Volume 5 Number 1

UNESCO
International Centre
for
Engineering Education

World Transactions on Engineering and Technology Education

Editor-in-Chief:
Zenon J. Pudlowski
Monash University, Clayton,
Melbourne, VIC 3800, Australia

MELBOURNE - WISMAR 2006

World Transactions on Engineering and Technology Education

2006

Vol.5, No.1

World Transactions on Engineering and Technology Education

Editor-in-Chief: Zenon J. Pudlowski
UNESCO International Centre for Engineering Education (UICEE)
Monash University, Melbourne 3800, Australia

Melbourne - Wismar 2006

UICEE Partners

Aalborg University
Aalborg, Denmark

Anna University
Chennai, India

Caledonian College of Engineering,
Muscat, Oman

Chinese Culture University
Taipei, Taiwan

East China University of Science &
Technology, Shanghai, PRC

Gdynia Maritime University
Gdynia, Poland

Glasgow Caledonian University
Glasgow, Scotland, UK

Higher Institute of Engineering
Hoon, Libya

Hochschule Wismar – University of
Technology, Business & Design
Wismar, Germany

Liverpool *John Moores* University,
Liverpool, England, UK

Lucian Blaga University of Sibiu,
Sibiu, Romania

Maharashtra Academy of Engineering
& Educational Research Pune, India

National Changhua University of
Education, Changhua, Taiwan

Polytechnic University
New York, USA

Silesian University of Technology
Gliwice, Poland

Technical University of Częstochowa,
Faculty of Management,
Częstochowa, Poland

Technologie- u. Gewerbezentrum
e.V. (TGZ) - Technology and
Commercial Centre, Schwerin-
Wismar, Germany

Tomsk Polytechnic University
Tomsk, Russia

University of Science &
Technology *Houari Boumediene*
Algiers, Algeria

University of Technology, Jamaica
Kingston, Jamaica

Published by:

UNESCO International Centre for Engineering Education (UICEE),
Faculty of Engineering, Monash University, Clayton, Melbourne, VIC 3800, Australia

ISSN 1446-2257

Papers published in the World Transactions have undergone a formal process of peer review by international referees.

Responsibility for the contents of these articles rests upon the authors and not the publisher. Data presented and conclusions developed by the authors are for information only and are not intended for use without independent substantiating investigations on the part of the potential user.

World Transactions on Engineering and Technology Education

Contents

Editorial

It is pleasing to see that the *World Transactions on Engineering and Technology Education* (WTE&TE), an international research and development journal published by the UNESCO International Centre for Engineering Education (UICEE), based at Monash University, Melbourne, Australia, has really taken off the ground with a large number of high quality articles being submitted to its recent issue, marked Vol.5, No.1.

This particular issue of the WTE&TE), initiates the fifth volume of this relatively new publication, with a collection of 46 contributions from academics from 18 countries worldwide. The articles included in this issue present research, development and promotional activities, which document well the recent status and quality of international undertakings in engineering and technology education. The authors of these articles endeavour to present a multitude of concepts, ideas, innovative procedures and practical applications so vital for the development of teaching/learning methodologies employed in engineering and technology education at academic education institutions on a worldwide basis. It should be pointed out that the release of this issue for the global circulation falls into the 13th year of the operation of the UICEE.

It is somehow disappointing that the prevailing majority of the authors of these innovative works presented in their and highly informative articles, who in their professional and academic work devise, develop and implement so many interesting ideas, apparatus, programs and procedures have not, as yet, taken the opportunity to collaborate closely with members of the UICEE, not only for their own professional and personal gain, but also for the benefit of the entire global community of engineering and technology educators. I would certainly appeal to the authors who have published their articles in the WTE&TE to support not only this journal, but also other activities of the UICEE and its international members which produce tangible results for academia, its staff and students.

On behalf of the entire Editorial Board and, indeed myself, it is my pleasant duty and real pleasure to express our sincere gratitude to the referees of these articles, who have contributed their precious time to the process of peer review of the articles included in this issue. I wish to acknowledge that the following senior academics, members of the UICEE global network, who have refereed these articles:

- Prof. Chih-Yang (Frank) Chao, National Changhua University of Education, Changhua, Taiwan
- Prof. Romuald Cwilewicz, Gdynia Maritime University, Gdynia, Poland
- Prof. Krzysztof Kluszczyński, Silesian University of Technology, Gliwice, Poland
- Prof. Romanas V. Krivickas, Kaunas University of Technology, Kaunas, Lithuania
- A/Prof. Wojciech Kuczborski, Edith Cowan University, Perth, Australia
- A/Prof. Ian H. Marshall, Monash University, Melbourne, Australia
- Prof. Derek O. Northwood, University of Windsor, Windsor, Canada
- Prof. Dieter Schott, Hochschule Wismar - University of Technology, Business and Design, Wismar, Germany
- Prof. Algirdas V. Valiulis, Vilnius Gediminas Technical University, Vilnius, Lithuania

Furthermore, I believe that the readers would be happy if I take this opportunity to offer our sincere thanks to all the authors of these articles for their willingness to publicise their work and achievements, and to share their ideas so vital for the future development of engineering and technology education. It is also my pleasure to direct our special gratitude to the staff of the UICEE for their tremendous assistance in preparing this issue for its publication and distribution, both in print and electronically.

Zenon J. Pudlowski

Students' allocation using fuzzy clustering algorithms and Fukuyama and Sugeno's fuzzy cluster validity index

Sani Susanto†, Ernawati‡ & Pandian Vasant*

Parahyangan Catholic University, Bandung, Indonesia†
Atma Jaya University, Yogyakarta, Indonesia‡
University Teknologi Petronas, Perak, Malaysia*

ABSTRACT: Data Structure is a compulsory 4th semester subject offered by the Department of Informatics at Atma Jaya University, Yogyakarta, Indonesia. Consider that there are 121 students enrolled in this subject, all of whom need to be allocated into classes. This fact raises three questions. Firstly, what is the appropriate number of classes? Secondly, how should those students be allocated into classes? Thirdly, which student belongs to which class? The answer to the second and the third questions for a given number of classes was formulated in a previous article by employing the fuzzy clustering concept, one of several tools in data mining. As a development to this prior article, the research presented by the authors in this current article endeavours to answer the first question by employing the Fukuyama and Sugeno's fuzzy cluster validity index.

INTRODUCTION

Consider the following fact: 121 students enrolled in the Department of Informatics at the Atma Jaya University, Yogyakarta, Indonesia, are going to take the subject TF4376 (Data Structure), a compulsory 4th semester unit. Those students must be allocated to, say, *n* classes. This fact raises three questions. Firstly, what is the appropriate value for *n*? Secondly, should those 121 students be allocated into classes? Thirdly, which student belongs to which class? In fact, there are common answers to those questions. According to the University's rules, up to 60 students are allowed to be in a class; thus, two classes are needed. Based on students' ID numbers, allocate the first 60 students to are assigned to class A and the remainder 61 students to class B.

However, is there any other more reasonable way to answer those three questions? The answer to the second and third question was given by Susanto, Suharto and Sukapto [6]. This was carried out by applying a data mining technique called *fuzzy clustering* or *fuzzy c-means*. This technique divides several items into several groups (also called *classes* or *clusters*), based on an items' characteristics or attributes.

The research presented in this article is a development of the previous article and tries to answer the first question [6]. The problem formulated by this question belongs to region of *fuzzy cluster validity* problems. Answering it requires a comparison to be carried out between the values of the *fuzzy cluster validity index* for several numbers of the clusters.

This article is organised as follows. The Approach and Methods section describes the approach, methods and concepts applied in order to solve the research questions formulated in the Introduction section. The Results section reports on the information obtained from the application of the approach, methods and the concept employed. In the Discussion section, the authors discuss and interpret the results obtained. The Conclusion section presents the summary of the research results. For the readers' ease and convenience and due to space limitations some tables are placed in the Appendices.

APPROACH AND METHODS IN CLUSTERING

The process of distributing students to classes is called *clustering*, while the class obtained is called a *cluster*. *Clustering* of the 121 students for the subject TF4376 is based on students' mastery level of its prerequisite. In the case of TF4376, its prerequisite subjects are TF2474 (Algorithms and Programming) and TF3276 (Introduction to Data Structure). Students' individual mastery levels of the prerequisites are based on the scores that students achieved. At the Atma Jaya University, students' grades are divided into 11 categories, ie from A (excellent) to E (fail), which corresponds to the score from 4 to 0, as listed in Table 1.

Table 1: Grade and score.

Grade	Score
A	4.00
A^-	3.70
B^+	3.30
B	3.00
B^-	2.70
C^+	2.30
C	2.00
C^-	1.70
D^+	1.30
D	1.00
E	0.00

Scores provide the input information for *clustering*. Successful *clustering* results in *clusters* of students with similar mastery levels of prerequisite subjects. Students' scores of these prerequisites are listed in Table 2 (see Appendices) as