

Detecting Major Disease in Public Hospital Using Ensemble Techniques

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Abstract—Hepatitis is chronic disease that becomes major problem in developing countries. Health experts estimate that more than 185 billion people have chronic hepatitis worldwide. This paper attempts to detect major disease such as hepatitis in public hospital using ensemble methods. Several ensemble techniques were applied to acquire knowledge from patient medical records. Afterwards, rule extraction from decision tree and neural network are summarized in order to assist experts in detecting hepatitis. Accuracy of those algorithms is also performed and from the experimental result shows that Bagging, with decision tree as base-classifier, denotes best performance among other classifiers.

Keywords - ensemble methods, hepatitis, predictive accuracy, public hospital, rule extraction.

I. INTRODUCTION

Hepatitis is a major global health problem. Currently, Indonesia is a third largest country worldwide after China and India which has large number of hepatitis patients. Experts predict about 23.9 million people in Indonesia are infected with the hepatitis type-B virus [1], whereas World Health Organization (WHO) estimates more than 240 million people worldwide have chronic infections of hepatitis. It yields about 600 thousand people die every year in the consequence of critical outcomes of hepatitis type-B virus [2].

Hepatitis has no clear clinical symptoms, so as many hepatitis patients unable to gain appropriate diagnosis and treatment. To date, symptoms of hepatitis disease is also different, depending on the type of hepatitis virus itself. Hence, it is necessary to find proper approaches as well as early detection, prevention and treatment of hepatitis disease.

Corresponds to the context of early detection and prevention, data mining could be applied as an alternative method by discovering knowledge from the medical records data. Data mining deals with the analysis and extraction of knowledge from medical data, intended for supporting diagnostic, screening, prognostic, monitoring, or overall patient management tasks [3].

In public hospital, large amount of medical data are stored, accumulated, and growing as ‘data tombs’ without undertaking further analysis to the data. Intelligent data analysis as well as data mining was disseminated in order to promote the creation of knowledge to assist clinicians on making decisions as for early detection of the disease. Knowledge discovery as part of data mining process has significant role to discover interesting patterns (knowledge) from huge amounts of data. Interesting patterns is commonly as non-trivial, implicit, previously unknown and potentially useful [4], so as in such way they can

be put to use in areas such as decision support and prediction [5], and nowadays, in hepatitis domain, finding knowledge is an active and challenging research.

Several researches have been conducted on detection methods of hepatitis disease. A rule discovery support system for sequential medical data was firstly introduced by Ohsaki et al. They used K-means algorithm and C5.0 (latest version of C4.5) algorithm to discover rules to predict the trend of hepatitis data in the future [6]. Ho et al proposed a temporal abstraction method to find interesting pattern from hepatitis data. Temporal abstraction method was developed since many machine learning techniques could not be applied to temporal domains [7].

The latest study on data mining application in detecting hepatitis, for instance, can be found in [8]. The objective of the study is to construct a simple model to identify hepatitis patients with high-risk of developing hepatocellular carcinoma (HCC). Chronic hepatitis type-C patients were involved and analyzed by decision tree to build a predictive model for HCC development. A comprehensive literature review concerning predictive data mining in clinical medicine also can be found in [9]. They surveyed and clustered researches found in many literatures into four areas depending on the data used such as predictive data mining techniques in clinical applications, data mining with temporal approaches, feature selection in predictive modeling, and predictive medicine and ‘omics’ sciences.

However, most of those researches merely employed common data mining techniques that implied such other techniques i.e. ensemble methods have not been utilized. Hence, this paper aims to address ensemble techniques so as finding most influential attribute on hepatitis disease. We have collected up to 300 records of hepatitis data (all type of hepatitis are included) in one of local public hospital in Indonesia. Then, we extracted the data and constructed several classifiers. Classification accuracy at different number of features is performed and examined to find the best classifier. Finally, we extract and compare extracted rules from decision tree (J48) and neural network (with REANN algorithm).

II. LITERATURE REVIEW

In this section, ensemble methods and implementation of REANN algorithm with Java-based interface are presented. Rule extraction from J48 is not presented in detail here as it can be found in many literatures for instance in [10], [11], and [12].

A. Ensemble Techniques

In data mining researches, ensemble techniques have spent great attention. Incorporating multiple classifiers are becoming prevalent owing to empirical outcomes that proposing them yields more robust and more accurate prediction as they are compared to the individual classifiers [13]. An ensemble contains a number of learners called base-learners. Base-learners are usually generated from training data by a base learning algorithm. Examples of these techniques include Bagging (Bag) [14], AdaBoost (Bo) [15], Random Subspace (RS) [16], Random Forest (RF) [17], and Rotation Forest (RFor) [18].

Among those approaches, AdaBoost become very popular as there were many variants. We utilized AdaBoost.M1 [19] algorithm that is already implemented in well-known open source data mining software, WEKA [12], to boost two popular base-classifiers, those are, decision tree (J48) [10] and neural network (NN) with multilayer perceptron architecture. Despite boosting, bagging, random subspace, and other ensemble methods are designed, and usually used with J48, it is also applicable to perform other base classifiers [20].

A novel ensemble algorithm called Rotation Forest was firstly introduced by Rodriguez et al [18]. This approach generates an ensemble classifier by training a base-learner on a randomly selected subspace of the input data that has been rotated using Principal Component Analysis (PCA) [21]. The latest work of ensemble technique which combined Rotation Forest and AdaBoost called RotBoost was proposed by Zhang and Zhang. It could generate ensemble classifier with significantly lower prediction error than either Rotation Forest or AdaBoost. It was also developed to perform much better than Bagging and Multi-Boost [22].

B. Rule Extraction from Neural Network

Several approaches of rule extraction from neural network have been discovered in the last decades. For instance, a method called X2R has been proposed by Liu and Tan [23]. X2R can generate concise rules from data set; however, generated rules are order-sensitive.

A hybrid method that is suitable for data set with binary attributes was proposed by Setiono et al [24]. The method was built upon neural network rule extraction (with M-of-N construct) [25] and consists of two components such as neural network and a decision tree classifier. Though the method can be performed well in general, there are some drawbacks i.e. the neural network training is slow when the data set is large in terms of the numbers of samples and/or attributes.

REANN algorithm was proposed by Kamruzzaman and Islam [26]. The objective of REANN algorithms was to find simple rules with high predictive accuracy. Some key advantages using REANN include; (1) as using constructive pruning strategy, it can determine optimal ANN architecture automatically, and (2) it can extract rules that are concise, comprehensible and highly accurate [26].

A Java-based interface for rule extraction with REANN algorithm was developed (as shown in Figure 1) in order to create simple and easy tool that can be employed by researchers, clinician, or decision makers in detecting hepatitis disease. The interface was equipped with parameter selection

and rule extraction button. Training error and epochs could be selected as well to perform neural network training.

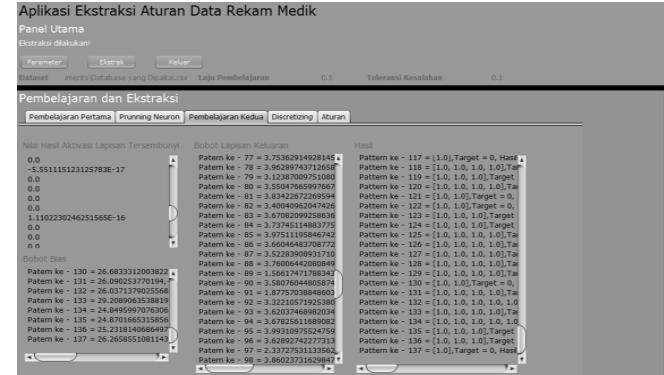


Figure 1. An Interface for Detecting Hepatitis Disease with REANN Algorithm.

III. EXPERIMENTAL DESIGN

A. Data Collection and Pre-processing

Raw data was obtained from patient medical records in one of the public hospital in Indonesia from 2009 to 2013. We included all type of hepatitis disease. After performing data pre-processing task such as cleaning, transformation and integration, the data set comprises 206 records and 12 features, where 51.46% (106) cases in hepatitis type-A (Class A), 27.18% (56) cases in hepatitis type-B (Class B), and 21.36% (44) cases in hepatitis type-C (Class C). The top-12 significant features used in this study in descending order by information gain are: (1) Myalgia, (2) Hives, (3) Age, (4) Gender, (5) Abdominal pain, (6) Cough, (7) Heartburn, (8) Fever, (9) Headache, (10) Jaundice, (11) Fatigue, and (12) Appetite.

B. Experimental Setup

We conducted an empirical study using our real dataset described previously. Firstly, we applied all ensemble methods with decision tree and neural network as base learners. Hereafter, we compared and examined their accuracy through different feature number.

We used 10-folds cross validation to evaluate all classifiers. Standard cross-validation is 10-cross validation as extensive experiments have shown that this is the optimal number to get an accurate estimate.

Several interesting patterns (rules) that were successfully extracted from J48 and REANN are also presented and discussed in the next section. Rules are beneficial for early detection of hepatitis in the public hospital.

IV. RESULT AND DISCUSSION

A. Classification Analysis

We carried out and compared algorithms as single-classifiers (J48, NN, and RF) and all ensemble techniques (Bag, Bo, RS, RF, and RFor) for both base-classifiers (NN and

decision tree) by assessing them with different feature number. A total of 77 experiments were conducted for classification analysis. Table 1 shows the classification accuracy as the number of input variables increase, we can find out that the higher classification accuracy was acquired.

In term of average performance as shown in Figure 2, bagging J48 performed best accuracy among other methods. When applying J48 in several ensemble techniques as well as bagging, boosting, and random subspace; their accuracy were slightly worse compared to individual classifier, except for bagging and random forest. In other side, when applying neural network in several ensemble methods such as bagging and boosting, their accuracy were worse compared to neural network as individual classifier.

TABLE I. ACCURACY COMPARISONS OF EACH MINING TECHNIQUE (%)

Methods	Feature Number						
	3	4	6	7	8	10	12
J48	44.2	60.2	75.2	68.9	62.6	70.4	70.9
NN	44.2	64.1	71.8	62.1	61.7	64.1	68.0
RF	39.3	60.2	71.8	59.7	63.1	62.1	67.0
Bag-J48	44.2	61.7	75.2	66.5	66.5	67.0	72.3
Bo-J48	44.2	58.7	72.3	65.5	63.1	62.1	69.4
RS-J48	44.2	64.1	75.2	64.6	57.3	66.0	68.9
RFor-J48	42.7	60.2	75.2	67.0	63.6	67.0	75.2
Bag- NN	40.3	59.2	72.3	61.7	62.1	65.5	69.0
Bo-NN	44.2	62.6	72.3	58.7	65.0	62.1	64.6
RS-NN	44.2	64.1	75.2	64.6	57.8	64.6	71.4
RFor-NN	41.8	63.1	72.8	64.1	66.0	65.0	68.9

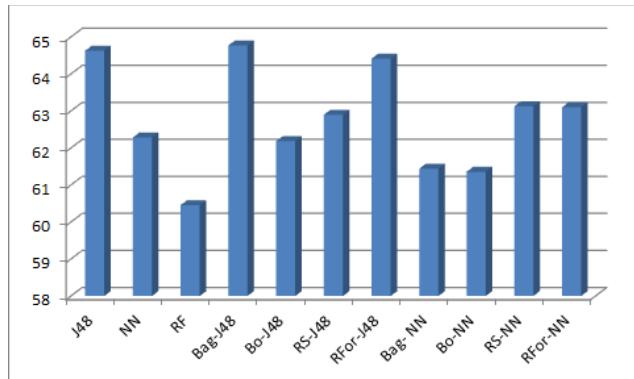


Figure 2. Average Performance of Classifiers

Furthermore, to our experimental study carried out for real data set, ensemble classifiers generally outperform single classifiers as the conclusion of empirical study of bagging [14],

which stated that bagging improve performance of single classifiers by reducing bias and variance. Meanwhile, our results for random forest were poor in comparison to other methods opposes to previous study [17], which stated that random forest give results competitive with bagging and boosting.

B. Rule Extraction

Decision tree (J48) uses information gain measure to choose among the candidate attributes at each step while producing the tree [11]. From our experimental result, J48 generated a total of 9 rules. Three rules classify samples as hepatitis type-A, the 2 rules classify samples as hepatitis type-B, and the 4 rules classify samples as hepatitis type-C. The accuracy rate of these rules on the training sets is 78.64%, whilst accuracy rate of these rules on validation sets is 71.8%. The most significant rules for each type of hepatitis are presented as follows:

- R1 : IF hives = false and myalgia = false THEN
Class A
- R2 : IF hives = false AND abdominal pain = true AND
myalgia = true AND fatigue = true AND
appetite = true THEN Class C
- R3 : IF hives = true AND myalgia = false THEN
Class B

Otherwise, total of 2 extracted rules were obtained from REANN. The accuracy rates of these rules on the training and validation sets are 79.15 and 70.60%, respectively. The rules are presented as follows:

- R1 : IF jaundice = true AND myalgia = false THEN
Class A
- R2 : IF abdominal pain = true AND
hives = true AND appetite = true THEN Class B

From the rule extraction experiment, it is shown that training set accuracy rates from the two methods are quite similar, the accuracy rates of the rules extracted from REANN on the validation set are higher by up to 0.51% than the accuracy of the rules from J48. However, of the total 9 significant rules that had been obtained from J48, we think that those three rules are the most significant because it can directly address the question as for early detection method of hepatitis in public hospital.

Furthermore, two rules extracted from REANN have close relation to rules obtained from J48. Two rules are only for hepatitis type-A and type-B, while hepatitis type-C could not be successfully extracted by REANN. All significant rules have been confirmed by clinicians and they agreed to accept the rules as second opinion concerning detection hepatitis.

V. CONCLUSION

We employed and examined several ensemble techniques in detecting hepatitis in public hospital. Several significant rules from decision tree and neural network have been successfully obtained. From the experimental result, bagging methods with decision tree as base classifier yielded best

accuracy among other methods. This research might have some limitations. There is direction for further research that could be taken. It would be interesting to perform cross-sectional research by comparing the characteristics of patient with other type of hospitals. Finally, it would be useful if more medical data records could be acquired later.

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TABLE OF CONTENTS

COPYRIGHT NOTICE	iv
ABOUT THE CONFERENCE	x
FOREWORD Chairman of ISTMET 2014	xi
PROGRAM SCHEDULE	xii
KEYNOTE SPEAKERS	xiii
DAY 1 Schedule	xvi
DAY 2 Schedule	xxviii
Full Papers	xxxvii
1. Triple Band Off-Centre-Fed Microstrip Antenna on LTCC Technology	1
2. Optimizing Sales Using Mobile Sales Ticketing Application	6
3. Feature Points Repeatability on Facial Deformation	14
4. A Control Method for Single-Phase Bidirectional Converters	19
5. Comparison of Conventional Circular Split Ring and Circular Split Ring with Triangular Tip Edge to Increase Electrical Field Response	25
6. A 2.45 GHz Wearable Antenna Using Conductive Graphene and Polymer Substrate	29
7. Metal Mountable UHF-RFID Tag Antenna with Meander Feed Line and Double T-Match	33
8. Electronic Voting for the People of Mount Merapi, Really?	39
9. Wireless Real Time Design for Artificial Sphincter Control for Urinary Incontinence	44
10. Development of a Resilient Wireless Sensor Network for Real-Time Outdoor Applications	50
11. An In-Body Wireless Communication System for Targeted Drug Delivery: Design and Simulation	56
12. Dual-band Planar Inverted F Antenna with Parasitic Element for LTE and WiMAX Mobile Communication	62
13. Design of Broadband Tri-Polarized Antenna for Wireless MIMO Systems	68
14. A Review on Circular Polarization Antenna for Wireless MIMO Application	73
15. Band-Reject Ultra-wideband Antenna for WLAN and DSRC Environments	78
16. System Integration and Control of Dynamic Ankle Foot Orthosis for Lower Limb Rehabilitation	82
17. Electrical Conductivity Characteristics of Tin-doped Zinc Oxide Thin Film Deposited Using Sol-Gel Immersion Method	86
18. Comparison of Optimal Calculation of Inventories	90
19. The Difference in Eco-tourist Preferences to Marine Tourism Destination Base on Biocentrism Segments	94
20. Development of Prototype System for Monitoring and Computing Greenhouse Gases with Unmanned Aerial Vehicle (UAV) Deployment	98

21.	An Integrated Document Management System for Managing Self Programme Accreditation Using Scrum Approach	102
22.	Understanding Factors on the Customer Intention Behavior Through Facebook Commerce: a Conceptual Model	107
23.	Towards a Unified PKI Framework	113
24.	Plagiarism: A Review of Why Malaysian Students Commit the Academic Dishonour	119
25.	Using PLS-SEM Technique to Model Malaysian Construction Firms' Entry Timing Decisions in International Market Expansion	123
26.	Dielectric Barrier Discharge Plasma Reactor Analysis as Ozone Generator	129
27.	Force Assisted Hand and Finger Device for Rehabilitation	133
28.	Visualization Skills Among Universiti Teknologi Malaysia Student	139
29.	Analysis and Design of Variable Double-Band Hysteresis Current Controller for Single-Phase Full-Bridge Bidirectional Converters	143
30.	Detecting Major Disease in Public Hospital Using Ensemble Techniques	149
31.	Evaluation of Canny and Sobel Operator for Logo Edge Detection	153
32.	Applicability of Machine Learning Techniques in Predicting Customer's Defection	157
33.	SQL Injection Detection and Prevention System with Raspberry Pi Honeypot Cluster for Trapping Attacker	163
34.	Development of Ozone Technology Fish Storage Systems for Improving Quality Fish Production	167
35.	Growth of Aligned ZnO Nanorod on Undoped and Tin-Doped ZnO Thin Films and Their Application in Dye-Sensitized Solar Cell	173
36.	Boron Doped Amorphous Carbon on N-Type Silicon with Low Negative Bias by Using Palm Oil Precursor	178
37.	Structural and Electrical Properties of Nanostructured TiO ₂ Thin Film At Low Molarity	183
38.	Electrical and Structural Properties of Nanotrapod Zinc Oxide Thin Films Prepared with Different Deposition Temperature	188
39.	A Review of Technological Capability and Performance Relationship in Manufacturing Companies	193
40.	A Systematic Literature Review on the Success Factor of Innovation Commercialization Performance	199
41.	Knowledge Transfer of University-Industry Partnership in Malaysian Technical University: Preliminary Findings	205
42.	Agent Parameters for Building Consultant Teamwork in the Agent-Based Simulation Model Development	212
43.	Information Security Awareness Measurement with Confirmatory Factor Analysis	218
44.	Dynamic Supply Chain Practices in Malaysia: A Case Study in Oil and Gas Company	224
45.	Measuring Service Quality in Hotel X Bandung	230
46.	A Conceptual Floating Alternative to Land Reclamation for Application in Congested Island States and Coastal Cities of Malaysia	235
47.	Green IT for Competitive Advantage: Internal Management Perspective	240

48.	Smart Le Tour Checkpoint Using RFID	246
49.	Design and Development of RFID Based Elevator	252
50.	Biometric Attendance	258
51.	The Evaluation of National Quality Infrastructure System in Indonesia	264
52.	Waste-to-Energy: Solution for Municipal Solid Waste Challenges- Global Prospective	270
53.	Implementation of ISO50001 Energy Management System	275
54.	Technology Management in Lean Manufacturing Implementation: A Case Study	281
55.	Roadmap Energy in Special Region of Yogyakarta to Empower Renewable Energy Source	285
56.	An IPD Framework for Sustainable Design in UUM Campus Development	291
57.	Incorporating Instructional Design and Adult Learning Theory in the e-Content Development of an Interactive Multimedia Course	296
58.	The Existance of Target Capital Structure on Indonesian Firms. A Dynamic Approach	302
59.	Performance Analysis of Orthogonal - Diamond Search Algorithm for Motion Estimation	306
60.	Nonlinear Filter Design with Integrator for a Class of Polynomial Discrete-time Systems	311
61.	Ontology Development of Metacognitive Support System for Novice Programmer (MSSNP)	316
62.	WRF Model Input for Improved Radar Rainfall Estimates Using Kalman Filter	322
63.	Performance Study in Energy Efficiency on Variable Speed Drive,VSD Design for Serting High Lift Pumping Station	328
64.	Testing Standards Assessment for Silicone Rubber	332
65.	Video Target Tracking Based on Fusion State Estimation	337
66.	A Review on Compact Slot Antenna for Wireless MIMO Communication System	344
67.	Navigation in Image-based Virtual Reality as the Factor to Elicit Spatial Presence Experience	349
68.	A Low Cost Approach of Multisensor Device for Global Warming Studies	355
69.	Fun Beliefs in Digital Games From the Perspective of Human Nature: A Systematic Review	359
70.	A Comparative Study of Student's Attitudes Among IT and Non-IT Students in Information Technology Education	365
71.	Selection the Way to Start Business Based on Social Media Features	371
72.	A Method for Simplifying the Submission of an Online Request for an E-Government Service	377
73.	Utility Consumption Among Malaysian Electricity Users in Goverment Building	383
74.	Valuing Local Manufacturing Technology: A Technology Acquirer's Perspective	388
75.	A Proposed Model of the Relationship Between Corporate Social Responsibility and Firm Performance	394
		400

76.	Preferred Information Quality Factors as A Web Content Quality Measures on Malaysian Government Websites: A Conceptual Paper	406
77.	The Link Between High Tech Export Intensity and Telecommunications Infrastructure	412
78.	Strategic Decision Making Process and Companies Performance: Perception of Indonesian Executives	417
79.	Strategy Tools Usage in Indonesia: A Survey of Indonesia Managers	421
80.	Optimal Portfolio in Discrete-Time Under HARA Utility Function	425
81.	Managing Transactional and Relational Quality in Indonesia:The Franchisees' Perspective	433
82.	Determining Customers' Perception on Green Hotel Using Attitudes Toward Green Behaviour (ATGB) Model	438
83.	Components of Tax Compliance Costs for the Malaysian Corporate Taxpayers	444
84.	Wireless Gesture Recognition System Using MEMS Accelerometer	448
85.	Sources of Corporate Income Tax Compliance Costs: The Case of Malaysian Self-Assessment System	454
86.	The Effect of Different Levels of Continuous Tones Vibrant on Focus Ability in Teenagers	458
87.	The Correlation Between Salinity and Electric Voltage	462
88.	Characterization of Silicon Avalanche Photodiode in Term of Breakdown Voltage and Leakage Current	467
89.	Bending Optical Waveguide Investigation for Electromagnetic Field Radiation and Propagation Application	471
90.	0.35 Um AMS Silicon MOSFET for Continous-Wave (CW) Sub-THz Detection in Room Temperature	475
91.	Feed Lines Effects on UWB Double Sided Circular Disc Bow Tie Antenna	479
92.	An Analysis of Vital Sign Using Microwave Doppler Technique	486
93.	Characteristic Impedance Modelling of Circular Loop and Square Loop Frequency Selective Surface (FSS) on Hybrid Material	492
94.	Assembler Design for a Low-end Reconfigurable RISC Processor	497
95.	Computing Penetration Depth of Collision Detection Between Primitives	502
96.	Closest Features Determination Between Range Point of Contact	506
97.	Vector-Based Technique for Distance Computation in Narrow Phase Collision Detection	511
98.	Methodology of Performing Narrow Phase Collision Detection	516
99.	The Experimental Analysis of Class E Converter Circuit for Inductive Power Transfer Applications	521
100.	Dual Band Monopole Antenna for Wireless Communication System	

COMMITTEE	
Organizing Committee	xxxviii
AUTHORS INDEX	
LIST OF REVIEWERS	xxxix xliii
ACKNOWLEDGEMENT	
Organizer and Supporters	xlvi

ABOUT THE CONFERENCE

Malaysia Technical Scientist Group with Technical Co-Sponsored of IEEE Malaysia Section and Indonesia Section are pleased to announce 2014 International Symposium on Technology Management and Emerging Technologies (ISTMET 2014) which will be held in Aston Braga Hotel & Residence, Bandung, Indonesia, on May, 27 – 29, 2014. This very first meeting of conferences will provide excellent opportunities for researchers, scientists, engineers and vendors working in areas related to Technology Management and Emerging Technologies to present latest research results, and exchange views and experience.

ISTMET

The proceedings of the conferences will be available on IEEE Xplore, and can be reached after the conference.

This conference has been listed at IEEE Conference Search:

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ISTMET 2014

#135 (1569912321): Detecting Major Disease in Public Hospital Using Ensemble Techniques



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Title	Detecting Major Disease in Public Hospital Using Ensemble Techniques									
Abstract	Hepatitis is chronic disease that becomes major problem in developing countries. Health experts estimate that more than 185 billion people have chronic hepatitis worldwide. This paper attempts to detect major disease such as hepatitis in public hospital using ensemble methods. Several state-of-the-art data mining techniques such as Bagging, AdaBoost, Random Subspace, Random Forest, and Rotation Forest were employed to acquire knowledge from patient medical records. Afterwards, rule extraction from decision tree and neural network are summarized in order to assist experts in detecting hepatitis. Accuracy of those algorithms is also performed and from the experimental result shows that Bagging, with decision tree as base-classifier, denotes best performance.									
Keywords	Only the chairs (istmet2014-chairs@edas.info) can edit ensemble methods, hepatitis, predictive accuracy, public hospital, rule extraction									
Presenter(s)	Afriyan Firdaus (bio)									
Registration	Afriyan Firdaus has registered and paid for CF1:ALL									
DOI	Only the chairs (istmet2014-chairs@edas.info) can edit									
Status	minor revision required									
Copyright form	Regular copyright February 25, 2014 09:00:17 EST									

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Review manuscript		4	236,901	February 13, 2014 13:03:33 EST	
Final manuscript		authorname	Doubleblind conference, but author name 'Adhi Tama' is visible on first page. (This is only a warning; ignore if false positive.) See FAQ for details.	Can upload 8 pages, and purchase 2 extra pages until May 1, 2014 23:59:00 EDT.	-

Personal notes



You are an author for this paper.

Reviews

2 Reviews

Review 1 (Reviewer F)

Originality	Significance of Topic	Presentation
Accept (8)	Accept (8)	Weak Accept (6)

Strengths/Weakness (What are the major reasons to accept/reject the paper? [Be brief.])

Strengths:

The structure is good.
The study is good, can be a nice contribution for future work.
References and literature reviews are well in order.

Weakness:

Typos.
Ambiguity in explanations of results.
Rule extraction is not defined properly.

Contribution/s & Detailed comments (What are the major issues addressed in the paper? Do you consider them important? Comment on the degree of novelty, creativity and technical depth in the paper. Please provide detailed comments that will be helpful to the TPC for assessing the paper, as well as feedback to the authors.)

The paper reports a study on different ensemble techniques on a raw data collected from a public hospital. And present a clear comparison as Method vs Feature.

But, the paper lacks few points...

- 1) The results have not been explained well, there is a ambiguity in the analysis.
- 2) Input variables and their relation with Feature number are not clear?
- 3) Table I. is not very clear?
- 4) Author should put more stress on Rule extraction, and how their rules are better than others?
- 5) There is not much information on the raw data and its relation with different diseases, and identification concept is not clear.

However, I appreciate the efforts and the study made.

But, paper need to be more clear.

Review 2 (Reviewer I)

Originality	Significance of Topic	Presentation
Accept (8)	Accept (8)	Weak Accept (6)

Strengths/Weakness (What are the major reasons to accept/reject the paper? [Be brief.])

The objective of this study is to determine the best data mining system to extract information of disease reported in Hospital. The issues was well discussed but there are lots of grammatical mistake and need to be corrected. Nevertheless, based on the knowledge contents, this paper is acceptable.

Contribution/s & Detailed comments (What are the major issues addressed in the paper? Do you consider them important? Comment on the degree of novelty, creativity and technical depth in the paper. Please provide detailed comments that will be helpful to the TPC for assessing the paper, as well as feedback to the authors.)

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EDAS at 72.233.114.26 (Tue, 11 Mar 2014 03:45:24 -0400 EDT) [User 1058835: 0.126/0.222 s] [Request help](#)

Detecting Major Disease in Public Hospital Using Ensemble Techniques

Mgs. Afriyan Firdaus, Rin Nadia, Bayu Adhi Tama

Department of Information Systems, Faculty of Computer Science, Sriwijaya University

May 23, 2014

Background

- Hepatitis is a major global health problem.
- World Health Organization (WHO) estimates more than 240 million people worldwide have chronic infections of hepatitis.
- symptoms of hepatitis disease is also different, depending on the type of hepatitis virus itself → necessary to find proper approaches as well as early detection, prevention and treatment of hepatitis disease.
- Hepatitis has no clear clinical symptoms.
- In public hospital, large amount of medical data are stored, accumulated, and growing as data tombs without undertaking further analysis to the data

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Objectives:

This paper aims to address ensemble techniques so as finding most influential attribute on hepatitis disease

Purpose of Study:

- Intend for supporting hepatitis diagnostic
- To promote the creation of knowledge to assist clinicians on making decisions as for early detection of the disease.

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① Ensemble Techniques

- Contains a number of learners called base-learners (i.e decision tree, neural network,etc)
- i.e. Bagging, Random Forest, Rotation Forest, etc

② Rule Extraction from Neural Network

- Generated interesting rules for decision making purpose
- i.e. X2R, REFANN, REANN, etc

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Research Methods

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- ② Apply and construct classifiers (Ensemble techniques)
- ③ Examine performance for each classifiers
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Data Collection

- Obtained from public hospital in South Sumatera between 2009-2013
- All type of hepatitis are included. 51.46% (106) cases in hepatitis type-A (Class A), 27.18% (56) cases in hepatitis type-B (Class B), and 21.36% (44) cases in hepatitis type-C (Class C)
- Final dataset contains 206 records and 12 features.
- 12-significant Features: (1) Myalgia, (2) Hives, (3) Age, (4) Gender, (5) Abdominal pain, (6) Cough, (7) Heartburn, (8) Fever, (9) Headache, (10) Jaundice, (11) Fatigue, and (12) Appetite.

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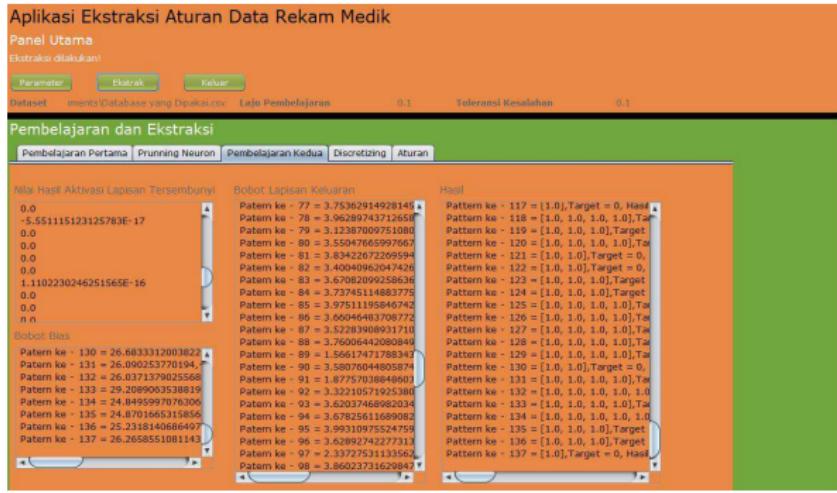
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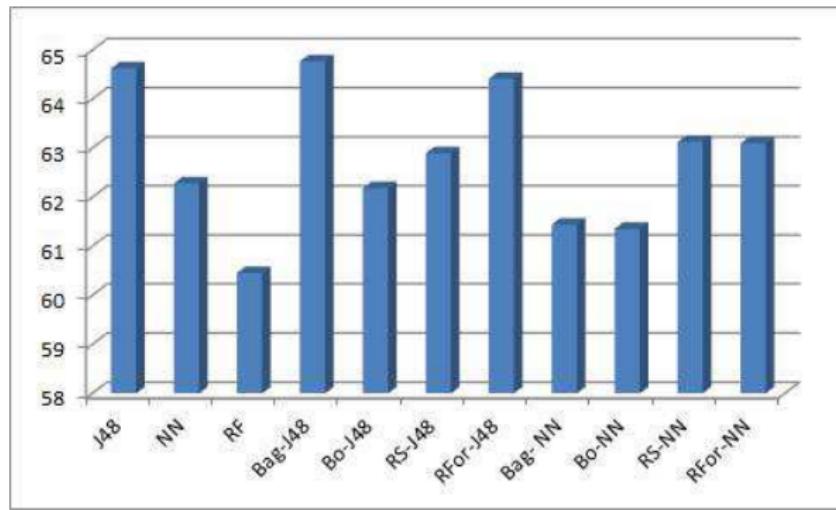
Constructing Classifiers

- Employed all ensemble techniques implemented in Weka, including extracted rules from decision tree
- Implemented rule extraction from neural network (REANN)



Examine Classifier Performance

- Compared single-classifiers and all ensemble techniques with either neural network or decision tree as base-classifier
- Bagging J48 performed best accuracy among other methods



Rule Extraction(1)

- Decision Tree

- Three rules classify samples as hepatitis type-A, the 2 rules classify samples as hepatitis type-B, and the 4 rules classify samples as hepatitis type-C
- accuracy rate 78.64%
- significant rules:

R1 : IF hives = false and myalgia = false THEN
Class A

R2 : IF hives = false AND abdominal pain = true AND
myalgia = true AND fatigue = true AND
appetite = true THEN Class C

R3 : IF hives = true AND myalgia = false THEN
Class B

Rule Extraction(2)

- REANN Algorithm

- 2 extracted rules were obtained.
- accuracy rate 79.15%
- significant rules:

R1 : IF jaundice = true AND myalgia = false THEN
Class A

R2 : IF abdominal pain = true AND
hives = true AND appetite = true THEN Class B

Conclusion

- Several significant rules from decision tree and neural network have been successfully obtained.
- Bagging methods with decision tree as base classifier yielded best accuracy among other methods.