From Individual to Collective: Intelligence Amplification with Bio-Inspired Decisional DNA and its Extensions

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Abstract. In nature, deoxyribonucleic acid (DNA) contains the genetic instructions used in the development and functioning of all known living organisms. The idea behind our vision is to develop an artificial system, an architecture that would support discovering, adding, storing, improving and sharing information and knowledge among agents and organizations through experience. We propose a novel Knowledge Representation (KR) approach in which experiential knowledge is represented by Set of Experience (SOE), and is carried into the future by Decisional DNA (DDNA). This research has enormous and exciting potential of opening entirely new and so far not conceptually conceived horizons in developing and using collective intelligence to find solutions to different problems.

Keywords: Collective Intelligence, Decisional DNA, Knowledge Management

1 Introduction

The Semantic Web concept was first proposed in [1] offering a future vision of the WorldWideWeb (WWW) where both humans and machines (man-made systems) are able to communicate and exchange information and knowledge. One of the challenges of Semantic Web is smart and trusted storage of information and knowledge in artificial systems so it can be unified, enhanced, reused, shared, communicated and distributed with added intelligence [2] . Our study represents an important component of addressing the above challenge and exciting, cutting-edge global research trend in the general area of augmented intelligence.

Bio-inspired ideas and implementations have a long history starting with Chinese effort to develop artificial silk some 3000 years ago, later inspiring Leonardo daVinci's flying machines, and recently enhancing our everyday lives with Velcro and Gecko tapes, improving drag and friction on Airbus airplane wings by following design principles based on humpback whales flipper and skin of the shark, applying lotus effect to develop self-cleaning surfaces, pine cone effect to manufacture smart fabrics, amoeba based network design, and control of robots [3,4,5]. All these popular real life implementations represent successful biomimetic applications. Nature is full of excellent examples of design and smart organizational/management approaches that produce outstanding results in highly complex situations. The main problem is that most often we simply do not understand how this happens.

1.1 Artificial versus Augmented

Most experts agree that truly intelligent artificial system is yet to be developed. The main issue that still remains a challenge is imposing trust and explainability into such systems. However, is full replication of human intelligence really desirable key aim in intelligence related technology and research? This is where the concept of augmented intelligence comes into play [6]. It is an alternative conceptualization of artificial intelligence that focuses on AI's assistive role. Visionaries believe that one of the most promising potentials for intelligence augmentation is the creation of a hybrid biological and non-biological thinking as a way to "supercharge" the human brain [7].

To make the post pandemic evolvement of cognitive society sustainable we have to address the global challenge that can be formulated as the need for increasingly smarter and abler decision-making enhancement and amplification. Help is required in decision making, complex problem solving, and attaining goals. We attempt to address this global challenge by proposing intelligence augmentation with Decisional DNA [8] and its various extensions which could provide decision-makers with the tools to choose the best outcomes that would promote sustainability, wellbeing, and security to individuals and populations.

1.2 Our Augmentation Approach

Our research inspiration stands in the role of deoxyribonucleic acid (DNA) in storing and sharing information and knowledge [9]. The initial idea and vision behind our research was to develop, expand, and extend an artificial intelligence augmentation system, an architecture that would support smart discovering, adding, storing, improving and sharing information and knowledge among agents, machines, and organizations through experience. Bio-inspiration comes in this case from the fact that in nature experiences that all living organisms (including humans) go through during their active lives support sustainable development, evolution, and add smartness to all associated functionalities and processes. The importance of experience in natural evolvement cannot be overemphasized. We propose a novel Knowledge Representation (KR) approach in which experiential knowledge is represented by Set of Experience (SOE) (see Fig. 1) and is carried into the future by Decisional DNA (DDNA) (see Fig. 2) [8].

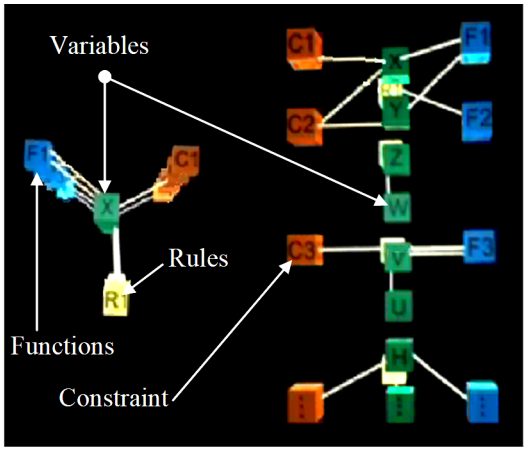

Fig 1. Set of Experience graphical interpretation: SOE is combination of four components that characterize decision making actions (variables, functions, constraints, and rules) and it includes a series of mathematical concepts (a logical component), together with a set of rules (a ruled based component), and is built upon a specific event of decision-making (a frame component).

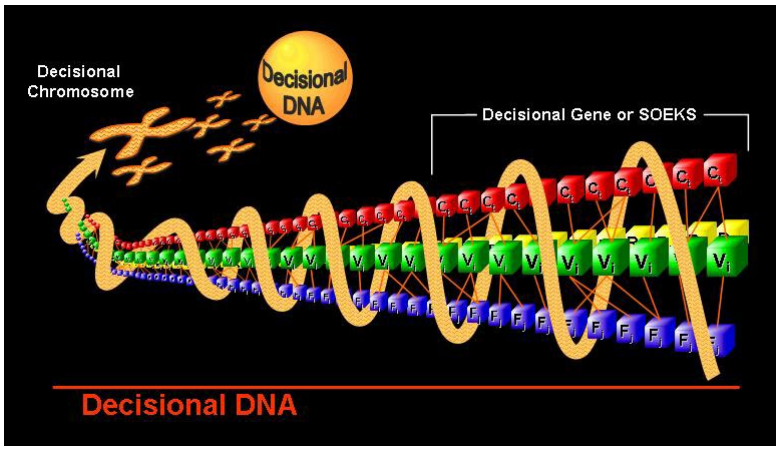

Fig.2. DDNA development process illustrated: Sets of Experience SOEKS (Decisional Genes) are grouped according to their phenotype creating Decisional Chromosomes, and groups of chromosomes create the Decisional DNA (DDNA)

2 DDNA and SOEKS in Practice

Table 1 at the end of this Section, list some of the most successful DDNA based real life implementations with their references for possible further reading. All of them use our advanced portable and domain independent software representation for SOE and Decisional DNA embedded in DDNA Manager (see Fig. 3).

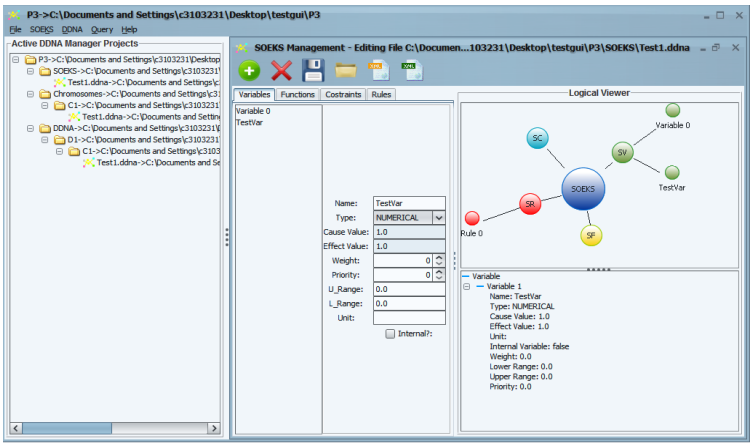

Fig. 3. Screenshot of DDNA Manager dialog window [8].

The Decisional DNA Manager is a software platform for experience administration. This tool supports collecting, storing, improving, and reusing experience from formal decision events. It can be used as a tool to analyze, query, consolidate and administer semantic experience captured by the means of SOE and Decisional DNA. Additionally, the software allows exportation of semantic experience into XML and OWL as a way to share knowledge. With DDNA Manager in hand we will be able to develop in the next future step its hardware representation entering into the fully evolved age of Semantic Web where machines and other man-made systems would have their "own DNA" allowing for the future Artificial Evolution (AE).

Table 1. Some applications of SOE-DDNA in various fields in chronological order.

Application/Domain	Reference
Implementation of Decisional Trust and Reliability	[10]
Virtual Engineering	[11]
Geothermal Energy, Renewable Energy and Net Income	[12]
Workflow-Centred Experience Management	[13]
Embedded Systems/Robotics	[14]
Knowledge Quantification	[15]
E-Decisional Community	[15]
Business Experience Management	[16]
Continuous Improvement in Experience Feedback	[17]
Interactive/Smart TV	[18]
Decision Support Medical Systems for Alzheimer and Breast Cancer Diagnosis	[19]
Virtual Engineering Object, Virtual Engineering Process, Virtual Engineering Factory for Industry 4.0	[20]
Innovation Amplification	[21]
Industrial Hazard Control	[22]

3 The Most Recent DDNA-based Extensions: Towards Collective Intelligence based on Collective Experience

3.1 Human activity recognition (HAR)

Human Activity Recognition (HAR) is one of the most active research areas in computer vision for various social contexts like security, wellbeing, smart healthcare, and intelligent human computer interaction. We propose a novel approach that utilizes the convolutional neural networks (CNNs) using experience and the attention mechanism for HAR [23]. In the presented method, the activity recognition accuracy is improved by incorporating attention into multi-head convolutional neural networks for better feature extraction and selection.

3.2 Cognitive vision platform (CVP)

This research is part of an effort for the development of a Cognitive Vision Platform for Hazard Control (CVP-HC) for applications in industrial workplaces, adaptable to a wide range of environments. We tackle the problem of cognitive vision classification with knowledge-based vision system using experience and Decisional DNA (see Fig 4.)

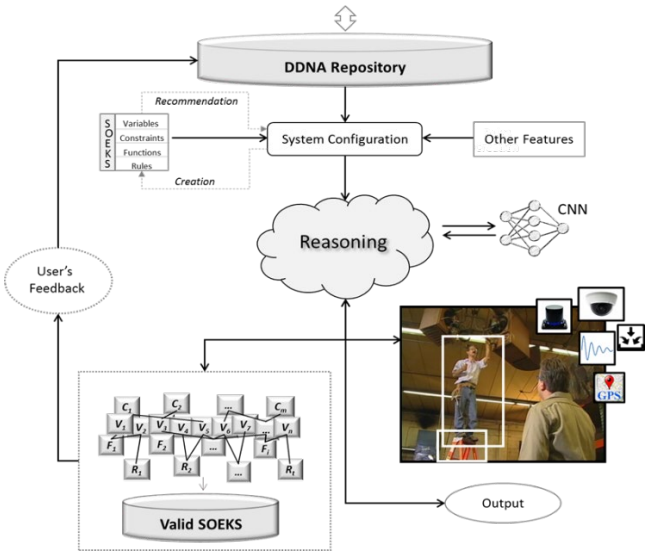

Fig. 4. DDNA-based Cognitive Vision Platform [22].

3.3. KREM model

This DDNA extension is developing collective intelligence systems to support and improve human actions in cognitive society. KREM architecture (Knowledge, Rules, Experience, Meta-Knowledge) is presented in [24]. The novelty of the model comes from the inclusion of the capitalization of experience and the use of meta-knowledge.

3.4 Idream.technology

We apply the Decisional DNA (DDNA) and the Set of Experience Knowledge Structure (SOEKS) technologies as the core of an AI engine for *idream.technology* platform (Figure 5. It provides DDNA technology based tools to enhance peoples' well-being and sustainable development.. IDREAM TECHNOLOGY PTY LTD has successfully applied DDNA and SOEKS to develop a personalized goal achieving plan using collective intelligence captured form collective experience of platform users. The implemented bio-inspired DDNA technology allows creating "fingerprints" distinctive for each individual user and recommends a tailored action path that helps achieving their dreams and aims.

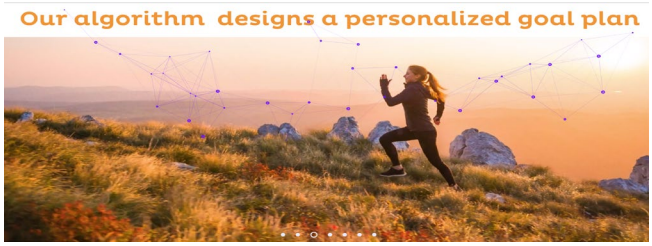

Fig.5. The AI platform to coach to achieve your goals and dreams - idream.technology homepage screenshot (https://www.idream.technology)

4 Future Outlook

Set of Experience and Decisional DNA concepts are at the beginning of their advance but are already making a difference to intelligence augmentation. Future integration of various DDNA extensions would provide an intelligent and sustainable Internet application environment that enables virtual roles (mechanisms that facilitate interoperation among users, applications, and resources) to effectively capture, publish, share and manage explicit knowledge resources. It would also provide support for on-demand services creating vast commercial potential for our technology. Through our approach to knowledge representation and formalization embedded in the concept of Decisional DNA, the future DDNA-based knowledge grid would incorporate epistemology and ontology to reflect human cognition characteristics and adopt the techniques and standards developed during work toward the next-generation, beyond-semantic web.

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