA, the model includes the causal relationship between mechanics, dynamics and aesthetics. They were established in accordance to the discussion made in section 5.1.1.

### 5.3 OntoBG-M : mechanics unbound

OntoBG-M leans heavily on the ontology created in KRITZ *et al.* (2017), using the same concepts and definitions. It enhances the structure with UFO stereotypes both for universals and relationships. The diagram for this ontology can be found in Appendix Seção A.3

Firstly, all concepts in OntoBG are kinds. This is due to the conceptual meaning of each one in the original ontology. All of them have instances and provide individualization, and they are actual mechanics, even if each of them has a different abstraction level. This difference is explicit in the generalization hierarchy of the model, which is the same presented on the original work.

The most important increment to the model is the presence of the meronymic relationships provided by UFO. Being able to identify mechanics to be part of one

another brought the possibility of linking both sides of the mechanics ontology. Algorithms and Data Representations mechanics could not be precisely related in KRITZ *et al.* (2017), and introducing a parts and wholes theory broke this limitation. Connecting them came in two different aspects: one is the essential necessity of one mechanic to another and the other is possible interaction when designing a mechanic on top of another one. The first brought structural solidity. It is represented mostly by limitations such as:

- Card is an essential part of deck;
- Die is essential to dice rolling;
- Resources are essential to resource management;
- Pattern is essential to both pattern recognition and pattern building;

Although they look obvious they are important to establish the structure of a game within the whole ontology. The other side of the meronymic relationships in mechanics is used to model the design of a given board game. This comes in form of mechanics which can be used as a building block for another, for example:

- Areas can be part of pick up and delivery. This differentiate when the pick up and delivery is represented by actually moving something from an area to other one from just collecting resources and using them to complete tasks.
- Cards can be part of card draft. This is important because it shows that a card draft, even though the name, does not need to be made of cards. Its idea can be applied with tiles or even tokens and still have the same significance.

Looking into this can improve the possibilities of game design. By understanding if a mechanic can be combined with another and create meaningful play, one can start answering why this happens in some cases and not in all of them. Even more, analyzing the already created combinations allows for innovation. An attempt to create a new interaction between mechanics, successful or not, create invaluable knowledge about mechanics.

## 5.4 OntoBG-D : dynamics uncovered

Structuring the concepts of dynamics that were created was the first step to create the ontology. To do this, we adopted a procedure. Firstly group the concepts by similarities using a *Category* universal which generalizes them, which provide a taxonomic structure to dynamics. This process resulted in the following categories:

- Action based: generalizes the dynamics which are based on the agency of the players.
- Intention of use: generalizes the dynamics which arise from a specific intention when using an action.
- Meta-game: generalizes the dynamics that happen outside of the game space but still inside the magic circle.
- Behaviour: generalizes the dynamics that represent a particular behaviour a player can adopt.
- Playing patterns: generalizes the dynamics which amount to how a player play the game along some time or even the whole game.
- Strategy choices: generalizes the dynamics that evaluate a specific play or principle used momentarily during the game.

After that, the 29 concepts of dynamics created in Chapter 4 were organized under these categories . Some of the concepts did not fit in any of them. They also did not had enough similarities with the other concepts to justify a category, leaving them without generalizing categories, but still providing other types of relationships with other dynamics.

Afterwards, the dynamics were connected through part of relationships and generalizations. This was done using the discussions made during the focus group and the author's expertise.

The diagram for this ontology can be found in Appendix Seção A.4.

### 5.4.1 The expected

Dynamics, by definition, are the behaviour of mechanics through input of the players during the game. The unexpected or not planned dynamics are not the only type of dynamics. The former work done to compose OntoBG-D focused on acquiring insight on those unexpected forms of dynamics. But only because they are the most tricky part of game design. The expected use and behaviour of game mechanics are also dynamics in this definition. Thus it needs to be included in this model, although not specifically as a dynamic for each mechanic expected use. This work is not comprehensive so it would be taxing to demand that for each mechanic that has an expected use a new dynamic should be created. Thus, expected use of dynamics needs to be a single concept.

Expected dynamics, in its essence are actually derived from their underlying mechanic. Firstly, one should notice that understanding them as the expected behaviour of a given mechanic makes it exclusively related to this mechanic. Imagine

that we define the *attack to damage* dynamic, which comes from the expected use of attacking to reduce life from an enemy. This dynamic cannot be related to a different mechanic, *dashing into an enemy to damage it* is not *attacking to reduce its life*. Being intrinsically related and attached to their underlying mechanics, the expected dynamics do not provide the sense of identity needed for a sortal concept. Thus pairing it with the other dynamics in the same abstraction level would be wrong from a conceptualization point of view. But using the more generic concept of a derived dynamic, that possess the sense of identity, fulfills our need for the expected behaviour of mechanics. Thus the *kind Derived*, is added to the model.

## 5.5 OntoBG-A : aesthetics unearthed

This ontology was a composition of two emotion models. Thus we needed to translate them to UFO patterns before uniting them, using a similar procedure from the mechanics ontology of KRITZ *et al.* (2017) to achieve this translation. Finally their union came through the causal relationship established by this work. The diagram for this ontology can be found in Appendix Seção A.5

### 5.5.1 Ekman to UFO

Ekman's understanding of emotions was not stated as a formal conceptual model. But through careful study of his ideas' structure it is possible to create a conceptualization of emotions. His definitions and relationships proved to be well aligned with UFO modeling perspectives. Although such relationships are not explicitly defined in his work, it is possible to identify them from ideas and build them in the ontology.

Emotions are kinds. Following the ideas and definitions of Ekman's research it is easy to see that they are concepts which provide individuation and identification. This is also in accordance to MDA's model definitions and conceptualization. Which brings greater consistency to the ontology.

The atlas of emotion provides a spectrum of emotional states. These emotional states represent the different forms of experiencing the emotion. Even though linked to the scale of intensity of the emotion, which would induce modeling them as qualities, we chose to model them as subkinds of the emotion. This is due to the flexibility in using them directly to model games. Defining them as universals is important to recognize them more explicitly in the gameplay. This distinction makes possible to model a dynamic relating it directly to an emotional state, without the need to associate the emotion. For a game designer it brings value when specifying the outcome of a given dynamic. For example, it is better to say that Protectionism dynamic instigates a Pride emotional state. When saying it instigates Enjoyment

emotion could include Schadenfreude emotional state in its possible outcomes, which is undesired when modeling for game design.

Compound emotions are acknowledged in Ekman's theory. But he does not provide a complete explanation of them, neither enough examples or structure. Even though, thinking of modeling games compound emotions might be of use to some games or game designers. Thus we define and include them in the conceptual model in resonance with the theory ideas.

### **5.5.2 Dillon to UFO**

The 6-11 model presents two primary concepts: emotions and instincts. Emotions were already covered in Ekman's model, and Dillon seems to have emotions which are contained in it. Thus we focus on the instincts and its relationships.

Instincts were stereotyped as Kinds, following the same principles as the emotions. Their definitions and meanings in psychology theories bring them the same light of individuation and identification as emotions.

Different from Ekman, Dillon explicitly stated the relationships of his model. Featuring relationships between both instinct and emotions as well as inside the same group. This proved to be a challenge when trying to model them into the ontology. Using the Causal relationship created here we could imprint the meaning desired by Dillon in both associations alike. Thus they were stereotyped as Causal relationships, which also kept the directional propriety.

Differentiation of each of those relationships were done through their names. Between instincts there is an association of reinforcement thus the name Reinforces. Instincts are auxiliary in creating the feeling of emotions, thus an instinct Evoke an emotion. Emotions on the other hand pave the ground for instincts, which led to the Stimulate relationship.



# Capítulo 6

## Prolog implementation

Here the process of creation of the Prolog program representing the ontology is elucidated. Its features and functionalities are also discussed and explained in this chapter.

The files with the program and database are stored in GitHub<sup>1</sup>. This is an eclipse project using SWI-Prolog distribution and the prolog files are all under the source folder.

### 6.1 Motivation

The program is needed as a tool for using the ontology. The conceptual model and its specifications are useful by themselves when the objective is to learn and understand boardgames. For more practical applications, a logical program that allows automated inquiries about the model becomes of utmost importance. Without it, the user will need to peruse the model manually, which is a tiring work and also vulnerable to human error or inconsistency. This is the reason this work presents a prolog program for navigation within the model.

The first part of the program will be the description of the ontology in a prolog database. First the concepts of the ontology will be described as a functor with a single argument. Then the relationships will be defined using compound terms. Rules, which are used for more complex queries, are created focusing on specific questions and the integrity of the model.

Practical uses of the ontology mostly include studying specific games. Thus the program includes a compound term to define a game, in respect to their mechanics, dynamics and aesthetics. This in conjunction with the rules created for specific questions allows the user to fully use the complete potential of the model.

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<sup>1</sup><https://github.com/HuntedSouls/OntoBGRRep>

## 6.2 Translating OntoBG to Prolog

Transporting the meaning comprised in a conceptual model to a different language can be a challenge. But prolog is first order logic, which is quite useful to describing concepts in a simple form. Following this idea of simplicity of traditional logic, this process focused in transferring the ideas with minimal modifications.

OntoBG concepts are divided in three types: mechanics, dynamics and aesthetics. Then the concepts inside each of them are introduced in prolog using their type as a functor and their own name as argument. This provides a clear distinction of the concepts and ease of access to the bigger group. An example: mechanics(action) represent the *Kind* Action that is a mechanic, dynamics(actionBased) is the *Category* Action Based that is a dynamic. Aesthetics has a distinction between its kinds because the model is composed of emotions and instincts. This is brought to the model as different functors, both representing concepts of aesthetic model. AS example: emotion(fear) is the *kind* Fear, the instinct(agressiveness) represents the *kind* agressiveness.

Relationships on the model are *Causal*, Generalizations or Meronymic. Causal is directly created in a functor with two arguments, where the first one is the cause and the second the consequence. As example: causal(instinct(identification),emotion(fear)). Generalization is also made with a functor with two arguments, like generalization(mechanic(phase),mechanic(ruleset)). But it has some restrictions. To be correct there can be no circular generalization. That is, if generalization(A,B) exists, generalization(B,A) cannot exist. Meronymic relationships have many forms, but in OntoBG they are mostly are part-whole relationships. Thus we introduce it in prolog as a functor again, called *partof*. The first argument is the part and the second the whole. Giving priority to the part over the whole comes from a characteristic of the model. Most of the part-whole relationships in the model are centered in the part role. If there is any interest in a whole focused relationship it should be added as a whole-of functor.

All relationships defined are not reflexive. This means that the order of the arguments is important. A change in the order of the arguments creates a great semantic difference. Which means that most of the times using the inverted order is incorrect.

Regarding other proprieties of the relationships, each has its own rules. Generalization and part of are necessarily transitive on theirselves. Whilst causal might not be some times. Although when causal and part of have transitivity some times it does not hold the same meaning of the smaller relationships. But as the prolog model does not hold the specificity of the relationships, like cardinality and

semantics, the program can define this transitivity directly without taking this into consideration.

Relationship between mechanics, dynamics and aesthetics are very important for the usability of the model. As they are responsible for describing games and defining their correctness. OntoBG presents these relationships with each direction having different meaning. But for the purpose of use of this program, this is not relevant. As such they are defined in functors as:

- `mdRelation (MECHANIC,DYNAMIC)` : - determines that there is a relationship between the MECHANIC and the DYNAMIC
- `daRelation (DYNAMIC,AESTHETIC)` : - determines that there is a relationship between the DYNAMIC and the AESTHETIC

## 6.3 Creating games and asking them questions

Developing a prolog database that mirrors the conceptual model is not by itself useful. There need to be some functionality not present in the original model. Thus this implementation has two new functionalities: Possibility of describing a particular game, through its mechanics, dynamics and aesthetics, and thus creating a database of games. And the other is the availability of looking for suggestions to complete a game.

### 6.3.1 Game validity

Defining a game in the program comes with the need of a predicate which verifies if a given game is valid. By valid we mean that all its components are in the model and that they interconnect through causal relationships. These requisites represent the MDA definition of what a game is. As this initial model is not comprehensive the value of creating this predicate is more indirect. A designer that wants to include his game in the database, use the predicate `isGame()` including the mechanics his game have, and the dynamics and aesthetics identified through his play-testing experiences. If the predicate says the game is not valid it means either that there is no relationship between some of its concepts or have some component not present in the model. With this the user should consider improving the database with his experience, evaluating first if the components that are not in the model should to be included and most importantly where and how they must be. Then, considering the relationships between concepts, the user must evaluate by himself which causal relationships he observed in his playtesting and design and include them into the model.

Now that we have validity of games, it is possible to add games to the database without compromising it. To formalize this in the prolog program we define the predicate *game* as:

```
49
50 game(Name,[mechanics(M)...],[dynamics(D)...],[aesthetics(A)...]).
```

The first argument is a name for the game, aside from clarity it also allows for differentiation between games with the same components. The second, third and fourth arguments are lists. Each list should contain any number of atoms representing components of each type, respectively mechanics, dynamics and aesthetics. In other words the description of a game is his name with lists of components.

Verifying the validity of a game is made by a rule called *isGame*. It is defined as:

```
40
41 isGame(M,D,A) :- mechIsThere(M),dynIsThere(D),aestIsThere(A),
42                  allMechHasDyn(M,D), allDynHasAest(D,A),
43                  allDynHasMech(D,M),allAestHasDyn(A,D).
44
```

This rule checks every component list to make sure all elements are present in the database. Then it also verifies if there is a connection between each of its components. That is, each mechanic is connected to a dynamic and each dynamic is related to an aesthetic. Connected means either there is a relationship from mechanic to dynamic or there is a relationship from dynamic to mechanic. Negative results mean there is some error.

### 6.3.2 Finding the error

IsGame evaluates whether the game is valid, but in the negative case it does not point what is wrong with the description. Sometimes the user will want to find what makes a description incorrect. Manual investigation will be necessary to find this information. The first step should be to evaluate if every concept in the game description features in the model. Absent from the model, the user has to add the concept to the model or change its description to be in accordance with the model. How to deal with each of these situations is discussed in the next section.

Assured that all concepts of the description are part of the model, the next step is to check the relationships between the concepts. This is done by making sure that all components are connected, in other words, that no concept is isolated. To help the user in this investigation, some rules were created. Their objective is to evaluate possible representations inside the model structure. They do not specifically state

what is incorrect. This is because they were create to fulfil other objectives discussed later. The first three are:

- $\text{whatMech}(D,A)$  : Prints a list of possible mechanics given a list of dynamics  $D$  and aesthetics  $A$  of the model. Possible means mechanics which have a valid relationship with the other concepts.
- $\text{whatDyn}(M,A)$  : Prints a list of possible dynamics given a list of mechanics  $M$  and aesthetics  $A$  of the model. Possible means dynamics which have a valid relationship with the other concepts.
- $\text{whatAest}(M,D)$  : Prints a list of possible aesthetics given a list of dynamics  $D$  and mechanics  $M$  of the model. Possible means aesthetics which have a valid relationship with the other concepts.

Summarizing, each rule displays all correct concepts of a type in respect to the given lists. With this the user can check if every concept of each part of his description is connected with at least one other type.

Assured that every concept of his list is included the model, the user now needs to evaluate the relationships. There is another set of rules that can improve this investigation. They aim to answer if there is a connection between two types of components in the user description. They are:

- $\text{mechHasDyn}(\text{Mech},[D])$  : checks if a given mechanic  $\text{Mech}$  is connected to at least one dynamic in list  $D$ .
- $\text{allMechHasDyn}([M],[D])$  : checks whether all mechanics in list  $M$  are connected to some dynamic in list  $D$ .
- $\text{aestHasDyn}(\text{Aest},[D])$  : checks if a given aesthetic  $\text{Aest}$  is connected to at least one dynamic in list  $D$ .
- $\text{allAestHasDyn}([A],[D])$  : checks whether all aesthetics in list  $A$  are connected to some dynamic in list  $D$ .
- $\text{dynHasMech}(\text{Dyn},[M])$  : checks if a given dynamic  $\text{Dyn}$  is connected to at least one mechanic in list  $M$ .
- $\text{allDynHasMech}([D],[M])$  : checks whether all dynamics in list  $D$  are connected to some dynamic in list  $M$ .
- $\text{dynHasAest}(\text{Dyn},[A])$  : checks if a given dynamic  $\text{Dyn}$  is connected to at least one aesthetic in list  $A$ .

- `allDynHasAest([D],[A])` : checks whether all dynamics in list D are connected to some aesthetic in list A.

Each combination of types can be investigated using these rules. For each pair there is one that verifies a single component against a list and another to compare two lists. Investigating thoroughly which component of your description is wrong will mainly use the comparisons of a single component. It will be able to pinpoint the incorrect part of the description. Given the four types of relationships present, finding which concept is wrong would take a considerable effort. The *all* rules were created to quicken this task. They evaluate if the incorrectness is within a given relationship. Executing all four of them will tell the user where he does not need to investigate.

Capable now of evaluating the incorrectness of the description, the user is fully capable of utilizing the model to his own purposes. If he ever decide the model needs to be incremented, he should do it in accordance with the ideas discussed in the following section.

## 6.4 Enhancing the model

Ontologies define domains. A non-comprehensive ontology is like a house in construction, with only the walls. Such house can shield you from the wind but cannot protect from the rain. This incomplete ontology has its uses, but it does not achieve its full potential. It does not mean, though, that this work is not complete. Proposing a non-comprehensive ontology mean that it should be created collaboratively. Using crowd knowledge and its multiple points of view rather than a single opinion. This creates a knowledge base founded upon the ideas of the users rather than a specialist.

Contributions are necessary, but have to be made carefully. It is important that the model remain cohesive and correct. With this the contribution has to go through some evaluation, which will guarantee that it is really enhancing the model.

There are two different contributions: a new concept or a new relationship. Each has to be evaluated differently, but they are linked. Creating new mechanics, dynamics or aesthetics include creating new relationships. An isolated concept will be incorrect. With this, first we introduce how to create relationships and then cover the new concepts.

Before addressing the specific cases, there are some directives that are common for all of them. First thing to be evaluated is the possibility of redundancies. This is, evaluate if there is some other concept or relationship that has the same significance. To know this the user has to compare the description of each idea with

his contribution. And ask whether they can be used to represent his idea, even if having some difference in abstraction level. Also use this process to evaluate if the new idea is contained or is an specification or generalization of some part of the model.

Users going through this process should take into account that its objective is to answer the question: This new idea is really important for the model? Meaning he needs to focus in understanding if the model is improved with his addition.

Investigating redundancies is more conceptual than mechanic. Thus the main research should be made in the model's descriptions rather than through the program. Even then there is some use for the program. It can be used to find objects related to a concept in the model, which can help the user to find some idea related to his contribution.

### 6.4.1 Creating relationships

Relationships in OntoBG are mainly of two types: between mechanics, dynamics and aesthetics, henceforth called cross-model relationships; As well as within each model, henceforth called in-model relationships. The first one is exclusively of causal stereotype. Although it has some differences in regard to which types of concepts it connects. The other relationships can be generalizations, causal and meronomic relationships. Each has its own restrictions that need to be addressed. How to deal with each case is discussed here.

Firstly, the meaning of the relationships is of utmost importance. Cross-model relationships are necessarily causal. When evaluating this type of new relationship the user has to be sure that it has the semantics of a causal relationship. That is, if it fits the idea behind a cause and consequences established in chapter 5. Moreover, this relationship is connecting two concepts, and these concepts imply different semantic to the relationship. This is noted in the game model, that gives an abstract definition for these relationships. Connections between different concepts have slightly different ideas, which need to be present in the proposed relationship.

To include these relationships into the program the user creates the predicate representing his relationship. The different types of cross-model relationships are divided into two functors in the program.

- `mdRelation(MECHANIC,DYNAMIC)` - Represents relationships between mechanics and dynamics, where `MECHANIC` and `DYNAMIC` are respectively the mechanic and dynamic of the relationship.
- `daRelation(DYNAMIC,AESTHETIC)` - Represents relationships between dynamics and aesthetics, where `DYNAMIC` and `AESTHETIC` are respectively the dynamic and aesthetic of the relationship.

When proposing in-model relationships the same principle holds. But each stereotype has its meaning, and thus the user can use this process to evaluate which is the stereotype of his new relationship. In-model causal relationships have to be in accord to cause and consequence, but do not have a more abstract definition like cross-model. Generalization relationships represent changes in abstraction level. Meronymic relationships are a bit more complicated and should be addressed carefully. Even so, most of the part of relationships will be quite intuitive, like *card* being a part of *deck*. Other cases might require the user to evaluate what meaning is behind his relationship to properly describe it and acknowledge if it fits the model.

Including these relationships in the prolog is done creating a predicate where the functor defines the stereotype of the relationship. Each is defined as:

- `generalization(A,B)` - represent that A is a generic form of B, and conversely that B is more specific than A.
- `causal(A,B)` - represent that A is the cause of the consequence B
- `partof(A,B)` - represent that A is a part of the whole B

Beware that each of these relationships defined are not reflexive. The order of the arguments change the meaning of the term. Due the conceptual relationship they represent being directional.

## 6.4.2 Creating concepts

Concepts provide a bit more challenge. This is because they need to have relationships to be in the model. When proposing a new concept the user must also propose relationships and go through all the process of assuring they should be included.

First step of the evaluation is to address which type of concept it is. To do this the user has to go through the definitions of each type. Taking into account how this new concept came to be, the user compares his idea with these definitions to establish its type. It may be tricky to differentiate dynamics from mechanics and thus, when proposing one of them, the user needs to be careful. All concepts in these models are *kinds*. Their representation in the program is:

- `mechanics(NAME)` - represents a concept which is a mechanic and belongs to its model. NAME is the name of the concept.
- `dynamics(NAME)` - represents a concept which is a dynamic and belongs to its model. NAME is the name of the concept.



- emotion(NAME) - represents a concept which is an emotion that is part of the aesthetic model. NAME is the name of the concept.
- instinct(NAME) - represents a concept which is an instinct that is part of the aesthetic model. NAME is the name of the concept.

Afterwards the user defines where this new concepts fit inside his type's model. Which means evaluating how it relates to the other concepts of the same type. This creates many relationships to be evaluated separately. Using their evaluation the user will be able to define how the new concept will relate to its peers. Although, it should be noted that it is not necessary to have these relationships. Concepts isolated from other ones of the same type is not incorrect. But as the ontology grows in number of concepts it will be harder for a concept not to relate with another. So it is better for the model quality if the concept has such relationships.

Cross-model relationships are now evaluated. They are necessary because of the MDA definition. The model then is only correct if a mechanic is related to a dynamic, dynamic to aesthetic and so on.

Including a new concept will demand creation of these relationships. To be able to identify these relationships in his concept, the user has to look into how his idea came to be. Normally this new concept is present in a game being created or analyzed by the user. He has to observe how this concept exists in this game. As example: if a mechanic, evaluate how it is used by players in different moments to decide which dynamics it creates. But the evaluation should not be limited to a single game. Looking into a diversity of games will provide better data and thus better relationships.

### 6.4.3 Hit the nail in the head

Having established the contribution correctness and its value, it is time to decide whether this is a good addition to the model. This process described should have given the user enough knowledge about his contribution and the model. With it he has the tools to decide.

To make this decision, the user analyzes his information. Focusing on the question: Does my contribution makes the model a better one? This means he should inquire whether the contribution is repetitive. Even though it is not redundant it can still be repetitive. That is, this new concept or relationship is used only in minor cases or is so close in meaning to an existing one that it is never used.

All these steps and difficulties in creating new objects for the model exist with a purpose. They ensure that the model does not become redundant or inexpressive. That is, having multiple concepts and relationships which are only simplifications

of the other ones. This leads to a model which is large but cannot describe many aspects of games, being inexpressive. In other words, keep the model lean.

# Capítulo 7

## Finale

Concluding this dissertation, this chapter wraps all the work that was done. Establishing clearly the contribution of both the process and results created here. Based on this, I also propose future works in this line of research as well as improvements to OntoBG.

### 7.1 OntoBG: ontology of boardgames

Here it was assembled a novelty approach to the study of boardgames: an ontology of the domain. It is not the only approach at the time of publishing as in July of 2019 the book *Building blocks of tabletop game design* ENGELSTEIN & SHALEV (2019) was released. It provides encyclopedic knowledge in mechanics of tabletop games. While it is a far more precise and comprehensive work in terms of mechanics, this work has a broader aspect when addressing dynamics and aesthetics. In Seção A.6 there is a table with an analysis of how this new work should be evaluated in the light of this theory and ontology. Nonetheless, this work still provide different insight and usability in comparison to this book.

OntoBG at the end of this work is an ontology that represents the world of analog games. It does so using a heavy theoretical basis, which is one of the greatest contributions of this work. The MDA framework used as core for the ontology is a flexible and widely accepted model. This allows the creation of a more in depth theory of its aspects. The knowledge on mechanics, dynamics and aesthetics, specially the last two, are the greatest value of this work.

This ontology was made to represent the knowledge of the players and designers of such games. But to better represent it they were crossed with academic knowledge. Mechanics were extracted from a widely used forum then structured and verified with academic researches in KRITZ *et al.* (2017). Dynamics were evaluated through a focus group and survey, then structured according to the author academic

knowledge. For aesthetic aspects of the game, two models, one from a game designer and other from a psychologist were mixed to create better knowledge.

Using this ontology as basis it will be possible to create a more complete knowledge of games. Both scholar and industry shall find this mixed approach of great insight.

OntoBG is not comprehensive as it is and it is far from complete. Which leads to a clear future work of complementing it. This can be done by analysing other experiences and points of view to discover new concepts and relationships not featured in the model. Also, reviewing the ontology through other lenses, comparing it to other models or theoretical structures, aiming to find what it lacks and then fill the gaps are all possible contributions to be done.

This ontology was created mostly to be used in analysis and creation of boardgames. Including the ontology on game design methods, describing games and comparing different types of games are all good forms of using this work. This form of new work is very important. So far, there is a lack of structure in those processes for boardgames.

## **7.2 Theories**

Not only the practical part of this work is a contribution. The theories established here provide new insight about boardgames. It is divided in three different areas, mechanics, dynamics and aesthetics. Each with a contribution, which are covered followingly.

### **7.2.1 Preliminary work on dynamics**

Throughout the process of creating the theoretical background of the ontology, this work addressed dynamics as an academic subject in games. This by itself is a contribution. Dynamics are very neglected by both industry and scholars and this work created a model of these dynamics, which is not seen in boardgame literature. Thus presenting a theoretical foundation which can be used to structure new research.

Proposing new works in dynamics shall begin with new research on the vocabulary created. It is clearly lacking and simple. Together with new researches in game dynamics subject the model can be greatly improved. Another good use for a model of dynamics is identifying them automatically from gameplay data. This can lead to new forms of classification for games as well as change how we analyze e-sports data. To create this automatization one should unite with studies on game telemetry, game provenance and process mining.

### 7.2.2 Aesthetic values in perspective

Aesthetic is a term originated from philosophy. With this is not actually clear of what it means. Specially for games, where there are two common interpretations, visual appreciation and emotions. MDA framework HUNICKE *et al.* (2004) agrees with the emotions as the aesthetic response that matter for games. But it might not be everything. With this in mind here was built a model for aesthetic responses including instincts and emotions.

Emotions and instincts were first related in the games perspective by Dillon DILLON (2010). His work was of great importance because it was created inside the games domain and based on a game designer experience. But given the fact that the understanding of what is aesthetics is by itself without common agreement, here we looked upon a different area of knowledge for more information on what are emotions. Using Ekman's EKMAN theory we enhanced Dillon's perspective and created a reliable model for aesthetics of games.

Next steps in this line of research should first look into other areas for different perspectives on emotions and instincts. Which would enhance even more the theoretical foundations established in this work. In particular it would be of great interest to the game studies community to go through philosophy and fully understand aesthetics.

### 7.2.3 Mechanics and praxis

The mechanics model was created using a user created database. With this it reflects what these people believed about games. When this knowledge was put through the lenses of other scholar's ideas it was clearly insufficient. This work did not fix this aspect of the model, but linked it to the other models created. Which by itself improves what is said about the mechanics

Creation of this ontology was detailed thoroughly in KRITZ *et al.* (2017). There it was already discussed the enormity of creating a good database on mechanics knowledge. This work did not increase the mechanics specific knowledge because it would rather cover more ground using more concepts of games, leaving this effort to future work.

## 7.3 Program of the model

Lastly this work implemented a program in the prolog language. This program translated the model and made it computable. It is responsible for most of the usability of OntoBG, allowing an user to evaluate his own games and easily describe new ideas into the model. Creating a tool for interaction with the model is important

to provide the means for achieving this works purpose. That is, to help designers and scholars a facilitating tool for their craft. Be it in describing or analyzing games.

There is room for improvements in the program. It does not automatically verify the possibility of a new idea. And if correct it still should be added manually rather than through the program execution. Other new functionalities would be: new rules and processes to evaluate described games; Automatic generating games, given some parameters; Proposing changes in games as the user needs, for example suggesting a different set of mechanics that does not remove any dynamics.

Another interesting approach in this line would be to import descriptions of games from their manual. This would mostly generate mechanics and dynamics. Nonetheless it would be interesting to compare with human made descriptions of these games.

## 7.4 The issue of validation

Due to time complications the work created here was not thoroughly evaluated and validated. For the ontological model itself using a well established foundational ontology in the process of creation provides great assertiveness of its correctness. Even then it is possible to enhance this assertiveness through some validation methods.

Thus here lies suggestions of validation for this work. There are three processes that should be evaluated for their validity. The ontology creation, the creation of the dynamics' vocabulary and the prolog program.

The ontology creation can be validated through experts in the area. It is traditional to validate models by showing them to other specialists in the subject, then collecting their criticism or approval. Being no different from other models in this aspect it can be a proper form of validation.

Our vocabulary of dynamics was created using a specific process. This process can be replicated and remade in various ways. Which would be the best way of validating the vocabulary, although it could also be validated through expert criticism.

Finally the program can be validated through software engineering methods. Or it could be tested by users. if they can use the program to create applications or solve their problems will yield positive results regarding the program validity.

## 7.5 At the end...

This research aimed to evaluate if it was possible to create a boardgame ontology focused on humans use. To do this, it evaluated the different possibilities of ontology creation. How to provide fundamental knowledge on the domain and, more

important, how to make this knowledge resonant with the humans interested in this domain.

Analyzing the processes of this ontology creation, from establishing theoretical background to acquiring real users data and then modeling of this information, and the fact that it is complete without any modeling inconsistency, it can be concluded that creating a boardgame ontology for human use is possible and beneficial to the community. Although it needs to be improved in many aspects to be fulfilled as a full fledged ontology, this preliminary work indicates that this is a valuable form of knowledge and should not be neglected.

# Referências Bibliográficas

- BABB, J., TERRY, N., 2013, “Comparing video game sales by gaming platform”, *Southwestern Economic Review*, v. 40, pp. 25–46.
- BALDEON, J., RODRIGUEZ, I., PUIG, A., et al., 2016, “From learning to game mechanics: The design and the analysis of a serious game for computer literacy”. pp. 1–6. IEEE, jun.
- BAMPAROPOULOS, G., KONSTANTINIDIS, E., BRATSAS, C., et al., 2016, “Towards exergaming commons: composing the exergame ontology for publishing open game data”, *Journal of Biomedical Semantics*, v. 7, n. 1.
- BATEMAN, C., 2015, “Implicit Game Aesthetics”, *Games and Culture*, v. 10, n. 4 (jul.), pp. 389–411.
- BATEMAN, C., 2014, “Empirical Game Aesthetics”. In: *Handbook of Digital Games*, John Wiley & Sons, Inc., pp. 411–443, Hoboken, NJ, USA.
- BJORK, S., HOLOPAINEN, J., 2005, *Patterns in game design*. Charles River Media game development series. 1st ed ed. Hingham, Mass, Charles River Media.
- BOARDGAMEGEEK. “BoardGameGeek|Game Mechanics”. <https://boardgamegeek.com/browse/boardgamemechanic>. (Accessed on 07/28/2017).
- CALADO, F., LEITE DE VASCONCELOS, L., NEVES, A., et al., 2015, “Modelo para avaliação do grau de novidade de jogos digitais”, .
- CRAWFORD, C., 1984, “The art of computer game design”, .
- DEVELLIS, R. F., 2016, *Scale development: Theory and applications*, v. 26. Sage publications.
- DILLON, R., 2010, *On the way to fun: an emotion-based approach to successful game design*. CRC Press.



- EKMAN, P., 1992, “Are there basic emotions?” .
- EKMAN, P., 2016, “What Scientists Who Study Emotion Agree About”, *Perspectives on Psychological Science*, v. 11, n. 1 (jan.), pp. 31–34.
- EKMAN, P. “The Ekman’s Atlas of Emotion”. <http://atlasofemotions.org/> . Accessed on 10/03/2020.
- ENGELSTEIN, G., SHALEV, I., 2019, *Building Blocks of Tabletop Game Design: An Encyclopedia of Mechanisms*. CRC Press.
- GAMEONTOLOGY, 2015. “Main Page — gameontology,”. [http://www.gameontology.com/index.php?title=Main\\_Page&oldid=254](http://www.gameontology.com/index.php?title=Main_Page&oldid=254) . [Online; accessed 6-August-2017].
- GHANNEM, A., KHEMAJA, M., 2011, “Defining a game ontology for helping games and learning processes integration”. In: *eLSE Conference*,.
- GRANDY, R. E., 2016, “Sortals”. In: Zalta, E. N. (Ed.), *The Stanford Encyclopedia of Philosophy*, winter 2016 ed., Metaphysics Research Lab, Stanford University.
- GRUBER, T., 2009, “Ontology”, *Encyclopedia of database systems*, pp. 1963–1965.
- GUARINO, N., 1998, *Formal ontology in information systems: Proceedings of the first international conference (FOIS’98), June 6-8, Trento, Italy*, v. 46. IOS press.
- GUIZZARDI, G., 2005, *Ontological foundations for structural conceptual models*. University of Twente.
- GUIZZARDI, G., WAGNER, G., GUARINO, N., et al., 2004, “An ontologically well-founded profile for UML conceptual models”. In: *International Conference on Advanced Information Systems Engineering*, pp. 112–126. Springer.
- GUIZZARDI, G., WAGNER, G., ALMEIDA, J. P. A., et al., 2015, “Towards ontological foundations for conceptual modeling: the unified foundational ontology (UFO) story”, *Applied ontology*, v. 10, n. 3-4, pp. 259–271.
- HAINES, T., CONNOLLY, T. M., BOYLE, E. A., et al., 2016, “A systematic literature review of games-based learning empirical evidence in primary education”, *Computers & Education*, v. 102, pp. 202–223.

- HOWARD, S., 2014. “Three Hundred Mechanics”. <http://www.squidi.net/three/index.php> . [Accessed 6-August-2017].
- HUIZINGA, J., 2014, *Homo Ludens IIs 86*, v. 3. Routledge.
- HUNICKE, R., LEBLANC, M., ZUBEK, R., 2004, “MDA: A formal approach to game design and game research”. In: *Proceedings of the AAAI Workshop on Challenges in Game AI*, v. 4.
- ISMAIL AL-ALAWI, A., YOUSIF AL-MARZOOQI, N., FRAIDOOON MOHAMMED, Y., 2007, “Organizational culture and knowledge sharing: critical success factors”, *Journal of knowledge management*, v. 11, n. 2, pp. 22–42.
- JÄRVINEN, A., 2009, “Games without frontiers”, *Doctora Dissertation Study for Media Cuture*.
- JUUL, J., 2010, “The game, the player, the world: Looking for a heart of game-ness”, *PLURAIIS-Revista Multidisciplinar*, v. 1, n. 2.
- KARPOUZIS, K., 2016, *Emotion in games: theory and praxis*. Springer Berlin Heidelberg.
- KITZINGER, J., 1994, “The methodology of Focus Groups: the importance of interaction between research participants”, *Sociology of health & illness*, pp. 103–121.
- KRITZ, J., MANGELI, E., XEXÉO, G., 2017, “Building an Ontology of Board-game Mechanics based on the BoardGameGeek Database and the MDA Framework”. In: *XVI Brazilian Symposium on Computer Games and Digital Entertainment, Curitiba*, pp. 182–191.
- LEBLANC, M., 2006, “Tools for creating dramatic game dynamics”, *The game design reader: A rules of play anthology*, pp. 438–459.
- LEÓN Z, A. C., SÁNCHEZ L, A., 2010, “An Ontology for Mobile Video Games”. In: *2010 Ninth Mexican International Conference on Artificial Intelligence*, pp. 154–159.
- LIAMPUTTONG, P., 2011, *Focus Group Methodology: Principles and Practice*. SAGE Publications Ltd.
- LOCKE, J., 1841, *An essay concerning human understanding*. Kay & Troutman.
- MÄÄTTÄ, M.-P., 2019, “Growth and Future of video game industry”, .

- MALHOTRA, N. K., 2012, *Pesquisa de marketing: uma orientação aplicada*. Bookman Editora.
- MUSEN, M. A., 2015, “The protégé project: a look back and a look forward”, *AI Matters*, v. 1, n. 4, pp. 4–12.
- NOY, N., MCGUINNESS, D. “What is an ontology and why we need it”. [https://perso.liris.cnrs.fr/alain.mille/enseignements/Ecole\\_Centrale/What%20is%20an%20ontology%20and%20why%20we%20need%20it.htm](https://perso.liris.cnrs.fr/alain.mille/enseignements/Ecole_Centrale/What%20is%20an%20ontology%20and%20why%20we%20need%20it.htm) . Accessed in 10/03/2020.
- ORTONY, A., CLORE, G. L., COLLINS, A., 1990, *The cognitive structure of emotions*. Cambridge university press.
- PARKKILA, J., RADULOVIC, F., GARIJO, D., et al., 2017, “An ontology for videogame interoperability”, *Multimedia Tools and Applications*, v. 76, n. 4, pp. 4981–5000.
- RABIEE, F., 2004, “Focus-group interview and data analysis”, *Proceedings of the Nutrition Society*, v. 63, n. 04 (nov.), pp. 655–660.
- ROMAN, M., SANDU, I., BURAGA, S. C., 2011, “Owl-based modeling of RPG games”, *Studia Universitatis Babeş-Bolyai*, v. 56, n. 3, pp. 83.
- SACCO, O., LIAPIS, A., YANNAKAKIS, G. N., 2017, “Game Character Ontology (GCO) A Vocabulary for Extracting and Describing Game Character Information from Web Content”. pp. 9–16. ACM Press.
- SALEN, K., ZIMMERMAN, E., 2004, *Rules of play: Game design fundamentals*. MIT press.
- SCHELL, J., 2014, *The Art of Game Design: A book of lenses*. AK Peters/CRC Press.
- SCHERER, K. R., SCHORR, A., JOHNSTONE, T., 2001, *Appraisal Processes in Emotion: Theory, Methods, Research*. Oxford University Press.
- SMITH, B., WELTY, C., 2001, “Ontology: Towards a new synthesis”. In: *Formal Ontology in Information Systems*, v. 10, pp. 3–9. ACM Press, USA, pp. iii-x.
- TANG, S., HANNEGHAN, M., 2011, “Game Content Model: An Ontology for Documenting Serious Game Design”. pp. 431–436. IEEE.

THE MANA WORLD. “the Mana World”. <https://www.themanaworld.org> .  
Accessed 6-August-2017].

DURIC, B. O., KONECKI, M., 2015, “Specific owl-based rpg ontology”. In: *Central European Conference on Information and Intelligent Systems*, p. 185. Faculty of Organization and Informatics Varazdin.

WITTGENSTEIN, L., 2009, *Philosophical investigations*. John Wiley & Sons.

ZAGAL, J. P., BRUCKMAN, A., 2008, “The Game Ontology Project: Supporting Learning While Contributing Authentically to Game Studies”. In: *Proceedings of the 8th International Conference on International Conference for the Learning Sciences - Volume 2, ICLS'08*, pp. 499–506. International Society of the Learning Sciences.

# Apêndice A

## Surveys submitted

These are the surveys submitted in both Portuguese and English.

### A.1 English survey

# Dynamics of boardgames

This research seeks to establish the dynamics present in boardgames according to the opinion of the public which is related to it.

The meaning of dynamics adopted in this research is on par with the MDA model, which define dynamics as:

- the behavior of mechanics of the game based on interactions of the players  
in other words, it is how the game develops, what happens during gameplay, how the player uses a mechanic and how they play the game itself.

In this survey, you'll be presented with different concepts of dynamics identified in boardgames, and will inquired about how much do you agree that it is a dynamic, in respect to the definition, which are present in boardgames. The answer will be a scale from 1 to 5 where 1 means completely disagree and 5 means completely agree.

This is a quick survey and should take no more than 15 to 20 min to complete. Hope you'll be able to contribute with the research

If you want to know about the final results, at the end of the survey you can inform your e-mail and when it is all done i'll send the results to those interested.

**\*Obrigatório**

1. Which of this profiles is more fitting to describe you? \*

*Marcar apenas uma oval.*

- Gamer ( a board game enthusiast)
- Boardgames Desinger
- Industry (Work on a publisher of boardgames, or other related companies)

2. How often do you play? (choose the closest one) \*

*Marcar apenas uma oval.*

- thrice a week
- once a week
- once a month
- lesser than the above

## Dynamics

Following up, you should answer how much you agree that each described dynamic (the situation) is present in boardgames.

i.e. use 4 if you think it happens but not 100% sure or 3 if you don't know or not so sure.

3. Do an action to limit the options of other players (refresh the available cards so a player cannot buy one of them) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

4. Use an colateral effect ( hit A causing event B which attack C) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

5. Use actions to discover information (watch and analyze other players reactions) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

6. Block a player (use an action to stop him from doing it) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

7. Use an action to change the game state (do an action to increase the market prices) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

8. One versus many: one player decides to attack all other players \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

9. All versus one: many players unite themselves to attack a single player (in example, because he is winning) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

10. Ally with another player (To achieve an objective or surpass an obstacle) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree



11. Persecute a player (attack and hinder a single player always) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

12. Survive: play with focus on not being eliminated (keep healing yourself to not die) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

13. Combo: chain automatic effects of the game \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

14. Render useless or reduce usability determined resource of the game (eliminate all forms of using iron) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

15. Protect oneself from a player by hiding behind another one \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

16. Parallax: Observe a outcome intending to force a result more beneficial for you. (' but from here it hits') \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

17. Avoid getting points in the game to have some benefit (in example, to be the first one to play next round) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

18. Camping on a same position / doing always the same strategy or action \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

19. Stale the progress of the game (delay the end of the game) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

20. Play foreseeing your next actions / plan a sequence of actions \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

21. Alpha player: The player that plays for the other ones, which force them to play how he wants them to play \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

22. Protect a position or pieces (play impeding other players to access your resources) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

23. Play safe (do not make risky moves, always play on certainty) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

24. Ritualism: player that repeats a specific form of play intending to get the same result from previous plays ( roll the dice a specific way wanting to get the same result) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

25. Count cards, tokens and other resources \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

26. Aim for a personal objective not defined in the game (Conquer all mountain territories, 'I am the king of the mountain!') \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

27. Hasten the end of the game (In puerto rico, build a lot of structures as fast as possible) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

28. Make a sacrifice (sacrifice an important piece in Chess) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

29. Distraction: do an action to take the other players focus of your real objectives (conquer a territory in a region in which you have no interest so the other players believe otherwise) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

30. Change your strategy based on the game status (can't get points with corn so i'll start getting them with wood) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

31. Deduce secret information through open information (see one or more cards played by an opponent and find out which cards he can have on his hand) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

32. Communicate indirectly with teammates, so that other players don't understand (whispering, mimics, predefined visual signs) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

33. Forfeit the game (keep walking in circles without any objective, repeat the same action without any purpose) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

34. Cheating: Break the rules of the game \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

35. Troll: play only to annoy the other players without any care for winning \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

36. Intimidate: Use a stronger position to force another player to do something you want (do that, or i'll attack you) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

37. Bluffing: relay false information to manipulate another players choices \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

38. Convince other players (convince another players that both of you do not have the same interests so he does not attack you) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

39. Confuse a player, inducing him to make a bad play \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

40. Exclusion of a player (in a game where you can select participants for a given event, never chose a specific player) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

41. Small talk: keep talking all time to distract other players \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

42. Play riskily (pursue the greatest risks to get the biggest rewards) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Completely disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree



43. Any suggestion of dynamics that didn't featured on this survey?

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44. E-mail for further information when the research is finished:

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Google Formulários

## A.2 Portuguese survey

# Dinâmicas em jogos de tabuleiro

Esta pesquisa visa definir o mundo de dinâmicas que existem em jogos de tabuleiro de acordo com a opinião dos que jogam.

O sentido de dinâmicas é adotado por esta pesquisa de acordo com o modelo MDA, que define dinâmicas como:

- o comportamento das mecânicas do jogo de acordo com as interações dos jogadores. em outras palavras é o que acontece durante o jogo, como os jogadores usam as mecânicas e como jogam o jogo em sí

Ao longo deste questionário você verá diversos conceitos de dinâmicas identificados em jogos de tabuleiro, e será questionado sobre o quanto concorda que isso é uma dinâmica, de acordo com a definição, presente em jogos de tabuleiro. A resposta é uma escala de 1 a 5 onde 1 é discordo totalmente e 5 é concordo totalmente.

É um questionário rápido dura em média 15 a 20 min. Espero que possa contribuir com a pesquisa!

Caso queira depois acompanhar os resultados no final terá um campo para colocar seu e-mail e quando o trabalho estiver concluído enviarei para os interessados!

**\*Obrigatório**

1. Em qual desses perfis você se encaixa melhor? \*

*Marcar apenas uma oval.*

- Jogador (entusiasta de jogos de tabuleiro)
- Designer de jogos de tabuleiro
- Empresarial (trabalha em uma empresa que publica jogos de tabuleiro)

2. Com que frequência você joga jogos de tabuleiro? (escolha a mais próxima)

*Marcar apenas uma oval.*

- 3 vezes por semana
- 1 vez por semana
- 1 vez por mês
- menos que as anteriores

## Dinâmicas

Em cada pergunta responda o quanto você concorda que a dinâmica descrita (o evento descrito) acontece em jogos de tabuleiro.

por exemplo: 4 significa que acha que sim, mas não está 100% certo, 3 que não sabe ou não tem muito conhecimento.

3. Fazer uma ação para diminuir as opções dos outros jogadores (Renovar a oferta de cartas para que um jogador não compre uma carta) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

4. Usar efeito colateral (atingir A causa evento B que ataca C) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

5. Usar uma ação para descobrir informações (ver e analisar a reação dos outros jogadores) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

6. Bloquear um jogador (cortar, usar uma ação para impedir que outro jogador a use) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

7. Usar uma ação para mudar o estado de jogo (fazer uma ação para encarecer o mercado) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

8. Um contra todos: um jogador decide atacar todos os outros jogadores \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

9. Todos contra um: vários jogadores se unem para atacar um único jogador (por exemplo por que ele está vencendo) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

10. Se aliar a um outro jogador (para conseguir um objetivo ou vencer um obstáculo) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

11. Perseguir um jogador (atacar e atrapalhar um mesmo jogador o tempo todo) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

12. Sobreviver: jogar para não ser eliminado (ficar se curando para não morrer) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

13. Combo: encadear efeitos automáticos do jogo \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

14. Inutilizar ou reduzir determinado recurso do jogo (eliminar todas as formas de usar ferro) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

15. Se proteger de um jogador se escondendo atrás de um terceiro \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

16. Paralaxe: Observar um resultado visando forçar um resultado mais benéfico para si (daqui encostou!!) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

17. Evitar pontuar no jogo por algum benefício (por exemplo não pontuar para ser o primeiro a jogar na próxima rodada) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

18. Acampar numa posição / fazer sempre a mesma ação ou estratégia \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

19. Impedir o progresso do jogo (atrasar o jogo) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

20. Jogar em função das suas próximas ações / planejar uma sequência de ações \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

21. Alpha player: Jogador que joga pelos outros, que força outros jogadores a jogarem da forma que ele quer \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



22. Proteger posição ou peças (jogar impedindo que outros jogadores acessem um recurso seu) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

23. Jogar de forma segura (não fazer jogadas arriscadas, sempre jogar na certeza) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

24. Ritualidade: jogador que repete a forma de jogar visando um mesmo resultado obtido anteriormente (jogar o dado da mesma forma esperando o mesmo resultado) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

25. Contar cartas, tokens e outros recursos \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

26. Procurar objetivo próprio não definido pelo jogo (conquistar todos os territórios de montanha, 'Eu sou o rei da montanha!') \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

27. Acelerar o fim do jogo (Em puerto rico construir rapidamente varias construções) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

28. Fazer um sacrificio (sacrificar uma peça importante no xadrez) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

29. Distração: fazer uma ação para tirar o foco/atenção dos outros jogadores do seu objetivo real. (conquistar um território em uma região que não lhe interessa para que os outros pensem que interessa) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

30. Mudar de estratégia por causa dos status do jogo (não consigo mais pontuar por milho vou tentar pontuar por madeira) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

31. Deduzir informações secretas através das que estão abertas (ver uma ou mais cartas jogadas por um oponente e deduzir quais cartas ele pode ou não ter na mão) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

32. Se comunicar de forma indireta com aliados, para que os outros jogadores não identifiquem a mensagem (sussurrar, mimica, sinais pré-combinados) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

33. Desistir do jogo (ficar apenas andando em círculos sem objetivo algum, repetir a mesma ação sem nenhum proposito até o jogo terminar) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

## 34. Trapacear: quebrar uma regra do jogo \*

Marcar apenas uma oval.

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

## 35. Trollar: jogar para atrapalhar os outros jogadores, sem se importar em vencer \*

Marcar apenas uma oval.

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

## 36. Intimidar: Usar de uma posição de maior poder para forçar um jogador a fazer uma jogada. (faça isso se não eu te ataco) \*

Marcar apenas uma oval.

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

## 37. Blefar: passar informações falsas para manipular a jogada de outro jogador \*

Marcar apenas uma oval.

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

38. Convencer os outros jogadores (convencer um jogador de que não tem o mesmo interesse que ele para que não o ataque) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

39. Confundir um jogador para que ele faça uma jogada ruim \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

40. Excluir alguém do jogo (em um jogo que se seleciona participantes, nunca escolher a tal pessoa) \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

41. Small talk: falar durante todo o tempo para distrair os outros jogadores \*

*Marcar apenas uma oval.*

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

42. Jogar de forma arriscada (procurar os maiores riscos para ter as melhores recompensas) \*

*Marcar apenas uma oval.*

1      2      3      4      5

Discordo totalmente      Concordo totalmente

43. Alguma sugestão de dinâmica que não encontrou neste questionário?

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44. E-mail para receber mais informações:

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Google Formulários

## A.3 OntoBG-M diagram

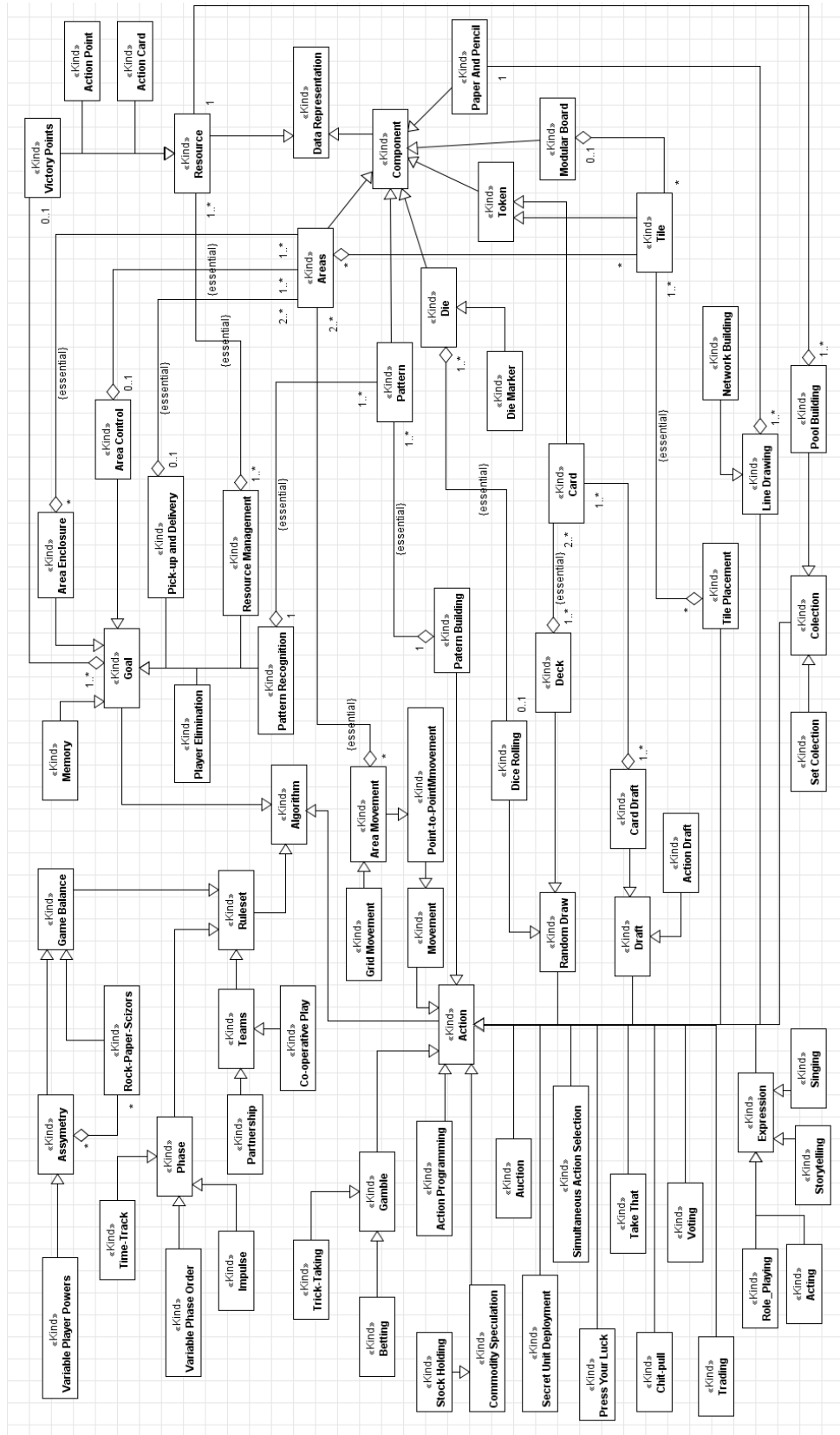


Figure A.1: Mechanics ontology Diagram

## A.4 OntoBG-D diagram

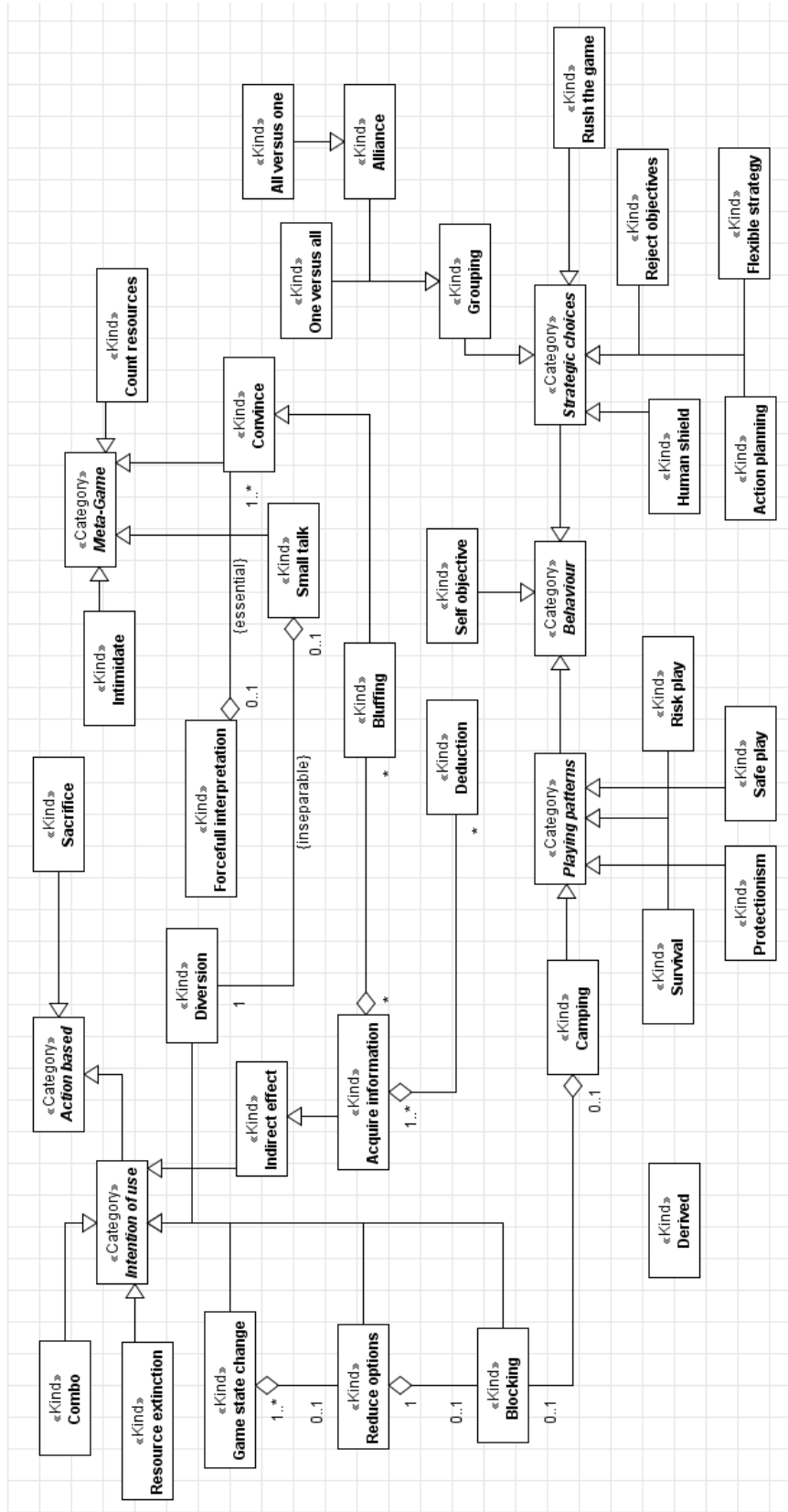


Figura A.2: Dynamics ontology Diagram



# A.5 OntoBG-A diagram

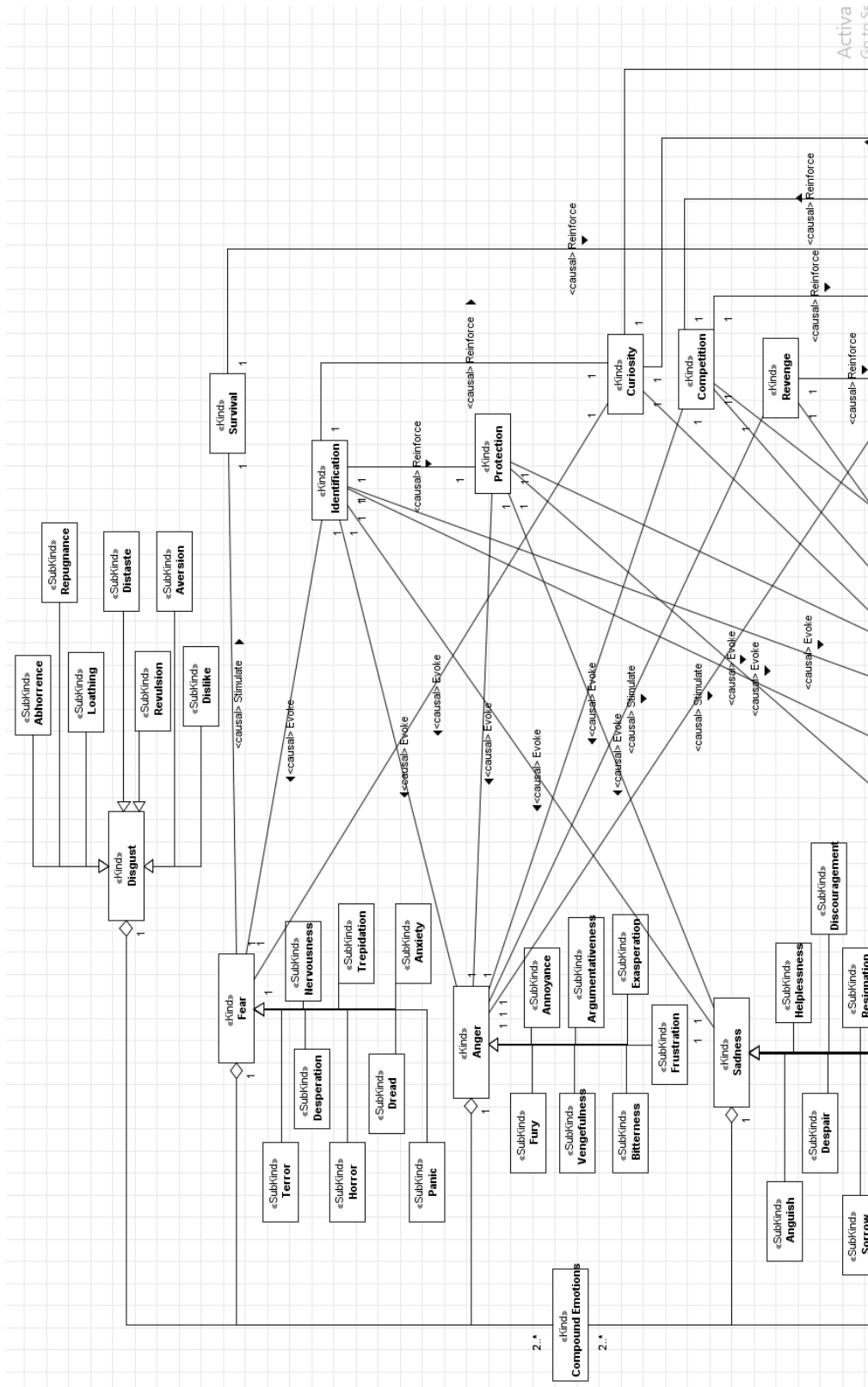


Figura A.3: Aesthetics ontology Diagram top section

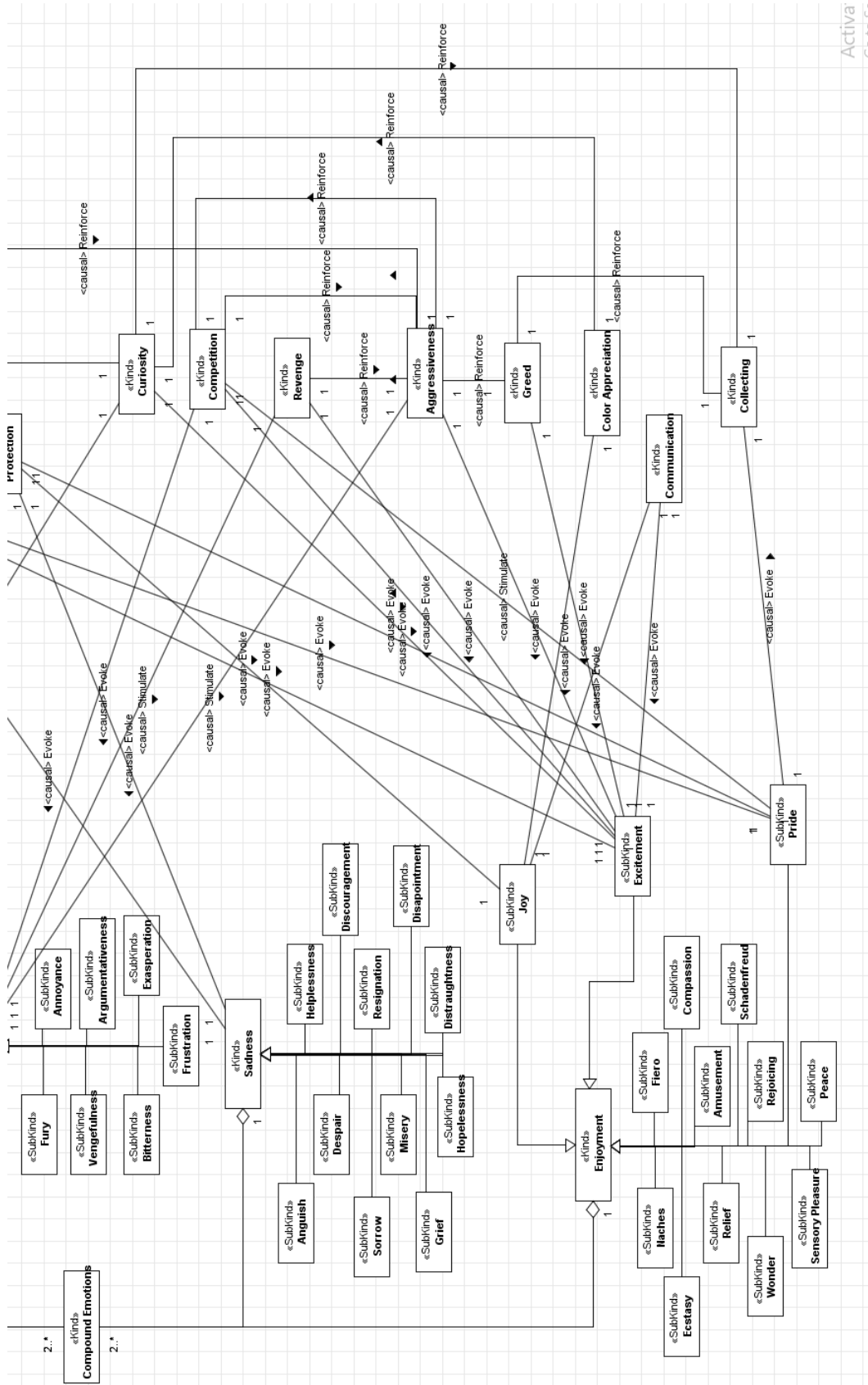


Figura A.4: Aesthetics ontology Diagram bottom section

## A.6 Building Blocks analysis

Building Blocks mechanic	OntoBG Evaluation
STR-01 Competitive Games	Should be included as an specification of Teams
STR-02 Cooperative Games	Already included as Co-operative play
STR-03 Team-Based Games	Already included as Teams
STR-04 Solo Games	Should be included as an specification of Teams
STR-05 Semi-Cooperative Games	Should not be included as it is only an instance of Co-operative
STR-06 Single Loser Games	Should not be included as it is only a an instance of Competitive Games
STR-07 Traitor Games	Should be included as an specification of Co-operative play
STR-08 Scenario/Mission/Campaign Games	Should not be included as its differences are not significant in the model's abstraction level
STR-09 Score-and-Reset Games	Should not be included as its differences are not significant in the model abstraction level
STR-10 Legacy Games	Should not be included as its differences are not significant in the model's abstraction level
TRN-01 Fixed Turn Order	Should be included as an specification of Turn Order, a new concept that specifies Ruleset
TRN-02 Stat Turn Order	Should be included as an specification of Turn Order
TRN-03 Bid Turn Order	Should not be included as it is only an instance of Stat Turn Order
TRN-04 Progressive Turn Order	Should be merged with Claim Turn Order to create Variable first player, an specification of Turn Order
TRN-05 Claim Turn Order	Should be merged with Progressive Turn Order to create Variable first player, an specification of Turn Order

TRN-06 Pass Order	Should not be included as it is an instance of Stat Turn Order
TRN-07 Real Time	Should be included as an specification of Ruleset
TRN-08 Punctuated Real-Time	Should not be included as it is an instance of Real Time
TRN-09 Simultaneous Action Selection	Already included
TRN-10 Role Order	Should not be included as it is an instance of Simultaneous Action Selection
TRN-11 Random Turn Order	Should be included as an specification of Turn Order
TRN-12 Action Timer	Should not be included as it is an instance of Real Time
TRN-13 Time-Track	Already Included
TRN-14 Passed Action Token	Should not be included as it is an instance of Real Time
TRN-15 Interleaved vs Sequential phases	Should be included as two concepts each specifications of Phase
TRN-16 Lose a Turn	Should not be included as its differences are not significant in the model's abstraction level
TRN-17 Interrupts	Should be included as an specification of Turn Order
ACT-01 Action Points	Already included as Action Point
ACT-02 Action Drafting	Already included as Action Draft
ACT-03 Action Retrieval	Should be included as an specification of Action
ACT-04 Action/Event	Already included as Action Card
ACT-05 Command Cards	Already included as Action Card
ACT-06 Action Queue	Already included as Action Programming
ACT-07 Shared Action Queue	Should not be included as it is an instance of Action Programming
ACT-08 Follow	Should be included as an specification of Action

ACT-09 Order Counters	Should not be included as its differences are not significant in the model's abstraction level
ACT-10 Rondel	Should not be included as it is an instance of Action Selection Restrictions
ACT-11 Action Selection Restrictions	Should be included as an specification of Action
ACT-12 Variable Player Powers	Already included as Variable Player Powers
ACT-13 Once-per-game Abilities	Should not be included as its differences are not significant in the model's abstraction level
ACT-14 Advantage Token	Should not be included as its differences are not significant in the model's abstraction level
ACT-15 Gating and Unlocking	Should not be included as it is an instance of Action Selection Restrictions
ACT-16 Tech trees/ Tech tracks/ Track bonuses	Should not be included as it is an instance of Action Selection Restrictions
ACT-17 Events	Should be included as an specification of Action
ACT-18 Narrative Choice	Should not be included as it is an instance of Action Selection Restrictions
RES-01 High Number	Should not be included as its differences are not significant in the model's abstraction level
RES-02 Stat Check	Should not be included as it is an instance of Random Draw
RES-03 Critical Hits and Failures	Should not be included as it is an instance of Random Draw
RES-04 Ratio/Combat Result Table	Should not be included as its differences are not significant in the model's abstraction level
RES-05 Die Icon	Should not be included as it is an instance of Random Draw
RES-06 Card Play	Should not be included as it is an instance of Random Draw

RES-07 Rock, Paper, Scissors	Already included as Rock-Paper-Scissors
RES-08 Prisoner's Dilemma	Should not be included as its differences are not significant in the model's abstraction level
RES-09 Alternate Removal	Should not be included as its differences are not significant in the model's abstraction level
RES-10 Physical Action	Should be included as an specification of Action and generalisation of Expression
RES-11 Static Capture	Should not be included as its differences are not significant in the model's abstraction level
RES-12 Enclosure	Already included as Area Enclosure
RES-13 Minimap	Should not be included as its differences are not significant in the model's abstraction level
RES-14 Force Commitment	Should not be included as its differences are not significant in the model's abstraction level
RES-15 Voting	Already included as Voting
RES-16 Player Judge	Should not be included as it is an instance of Voting
RES-17 Targeted Clues	Should not be included as its differences are not significant in the model's abstraction level
RES-18 Tie-Breakers	Should not be included as its differences are not significant in the model's abstraction level
RES-19 Dice Selection	Should not be included as it is an instance of Draft
RES-20 Action Speed	Should not be included as it is an specification of Stat Turn Order
RES-21 Re-rolling and Locking	Should be included as an specification of Dice Rolling

RES-22 Kill Steal	Should not be included as its differences are not significant in the model's abstraction level
VIC-01 Victory Points from Game State	Should not be included as it is an instance of Victory Points
VIC-02 Victory Points from Player Actions	Should not be included as it is an instance of Victory Points
VIC-03 Temporary and Permanent Victory Points	Should not be included as it is an instance of Victory Points
VIC-04 Victory Points as Resource	Should not be included as it is an instance of Victory Points
VIC-05 Hidden and Exposed Victory Points	Should not be included as it is an instance of Victory Points
VIC-06 End-Game Bonuses	Should not be included as its differences are not significant in the model's abstraction level
VIC-07 Race	Should be included as an specification of Goal
VIC-08 Player Elimination	Already included as Player Elimination
VIC-09 Fixed Number of Rounds	Should be included as an specification of new concept Game Duration which specifies Ruleset
VIC-10 Exhausting Resources	Should be included as an specification of Game Duration and related with Resource Management
VIC-11 Completing Targets	Should be included as an specification of Game Duration
VIC-12 Fixed Number of Events	Should be included as an specification of Game Duration
VIC-13 Elapsed Real Time	Should not be included as it is an instance of Real Time
VIC-14 Connections	Should not be included as it is an instance of Completing Targets
VIC-15 Circuit Breaker/Sudden Death	Should not be included as its differences are not significant in the model's abstraction level

VIC-16 Finale	Should not be included as its differences are not significant in the model's abstraction level
VIC-17 King of the Hill	Should not be included as it is an instance of Area Control
VIC-18 Catch the Leader	Should be included as an specification of Game Balance
VIC-19 Tug of War	Should be included as an specification of Goal
VIC-20 Highest Lowest	Should not be included as its differences are not significant in the model's abstraction level
UNC-01 Betting and Bluffing	Already included as Betting, and bluffing as a dynamic
UNC-02 Push-Your-Luck	Already included as Press Your Luck
UNC-03 Memory	Already included as Memory
UNC-04 Hidden Roles	Can be included under some level of specification of the Teams concept
UNC-05 Roles with Asymmetric Information	Should not be included as it is only an implementation of Hidden Roles
UNC-06 Communication Limits	Should be included as an specification of Ruleset
UNC-07 Unknown Information	Should not be included as it is only an implementation of Hidden Information
UNC-08 Hidden Information	Should be included as an specification of Ruleset
UNC-09 Probability Management	Can be included as both mechanic or dynamic, depending on the interpretation of each game
UNC-10 Variable Setup	Can be included as an specification of Ruleset
UNC-11 Hidden Control	Should not be included as its differences are not significant in the model's abstraction level
ECO-01 Exchanging	Should be included as an specification of a new concept Economics, which would also generalizes Trading



ECO-02 Trading	Already included as Trading
ECO-03 Market	Should not be included as it is only an implementation of Exchanging and Commodity Speculation
ECO-04 Delayed Purchase	Should not be included as it is only an implementation of Exchanging
ECO-05 Income	Should be included under Ruleset
ECO-06 Automatic Resource Growth	Should not be included as its differences are not significant in the model's abstraction level
ECO-07 Loan	Should not be included as its differences are not significant in the model's abstraction level
ECO-08 Always Available Purchases	Should not be included as it is only an implementation of Exchange
ECO-09 I Cut, You Choose	Should not be included as its differences are not significant in the model's abstraction level
ECO-10 Discount	Should not be included as it is only an implementation of Exchange
ECO-11 Upgrades	Should not be included as it is only an implementation of Exchange
ECO-12 Random Production	Should not be included as its differences are not significant in the model's abstraction level
ECO-13 Investment	Already included as Stock Holding
ECO-14 Ownership	Should not be included as its differences are not significant in the model's abstraction level
ECO-15 Contracts	Should be included as an specification of Goals
ECO-16 Bribery	Should be included as dynamic
ECO-17 Increase Value of Unchosen Resources	Should not be included as its differences are not significant in the model's abstraction level

ECO-18 Negotiation	Should be included as dynamic, when bound by rules is an implementation of Trading
ECO-19 Alliances	Already included as Partnerships
AUC-01 to AUC-16	The whole Auction section is present in the Auction mechanic, if is in the interest of the modeler the particular of each type of auction they can be included as specifications of this concept
WPL-01 to WPL-08	The whole Worker Placement section is an specification of the Action Draft mechanic and can be included as such.
MOV-01 Tessellation	Already included as Areas
MOV-02 to MOV-06	Should not be included as they are only implementations of Movement, that state the amount of movement done.
MOV-07 Different Dice	Should not be included as its differences are not significant in the model's abstraction level
MOV-08 Drift	Should not be included as its differences are not significant in the model's abstraction level
MOV-09 Impulse	Should not be included as its differences are not significant in the model's abstraction level
MOV-10 Programmed Movement	Should not be included as it is only an implementation of Action Programming
MOV-11 Relative Position	Should not be included as its differences are not significant in the model's abstraction level
MOV-12 Mancala	Should be included as an specification of movement
MOV-13 Chaining	Should not be included as its differences are not significant in the model's abstraction level
MOV-14 Bias	Should not be included as it is only an implementation of Movement

MOV-15 Moving Multiple Units	Should not be included as its differences are not significant in the model's abstraction level
MOV-16 Map Addition	Should not be included as its differences are not significant in the model's abstraction level
MOV-17 Map Reduction	Should not be included as its differences are not significant in the model's abstraction level
MOV-18 Map Deformation	Should not be included as its differences are not significant in the model's abstraction level
MOV-19 Move Through Deck	Should not be included as its differences are not significant in the model's abstraction level
MOV-20 Movement Template	Should not be included as it is only an implementation of Measurement
MOV-21 Pieces as Map	Should not be included as its differences are not significant in the model's abstraction level
MOV-22 Multiple Maps	Should not be included as its differences are not significant in the model's abstraction level
MOV-23 Shortcuts	Should not be included as its differences are not significant in the model's abstraction level
MOV-24 Hidden Movement	Should be included as an specification of Movement
ARC-01 Absolute Control	Should not be included as it is only an implementation of Area Control
ARC-02 Area Majority/Influence	Should not be included as it is only an implementation of Area Control
ARC-03 Troop Types	Should not be included as its differences are not significant in the model's abstraction level
ARC-04 Territories and Regions	Should not be included as it is only an implementation of Areas

ARC-05 Area Parameters	Should not be included as it is only an implementation of Areas
ARC-06 Force Projection	Should be included as a dynamic
ARC-07 Zone of Control	Should not be included as its differences are not significant in the model's abstraction level
ARC-08 Line of Sight	Should not be included as its differences are not significant in the model's abstraction level
SET-01 Set Valuation	Should not be included as its only a specific attribute of Set Collection
SET-02 Tile-Laying	Already as Tile Placement
SET-03 Grid Coverage	Should be included as an specification of Tile Placement
SET-04 Network Building	Already included as Network Building
SET-05 Combo Abilities	Already included as the dynamic Combo
CAR-01 Trick Taking	Already included as Trick-Taking
CAR-02 Ladder Climbing	Should be included as an specification of Action
CAR-03 Melding and Splaying	Should not be included as its differences are not significant in the model's abstraction level
CAR-04 Card Draw, Limits and Deck Exhaustion	Should not be included as it is only specific attributes of the Card and Deck mechanics
CAR-05 Deck Building	Already included as Deck-Building
CAR-06 Drafting	Already included as Draft