Looking into the Future of Creativity and Decision Support Systems

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A message from the Vice President of JAIST:

本国際会議KICSS AGH大学とP＆B財団からアンドリューM. Skulimowski
教授と小生が立した国際会議で2006年から毎年1回、世界各地で開催している。最初は
創造性支援システムの研究開発をしている研究者が中心にスタートしたが、
今や知識情報を駆使して、人間の知的活動を支援するシステムを研究開発してい
る研究者が国際的に集まり、研究発表および研究交流する場に発展している。
開催地もアユタヤ(タイ)、能美市(日本)、ハノイ(ベトナム)、ソウル(韓
国)、チェンマイ(タイ)、北京(中国)、メルボルン(オーストラリア)と
太平洋岸を変遷した。今年は太平洋を離れ、ヨーロッパの古都クラコフ(ポーラ
ンド)で開催されるのは、創立者として望外の喜びである。KICSS2013では
研究発表を楽しみ、大いに情報交換してこの分野の研究が盛り上がることを
期待したい。

Creativity enters into every aspect of life. Facing the ever-changing and full-of-conflicts world, creative thinking, innovative ideas and implementations are openly needed. Supporting creativity is natural and becoming one of most challenging areas in the 21st century. Research on creativity support systems and its relevant fields is emerging. The conference of KICSS aims to facilitate technology and knowledge exchange between international researchers/scholars in the field of knowledge science, information science, system science and creativity support systems. KICSS started in Ayutthaya (2006) and successfully was held in Nomi (2007), Hanoi (2008), Seoul (2009), Chang Mai (2010), Beijing (2011), and Melbourne (2012). It is my pleasure that KICSS2013 is held in Europe, because Krakow is the most beautiful ancient city in Poland.

Susumu KUNIFUJI (JAIST)

Conference Organizers:

Progress and Business Foundation

International Center for Decision Science
and Forecasting

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Abstract. The scope of the 8th International Conference on Knowledge, Information and Creativity Support Systems (KICSS'2013) and basic paper submission characteristics are presented in the context of the historical development of this conference series. General remarks and acknowledgements are included as well.

After seven highly successful interdisciplinary conferences organized in East Asia and Australia, the 8th International Conference on Knowledge, Information and Creativity Support Systems (KICSS'2013) has been organized for the first time in Europe -- in Kraków and Wieliczka, Poland. The previous conferences in this series were held in Ayutthaya, Thailand (2006), Ishikawa, Japan (2007), Hanoi, Vietnam (2008), Seoul, Korea (2009), Chiang Mai, Thailand (2010), Beijing, China (2011) and Melbourne, Australia (2012). The proceedings of KICSS conferences have been published a.o. by Springer in the LNCS/LNAI series, IEEE CPS and JAIST Press [1-3,5]. KICSS conferences provide an international forum for researchers as well as IT practitioners to share new ideas and original research results. New research and development areas for knowledge, decision and creativity sciences are also determined and practical development experiences in all the areas mentioned above are discussed.

Following the tradition of previous conferences on Knowledge, Information and Creativity Support Systems, KICSS'2013 covers all aspects of knowledge management, knowledge engineering, decision support systems, intelligent information systems and creativity in an information technology context. The conference specifically covers computational creativity and its cognitive and collaborative aspects. The focus theme of KICSS'2013 is "*Looking into the Future of Creativity and Decision Support Systems*", consequently, the list of conference topics includes for the first time future-oriented fields of research, such as anticipatory networks and systems, foresight support systems, relevant newly-emerging applications such as autonomous creative systems, and the areas of future research such as general creativity. In addition, several sessions include papers presenting the results of the recently concluded foresight project SCETIST [4], devoted to investigating the future trends and scenarios of selected artificial intelligence and information society technologies until 2025. Some of them model the development of decision and creativity support systems.

needs of real-life problem solving in government, finance and industry. For over two decades of activity, the Foundation has developed a unique combination of expertise in applied research in artificial intelligence, decision sciences, financial and economic modeling, as well as information technologies with practical aspects of know-how transfer and R&D policy research. In particular, the Foundation performs foresight studies and technological roadmapping exercises in Artificial Intelligence, basic information technologies, green technologies, and other areas.

Kraków, November 2013

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On Potential Usefulness of Inconsistency in Collaborative Knowledge Engineering [*]

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Abstract. Inconsistency in knowledge bases traditionally was considered undesired. Systematic eradication of it served to ensure high quality of a system. However, in Collaborative Knowledge Engineering ($\mathcal{CKE}$), where distributed, hybrid knowledge bases are developed and maintained collectively, inconsistency appears to be an intrinsic phenomena. In this paper, we analyze inconsistency in $\mathcal{CKE}$ in terms of its origin, level, type and significance. We claim that in some cases inconsistency should be tolerated and show examples where it can be used constructively.

Keywords: Collaborative Knowledge Engineering; inconsistency

1 Introduction

Traditional approach to inconsistency in Knowledge-Based Systems considered it an anomaly [29]. One of the main reasons for that is the "principle of explosion" (ECQ, from Latin: *Ex contradictione sequitur quodlibet* which means "from a contradiction, anything follows"). If anything can be entailed from a set of inconsistent statements, then the inconsistent knowledge base becomes unusable. Therefore, numerous methods and techniques have been developed to suppress inconsistency, either by rejecting contradictions (removing, forgetting etc.) or by searching for a consensus to restore consistency.

With the advent of modern Web-based technologies, there is a growing intensity of collaboration on the Web. Wikipedia-like portals, recommendation systems or community websites are examples of modern knowledge bases. New challenges are posed by distributed knowledge authoring, increased use of mobile devices, dynamic changes of the knowledge, and use of hybrid knowledge representation with mixed levels of formality [7]. Quality of knowledge is often evaluated collectively, by voting and discussion.

It is unpractical to treat such knowledge bases same as centralized homogenous systems, where consistency was an important quality factor. We claim that in Collaborative Knowledge Engineering ($\mathcal{CKE}$), struggling for consistency can be ineffective, and can suppress such desirable phenomena as collaborative synergy and fast development of knowledge. Thus, inconsistency should be accepted and incorporated into reasoning rather than removed or ignored.

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Communities of Practice for Developers: HelpMe tool

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Abstract.
The term Web 2.0 focuses on: user, software development and content, which results from many users that share experiences and interests. Due to the fact that many people gather on web sites looking for a solution to their problem, communities of practice (CoPs) were developed. CoPs have become important places for people who seek and share experience. In CoPs area, Argumentative Collaboration is developing between users, so that users can help each other. This paper refers to CoPs and especially to the field that refers to computer programmers. We introduce HelpMe tool that receives questions about a subject that is tagged by the init (or start) user. The start user of a query process is the user that brings the initial question to the community. HelpMe tool automatically selects a group of people according to rules and metrics, in order to supply feedback to the community group who deals with the specific subject (according to label tagging). We introduce two new metrics ULQI (user label query importance) and ULCI (user label communication importance) that are responsible for selecting the appropriate group of people in the community and computing the reputation scores based on the received ratings. HelpMe tool visualizes conversations through graphs, text clouds and statistics.

Keywords: Collaboration, Web2.0, Communities of Practice (CoPs), argumentative collaboration, social media, recommender systems, expertise finding, forum, help, seeking, tools in CoPs

1   Introduction

1.1   Communities of Practice (CoPs)

Social media, wikis, blogs, forums are characteristic applications of web2.0, where interaction instructions such as search, tag, ranking, links and authoring enable users to refresh and modify articles. Web2.0 focuses on user actions, on software implementation, on content that is contribution result of many users. That is why the need of communities of practice, a gathering place of people with common interests, is created. CoPs have become important places for people that seek and

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Learners' attitudes toward knowledge sharing in the inter-cultural and high-contextual cooperative learning

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Abstract. In this paper, we investigated how the cultural differences affect to a cooperative learning based on Jigsaw technique. The experiment measured attitudes of learners from Thai, Japan and China who have different cultures but share the similar style of high-context communication and showed a comparison between learners' feelings in the intra-cultural learning and the inter-cultural learning. The results revealed that the cultural differences and the style of high-context communication caused learners facing more difficult to share their own knowledge in the inter-cultural group than that in the intra-cultural group. Though a quiz score in the experiment showed a fair learning outcome, learners reported a low level of achievement feeling to share knowledge in the inter-cultural group. This work also analyzed the effects of cultural background and cultural dimensions on learning outcome. The results showed that cultural background can enhance inter-cultural competences in cooperative learning. Besides the attitudes of high difficulty and low achievement, the differences in culture and the high-context style also impacted on three feelings including annoyance, interest and understanding. Learners felt more annoyed but less understandable when learning with partners from different cultures. Nevertheless, the results revealed that learners showed more interest in inter-cultural cooperative learning.

Keywords: Inter-cultural learning, Cooperative learning, Jigsaw method, High-context communication

1   Introduction

In the era of globalization, the education system faces a lot of changes. Cooperative learning is an effective educational approach that involves small groups of learners using a variety of learning activities for sharing their own knowledge to complete a task, solve a problem or accomplish a common goal [11]. However, a process to share knowledge in a cooperative learning among people from different countries and cultures may face communication problems such as negative feelings and lead to misunderstandings.

Hall [2] has classified styles of communication based on a key factor "context". It relates to the framework, background and surrounding situations in which communi-

cooperative learning. Moreover, this work analyzed the effect of cultural background and cultural dimensions on learning outcome. The result showed that cultural background can enhance inter-cultural competence in cooperative learning.

For the future directions, we will point out how information technology can reduce a culture gap and can enhance performance of cooperative learning among learners from different cultures. For example, the level of understanding influenced from the difference in languages can be improved by using techniques of Natural Language Processing such as machine translation and speech recognition. Moreover, the shared information space and groupware technology can reduce misinterpretations of the communicated messages in the inter-cultural situations and can make mutual understanding among participants in the knowledge sharing process.

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A Logical Foundation For Troubleshooting Agents

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Abstract. Intelligent software agents interacting with users arise in different applications. One of the applications of such agents, which are called virtual experts, is troubleshooting systems. In this project, we are trying to use different available textual resources to automatically construct a troubleshooting virtual expert. In our solution, we extract the information about the structure of the system from textual document, then generate a conversation with the user in order to identify the problem and recommend appropriate remedies. To illustrate the approach, we have built a knowledge base for a simple use case. A special parser generates troubleshooting conversations that guides the user solve configuration problems.

Keywords: Description Logic, Ontology, Troubleshooting Systems

1 Introduction

Troubleshooting of complex systems is a form of problem solving, often applied to repair failed systems composed of different components and sub-systems. Troubleshooting is a logical, systematic search for the source of problems so that they can be fixed and the system can be made operational again. Troubleshooting techniques are used widely in different complex systems, such as smart phone services and applications. A *troubleshooting and diagnosis system* identifies the malfunction(s) within a *failed system* according to its knowledge about the *original complex system*, and it provides solutions for the potential problems. A *troubleshooting and diagnosis system* runs a troubleshooting process which not only identifies the malfunction(s) within a failed system, but also requires confirmation that the solution restores the failed system to a working state. An efficient and powerful knowledge representation component is usually required to have such troubleshooting and diagnostic process.

Designing such diagnostic systems dates back to 1989. In [4], Martin et al. proposes a diagnostic system based on a simple search of symptoms and causal models. Portinale [7] provides a diagnostic model which is captured within a framework based on the formalism of Petri nets; it shows how the formalization

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a picture of complex system structure which helps the diagnosis systems to extract an organized case repository out of unstructured data sources. Our formalism is a Description Logic extension including problem-solution cases. We not only extended Description Logic according to the requirements of diagnosis system, but also limited its semantics to fit in our application. We have completely developed a parser which gets the knowledge base and builds the troubleshooting procedure in an imperative programming language. Using a practical example about smart phone services, we have shown that our formalism can completely express the required knowledge about complex system structure and use it to refine and organize its case base. Our implementation also showed that this knowledge base is expressive enough to automatically build the interactive troubleshooting process.

Although constructing a behavioral model of a complex system needs to have a detail knowledge about how the complex system works, it can be really helpful to use such dynamic behavior representation beside of our structural knowledge about the complex system.

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Strategic Planning Optimisation using Tabu Search Algorithm

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Abstract. In this paper we introduce a method for optimisation of strategic tasks using an approximation algorithm. We propose the mathematical model and algorithm for solving this problem near optimality. An overall motivation for the development of the proposed algorithm is discussed with detailed efficiency analysis. From the end users' perspective the proposed method has practical application because it can be used in several practical use cases.

Keywords: Discrete Optimisation, Strategic Planning, Artificial Autonomous Decision Systems, Tabu Search

1 Introduction

Scheduling of strategic tasks can be embedded in creative roadmapping processes of NPD type [6] for a multicriteria model of creative NPD problem solving. Organizational adaptation of a unit to perform tasks is an important aspect of strategic planning. If their way of realization is dependent on the implemented procedures (legislation), they restrict greatly the freedom of design solutions. In the case of complex units, specialized departments are extracted, which are responsible for homogeneous subtasks, often referred to as operations or activities. Considering the sequence of their realization in a such defined structure, we can apply the models of scheduling theory. They provide a wide range of choice of the criterion function, constraints on resources, priorities, defining the ordering relationships between the operations, the critical deadlines, the efficiency of departments/teams. Due to constraints, the tasks may be interruptible or uninterruptible, and their processing may be serial or parallel.

In the presented case a company carries out a strategic plan - a specific set of objectives, consisting of strategic tasks. Departments, having allocated specific resources, are specialized to perform the subtasks.

The realization of the strategic plan assumes that:

- the processing time of subtasks in the company departments is given,
- subtasks can not be interrupted, executed only once,

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Removing redundant features via clustering: preliminary results in mental task separation

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Abstract. Recent clustering algorithms have been designed to take into account the degree of relevance of each feature, by automatically calculating their weights. However, as the tendency is to evaluate each feature at a time, these algorithms may have difficulties dealing with features containing similar information. Should this information be relevant, these algorithms would set high weights to all such features instead of removing some due to their redundant nature.

In this paper we introduce an unsupervised feature selection method that targets redundant features. Our method clusters similar features together and selects a subset of representative features for each cluster. This selection is based on the maximum information compression index between each feature and its respective cluster centroid.

We empirically validate out method by comparing with it with a popular unsupervised feature selection on three EEG data sets. We find that ours selects features that produce better cluster recovery, without the need for an extra user-defined parameter.

Keywords: Unsupervised feature selection, feature weighting, redundant features, clustering, mental task separation.

1 Introduction

Given a data set Y of n entities over m features $V = \{v_1, v_2, ..., v_m\}$, feature selection aims to reduce the cardinality of V by removing those features that are redundant or have no relevance to the task at hand. There are a number of reasons to motivate such reduction in V. For instance, (i) the amount of time a classification or clustering algorithm takes to process Y tends to be inversely proportional to the data set size and dimension; (ii) it reduces the chances of issues related to overfitting; (iii) it is possible that there will be a general improvement in the accuracy of predictions [23, 13].

Feature weighting is a generalization of feature selection. While the latter either selects or removes a feature from V, the former assigns a weight w in the interval $[0, 1]$ to each feature in V. This weight, w_v, aims to be directly proportional to the degree of relevance of feature v. Feature

eficial for such algorithms, particularly when this feature selection takes into account the data set structure - as its the case with iKFS.

Future research will aim to optimise even further the features selected by iKFS and apply this algorithm as a pre-processing step for a feature weighting clustering algorithm such as iMWK-Means in different scenarios.

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Machine Understanding for Interactive Storytelling

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Abstract. This paper describes our research-in-progress which integrates several domains, in particular natural language processing and the development of virtual immersive environments. Our research aims at "bringing a given text to life" via an immersive environment where the user can freely explore the surroundings and increase his understanding of the given text. We describe some important challenges in achieving this goal and outline our current research results. Our work is practically oriented, aiming at fulfilling some societal needs related to education on which we also report.

Keywords: Natural language processing, machine learning, cognitive psychology, digital immersive environments

1 Introduction and outline of the paper

In this paper we present an artificial intelligence challenge that is truly interdisciplinary, covering such diverse domains as natural language processing (NLP), machine learning and the development of interactive computer simulated environments, computer graphics and cognitive psychology. The challenge is to develop a methodology that bridges the gap between natural language and the formal representations of interactive storytelling. Although the domains of natural language processing and the development of immersive digital environments have both seen rapid progress in recent years, their integration is an untouched research domain. Thus the intriguing question: how to create immersive environments that are driven by texts that are written in natural language, but that are not especially written for this purpose? That is, whereas virtual worlds are developed by first handcrafting a knowledge base, the ultimate challenge we present is to consistently transform *arbitrary* texts, not only in terms of content but also in terms of genre (scientific articles, blogs, etc.), to virtual worlds in such a way that these worlds become the main source of information.
The challenge we present here regards a project called MUSE (an acronym for Machine Understanding of interactive StorytElling), which recently started at our university, in collaboration with several universities worldwide, representing

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On the Application of Fourier Series Density Estimation for Image Classification Based on Feature Description

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Abstract. This paper presents an image classification algorithm called Density Based Classifier (DBS). The proposed method puts together the image representation based on keypoints and the estimation of the probability density of descriptors with the application of orthonormal series. For each class of images a separate classifier is constructed. The presented procedure ensures that different descriptors affect the final decision in a different degree. The trained classifier determines whether the query image is assigned to the class or not. The obtained experimental results show that proposed method provides good results. The algorithm can be applied to many tasks in the field of image processing.

Keywords: image classification, image processing, density estimation, orthonormal series

1 Introduction and Motivation

Image processing is a very fast expanding field of knowledge, however there is still a lot of open problems to be solved [5]. Image classification seems to be one of the most important aspects, which still needs to be improved and other approaches should be searched. The most important steps in every image classification system are:

– selection of training samples (which are denoted by T)
– image description
– selection of suitable classification approaches
– accuracy assessment

Choice of a method to execute above steps depends on a few conditions, firstly user's needs. User should determine type of query before selecting type of classifier. Different approach should be applied to find similar image, other to point an object on an image, and another to indicate a class of object, etc. Secondly: scale

6 Conclusion and future work

In this paper the DBC algorithm was introduced. It is used for verifying the membership of the image to the considered class. The obtained experimental results showed the usefulness of the presented solution. The big advantage of the proposed method is the low memory requirement.

The algorithm, however, leaves a lot of space for future consideration. The algorithm should be tested on a larger number of classes. A promising appears to be the extension of the algorithm functionality to other image processing operations. For example, the detection of images in a query image can be accomplished by the application of procedures like the pyramid representation. Also it seems to be justified to search methods of keypoints detection which are dedicated for image classifier.

Acknowledgments

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Idea Planter: A Backchannel Function for Fostering Ideas in a Distributed Brainstorming Support System

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Abstract. This paper describes the development and evaluation of a backchannel function for distributed brainstorming support system. It also considers the effect of backchannels on ideas in a distributed environment. We defined 'Ability to see or sensitivity to problems', 'Originality', and 'Elaboration' as factors of backchannel that contribute to idea creation. The backchannel function was implemented as a single button click. The experiment was carried out with two sets of four people in a distributed environment. The comparison of the quantity of ideas showed that there was no statistical difference (Mann-Whitney U test: $p > 0.75$). Moreover, the ratio of feasibility between created ideas also did not show a statistical difference (Mann-Whitney U test: $p > 0.2$). On the contrary, the ratio of fluency between created ideas showed a statistical difference (Mann-Whitney U test: $p < 0.046$). As a result, it was suggested that a backchannel function might improve the outcome of distributed brainstorming sessions. In particular, the fluency of individual ideas might be improved significantly.

Keywords: Backchannel, Brainstorming Support System, CSCW, Distributed Brainstorming.

1 Introduction

In recent years, the study of groupware in distributed environments has especially attracted attention in computer supported cooperative work (CSCW). In particular, research into brainstorming support systems has progressed significantly.

The distributed environment is non face-to-face, hence communication is limited in comparison with face-to-face communication scenarios. For this reason, it is necessary to develop a new communication function for creative activities between participants in distributed environments.

On the contrary, uncontrolled communication has a high risk of loss of anonymity. As a result, it might inhibit idea creation. Hence, new communication functions that do not disturb brainstorming activities are needed.

In order to meet these requirements, this paper focuses on 'Backchannel' as a means of effective communication in brainstorming activities conducted in distributed environments. A backchannel is a straightforward communication, and is usually used

of our evaluation showed that *Use-BF* is more effective in generating ideas with better quality as compared to *Non-BF*. However, the same cannot be said of the quantity of ideas generated by *Use-BF*.

The results of the experimental evaluation suggested that the effects of the back-channel may depend on the theme. Therefore, it is necessary to conduct experiments with multiple themes that vary according to their purpose. Moreover, a study of the associative process of ideas and types of backchannel, as well as the associative process of newly created ideas and types of backchannel, is not sufficient. It is necessary to increase the number of subjects. We would consider conducting such studies in future.

Acknowledgement

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The Impact of Changing the Way the Fitness Function Is Implemented in an Evolutionary Algorithm for the Design of Shapes

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Abstract. Evolutionary algorithms (EA's) have been used in many ways for design and other creative tasks. One of the main elements of these algorithms is the fitness function used by the algorithm to evaluate the quality of the potential solutions it proposes. The fitness function guides, constrains, and biases the algorithm's search for an acceptable solution. In this paper we explore the degree to which the fitness function and its implementation affects the search process in an evolutionary algorithm. To do this, the reliability and speed of the algorithm, as well as the quality of the designs produced by it, is measured for different fitness function implementations.

Keywords: Evolutionary algorithms, fitness function, evolutionary design

1   Introduction

Evolutionary algorithms (EA's) are general-purpose search methods that operate on the individuals in a population of potential solutions to a problem [4]. An EA will evolve these potential solutions through a series of generations until some convergence criterion is reached. They embody such a general-purpose search method that it is no surprise that EA's have often been applied to the support of design and other creative tasks. Two compendia of example systems and applications can be found in [1] and [2]. In many of the examples included in these compendia, the fitness function is not automated. Instead, in some of the example approaches a user is asked to determine the fitness function by tweaking the values of different parameters provided through system interface controls. In some of the other examples, votes are gathered from a large set of users to rank the solutions proposed by the systems and therefore eliminate the need for a fitness function to be explicitly programmed. Instead, in our work we are concerned with the traditional EA method of having a completely pre-programmed, autonomous, fitness function integrated into the EA's functioning.

vergence, and the quality of the solutions it produced. In one of the experimental scenarios tested, a slight difference in how the evaluation functions were combined was also the difference between the EA being able to complete its task (the experiment) or not (because the computer ran out of memory space in the middle).

In a typical paper describing a given EA, the way that fitness evaluation is performed by the EA is usually merely described, without any explanation about why it is the "best" way of doing it or whether alternative algorithms/implementations might be feasible or were tested. This leads us to suspect that in most cases alternatives may not have even been considered, and that the implementation that was used was chosen merely because it was the first one that came to mind to the researcher involved in the project, or because it has worked in the past for the same or other researchers (whether the application domain was similar or not), or because the researcher is comfortable with it, or other such possibilities.

However, as we have seen with our experiments, even minor variations in the way that fitness evaluation is implemented can cause large differences in the performance of an EA. What this indicates is that, when using an EA, making a few preliminary trials that evaluate alternate fitness evaluation implementations might enable the construction of more robust, more efficient, more reliable EA's, capable of producing better solutions. If, instead, an EA is simply endowed with whatever the first implementation that comes to mind is, without even thinking about alternatives, there is no guarantee that one has achieved the "best" possible EA for that domain. Taking into account these lessons learned from our experiments can have a major impact on whether a particular EA will be able to successfully provide support for creativity in a given domain or not. Further work would be needed to determine whether general principles or guidelines could be proposed in order to suggest how to implement the fitness evaluation function under different application domains and operating conditions when using EA's for creativity support.

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Feature Selection using Cooperative Game Theory and Relief Algorithm

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Abstract. With the advancements in various data-mining and social network related approaches, data-sets with a very high feature - dimensionality are often used. Various information theoretic approaches have been tried to select the most relevant set of features and hence bring down the size of the data. Most of the times these approaches try to find a way to rank the features, so as to select or remove a fixed number of features. These principles usually assume some probability distribution for the data. These approaches also fail to capture the individual contribution of every feature in a given set of features. In this paper we propose an approach which uses the Relief algorithm and cooperative game theory to solve the problems mentioned above. The approach was tested on NIPS 2003 and UCI datasets using different classifiers and the results were comparable to the state of the art methods.

Keywords:
Feature Selection, Game Theory, Shapley Values, Relief Algorithm

1 Introduction

A lot of modern day machine learning problems, such as social network clustering, gene array analysis and various other bioinformatic problems have to deal with a lot of data in the form of a large number of features. Feature selection is a process of selecting a set of features from the original features such that it boosts the performance of the task at hand. Feature selection is defined by many authors by looking at it from various angles. But as expected, many of those are similar in intuition and/or content. The following lists those that are conceptually different and cover a range of definitions [6].

Idealized : find the minimally sized feature subset that is necessary and sufficient to the target concept [16].

Classical: select a subset of M features from a set of N features, $M < N$, such that the value of a criterion function is optimized over all subsets of size M [22].

Improving Prediction accuracy: the aim of feature selection is to choose a subset of features for improving prediction accuracy or decreasing the size of the structure without significantly decreasing prediction accuracy of the classifier built using only the selected features [15].

Table 5: Comparison of the best results with the state of the art results

Name	Highest Accuracy	State of the Art
Arcene	85.4%	86% [4]
Arrhythmia	81.92%	84.2% [4]
Dexter	96.19%	94% [4]
Isolet	77.59%	83.65% [27]
Musk	94.78%	96.13% [27]
Optical Recognition	98.31%	98.72% [27]

The state of the art results are compiled from various published results.

d reduces the number of computations drastically. α is useful when we have a tradeoff between the final data at hand and the overall accuracy of the system. We prove it experimentally that we can easily change the value of α depending on the problem at hand. β allows us to from a coalition of features such that their overall contribution to the coalition increases, which also means that the importance of the feature towards the overall coalition increases.

As can be seen from the above results, the proposed algorithm is close to the state of the art feature selection techniques in most of the cases and beats some of the others either when it comes to processing time or the accuracy achieved by the classification algorithm. This proves that the proposed approach can easily be used to do a smart feature selection for a lot of real-world problems.

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Detecting Context Free Grammar
for GUI Operation

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Abstract. We apply an algorithm of grammar compression to the detection of regularity in our operation of a computer. When we observe only a surface sequence of inputs, we may be able to find a simple grammar as is often the case in usual grammar learning algorithms. In order to learn such regularity, however, we consider the resultant state of each operation, that is, the output when we regard an operation as an input. In this paper, we aim at finding a hidden grammar rules, considering the each state change in a computer system per an input. As a result, we find the regularity of human behavior in system manipulation, as well as hidden grammar rules.

Keywords: Knowledge extraction and integration, Context Free Grammar, Grammar compression, Programming by Example

1 Introduction

Many disciplines of research concern how we can reduce the burden of daily routine work on computers. Automating such routine work will help us to improve our creativity. For such techniques, Programming by Example (PbE) tries to find our intentions, given examples of tasks, and generates a program. PbE has been well studied in relation to program synthesis, and its recent results are shown in [2].

One of the most significant functions of PbE is to learn *macro*s, which is a kind of tape recorder that record and replay sequences of inputs. Recently, the automatic detection of the beginning/terminal points is proposed by [1]. Elliott revised the compression algorithm of Lempel-Ziv78 (LZ78) [7], and proposed to learn a macro from the history of operation from Graphic User Interface (GUI), i.e., desktop appearance. The result of the algorithm is a special representation of Trie tree, i.e., a finite state automaton (FSA).

LZ78 belongs to a class of algorithms of universal data compression, and there exists another class is called grammar compression (GC) [4]. The result of GC algorithm is context free grammar (CFG) which is a different representation of the result by Elliott. Thus, we can consider to apply the criteria of macros by Elliott also to the result of GC without modification of its algorithm, since such repetitive substrings are always regarded as a hierarchical category. Therefore,
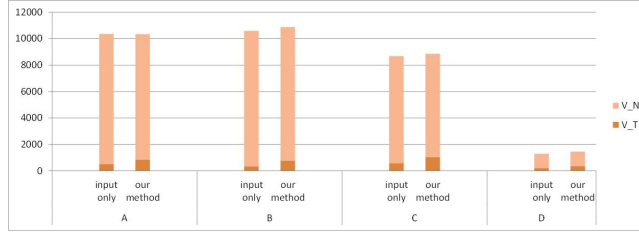
Fig. 8. Ratio between V_T and V_N for each CFG
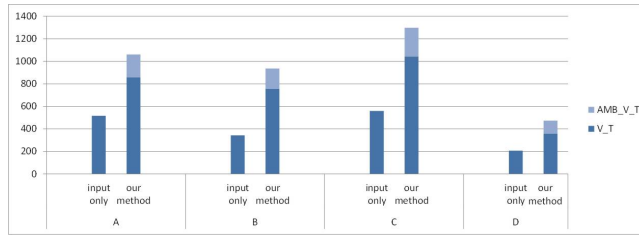
Fig. 9. Normal and ambiguous terminal symbols

and tried to find this hidden CFG rules. As a result, we could find a proper representation of such rules.

We have collected rather limited record of human operations, but still we could find the features of human behavior in such grammar finding process. Our future target is to find regularity in such a complicated situation, with bigger data. The more a result includes such actual information, the more it contributes to our creativity through analyzing and reducing our routine works.

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Creativity Effects of Idea-Marathon System (IMS): Torrance Tests of Creative Thinking（TTCT）Figural Tests for College Students

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Abstract. Idea-Marathon System (IMS) is a creativity training process, based on the use of notebooks, in which we make a daily habit of writing our ideas immediately by managing to create any new idea regardless of any thinking area. This paper presents an experimental analysis conducted at Ohtsuki City College (OCC) to quantitatively measure creativity effect on college students before and after a 3 month IMS training. TTCT (Torrance Tests of Creative Thinking) Figural Pre and Post tests were used to confirm the creativity effects on students quantitatively. The group with 3 months of IMS training showed significant increases in "Total Score", "Fluency," "Originality" and "Resistance to Premature Closure (RPC)" while students in the control group showed a significant increase in "RPC" only. Support system of IMS "e-Training System (ETS)" was found moderately correlated with "Fluency". Top, Middle and Low analysis showed improvement in Middle and Low through 3 month IMS.

Keywords: Idea-Marathon System (IMS), Torrance Tests of Creative Thinking (TTCT) Figural tests, e-Training System (ETS)

1   Introduction

The four P's model of Mel Rhodes: a creative person, a creative product, the creative process and the creative press[13], shows that creativity means wide-ranges, many directions and many fields. In this paper, we discuss the creativity education in college students.

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Complementarity
and Similarity of Complementary Structures
in Spaces of Features and Concepts

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Abstract. Authors present an approach to real-life phenomena modeling through concepts' descriptions gathered in features vectors. The start point of analysis are imprecise, fuzzified features, which describe objects. Developed model (feature and concept spaces) formalizes units and groups of knowledge granules. The goal of this study is to discuss complementarity and similarity of complementary features structures. Complementarity of features provides auxiliary knowledge, which should be taken into account. In the article two methodologies for calculating similarity between complementary sets of features are presented. First approach is based on authors generalized similarity measure based on the underlying concept space. The second methodology relies on distance measure, computed directly between features vectors. Addressed issues (most importantly complementarity) are authors contribution to the area of knowledge modeling and structuralization.

Key words: concepts, features, similarity, complementarity

1   Introduction

Real-world phenomena are often very difficult to describe and to process. Conventionally, we are rather using attributes, or in other words features, to characterize objects. Complexity of real-world concepts makes it impossible to precisely define and predict phenomena like unemployment, market fluctuations or consumer behavior. Plenty of contemporary models account only a fraction of influencing attributes, but it is often impossible to identify them all. Moreover, it is often not doable to precisely express knowledge about attributes.

In this article a general approach to phenomena description is discussed. Of interest is the space of concepts (real-world objects), which are being described by their features. Feature and concept spaces contain available knowledge and allow to characterize relations between features and relations between concepts. The nature of analyzed knowledge is imprecise. Features evaluations are fuzzified. We focus on positive information only. Of interest is structuring in the space

5   Conclusions

The paper discusses structuralization in the feature and concept spaces. The nomenclature of formalized units of knowledge - space, which correspond to the real-world objects is introduced. Concepts are described by their features. Particular evaluations of features allow to describe and distinguish different objects. Features evaluations are expressed as numbers from the $[0,1]$ interval. Valuation mapping links space of descriptions with the space of concepts. Within such formal model authors have developed similarity relation s_G, which allows to calculate similarity between two concepts.

In this study the property of complementarity has been presented. Similarity of complementary structures was discussed. Two distinct methodologies were suggested. First approach allows to compute similarity directly between features vectors. Second methodology relies on the underlying concept space and utilizes similarity relation s_G and the valuation mapping $\mathcal{V}$. In the second approach objects' descriptions are compared indirectly, thorough the space of concepts.

In future research authors plan to analyze different forms of structuring in the space of features. We will also focus on further generalization of our approach and on applying it with bipolar information representation models.

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Classification with rejection: concepts and formal evaluations

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Abstract. Standard classification allocates all processed elements to given classes. Such type of classification assumes that there are only native and no foreign elements, i.e. all processed elements are included in given classes. The quality of standard classification can be measured by two factors: numbers of correctly and incorrectly classified elements, called True Positives and False Positives. Admitting foreign elements in standard classification increases False Positives and, in this way, deteriorates quality of classification. In this context, it is desired to reject foreign elements, i.e. to not assign them to any of given classes. Rejecting foreign elements will reduce the number of False Positives, but can also reject native elements reducing True Positives as side effect. Therefore, it is important to build well designed rejection, which will reject significant part of foreigners and only few natives. In this paper, concepts of evaluations of classification with rejection are presented. Three main models: a classification without rejection, a classification with rejection, and a classification with reclassification are presented. The concepts are illustrated by flexible ensembles of binary classifiers with theoretical evaluations of each model. The proposed models can be used, in particular, as classifiers working with noised data, where recognized input is not limited to elements of known classes.

Key words: rejection rule, ensemble of binary classifiers, reclassification

1 Introduction

Pattern recognition is one of the leading subjects in the field of computer science in its both theoretical and practical aspects. For decades, it has been a subject of intense, purely theoretical research inspired by practical needs. The results have been published in prestigious scientific journals. Example applications are: recognizing printed text, manuscripts, music notation, biometric features, voice, speaker, recorded music, medical signals, images, etc.

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E-Unification of Feature Structures

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Abstract. Unlike structural unification, *E*-unification of feature structures has, to the best of our knowledge, never been used in natural language processing (NLP). We formalize the concept of *E*-unification for features structures, present a universal *E*-unification procedure and discuss its computational tractability for arbitrary as well as linguistically motivated *E*-theories. A number of examples illustrate the usefulness of *E*-unification in the domain of NLP.

Keywords: feature structures, *E*-unification, abstract rewriting systems, knowledge representation and reasoning

1 Introduction

The use of *E*-unification in feature structure based grammar formalisms is investigated in this paper. The reported results are an outgrowth of research on syntactically formed complex predicates [1, 2] and their linguistically motivated formal description and treatment without the use of the so-called restriction operator [9, 10, 17].

The notion of feature as a formal means of linguistic description originated in the tradition of the Prague school of linguistics in the interbellum [14]. The methods described in this paper can be used in any feature structure based formalism such as Lexical-Functional Grammar [8, 7, 5] or Categorial Unification Grammar [15]. Most of the formalisms utilize a context-free or categorial grammar processed by a chart parser as a backbone. The use of charts and unification in natural language processing goes back to Colmerauer [6]. Kay [11, 12] was probably the first to use feature structures and the operation of unification on them in a formal grammar which is an analogue to term unification in first-order logic. *E*-unification [3, 4] comes into play if we define equality (modulo a theory *E*) on feature structures. An example from the domain of NLP is presented in the next section.

2 Motivation

Informally, (structural) unification only adds information to feature structures. However, sometimes it seems necessary to "merge" two feature structures in a way that is incompatible with structural unification. A well investigated case are syntactically formed causatives in Romance languages [1, 2]. A Catalan example is given in (1).

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Functional Dependency Parsing of Nonconfigurational Languages

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Abstract. The paper presents a dependency-based linguistic formalism which defines two syntactic layers, surface and deep, and the formal relationship between them. This relationship forms the basis of a rule-based grammar description that can be straightforwardly implemented to be used in natural language processing.

Keywords: natural language processing, syntactic analysis, unification-based grammar

1 Introduction

Chomsky's original approach to formal syntax which is still the foundation of many computational frameworks assumes that sentences consist of constituents[1] and that the type and order of these constituents define configurations that specify grammatical relations. As has been shown by Hale [7], there are languages in which word order has no or limited relevance for grammatical relations and the respective constituent trees are flat. In most such languages, word order is said to specify information structure (hence the name "discourse-configurational languages" coined by Kiss [10], as opposed to syntax-configurational languages). In this paper we examine parsing techniques for Aymara,[2] an affixal polysynthetic language (according to Mattissen's [12] classification, see also [2]) which is neither syntax-configurational nor discourse-configurational. In Aymaran languages,[3] information structure is expressed morphologically. As an example, consider the following sentences in English (syntax-configurational), Russian (discourse-configurational) and Aymara (**N** marks contextually new, i.e. non-predictable information; * marks an ill-formed sentence):

(1)
  (a) *Peter came*$_N$
     It's Peter$_N$ *who came* (**Came Peter*)
  (b) *Петр пришел*$_N$
     Пришел Петр$_N$
  (c) *Pedrox jutiwa*$_N$ or *Jutiw*$_N$ *Pedroxa*
     Pedrow$_N$ *jutixa* or *Jutix Pedrowa*$_N$

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[1] continuous phrases

[2] Detailed information about Aymara can be found in [9, 3, 1, 5].

[3] Aymara, Jaqaru, and Kawki

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How Does Human-Like Knowledge Come into Being in Artificial Associative Systems?

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Abstract. Knowledge is fundamental for intelligence and allows us to
consider tasks and solve various problems. Knowledge is formed individu-
ally in brain during one's whole life. It can be verified, changed, specified
and expanded. The knowledge is available through associations that can
be automatically triggered in a context of previous thoughts, associations
and changing happenings in surroundings. The associations are instan-
taneously triggered all the time in various brain parts. One association
usually triggers another. The way of association can change accordingly
to the surroundings, needs, emotions, and the current knowledge in time.
The changes in knowledge influence individual processes of association
and reasoning. All conclusions are knowledge dependent. This paper re-
veals and models some associative processes that take place in neural
associative systems and enables them to form knowledge in an associa-
tive way. Such associative systems allow us also to exploit the knowledge
in the similar way people do using associations, various contexts and
previous states of neurons of the biological associative systems.

Keywords: knowledge representation, knowledge formation, knowledge
engineering, associative knowledge, as-knowledge, artificial associative
systems, associative neuron, as-neuron, associative reasoning, semassel.

1 Introduction

Knowledge is essential for intelligent intentional reasoning. Knowledge is nowa-
days often treated as a set of facts and rules, and implemented using various
kinds of data bases and expert systems [6] [7] [9] or as an inner configuration
of a neural network that has been created in a training process for a given set
of training samples [12]. Human knowledge cannot work as a relational data
base because the speed of neurons could not enable people fast associations in
a process of looping and searching for suitable data taking into account a large
amount of knowledge and remembered data. Moreover, brains of living creatures
have no suitable structures for storing data tables that are currently commonly
used in today's computer systems. On the other hand, the various kinds of artifi-
cial neural networks currently used in computational intelligence can be trained

recalled answers can be sometimes new and creative as a result of generalization. This is possible due to the limited context that as-neurons can take into account because they still gradually return to their resting states. Their under-threshold excitations can affect next activations and the associative process that creates the answers for the asked questions. Finally, the often activated as-neurons in close periods of time can be connected or reinforce existing connections.

The introduced artificial associative systems and their ANAKG subgraphs are able to form knowledge in an associative way. The trained systems can answer questions recalling artificial associations. The training process as well as the process of recalling associations is fast and contextual thanks to the introduced associative model of neurons. The context is not always sufficient for unambiguous activations and recalling trained sequences but this feature is beneficial in view of generalization and creativeness. If the context would be always precise then alternative and new associations will not be possible. Concluding, knowledge can be formed in the as-systems as a result of weighted consolidation of various facts and rules in accordance to their similarities and subsequent occurrences. Knowledge can be contextually evaluated by recalling some facts and rules as the result of activations of as-neurons. Some new facts and rules can be also created thanks to generalization mechanisms that works in these systems.

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Integrated Analysis System to Improve Performance of Manned Assembly Line

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Abstract. Presented in this paper is a framework for an integrated analysis system for performance improvement of a manned assembly line. In a manufacturing system, productivity is a key for competitiveness, for product output, and the performance of assembly line operations is one of the decisive factors of productivity. However, existing approaches to the manufacturing systems are limited to matters of the plant layout or the robot tasks design in the automated factory and to the manual work focused on the ergonomic based analysis. Consequently, a modern approach for line performance improvement has been researched as individual elements that contribute the line performance, but it has not been researched a framework to synchronize the elements as a productivity improvement activity in terms of an entire line. In other words, there is not a clear solution to integrate analysis results of micro and macro elements, which represent line capabilities in different levels. As a solution of this problem, this study proposes a framework for a system that focuses on the analysis result integration to improve performance of a manned assembly line, and shows a software tool that is implemented based on the proposed framework.

Keywords: Integrated Analysis, Manned Assembly Line, Performance Improvement, Productivity

1   Introduction

Productivity of a manufacturing system is the most important element that determines the enterprise competitiveness. Manufacturing enterprises must have an activity for productivity improvement continuously. A manned assembly line is one suitable manufacturing system to manufacture for better flexibility than the automated system. This system has been adopted in the industry for electronic appliances, i.e. television and refrigerator. In design of the manufacturing system, fully automated using dedicated tools for the system is hindered, because electronic appliances are many different products with frequent changes. The manned assembly line is structured by three factors of machine, worker and material (see Fig. 1), and the productivity is determined by machine capacity, worker performance and product design. After built up all the equipment and operation plans of assembly lines, it is difficult to modify the layout or replace the equipment. Therefore, improvement of the worker performance is an appropriate approach to the productivity enhancement of installed lines.

every workstation of an assembly line are aligned to represent productivity of an assembly line in the line analysis. The line analysis result represent line balance efficiency and poor workstations that are required to be revised in the workstation analysis. Finally, the low line balance efficiency is revised by re-allocation of work elements to workstations of a line.

The implemented system based on the framework was already distributed to workfields. In the future study, we will research whether the system fits all requirements to analyze all issues of performance improvement in a manned assembly line, and show an example of workstation and line performance improvement.

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Formal Encoding and Verification of Temporal Constraints in Clinical Practice Guidelines

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Abstract. In the last decades, clinical practice guidelines have been formulated in order to help decision making about treating specific diseases and promote standards of care quality. Despite the efforts involved to provide solutions for both specifying and verifying temporal constraints in computerized guidelines, none of them is concerned with directly embedding the theoretic semantics of a formal language as the basis of a guideline formalism in order to easily and directly support the temporal perspective. In such a direction, this paper proposes a formal approach which has been seamlessly embedded into a standards-based verifiable guideline model, named GLM-CDS (GuideLine Model for Clinical Decision Support). Such an approach integrates the theoretic semantics of ontology and rule languages to specify and automatically verify a variety of temporal constraints. Such constraints are formulated according to some time patterns, i.e. task duration, periodicity, deadline, scheduling and time lags, and encoded as axioms/formulae verifiable at run-time during the guideline enactment, in order to detect violations or errors occurred with respect to the temporal perspective. As an example of application of the proposed approach, some temporal constraints have been implemented and integrated in GLM-CDS, according to the time patterns identified.

1   Introduction

In the last decades, Clinical Practice Guidelines (hereafter, CPGs), embracing both clinical evidence and expert consensus, have been formulated in order to help decision making about treating specific diseases, promote standards of care quality and focus efforts to improve health outcomes when followed [15]. Several recent studies have suggested that an actual empowerment in the overall quality of care has been realized by encoding CPGs into advanced Decision Support Systems (hereafter, DSSs), i.e. computer-based systems designed to promote a better integration into the

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A Color Extraction Method from Text for Use in Creating a Book Cover Image that Reflects Reader Impressions

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Abstract. The image on a book cover gives potential buyers not only an impression of the book's contents but also a clue for search and browsing before or after buying the book. We propose using a color extraction method as the first step in automatically creating book cover images that reflect readers' impressions. We constructed a database expressing the relationships between adjectives and colors and extracted colors from text such as sentences in the book and user reviews. In an experiment with 20 participants who were tasked with reading a book, writing a review of the book, and drawing an image of the book cover, we demonstrated that the colors extracted using this method were more consistent with the colors in the images drawn by the participants than the colors in the actual cover, especially for novels, regardless of the amount of text in the book.

Keywords: color extraction, adjective, book cover image, user review, color psychology

1   Introduction

The use of electronic devices for reading digital books is quickly spreading, and the market for digital books is growing rapidly [6]. There are two basic types of digital books: printed books that have been digitalized and books prepared only in digital form. The use of electronic devices for reading has changed not only how people read books but also how they select books. Moreover, some digital books come without a cover, unlike printed books.

A book cover serves an important function—it gives potential buyers an impression of the book. Therefore, digital book sold online [2,3] that have been in the public domain or are original digital books and are provided without book cover images. They are often given images containing only the book title with a standard design. The colors in the image are defined on the basis of the genre or are simply random.

oped a method for extracting colors from texts such as digital books and user reviews. We evaluated this method experimentally by tasking 20 participants to read a book, write a report about it, and draw an image of the book's cover. We found that (1) the degree of coincidence between colors extracted from our method and colors extracted from p-cover images was higher when the text was extracted from both books and reviews than when it was extracted from only the books, (2) there is sometimes a difference between the actual cover and the readers' impressions after reading it, (3) our method can extract colors related to the reader impressions regardless of the number of letters in the book, and (4) our method is works better for novels than for reviews. We have demonstrated that our method can extract colors for use in creating book cover images that reflect the reader impressions.

To create an effective cover image reflecting readers impressions, it is necessary not only to improve the accuracy of the color extraction by enhancing the word analysis but also to optimize the arrangement of the extracted colors, to extract symbolic objects from body text, and to represent bibliographic information (title, authors, etc.).

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On the role of computers in creativity-support systems

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Abstract. We report here on our experiences with designing computer-based creativity-support systems over several years. In particular, we present the design of three different systems incorporating different mechanisms of creativity. One of them uses an idea proposed by Rodari to stimulate imagination of the children in writing a picture-based story. The second one is aimed to model creativity in legal reasoning, and the third one uses low-level perceptual similarities to stimulate creation of novel conceptual associations in unrelated pictures. We discuss lessons learnt from these approaches, and address their implications for the question of how far creativity can be tamed by algorithmic approaches.

Keywords: Algorithmic creativity, creativity-support systems, conceptual similarities, legal reasoning, perceptual similarities, stimulating creativity.

1 Introduction

Even though the last few decades have seen a steady progress in the development of computer systems that produce artifacts in the domain of visual art [7] [37], music [6] [34] [38], literature [33] [42]; and so on, generally they have received a negative press as regard to their creativity: computers cannot have emotions, programs do not have intents, creativity cannot be algorithmic, etc. etc. [4] [48]. Even designers of computational creativity systems seem to take an apologetic tone when it comes to ascribing creativity to their systems. For example, Colton [8] argues that it is not enough to generate an interesting or creative artifact, but one must also take into account the process by which the artifact was generated. Krzeczkowska *et al.* [32] took pains to project some notion of purpose in their painting tool so that it might be perceived as creative. Such views blatantly expose the implicit assumptions underlying creativity: namely that it crucially needs a creator with emotions, intentions, and such. A consequence of this view is that creativity is considered an essentially human trait, and cannot be ascribed to computer programs or AI systems (or to animals like elephants and gorillas).

We critically examine this traditional view in the light of our previous experiences in designing creativity-support systems and modeling creativity. We present three such

order to be useful for at least some audience [2] [47] [56]. For novelty, research on real-world creativity shows that it is difficult for people to step out of their conventional and habitual conceptual associations. To overcome this inertia, several methods like making the familiar strange [15], concept displacement [49], bisociation [30], lateral thinking [11], estrangement [45], conceptual blending [12], and so on, have been proposed in the literature. However, computers do not have this inertia, and so they can be very effectively used to generate novel ideas. This argument has been presented in more detail elsewhere [26]. Our experience in developing creativity-assistive systems (reviewed in Sec. 2 above) lends supports to this hypothesis.

However, when it comes to incorporating usefulness of the generated perspective or idea, our feeling is that, in principle, it is not possible to capture this aspect of creativity algorithmically. As this is a negative conclusion, we cannot really offer evidence to support it, but we hope that the arguments presented in Sec. 3 above are persuasive. Notwithstanding this hypothesis, we do not rule out the possibility that in limited domains it may be possible to characterize usefulness algorithmically, and design and implement computer systems that can generate statistically a larger number of useful and interesting artifacts and ideas. So combining this with novelty-generating systems, we can have computer systems that are creative. Systems like Aaron exemplify this approach.

Nonetheless, even in a limited domain, once the usefulness is characterized algorithmically, it loses its novelty, and gradually ceases to be creative. (See, for instance, the model of literary style change proposed by Martindale [36].) So while, we may be able to model some aspect of creativity within a style (with respect to usefulness), it remains doubtful whether creative changes in styles can be modeled successfully in a universal way. Again, to emphasize, novelty can be modeled — it is relatively easy to computationally generate new styles, but the problem is incorporate which styles will be successful (meaning people will adapt to them and find them useful). Therefore, our conjecture is that this second aspect of creativity will always remain the last frontier for the computational modeling techniques.

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Similarity of Exclusions in the Concept Space

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Abstract. The study is devoted to a developed model of formal knowledge representation. The author presents concept and feature spaces. Concepts correspond to existing entities and are described by their features. Valuation mapping matches evaluated features with the underlying concept space. The author is interested in relations structuring knowledge. The goal of this article is to investigate exclusion and similarity in the spaces of features and concepts. Three types of exclusions: weak, strict, and multiple qualitative are defined and discussed. Similarity of features evaluation vectors satisfying relations of weak or strict exclusion is thoroughly analyzed. Research on similarity is presented from two distinct points of view. First approach relies on direct features comparison. Second methodology uses dedicated similarity relation rooted in the underlying concept space.

Key words: concept space, feature space, similarity, exclusion, similarity of excluding features

1 Introduction

Formal models of knowledge and relations within data are important not only from theoretical, but also from applicational point of view. The literature discusses various approaches to knowledge representation and structuralization, for example ontologies or cognitive maps. In this paper the author presents a model of concept and feature spaces. The aim is to investigate relations in feature and concept spaces. In this study attention is paid to similarity and exclusion. Author's inspiration was the world of consumers. Hence, examples are related to common life situations, including purchasing choices.

The paper is structured as follows. In Section 2 a framework which formalizes feature and concept spaces is presented and a vector-based representation model is described. Valuation mapping, which allows to relate feature space with concepts, is introduced. Similarity relation customized for the developed model is presented. Section 3 is devoted to exclusion relations. Three distinct definitions of strict, weak and multiple qualitative exclusions are given. Section 4 discusses similarity of features satisfying weak or strict exclusion relations. Two distinct methodologies of calculating similarity for such features vectors are investigated.

To take full advantage of dependencies in the concept space, the second proposed methodology should be used. It calculates similarity of concepts' descriptions through the underlying concept space. The key is the valuation mapping, which relates features with concepts. An alternative and very flexible way of obtaining similarity of two vectors of features evaluations satisfying the relation of weak or strict exclusion is to calculate dependency directly with a distance-based measure.

In future, the author plans to extend the scope of research on other information representation models.

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Modeling Behavioral Biases
Using Fuzzy and Balanced Fuzzy Connectives

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Abstract. Authors present consumer decision making model built with respect to Lewin's field theory and Maslow's needs theory. A two-phase procedure for obtaining the decision is introduced. Consumer's opinions regarding arguments speaking for or against the decision are gathered in premises (general opinions) and priorities (particular attitudes) vectors. Premises and priorities are aggregated with balanced norms. The authors set focus on capturing complex aspects of the decision making process, namely imprecise, gradual information and behavioral biases. Various balanced norms, which allow to include biases and compute decisions, are investigated and described. Presented model joins psychological theories of motivation and decision making with balanced norms. The aim of this study is to show that well-known operators have powerful modeling capabilities and may be applied to describe complex aspects of human behavior.

Key words: multiple criteria decision making, behavioral biases, triangular norms, balanced norms

1 Introduction

Decision making is a cognitive process, which aims at expressing individual's preferences. It is based on input arguments and on subject's cognitive abilities. Cognitive abilities determine how one processes information. Specialists have observed systematic deviations from behavior considered as rational. These unexpected, but yet often occurring phenomena are called behavioral or cognitive biases. The research on cognitive biases is crucial in decision making.

Decision making has been discussed by scientists representing fields of economics, information sciences, mathematics and psychology. This article presents an interdisciplinary approach to decision making. The objective of this paper is to discuss various fuzzy sets connectives generalizations and their application to decision making modeling with behavioral biases taken into account.

The article presents how, using various pairs of balanced t-norms and t-conorms, we can model decision making based on both unipolar and bipolar information. Developed approach enables to capture complex aspects of this process, including imprecise, gradual knowledge and behavioral biases. The choice of operators determines the output. It is beneficial to apply balanced norms obtained with generating functions, adjusted to modeled phenomena. Balanced norms provide a solid framework for consumer decision making modeling. Modeling complex phenomena, like consumer behavior requires careful model preparation. In future research we plan to look closer into other information representation models, especially ones based on bivariate scales (with separate scale for negative and positive influences).

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Optical Music Recognition as the Case of Imbalanced Pattern Recognition: a Study of Single Classifiers

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Abstract. The article is focused on a particular aspect of classification, namely the imbalance of recognized classes. The paper contains a comparative study of results of musical symbols classification using known algorithms: k-Nearest Neighbors, k-means, Mahalanobis minimal distance and decision trees. Authors aim at addressing the problem of imbalanced pattern recognition. Firstly, we theoretically analyze difficulties entailed in classification of music notation symbols. Secondly, in the enclosed case study we investigate the fitness of named single classifiers on real data. Conducted experiments are based on own implementations of named algorithms with all necessary image processing tasks. Results are highly satisfying.
Keywords: pattern recognition, classification, imbalanced data

1 Introduction

The problem of pattern recognition is a data mining branch studied and developed for many years now. In a number of its applications, satisfying results have already been achieved, however, in many fields it is still possible to obtain better results. Certainly, one of the possible research fields is the issue of imbalanced data. For the purposes of this paper, the issue of imbalanced data can be defined as a case in which there are one or more of the following characteristics:

1. there are significant differences in the number of elements between classes;
2. elements within the same class have shapes that do not overlap;
3. objects belonging to different classes are very different in size;
4. objects in different classes are both simple and complex.

In this paper, the issue of imbalanced data is illustrated on the example of music notation symbols. The characters on the score have all of the four characteristics given above.

Musical notation symbols appear with varied frequency. Some of them, such as quarter and eighth notes, are very common, often appearing several times

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Building Internal Scene Representation in Cognitive Agents

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Abstract. Navigating in realistic environments requires continuous observation of a robots surroundings, and creating internal representation of the perceived scene. This incorporates a sequence of cognitive processes, including attention focus, recognition of objects, and building internal scene representation. The paper describes selected elements of a cognitive system, which implement mechanisms of scene observation based on visual saccades, followed by creating the scene representation based on a distance matrix. Such internal representation is a foundation for scene comparison, necessary for recognizing known places, or changes in the environment.

Keywords: visual saccades, scene model, episodic memory

1 Introduction

Humans are capable of intelligently acting in complex environments. For instance, we can find our destination in a city, interact with other people to exchange information or arrange objects in a room in a suitable way. In these tasks, we outperform current men built systems such as autonomous robots. Thus it is highly desirable to develop artificial agents, which will be able to support us in performing a rich variety of tasks, both in our daily environment, as well as in dangerous and inaccessible places.

For this purpose we devise computer models of intelligent information processing called cognitive systems [5]. Such systems should be able to collect and process a stream of sensory data to create internal representation of the environment, and undertake the proper actions. The original foundations for cognitive systems come from psychological theories and are also a part of artificial intelligence research. Such systems are composed of various components that mimic different mental functions. Among their most important elements are: sensory and motor functions, as well as different kinds of memory, including semantic, episodic, procedural, and working memory.

It is known that to carry out a successful navigation in complex environments, mobile robots must acquire and maintain internal representation of the
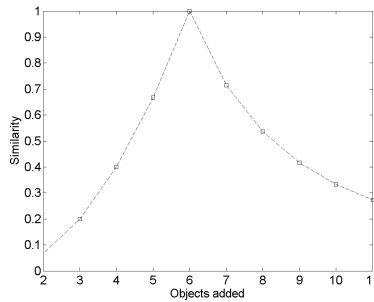
Fig. 8. Similarity for each step of the experiment

comparison, which can be used for comparing the currently observed scene with the contents of the episodic memory. The same mechanism can be applied to analysis of complex objects contained within scenes.

Sample experiments based on a virtual 3D environment were performed, in which the performance of the proposed similarity measure was demonstrated. The results show, that the proposed methodology gives satisfying results, however, the scene created in the virtual environment is simplified, and of much smaller complexity, than real world scenes. Thus the aim of future work will be extending the system to be able to process all the data delivered by a video stream, either registered in the virtual simulation or in real environment. The other research direction is developing a method for objects representation. In the current version of our system the objects have no internal structure.

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Selflocalization and Navigation in Dynamic Search Hierarchy for Video Retrieval Interface

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Abstract. We have improved previously proposed graphical search interface, 'Revolving Cube Show,' for multi-faceted metadata. This interface can treat discrete, continuous, and hierarchical attributes, enabling users to search flexibly and intuitively by using simple operations to combine attributes. We added two functions, one for displaying a search hierarchy as a guide tree and one for moving to a specific position in the search hierarchy, to solve problems identified through user testing. We created a video retrieval application using the improved interface for the iPad and tested it using data for 10,352 Japanese TV programs. The improved interface enabled users to easily understand the current position in the overall hierarchy and to quickly change specific attribute values.

Keywords: Multi-faceted navigation, Dynamic hierarchy, Video collection, Interactive visualization, iPad application

1   Introduction

A graphical search interface called *Revolving Cube Show* (*Cube* for short) for multi-faceted metadata has been proposed [10]. *Cube* can treat discrete, continuous, and hierarchical attributes, enabling users to search flexibly and intuitively by combining attributes with simple operations. A video navigation system implementing this interface for use with Japanese TV programs has been developed; it supported five attributes: channel, time zone, performer, genre, and airtime. Users were able to search intuitively by creating dynamic search hierarchies. However, *Cube* had two problems: (i) a user sometimes misunderstood the current position in the overall hierarchy because *Cube* displays only the previous and next values, and (ii) a user had to change the attribute values in the order specified by the system. That is, the user could not specify an attribute other than the previous or next attribute as a search key. To solve these problems, we added two functions: one for displaying a search hierarchy as a guide tree and one for moving to a specific position in the search hierarchy.

7am,' 'start time: morning - 8am' would appear after the user flicked the right side of the frame to the left. Although several faceted navigation approaches have been reported [1,12], they do not take into account the features of each attribute value.

5   CONCLUSION

We improved 'Revolving Cube Show' graphical search interface on the basis of user testing. We added two functions, one for displaying a search hierarchy as a guide tree and one for moving to a specific position in the search hierarchy. We created a video retrieval application for the iPad that takes into account attribute features and tested it using data for 10,352 Japanese TV programs. The improved interface enabled users to easily understand the current position in the overall hierarchy and to quickly change attribute values.

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Intuitionistic Fuzzy Dependent OWA Operator and Its Application

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Abstract. In this paper, we propose a novel approach, based on entropy and similarity measure of intuitionistic fuzzy sets, to determine weights of the IFOWA operator. Then we define a new intuitionistic fuzzy dependent OWA (IFDOWA) operator which is applied to handling multi-attribute group decision making problem with intuitionistic fuzzy information. Finally, an example is given to demonstrate the rationality and validity of the proposed approach.
Keywords: Multi-attribute group decision making, intuitionistic fuzzy values, intuitionistic fuzzy dependent OWA operator, entropy, similarity.

1 Introduction

The ordered weighted aggregating (OWA) operator [26], as an important tool for aggregating information, has been investigated and applied in many documents [1, 11, 20, 27]. One critical issue of the OWA operator is to determine its associated weights. Up to now, a lot of methods have been proposed to determine the OWA weights. Xu [19] classified all those weight-determining approaches into two categories: argument-independent approaches [6, 11, 14, 20, 23, 26] and argument-dependent approaches [1, 7, 19, 21, 24, 25]. For the 1st category, Yager [26] suggested an approach to compute the OWA weights based on linguistic quantifiers provided by Zadeh [28, 29]. O'Hagan [11] defined degree of orness and constructed a nonlinear programming to obtain the weights of OWA operator. Xu [20] made an overview of methods for obtaining OWA weights and developed a novel weight-determining method using the idea of normal distribution. For the 2nd category, Filev and Yager [7] developed two procedures to determine the weights of OWA operator. Xu and Da [21] established a linear objective-programming model to obtain the OWA weights. Xu [19] proposed a new dependent OWA operator which can relieve the influence of unfair arguments on the aggregated results. In [24, 25], Yager and Filev developed an argument-dependent method to generate the OWA weights with power function of the input arguments.

5 Concluding

In this paper, we propose a new argument-dependent approach, based on entropy and similarity measure, to determine the OWA weights. we apply the IFDOWA operator to a multi-attribute group decision making problem and illustrate the effectiveness of the approach. It is worth noting that the results in this paper can be further extended to interval-valued intuitionistic fuzzy environment.

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Creativity in online communication. Empirical considerations from a connectivist background.

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Abstract.

Computer-mediated communication (CMC) influences the user`s self. Different predictions were made how users' self and creativity may arise in an 'a-social' setting during the use of modern information and communication technologies. Some of these discourses even observe a new potential for creative self-constructions. The conceptual frame of this paper is delivered by the combination of different social scientific approaches coming from Social Psychology, Sociology and Communications Studies (cp. Köhler, 2003). Based upon a series of experiments, this paper investigates how the social self develops in CMC. Overall, the self is moderated by the characteristics of the channel, by psycho-social and finally by socialization variables. The influence of the channel is marked by immediate effects of certain cues, the psycho-social variable is the individual versus joint usage of CMC and the sociological dimension is the familiarity with CMC. All those influences have a specific meaning for the Creativity development in online communication. From a connectivist background it is discussed why and to what extent CMC has a prototype character for creative co-constructions in further forms of mediated interpersonal communication.

Keywords: Co-constructivist learning, social creativity, online user's self-development, computer-mediated communication.

1   Introduction

1.1   Influences of information and communication technologies of the users' identity and creativity

In recent years, information and communication technologies (ICT) have taken an increasing position of utmost importance in our private and business living environments. A great number of such social communities are nowadays inconceivable without using this technology, while other moulds emerge completely new, e.g. chatrooms. The term computer-mediated communication (CMC) has been established in psychological research and has been adopted by Sociology and Communication Sciences.

The user's self is treated as a theoretical construct describing a hypothetical cognitive structure. A theoretical background of the user's self advises the existence of at least two core components: can a personal individual and a social identity (cp. Mummendey, 1985). Whereas the individual identity involves the idiosyncratic aspects of a

5   Acknowledgement

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ALMM Approach for Optimization of the Supply Routes for Multi-location Companies Problem

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Abstract. Algebraic-logical meta model (ALMM) is a mathematical model of multistage decision process. This formal schema is knowledge representation of a problem and allows to optimize difficult problems on the basis of simulation. It is specially designed for decision problems for which it is impossible to establish all values and parameters a priori. One of such problems is the supply routes for multi-location companies problem. The aim of the paper is to present substitution tasks method (an optimization method based on ALMM) applied to mentioned problem. A formal algebraic-logical model of this problem, an algorithm based on substitution tasks method and results of computer experiments are presented.

Keywords: algebraic-logical meta model (ALMM), substitution tasks method (ST method), multistage decision process, scheduling problem, Multiple Traveling Salesman Problem (mTSP)

1 Introduction

Most of real optimization problems in logistic and manufacturing processes are NP-hard problems. Different exact and approximate methods are used to solve them, such as: mathematical methods (e.g. petri net, branch and bound, integer programming), heuristics (e.g. constructive heuristics, improvement heuristics) [9], metaheuristics (genetic algorithm, tabu search, simulated annealing) [10, 11] and agent methods [8, 12, 13]. Furthermore, there are numbers of problems for which values of some important parameters can not be determined a priori, because they depend on current state of the process. For example, time or cost of activities (job) performance depends on type and number of available resources in a current time - some resources can be already in use or new ones can be created during process. Also ability to start some job can depend on combination of different factors. Thus, in that case, it is impossible to determine a priori value of variables, parameters and constrains. In consequence it is hard or even impossible to implement the methods mentioned above. Such problem needs approach that allows to construct the solution sequentially, during simulation of

extensional research are planned, i.a. a comparison of ST method and SSIG method (learning method of Solution Search with Information Gathering [5]) and a possibility of changing (during process) an earlier made decision.

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A Japanese problem solving approach: the KJ-Ho method

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Abstract. In Japan, by far the most popular creative problem-solving methodology using creative thinking is the KJ Ho method. This method puts unstructured information on a subject matter of interest into order through alternating divergent and convergent thinking steps. In this paper we explain basic procedures associated with the KJ Ho.

Keywords: creative thinking, W-shaped problem-solving methodology, the KJ-Ho method

1 Outline

There is a number of creative thinking methods in existence, for example, brainstorming, brain-writing, mind-mapping, the KJ Ho (method) [1], the NM method, the Equivalent Transformation method, etc. Human thinking processes for creative problem solving typically consist of four sub-processes: divergent thinking, convergent thinking, idea crystallization, and idea-verification. In Japan, the most popular creative thinking method by far is the KJ Ho [6].
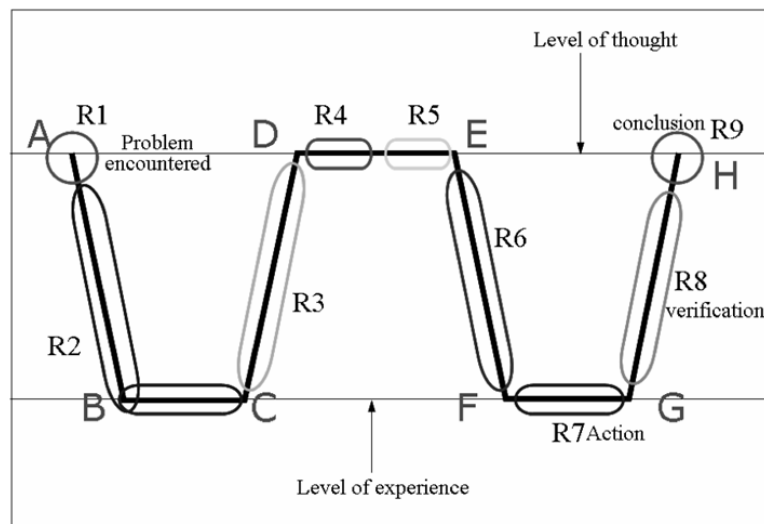
Fig. 1. The W-shaped problem-solving Methodology [5]

Round 8: Verification by testing. If the hypothesis is rejected, then retry another hypothesis generation by backtracking to Round 3.5. If it is acceptable, move to next Round 9. If all hypotheses are rejected, then go back to the checkpoint of Round 1.

Round 9: Conclusion and Reflection process. Accepted hypothesis must be added to our knowledge base.

4 Applications of the Cumulative KJ Ho

The Nomadic University [3,4] is a form of project where the cumulative KJ Ho as a W-shaped problem solving method is applied to a specific problem. These Nomadic Universities are typically held at the locations where the problems exist. The first Nomadic University was founded by Prof Jiro Kawakita (then, a Professor at Tokyo Institute of Technology) in August 1969, in Kurohime, Nagano, in the midst of student uprisings in Japan. This first event was called the Kurohime Nomadic University [3], a two week workshop in an outdoor campus, with attendants staying in tents. The author participated in this first event and this series continued to be held twenty five times in Japan up until 1999.

Further to this, there have also been numerous projects, seminars and mini Nomadic Universities [7] (shorter events, from 2008), which still take place today covering a very wide range of domains, including management and administration, energy and environment, health services, psychotherapy, regional development, engineering, construction, etc. in Japan.

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Modeling and Empirical Investigation on the Microscopic Social Structure and Global Group Pattern

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Abstract. In this paper, we investigate the microscopic social mechanisms through agent based modeling and empirical data analysis with the aim to detect the intrinsic link between local structure balance and global pattern. Both investigations suggest that three types of social influences give rise to the emergence of macroscopic polarization, and the polarization pattern is closely linked with local structure balance.

Keywords: social influences, agents based modeling, empirical data analysis, structure balance, macroscopic polarization

1   Introduction

Global polarization is widely observed in human society. Examples about the group behaviors patterns include culture, social norms, political election and on-line public debates on highlighted issues. From decision-making perspective, the global pattern of collective dynamics is rooted from individuals' micro-level decision making processes where social influence, as one of the important social psychological factors, plays a dominant role. Generally to say, from the social influence point of view, three types of impact run through the whole processes of group decision-making especially in voting. One is positive influence among in-group members; this kind of social force accelerates intra-group opinion convergence. The second one is the negative social impact which may block the formation of consensus among different groups. The third type refers one kind of special individuals' attitudes, or a state that the individuals do not belong to any labeled subgroups; members in the group have no common social identity, no firm stand about some opinions and are in a state of neither fish nor fowl [10-12].

From a bottom-up point of view, in modeling social processes, individuals' local cumulative interacting behaviors would evolve into different global patterns. The emergence of global features comes from the local interconnecting mechanism, e.g., short average path and high clustering coefficients contribute to small world mechanism [14]. However, it is difficult to infer how the global patterns are generated from

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Mining Music Social Networks
from an Independent Artist Perspective

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Abstract. The goal of this paper is to discuss various aspects of composing music in the computer era and mining music social networks from the independent artist perspective. Amateur pop composers search for music similar to their composition in order to be sure that certain aspects of their music are common to others, or, on the contrary, to be sure that they did not commit plagiarism. Others are interested in surprising effects of automated composing and put some demands on the produced music, e.g. required emotional character. As an illustration of the support that mining social networks may bring to independent artists some projects related to this subject, accomplished in the Institute of Computing Science, Poznan University of Technology, are presented.

Keywords: creativity, collaborative music composition, music social networks, music retrieval, music genre classification, music emotions recognition.

1 Introduction

Modern technologies have entered into the advanced process of audio creating, recording and processing. They also gave birth to new forms of distribution of recorded music among listeners. Traditional media, e.g. compact discs are constantly being replaced by the delivery of sound files via the Internet. As a result, we can observe an increasing number of sites offering large collections of musical works, counting millions of music tracks, requiring not only efficient database systems, but also advanced functionality, consistent with the growing user requirements for audio services.

Music, like any artwork, involves the activity of a number, often a large number of people. The expansion of Web 2.0, cheap music production possibilities and the *anybody-can-do it* paradigm enables many independent artists to create, perform and disseminate music. According to Chris Anderson [1], *The future of entertainment is in the millions of niche markets at the shallow end of the bitstream*. All these facts entail varying social dimensions and occur across an expansive range of social networks, often structured in completely different ways.

The common problem related to the Internet music consumption as well as independent music production is the search for musical pieces from huge variety of tracks – the search appropriate to the listener preferences or needs. Selection of music is a subjective task with fuzzy boundaries and thus it is difficult to be systemized. How-

The architecture of the system has been inspired by the modular system proposed in 1995 by B.L. Jacob [7] with the additional module responsible for the recognition of emotions. Even if the system automatically generates music, it still needs social network to mine the music according to emotions, which is needed to train the assessing module. Therefore, the emotional character of the music will be built on existing pieces and their emotional labels.

Conclusions

The development of Web 2.0 and 3.0 brought new opportunities for creative people and also changed the way of creating, distributing and listening to music. All these changes have influenced and will stimulate the creativity in general and music creation in particular. The paper has highlighted some problems related to music composing, that are related to amateur independent creators and their use of digital technology and social networks. The interest in utilizing digital technologies and machine learning in creative process depends on the musical interests of young composers and also change in time. Deeper insight into this problem needs more space and hopefully it will be possible to extend this topic in the near future.

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AN INTELLIGENT SYSTEM WITH TEMPORAL EXTENSION FOR REASONING ABOUT LEGAL KNOWLEDGE

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Abstract. Any enterprise has to adjust its strategy to environmental aspect, one of elements of which is legal environment. This environment is partly of temporal nature, so time has to be taken into account by an intelligent tool. In the paper we present first results of research aimed at building an intelligent system capable of reasoning about legal knowledge with its temporal aspects.

Keywords: temporal legal knowledge, intelligent systems, temporal reasoning, temporal logic and representation

1   Introduction

In the field of artificial intelligence, there are at least six "traditional" areas, in which temporal reasoning is needed. These are temporal databases, expert systems, planning, robotics, naïve physics, natural language understanding [5]. In contrast to classical logic, in temporal logic the same sentence can have different boolean values at different time (see e.g. [21]). Taking into account some ontology aspects, a strong connection of rules with logic makes it easier than other ways of knowledge representation to link them to temporal logic.

We would like to address in our paper the area of law. In 1992 Bench-Capon and Coenen [2] pointed out the need for using knowledge based systems in law. Law changes over time, and the structure of legal knowledge is of critical importance. Therefore knowledge based systems – if properly built – may constitute a great help for lawyers. Why legal knowledge is specific? As Mommers points out, this knowledge is of dual nature: it can concern legal rules and legal cases, or it can concern factual aspects of cases. This in turn causes different types of belief in the legal domain (for further details see [12]). Moreover, legal domain is nondeterministic, which makes reasoning even more complicated. Reasoning tasks must replace traditional analytical ones, as analytical tools are not applicable here [1].

Temporal aspects of legal rules were very well visible in one of the first experiments with formalization of British Nationality Act (1981), defining British citizen-

effectively solve certain classes of problems. The lack of ability of mapping/codification of the time in knowledge bases can limit range of applications of artificial intelligence systems as a tools for decision support in legal area. We are convinced that an important role after the acquisition and codification of legal knowledge in the knowledge base plays a process of validation and verification. So as far as temporal knowledge bases and reasoning are concerned, some of the possible future directions of Logos development are embracing among others: extension of its V & V functionality, taking into account aspects of temporality as well as implementation of selected temporal relations. From this perspective, Logos seems to be a ready environment for various experiments related to the testing of selected aspects of temporality. Using this system we plan to build more realistic temporal knowledge base in the legal domain having status of research prototype. If we succeed we will try to implement it in the selected organization.

As for representational issues, we are currently working on adapting temporally extended Situation Calculus to formalize temporal legal knowledge.

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Structural modeling approach to management of innovation projects

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Abstract. In the global and highly competitive economy innovativeness becomes the key factor of competitive advantage. Selecting the proper direction of projects development is the vital point of the innovation management. Such a decision is characterized by many conflicting objectives that additionally influence each other. To overcome the problem of interrelations between criteria the structural approach has been proposed. Two such methods, ANP and WINGS, have been applied to the choice of innovations' development. Their procedures and results have been also compared.

Keywords: innovation management, decision analysis, structural modeling, ANP, WINGS

1 Introduction

Innovation management belongs to the most important processes in many enterprises. Especially those that are active in high technology sector. Choosing the right way for future development of innovations is a crucial decision that needs processing a large amount of information coming from various resources. The competencies of different firm's divisions should be evaluated against the market conditions and their potential development. Taking into account the complexity of the problem the properly constructed model can become the important part of efficient decision making.

We propose a systematic approach to potential criteria that can appear in innovation management using the 5 main categories. It is argued that the interrelations between criteria do not permit the use of traditional model with the assumption of independence. Consequently, we need the appropriate methods that can cope with interdependencies. Currently there are not many possible approaches of this kind. We construct the multiple criteria model and solve it with the two currently available methods: Analytical network Process (ANP) and Weighted Influence Non-linear Gauge System (WINGS).

The rest of the paper is organized as follows. In Section 2 the criteria of innovation management are discussed. The multiple criteria model and its components are presented in Section 3. In Section 4 and Section 5 we show the solutions of the model received with two structural methods. Summary (Section 6) concludes the paper.

Table 3. *Total engagement* $(r + c)$ and *net position* $(r - c)$ received in WINGS

		$r + c$	$r - c$
Leader in production line	S1	0, 213	−0, 173
Enhance competitive advantage	S2	0, 227	−0, 174
Technological competencies	T1	0, 119	0, 028
R&D Competencies	T2	0, 147	0, 042
NPV	F1	0, 216	−0, 103
Financial risk	F2	0, 208	−0, 102
Stage of life-cycle	M1	0, 099	0, 001
Competitors' reaction	M2	0, 085	−0, 005
Customer satistisfaction	M3	0, 154	0, 042
Logistic competencies	O1	0, 122	0, 025
Marketing competencies	O2	0, 136	0, 045
Alternative 1	A1	0, 106	0, 106
Alternative 2	A2	0, 075	0, 075
Alternative 3	A3	0, 082	0, 082
Alternative 4	A4	0, 112	0, 112

The multiple criteria model that has been constructed can serve as the framework of decision support system for innovation management. It comprise 11 criteria grouped in 5 general categories. The decision alternatives represent the 4 possible directions of firm's innovation policy. They are based on the real options that can help to lower the risk of the decision.

Two structural approaches – ANP and WINGS – have been used to solve the model. It appeared that in similar circumstances and with similar evaluations they led to different decisions. To some extend, a choice of the method is the arbitrary decision and may be based on the user feelings. However, the direct comparison of the procedures shows that WINGS has some advantages. It is less demanding because, in contrast to the ANP, it uses the direct evaluations instead of pair-wise comparisons. WINGS does not need any specialized software as it employs only elementary matrix algebra. In addition WINGS always lead to non-ambiguous result. In the case of the ANP, an analysis is much more complicated since the final result depends on reducibility, primitivity and cyclicity of the stochastic matrix and, in many cases, some additional manipulations are needed [9].

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A Fuzzy Knowledge-Editing Framework for Encoding Guidelines into Clinical DSSs

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Abstract. Clinical guidelines have been more and more promoted as a means to foster effective and efficient medical practices and improve health outcomes, especially when implemented in clinical Decision Support Systems (DSSs). In this context, Fuzzy Logic has been proposed as the most suitable approach for profitably tackling uncertainty and vagueness in both clinical recommendations and signs triggering them. In this respect, since the task of building and maintaining a fuzzy knowledge base can be very complex and must be carried out carefully, this paper proposes AFEF (A Fuzzy knowledge Editing Framework), an editing and visualization framework for encoding fuzzy linguistic guidelines into clinical DSSs with the aim of providing intuitive solutions specifically devised to: i) define block of rules pertaining the positive evidence of the same abnormal situation; ii) compose ELSE rules for modeling the negative evidence associated to a block of rules; iii) customize the rules inside a block of rules through a common configuration for the inference; iv) simulate an actual DSS for testing the fuzzy rules inserted; v) automatically encode into a machine executable language the fuzzy clinical knowledge that could be functional in the context of clinical DSSs.

Keywords: Clinical DSS, Knowledge Editor, Fuzzy Rules.

1   Introduction

Recently [5, 6, 16], Decision Support Systems (DSS) have been proposed for medical scenarios in order to support physicians and patients in their daily activities by embedding a set of clinical recommendations of interest, with the final aim of simulating the process followed by the physicians. In medical settings, the use of clinical guidelines has been more and more promoted since they are able to foster effective and efficient medical practices and improve health outcomes when followed [17]. In this respect, the relevant medical knowledge formalized into a clinical DSS, coming from the encoded clinical recommendations, represents an active knowledge resource that uses patient data to generate case-specific advices, supporting health professionals, the patients themselves or other concerned about them [10]. With respect to mechanisms for embedding guidelines into clinical DSSs, on the one hand, some
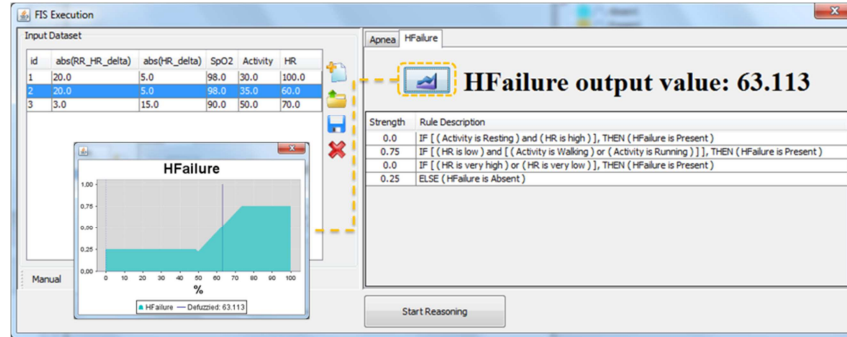
Fig. 10. The interfaces for visualizing the reasoning outcomes.

5   Conclusions

This paper described AFEF, a knowledge editing and visualization framework for guiding and assisting users in the creation and formalization of clinical practice guidelines. The driving philosophy of AFEF is to provide simple and intuitive interfaces for composing and verifying the parameters of the fuzzy inference system underpinning a clinical DSS so that a desired behavior is attained.

Differently from existing solutions, which do not provide any form of vertical arrangement for the particular domain of interest, AFEF has been mainly designed to face medical requirements, such as the coherent grouping of rules pertaining to a same conclusion (e.g. a particular diagnosis or therapy), explicit specification of rules for the positive evidence and the implicit formalization of rules for the negative one, intuitive facilities for a simple graphical formalization of guidelines, automatic encoding into an executable language for the final DSSs.

The key issue of AFEF relies on graphical facilities offered for easily creating and updating clinical guidelines, where each guideline pertaining a patient condition is composed by defining a strict relation between the linguistic variable modeling a patient condition, and the group of rules that contribute to make inference on such a variable. Next step of the research activities will also regard the improvement of AFEF by means of new intuitive facilities to automatically optimize the parameters of the fuzzy inference system underpinning a clinical DSS, such as data-driven techniques for tuning the knowledge base, and more advanced verification facilities to evaluate the consistency of the clinical guidelines encoded as fuzzy rules.

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Evacuation Assist from a Sequence of Disasters by Robot with Disaster Mind

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Abstract.   Great East Japan Earthquake in 2011 caused 118,549 people lost their lives. Especially, 70% of residents around the shore area could not evacuate immediately from the devastated Tsunami by the earthquake. Additionally, the devastated Tsunami by the earthquake caused Fukushima nuclear power plants explosions and nuclear spread influenced that 315,196 people evacuated from their home town. We propose a disaster robot as assistant robot "ACROS" including "disaster mind" to help people to avoid people's frequent psychological problems ("Normalcy Bias" and "Catastrophe Forgetting") and guide them to a safer place. ACROS could provide the latest information to the residents such as real-time Big Data emergency support, a map of radioactive contaminant, etc. We also discuss refugees support simulation by showing the warning pictures on a screen in a prototype of ACROS.

Keywords. safe evacuation guide, disaster robot, normalcy bias, catastrophe forgetting, collaboration among human and robot

1   Introduction

A sequence of the great disasters [8, 9, 10 and 14] such as the Great East Japan Earthquake in 2011 (See Fig. 1) and the devastated Tsunami by the earthquake caused Fukushima nuclear power plants explosion and nuclear spread. Especially 18,549 residents in many towns of about 400 kilo meters length near the earthquake area have lost their lives and 315,196 people needed to move out from their home towns, then. Therefore, many people in Japan aware the needs of emergency support to residences.

In the disaster time, people suffered from psychological problems such as "Normalcy Bias (NB)" and "Catastrophe Forgetting (CF)." For example, In the Great East Japan Earthquake, about 70% of residents in the beachside

Figure.1 Great earthquake with fire, giant tsunamis and an explosion of Fukushima III [12]

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Tree Representation of Image Key Point Descriptors

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Abstract. This paper describes a concept of image comparison method based on descriptors of key points generated by SURF algorithm. Proposed method for speed up comparison process uses tree-based representation of descriptors. We assume that descriptors tree representation of image key points is more efficient than standard list representation. The number of steps to compare sets of image descriptors will be smaller than in a case of list-based, all to all methods.

The proposed method assumes generation of a tree structure from a set of image descriptors generated by SURF algorithm. The descriptors are stored as leaves in the tree structure and other parent tree nodes are used to group similar descriptors. Each next parent node of the tree forms a wider, more general, group of descriptors. We store average values of the descriptors in the nodes making it possible to quickly compare sets of descriptors by traversing the tree from the root to a leaf by choosing the smallest deviation between searched descriptor and values of nodes. Each step in a tree traversing can drastically reduce the final number of descriptors that will be needed to compare. The proposed structure also allows for the comparison of whole trees of descriptors that speed up the process of images comparison.

Our method involves generating trees of descriptors for single images or groups of related images accelerating the process of searching for similarities among others. In future the method will be used as a base to develop tools for indexing images by their context.

Keywords: image processing, key points comparing, comparing trees

1 Introduction.

Recognizing and comparing images by their content is increasingly applied in many aspects of human life. These methods allow improving a lot of human activities that tend to be monotonous and grudgingly performed. Growing popularity of these methods is mainly due to development and increasing efficiency of electronic devices. It is closely related because image processing methods are very demanding in terms of the required number of operations and the amount of data that need to be processed.

5 Conclusions

The proposed method can speed up images comparison thanks to building descriptors tree. It requires only approximately 5% comparison operations of all possible key point combinations. Generated tree requires more memory than a list of all descriptors but its size is reduced by grouping similar descriptors. Number of similar descriptors depends on the amount of image details. The method obtained the worst results on images representing nature. In such a case, background contains a lot of unimportant and difficult to group details. These key points expand the descriptor tree by insignificant details of the compared images.

The method obtained the best results by processing artificial images created by humans, such as logos, diagrams, schematic. This is caused by a greater number of similar key points which mostly are related to the characteristic elements of the image that allows for better grouping of key points.

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Recognition of Agreement and Contradiction between Sentences in Support-Sentence Retrieval

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Abstract. Automatically classifying semantic relations between sentences is important for text understanding, specifically in helping users collect various viewpoints on a given topic (statement). This paper considers two main semantic categories which are agreement and contradiction in the scope of an application, namely support-sentence retrieval. We present here new sentence classification algorithms based on rules and bootstrapping method. Our initial seed data for training the bootstrapping-based classifiers is automatically built. Our best configuration of bootstrapping-based classifiers yields 5.9% higher result than the word overlap baseline in the agreement category. For the contradiction category, applying bootstrapping learning increases the $P@10$ by 12.1% when compared to the rule-based approach. These results are promising due to the fact that the whole process requires no human interaction.

Keywords: sentence classification, bootstrapping, text similarity

1 Introduction

Computing has realized human dreams of storing and transferring knowledge, which is primary represented by text. There have been a number of computer systems that can read text as good as a human and search for text faster than a human does. However, understanding text is still a difficult problem for a computer as natural language is so flexible. Humans can explain an idea in various ways (e.g., using synonym, altering sentence structure) while a computer could not learn such changes as easily as us. In the field of natural language processing, there are many tasks that deal with this issue, such as Word Sense Disambiguation [10], Semantic Role Labeling [7], Classification of Semantic Relations [8], Semantic Textual Similarity [1], etc. Recently, the task to recognize textual entailment (RTE task [5]) between two text fragments has been proposed as a generic task that captures major semantic inference for many NLP applications such as Question Answering, Information Retrieval, Information Extraction and Text Summarization. However, besides entailment, there are more semantic relations among text. Cross-document Structure Theory (CST) attempts to characterize 18 kinds of relationships that exist between pairs of sentences coming
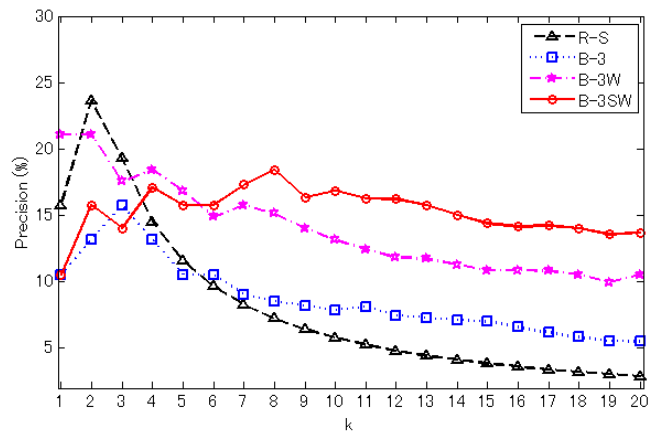
Fig. 3. P@k with different k in contradiction category

and contradiction sentences. The best classifier is 5.9% higher than the baseline on the agreement class, and 12.1% higher than the best rule-based classifier on the contradiction class. Given the fact that our bootstrapping-based classifiers are trained from untagged data, we believe that applying bootstrapping learning into the classification module of SSR system is promising. Nevertheless, the extraction of contradiction sentences is still a problem in our algorithms due to the complexity of different types of controversy. In the future, we would like to explore more effective ways to learn the characteristic of contradiction sentences in order to acquire better performance on the contradiction class. Moreover, we would also move forward to the next step of sentence classification, that is recognizing more specific semantic classes such as refinement, subsumption and cross-reference.

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Eval-net: implementation evaluation nets elements as Petri net extension

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Abstract. Evaluation nets are an easy, readable and functional method for visualizing states and communication between computer systems using diagrams. They are, unfortunately not so popular and there are no tools to help their creation, verification and simulation. However evaluation nets have many common characteristics with Petri nets; and Petri nets have many such tools. In this article an extension to Petri nets called Eval-nets is presented. Eval-nets introduce the most useful elements of evaluation nets. This extension is capable of being used in existing tools and it is not necessary to implement the common elements for Petri and evaluation nets to achieve new functionality. As a result a functional tool for creating, analysing, running, debugging and simulating communication protocols may be build based on Petri nets.

Keywords: evaluation nets, eval-net, petri net, simulation

1 Introduction

Evaluation nets [18] were invented at the beginning of '70 and became an alternative to Petri net [23]. This method has some restrictions and is not so easy in automated analysis, so is not so popular.

Evaluation nets consists of two parts: a frontend and a backend.

The frontend is similar to a Petri net. The backend is the source code that is executed at the appropriate time and has an impact on the future flow of tokens. The backend determines which of the enabled transitions will be firing.

It allows for easily linking a visualization state and sending messages to the actual source code. However, this relationship makes it difficult or even impossible to use mathematical tools to analyse the entire system because these tools examine only the graph and not the source code. For example, a reachability graph based on Petri net can be built. A similar graph can be built on the basis of the evaluation nets frontend. However, when you start such evaluation nets it may be the case that the backend will never run some routes and some states of the reachability graph will became unattainable.

The properties of evaluation nets had been very useful for modeling and verifying negotiation protocols (e.g. Complex Negotiations protocol [15]) and

This mix gives a simple to implement extension. Simplicity is available because it is based on solutions built for Petri nets and does not create conflicts with many existing extensions for Petri nets.

The described solution is a part of a simulation platform that consists of Eval-net interpreter, editor and tools for simulation and analysis. The interpreter runs within an agent that acts on the JADE platform. It passes net evaluation (created in the editor) and executes the source code backed (written in Python). The editor allows you to create and view the current state of the network together with the history of transitions. It also allows you to make changes to on-line in both the frontend and the backend. The analysis tools are adapted from Petri net tools, while the simulator allows you to perform a specific scenario, to generate test data and visualize simulation results.

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The use of evaluation nets in Complex Negotiations modelling

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Abstract. In this work Complex Negotiations are presented by use of evaluation nets. Complex Negotiations is a protocol for negotiating the terms and conditions of a contract to provide a particular service. It includes negotiation of terms prior to concluding a contract as well as their renegotiation while the contract is being executed. Evaluation nets constitute a sort of Petri net extension and they are well-suited for modelling communication protocols. Their application facilitates graphical visualisation, analysis and verification of the validity of Complex Negotiations performed by particular participants.

Keywords: evaluation nets, petri net, complex negotiation

1 Introduction

The problem of negotiation is very often invoked in communications. Negotiations are talks between two participants, the objective of which is to make some arrangements (concerning terms and conditions of a contract) between them.

The life of a contract can be divided into two phases: the phase of concluding it and the phase of executing it. During the first phase the parties make an agreement concerning the terms and conditions of their mutual obligations. In the second phase these obligations are executed, but it may be necessary to renegotiate the terms and conditions (e.g. in the case of a failure, changes in the market of goods and service etc.). The automatic negotiation systems that are described in the literature mainly focus on the first phase of the contract or just on negotiations. Only specialist systems focus on the second phase of a contract's life, such as e.g. renegotiation of a data link protocol between network devices when the types of disturbances or network traffic intensity have changed. This has become the motivation to develop Complex Negotiations [15], which take both contract phases into account.

In that work we assumed that none of the parties to a contract would optimise its activities by terminating the contract and concluding a new one with another partner.

Complex Negotiations is a communication protocol. In this work the authors chose to use evaluation nets as Petri net extension [16]. The motivation for using

due to many similarities that they share with Petri nets, it is possible to adjust programming tools made for Petri nets to work with evaluation nets. Further works will focus on developing such tools.

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Exploring Associations between the Work Environment and Creative Design Processes

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Abstract. Creative thinking is a critical activity in design work, and it can be influenced by the climate of a space that designers work in, either individually or in groups. Designers experience different emotions during creative design processes, and these emotions can influence their levels of both creativity and productivity, so modifying the environments in which design work is done can impact on creative design outcomes. In this paper we report some first empirical research that investigates associations between environment, emotion and creative design work undertaken using different creativity and design techniques.

Keywords: creativity, environment, emotion, and design

1   Introduction

Characteristics of workspace are similar to body language and both reflect the attitudes of people to work and afford different behaviors of the people in that space. Indeed, space designers argue that an environment that is more creative can foster the people's creativity [2]. Not only can the characteristics of a space directly afford more creative behavior, for example through collaborative working around shared artifacts [16], but the qualities of the space can influence peoples' emotions so that they are more predisposed to be creative [1]. In this paper we empirically explore the link between environment, emotion and creative outcomes in a collaborative creative tasks.

We have previously investigated emotions in collaborative design work by observed post-graduate design students during face-to-face creative tasks over a 5-week period. Results revealed that, at the beginning of each session, most students reported more negative and uncertain emotions such as *unsure*, *confused* and *frustrate,* whilst most students at the end of the same creative tasks reported emotions such as *progress*, *relief*, *funny* and *productive*. Designers' emotions appeared to change during creative work, but reasons for these changes were unclear, leaving scope for more empirical research.

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An interactive procedure for multiple criteria decision tree

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Abstract. A lot of real-world decision problems are dynamic, which means that not a single, but a series of choices must be made. Additionally, in serious problems, multiple criteria and uncertainty have to be considered. In the paper an interactive algorithm for multiple criteria decision tree is proposed. Various types of criteria are taken into account, including expected value, conditional expected value and probability of success. The procedure consists of two steps. First, non-dominated strategies are identified. Next, the final solution is selected using interactive technique. An example is presented to show the applicability of the procedure.

Keywords. multiple criteria decision making, dynamic decision problems, decision making under risk, decision tree.

1 Introduction

The dynamics characterize numerous decision problems. In real-world the decision process can rarely be posed in terms of a single choice. Often, a series of interdependent decisions must be made at different periods of time in order to achieve an overall goal. Moreover, as the future is unknown, the results of these decisions are usually uncertain. A decision tree is well-known tool to model and to evaluate such processes. In classical version it provides a method for identifying a strategy maximizing expected profit or minimizing expected loss. Thus, it's application is limited to single criteria problems in which consequences are measured on cardinal scale. Real-world decision problems, however, usually involve multiple criteria. In addition, at least some of them are qualitative in nature, and as a result cardinal scale cannot be used.

In this paper, we analyze sequential multiple criteria decision making problems under risk, which can be characterized as follows:

1. The decision process consists of T periods. At each period, a decision must be made. Any decision made at period t determines the characteristics of the problem at period $t + 1$.
2. Risk is taken into account. It is assumed that states of nature are defined for each period and are modeled by probabilistic distributions.
3. Multiple conflicting criteria, both quantitative and qualitative in nature, are considered.

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A Comparative Study on Single and Dual Space Reduction in Multi-label Classification

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Abstract. Multi-label classification has been applied to several applications since it can assign multiple class labels to an object. However, its effectiveness might be sacrificed due to high dimensionality problem in both feature space and label space. To address these issues, several dimensionality reduction methods have been proposed to transform the high dimensional spaces to lower-dimensional spaces. This paper aims to provide a comprehensive review on ten dimensionality reduction methods that applied to multi-label classification. These methods can be categorized into two main approaches: single space reduction and dual space reduction. While the former approach aims to reduce the complexity in either feature space or label space, the latter approach transforms both feature and label spaces into two subspaces. Moreover, a comparative study on single space reduction and dual space reduction approaches with five real world datasets are also reported. The experimental results indicated that dual space reduction approach tends to give better performance comparing to the single reduction approach.

Keywords: multi-label classification, dimensionality reduction, dual space reduction

1 Introduction

In the past, traditional classification techniques assumed a single category for each object to be classified by means of minimum distance. However, in some tasks it is natural to assign more than one category to an object. For examples, some news articles can be categorized into both *politic* and *crime*, or some movies can be labeled as *action* and *comedy*, simultaneously. As a special type of task, multi-label classification was initially studied by Schapire and Singer (2000) [9] in text categorization. Later many techniques in multi-label classification have been proposed for various applications such as image classification, music to emotion categorization, automated tag recommendation, Bioinformatics research and sentiment analysis. However, these methods can be grouped into two main approaches: *Algorithm Adaptation* (AA) and *Problem Transformation* (PT) as suggested in [11]. The former approach modifies existing classification

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Understanding Context-Aware Business Applications in the Future Internet Environment[*]

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Abstract. The obvious move towards a Future Internet environment that is strongly distributed, mobile, cloud-based, semantically rich has raised and emphasized the need for a different type of applications. The focus of this new type of applications can no longer be on the software itself but directly on the relevant needs and goals of end-users. We argue that because these applications are strongly end-user oriented, context and context-awareness play an important role in their design and development. Hence in this paper we discuss context-aware business applications towards a better understanding of their specific features. We emphasize two major directions related to context oriented applications, their importance, and the order in which they should be followed and interlinked.

Keywords: context-aware systems, business applications, user centric approach

1 Introduction

We are witnessing an obvious trend towards the Future Internet environment which is essentially cloud-based and which comes with a new set of characteristics and challenges. In this new environment that is generative and fosters innovation [36] business models and customer relationships are changing, it is about software on demand, simple to use, software that takes into account users' needs, it is mobile, runs everywhere, including web browsers.

A series of new challenges emerge from this new environment. To name just a few:

- how to design software that is highly end-user oriented and social;
- how to involve the end-user in the development process;

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Symptom -Treatment Relation Extraction from Web-Documents for Construct Know-How Map

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Abstract. This paper aims to extract the relation between the disease symptoms and the treatments (called the Symptom-Treatment relation), from hospital-web-board documents to construct the Problem-Solving map which benefits for inexpert-people to solve their health problems in preliminary. Both symptoms and treatments expressed on documents are based on several EDUs (Elementary Discourse Units). Our research contains three problems: first is how to identify a symptom-concept EDU and a treatment-concept EDU. Second is how to determine a symptom-concept-EDU boundary and a treatment-concept-EDU boundary. Third is how to determine the Symptom-Treatment relation from documents. Therefore, we apply a word co-occurrence having a symptom/treatment concept to identify a disease-symptom-concept/treatment-concept EDU, respectively, and also their boundaries. We propose using Naïve Bayes to determine the Symptom-Treatment relation from documents with two feature groups, a symptom-concept-EDU group and a treatment-concept-EDU group. Finally, the result of extraction shows successfully the precision and recall of 84% and 72%, respectively.
Keywords: word order pair, Elementary Discourse Unit, Symptom-Treatment relation

1 Introduction

The objective of this research is to develop a system of automatically extracting relation between the group of disease's symptoms and the treatment/treatment procedure (called the Symptom-Treatment relation) from the medical-care-consulting documents on the hospital's web-board of the Non-Government-Organization (NGO) website edited by patients and professional medical practitioners. The extracted Symptom-Treatment relation is used for constructing the Know-How map which is a map representing how to solve problems, especially disease treatments, called Problem-Solving map (PSM). PSM benefits general people to understand how to solve their health problems in the preliminary stage. Each medical-care-consulting document contains the disease symptoms and the treatments are expressed in the form of

board documents of medical-care-consulting. The evaluation of the Symptom-Treatment relation extraction performance of this research methodology is expressed in terms of the precision and the recall. The results of precision and recall are evaluated by three expert judgments with max win voting. The precision of the extracted Symptom-Treatment relation is 84% and 72% recall. These research results, especially the low recall, can be increased if the interrupt occurrences on either a symptom boundary or a treatment boundary, as shown in the following, are solved.

EDU1: *หนูมีอาการท้องผูกค่ะ* (**I have a constipation symptom.**)

EDU2: [*หนู*]*พยายามฝึกถ่ายทุกวัน* (**[I] try to train excretion every day.**)

EDU3: *ได้ผล* (**It can work**)

EDU4: *แต่หนูต้องกินโยเกิร์ตด้วย*: (**But I must have yogurt too**)

where EDU3 is an interrupt to the treatment-concept-EDU boundary (EDU2 and EDU4). Moreover, our extracted Symptom-Treatment relation can be represented by PSM (Fig. 2) which is very beneficial for patients to understand the disease symptoms and their treatment. However, the extracted symptoms and the extracted treatments are various to the patient characteristics, environment, time, and etc. Therefore, the generalized symptoms and the generalized treatments have to be solved before constructing PSM.

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Range Reverse Nearest Neighbor Queries

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Abstract: Reverse nearest neighbor (RNN) queries have a broad application base such as decision support, profile-based marketing, resource allocation, data mining, etc. Previous work on RNN, visible nearest neighbor and visible RNN has been done considering only point queries. Such point queries are highly unlikely in the real world. In this paper we introduce a novel variant of RNN queries - Range Reverse Nearest Neighbor queries which consider queries over a region rather than a point.

Keywords: Data Mining, Query processing, Spatial Databases, Nearest Neighbor Queries.

1   Introduction

Data Mining is a relatively young and interdisciplinary field of computer science that discovers new patterns from large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics and database systems.

While the Reverse Nearest Neighbor (RNN) search problem, i.e. finding all objects in a database that have a given query q among their corresponding k-nearest neighbors, has been studied extensively in the past years, considerably less work has been done so far to support RNN queries on a region that may not be indexed by a point access method. Also less research is done for handling obstacles in case of Range queries. This paper proposes a novel approach to handle queries like "Finding an apartment in a set of buildings which is closest to a park."

2   Range Reverse Nearest Neighbor Queries

2.1   Preliminaries

Suppose that we are interested in a particular region and want to check for its reverse nearest data points. In order to expand the query point defined in R′NN to an area, we can stress on using a Range Nearest Neighbor Query.

Now suppose we are out to buy an apartment for ourselves but a requirement is that it must be near a particular monument or a recreational area or even say a road. We can consider this region of interest as a query region and this will have to be a

queries. Research enthusiasts can dwell more into techniques developed in this paper and move ahead in the exciting field of data mining.

Acknowledgement

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Knowledge Extraction from the Behaviour of Players in a Web Browser Game

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Abstract. Analysis of player behaviour is a technique with growing popularity in the traditional computer games segment and has been proven to aid the developers creating better games. There is now interest in trying to replicate this attainment in a less conventional genre of games, normally called browser games. Browser games are computer games that have as defining characteristic the fact that they are played directly on the web browser. Due to the increased ease of internet access and the growth of the smart phone market, this game genre has a promising future. One of the advantages of browser games in the area of game mining is that player behaviour is relatively easy to record. In this paper we describe a study where we aim to extract knowledge from the behaviour of players in a browser game, during a short period of time.

Key words: Knowledge Extraction, Data Mining, Machine Learning, Browser Games, MMOG.

1 Introduction

Browser games are computer games that have the unique characteristic of being played directly on the web browser, without the need of additional software fittings. Typically games in this genre offer a multiplayer environment where users can interact with each other. Attending to the way this genre works, the current game status of the players needs to be stored by the game provider. This fact makes it easy to collect information about the players, since companies already need to store it in order for their games to work.

There is an increasing awareness in the game developers community about browser games with the rise of smart phones with web access [2] and the growing popularity of social platforms [11].

Therefore, the traditional one-size-fits-all courses will be replaced by one-to-one. However, to introduce such functionality content adaptation methods must by feasible in the business terms.

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Combination of Interpretable Fuzzy Models and Probabilistic Inference in Medical DSSs

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Abstract. Fuzzy logic have gained increasing importance in Decision Support Systems (DSSs), in particular in medical field, since it allows to build a transparent and interpretable knowledge base. However, in order to obtain a general description of a system, probabilistic approaches undoubtedly offer the most significant information. Moreover, a good system should be useful also to classify data items which are lacking of some input features. In this work, an approach is proposed to construct an interpretable fuzzy system, which furnishes probabilistic information as a result. The resulting fuzzy sets can be interpreted as the terms of the involved linguistic variables, while the resulting weighted rules model probabilistic information. Rules are presented in two forms: the first is a set of one-dimensional models, which can be used if only one input feature is known; the second is a multi-dimensional combination of them, which can be used if more input features are known. As a proof of concept, the method has been applied for the detection of Multiple Sclerosis Lesions from brain images. The results show that this method is able to construct, for each one of the variables influencing the classification, an interpretable fuzzy partition, and very simple *if-then* rules. Moreover, a multi-dimensional rule base is presented, by means of which improved results are obtained, also with respect to naive Bayes classifier.

Keywords: probability; statistical learning; fuzzy partition; rule extraction; classification; linguistic variable; clinical DSS.

1   Introduction

Decision Support Systems (DSSs) are gaining increasing importance in recent research. In particular, in some fields of application like medicine, DSSs are often required to manage data affected by uncertainty and vagueness, and to offer a transparent and comprehensible knowledge base. These issues can be accomplished by using fuzzy logic [17]: on the one hand, fuzzy sets can model terms of linguistic variables; on the other hand, fuzzy rules show a clear and logic justification for each conclusion.

Table 4. Classification power

Method	CR	SCE
Proposed method	84 %	0.176
Naive Bayes classifier	81 %	0.189

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Dynamic data discovery

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Abstract. This paper[1] presents a new approach to mine dynamic data. We propose generalised tree languages together with their finite models and show how they can represent systematic series of sequential and parallel actions organised into a process. Then we develop an evolutionary heuristic based on skeletal algorithms to learn tree automata. We present two major applications of our techniques: one in process mining and another in discovering a mathematical theory.

Keywords: data mining, process mining, skeletal algorithms, theory discovery, tree automata

1 Introduction

In order to survive in today's global economy more and more enterprises have to redesign their business processes. The competitive market creates the demand for high quality services at lower costs and with shorter cycle times. In such an environment business processes must be identified, described, understood and analysed to find inefficiencies which cause financial losses.

One way to achieve this is by modelling. Business modelling is the first step towards defining a software system. It enables the company to look afresh at how to improve organization and to discover the processes that can be solved automatically by software that will support the business [9]. However, as it often happens, such a developed model corresponds more to how people think of the processes and how they wish the processes would look like, then to the real processes as they take place.

Another way is by extracting information from a set of events gathered during executions of a process. Process mining [16], [14], [22] [5], [20], [19], [21], [24], [17], [18], [15], [23], [13] is a growing technology in the context of business process analysis. It aims at extracting this information and using it to build a model. Process mining is also useful to check if the "a priori model" reflects the actual situation of executions of the processes. In either case, the extracted knowledge about business processes may be used to reorganize the processes to reduce they time and cost for the enterprise.

Skeletal algorithms [10], [11] are a new branch of evolutionary metaheuristics [3], [6], [7], [12], [8] focused on data and process mining. The basic idea behind

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In future works we will be mostly interested in validating the presented algorithms in industrial environment and apply them to real data.
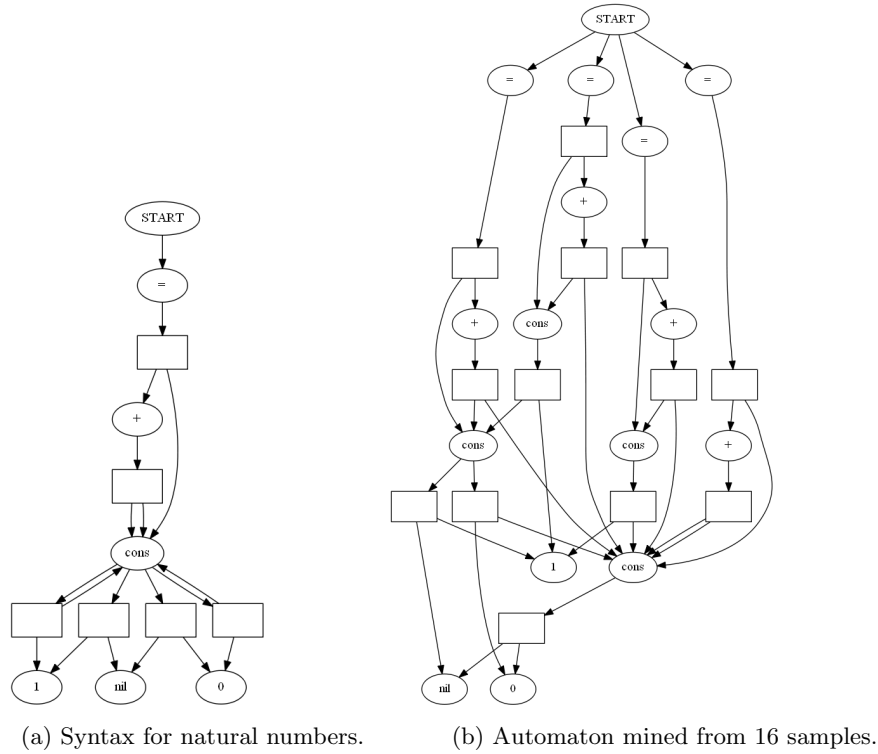

(a) Syntax for natural numbers.

(b) Automaton mined from 16 samples.

Fig. 3: Natural numbers.

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On a Constrained Regression Problem and its Convex Optimisation Formulation

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Abstract. We shall consider a constrained regression problem. A shape constraint is applied to a third-degree polynomial regression. We show that some of those problems might be formulated as a problem of finding a proper metric projection. They belong to a class of convex optimisation problems for which efficient solvers exist. A numerical example for a related problem arising in econometrics is given.

Keywords: Convex optimisation, constrained regression, econometrics, total cost function.

1 Introduction

Numerous statistics-related models, especially in econometrics, require the user to find approximate values of several unknown parameters (the process of so called *estimation*), usually by employing the least squares method.

The model is frequently a carefully chosen family of functions that depends on some finite (and often small) number of parameters. It could be a family of affine functions of one variable, namely $\eta = a\xi + b$, that depends on two parameters a and b, both of them being arbitrary real numbers. The process of finding a and b is then usually called *linear regression* (see [14, 17]).

All information that we have about the model is that independently chosen values of $\xi_1, \xi_2, \ldots, \xi_K$ have led to making observations of $\eta_1, \eta_2, \ldots, \eta_K$ results, respectively. Those pairs do not have to, and usually do not, satisfy the postulated equality $\eta_k = a\xi_k + b$, for a given a and b, for all $k = 1, 2, \ldots, K$. The difference $\eta_k - a\xi_k - b$ is often considered a random variable that represents *all the errors in the model*.

First of all, the error is caused by *observational error* (sometimes called a *measurement error*) of the variable η, which reflects the difference between the actual value of a quantity and the measured value. Secondly, the error due to actual *variation of the variable η* itself. It might be caused by influences of some external randomness, that can not be explained by the model alone, but affects the measured quantity.

Linear regression problem could be then formulated as a problem of finding real numbers a and b that minimise the following function

$$f_0(a, b) = \sum_{k=1}^{K} \left(\eta_k - a\xi_k - b \right)^2. \tag{1}$$

regression. We have also proven that the solution of the constrained optimisation problem (which is convex, after all) exists and is uniquely defined without the analysis of constraints' Hessian matrix.

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A FUZZY-GENETIC SYSTEM FOR CONFLP PROBLEM

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Abstract. The article presents the idea of the fuzzy-genetic system, that support making decisions in multiobjective optimization problems. The Genetic Algorithm realizes the process of multiobjective optimization and search Pareto-optimal solutions in a given area of the search space. The Fuzzy Logic Controller (FLC) is used for making decisions, which solution from the Pareto-optimal set will be used. The FLC uses additional fuzzy logic criteria obtained from experts. The article presents the results of solving the Connected Facility Location Problem (ConFLP). The ConFLP is a theoretical model used in telecommunication network design. ConFLP is a NP-hard problem, based on the graph theory. The Genetic Algorithm optimizes three different objective functions: looking for a tree with the minimal edge length that connects each clients' terminals, optimizing the number of network nodes which interlink the terminals and designing their distribution in the given network area. All objective functions are mutually dependent, which additionally makes problem solving very difficult. The experiments show, that the proposed algorithm is an efficient tool for solving the Connected Facility Location Problem. The algorithm can be also used for solving similar optimization problems.

Keywords: genetic algorithms, multi-objective optimization, connected facility location problem

1   Introduction

In many practical problems of optimization, it's often expected that several objectives reach the optimal value at the same time, which is called the multi-objective optimization problem [15][18]. These multiple objectives, often conflicting each other, can accept the maximum or minimum in different points of the search space. The multi-objective optimization problems is a type of multiple attribute decision problems with infinite number of potential alternative solutions. In the given task of the multi-objective optimization, instead of one optimal solution we receive a set of solutions, with a similar value. These multiple solutions are called Pareto-optimal solu-
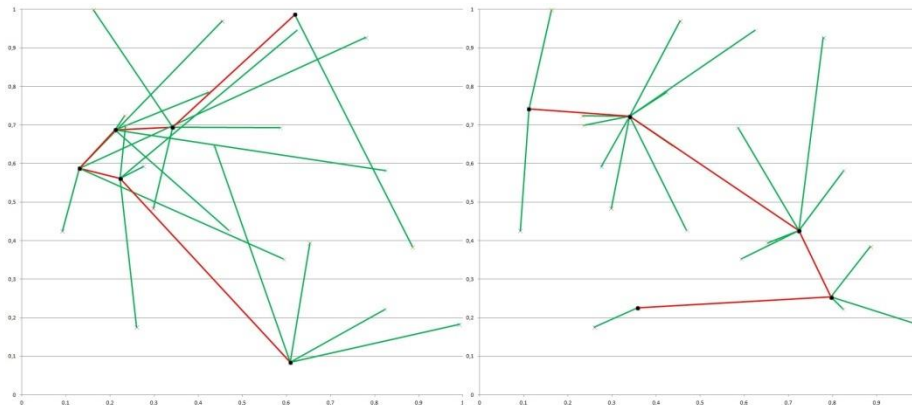
Fig. 5. The distribution of network nodes in estein20 task: a) before the optimization, b) after the optimization

The proposed algorithm lets on finding a set of Pareto-optimal points. Fuzzy Logic Controller permits to direct the special attention on the prefered area of the search space. Decision-maker can choose a final solution, which best realizes his own rules.

The Genetic Algorithm permits to find a solution with the smaller number of nodes than in the optimum Steiner tree problem. For example, in estein100 task, the number of nodes was diminished from 44 to 8. The value of the total length of links is greater than the optimum, but such a solution is better from the point of view of the computer network designer.

In the example of the optimization of estein20 task, we can notice that the Genetic Algorithm is able to diminish the number of nodes with relation to the initial value during the process of evolution. In such a case, no terminal is assigned to the node.

The operating time of the algorithm on the class PC computer did not exceed 5 minutes for the task of optimization 100 terminals. This permits the use of the program for solving tasks typical for a designer of small computer networks. In the case of large networks, the time of calculations can be considerably longer. The parameters of the algorithm, eg. the number of generations, can be changed by adapting the algorithm to the needs of the user and the required accuracy of calculations.

The proposed algorithm is an efficient tool for solving optimization problems for criteria of the tree length, the number of nodes and for assigning terminals to network nodes. The proposed algorithm can be used for solving similar problems of multi-objective optimization.

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Knowcations - Conceptualizing a Meme and Cloud-based Personal 2nd Generation Knowledge Management System

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Abstract. The first generation of Organizational Knowledge Management (OKM) focused on the capturing, storing, and reusing of existing knowledge. To be classed as second generation, systems need to facilitate the creation of new knowledge and innovation which requires creativity and the awareness that old knowledge becomes obsolete.

Recent suggestions also urged to advance Personal Knowledge Management (PKM) as an overdue support tool for knowledge workers in the rising Creative Class and Knowledge Societies. Based on the assumption of creative conversations between many individuals' PKM devices, the autonomous systems are supposed to enable the emergence of the distributed processes of collective extelligence and intelligence, which in turn feed them.

With a PKM prototype system pursuing these qualities, the paper illustrates the interaction between a user and external information-bearing hosts and vehicles. The resulting feedback loop incorporates Boisot's I-Space Model, Dawkins' Memes, Probst's KM Building Blocks and Pirolli's Sensemaking Model for Intelligence Analysis.

Keywords: Personal Knowledge Management Systems. Information Space. Extelligence. Memes. Memetics. Business Genes. Sensemaking. Creative Class. Knowledge Worker.

1   First versus Second Generation Knowledge Management

In the "Complete Guide to Knowledge Management", Pasher and Ronen describe the focus of the first generation of Knowledge Management (KM) as the capturing, storing, and reusing of existing knowledge including "systems of managing knowledge like company yellow pages, experts outlining processes they are involved in, creating learning communities where employees/customers share their knowledge, creating information systems for documenting and storing knowledge, and so on. These first-generation KM initiatives were about viewing knowledge as the foremost strategic asset, measuring it, capturing it, storing it, and protecting it. They were about treating

6   The Road ahead

In "Creative Environments" [34], Wierzbicki and Nakamori affirm: "In the new knowledge civilisation era, given the systemic methods and tools of intercultural and interdisciplinary integration of knowledge, we shall also need computerised creativity support", but they also maintain: "Before we think of constructing systems of tools to support creativity, we should reflect upon what prescriptive conclusions can be derived from descriptive theoretical considerations". The system-in-progress introduced agrees with this notion; it provides a pragmatic novel solution based on established concepts and theories, some of which have already been alluded to.

In follow-up papers-to-be-submitted the prescriptive character of the system is further verified against the notion of the 'Ideosphere' [Sandberg, Kimura], Nonaka's concept of 'ba' as well as the integrated JAIST Nanatsudaki Model of knowledge creation. After reflecting on the potent co-evolutions which shaped human innovativeness, the more recent organizational, commercial, and social changes with their profound impacts on the way we work and live are explored together with the diverse shortcomings experienced by societal stakeholders. With Gurteen's interpretation of the knowledge worker and Florida's concept of the rising creative class gaining currency, the paper further looks at Vannevar Bush's still unfulfilled vision of the 'Memex' and the wider role of PKM in the context of ICT for Development (ICT4D) and a new era of networked open science.

It is planned to transform the prototype to a commercially viable PKM software application within two years. In parallel, a system training seminar will be set up as well as a curriculum and study guide for the wider multi-disciplinary Personal Knowledge Management contexts and methodologies. Further papers in progress or planned will feature the meta-entities of the system-in-progress (Sources, Actors, Profiles, Uses, and Projects) and their interdependencies as well as a case study. The latter will integrate the papers published with all their memes and references to demonstrate the knowledge management and authoring capabilities of the system.

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Towards a New Insight into Technological Evolution: the Foresight of Information Society and Emerging Intelligent Technologies

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Abstract. This paper presents the methodological background of the foresight of selected artificial intelligence technologies carried out within the research project SCETIST [2] and a review of its results. Unlike usual approaches to foresight exercises, the technological trends and scenarios are generated via simulation of a hybrid system consisting of a discrete-time-control and discrete-event components. The first one is a complex Information Society (IS) model, which describes the evolution of social, economical and scientific factors relevant to the production and adsorption of intelligent technologies, while the discrete event components are tailored to model the legislative and science and technology (S&T) development processes in each technological area under study. The above mentioned class of models have first been elaborated and applied within the 5th FP project FISTERA to the foresight of the information society development in the EU member states accessed in and after 2004. In the project SCETIST, we investigate specifically the development of intelligent internet technologies, including e-health and e-government, expert systems, with a special attention paid to the decision support systems and recommenders. Other workpackages of the project encompass the neurocognitive and computer vision systems, quantum and molecular computing. Finally, we will present first foresight results related to the evolution of decision-support systems and recommenders in the context of overall progress in the information technology (IT) and computer science (CS), global economic trends and social behaviour.

Keywords: Information Society Foresight, Scenario Analysis, Collaborative Foresight Tools, Intelligent Systems, Complex System Modelling

1. Introduction

The origin of research described in this paper goes back to the report [7] prepared for FISTERA (Foresight of the Information Society in the European Research Era) by the International Centre for Decision Sciences and Forecasting, P&B Foundation, Cracow. The aim of the above mentioned report was to catch new trends, processes, and phenomena concerning the Information Society (IS) current status and technological, social and economical trends in the twelve EU New Member States

for IT, which is of benefit to developers of Content Management Systems (CMS), recommenders and decision support systems (DSS) [12]. The outcomes of the project also inform R&D and educational institutions on the most likely in-demand directions of development as well as the demand for IT professionals. The main user group of the future trends and scenarios are yet innovative IT companies seeking technological recommendations, advice concerning R&D priorities, as well as corporation from different sectors that invest in IT. A generic way to elaborate on such recommendations concerning strategic planning in corporations is the technological roadmapping process (cf. e.g. [4,13]). An online roadmapping methodology, tailored to the needs of the Polish IT companies and to the scope of foresight research, has been elaborated by the project's team [13].

By comparing quantitative vs. descriptive approaches to building scenarios, we can observe that extracting evolution rules prior to scenario analysis proves especially useful in the case of converging information societies as exemplified by the case of Poland. The first ex-post assessments confirm the efficacy of the modelling methods developed and applied, as well as a good coherence of forecasts and real-life data ex-post real-life catch-up process.

To know more details of these findings, the reader is referred to further reports and publications at www.ict.foresight.pl.

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Modeling and recognition of video events with Fuzzy Semantic Petri Nets *

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Abstract. This paper addresses the problem of modeling and automated recognition of complex behavior patterns in video sequences. We introduce a new concept of Fuzzy Semantic Petri Nets (FSPN) and discuss their application to recognition of video events. FSPN are Petri nets coupled with an underlying fuzzy ontology. The ontology stores assertions (facts) concerning classification of objects and detected relations. Fuzzy predicates querying the ontology content are used as guards of transitions in FSPN. Tokens carry information on objects participating in a scenario and are equipped with weights indicating likelihood of their assignment to places. In turn, the places correspond to scenario steps. The Petri net structure is obtained by translating a Linear Temporal Logic formula specifying a scenario in a human-readable form. We describe a prototype detection system consisting of an FSPN interpreter, the fuzzy ontology and a set of predicate evaluators. Initial tests yielding promising results are reported.

Keywords: Petri nets, fuzzy ontology, event recognition, temporal logic

1 Introduction

Automatic recognition of complex behavior patterns in analyzed video sequences is a challenging area in computer vision. Such patterns, commonly referred as scenarios or events, can be perceived as combinations of simpler events describing interactions between objects that are either detected and tracked, or predefined as components of a scene configuration. Practical implementations of event recognition systems face two problems [13]. The first is related to methods used for extraction of features, which are further used to recognize and discriminate events. The methods are often delivering uncertain or noisy data. The second problem is an approach to scenario modeling. Definitions of scenarios, to be meaningful and manageable, should preferably be decoupled from a software implementation and use semantic description of objects and their relations. In particular, such semantic information should be communicated to system operators in case of intelligent video surveillance systems or used as a video metadata when applied in automated video indexing engines.

In the further development, it was replaced by a new corrected implementation: *movesTowardsVerticalObject.*
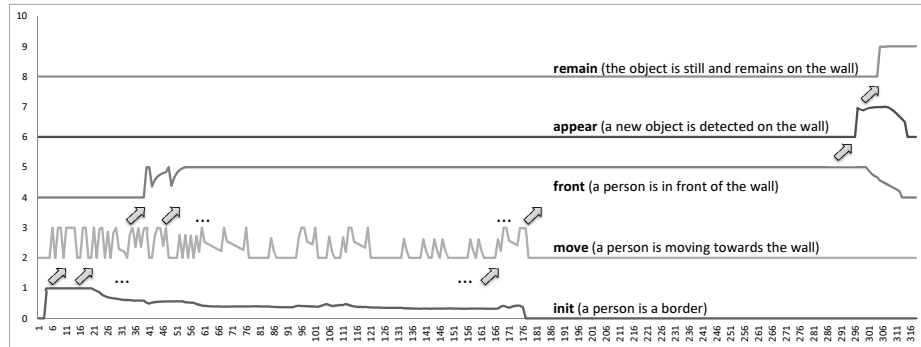

Fig. 8: Weights of tokens assigned to places at consecutive frames

Analogous experiments were conducted for several event recognition tasks including abandoned luggage and detecting violation of a surveillance zone. Tests for the abandoned luggage and graffiti painting events yielded 100% correct results (true positives). For a zone violation the recognition ratio was about 76%. Detailed analysis revealed that in this case the lower performance was caused by tracking problems (lost of identity in case of occlusion and in some cases invalid segmentation).

7   Conclusions

In this paper we address the problem of modeling and recognition of video events. To summarize our contribution: firstly, we propose to apply a temporal logic formalism to specify event scenarios and further to translate them to Petri net structures; secondly, we introduce Fuzzy Semantic Petri Nets; finally, we describe a proof of concept prototype system that interprets a data resulting from a tracking algorithm, represents it as a content of a fuzzy ontology and detects event occurrences with a FSPN interpreter. An advantage of FSPN is their capability of detecting concurrently occurring events, in which participate various combinations of objects, analyze scenario alternatives and their likelihoods.

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A system using n-grams for visualizing the human tendency to repeat the same patterns and the difficulty of divergent thinking

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Abstract. One of the factors that inhibits creative thinking is that humans tend to think in the same patterns repetitively and cannot easily come up with a totally new combination of concepts. In other words, humans are not talented at evenly exploring combinatorial space. In order to visualize how strong this tendency is, we implemented a system that asks users to type a long sequence of numbers and then evaluates the frequency of the appearance of the same subsequences, or n-grams. This system can also be used to train oneself to avoid such tendency. We call it "the Creativity Test". The reason for the name is because we believe that efficiency in exploring a wider part of a combinatorial space without being caught in few patterns is important for divergent thinking, which constitutes an integral part of creativity. When we tested the system on a group of participants, we discovered that, for most of them, surprisingly long subsequences appeared repeatedly, making the participants realize how inefficient they were at coming up with new combinations.

Keywords: Creativity, divergent thinking, heuristics, visualization, n-gram

1 Introduction

Creativity, or the ability to create new ideas, is a fundamental mechanism that drives the advancement of human society. It is not easy to actually define creativity, and many theories have been proposed. If we could concisely define what it is to make an idea new, it would be easier to implement a computer program that comes up with new ideas. In an abstract sense, however, a new idea is nothing but a new combination of existing concepts. This is because unless it can be expressed using existing concepts, it cannot be communicated to others. Therefore, we put forth that creative thinking is the process of searching through combinations to find ones that are useful but have not been utilized. We can formalize this mathematically as follows.

We have not shown that training by this system can raise the level of practical creativity. It is still unclear if unevenness in the appearance of number sequences is related to the unevenness of searching through combinatorial space in terms of practical creative behavior. To make the system more connected to the actual process of creative thinking, we would like to build a system that presents the sequence of objects or concepts belonging to a certain category, rather than using numbers. For example, we are considering building a system that asks chemists to list the names of reactions or molecules in random order, which may make them realize that they are likely to fall into a certain pattern, therefore restricting the generation of new combinations and potential inventions.

We would also like to explore the differences among individuals and if the ability to generate random patterns is actually relevant to the level of creativity the individual has. We plan to compare our system with existing tests that are said to measure creativity and see if there is any correlation. We want to see what factors affect scores in our system: for example, if the time of day would affect the level of creativity. Are individuals more likely to fall into the same pattern in the morning, or late at night? Also, we would like to compare scores when the subject is in different mental states: for example, when the subject is either elated or depressed, would the result be different?

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Evoking Emotion through Stories in Creative Dementia Care

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Abstract. This paper reports research to refine the design of a mobile creativity support app to improve person-centred care for older people with dementia. One barrier to previous app use during creative thinking appeared to be the negative activation emotions associated with problem avoidance and prevention exhibited by care staff when resolving challenging behaviours. Therefore we investigated the redesign of the app's content so that care staff were more likely to positive activation associated with creative thinking through storytelling through a first formative evaluation.

1. Dementia Care and Creativity

Dementia is a condition related to ageing. After the age of 65 the proportion of people with dementia doubles for every 5 years of age so that one fifth of people over the age of 85 are affected. This equates to a current total of 750,000 people in the UK with dementia, a figure projected to double by 2051 when it is predicted to affect a third of the population either as a sufferer, relative or carer [14]. Dementia care is often delivered in residential homes. In the UK, 4 in 5 of all home residents have some form of dementia [13], and delivering the required care to them poses complex and diverse problems that new software technologies have the potential to overcome.

The prevailing paradigm in the care of older people with dementia is person-centered. This paradigm seeks an individualized approach that recognizes the uniqueness of each resident and understanding the world from the perspective of the person with dementia [5]. It can offer an important role for creative problem solving that produces novel and useful outcomes [12], i.e. care activities that both recognize a sense of uniqueness and are new to the care of the resident and/or care staff. However, there is little explicit use of creative problem solving in dementia care with and without technical support, in spite of its potential benefits to both improve care and reduce the stress associated with caring for people with dementia [7].

During design studies, care staff demonstrated the greatest potential and appetite for the Other Worlds technique [1] that exploits similarities between domains. There-

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On quick sort algorithm performance for large data sets

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Abstract. Sorting algorithms help to organize data. However sometimes it is not easy to determine the correct order in large data sets, especially if they present special poses of the input series. It often complicates sorting, results in time prolongation or even unable sorting. In such situations, the most commonly used method is to perform sorting process to reshuffled input data or change the algorithm. In this paper, the authors examined quick sort algorithm in two versions for large scale data sets. The algorithms have been examined in performance tests and the results helped to compare them.
Keywords: computer algorithm, data sorting, data mining, analysis of computer algorithms

1 Introduction

Quick sort algorithm is known from [1, 7]. In classic method, described also in [3, 17–19, 21], we sort elements idexed i_{left}, i_{left-1}, …, $i_{right-1}$, i_{right}. All the elements are placed according to the order on both sides of the one reference element, chosen to divide them. A reference element index is an arithmetic average of indexes in the form of lower minimum total value, for more details see [1, 7, 17, 21]. Unfortunately, the cost of calculating this element index is determined by the number of elements in the sequence. This slows down the sorting of large data sets. An additional complication is the fact, that in practice there are often sequences mearly sortable for the classic version. Therefore we may often face some complications. These difficulties encourage looking for an optimal solution. Authors of [4, 13, 16, 19] describe the specific features of quick sort. Moreover, the authors of [5, 8, 10, 12, 18, 19, 22] pay attention to the impact on memory management or practical application of sorting algorithms. At the same time the authors of [16, 18–20] present the results of research on increasing efficiency. In Section 2 we have examined the quick sort to make it faster and more stable for large data sets. The results, presented in Section 2.2, suggest that there are some aspects of this method that may help to make it more stable and faster.
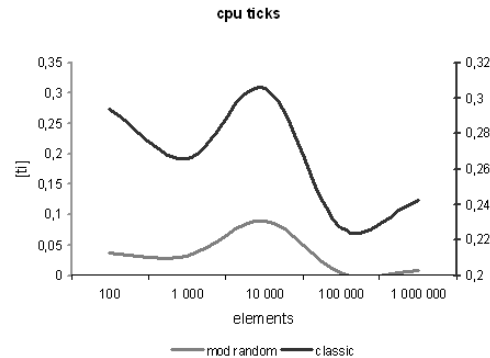
Fig. 6. Comparing the values of expected variability of CPU clock cycles

be appropriate for large data sets, even those described in Section 1.1. The authors consider increasing the efficiency of sorting algorithm for large data sets in further research and development.

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Triple heap sort algorithm for large data sets

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Abstract. Sorting algorithms are important procedures to facilitate the order of data. Classic versions of algorithms often can not efficiently determine the correct order in large scale data sets. In this article, authors describe and examine an extended heap sort algorithm performance for large data sets. Extension of the heap structure was subject to performance tests, that showed validity. With the extension, algorithm is able to sort incoming strings faster, regardless to the arrangement of incoming data.
Keywords: computer algorithm, data sorting, data mining, analysis of computer algorithms

1   Introduction

In the heap, we make levels to place in them sorted elements. Since the levels are stacked one on the other, we obtain a multi-level structure. With this arrangement, we can propagate inheritance and relationship among the elements in successive levels of the heap. In [2] the heap is also called a tree. The tree is a custom graph that is coherent and acyclic. Coherence means that all the nodes of the graph are combined into a single structure. Acyclic means that from each node we can move to another node in one and the only one way. This structure allows to introduce the inheritance and relationship between the nodes. Relationships are determined for the child nodes, which are in the next level of the heap and are connected to the node of the previous level. Discussing the examined heap sort algorithm we assume the following:

1. In the next levels of the heap, all the nodes have the same number of descendants.
2. In the middle levels (layers), there are no nodes without children.
3. The only level that may have an incomplete structure of the descendants is second to last. Having children in this level depends on the number of items in the string that we are deploying in the created heap.
4. In the level, elements are placed in the nodes from the left to the right side of the heap.

3 Final Remarks

In conclusion, examined triple heap structure has a positive effect on increasing the efficiency and reducing the time costs. Triple heap sort algorithm has a good stability and sorts large data sets about 15% faster than classic version. Thus, the proposed algorithm is proper for sorting large scale data sets regardless of input elements. We therefore conclude that replacing classic structure of the heap by the triple heap allows to increase the efficiency of sorting. The authors of this paper intend to focus on the research conducted to examine the impact of increasing the number of divisions of the heap structure on sorting large scale data sets and implementing parallel sorting.

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