Lecturer Workload Optimization Applying Interactive Visualization

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Abstract. Lecturers are required to perform three basic activities to be accomplished each semester, i.e. teaching, performing research, and participating in community services. However, capturing lecturer productivity for the evaluation purposes is a complex problem. This research aims to design and develop a tool to visualize and conceive lecturer workload. Instead of analysing text-based big data distribution, this research adopted interactive visualization approach that offers interaction to support lecturer workload exploratory data analysis. This approach consists of overview, zoom and filter, and detail on demand. The result is able to show the workload of each lecturer in three different level: lecturer level, head of department level, and institution level, thus made it easier to examine each lecturer activity and productivity. The contribution of this research is to provide a visualization tool for determining fair and reasonable workload for lecturers to optimize their productivity and evaluate their work rate distribution.

1. Introduction

Lecturers are the main human resource that support learning process in a higher education institution. The Ministry of Research, Technology and Higher Education (Menristekdikti) of the Republic of Indonesia has set three major activities that each lecturer is required to perform in each semester, namely: 1) teaching, 2) performing research and 3) performing community services [1].

In the beginning of every semester, each lecturer is required to submit a program that contains the three activities during the semester. The institution, on behalf of the Menristekdikti, evaluates lecturer performance based on their performance on each activity. The performance evaluation should be performed on each individual lecturer. However, the institution also requires to determine the overall performance of all lecturers. For the institution, imbalance distribution of the three main activities would be harmful towards their performance. Therefore, the proportion of each activity must be monitored and the balance must be maintained.

This research aims to illustrate the institution performance based on the three major activities of its lecturers. To support data exploratory analysis, we adopted the Interactive visualization approach. We leveraged the visual variable and interactive system concept to allow user to have direct access to learn about the data.

Visualization is used in many domains, specifically to overcome big number and multidimensional data analysis. Visualization also have the advantage compares to the textual information in that the visualization can amplify user cognition about data behaviour, interesting pattern and tendency. Interactive visualization approach is related to information visualization, which is a method to translate textual data or information to visual form to augment user cognition [2]. Information visualization supports data exploratory analysis including process to format many and complex data. This method converts raw data to a graph as a solution to improve interactivity, such as interactive visualization in a small word graph [3-8]. Moreover, interactive approach provides guidance to select particular interaction features which can be used to support data exploratory analysis. The Seeking Mantra defined by Schneiderman [9-11] explains the six main factors of interactive visualization characteristics, i.e.: overview, detail on demand, extract, zoom and filter, relate, and history.

The remaining of the paper is structured as follows. Section 2 explains the methods of this research. Section 3 discusses the result of this research. We summarize the findings in Section 4. The result is able to show the workload of each lecturer in three different level: lecturer level, head of department level, and institution level, thus made it easier to examine each lecturer activity and productivity.

2. Method

The tool was developed using JavaScript, JQuery and PHP, including D3JS library. Data was stored in a database using MySQL as the DBMS.

We collected the performance of lecturers in Politeknik Negeri Batam. Data from each lecturer consisted of the number of *sks* (hour) of each activity per semester per year. This step also required data pre-processing step to clean the data from noises, such as redundant data, inconsistency removal and errors in data transformation. Figure 1 illustrates an excerpt of data on the lecturer performance. (Figure 1-3)

Staff Number	Major Activity	Activity	*SKS* (Hour)	Year	Semester
1234	Teaching	Teach subject X - 1 Class	1.45	2016	Odd
1234	Teaching	Teach subject Y – 2 Classes	2.34	2016	Odd
1234	Support	Member of Graduation Committee	3	2016	Even
4567	Community Service	Teach MS Office Training for kids	3	2016	Even
4567	Research	Publish an article on Journal Z	4	2016	Even

Figure 1. An excerpt of lecturer performance data.

Figure 2. Data integration process.
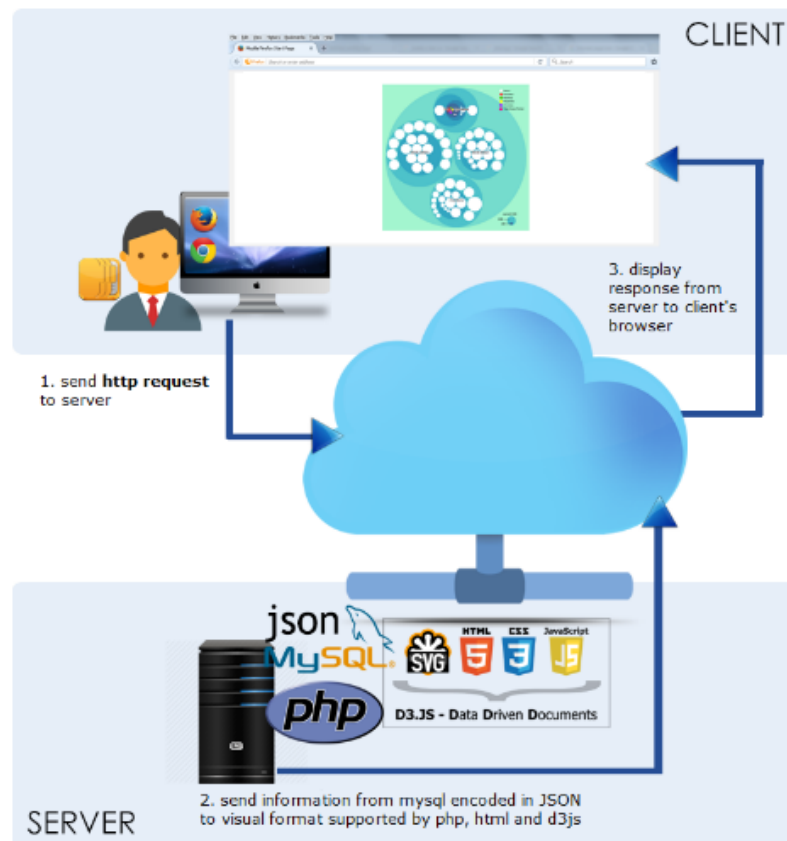
Figure 3. System architecture.

Figure 1 shows two lecturers with each one performing different activities. Lecture 1234 taught subject X for one class and subject Y for two classes, which considered into teaching activities, and they also a member of graduation committee, which was considered as supporting activities. Meanwhile, lecturer 4567 provided community service through taught MS Office for kids and published an article on Journal Z as part of their research.

These data were then processed through data integration, which transform data in the MySQL database to d3js for visualization. The data integration process. In this process, data was captured via web form and then stored in a MySQL database. These data were then converted and encoded into JSON (JavaScript Object Notation). Lastly, the data was visualized using D3js library in PHP. The architecture of the machinery is presented in Figure 2.

3. Result and discussion

3.1. Data abstraction
We defined three levels of data abstraction, i.e.:

3.1.1. Lecturer level. Data abstraction for lecturer consists of all attributes belonging to each lecturer, e.g. staff number, and the performance for each semester for each individual lecturer. Activity can be grouped by these attributes and visualized as such. For example, activities of any particular staff are grouped by year, semester and so on, then visualized as circle components. Figure 4 shows the detail of the lecturer level data abstraction.
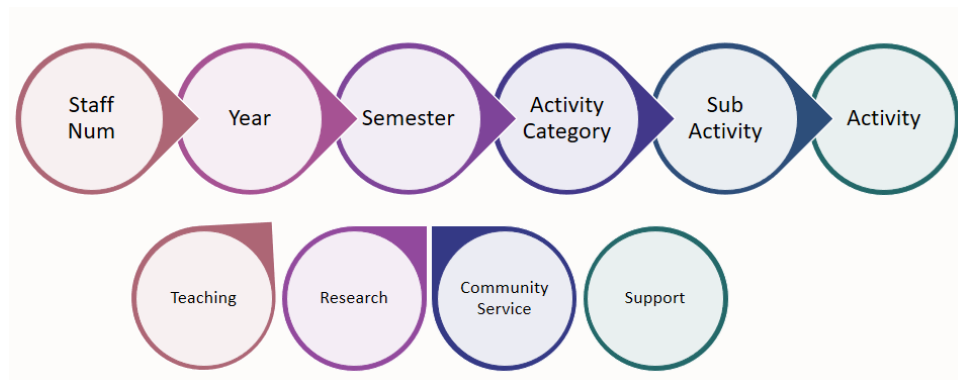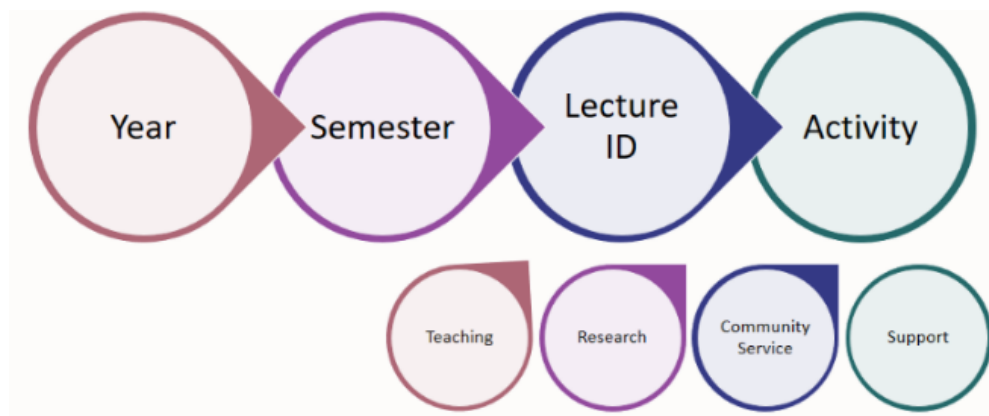
Figure 4. Lecturer level data abstraction.

3.1.2. Head of department level. Head of department level data abstraction is the summary of performance data of all lecturers in a particular department. Figure 5 presents the head of department level data abstraction.
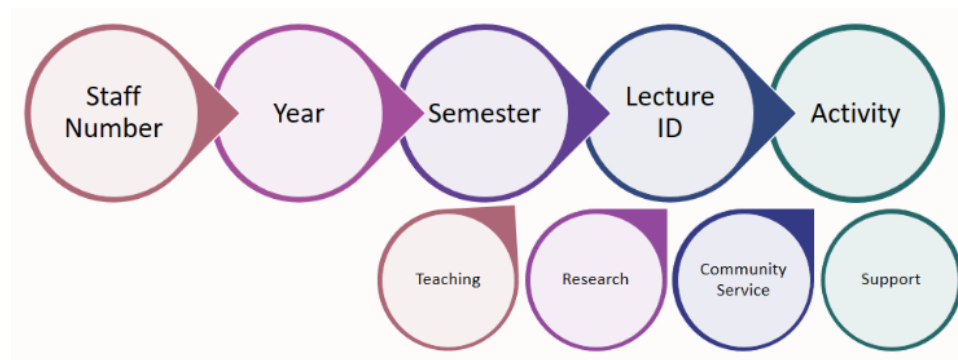
Figure 5. Head of department level data abstraction.

3.1.3. Institution level. Institution level data abstraction is the summary of all departments' performance data. Figure 6 illustrates the institution level data abstraction.
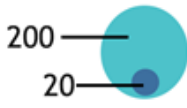

Figure 6. Institution level data abstraction.

Each level was incorporated into data visualization using *zoomable circle packing* (ZCP). ZCP allows data to be transformed into an SVG (Scalable Vector Graphics) image format, which contains

several zoomable levels to examine details of the data. The components of a ZCP is presented in Table 1.

Table 1. Component of a ZCP.

Visual Component	Description
Area	*Circle* is an area type of SVG to visualize a performance component (an activity) or a group of components.
Size	**Number of hours** The bigger a circle area of the data, the number of hours of the activity is also bigger.
Colour	 Distinguish colour of each performance component to simplify user in finding the component.
Intensity	The higher of the level of the circle area, the colour intensity is higher (the image seems lighter in colour).

3.2. Data visualization

Result and discussion of the data visualization is described in this section. Figure 7 shows the legends of the visualization. The components of the visualization consist of the three major activities (teaching, research and community service, and support). Each component is visualized as a circle area with different colours. The size and intensity are also explained in this legend (as presented in Table 1).

Result of the data integration, where data in the database were converted and encoded to the JSON and compiled by D3JS, is illustrated in Figure 7. In this figure, the level of data abstraction in on institution level, where the visualization shows the performance of all lecturer in all departments. The data is categorized according to its year and semester; therefore, we can observe that each year the performance differs between each component. For example, in year 2016, there are two semesters. For research, the yellow circle in the odd semester (on the left) is bigger than the on the even semester (on the right), which means that the research (*penelitian*) in the odd semester of 2016 is higher in number of hours than in the even semester of 2016 (Figure 7).
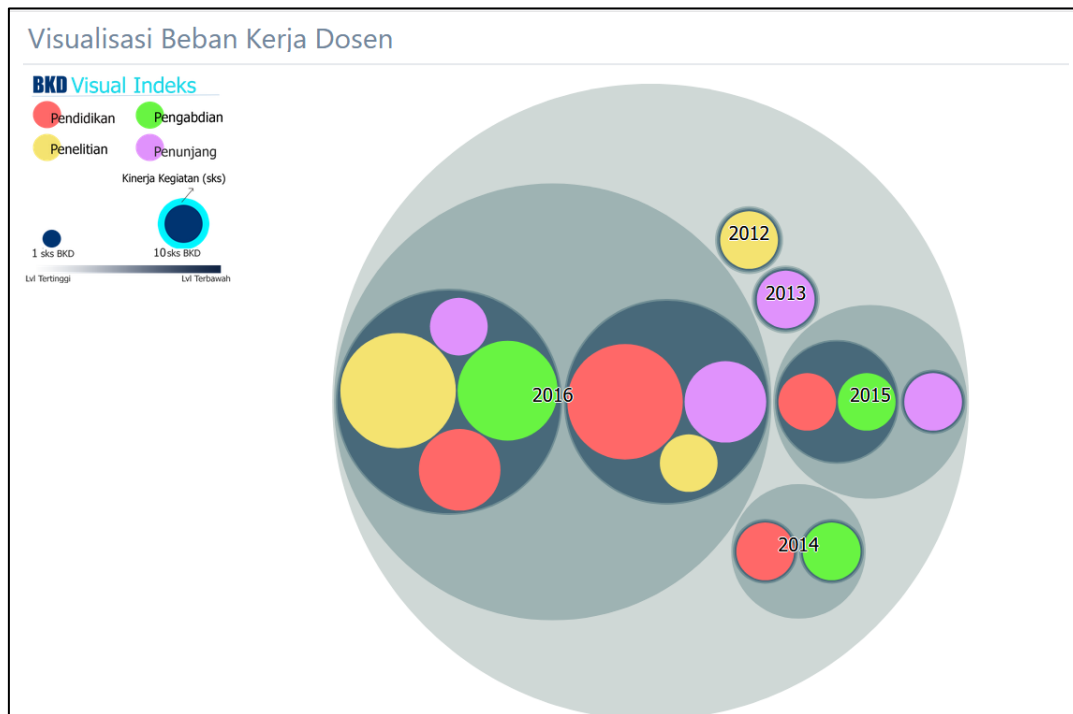
Figure 7. Visualization web home.

3.3. User interaction

There were three interactions defined as users features in order to explore visualization page, namely:

- **Overview**: help user to get holistic information about the data, illustrated in Figure 8.
- **Zoom and filter**: help user to see closer and clearer as illustrated in Figure 10.
- **Details-on-Demand**: help user to see more details of data and examine the data and meta data better. This feature is illustrated in Figure 9.

Based on the result obtained in this research we found that visual variable such as colour, size and hierarchy in the role of data visualization main features enriched by the user interaction element such overview, zoom and filter and details-on-demand. It allows better performance on data exploratory analysis. However other interaction such Extract, History and Relate could to improve the result as an additional feature.
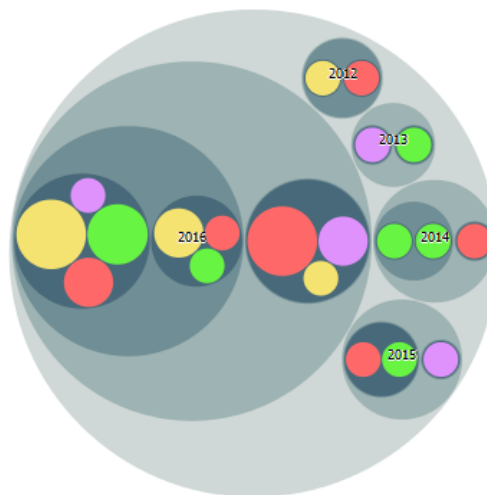
Figure 8. Data overview.
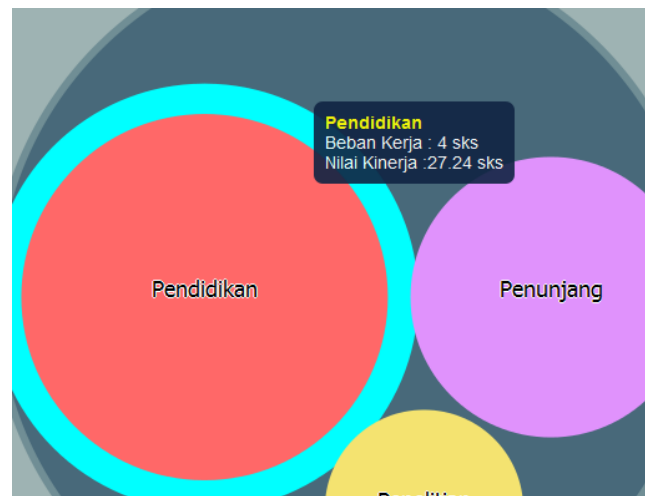
Figure 9. Details on demand.

(a)   (b)
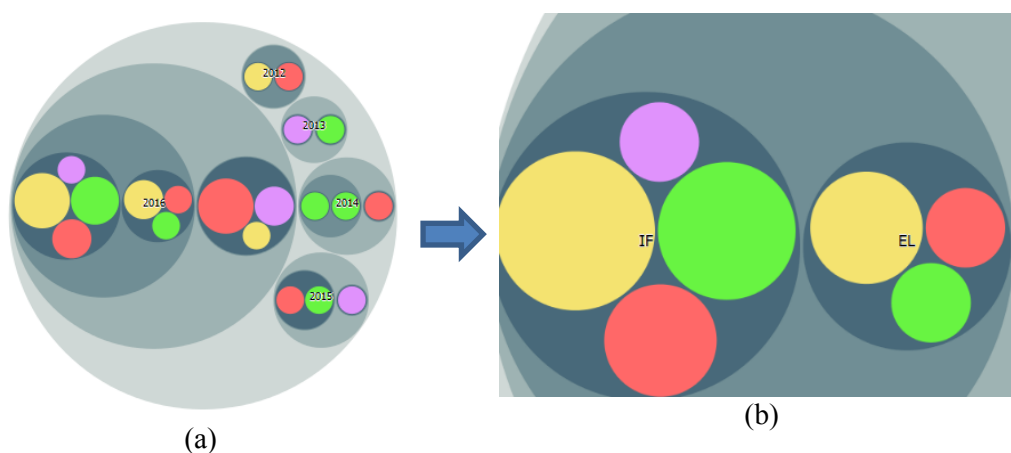
Figure 10. Zoom feature.

4. Conclusions

This research was aimed to provide support to the institution in performance evaluation by visualizing the number of hours of each activity. The result of this research shows that the machinery that we developed is able to provide user with interactive visualization and grouped data based on years, semester and type of activity. There was three level of data abstraction provided to the user, i.e.: lecturer level, head of department level, and institution level. With these level of abstraction, it is easier for user to observe the performance on each level. More specifically, in the machinery, we provide three user features, i.e.: overview, detail on demands, and zoom.

References

[1]   Kementrian Riset Teknologi dan Pendidikan Tinggi Republik Indonesia 2015 "Pedoman BKD," *Proc. Workshop Pengisian Beban Kerja Dosen (BKD) 2015.*
[2]   Craft B and Cairns P 2005 "Beyond guidelines: what can we learn from the visual information seeking mantra?," *Proc. 9th Int'l Conf. Information Visualisation* pp 110–118.
[3]   Mufida M K, Calvary G, Chessa S D and Laurillau Y 2015 "MoVi: models visualization for

mastering complexity in model driven engineering," *Proc. of the 2015 British HCI Conference* (ACM).

[4] Mufida M K, Calvary G and Chessa S D 2016 "Mastering Model Driven Engineering complexity by interactive visualization," *Technique et Science Informatiques* **35** pp 175– 202.

[5] Segel E and Heer J 2010 "Narrative Visualization: Telling Stories with Data," *IEEE Trans. Visualization and Computer Graphics* **16** 6 pp 1139–1148.

[6] Carlis J V and Konstan J A 1998 "Interactive visualization of serial periodic data," *Proc. of the 11th annual ACM symposium on User interface software and technology* (ACM).

[7] Van Ham F and Van Wijk J J 2004 "Interactive visualization of small world graphs," *Proc. of IEEE Symposium on Information Visualization* (IEEE).

[8] Mulyana S and Winarko E 2009 "Teknik Visualisasi Dalam Data Mining," *Proc. Seminar Nasional Informatika E* pp 100–106.

[9] Shneiderman B 1996 "The eyes have it: A task by data type taxonomy for information visualizations," *Proc. of IEEE Symposium on Visual Languages* (IEEE).

[10] Shneiderman B 1996 "The Eyes Have It : A Task by Data Type Taxonomy for Information Visualizations," *Proc. IEEE Visual Languages '96* pp 336–343.

[11] Card S K, Mackinlay J D and Shneiderman B 1999 *Readings in information visualization: using vision to think* (Morgan Kaufmann).