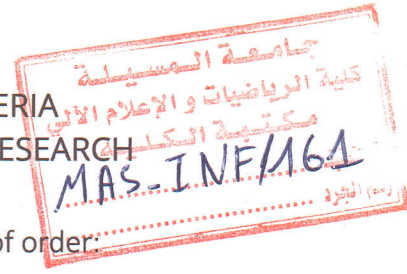


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SUBJECT

**DIHYA, AN INTELLIGENT LEARNING
OBJECTS REPOSITORY**

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GENERAL INTRODUCTION

We are living in a modern digitized world and getting through one of the most extraordinary transformations in human history, where the humans' imagination is unleashing innovations in technology that were previously unimaginable and brought to us possibilities of interactivity, collaboration and creativity. One of them, "E-Learning". This emerging technology which is based on the supply of educational content through educational scenarios in a digital environment has spawned the creation of small, still reusable educational grains of information that teachers can use while designing their courses and therefore share with others. Thereupon, storing and sharing, eliminates the redundancy and the need to recreate what already exists. These digital chunks of information take on many forms: text, video, graphics, and multimedia, etc. and include tutorials, simulations, experimentations and assessments. The accepted term for these small units of learning is Learning Objects (LOs). To enable their accessibility, reusability, generativity, shareability, durability, and scalability, metadata standards and Learning Objects Repositories (LORs) are being developed.

PROBLEMATIC

In recent years, major efforts have been devoted to establish standards and norms to solve many problems of description, indexing and classification of information, that of processes and services and the best way to recommend them to a given entity. The education community has not escaped this tendency since the dramatic increase in LOs has necessitated the development of Metadata standards as well as proper LORs to facilitate the storing and retrieval of these resources. However, theoretical usability analysis show that LORs are still in an immature stage which is reflected in the low level of support to the user. So what if a repository would not be only a database to store LOs, and improve their modularity, discoverability and interoperability, but also allow LOs to adapt themselves to learners' historical background and learning styles, following the learning goals?

MOTIVATION AND AIM

Such mentioned complex technologies entails an extensive research and provides the motivation towards writing this Dissertation. Therefore, the aim of this study was firstly to clear the air on LOs, LORs and the standards used for improving their features, by providing an unbiased and independent outlook of these technologies. Secondly, to develop a Learning Object Repository for computer science educational institutions at first glance, in order to facilitate the accessibility to different Learning Objects and therefore, enhance their reusability, interoperability, while taking advantage of their granularity/aggregation features. This LOR will give teachers the possibility to design courses that may include one or many LOs, second, the courses that depend on each other are linked together as nodes to form a graph that represents the global learning experience. Finally, it is to integrate a recommendation system which recommends to students the best paths to follow during a learning experience using the multi-agents approach where the recommender agent uses the A star pathfinding technique while taking into consideration the course learning goals, students behavior patterns and their academic standing.

We have chosen Django framework for the repository's development and Spade for Python to implement the agents, because of many reasons mentioned in the fifth chapter of this dissertation, I specify:

- My Python programming skills.
- Django framework is free and open source with many features, especially for being fast, secure, scalable and versatile and the diversity of its packages
- The documentation is rich and the multitude of Developers communities is high everything is well documented on the <https://docs.djangoproject.com/en/1.8/> site.

This dissertation is to be structured into two distinct parts and five chapters:

1. Part one: Bibliographical Study

- **Chapter I: State of the Art**—this chapter represents the state of art where we will try to "demystify" the concept "learning object", what are the metaphors used to

facilitate its understanding together with its main characteristics. The concept of metadata will also be thorough

- **Chapter II: Metadata Standards and Learning Objects Repositories** — we will discuss in this chapter the best known standards and norms for metadata description that we have handled in our work and then we take a deep look into Learning Objects Repositories.
- **Chapter III: The Intelligent Learning Objects paradigm** — we will first present the multi-agent systems approach, its characteristics along with its structure. Next, we will try to clear the air on Intelligent Learning Objects (ILO) paradigm, and how integrating the MAS and the LOs improves the interoperability among latter and adds an intelligent behavior to LORs

2. Part two: Conceptual Study

- **Chapter VI: Design and Analysis of Dihya** — this chapter focuses on the design process of the “Dihya” Learning Object Repository, which allow us to have a general preview of the Repository’s functionalities and a deep understanding of its goals, tasks, and requirements.
- **Chapter V: Implementation of Dihya** — in this chapter, we talk about the implementation of Dihya and the technologies used to implement it. Next, we present the various tools and application components implemented. Then we present the configuration and installation process to follow before describing using a few screenshots how to handle the platform and the mechanism used to perform different tasks.

GENERAL CONCLUSION

In this study, our principal aim was to clear the air on Learning Objects and Learning Objects Repositories with the metadata standards associated to them, by providing an unbiased and independent outlook of the technology and to develop a discipline specific LOR for computer science educational institutions, therefore to integrate a Recommendation System based on the agents paradigm and Intelligent Learning Objects in order to recommend content based on students behavior patterns and their academic grades.

First, I have gone through the bibliographical study by presenting the state of the art in Learning Objects and LO Repositories, by presenting their features, functionalities and their meta-tagging norms in the first two chapters. Second, in the third chapter, I explained how merging these concepts with the MAS paradigm will improve their limitations and therefore convert them to intelligent entities. Finally, in the fourth and fifth chapters, I presented my conceptual study, by describing the details in UML diagrams, and following the Prometheus methodology to analyze the agents with a detailed analysis to the repository and its different functions, then I explained the implementation and configuration processes of Dihya.

Among this study, I discovered that the Learning Objects have uncounted features, together with the Repositories hosting them, therefore, they are the most adequate solution for educational institutions to implement if merged with the agents paradigm in order to reuse and share the educational resources and to facilitate the learning process.

This dissertation has enabled me to gain a clearer view of the applications development on the Django framework and BDI agents' implementation in SPADE environment where I encountered many problems such:

- 1) SPADE fails to run in the virtualenv environment;
- 2) The BDI implementation has changed its interface in the versions 2.0 / 2.1 / 2.2 and parts of the documentation / test cases have not been updated;
- 3) SPADE relies on XMPP background messaging processes which is not really suitable to be integrated into a (blocking) multi-user execution on a Django web page;

- 4) Performance is limited as there is a large overhead in the integration of the concept data into SPADE;
- 5) Functionality is highly instable:
 - Sporadic fails to delete agents / services properly.
 - Segmentation faults in XMPP communication library leading to a complete crash of Django.
 - Adding unrelated services lead to simple test cases not functioning any more (s1 -> s2 -> target works, adding an unrelated s3 leads to no path found).
- 6) Spade is not actively developed / maintained anymore

Hence, I had to hack around in the SPADE source code in order to make it working, and then I come up with the idea of implementing the A star algorithm as an addition which did the job perfectly.

This dissertation also enabled me to understand the architecture of LO Repositories, their Metadata standards, and the types and characteristics of agents; with a better understanding of the Intelligent Learning Objects paradigm. Although several other concepts remain to be studied. It is therefore not the end.

FUTURE WORK

The very next steps to do is to ameliorate and improve the Dihya Repository by encapsulating many others technologies such as Mobile based learning. In addition, more functionalities will be studied and added and because we are expecting huge amounts of data in our repository in the future, "Big Data" will be my next ocean to explore.

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ملخص: يعتمد التعليم الإلكتروني على توفير المحتوى التعليمي من خلال سيناريوهات تعليمية في بيئة رقمية وهذا ما أدى إلى إنشاء كائنات التعلم القابلة لإعادة الاستخدام، التشغيل المتبادل والمشاركة، ويمكن الوصول إلى هذه الأخيرة عن طريق المستودعات الرقمية. على الرغم من العديد من الميزات فإن هذه المستودعات لا تزال في مرحلة نمو، و حتى يتم تطويرها والقضاء على القيود التي تحيط بها، يجب أن تصبح أكثر ذكاء وقابلة للتكيف وهنا يأتي دور الأنظمة متعددة الوكلاء. ينقسم هذا البحث إلى خمسة فصول، في الفصول الثلاثة الأولى مررنا عبر حالة كائنات التعلم، والمعايير المرتبطة بها، ثم المستودعات الخاصة بتخزينها، وكيفية إنشاء كائنات تعلم ذكية عن طريق دمجها مع الأنظمة المتعددة الوكلاء. وفي الفصلين الأخيرين، قدمنا تحليلا مفصلا عن هذا المستودع الذي ووظائفه المختلفة. كان هدفي الرئيسي إزالة الغموض المحيط بهذه التكنولوجيات، وذلك من خلال توفير وجهة نظر محايدة ومستقلة. وأخيرا، تطوير مستودع ذكي للكائنات التعليمية مخصص للمؤسسات التعليم الخاصة بالإعلام الألي التي تقترح المحتوى للطلاب بطريقة ذكية وفقا لأنماط سلوكهم وأدائهم الأكاديمي.

الكلمات المفتاحية: التعليم الإلكتروني، كائنات التعلم، مستودعات الكائنات التعليمية، الأنظمة متعددة الوكلاء، الذكاء الاصطناعي.

Abstract: E-Learning, which is based on the supply of educational content in a digital environment, has led to the creation of reusable, interoperable and shareable Learning Objects, accessible via the Learning Objects Repositories. Despite their many features, these LORs have some limitations. In order to eliminate them, these LORs need to become more intelligent and adaptive which is the role of Multi-Agents systems. This dissertation is divided into five chapters, we have gone through the state of art of LOs, and the Metadata standards associated with them, the LORs and the way to create Intelligent Learning Objects by merging the LOs and the agent paradigm; then we presented the conceptual study, with a detailed analysis of the repository and its different functions. My principal aim was to clear the air on these technologies, by providing an unbiased and independent outlook and to develop an Intelligent LOR dedicated to computer science educational institutions that recommends its content to students according to their behavior patterns and academic standing.

Keywords: E-Learning, Learning Objects, Learning Objects Repositories, Multi-agent systems, Intelligent Learning Objects, Recommender Systems, Artificial Intelligence.

Résumé : Le E-Learning qui est basé sur la fourniture de contenu éducatif dans un environnement numérique, a engendré la création des Objets Pédagogiques (OP) réutilisables, interopérables et partageables, qui sont accessibles via des entrepôts numériques. Malgré leurs nombreuses caractéristiques, ces entrepôts d'OPs présentent certaines limitations, afin de les éliminer, ces entrepôts doivent être plus adaptative, qui est le rôle des systèmes multi-agents. Ce mémoire est divisé en cinq chapitres, nous avons traversé l'état de l'art des objets pédagogiques, et les normes Metadata qui leur sont associées, les EOP et la façon de créer des OP intelligents en les fusionnant avec le paradigme des agents; puis nous avons présenté une analyse détaillée de notre plateforme et ses différentes fonctions. Notre but principal était de démystifier ces technologies, en fournissant une perspective impartiale et indépendante, et de développer un entrepôt intelligent des OPs dédié aux établissements d'enseignement de l'informatique et qui recommande le contenu aux étudiants en fonction de leurs modes de comportement et leurs résultats scolaires.

Mots clés : E-Learning, Objets Pédagogique, Entrepôts d'Objets Pédagogiques, Systèmes multi-agents, Objets Pédagogique Intelligents, Intelligence Artificielle.