

Automatic Detection of Learning Styles in Learning Management System by Using Literature-Based Method and Support Vector Machine

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Abstract - Each learner has their own preferences in the learning process. Differences in preferences are closely related to the learning style of each learner. Personalization of e-learning is an overview of online learning that has been customized content based on learning styles of each learner. Detecting learning style needs a technique that is effective and accurate. This study combines literature based method with Support Vector Machine (SVM) to detect students' learning styles. The data used is learning log data of Data Structures and Algorithms class at the Faculty of Computer Science, Universitas Indonesia. The test results showed that SVM has better accuracy compared to Naive Bayes.

Keywords—*E-learning Personalization, learning style, automatic detection, SVM*

I. INTRODUCTION

There are differences in the learning process, which is caused by differences in preferences and habits learned from each learners. Some learners like verifying facts or data through the learning experience, some others prefer to learn through abstract knowledge, such as formulas, basic principles, mathematical symbols, and others. Other learners prefer graphics or visual data such as graphs, charts, animations and others. Moreover, while a group of learners prefer to learn through texts, such as verbal and audio, another group of learners prefer to try new things and do practices [1]. Understanding the differences among learners, learning content can be adapted to their learning style to make the learning process more effective. Learning styles used in this study is the Felder-Silverman learning styles [2]

The development of online learning (e-learning) is rapidly increasing, making the issue of personalization is now possible in the learning process. Personalization needs a precise and accurate method to detect learning styles in each learner. There are two approaches to detect a student's learning style, collaborative approach and automated approach. In this study, researchers use the automated approach, since this approach is based on actual behavioral patterns during the online learning process. Automated approach, is divided into two methods, data-driven method and literature-based method [3].

Support Vector Machine (SVM) is an example of a technique in data driven methods. Among the widely used

classification methods such as Decision Tree, Bayesian method, Neural Network, K-Neighbor method, SVM performs better than the other methods. These are SVM characteristics: (1) SVM has generalization performance that can avoid the selection of local minima structure; (2) It does not rely on human experience and knowledge; and (3) It is suitable for solving high-dimensional problems [4].

Problems were found in the data-driven approach is the label of the data used to build the model based on the ILS (Index of Learning Style) questionnaires filled out by students. Comparative studies of Graf on methods of data - driven and literature based method found that the literature-based methods produce data that is more accurate in identifying learning styles. Therefore the study combines literature-based methods for the determination of label data and classifying the data with data-driven method SVM [5].

II. LITERATURE REVIEW

A. E-learning

E-learning is a learning process that is facilitated and supported by the use of information and communication technology [6]. While the learning management system is a software system which is used for managing learning and available in various forms, such as a portal website that collects all the links and video directory, as yet another added feature tests to guide learners into the learning stages[7].

B. Felder-Silverman Learning Styles

Learning styles are strong characteristics and preferences will someone about how to learn, especially in the process of obtaining information [2]. Felder-Silverman learning styles suitable for use in modeling the learning styles of engineering disciplines [8]. In this study, learning styles restricted to the dimensions processing with active and reflective learning style. Table 1 describes the distribution of the dimensions and characteristics of learning styles according to Felder and Silverman [2].

C. Support Vector Machine (SVM)

The support vector machine (SVM) is a learning system that uses a hypothetical form of function space - a linear function in a feature space (feature space) high

TABLE 1. FELDER-SILVERMAN LEARNING STYLES

| Dimension | Category | Explanation |
|---------------|------------|---|
| Perception | Sensory | Tend to perceive information concretely, practically oriented, facts and loved examples |
| | Intuitive | Tend to perceive information conceptually, through abstract material, impatient with details and like the challenge |
| Input | Visual | Are likely to remember the information well what is seen as images, diagrams, videos, and so forth. Then this category is often easy to forget the words that have been spoken of others. |
| | Auditory | Tend to get a lot of information through writing or speech as lecture slides, audio and so on. |
| Processing | Active | Tend to process information by doing activities, such as to discuss or explain it and love working group |
| | Reflective | Tend to process information by doing activities such as discussing or explaining it, and love working group |
| Understanding | Sequential | Tend to understand the information in a linear or sequential and learn to move step by step |
| | Global | Tend to understand information to get the picture summary or explore |

dimension, trained with the learning algorithm based on the theory of optimization by implementing learning bias derived from statistical learning theory [8]. SVM characteristics are as follows :

1. In principle SVM is a linear classifier
2. Pattern recognition is carried out by transforming the data in the input space into higher dimensional space, and the optimization is done in the new vector space. It distinguishes from the SVM pattern recognition solutions in general, the optimization parameters on dimensional space transformation result is lower than the input dimensional space.
3. Implement the Structural Risk Minimization (SRM) strategy
4. The principle of SVM is basically only able to handle two-class classification.

D. Detection Learning Style

There are two different ways of learning models according to Brusilovsky [3] :

- Collaborative Approach

In this approach, the learners provide explicit feedback that can be used to build or renew the

teaching model. The most common ways are to use a questionnaire to identify the learning style [9].

- Automated Approach

Automated approach is a learning process and update the model is done automatically based on the behavior and actions of learners when they use the system for learning [9].

In the automated approach, there are two methods used:

- a. Data-Driven Method

Data-driven method aims to build a model that follows the ILS questionnaire (Index of Learning Style) from Felder and Silverman [2], and uses sample data to build a model.

- b. Literature-Based Method

Literature-based method is used to identify the learning style based on students' behavior when using the LMS to obtain clues about their learning style preferences [10].

III. METHODOLOGY & RESULT

To detect the student's learning style using the literature-based method and SVM, the study was conducted by following five steps as can be seen in the Figure 1 below.

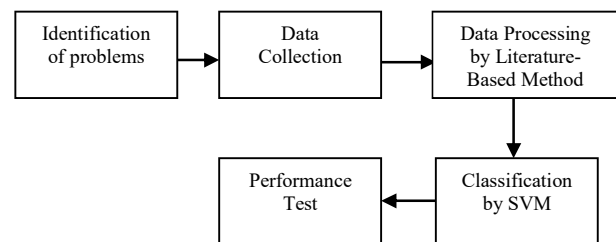


Fig. 1. Research Methodology

The five steps are elaborated below.

A. Identification of Problem

Problems related to the research topic was gathered by conducting a literature review, especially gathering data about the problem of detection techniques of learning styles.

B. Data Collection

In this step, data were collected by gathering learning log in a learning management system called the Student e-Learning Environment. The data used in this study is a learning log data of Data Structures and Algorithms at Faculty of Computer Science Universitas Indonesia. The data collected were 200 student data.

C. Data Preprocessing

After gathering the data, the authors conducted data preprocessing. The goal was to obtain the data label using the SVM classification process. The series of pre-processing this data using literature-based methods. This step is the most

time-consuming. During the data preprocessing, the following steps were carried out:

- 1) Define the features and learning behavior pattern that is relevant to the style of learning.
This step is the default view and compares features of a learning management styles (i.e., Moodle), with features that exist in the literature. Then determine the learning behavior pattern of the feature and the last step is mapping based on the literature about the features that correspond to the active and reflective learning style.
- 2) Determine the threshold of learning behavior patterns
Features and learning behavior pattern that has been found from the first step is then used to determine the threshold.
- 3) Define the learning styles (labelling process)
 - a) Calculate the number of access from any behavior pattern that has been set based on user id
 - b) Give the value of each feature based on a predefined threshold (discretization)
 - c) Calculate the total of the features relevant to each learning style and divided by the number involved

D. Classification by SVM

Experiments were performed with 5-fold cross-validation, the data 200 is divided into 5 in which 4/5 of the data is treated as training data and the remaining 1/5 as test data. The composition of training data and test data have been selected at random and with holdout technique. Table 2 presents the results obtained from the experiment five times.

TABLE 2. ACCURACY OF EXPERIMENTS WITH SVM

| Experiment | SVM (%) |
|------------|---------|
| 1 | 84,62 |
| 2 | 74,49 |
| 3 | 84,62 |
| 4 | 84,62 |
| 5 | 84,62 |
| average | 83,59 |

E. Performance Test : Comparison with Naive Bayes

To see if SVM is more accurate than other methods of data mining. This study did a comparison with methods Naive Bayes.

TABLE 3. ACCURACY COMPARISON BETWEEN SVM AND NAÏVE BAYES

| Experiment# | Naive Bayes (%) | SVM (%) |
|-------------|-----------------|---------|
| 1 | 61,54 | 84,62 |
| 2 | 64,11 | 74,49 |
| 3 | 56,41 | 84,62 |
| 4 | 64,36 | 84,62 |
| 5 | 66,67 | 84,62 |
| Average | 62,61 | 83,59 |

Using data and equal treatment with SVM, Table 3 shows the results of the classification accuracy between SVM and Naive Bayes.

IV. RESEARCH IMPLICATION

This study shows that labeling technique with literature-based methods and classification by SVM can automatically detect learning styles in Learning Management System well. Some of the implications include:

1. Theoretical implications: The study results can be used as the basis for building a personalized e-learning system.
2. Managerial implications: Learning service providers such as lecturers and developers can take advantage of and maximize the features that are relevant to the learning styles as described in the research.

V. CONCLUSION

From this study, it can be concluded that the classification method of learning styles by using SVM and literature-based methods provide good accuracy compared using other data mining methods of data mining.

To detect learning styles for the label needs a dataset with literature-based methods do several steps: 1) determine the features and learning behavior patterns that are relevant to the learning style 2) determine the threshold learning behavior pattern 3) label. In the process of labeling there are several steps that need to be done, namely: 1) Calculate the number of access from any behavior pattern by id user 2) Provide the value of each feature based on the threshold predefined 3) Calculate the total relevant features for each learning style and dividing by the number of features that involved and 4) labeling based on the trend of learning styles.

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