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Experimentation of a smart learning system for law based on knowledge discovery and cognitive computing

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ABSTRACT

This work presents a Smart Learning system based on Knowledge Discovery and Cognitive Computing techniques aimed at citizens, legal students and experts alike, providing them with the possibility of submitting legal cases expressed in natural language and obtaining legal insight and advice in return. Advanced features implemented within the system include the automatic conceptualization and classification of textual legal cases via natural language processing, the generation of learning paths by relying upon legal ontologies, and additional features for managing legal knowledge bases, including editing, versioning, integration and enrichment. The system has been experimented on a diversified user-base and succeeded in obtaining a positive evaluation with respect to the aspects that were subject of the investigation, including effectiveness, efficiency and usability, thus paving the way to make the system a successful cognitive learning platform for future law professionals and knowledgeable citizens.

1. Introduction and related work

Intelligent Technologies and research results from the field of *Cognitive Computing*, over the course of the last decades, have steadily and progressively improved people's quality of life and work. Whereas a number of activities have been or are on the verge of being replaced by computer methods and technologies altogether, a wide range of professions have benefited from the latter and are augmented by them in terms of both effectiveness and efficiency.

The legal area, historically one of the least prone to adopt and use innovative technologies and solutions, is being tackled as well by systems able to perform the so-called *Alternative Dispute Resolution* processes, providing users with computational means to assess their individual cases and preliminarily explore their options before opting for a full-fledged legal action.

Systems like these should in principle find their usefulness not only for common citizens before turning to (or throughout their consultation with) human legal experts, but also for aspiring lawyers and students of law who are still honing their skills and competences and may be assisted in their studies and training. As such, these systems fall within the broader area of *Smart Learning*, with their aim to facilitate learning activities and improve their efficacy. Smart Learning systems are in fact technology-enhanced systems that on one hand enable users to interact with digital learning resources at any given time and place, and on the other hand provide them with supporting tools, suggestions and guidance to further improve the learning experience (Hwang, 2014).

More specifically, systems able to somewhat "understand" cases and needs expressed in natural language, and derive from them domain-specific hints, resources and knowledge are usually products from cutting edge research in the cognitive computing subfields of *Natural Language Processing* and *Knowledge Discovery*, also exploiting formalisms and techniques originating from the *Semantic Web* (Davies, Fensel, & van Harmelen, 2002) and representing dramatic enhancements for learners in a variety of subjects and fields. As a matter of fact, semantic methodologies and technologies have recently become prominent in *Technology-Enhanced Learning*, and a number of platforms using such techniques combined with ontologies have been proposed and implemented for fulfilling the needs of both academia and industry (Gaeta, Mangione, Miranda, & Orciuoli, 2013; Gaeta, Loia, Orciuoli, & Ritrovato, 2015; Miranda, Mangione, Orciuoli, Gaeta, & Loia, 2013; Capuano, Dell'Angelo, Orciuoli, Miranda, & Zurolo, 2009a; Capuano, Mangione, Pierri, & Salerno, 2014; Del Nostro, Orciuoli, Paolozzi, Ritrovato, & Toti, 2013b; Del Nostro, Gaeta, Paolozzi, Ritrovato, &

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0747-5632/

Toti, 2013a; Del Nostro, Orciuoli, Paolozzi, Ritrovato, & Toti, 2013c).

A number of proposals have tried to foster the use of semantic methodologies and technologies specifically in the legal area (Casanovas, Sartor, Casellas, & Rubino, 2008; Valente & Breuker, 1994; van Kralingen, 1997), but mainly targeting legal professionals, experts and lawyers. Examples of related recent approaches include Estrella (Rubino, Rotolo, & Sartor, 2006), HARNESS (van de Ven, Hoekstra, Breker, Wortel, & El-Ali, 2008), LOIS (Biasiotti, Sagri, & Tiscornia, 2005), DALOS (Francesconi & Tiscornia, 2008), MetaSearch (Ferrer, Rivero, & Garcìa, 2008), ICT4Law (Ajani et al., 2009) and Ontomedia (Poblet, Casanovas, & Cobo, 2010), most of them proposing and employing information resources in the form of specifically-designed ontologies. Approaches like these are however less fruitful for learners and common users, since the latter typically lack the specific knowledge required to get the most out of the proposed methods and systems. More details on those systems were earlier mentioned in (Capuano, Longhi, Salerno, & Toti, 2015).

In this regard, the "electronic Justice Relationship Management" (eJRM) project, funded by the Italian Ministry of Education and Research, was meant to bring about an integrated knowledge discovery and learning system for supporting people (being them either experts or common citizens and learners) on a number of activities related to legal mediation and alternative dispute resolution. In (Arosio, Bagnara, Capuano, Fersini, & Toti, 2013; Capuano, De Maio, Salerno, & Toti, 2014; Capuano et al., 2015), some of the system's components and underlying methodologies for processing cases written in natural language and generating learning paths have been described.

The generated learning paths adopt a teaching approach based on *Storytelling*. The educational potential of narration in the legal field is in fact widely recognized (Blissenden, 2007; Capuano et al., 2014; Posner, 1997; Wolff, 2014): it facilitates the understanding of abstract concepts through realistic stories and creates emotional and empathetic immersion through role-play. This is proven by the fact that, especially in Anglo-American countries, law teaching is heavily based on casebooks made of true or fictional stories as well as on moot courts, *i.e.* simulated court proceedings. According to (Blissenden, 2007), storytelling is an essential method of legal practice, teaching, and thought and the idea that stories are a useful method of provoking thinking about law has been currently shifted to the legal academy.

In addition to traditional education, several examples of computer-based learning environments for law that adopt storytelling also exist. For example, CivilObiezion (Steslow & Gardner, 2011)! is a series of trial simulations in which students play the role of lawyers; TLE (Maharg, 2007), is a virtual simulation environment used in professional legal practice; Fishbowl (Douglas & Johnson, 2010) is an educational game based on problem solving for the development of legal skills. Leveraging these positive experiences, a storytelling model for eJRM was proposed in (Capuano et al., 2014; Capuano, Gaeta, & Fratesi, 2014) ensuring a high degree of involvement and skills development even for users inexperienced with legal topics.

In this paper, a brief recap of the main theoretical and technological components of eJRM that were fully described and explored in the other cited works is first laid out. For convenience purposes, Table 1. Summary of previous related work by the authors that laid the foundation of the present work reports a summary of the most relevant related work that laid the foundation of the eJRM system and that is cited throughout the paper. Afterwards, this paper proceeds to describe the experimentation of the system's component specifically related to knowledge discovery and learning path generation is reported, which has been carried out on a diversified user-base. Results of such an experimentation highlight the pros and cons of the provided features as perceived by the system's users, assessing its performance and effectiveness so that it may be possible to polish and refine it, with the purpose of making the system a successful support and learning platform for future law professionals and knowledgeable citizens.

This paper is structured as follows. In Section 2 the main features of the system for knowledge discovery and learning path generation are briefly recapped and outlined. Section 3 reports the experimentation carried out. Finally, conclusions are drawn.

2. Outline of the eJRM system

The eJRM system is made up of a number of components mutually interoperable meant to provide a plethora of features to the users. Among them, the Knowledge Discovery and Learning component, related to the management and the evolution of the internal knowledge base as well as to the extraction of relevant knowledge to fulfill users' learning needs, plays a fundamental role, and has been the subject of the experimentation reported in this work. In the following subsections its core features and characteristics are briefly recapped and outlined.

2.1. Management of the ontological knowledge base

The eJRM system adopts a conceptual management of available resources based on legal ontologies, the latter resulting from the enrichment of the *EuroVoc*,[1] *ItalGiure*[2] and *DeJure*[3] thesauri with common-sense knowledge coming from *Wikipedia*. The defined ontologies include about 13.000 concepts, mutually interconnected both via informative relationships (*narrower term*, *broader term*, *related term*), aimed at structuring the dictionary of legal terms, and via educational relationships (*requires*, *has part*, *teaching order*), aimed at introducing useful properties for learning. A small excerpt of a legal ontology is shown in Fig. 1.

The system includes functionalities for browsing the legal ontologies featured by the system and performing a number of operations upon them including: (i) editing, *i.e.* updating and deleting terms and relationships; (ii) versioning, *i.e.* saving and restoring different versions of the ontologies; (iii) enrichment, *i.e.* increasing the included information by associating further terms and topics coming from external sources; (iv) matching and integration, *i.e.* finding correspondences among terms from different ontologies and producing an integrated ontology as a result.

Functions (i) and (ii) rely upon a graphical ontology management system meant to be used not necessarily by domain experts, which is further described in (Toti & Longhi, 2015; Toti & Longhi, 2017 SEMANTO: a graphical ontology management system for knowledge discovery, 2017). Function (iii) is based on an algorithm described in (Capuano, De Maio, Salerno, et al., 2014) meant to automatically associate a set of *weighted terms* corresponding to *Wikipedia* topics with each ontological concept. The addition of common-sense meaning to legal concepts has the purpose of narrowing the gap between the formal language used to describe legal concepts and the informal and somewhat inappropriate jargon used by common citizens querying the system. Function (iv) is based upon an algorithm described in (Capuano et al., 2015), where a range of similarity criteria is applied to the ontological elements in order to detect exact, approximate or partial matches among them.

[1] http://eurovoc.europa.eu/.
[2] http://www.italgiure.giustizia.it/.
[3] https://www.iusexplorer.it/.

Table 1
Summary of previous related work by the authors that laid the foundation of the present work.

Ref.	Contribution	Methods
(Capuano et al., 2015)	Creation of an integrated legal ontology, definition and implementation of a methodology for generating learning courses from selected legal concepts.	Ontology modelling, knowledge matching and sequencing.
(Arosio et al., 2013)	Definition of an ontological model for representing a legal case from natural language input, and design of a reasoner able to provide automatic legal assistance by traversing the defined ontologies.	Ontology modelling, natural language processing and automatic reasoning.
(Capuano, De Maio, Salerno, & Toti, 2014)	Definition and implementation of a methodology for the automatic classification of legal cases within a learning and training platform for law.	Natural language processing, knowledge discovery, classification.
(Capuano et al., 2014)	Definition of a learning model based on storytelling to teach legal concepts also to inexperienced users	Digital storytelling, adaptive learning.
(Capuano, Gaeta, et al., 2014)	Automatic construction of learning courses based on storytelling from selected legal concepts	Knowledge matching and sequencing, digital storytelling.

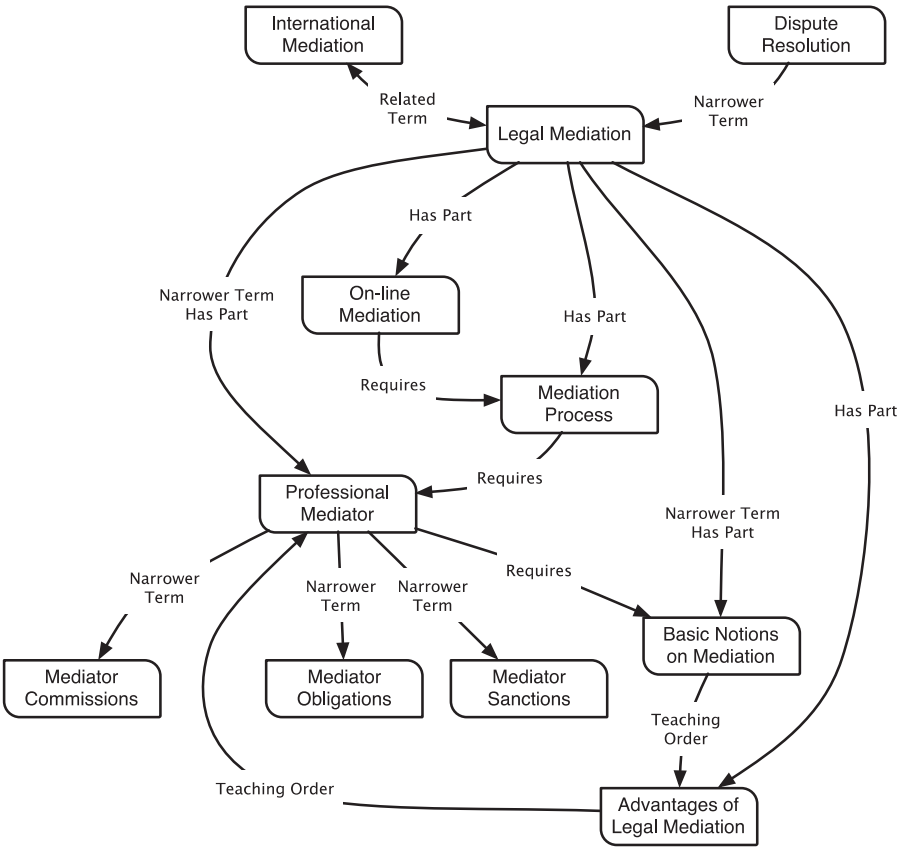

Fig. 1. Excerpt of a legal ontology including informative and educational relations.

2.2. Semantic search

The eJRM system implements a methodology for analyzing natural language text expressing a legal case and correlating it with domain-specific knowledge. The module, by evaluating the input text, is able to both identify and extract the most relevant concepts featured in it and to associate related topics not explicitly mentioned. Specifically, (i) relevant concepts are extracted from a user-input text; (ii) extracted concepts are then enriched with terms coming from external sources and (iii) classified according to their correspondences with terms from the managed legal ontologies; finally (iv) a semantic search for related information among available norms and sentences is performed, and the resulting documents are returned to the user.

Step (i) is carried out by using a knowledge discovery methodology incorporating part of the algorithm described and implemented in (Toti, Atzeni, & Polticelli, 2012a; Toti & Rinelli, 2016 On the road to speed-reading and fast learning with CONCEPTUM, 2016) and earlier derived from (Atzeni, Polticelli, & Toti, 2011a, 2011b, 2011c, 2011d; Toti, Atzeni, & Polticelli, 2012b); step (ii) is performed by employing the mechanism already described in subsection 2.1, which relies on the external, common-sense knowledge base of *Wikipedia*; step (iii) is performed by calculating a weighted combination of the standard measures of *precision* and *recall* as detailed in (Capuano, De Maio, et al., 2014; Capuano et al., 2015); step (iv) is obtained through connection to the repository of legal documents of the *Italian Supreme Court of Cassation*.

Fig. 2 summarizes the processes of ontology enrichment with terms coming from *Wikipedia* and the same process applied to relevant terms extracted from the input text describing a legal case.

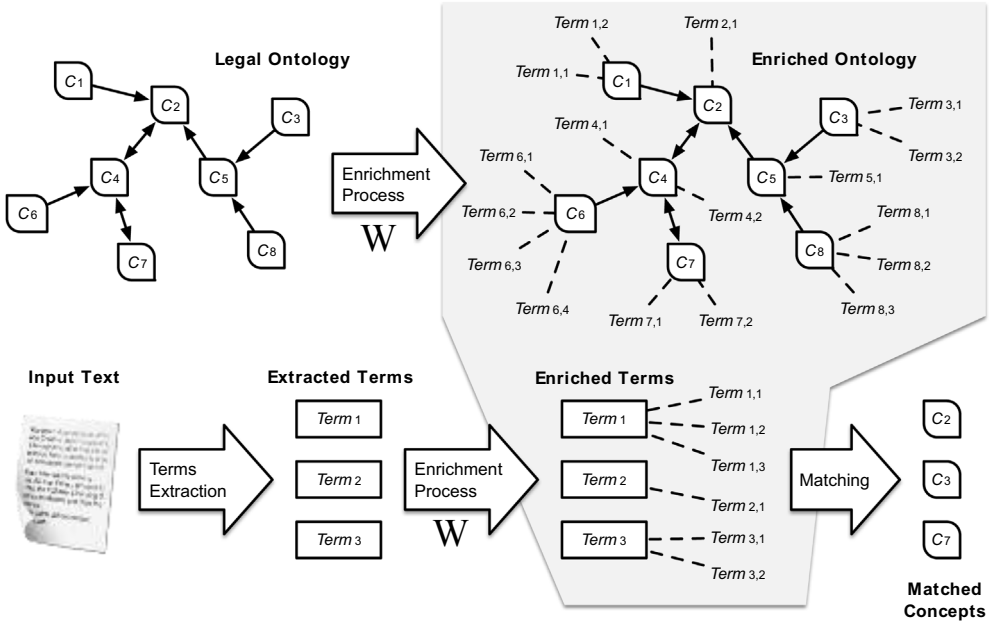

Fig. 2. Schematization of the enrichment process of the ontological concepts and the matching process between the terms extracted from an input text and the enriched concepts.

By comparing the enriched terms with those connected to the ontology concepts, it is possible to identify relevant legal concepts connected to the input text even when the text is written using imprecise or inappropriate terms. Identified concepts are used both to retrieve meaningful documents in the external repository and as a basis for the generation of a learning path as explained in the next subsection.

2.3. Training path generation

Given the input textual case provided by the user and the matched concepts extracted from it as earlier described, the system is also able to correlate them with existing learning resources from the managed legal ontologies, and thus generate learning paths meant to provide the basis for understanding legal issues related to the input case. Such a mechanism is made up of two steps: (i) the determination of the sequence of concepts to be transferred in accordance with educational relationships and (ii) the selection and delivery of learning resources covering the concepts in the sequence.

Both steps are based on models and techniques derived from adaptive learning systems (Capuano, Gaeta, Ritrovato, & Salerno, 2008; Capuano et al., 2009; Capuano, Mangione, et al., 2014; Capuano, Gaeta, Salerno, & Mangione, 2011; Costagliola, De Rosa, Fuccella, Capuano, & Ritrovato, 2010) that have been outlined in (Capuano et al., 2015). By using the legal ontology excerpt shown in Fig. 1 as an example, in the event that a learning path for the concept *On-line Mediation* is requested, step (i) generates the concept sequence presented in Fig. 3 that complies with the pre-requisite relationships. Afterwards, learning resources are selected from an internal repository according to step (ii).

In order to provide challenging learning resources usable also by common citizens who have little or no background on legal topics, a teaching approach based on storytelling is adopted. As explained in (Capuano et al., 2014a; Capuano, Gaeta, et al., 2014), the generated learning path is composed of several *situations*, each covering a target concept. According to (Mangione, Pierri, & Capuano, 2014), situations are in turn composed of an *Advancer Event* that activates the learner's prior knowledge to improve his involvement, a *Learning Event* that enables the understanding of concepts and a *Reflective Event* that helps consolidate the acquired knowledge. Fig. 4 shows examples of the eJRM learning resources based on such approach.

2.4. System implementation

The system has been implemented as a web application developed in Java EE 7, and includes three legal ontologies imported and fine-tuned accordingly. Fig. 5 shows a screenshot of the main panel of the Knowledge Discovery and Learning component. In the upper left, users may input a legal case written in natural language ("Natural Language Text") and select the legal ontology managed by the system against which they want the case to be classified ("Legal Ontology Selection"); in the rightmost part of the panel, the selected legal ontology can be freely browsed as needed.

Once confirmed via the "Classify" button, the results of the knowledge discovery process are displayed in the lower left part of the panel: specifically, the concepts from the legal ontologies associated with those extracted from the text are shown ("Ontology Concepts"), as well as the related topics identified from the

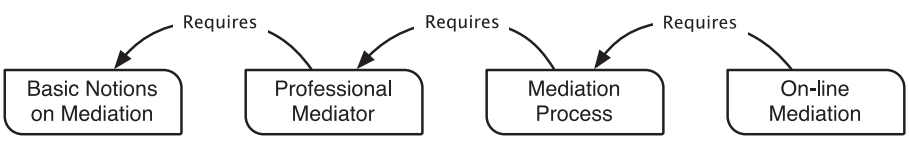

Fig. 3. Example of concept sequence generated from the legal ontology shown in Fig. 1.

Fig. 4. Examples of eJRM storytelling learning resources.

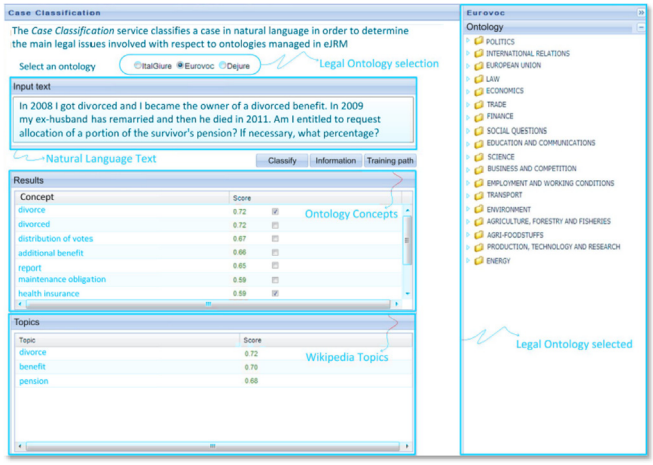

Fig. 5. Screenshot of the panel for semantic search and learning path generation.

Wikipedia knowledge base ("Wikipedia Topics"). By checking the desired concepts (ticking their respective checkboxes) and clicking the "Information" button, legal resources (*e.g.* rules, judgments, etc.) related to the selected concepts are shown, each with a hyperlinked reference to the original legal source; besides, the rightmost part of the panel is updated by displaying the tree hierarchy where such concepts are placed with respect to the whole ontology. The "Training path" button, instead, redirects users to the learning area, where they can follow the online course dynamically generated from the selected concepts as described in Section 2.3.

3. Experimental results

Two experiments have been performed to assess the system's efficiency, effectiveness and usability from both quantitative and qualitative perspectives. The first experiment was aimed at evaluating the efficiency of the semantic search process performed by the Knowledge Discovery and Learning component described in Section 2. The detected performance has been then compared with that of a standard search engine operating on the same document corpus.

The second experiment was aimed at assessing both the effectiveness and the usability of the system as perceived by the end user. For this reason, 35 potential users have been involved, diversified by age, educational level and occupation. Users have interacted with the system guided by simulated legal scenarios. Their feedback was collected and analyzed by using questionnaires designed to cover the different aspects under investigation. The following subsections present the experiments and the obtained results. "Efficiency of the search process" reports the quantitative results obtained in the first experiment, whereas the other subsections discuss the experiment with real users and the obtained results with respect to both effectiveness ("Perceived effectiveness") and usability ("System's usability").

3.1. Efficiency of the search process

To evaluate the system's performance with respect to the semantic search process described in section 2, 50 queries generated from different input text have been analyzed. Generated queries represent sample legal cases written in natural language like the following: *"I was traveling on the freeway with my car when I was involved in an accident caused by a large drop of fuel on the road. I reported physical injury and damage to the car. Can I claim damages to the highway company?"*. The average number of concepts involved in a sample query was 6 (with a minimum of 2 and a maximum of 16). The quality of the approach is assessed in terms of precision and recall measures, considering the analysis through micro-average of the individual precision-recall curves (van Rijsbergen, 1979).

Let $Q = \{Q_1, Q_2, \ldots, Q_n\}$ be a set of queries and D all the relevant resources for the given set of queries Q. For each query Q_i, $\lambda = 20$ steps are considered, up to its maximum recall value, and measure

the number of relevant documents retrieved at each step λ. The micro-averaging of recall and precision (at the generic step λ), is defined as follows:

$$Rec_\lambda = \sum_{Q_i} \frac{\left|R_{Q_i} \cap B_{\lambda,Q_i}\right|}{\left|R_{Q_i}\right|} \quad Prec_\lambda = \sum_{Q_i} \frac{\left|R_{Q_i} \cap B_{\lambda,Q_i}\right|}{\left|B_{\lambda,Q_i}\right|}$$

where R_{Qi} is the set of relevant resources for a given query Q_i, and $B_{\lambda,Qi}$ is the set of resources retrieved at the step λ for the query Q_i.

Fig. 6 shows the tendency of the micro-average of recall/precision curve evaluated on the collection set, and compares the approach used with the well-known keyword-based search engine *Lucene*.[4]

It is important to stress out that the effectiveness and accuracy of the semantic search is strongly dependent on the quality of the underlying legal ontology, along with the enrichment mechanism. The latter, as testified by the results, improves its effectiveness as the length of the input text query increases, since the more information is available, the better the tool is able to correctly understand its context and come up with meaningful concepts.

3.2. Perceived effectiveness

To assess the effectiveness of the proposed system and of the underlying models and methodologies, 35 potential users have been involved in an experimental interaction with the prototype. Such users (60% males, 40% females) belonged to different age ranges, educational levels and occupational categories as summarized in Fig. 7. 71% of them had already heard about civil and commercial mediation, while the remaining 29% did not know what it was.

The interaction with the system was guided by 15 scenarios covering three legal areas: motor liability, leases and e-commerce. For each scenario, a simulated dispute (covering some concepts of the related area) was described to the user. Then, each user was asked to play one of the roles involved in a dispute for a subset of at least three scenarios. For each selected role, the user had to interact with the system (after a brief introduction to its functions) by describing the case and the played role in natural language to obtain information for the (judicial or extrajudicial) settlement of the dispute. User feedback was collected and analyzed to determine the level of fulfillment of the following experimental hypotheses:

1. The resources provided by the system are coherent with the user-defined description of a case;
2. The resources provided by the system are coherent with the selected legal ontology;
3. The resources provided by the system are suitable for supporting the user in dealing with the case.

The system was made available on-line and the users were left free to schedule the time to dedicate to the experiment within two days. By the end of the second day, they had to fill a questionnaire made of the following set of items (where items 1–3 tested the 1st hypothesis, items 4–5 tested the 2nd hypothesis, and items 6–8 tested the 3rd hypothesis):

1. The legal concepts extracted from the case description are related to it;
2. The suggested information resources are coherent with the extracted concepts;

[4] http://lucene.apache.org.

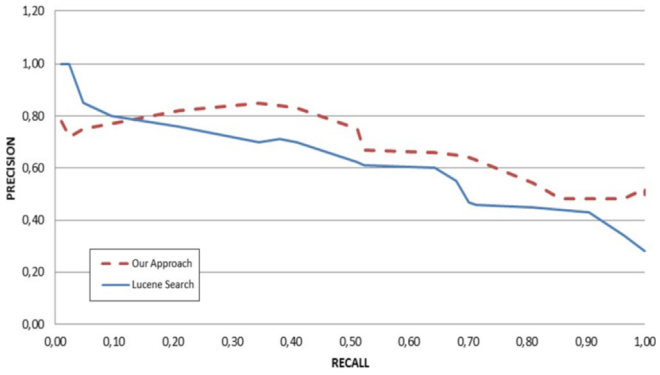

Fig. 6. Micro-average of recall/precision in comparison with Lucene.

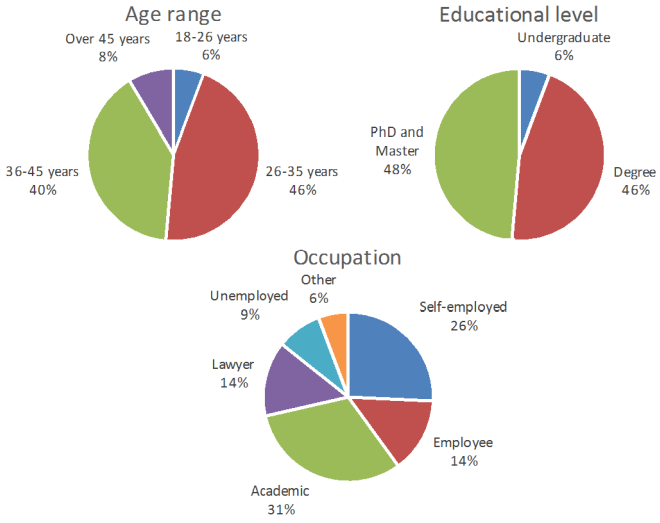

Fig. 7. Statistics about the potential users involved in the experimentation.

3. The generated learning path is coherent with the extracted concepts;
4. The learning path is presented by taking into account prerequisites;
5. The same topics are never repeated in the learning path;
6. The learning resources are understandable even by inexperienced users;
7. The quality and level of detail of learning resources are appropriate;
8. The provided information is suitable for supporting the user in dealing with the case.

Users had to specify their level of agreement or disagreement with each questionnaire item based on the following scale: *strongly disagree* (1), *disagree* (2), *neither/nor* (3), *agree* (4) and *strongly agree* (5), corresponding to the 5 points of the Likert scale. Fig. 8 shows the average students' evaluation with respect to each item.

The collected data shows a general positive evaluation of prototype effectiveness provided by potential users with an overall percentage of about 75% of positive answers (*i.e.* ranging from *agree* to *strongly agree*).

If the obtained answers are grouped with respect to the tested hypotheses, the overall percentage of positive answers is 72% for the 1st hypothesis (items 1–3) and about 76% for both the 2nd (items 4–5) and the 3rd (items 6–8) hypotheses. The lower performance is obtained by item 1 (66%), but this is probably due to the

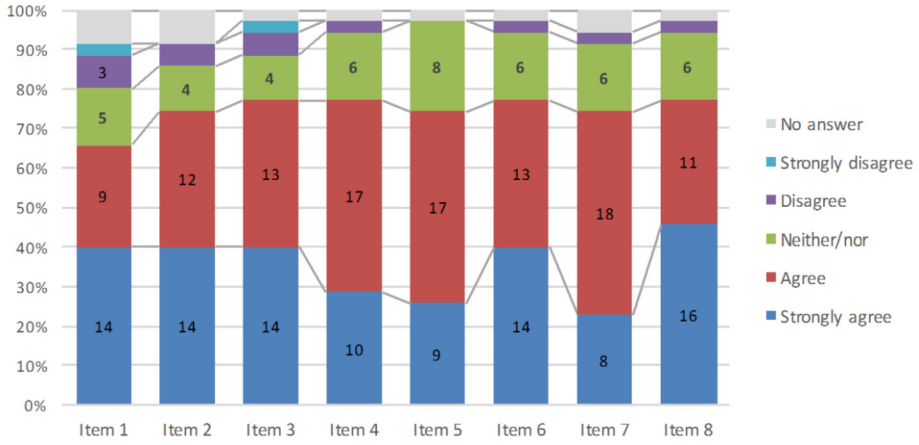

Fig. 8. Answers to the questionnaire on perceived effectiveness.

difficulty for a common user to correctly identify what legal concepts are involved in a given case. This interpretation is also supported by the higher number of missing answers obtained by the same item (9%). The overall percentage of negative answers (*i.e.* ranging from *strongly disagree* to *disagree*) is about 5%. If this data is grouped again by hypotheses, it is possible to see that the 1st one has 9% of negative answers, the 2nd one has 1% of negative answers, while the 3rd one has 3% of negative answers. By looking at both the percentages of negative and positive answers, it seems that the 2nd hypothesis is the strongest one, thus positively validating the work made both on the definition and management of the legal ontologies and on the generation of the learning paths.

Although the result is still positive, the 1st hypothesis seems to be the weakest, while the 3rd one, which is dependent from the preceding two, is in the middle. To analyze the data further, the collected answers have been compared with the user statistics on ages, educational levels and occupations.

The answers of each user have been summarized in an overall score by attributing 1 to 5 points to each item according to the provided answer (1 point for *strongly disagree* to 5 points for *strongly agree*) and mediating the score over the 8 items. The overall average score is 4.05. Fig. 9 shows how the obtained scores have been aggregated with respect to user statistics.

As it can be seen, the overall score decreases quite linearly when age range increases (from 4.19 of the youngest to 3.91 of the elderly). This could be related to a general greater familiarity of the younger generations with technology. With respect to the educational level we notice that, while undergraduates are more uncritical with respect to system (average score of 4.33), the criticisms rise as the level of education increases. When switching to occupation, it is possible to see that unemployed people is the least critical user category at all, with an average score of 4.63 but this is due to the fact that, in our sample, this category is mainly composed of young undergraduates that, as seen before, are among the most enthusiastic users. Lawyers reach the second highest average score (4.33) and this is particularly encouraging, given the familiarity that this category of workers has with the legal issues addressed by the system.

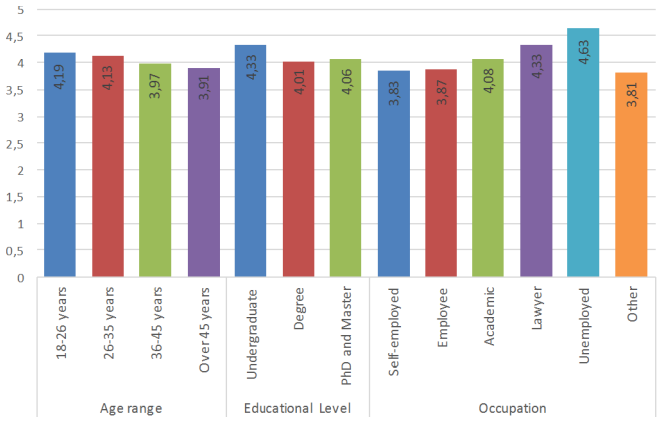

Fig. 9. Correlation of average scores with user statistics.

3.3. System usability

To measure the usability of the system, the System Usability Scale (SUS) defined in (Brooke, 1996) has been used. SUS is based on a set of 10 questions whose answers are given on the same 5-point Likert scale used for the perceived effectiveness (ranging from *strongly disagree* to *strongly agree*). The 10 items that compose the SUS questions are:

1. I think that I would like to use this system frequently;
2. I found the system unnecessarily complex;
3. I thought the system was easy to use;
4. I think that I would need the support of a technical person to be able to use this system;
5. I found the various functions in this system were well integrated;
6. I thought there was too much inconsistency in this system;
7. I would imagine that most people would learn to use this system very quickly;
8. I found the system very cumbersome to use;
9. I felt very confident using the system;
10. I needed to learn a lot of things before I could get going with this system.

The SUS yields a single number representing a composite measure of the overall usability of the system. To calculate the SUS score it is necessary to sum the score contributions from each item. For items 1, 3, 5, 7 and 9 (having positive polarity) the score contribution is the scale position minus 1. For items 2, 4, 6, 8 and 10 (having negative polarity), the contribution is 5 minus the scale position. The final score, ranging from 0 to 100 is obtained by multiplying the sum of the scores by 2.5.

Fig. 10 summarizes the results obtained in the usability

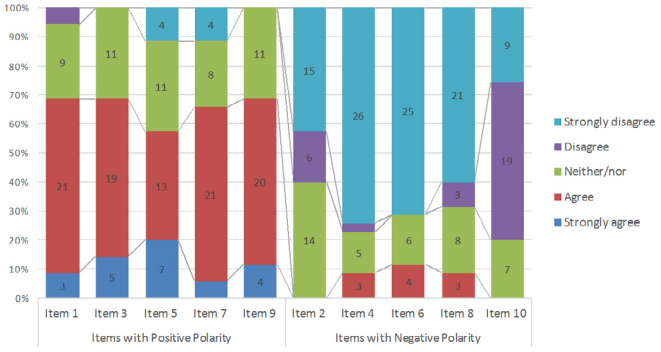

Fig. 10. Answers to the questionnaire on usability grouped by item polarity.

questionnaire. In the figure, the items are grouped with respect to their polarity (positive polarity on the left, negative polarity on the right). Obviously, for items with a negative polarity, a positive level of agreement corresponds to a negative evaluation (and vice-versa). The average SUS score obtained for the system, over all users, according to the provided answers is 73.5 (SD 12.6). The minimum individual SUS score is 50.0, while the maximum is 90.0. In industry, a SUS score above 68.0 is considered above average. The obtained score, that is 5.5 point above the average, is thus quite encouraging, also taking into account the prototypical nature of the system.

Users also had the opportunity to express short comments on the use of the system. Many comments found the system "intuitive" and "useful" both for education and for work, even for expert and novice users. Such judgments, therefore, are in line with the positive responses to the questionnaire. Someone pointed out that "sometimes the generated learning paths do not cover all topics identified in the text". Indeed, this is due to the fact that, at the current stage of the project, learning activities only cover a small subset of legal topics.

4. Conclusion

This work reported the experimentation of a Smart Learning system based on Knowledge Discovery and Cognitive Computing techniques intended for common users, legal learners and experts. In light of the results obtained by the experimentation carried out, the system gained a positive evaluation with respect to all the aspects under investigation: efficiency, effectiveness and usability. Efficiency, evaluated quantitatively in comparison to a standard search engine, shows a better micro-average of recall/precision curve for almost all cases (and at least for recall greater than 0.15). The effectiveness of the system is evaluated positively by the end users with an overall score of 4.05 over 5 and a percentage of positive answers of about 75% regardless of age, level of education and occupation. Usability, measured in terms of SUS score, reaches 73.5 points, that is 5.5 points above the average.

The positive results obtained are encouraging, and the small amount of negative criticism received will be appropriately taken into account for further polishing and refinements, with the ultimate purpose of making the system even more successful in supporting citizens and future legal professionals for learning and training. Such results contribute to demonstrate the potential of *Cognitive Computing* in improving the user experience and in the provisioning of advanced services for learning. In addition, the application of advanced learning content and strategies based on digital storytelling also fosters the transition toward *Personalized Learning Environments*, going beyond the limitations of traditional classroom-based paradigms. At the same time, most of the semantics-based methodologies implemented can be in principle re-used and appropriately tuned and applied to other learning areas and domains with expected comparable results.

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References

Ajani, G., Boella, G., Lesmo, L., Martin, M., Mazzei, A., Radicioni, D. P., et al. (2009). Legal taxonomy syllabus version 2.0. In *3rd ICAIL workshop on legal ontologies and articial intelligence techniques*.

Arosio, G., Bagnara, G., Capuano, N., Fersini, E., & Toti, D. (2013). Ontology-driven data acquisition: Intelligent support to legal ODR systems. *Frontiers in Artificial Intelligence and Applications, 259*, 25–28. https://doi.org/10.3233/978-1-61499-359-9-25.

Atzeni, P., Polticelli, F., & Toti, D. (2011a). A framework for semi-automatic identification, disambiguation and storage of protein-related abbreviations in scientific literature. *International Conference on Data Engineering*, 59–61. https://doi.org/10.1109/ICDEW.2011.5767646.

Atzeni, P., Polticelli, F., & Toti, D. (2011b). An automatic identification and resolution system for protein-related abbreviations in scientific papers. *Lecture Notes in Computer Science, 6623*, 171–176. https://doi.org/10.1007/978-3-642-20389-3_18.

Atzeni, P., Polticelli, F., & Toti, D. (2011c). Automatic discovery and resolution of protein abbreviations from full-text scientific papers: A light-weight approach towards data extraction from unstructured biological sources. In *19th Italian symposium on advanced database systems* (pp. 317–324).

Atzeni, P., Polticelli, F., & Toti, D. (2011d). Experimentation of an automatic resolution method for protein abbreviations in full-text papers. In *2011 ACM conference on bioinformatics, computational biology and biomedicine* (pp. 465–467). https://doi.org/10.1145/2147805.2147871.

Biasiotti, M. A., Sagri, M. T., & Tiscornia, D. (2005). LOIS: Building a multi-lingual wordnet for the legal domain. In *4th international EGOV conference 2005*.

Blissenden, M. (2007). Legal education today: Teaching to actively engage law students – new approaches to the use of decided cases. In *62nd australasian law teachers conference*.

Brooke, J. (1996). A 'quick and dirty' usability scale. *Usability evaluation in industry*. Taylor and Francis.

Capuano, N., De Maio, C., Gaeta, A., Mangione, G. R., Salerno, S., & Fratesi, E. (2014). A storytelling learning model for legal education. In *8th International Conference on e-Learning* (pp. 29–36). Lisbon: IADIS.

Capuano, N., De Maio, C., Salerno, S., & Toti, D. (2014). A methodology based on commonsense knowledge and ontologies for the automatic classification of legal cases. In *ACM international conference proceeding series*. https://doi.org/10.1145/2611040.2611048.

Capuano, N., Dell'Angelo, L., Orciuoli, F., Miranda, S., & Zurolo, F. (2009a). Ontology extraction from existing educational content to improve personalized e-Learning experiences. In *IEEE international conference on semantic computing* (pp. 577–582). https://doi.org/10.1109/ICSC.2009.69.

Capuano, N., Gaeta, A., & Fratesi, E. (2014). An Adaptive e-Learning System Based on Storytelling for Civil Mediation. *IADIS International Journal on WWW/Internet, 12*(1), 1–16.

Capuano, N., Gaeta, M., Marengo, A., Miranda, S., Orciuoli, F., & Ritrovato, P. (2009b). LIA: an Intelligent Advisor for e-Learning. *Interactive Learning Environments, 17*(3), 221–239.

Capuano, N., Gaeta, M., Ritrovato, P., & Salerno, S. (2008). How to integrate technology enhanced learning with business process management. *Journal of Knowledge Management, 12*(6), 56–71.

Capuano, N., Gaeta, M., Salerno, S., & Mangione, G. R. (2011). An ontology-based approach for context-aware e-learning. In *3rd IEEE international conference on intelligent networking and collaborative systems. Fukuoka, Japan*.

Capuano, N., Longhi, A., Salerno, S., & Toti, D. (2015). Ontology-driven generation of training paths in the legal domain. *International Journal of Emerging Technologies in Learning, 10*(7), 14–22. https://doi.org/10.3991/ijet.v10i7.4609.

Capuano, N., Mangione, G. R., Pierri, A., & Salerno, S. (2014). Personalization and contextualization of learning experiences basing on semantics. *International Journal of Emerging Technologies in Learning, 9*(7), 5–14.

Casanovas, P., Sartor, G., Casellas, N., & Rubino, R. (2008). *Computable models of the law*. Springer.

Costagliola, G., De Rosa, M., Fuccella, V., Capuano, N., & Ritrovato, P. (2010). A novel approach for attention management in e-learning systems. In *16th international conference on distributed multimedia systems*. IL, USA: Oak Brook.

Davies, J., Fensel, D., & van Harmelen, F. (2002). *Towards the semantic web: Ontology-driven knowledge management*. Wiley.

Del Nostro, P., Gaeta, A., Paolozzi, S., Ritrovato, P., & Toti, D. (2013a). ARISTOTELE: An environment for managing knowledge-intensive enterprises. In *21st Italian*

symposium on advanced database systems (pp. 289–296).
Del Nostro, P., Orciuoli, F., Paolozzi, S., Ritrovato, P., & Toti, D. (2013b). A semantic-based architecture for managing knowledge-intensive organizations: The Aristotele platform. *Lecture Notes in Computer Science, 7652*, 133–146. https://doi.org/10.1007/978-3-642-38333-5_15.
Del Nostro, P., Orciuoli, F., Paolozzi, S., Ritrovato, P., & Toti, D. (2013c). Aristotele: A semantic-driven platform for enterprise management. In *27th international conference on advanced information networking and applications workshops* (pp. 44–49). https://doi.org/10.1109/WAINA.2013.43.
Douglas, K., & Johnson, B. (2010). Legal education and e-learning: Online Fishbowl role-play as a learning and teaching strategy in legal skills development. *eLaw Journal, 17*(28).
Ferrer, A. S., Rivero, J. M., & Garcìa, A. M. (2008). Improvements in recall and precision in wolters kluwer Spain legal search engine. In *Computable models of the law* (pp. 130–145). Springer.
Francesconi, E., & Tiscornia, D. (2008). Building semantic resources for legislative Drafting: The DALOS project. In *Computable models of the law* (Vol. 4884, pp. 56–70). Springer.
Gaeta, M., Loia, V., Orciuoli, F., & Ritrovato, P. (2015). S-WOLF: Semantic workplace learning framework. *IEEE Transactions on Systems, Man, and Cybernetics: Systems, 45*(1), 56–72. https://doi.org/10.1109/TSMC.2014.2334551.
Gaeta, M., Mangione, G. R., Miranda, S., & Orciuoli, F. (2013). Adaptive feedback improving learningful conversations at workplace. In *International Conference e-Learning* (pp. 175–182).
Hwang, G.-J. (2014). Definition, framework and research issues of smart learning environments - a context-aware ubiquitous learning perspective. *Smart Learning Environments, 1*(4). https://doi.org/10.1186/s40561-014-0004-5.
van Kralingen, R. W. (1997). A conceptual frame-based ontology for the law. *International Workshop on Legal Ontologies*, 15–22.
Maharg, P. (2007). *Transforming legal education: Learning and teaching the law in the early twenty-first century*. Ashgate Publishing.
Mangione, G. R., Pierri, A., & Capuano, N. (2014). Emotion-based digital storytelling for risk education: Empirical evidences from the ALICE project. *International Journal of Continuing Engineering Education and Life-Long Learning, 24*(2), 184–211.
Miranda, S., Mangione, G. R., Orciuoli, F., Gaeta, M., & Loia, V. (2013). Automatic generation of assessment objects and Remedial Works for MOOCs. In *12th international conference on information technology based higher education and training*. https://doi.org/10.1109/ITHET.2013.6671018.
Poblet, M., Casanovas, P., & Cobo, J. M. (2010). Online dispute resolution for the next web Decade: The Ontomedia approach. In *10th international conference on knowledge management and knowledge technologies*.
Posner, R. A. (1997). Legal narratology (reviewing Law's Stories: Narrative and rhetoric in the law by peter brooks, Paul Gewirtz). *University of Chicago Law Review, 64*(2).
van Rijsbergen, C. J. (1979). *Information retrieval* (2nd ed.). University of Glasgow.
Rubino, R., Rotolo, A., & Sartor, G. (2006). An OWL ontology of fundamental legal concepts. In *International conference on legal knowledge and information systems* (pp. 101–110). IOS Press.
Steslow, D. M., & Gardner, C. (2011). More than one way to tell a story: Integrating storytelling into your law course. *Journal of Legal Studies Education, 28*(2), 249–271.
Toti, D., Atzeni, P., & Polticelli, F. (2012a). A knowledge discovery methodology for semantic categorization of unstructured textual sources. In *8th international conference on signal image technology and internet based systems* (pp. 944–951). https://doi.org/10.1109/SITIS.2012.140.
Toti, D., Atzeni, P., & Polticelli, F. (2012b). Automatic protein abbreviations discovery and resolution from full-text scientific Papers: The PRAISED framework. *Bio-algorithms and Med-systems, 8*(1). https://doi.org/10.2478/bams-2012-0002.
Toti, D., & Longhi, A. (2015). A visual ontology management system for handling, integrating and enriching semantic repositories. In *International conference on intelligent networking and collaborative systems* (pp. 450–453). https://doi.org/10.1109/INCoS.2015.23.
Toti, D., & Longhi, A. (2017). Semanto: A graphical ontology management system for knowledge discovery. *Journal of Ambient Intelligence and Humanized Computing*. https://doi.org/10.1007/s12652-017-0518-0 (in press).
Toti, D., & Rinelli, M. (2016). On the road to speed-reading and fast learning with Conceptum. In *2016 international conference on intelligent networking and collaborative systems* (pp. 357–361). https://doi.org/10.1109/INCoS.2016.30.
Valente, A., & Breuker, J. (1994). A functional ontology of law. In *Towards a global expert system in law*. Cedam Publishers.
van de Ven, S., Hoekstra, R., Breker, J., Wortel, L., & El-Ali, A. (2008). Judging Amy: Automated legal assessment using OWL 2. *OWL: Experiences and Directions*.
Wolff, L. (2014). Let's talk about Lex: Narrative analysis as both research method and teaching technique in law. *Adelaide Law Review, 35*(1), 3–21.