Contents

The HaveNWant Common Cortical Algorithm  .......................................................... 1
P.A. King  .................................................................................................................. 1

Color Vision Consciousness System Capable of Additionally Learning New Knowledge
T. Matsunaga, J. Takeno  ......................................................................................... 9

The Individualization of Social Systems: A Cognitive Framework
M. Lenartowicz, D. Weinbaum (Weaver), P. Braathen  ........................................... 15

Pattern Turnover within Synaptically Perturbed Neural Systems
S.L. Thaler  ............................................................................................................ 21

Using a Conscious System to Construct a Model of the Rubin’s Vase Phenomenon
H. Xu, D. Matsumoto, K. Kanazawa, J. Takeno .................................................. 27

Study on the Environmental Cognition of a Self-evolving Conscious System
R. Sekiguchi, H. Ebisawa, J. Takeno .................................................................... 33

Modification of Holographic Graph Neuron Using Sparse Distributed Representations
D. Kleyko, E. Osipov, D.A. Rachkovskij ............................................................... 39

Development of Self-cognition through Imitation Behavior
T. Okawa, J. Takeno  ............................................................................................ 46

Robot Science Discussion on the Onset of Dissociative Identity Disorder (DID)
T. Hoshino, J. Takeno  ......................................................................................... 52

A Generative Probabilistic Model for Learning Complex Visual Stimuli
A. Potapov, V. Potapova  ..................................................................................... 58

Dynamical Unstable Processes in the Brain: A Biologically Inspired Communication Mechanism from “Unconscious” to “Conscious” Actors
A.L. Perrone  ...................................................................................................... 64

Which Features Matter How Much When?
L. Scheffler  ....................................................................................................... 71

A Formal Model of Script Construction Based on Salience and Abstraction
C. León  ............................................................................................................... 88

A Study of an Indirect Reward on Multi-agent Environments
K. Miyazaki  ....................................................................................................... 94

Lose a Leg but not Your Head – A Cognitive Extension of a Biologically-inspired Walking Architecture
M. Schilling  ....................................................................................................... 102

A Framework Based on Semantic Spaces and Glyphs for Social Sensing on Twitter
G. Pilato, U. Maniscalco  .................................................................................. 107

Psychologically Inspired Planning Method for Smart Relocation Task
A.L. Panov, K.S. Yakovlev  .............................................................................. 115

Implementing a Seed Safe/Moral Motivational System with the Independent Core Observer Model (ICOM)
M.R. Waser, D.J. Kelley  .................................................................................. 125

Design Index for Deep Neural Networks
P. Date, J.A. Hendler, C.D. Carothers  ............................................................. 131

The Virtual Reality of the Mind
J.F. Sowa  ......................................................................................................... 139

Convolutional Neural Network with Biologically Inspired Retinal Structure
J. Kim, O. Sangjun, Y. Kim, M. Lee  ................................................................. 145

Evaluation of Cognitive Architectures Inspired by Cognitive Biases
C. Doell, S. Siebert  .......................................................................................... 155

Peculiarities of Expert Estimation Comparison Methods
A. Tikhomirova, E. Matrosova  ....................................................................... 163

Recognizing Permutated Words with Vector Symbolic Architectures: A Cambridge Test for Machines
D. Kleyko, E. Osipov, R.W. Gayler  .............................................................. 169

Classification Based on Multilayer Extreme Learning Machine for Motor Imagery Task from EEG Signals
L. Duan, M. Bao, J. Miao, Y. Xu, J. Chen  ...................................................... 176

A Biologically Inspired Representation of the Intelligence of a University Campus
V. Seidita, A. Chella, M. Carta  ................................................................. 185

doi:10.1016/S1877-0509(16)32646-1
The Research of Emotional State Influence on Quality of a Brain-Computer Interface Usage
T.J. Voyzenko, G.A. Urvanov, A.A. Dyumy, S.V. Andrianova, E.V. Chepin .......................................................... 391
Functional Systems Network Outperforms Q-learning in Stochastic Environment
A.Y. Sorokin, M.S. Burtsev ........................................................................................................................................ 397
Modeling of Mechanism of Plan Formation by New Caledonian Crows
V.G. Red’ko, M.S. Burtsev ......................................................................................................................................... 403
Modeling of Searching Agent Behavior by Means of Neural Gas
V.G. Red’ko, T.I. Sharipova, G.A. Beskhlebnova ........................................................................................................ 409
The Bilingual Stroop Test from the View of the Information Images Theory
Y.P. Alexander, A.P. Sophia ........................................................................................................................................ 415
Influence of the Modern Web Communication on the Psychological Characteristics of the Rising Generation (12-13 Year Old) from the View of the Information Images Theory
Y. Petukhov Alexander, A. Polevaya Sophia, S. Chuprakova Natalia ................................................................. 423
A Case-driven Methodology for the Interdisciplinary Development and Examination of Mental Architectures
S. Schaat ........................................................................................................................................................................ 429
One Approach to the Quantitative Study of the Safety of Complex Engineering Systems
A.A. Evtifeev, M.A. Zaeva ................................................................................................................................................. 438
Using Automatic Case Generation to Enable Advanced Behaviors in Agents
K. M’Balé, D. Josyula ..................................................................................................................................................... 444
A Test for Believable Social Emotionality in Virtual Actors
A.V. Samsonovich, A. Tolsikhina, P.A. Bortnikov ........................................................................................................ 450
Cash Withdrawal from ATMs as Long Memory Time Series
A. Tsyganov ....................................................................................................................................................................... 459
Model of the Forecasting Cash Withdrawals in the ATM Network
S. Nemeshaev, A. Tsyganov ............................................................................................................................................ 463
Music Inspired Framework for Remediating Emotional Deficits in Autism
M. Tan, N. Khetrapal ....................................................................................................................................................... 469
Cognitive Architecture of Collective Intelligence Based on Social Evidence
A. Kolonin, E. Vityaev, Y. Orlov .................................................................................................................................. 475
Regular Agent Technologies for the Formation of Dynamic Profile
A. Artamonov, B. Onykiy, A. Ananieva, K. Ionkina, D. Kshnyakov, V. Danilova, M. Korotkov ........................................................................................................................................................................................................................................ 482
Approaches to Solve the Vehicle Routing Problem in the Valuables Delivery Domain
V. Korablev, I. Makeev, E. Kharitonov, B. Tshukin, I. Romanov .............................................................................. 487
Thematic Thesauruses in Agent Technologies for Scientific and Technical Information Search
A. Ananieva, B. Onykiy, A. Artamonov, K. Ionkina, I. Galin, D. Kshnyakov .............................................................. 493
Analysis of Mercury’s Magnetosphere States based on MESSENGER data by Kohonen Neural Network and other Clustering Algorithms
D. Parunakian, A. Efievarov, V. Shirokii .................................................................................................................... 499
On the Perceptual Advantages of Visual Suppression Mechanisms for Dynamic Robot Systems
J. Avelino, R. Figueiredo, P. Moreno, A. Bernardino .................................................................................................. 505
Adaptive Modelling of Trauma: Development and Recovery of Patients
D. Formolo, L. Van Ments, J. Truer ............................................................................................................................ 512
MAPPED Repository: An information System for the Emerging Unified Community of Researchers in Cognitive, Neuro and Computer Sciences
A.V. Samsonovich, A.S. Bondarenko, D.A. Azarnov .................................................................................................. 522
On Virtual Characters that Can See
E. Borovikov, S. Yershov .............................................................................................................................................. 528
Role of Intelligent Systems in Upgrading of Information Exchange between FSFM' and Banks
S. Klimova ......................................................................................................................................................................... 534
Weak Semantic Map of the Russian Language: Preliminary Results
A.V. Samsonovich .......................................................................................................................................................... 538
A Biologically Inspired Representation of the Intelligence of a University Campus

Valeria Seidita¹, Antonio Chella¹, and Maurizio Carta²

¹ Dipartimento di Ingegneria Chimica, Gestionale, Informatica, Meccanica, University of Palermo, Italy
{valeria.seidita, antonio.chella}@unipa.it
² Dipartimento di Architettura, University of Palermo, Italy
maurizio.carta@unipa.it

Abstract
Intelligence or smartness in an urban environment implies several factors directed to improve quality of life and efficiency. It is important to note that in this context the inclusion of citizens and their devices is a key factor for reaching smartness. Data from mobile devices are increasingly used in everyday activities and have to be considered a useful means for handling and analyzing knowledge and communications. This paper shows how to represent important data when dealing with smartness by creating an analogy between the representation of human brain areas, activated when specific tasks are performed, and groups of students when behaviors or needs arise. The brain traffic concepts have been used for representing data and information exchanged in the University of Palermo campus.

Keywords: Smart cities, Brain representation

1 Introduction

What does it mean to be intelligent, or smart, in an urban context is still an open question. Several different definitions of intelligent city have been proposed in the literature [9][7][13]. The proposed descriptions typically refer to one or more factors of a smart paradigm described by items like economy, mobility, environment, people, living, governance. Smartness thus resides on the capability of problem solving in an urban context by one or more of the cited axes. Nevertheless, an accepted definition of intelligent city is still a debated concept.

A comprehensive definition has been proposed by Komnios [8]: “Intelligent cities (communities, clusters, districts, multi-cluster territories) outline a new planning paradigm pertinent for urban-regional development and innovation management”.

Thus, smart cities or communities, aim at optimizing and innovating public services to improve citizens’ quality of life and to satisfy needs and demands of citizens, enterprises, and institutions.
Moreover, Komnios highlights the capability of a smart city to learn and innovate through
the digital infrastructures that allow the communication and knowledge management.

However, this is still a long-term vision rather than a reality: a vision of cities, or contexts,
where the needs of people are immediately satisfied. It remains an open question how these
goals could be reached.

Discussions in this field concern different arguments within the research area of smart cities.
For instance, the problems related to the development and implementation of novel technologies
are today a mainstream debate. An important feature of smart cities is related to the network
infrastructure as a mean to improve the efficiency of the city from the political and economic
point of view. Above all, the problem is how to foster the social, urban and cultural development
of a city [7].

Networks infrastructures should be analyzed and studied not only from a technological point
of view but also from the methodological and theoretical perspective concerning the knowledge
and the data management they imply. Latest technological advancements radically changed
the way knowledge is produced and managed in a city. Today, a huge number of citizens own
and use smart devices. These smart objects make oneself recognizable and moreover, they can
communicate data and have access to information from other similar items. Thus, citizens own
an active role towards the realization of city smartness.

In the urban development, citizens have an important social role: they may be included in
public services managed by innovative apps deployed in smart devices. Then, citizens are vital
actors for the co-designing of services and for the changes needed to reach smartness [4].

The realization of a smart city implies a novel way of managing knowledge and innovation
in the urban context. It is then vital to understand how cities are changed and may change,
how the vast amount of data and information may be managed to figure out in which direction
urban creativity and smartness may go together and how to handle them. To figure out how
the new paradigm of Augmented City may be realized [5]. A city where the enhancement of life
goes beyond the pure employment of technology but refers to a connection of spatial, social,
cultural and economic forms.

It thus becomes necessary to represent the flow of data and information within a city to
plan the urban policies and identify values and potentiality. Urban systems are complex and
interactive entities that need to be investigated in an integrated fashion.

There is thus the need for a systematic and methodical approach that starts from data and
communication knowledge and management toward the implementation of intelligent activities
satisfying people’s needs.

In this paper, inspired by the “brain traffic” representation (Taylor et al. [11]), we propose a
biologically inspired model for analyzing and managing these data. Then, we show a preliminary
experiment on representing aggregate data exchanged among students in the University of
Palermo campus (UNIPA campus). Along this work the UNIPA campus will be considered as
a small city district.

The rest of the paper is organized as follows, in section 2 Taylor et al.’s work is briefly
introduced, in section 3 the biologically inspired analogy is explained along with an example of
data representation and in section 4 some conclusions are drawn.

2 Representing Functions of the Brain Modules

Taylor et al. [11] combined two different approaches (brain topography and neural modeling)
to represent and model the tight interactions among different brain areas during the solution
of a task. Their objective is to explain how neural modules interact in the brain and which function they perform while a task is activated.

They primarily discussed the question on what are the roles of the several brain modules involved in cognitive functions. In particular, they analyzed the interactions among brain modules during memory tasks.

The problem was to understand the brain operations by the representation of the network of modules performing suitable functions. After the acquisition of brain imaging data by PET or fMRI, they employed the structural equation modeling (SEM) to analyze the acquired brain images [10][3].

SEM is a mathematical technique that allows to analyze statistical data in situations where multiple random variables are involved. SEM allows inferring the so-called “latent variables” starting from a representative model of some observable and measurable variables: the latent variables depend on the observable variables. As a trivial example, intelligence is not physically measurable; however, in psychology, researchers elaborated techniques, based on specific questions (observable variables), that employ SEM to analyze intelligence.

The representation of the paths among variables that represents the areas activated by tasks, allows to infer suitable values about the interaction between modules, about the convergence of information in the brain and the existence of convergence zones. Taylor et al. employed the notion of “brain traffic” associated with the brain modules to guide SEM analysis.

3 UNIPA Campus as a Brain

Inspired by the previously described work by Taylor at al., we claim that, as in the human brain the flow of data carried by the blood, oxygen and so on, converges into the brain areas related to suitable tasks, the same happens by analogy with data exchanged among citizens or groups of them in an intelligent city. In brief, we propose the analogy of brain traffic with smart city data traffic.

According to this analogy, data spontaneously aggregate, locally and semantically, on arguments, events or themes. This aggregation is the signal of emergent behaviors or needs to pay attention in order to enhance the quality of life of the city area.

Our long-term objective is planning and design of an intelligent campus, and therefore, we consider the UNIPA campus like a brain where brain traffic approach is applied. In doing so, we perform the following steps: (i) representing the flow of information among students; (ii) representing emergent phenomena and needs; (iii) analyzing variables and events generating emergent phenomena and needs; (iv) activating all the tasks that allow UNIPA to acquire, as a whole, an “intelligent” behavior.

Figure 1 briefly shows the analogy: on the left the Taylor’s approach on the human brain is sketched whereas on the right our approach applied to UNIPA campus is depicted.

It is worth noting that functions in the brain trigger suitable tasks, and each task is, in turn, the answer to some urgent or delayed need of the human organism. In the same way, in the proposed analogy, the UNIPA campus needs are satisfied by automatically activating suitable tasks in response to the necessities underlined by the flow of information among groups. Similar to the blood flow in the brain, we take into consideration the flow of messages from the students in the UNIPA campus. In particular, we consider suitable messages and data extracted from Twitter and Facebook groups.

Our reported results have been reached by employing the Gephi software [2] that helped us to understand how graph representations of the flow of messages can be interactively analyzed in our framework. In the literature the adoption of graph representation is well known in the
How flow of data converges into different modules (activates specific areas) $M_i$ when a task $T_i$ is activating - representation by using brain imaging.

How flow of data converges into different groups when an opinion, an idea or a behavior is arising for specific purposes.

Data comes from organic factors such as blood, oxygen and so on.

Data comes from smart devices and in particular from Twitter and Facebook

Modules perform functions that has as effect some tasks to be performed

Groups show opinion/ideas/behavior that have as effect some tasks to be performed

Figure 1: The Biologically Inspired Analogy between Brain and UNIPA

areas of social science and simulation of behavior, see e.g. behavior of crowds. But we go one step further, and we aim to have a tool allowing us to answer to these questions:

- how many connections among different groups for a given argument?
- how are groups localized?
- when and how much do connections among groups suggest the emergence of a social phenomena? Which are the interested parameters?
- can we measure the capability of adaptation on the basis of the emergent phenomena?
- does a complex system adapt in a passive fashion or by evolving itself?

To answer these questions, we firstly need a suitable representation and analysis of data.
3.1 Data Representation

In the context of the UNIPA campus, messages on Facebook and Twitter have been used as a source for identifying observable variables to be used for inferring knowledge on latent variables.

Firstly, we analyzed a great amount of data and used a set of existing tools, such as Netvizz, for retrieving and exporting data to format compatible with software like Gephi. Then, we employed reading techniques [12][1] for data extraction in order to identify possible observable variables to represent in the form of a graph. The graph is then used for carrying out analysis and statistics.

Particularly, data representation with Gephi allows to set several parameters and algorithms for the graph visualization. Moreover, novel plugins may be implemented for performing specific analysis or for applying particular algorithms.

![Gephi Representation on Communication about Welcome Week event](image)

The graph reported in Figure 2 shows an excerpt of the data retrieved from Facebook during the Welcome Week event in the University Campus and some statistics on the graph. For clarity reasons, we show only few labels and use as main parameter the numbers of likes received by each post. Each node represents a post about an argument and its dimension represents the number of likes it received; edges represent relationships among different arguments with a weight (the line width) representing how many times the argument has been discussed. Arguments correspond to observable variables. For instance, the Welcome Week event is related to arguments such as Tutoring, In-Test and Work; the dimension of nodes reveals that students attending the Welcome Week event are much more interested to the entry tests to the university courses than to the possibility to have a tutor during their study. Moreover, students are more interested in the possibility to study in libraries and to be in some student associations rather than in knowing the structure of the university (departments and so on).

From this very trivial and little example, we may obtain results representing some needs to face and then the indication of some tasks to perform in order to improve efficiency and the
quality of life. In our vision tasks may be automatically activated by apps.

4 Conclusions

The work presented in this paper is the first step of a long-term project aimed at designing an intelligent campus. Students with their smart devices provide a great amount of data to be used and elaborated for different purposes, mainly for enhancing quality of life and efficiency. Especially, for a first experiment, we handled the flow of data exchanged through social networks (we mainly used Facebook and Twitter) and employed a biologically inspired analogy with the “brain traffic” concept.

The UNIPA campus is assimilated to a human brain where the flow of blood grows when specific tasks are activated for performing functions. The same happens to data and information among students when a behavior or a need emerge. Data flow within the campus is represented and analyzed using Gephi and the structural equation modeling.

In the future, we plan to refine techniques for data retrieving and for the creation of the Gephi data set and to implement plugins for applying various SEM-based measures.

Moreover, a further improvement in the data analysis may be reached using Agent Based Modeling [6] paradigm which representation and simulation of complex systems ground in.

References

[1] Victor R Basili, Scott Green, Oliver Laitenberger, Filippo Lanubile, Forrest Shull, Sivert Sørungård, and Marvin V Zelkowitz. The empirical investigation of perspective-based reading. *Empirical Software Engineering*, 1(2):133–164, 1996.

[2] Mathieu Bastian, Sebastien Heymann, Mathieu Jacomy, et al. Gephi: an open source software for exploring and manipulating networks. 2009.

[3] Kenneth A Bollen. *Structural equations with latent variables*. John Wiley & Sons, 2014.

[4] Andrea Caragliu, Chiara Del Bo, and Peter Nijkamp. Smart cities in europe. *Journal of urban technology*, 18(2):65–82, 2011.

[5] Maurizio Carta. Creative Cities in Italy: new scenarios and projects. *Creative Cities in Practice-European and Asian Perspectives, year=2014, publisher=Tang Yan, Klaus R. Kunzmann (eds.)-TSINGHUA UNIVERSITY PRESS*.

[6] Nigel Gilbert and Pietro Terna. How to build and use agent-based models in social science. *Mind & Society*, 1(1):57–72, 2000.

[7] Robert G Hollands. Will the real smart city please stand up? *City*, 12(3):303–320, 2008.

[8] Nicos Komninos. Intelligent cities: towards interactive and global innovation environments. *International Journal of Innovation and Regional Development*, 1(4):337–355, 2009.

[9] Nicos Komninos. Intelligent cities: variable geometries of spatial intelligence. *Intelligent Buildings International*, 3(3):172–188, 2011.

[10] John C Loehlin. *Latent variable models: An introduction to factor, path, and structural analysis*. Lawrence Erlbaum Associates Publishers, 1998.

[11] John G Taylor, Barry Horwitz, N Jon Shah, Winfried A Fellenz, H-W Mueller-Gaertner, and JB Krause. Decomposing memory: functional assignments and brain traffic in paired word associative learning. *Neural Networks*, 13(8):923–940, 2000.

[12] Claes Wohlin, Per Runeson, Martin Höst, Magnus C Ohlsson, Björn Regnell, and Anders Wesslén. *Experimentation in software engineering*. Springer Science & Business Media, 2012.

[13] Marc Wolfram. Deconstructing smart cities: An intertextual reading of concepts and practices for integrated urban and ict development. *REAL CORP 2012, 1416 May 2012, Schwechat*. 