Describing Games

An Interaction-Centric Structural Framework

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ABSTRACT
We present a structural framework to describe games in terms of components. The components are divided into four major areas: meta-structure, bounding, narrative and objective. The framework is developed to be used in conjunction with *game design patterns*, descriptions of patterns of interaction relevant to game play. We describe the development of the framework and how it relates to patterns.

Keywords
Game Design, Patterns, Taxonomies, Game Models

Introduction
Even though games and playing are, and have been, ubiquitous in human culture there has been surprisingly little academic and theoretical interest in the basic components of the games humans play. The branch of mathematics, game theory [29], has approached this by simplifying[1] the definition of game to such extent that it renders the theory to be of little use in the actual design and analysis of more (socially) complex games. In cultural and media studies, play theory, anthropology, history, psychology, and narratology (see, for example, [2, 5, 10, 17, 19, 23, 28, 30, 31]) there has been work aiming at dissecting games but the results have mainly been typologies, genre distinctions, "best practices" guides or descriptions of the phenomena with limited use for the practitioner. The most robust research done has been in the emerging area of game studies, ludology (c.f. [11, 12, 13, 15, 18]), and by few theoretically inclined practitioners (c.f. [6, 7, 8, 14, 16, 24, 26, 27, 32]) where the focus really has been on understanding the invariant properties of games. Still, the current models seemed to be unsatisfactory for purposes to aid design, analysis and comparison of different kinds of games.

Taking off from this problem situation we set out to create a unified structural framework describing the basic elements of games, which are invariant, and important, from the design point of view. The reasoning behind this design oriented approach is that we believe that a theoretical tool which is able to aid the creation of games is going to be useful also in classification and

[1] If one can be said to be simplifying when transforming game play into mathematical models, theories and formulas.

analysis, and thus be able to function as a bridge between the two communities. Our work consists of two layers: design patterns (described in a companion paper [4]) and the structural framework itself. The difference between the two is that the design patterns are higher level, hierarchical conceptual models of the possible designs of games which manifest themselves in the structural framework by defining the logical, physical and temporal relations of the elements in the framework.

The framework focuses on the interaction between players and the game itself. Elements and components required for the analysis of interaction within the game are, in our opinion, way more invariant than the themes, characterization, narration or audio-visual style of games and thus they are explicitly left out from this treatise. Also, the difference between playing a game and free-form playing is addressed in such way that we describe play environments involving explicit rules and goals, i.e. games in quite strict definition. Some other forms of play than strict games may also be analyzed using the framework (e.g. free play as described in [25]) but we do not discuss this further in the paper.

This paper describes the basic elements of the framework and their relationships to each other, that is, the elements involved in 1) gaming as an activity as a whole, 2) an activity that can voluntarily be entered or left, 3) a temporal sequence of events and action, and 4) activity consisting of physical and logical components, as classified to the groups holistic, bounding, temporal and objective. The background and related work are briefly discussed as is the conceptual development of our twofold model.

Development of our model

Our starting point for identifying a need for a structural framework came during work we did on exploring the new possibilities for games by using proximity sensors REF[3]. When moving from a technology-oriented research approach to a game-oriented approach after the completion of a project, we noticed the lack of literature describing formalized concepts for (computer) game development. This led us to initiate a project where we explored the feasibility of using the concept of game mechanics as a design tool [20REF]. In parallel, a number of board game designers and computer game designers were interviewed about their craft; how they worked, their familiarity and use of mechanics etc. This provided a basis for looking more generally on how to describe games in terms of interaction [REF21]. Game mechanics were found not to fill all the requirements to support design (e.g. describing solutions without the problem and not relating to other game mechanics) which resulted in a branch of research into game design patterns based on the interaction in games.

However, these design patterns require a medium to emerge in and this prompted a separate investigation on how to describe games as instances of components within a structured framework. This, in one sense object-oriented approach, companion model would then serve to describe what the game design patterns emerged from and how the affected gameplay.

The development of game design patterns and the structural framework thus occurred in parallel, with some concepts moving between being patterns to being parts of the framework. To develop the models, we conducted a number of workshops and experimental game design session to collect empirical data, as well as analytic sessions where individual games were

examined or the current components of the models tested through thought experiments.

Definition of Game

Our goal with developing a structural framework was not to explicitly define what a game is but rather to identify the elements commonly found in what is consensually agreed upon as being games. However, previous definitions of games can help to identify the candidates for those elements.

Definitions of the word game found in dictionaries [REF22] show a variety of uses ("activity engaged in for diversion or amusement", "a procedure or strategy for gaining an end", "a physical or mental competition conducted according to rules with the participants in direct opposition to each other", and "any activity undertaken or regarded as a contest involving rivalry, strategy, or struggle; the course or period of such an activity", "area of expertise", "animals under pursuit or taken in hunting"). Further, game is sometimes used for concepts that are parts or meta structures of games proper ("a division of a larger contest", "the number of points necessary to win", and "organized athletics"), even leading to recursive definitions ("the set of rules governing a game", "a particular aspect or phase of play in a game or sport"). The large set of definitions makes it difficult to base a framework on any specific definition and not omit essential components. However, the definitions show an emphasis on an activity involving interaction, participants with conflicting goals, and formalized ways of achieving those goals.

Among the earliest formal study of games (excluding their use in, and inspiration of, probability and statistics) is found in the mathematically-oriented field of game theory. To describe games so they could be quantitative be analyzed, both a simplified and complete concept of a game was introduced in the seminal book, Theory of Games and Economic Behavior [REF29]. The simplified concept (which is the one of interest to non-mathematical areas) distinguishes between a *game*, the totality of the rules which describe it, and a *play* which is a particular instance at which the game is played. In a similar pattern, a *move* is defined as "the occasion of a choice between various alternatives, to be made either by one of the players, or by some device subject to chance, under conditions precisely prescribed by the rules of the game" while "[t]he specific alternative chosen in a concrete instance […] is the *choice*". The third distinction the make is between the *rules* of the games and the *strategies* of the players. The concept is then further developed with the introduction of technical terms such as preliminarity and anteriority to be able to analyzed different forms of transitivity in game play as well as allowing multi-player games to be simplified to two-player games and discuss the need for *direct signaling* (trying to convert correct information) and *inverted signaling* (trying to spread disinformation) between players. While game theory has contributed many concepts to the understanding of games, its foci upon mechanizing game play and mathematically finding optimal game strategies limits it from describing the actual activity of people playing games beyond what can be done through quantitative values and equations. Specifically, they do not mention the physical and logical components which facilitate the choices, information signaling and thematic setting of a game except in examples.

Parlett [REF23] differentiates between informal, which he exemplifies by the rough and tumble of children and puppies, and formal games, which has explicit ends and means. Games are a contest based around the completion of an end "and to achieve that object is to win" and "a formal game, by

definition, has a winner." The games have "an agreed set of equipment" which is manipulated by the rules but notes that the equipment does not have to be physical objects specifically designed for games, giving "player's organ of speech and a vocabulary of indefinite size" as an example for word-games. However, Parlett stresses the importance of rules stating: "'Every game *is* its rules', for they are what define it."

Chris Crawford [REF8] defines a game as "a closed formal system that subjectively represents a subset of reality". The use of closed indicates that the game should not require references to objects outside the game while formal denotes that the game has explicit rules (he does not, however, state that all rules need to be explicit). In addition to the definition, the element of conflict is deemed an intrinsic element of games but with a safety barrier thus "providing the psychological experiences of conflict and danger while excluding their physical realizations." Comparing games to other forms of representations of reality, Crawford stresses interaction as states "the highest and most complete form of representation is interactive representation. Games provide this interactive element, and it is a crucial factor in their appeal."

Costikyan [REF7] defines games as "[a]n interactive structure of endogenous meaning that requires players to struggle toward a goal". The use of endogenous meaning contributes the observation that a game "*creates its own meanings*". The objects used in a game receive a meaning (regardless of if they had it before) by the role they play within the context of the game activity.

Looking at multiplayer games, Zagal et al [REF33] use a simple model of a game which include components, Rules & Goals and Props & Tools, that define a game concept and are immutable between what they call *game instances*, which is a game in progress and include players. Focusing on social interaction, they introduce the distinction between *stimulated* (required by the game) and *spontaneous* (voluntary) interaction

Conceptual Model

From an early point in our research, we concluded that the physical and logical components of a game would not enough to describe a game satisfactory; a description of a game requires the (imagined) interaction between players or between players and the physical components of a game. A comparison can be made with computer code written to create a user interface, an omission of users and perceived activities they do would severely restrict the clarity of a description.

Thus, we wished to create a model that could describe games as an activity. The study of activities is unusually confined to the fields of ethnography and anthropology but as a rule-based activity, games have explicit requirements and more clear-cut boundaries than other activities, allowing the study of them without requiring the methods from these fields. This is not to say that these methods would not inform us but that the explicit formality of games makes it possible to study the activity in a detailed way without observing people conducting the activity, making it easier to focus on the activity instead of the people. This distinction is important as games unlike many other activities are *designed* and as such should be able to be treated as an objective material that can be shaped by the designer.

Looking at the survey of the definitions, the components identified can be placed in four different categories that describe different aspects of the activity: those that describe the overall activity (game, play, and interactive

representations), those that describe the meaning of the activity and what is allowed within the activity (rules, endogenous meanings, goals, and strategies), those that describe the unfolding of the activity (moves and choices), and by implication physical and logical objects (signaling and equipment) that maintain the game state or provide functionality such as randomizing, score-keeping or time-keeping.

A twofold model

As mentioned earlier, the importance we perceived interaction to have in games led us to a giving the descriptions of different interactions, and their relations, a paramount role. Thus, the interaction part of our model, for which we use *game design patterns*, is in principle a model of its own based on earlier uses of design patterns [1, 9REFREF]. Due to space constraints we do not describe the characteristics of game design patterns in this paper but refer the reader to the companion paper to this paper [REF4].

This division led to certain concepts falling between the two models, most noteworthy the previously mentioned game mechanics. This concept is widely used (see [20] for a REFmore detailed discussion) but usually informally defined as "[p]art of a game's rule system that covers one general or specific aspect of the game." However, there has been recently academic work to formalize the notion where "[g]ame mechanics is a functional game feature that describes one possible or preferred or encouraged means with which the player can interact with game elements as she is trying to influence the game state at hand. The practical realization of a game mechanics is a sequential combination of game elements which starts from a player procedure and is conducted via a direct or indirect interface to the game." [REF13]

Game mechanics are heavily depended on rules as "there can not be mechanics without rules, i.e. without prescribed game element relations." [REF13] but also have a close relationship to design patterns where "… mechanics present the particular means in a particular game that bring to realization the implementation of a particular design pattern. … taking a turn is an implementation of 'turn-based action' pattern, but the available means to play the game within that turn constitute the game's mechanics." [REF13]

An Interaction-Centric Structural framework of Games

The structural framework was developed from an initial analysis of how the terms used to describe games. This framework was expanded and refined by examining the relationship between the terms as well as try to use the structural framework to describe games and interaction in games.

The concepts used in the framework are basic "building blocks" of games. They have been selected on the basis of being clearly identified in archetypical games, not being overlapping and by having a natural relationship with other identified concepts. We do not claim that all concepts are present in all possible games nor do we claim that this model is the optimal framework to describe all games. Even though the components themselves may seem obvious, or even trivial, study of the realization of them within games can provide an analysis of a game on several levels which are connected through the relations we have identified between the concepts.

To structure the relationship between the concepts we have categorized the concepts into four groups. Reflecting views on 1) gaming as an activity as a whole, 2) an activity that can voluntarily be entered or left, 3) a temporal sequence of events and action, and 4) activity consisting of physical and

logical components, we classified the groups as *holistic*, *bounding*, *temporal*, and *objective*.

Holistic components

Given a definition of what is required for an activity to be a game, we can then proceed to explore concepts treating the game as one holistic entity. The concepts help defining the difference from other activities and their descriptions for specific games are linked to how players can join the game and the end conditions for the game.

Game instance

The first trivial observation is that every time a game is played it is unlike previous times the game has been played, either in the constitution of players, place where the game is played, external requirements such as limit playing time, or the experience of players. So although the game doesn't change the specifics of a single completion of game play does. We define this as a *game instance*.

Game session

Our definition of game instances is similar to Zagal et al [REF33] with the exception that we do not include a temporal aspect. We do not include this as games do not have to be studied from the perspective of objects primarily defined by their narrative structure (other perspectives could for example be game theoretical game strategy analyses or expression of culture). However, time clearly has a critical part to play when describing games, both in that it is required to allow interaction and that many games (especially computer games) have a narrative structure. Thus, we define *game session* as the activity defined by the time spent on playing a game instance. The actual time that a game session spans varies greatly between games. In the case of Paper-Rock-Scissors it is only a couple of seconds, in most board games a couple of hours while massively multiplayer online games have game sessions which only end when servers are shut down due to lost interest in the game from players.

We avoid the von Neumann and Morgenstern's REF[29] term play, which they define similar to our use of game session due to avoid confusion with the other uses of play and our own use of play session below.

Play session

The completion of a game session can be divided between several distinct periods of game play activity, *play sessions*, that typically last much shorter periods of time than the time between them. For example, complex tabletop board games can require many hours to complete and to find the required time players usually divide this time into play sessions lasting a couple of hours that are played over a period of several weeks. Play sessions are tightly coupled to players but do not have to be tied to all players. Play-by-mail games, for example, have separate play sessions for each player that are only related by the requirement to synchronize game play. Massively multiplayer online games have a multitude of play sessions ongoing simultaneously that start, merge, separate and disappear depending on players activities.

Bounding components

The holistic components describe how the activity of game play relates to other activities. Bounding components are the components that define when or what is required to redefine the activity taking place.

Rules

Rules dictate the flow of the game. In the framework the rules are embedded in every other component so that there are rules that govern what game

elements there are, how they behave, what are the player actions and so on. Rules can be *endogenous*, be explicitly stated as being part of the game, or *exogenous*, not being formally inscribed (or enforceable) within the game. Typical examples of exogenous rules are so-called house rules (regarding computer games) or rules regarding end conditions.

Breaking rules openly end game activities, or at least requires reformulation of them to exclude the rule breaker. Doing so secretly, or cheating, requires that the other players to detect the faulty behavior. As stated by [REF10] the cheater is not the one who make the activity of playing impossible; it is the person who refused to follow the rules.

Modes of play

Games are typically structured to different sections, phases or turns where the interface, available actions and information for the player changes dramatically. We call these as different *modes of play*, which can be seen as constructs to define boundaries between activities within the larger activity of playing a particular game. Typical examples switches of mode of play are the transition from a map view to an inventory screen in a computer role-playing game or turn taking in Chess.

How many modes of play a game has depends on the level of detail used to define the states a game can have. Chess can be said to have two modes (either its one players turn or the other players turn) or as many as there are combinations of locations the pieces can have.

Goals and Subgoals

The aim of players' plans and actions in a game are to complete *goals*, which can vary between players. Further, one player can have several goal that do not have to be related. For example, some games have several goals where progress in completing one goal makes it difficult to complete another goal. Note that the some games, for example space invader or Pacman, do not allow players to have the goal of being the winner (in Parlett's sense) as the game does not have a winning condition.

Similar to rules, goals can be endogenous or exogenous. The most typical kind of goal in games is endogenous, e.g. checkmate the opponent's king, occupy the largest amount of the game area, be the first to reach a certain point, or have the highest score. Exogenous goals are those goals brought to the game activity to give it meaning or increase the motivation for playing. Examples of games that require exogenous goals are role-playing games and computer simulation games such as the Sims or Sim City. Further, the game of poker can be said to have exogenous as well as endogenous goals due to that fact that the tokens used to play typically have an exogenous monetary value.

Goals in more complex games are often split into smaller *subgoals*, either to structure the game play (into levels or narrative structures) or to make the completion of the goal easier to achieve (acquire new powers or tools, reducing opposition, etc.). The existence of subgoals to a goal can be predefined by the game or be created implicitly by players. In the latter case, the creation of subgoals that ease the completion of the main goal can be seen as an indication of a player's skill.

Temporal components

The temporal components are those that are used to record the activity of playing a game. As such, the components either define the larger game play activity into temporally separated activities or the boundaries between those activities.

Actions

Players can only change the game state by performing actions. Actions available for the player typically change according to the current game state and mode of play. Depending on the game model, actions can *continuous*, being temporally defined by measure game time, or *discrete*, being temporally defined by its relation to other actions. Game time is here defined as that which is differentiable when comparing the same actions in different game sessions of the same game. Thus, chess has discrete actions as the outcome does not change between two games which are played with exactly the same moves but take different amount of time to play. A computer racing game has continuous actions as a difference in time to complete the game is a change in the outcome. Generally, games that allow player to perform actions at all times have continuous actions.

Beyond updating the game state, actions can be used to communicate non-public values in the game state or the player's strategy. This communication can be done direct or inverted signaling with the addition of the variant *indirect* (trying to convey correct information implicitly).

A special case of actions are those which do not update the game state but still are handled by the game system as other actions (they can be compared to the "no operation" command in computer assembly languages). A typical use of these is messaging between players in online games, actions that do not affect the game state but allow players to spread information.

Events

Events are the discrete points in the game play where the game state changes. The most typical events occur due to the completion of players' actions, which in the case of discrete actions are integrally connected to events. However, games can trigger events without player intervention, most commonly in computer games but also possible through mechanical means such as hourglasses.

The definition of an event does not specifically have to state how the game state changes. Rolling a die in monopoly triggers the state change in which a player moves his piece to a new place, but the event does not specify which place. Determining this, as similar events where the change is not known a priori, is controlled by evaluation functions (described below).

Closures

The completion of a goal or subgoal results in a *closure*, a change of game state that is clearly perceived as a semantically meaningful transition by players (typically by a switch of mode of play). Closures also occur when players clearly have reached a point where a goal is not longer achievable or by deterministic game events (e.g. emptying a drawing stack in a card game or the completion of a bidding round in poker).

End conditions

End conditions specify the game state of when a closure occurs. The paramount end condition of a game is, of course, that which defined when the game session ends. End conditions are usually accompanied with an evaluation function. End conditions do not necessarily have an isomorphic mapping to the goals in a game. Typical examples of when this is not the case are role-playing games or online first-person shooters games.

Evaluation functions

Evaluation function determines the outcome of an event. A typical evaluation function is the one used to determine the winner of a game at the end of a

game session. A similar evaluation function, also known as the winning condition, is the condition which determines the winner and *causes* the end of the game session. Thus, closures can cause evaluation functions to be determined which can in turn cause new closures. Scoring mechanisms in games are also examples of the use of evaluation functions.

Objective components

This category includes the concepts that are used to describe a game without taking temporal or contextual aspects into consideration, i.e. without looking upon it as an activity.

Players

An important observation concerning players is that they do not necessarily have to be human beings. Thus, we define players as the logical components that perform actions, can be interpreted as having strategies and goals, and can enter and leave the game. For example, in a single player strategy game the opponents controlled by the computer can be viewed as other players.

Normally the player is manifested in the game by a specific game component, avatar, such as Lara Croft in Tomb Raider series. However, as is most apparent in online board game lounges, players may have as little identity, besides the actions performed, as nothing more than name.

Interface

The player has access to the game through an interface. Game components are represented in the interface as tokens which come in different types and forms and have wide variety of different modes of manipulation depending on the game type. Board games have counters, pieces and boards; card games, obviously, have cards as tokens; digital games have digital representation of similar tokens as well as an audiovisual look and are manipulated by keyboard, mouse or other accessories. In other words the look and feel of the game is specified by the interface.

Game components

Game components are the physical and logical components of games that help maintain and inform players about the current game state. Normally the attributes also contain relationships to other game components thus creating game component configurations. These relationships can be game components themselves. The state of the game is the totality of the game component configuration at one given time. Changing the game component means that at least one of its attributes changes. To exemplify, game components can function in the game as:

1. tokens that represent players (i.e. avatars)
2. tokens that define the actions available to players (avatars, chess pieces or cards)
3. tokens or collection of tokens to enable evaluation functions (dice, cards stacks that have been shuffled)
4. tokens that represent non-player agents (e.g. the ghosts in Pac-Man or NPCs in RPGs)
5. physical and logical elements that spatially describe the game space (chess squares, both the cards and the emergent city walls, rivers, and road in Carcassone)
6. components representing specific values of the overall game state (time left in Counter-Strike or in time-limited chess games)

7. components of the game that convey intra-game information (signs in Zelda)
8. components of the game that convey extra-game information (such as the rules of the game)
9. non-interactive components that define the boundaries of the game space and convey theme and atmosphere through graphics or audio (backgrounds and textures in computer games, game boards)

This list is both non-exhaustive and overlapping; for example, the dice in monopoly both defines the action available (roll them) and are used to determine the random amount of steps to move.

Components have attribute structures (e.g. color, value, hit points, level) and action structures (e.g. move, press, turn) connected to them which have individual relationships to each player. Attribute relationships span a *known – unknown* scale while action relationships are spanned by two dimensions: *known – unknown* and *permitted – prohibited*.

Unknown attribute relationships are most common in games that have evaluation function depending on the attributes of several game components. For example, poker is a game where the play is based upon the imperfect information available about the other players' hand.

In Chess, the white player has a known and prohibited action relationship to the black player's pieces as the possible actions performed by the pieces are known but immutable. However, components can change between mutable and immutable during the course of a game as a component's actions can have requirements which depend on other elements in the game, e.g. it is not possible to move rooks in the beginning of Chess. Similarly, Stratego starts with the actions of the other player's pieces being unknown and prohibited. Further, manipulation of components may be possible by proxy, e.g. the player needs bombs in order to clear the boulders in Zelda.

DISCUSSION

The structural framework presented here tries to incorporate concepts existing from as many types of games as possible. As such it is restricted to a certain level of abstractness to limit the amount of concepts. However, we have identified areas, such as classifying game components more fully, which can be developed further on a general level without becoming specific to individual games or physical representations of game components.

The work presented in this article and the companion paper was developed with the focus of describing the components that together make a game and creating a language for talking about the design of interaction within game. Due to these two aims, two partially distinct models emerged. These models are interdependent in the sense that parts from one model can be used to describe, exemplify or analysis parts of the other although this is not necessary.

We believe that for many practical uses the two parts can be used without reference to the other. For example, the design patterns can be used without regard to the structural framework in early concept development while the structural framework can be used to create an object-oriented model for a computer implementation of a game. Further, if game design patterns were to be applied on free play activities [REF25], the structural framework would need to be replaced by a model reflecting the low-level characteristics of that activity.

The loose coupling between the models actually allows one model to be replaced with one more simple or more complex or functionally different depending on the intended use. The prime methods for developing the models were structural and functional analysis of existing games, taxonomical categorization of concepts identified, and experimental design which we believe are reflected in the models. The components of the model would have been different if the focus, both of intended use of the models and the methods used to create them, would have been different. For example, if ethnographical studies of people playing games would have been in focus the narrative category in our framework would have benefited from a concept such as Järvinen's use of game mechanics [REF13].

ACKNOWLEDGMENTS & CONTACT

We thank our collaborators Sus Lundgren and Tobias Rydenhag as well as Bernd Kreimeier and Aki Järvinen for valuable discussions.

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