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A Diagram Museum 2015.09: A TUT-KOSEN Cooperation Project

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Abstract

Diagrams have been used to elicit, organize, and communicate knowledge. Well organized diagrams can support even discovery of new knowledge. This note explores many diagrams presented in DIAGRAM VISUALIZATION DOJO (DOJO is a place to learn or practice martial arts such as JUDO, KENDO, etc.), which is a collaborative project involving TUT (Toyohashi University of Technology) and KOSENs (KOSEN is a college of technology). Involving ICT in presenting diagrams will lead to a new mode of interactive knowledge transfer, applicable to education. Several attempts of applying diagrammatic reasoning to engineering problems will be presented.

This note introduces three diagrams from the Diagram Visualization Dojo which has been supported by many KOSENs.

1. Introduction

Diagrams are any geometric objects that elicit scientific and engineering findings; support humans to find new knowledge and enhance persuasion of assertions to viewers. Diagrams have been playing a very important role, for example, Feynman Diagrams in physics; Block Diagrams in control theory; and graphs and networks in network science, to mention only a few. With the recent advent of smart info-media, Diagrams are becoming more important area [2-5, 7].

Since 2007, we have been collaborating with students and professors of many College of technology. This year celebrates 9th collaborative projects for the TUT-KOSEN Cooperation Project involving Diagrams. The results of the project (named DIAGRAM VISUALIZATION DOJO) have been included and presented in many international conferences.

In Diagram Museum in 2013, a special session called for papers on any Diagrams that will contribute to visual understanding of knowledge. For example, papers on the topic including, but are not limited to, the following areas of interest:

1. New Diagrams for Sciences and Engineering
2. Tangible Mathematics by Smart Info-Media

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3. Japanese (Asian) ASOBI (games)
4. WASAN (Japanese mathematics)
5. Electronic and Web-based Museum
6. Diagrammatic Reasoning
7. Symmetry-based Reasoning
8. Diagram based communication and education
9. Visualization

DIAGRAM VISUALIZATION DOJO developed many Diagrams such as:

- Using Diagrams Generated by Dynamical Systems (with Anan KO-SEN).
- Diagrams Generated in Space Weather Forecast (with Yonago KOSEN) [8]
- Visualizing Difficulty Level in Hierarchical Latins Square Puzzles (e.g. SUDOKU^{TM}) (with Akashi KOSEN) [9]
- Visualizing Entire Networks of Problem-Solving in the Sliding Puzzles (e.g., a sliding puzzle with 15 numbers with 9 by 9 grid) (with Akita KOSEN)
- Movie Profiling and Indexing for educational experiments (with Okinawa KOSEN) [3]
- Profiling with Keystroke Dynamics by Keystroke Networks (with Akashi KOSEN) [3]
- Visualizing with Networks of Roles in Computer and Network Administration (with Sendai KOSEN)
- Visualizing Network Robustness (with Kochi KOSEN) [3]
- Group Formation of Japanese Companies (with Ube KOSEN)
- Motion Picture Profiling in a Japanese dance KACHUSHA (with Okinawa KOSEN) [3]

Among these diagrams, we will present three diagrams. Among three diagrams, the second one (section 3) is also related to AntSAT (Autonomous Networked Tiny Satellites) which is shared with another TUT-KOSEN cooperation project: TINY NETWORK SATELLITES KOBO (KOBO is a workshop) which has been involved Akashi, Kochi, Nara, Okinawa, Tokuyama, Tokyo Metropolitan, Yonago KOSEN.

As the exhibitions for “Diagram Museum 2015.9 Singapore”, these three diagrams are presented in the following sections, while other Diagrams among the followings will be submitted to this ISRP workshop.

- AR-SANGAKU (Japanese Mathematics presented by AR)
- AR-AYATORI (Japanese String game guided by AR)
- Personalized HOJIN (Spatiotemporally extended Magic Squares)
- Geometric HOJIN [2]
- Dynamic HOJIN [2]
- Diagrams for understanding dynamics of the Stable Marriage Problem [3]
- Diagrams for strategy profiling in membrane formation of spatiotemporally extended Spatial Prisoner’s Dilemma [6]
- Diagrams for understanding dynamics of the Self-Repair Networks
- Diagrams and Dynamic Geometry [4, 5]

2. Diagrams as Design Pattern (with Anan KOSEN)

There are huge amount of technologies for textile dyeing depending on its cultural traditions. Indonesian and Malaysian BATIK and Japanese SOMEMONO, to mention only two. Indonesian BATIK is well known as “Masterpiece of Oral and Intangible Heritage of Humanity” designated by UNESCO. The textile dyeing often requires motif and inspirations from natural patterns (e.g., mountains and rivers), biological patterns (e.g., flowers and animals) and cultural patterns (e.g., Celt Spirals). While, on the other hand, mathematical model can generate huge amount of design patterns of not only these traditional ones but also of entirely new design patterns. Among others, mathematical model can generate not only static design pattern but also dynamic design pattern. We noticed that some dynamic pattern may be used for the motif and inspirations (or even as processes) for generating design patterns for textile dyeing.

This project will use membrane expanding patterns (Figure 1 [6]) for the inspirations, motifs and even process of the SOMEMONO in Japan. We have studied and collected dynamic patterns of the membrane expanding. Many parameters in the model allow us to generate diverse patterns. The hierarchical spatial prisoner's dilemma here can generate even every patterns appeared in snowflakes [6]. Fig. 1 shows two design patterns in hexagonal lattice (***left***) and square lattice (***right***) generated by the membrane formation of the spatial prisoner's dilemma where All-D (red), D of k-D (green, membrane) and C of k-D (blue) [6].

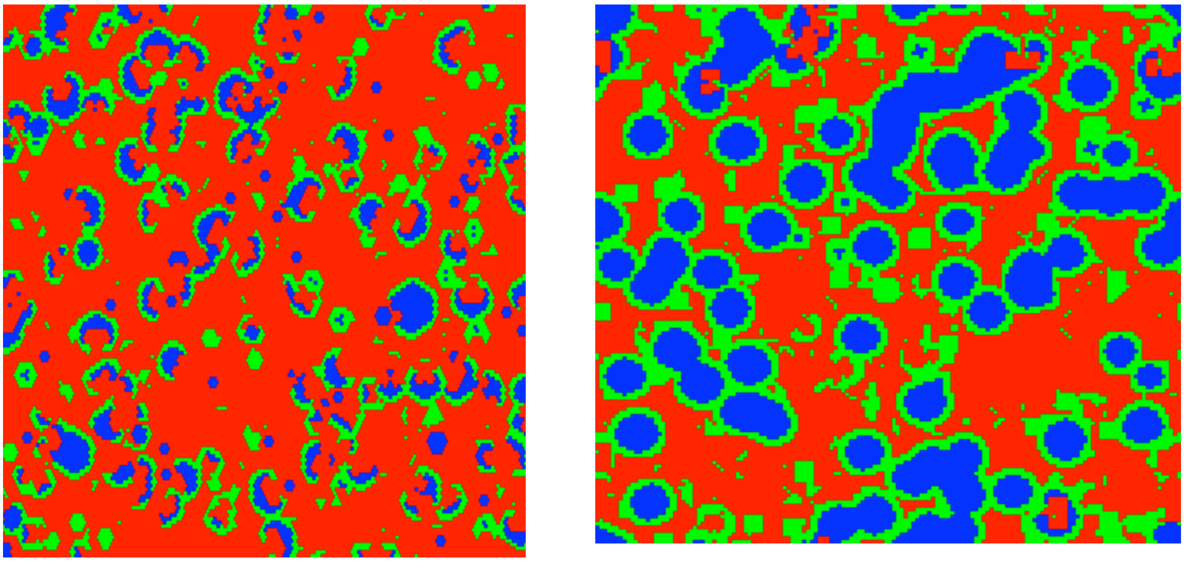

Figure 1. Two design patterns in a hexagonal lattice (***left***) and in a square lattice (***right***) generated by the membrane formation of the spatial prisoner's dilemma where All-D (red), D of k-D (green, membrane) and C of k-D (blue).

3. Diagrams as Interface Design (with Yonago KOSEN)

As example of Diagrams of AntSAT in Situ Sensing, diagrams of the self-recognizing network for space weather forecast [8] have been chosen.

Figure 2 [8] shows a snapshot of nodes in the dynamic relational network (eight-sensor model). The nodes evaluated as faulty from all sensors are colored red. The nodes evaluated as faulty from half nodes are also colored red. The plus and minus signs on arcs represent a diagnosis result (plus = normal/minus = abnormal). Rectangles represent regions of satellites equipped with sensors for observation. The solid lines indicate two nodes diagnose each other. The dashed lines indicate unidirectional diagnosis from one node to another one. The symbol V_i and B_{zi} (i = 1, 2, 3) respectively represent solar wind speed and north-south component of interplanetary magnetic field. The symbol E and E_{24} respectively represent high-energy electron flux and its 24 h ahead.

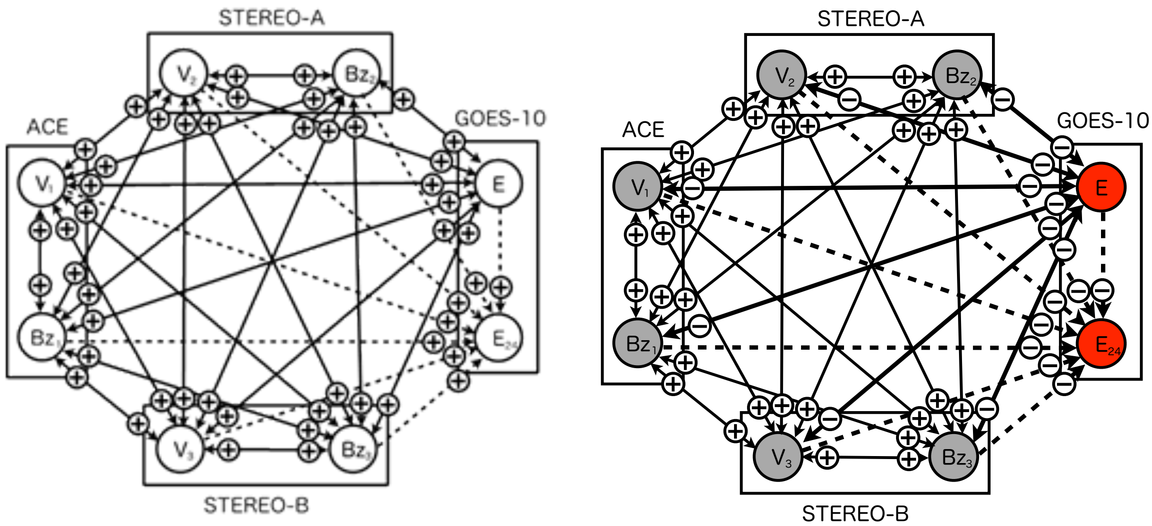

Figure 2. Initial state (Step = 0) of the dynamic relational network. All arcs show target sensors normal (*left*); Steady state (Step = 84) of the dynamic relational network (right). The nodes diagnosed as fault from all sensors is coloured red. The nodes diagnosed as fault from one node is coloured in graduation.

4. Diagrams for Visualizing Difficulty (with Akashi KOSEN)

Sudoku is a number-placement puzzle. The objective is to fill 9×9 grid with simple rules. Sudoku has become hugely popular in the world after a London newspaper company published Sudoku puzzles in 2004. It is known that the ancestor of Sudoku is the Latin square named by Leonhard Euler in 18 century. Since then, people have been enjoying filling up all Latin square cells from static given numbers. Most Sudoku puzzles are ranked with difficulty ratings set by puzzle creators or publishers. However, these difficulty ratings cannot be determined uniquely from the grid. Further, the ratings often do not consider cognitive difficulty people perceive when solving. To reveal the cognitive difficulty of Sudoku using a computational difficulty by evaluating a puzzle grid, we proposed a diagram that visualizes difficulty reflecting computational difficulty.

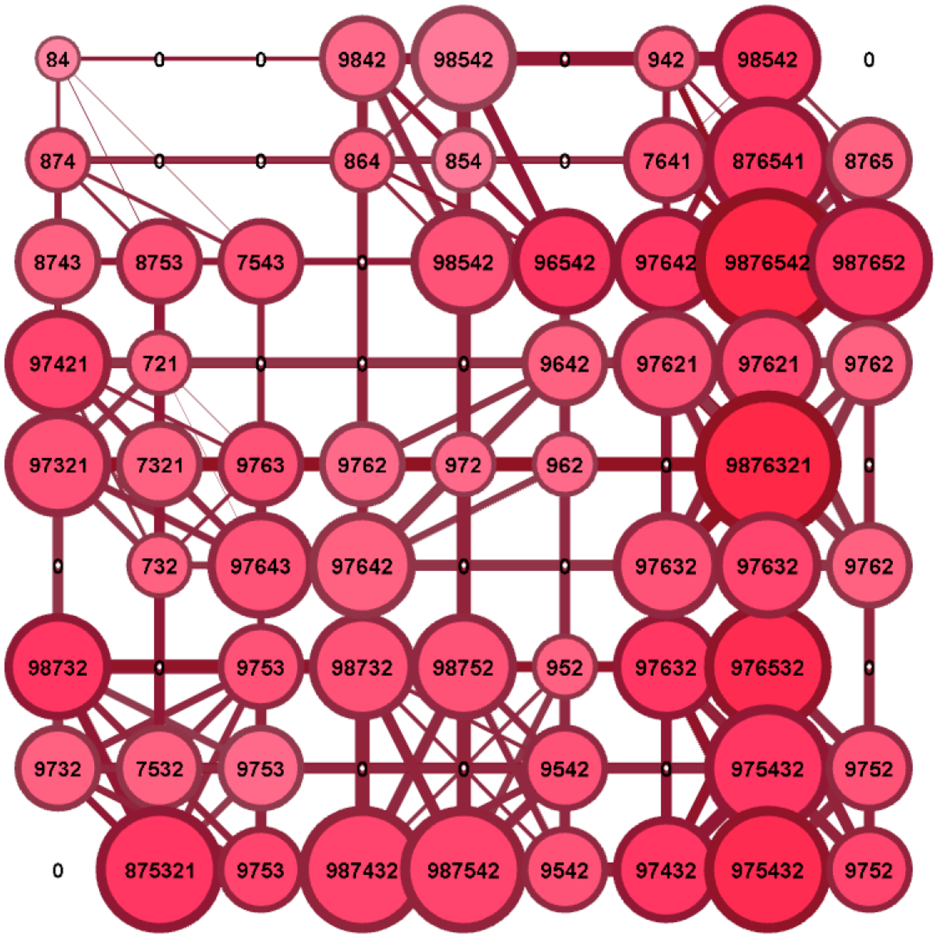

Figure 3. Diagram visualizing the Sudoku difficulty in two components: node size is proportional to the numbers to be filled in a vacant cell; and edge thickness is proportional to how many of these numbers are shared by these vacant cells.

Many researchers have been studying how to evaluate Sudoku difficulty. To visualize the difficulty, two components are involved: possible numbers to be filled in a vacant cell (c.f., Z. Chen used Sudoku entropy [1]); and how many of these numbers are shared by these vacant cells [9]. In Figure 3, the former is visualized as the size of nodes where the possible numbers are indicated; and the latter is visualized as the thickness of edges.
Figure 3 visualizes the difficulty of a Sudoku puzzle, which is left to readers to recover the original Sudoku puzzle, which itself is a puzzle dual to the original puzzle.

5. Conclusion

Diagram Museum is a new type of academic presentations. As a media, it can activate not only many academic presentations but also other presentations such as arts, business, technology and even music if they can be expressed as diagrams. Diagram Museum has demonstrated to enhance educations and communications in many inter and intra institution projects.

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Akashi KOSEN, Akita KOSEN, Anan KOSEN, Kochi KOSEN, Okinawa KOSEN, Sendai KOSEN, Tokuyama KOSEN, Ube KOSEN, Yonago KOSEN

Special thanks to the professors and their students of these KOSENs.

Among the three diagrams (Figures 1, 2 and 3), the diagram (Figure 2) from AntSAT (Autonomous Networked Tiny Satellites) is shared with another TUT-KOSEN cooperation project: TINY NETWORK SATELLITES KOBO (KOBO is a workshop) which has been supported by Akashi, Kochi, Nara, Okinawa, Tokuyama, Tokyo Metropolitan, and Yonago KOSENs.

The diagram (Figure 1) is based on the results made possible thanks to The Global COE Program “Frontiers of Intelligent Sensing”, from the Ministry of Education, Culture, Sports, Science and Technology, which had been led by Makoto Ishida in Toyohashi University of Technology (TUT).

The diagram (Figure 3) is also related to the Internship Program from Akashi KOSEN to TUT, which is financially supported by TUT.

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We had a workshop on “Diagram Museum” collaborating with Technical University of Dresden (TUD) in Toyohashi 2013, and then we participated in an international workshop focusing on designing Smart Cities “SynCity” in 2014 in TUD. Special thanks to Jörg Rainer Noennig who participated in the Diagram Museum at TUT in 2013 and organized the SynCity workshop at TUD in 2014.

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