Recognition and extraction of game patterns from text supported by interactive learning from board game instructions

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Abstract. Discovering and describing patterns is a process of manual work driven by experience. In many domains, these patterns are embedded in a rich set of documentation written in natural language. When humans extract information from text, they can exploit knowledge about the components typical for a genre. This work aims to close this gap between domain experts of board games searching for game patterns and machine learning by using the computer not only as a tool but as a companion system. In particular, an interactive learning companion system for the development of a hierarchical game pattern language on the basis of empirical evidence. In general, the results can be adapted to search for semantic concepts of any domain.

Keywords: pattern, machine learning, game design, companion system, interactive learning, entity extraction.

1 Introduction

In general patterns are not invented, but are already contained in the artifacts and must be found [1]. Unfortunately, this work requires a priori both methodical expertise in the process of pattern description as well as a deepened knowledge of the domain itself. Knowledge of the domain is necessary because knowledge can rarely be written down completely explicitly, but is only supplemented in combination with implicit knowledge from personal experience and background information [2].

While working on the project of "Empirical Analysis of Motivating Game Elements" (EMPAMOS) [3] to extract game design patterns based on board game instructions, the problem above arose. Finding text passages with semantically similar meaning in a large body of game instructions despite syntactically different formulations. But new pattern hypothesis can only be established and empirically proven or disproved based on the previous knowledge of game domain experts and with research on existing artefacts. Research is a time-consuming process, since e.g. in EMPAMOS the data set with more than 30.000 game instructions [4] is large and new entries are added every year. The patterns to be discovered are distributed over the entire data set or are only availa-

ble in subsets. Whether and where interesting patterns can be found in texts can therefore today only be decided with certainty by experts and specialists in a particular field. It is therefore tedious and difficult to delegate the search for new patterns and their formulation to untrained personnel, since implicit domain knowledge is required for this.

The search for empirical evidence for an already formulated hypothesis is complex, but can be automated. Possible applications are e.g. machine learning (ML) methods [5], which are able to search for sample records. Before this automation can take place, a pattern hypothesis is formulated and a classification model is constructed that recognize wanted semantic concepts. This requires a training of algorithms to find the searched sample evidences [5] or the evaluation of the results from unsupervised learning processes for patterns. The effort for training the algorithms can be equated with the effort required to train personnel.

Although the effort to discover patterns is high, once identified and described they contribute to a deeper understanding of the domain [6]. There are examples for the successful use of patterns in architecture [7] and software development [8]. Structures are revealed in an abstract form and open up a new access to the knowledge of the domain. Patterns are therefore also suitable for documenting and passing on existing knowledge and supporting the development of new, standardisable approaches by constantly recombining them and adapting them to the respective context [9]. Concrete application cases for game pattern can be found for game developer and publisher to analyze, compare and describe games. One step further game patterns can be used to construct systems to propose new game concepts or as base for General Game Playing (GGP) [10].

2 Research Question

The goal of this research is to explore the use of machine learning techniques to support game domain experts during the research and development of game related patterns. Specifically, this work aims to address the following questions:

1. How can interesting game pattern of different granularity in texts be automatically identified and described?
2. How can human tell the machine which semantic concepts are of interest to him?
3. How can the machine tell human why a semantic concept might be interesting?

Answers to these questions are required to find a solution for an incremental interactive learning system. These form the building blocks for an artificial companion which is able to take the role as a virtual domain expert at the side of man. This would allow a researcher in the domain of game patterns without deep knowledge of machine learning to prove and disprove made hypothesis.

3 Related Work

For this project a number of subtasks have to be solved, for which there are already partial solutions. However, up to now there is a lack of combination and integration of all components to enable researchers to discover game pattern without own knowledge of or support from specialized machine learning specialists.

Research has already been done in the field of game design patterns to develop extensive collections of patterns e.g. [11][12]. These works already define a rich set of game design elements but lacking the support of processing and discovering new patterns and structures.

There is a special topic in the field of artificial intelligence called General Game Playing which also provides a game description language [10]. This allows to describe a game in a way that it can be played by computer but is so far not suitable to describe all kind of games.

Classical machine learning requires too much technical knowledge for which with interactive learning [13] a solution already was proposed. For research questions 2 and 3 in particular, interactive learning may contribute to a solution. This approach is currently also the subject of active research [14].

For the task of natural language data mining exists a broad range of established procedures and toolkits [15][16]. These are being used in the field of digital humanities [17] and combined to ready to use research platforms [18]. The research platforms lack the support for the specialized task of interactive learning of game pattern. The lower level processing frameworks are ready to be used in applications but deeper knowledge in machine learning is required to do so.

To enable a system that adapts to the needs of its operating personnel, there is a paradigm of the companion system [19]. Since a Companion system is very special for the respective application (like already seen at digital humanities platform above) because it has components that represent domain-specific knowledge, there are no systems yet for supporting game pattern mining. However, there are studies on the basic structure and required components [20].

4 Approach

The research project will be carried out in cooperation with the project EMPAMOS [3]. For this project, the board game instructions were viewed manually by students of computer science and experts for game patterns according to new patterns and empirical evidence for already known or proposed patterns. Over the last three years, 106 typical game patterns and for these a total of more than 40.000 pattern evidences are documented by EMPAMOS.

The Ph.D. project will be done in parallel to EMPAMOS. The planned process is shown in **Fig. 1**. The three main phases are described below.

- **Phase 1:** Required algorithm and processes are determined by literature research. The existing data of EMPAMOS can be analyzed. This includes the manually found

patterns as well as already annotated evidences from game instructions. It is therefore possible to start with hand-picked and trustworthy data. Taking these results into account a better choice of suitable algorithm and data structures can be made. Based on the experiences of existing data requirements for pattern description and relations can be set up. Also, a base ontology of structures and game pattern that can be used in the following steps is des.

- **Phase 2:** A processing system architecture will be determined based on state-of-the-art techniques. It shall use the base ontology from phase one as part of a starting knowledge model [21] for the companion system. From this point the system shall be able to apply the basic knowledge on given board game instructions and identify already known patterns. This shall be the foundation on top of it the research work will take place.
- **Phase 3:** In the final phase the system shall become able to determine patterns by its own. In an incremental process of learning with interaction with a human expert the system knowledge shall be modified and extended until it is able to detect and propose game pattern. This is also the phase in which the research work is done and the research questions will be answered.

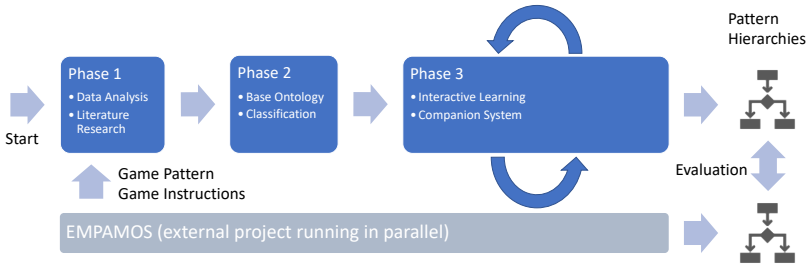

Fig. 1. Planned Ph.D. research process and evaluation

For evaluating the proposed game pattern from the interactive learning system, the knowledge of human domain experts from EMPAMOS can be consulted. Since the EMPAMOS project is continued in parallel to the Ph.D. project there will be a reference game pattern language made by humans, too.

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