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## **Technical Sessions Schedule**

		T	echnical Sessions ICIC 2018	
			17-Oct-18	-
		PID	Title	Page
TS-1	1	114	Texture Feature Extraction Based On GLCM and DWT for Beef Tenderness Classification	1
10:30- 12:00		119	Data Mining Classification of Intelligence Quotient in High School Students	5
	Session Chair:	134	Feature Extraction Using Histogram of Oriented Gradient and Hu Invariant Moment for Face Recognition	10
	Ргіпапфоко	148	Deep Learning Long-Short Term Memory for Indonesian Speech Digit Recognition using LPC and MFCC Feature	15
		152	Development Of Heartbeat Measures And Arrythmia Premonitory Based on Time Sampling	20
	2	280	Educational Data Mining (EDM) as a Model For Students's Evaluation in Learning Environment	27
		289	Critical Success Factors for Project Management Office: an Insight from Indonesia	31
	Session Chair:	293	Webuse Usability Testing for Farmer and Farmer Group Data Collection System	37
Suryono	296	Comparison of Two Methods Between TOPSIS and MAUT In Determining BIDIKMISI Scholarship	43	
		301	Evaluation of User Engagement in E-learning Standardization and Conformity Assessment Using Subjective and Objective Measurement	49
	3	236	Integration of Region-based Open Data Using Semantic Web	55
	Session	173	Cloud-based e-Business Framework for Small and Medium Enterprises: Literature Review	61
	Chair: Teddy	180	Usability Evaluation and Development of a University Staff Website	65
	iviantoro	183	The Ontology of SMEs's Form Application for Interoperability Systems	71
		191	Customer Awareness towards Digital Certificate on E-Commerce: Does It Affect Purchase Decision?	75



	4	213	Comparative Evaluation of Object Tracking with Background Subtraction Methods	79
	Session	225	Peripapillary Atrophy Detection in Fundus Images Based on Sector With Scan Lines Approach	85
	Chair: TB.	227	Drivers' visual search behaviour: Eye tracking analysis approach (Case study: on Ir. H. Juanda Street Depok)	91
	wauana	246	The Generalized Learning Vector Quantization Model to Recognize Indonesian Sign Language (BISINDO)	95
		250	Algorithm for Simple Sentence Identification in Bahasa Indonesia	101
	5	3	Template Matching Algorithm For Noise Detection in Cargo Container	107
	Session	22	Genetic Algorithm Modification Of Mutation Operators In Max One Problem	116
	Chair: Eri Prasetyo	24	Meme Opinion Categorization by Using Optical Character Recognition (OCR) and Naïve Bayes Algorithm	122
		79	Improving Naïve Bayes in Sentiment Analysis For Hotel Industry in Indonesia	127
		109	Early Identification of Leaf Stain Disease in Sugar Cane Plants Using Speeded-Up Method Robust Features	133
	6	188	Design of Orchid Monitoring System Based on IoT	139
	Session	190	Remote Sensing System of Odometry and Telemetry data in Real- Time	145
	Chair: <b>Amil Ilham</b>	199	Framework for Identifying Agent's Role in Multi-agent Based Self- healing System	151
		207	Fuzzy Rule-Based System for Monitoring Traffic Congestion using Technology Radio Frequency Identification	157
		209	Prediction of Smarthphone Charging using K-Nearest Neighbor Machine Learning	162
TS-2	1	179	Comparison of Color Constancy Approaches on Images with Unbalanced Color Distribution	166
14:15- 15:55	Session	203	Real-time Recognition and Information Extraction on C++ Syntax with Augmented Reality	172
	Chair: Ayu Dunucrionti	243	Performance Analysis of Big Data Frameworks on Virtualized Clusters	178
	Purwarianti	244	Fuzzy Kernel Robust Clustering for Anomaly based Intrusion Detection	182



	247	Segmentation of Overlapping Areas on Pap Smear Images with Color Features Using K-Means and Otsu Methods	186
2	223	Hybrid CPU and GPU Computation to Detect Lung Nodule in Computed Tomography Images	191
	239	Clustering Grey-Scale Face-Images Using Modified Adaptive Affinity Propagation with a New Modeled Preference	197
Session Chair:	245	Optimizing Marshall Test Parameters on Asphalt Concrete Using Hybrid Neural Network - Genetic Algorithm Approach	202
A. Benny Mutiara	252	An Initial Study to Solve Imbalance Sundanese Handwritten Dataset in Character Recognition	208
	254	Classification of Personality Type By Typology Hippocrates - Galenus Using Naïvebayes Algorithm and Naïvebayes Decision Tree Algorithm	214
3	210	An Adaptive e-Learning Model Based on Myers-Briggs Type Indicator (MBTI)	219
Session	241	Determinant factors of new investor intention for using online trading system	223
Chair: Betty	283	Comparative Analysis of Multi-Criteria Decision Making for Student Degree Completion Time based on Entropy Weighted	229
Purwandari	302	Global Software Development and Capability Maturity Model Integration: a Systematic Literature Review	234
	305	Influence Blended Learning on Learning Result of Algorithm and Programming	240
4	45	Filtering Impolite Words in Social Network Using Naïve Bayes Classifier	245
Session	49	Comparing CART and C5.0 Algorithm Performance of Human Development Index	250
Chair: <b>Rahmadya</b>	91	The Modeling of Artificial Neural Network of Early Diagnosis for Malnutrition with Backpropagation Method	255
	107	Mel-frequency Cepstral Coefficient-Vector Quantization Implementation for Voice Detection of Rice-Eating Birds in The Rice Fields	262
	162	Students' Academic Performance Prediction using Data Mining	268
5	171	Comparison of Job Position Based Promotion Using: VIKOR, ELECTRE And Promethee Method	273
Session	226	Symmetric Key Distribution Model Using RSA-CRT Method	280
Chair: <b>Opim Salim</b>	271	Identifying and Validating Components for National Cyber Security Framework	289



		272	Hybrid RC4 and Affine Ciphers to Secure Short Message Service on Android	294
		300	Verifying Authenticity of Digital Certificate and Transcript Using Background Subtraction Method	300
	6	268	Analysis Similarity of Taekwondo Movement Using Data Motion	305
		270	S-box Construction of Highly Strict Avalanche Criterion Using Algebraic Technique	311
	Session Chair:	288	Experiments on Character and Word Level Features for Text Classification Using Deep Neural Network	315
	Kiri Satria	299	Utilization of Semantic Web Rule Language for Tourism Ontology	321
		304	Neural Network with Support Vector Regression for Land-Use Growth Prediction	326
TS-3	1	65	Quran Tajweed Extraction and Segmentation Based on HSV Color Space Model	331
16:15- 17:50	Session	73	Digital Image Analysis of Beef Color Using Euclidean Distance Method	336
	Chair: <b>Suryono</b>	108	Android-Based Text Recognition on Receipt Bill for Tax Sampling System	341
		147	Hardware Based Artificial Neural Networks for Basic Pattern Recognition Application	346
		256	SPOT: A Low Cost Intelligent Parking System for Urban Malls	354
	2	38	Prediction the Crime Motorcycles of Theft using ARIMAX-TFM with Single Input	359
	Session	112	Steganography with Highly Random Linear Congruential Generator for Security Enhancement	366
	Chair: <b>Prihandoko</b>	136	Expert Mapping Development System with Disease Searching Sympthom Based on ICD 10	372
		151	Comparing SAW and AHP Decision Support Methods for Disease Analysis in Indonesia	376
	3	228	B2C Website Quality Criteria Analysis: A Case of 5-Star Hotel	382
		240	Information Technology Governance Profile of E-Government	388



Session Chair:	267	Analysis the Acceptance of Use for Document Management System Using Technology Acceptance Model	394
Media A. Ayu	282	Adoption Factors of e-Government Services in Indonesia	399
	307	Prototyping Web Based Information System of Animal Strategic Spreading Disease Using Kano Models	405
4	145	Literature review on Artificial Neural Networks Techniques Application for Stock Market Prediction and as Decision Support Tools	411
Session Chair: <b>Doni</b>	168	Classification of Indonesian Government Budget Appropriations or Outlays for Research and Development (GBAORD) Using Decision Tree and Naive Bayes	415
Purnama	176	The Pedagogy Optimization with Educational Data Mining and Learning Analytics for E-Learning System – A Review of the Literature Review	420
	61	Batik Motif Identification with Gray Level Co-Occurrence Matrix and Artificial Neural Network Backpropagation	425
	175	Customer Segmentation based on RFM model and Clustering Techniques With K-Means Algorithm	431
5	2	Redesigning CHIML: Orchestration Language for Chimera- Framework	437
Session	139	Performance Analysis of Information Quality Indexing in Government Agency's Social Media: a case of Customs in Indonesia	444
Chair: Dwiza	141	Development of Banten E-Heritage using Virtual Reality Technology on Mobile Device	450
Riana	178	Preprocessing For Crawler Of Short Message Social Media	455
	237	Toward Immersive Mobile Multimedia: From Mobile Video to Mobile Extended Reality	461
6	273	Classification Default of Credit Card Clients Using LS-SVM Ensemble	467
Session	274	Classification for Multiformat Object of Cultural Heritage using Deep Learning	471
Chair: TB.	291	Spellchecker Improvement on Stemmer Algorithm for Indonesian Language	477
wauana	303	Cluster Analysis of Indonesian Province Based on Prices of Several Basic Food Commodities	482



			18-Oct-18	
TS-4	1	216	Primary Care Functional Requirements of a Health Information System in Indonesia	486
07:50- 09:40	Session	312	The Digital Company Based on Competitive Strategy	492
	Chair: Lintang	286	Group Decision Support System to Selection Tourism Object in Bali Using Analytic Hierarchy Process (AHP) and Copeland Score Model	496
	Banowosari	78	Comparative Analysis Between Online E-Learning and Face to Face Learning: An Experimental Study	502
		269	Bioinformatics Resource Portal	506
	2	259	Mobile Measurement System of Ozone Concentration in Urban Areas	511
	Session	249	A Review: Contrast-Limited Adaptive Histogram Equalization (CLAHE) methods to help the application of face recognition	517
	Chair: Amil Ilham	166	Genetic Algorithms with Variable Length Chromosomes for High Constraint Problems in Spatial Data	523
		195	Heading Correction in Rocket Flight System Using Odometry Trajectory Information	528
	3	117	Implementation of Green IT In Education Industries	532
	Session	142	Change Management Methodology for e-Government Project in Developing Countries: a Conceptual Model	536
	Chair: <b>Husni Teja</b>	159	Foreign Direct Investment (FDI) and Information Communication and Technology (ICT) Perspective: Empirical Study In Asia	541
		200	The Ontology of IT Service Management by Using ITILv.3 Framework: A Case Study for Incident Management	547
		208	Technology-enhanced Learning Maturity Model: Component and Characteristics Analysis	552
	4	156	Review of the Recent Research on Automatic Text Summarization in Bahasa Indonesia	557
	Session	164	Saving The Vegetable Peddler (Mlijo) with Information Technology	563
	Chair: Cecilia	189	Automatic Time-based Learning Type Analysis towards Dynamic Personalization	569
	ivugraneni	193	Automatic Comparison of Products based on Opinion Features using Synonym and Jaccard Similarity	575



	5	229	The AlKesFar App, A Mobile Augmented Reality on Learning Media Tools for Indonesian Pharmacy School	581
	Session	232	Application Control and Monitoring of Light Usage in Smart Home Environment	586
	Chair: Nur Sultan	234	Predicting Grade Promotion Using Decision Tree and Naïve Bayes Classification Algorithms	590
	5	50	Speech Command for Automatic Sluice Gate Based on MFCC and Deep Neural Networks	594
		161	Secure Smart Card Reader for University Presence System	600
	6	196	A Proposed Crowdsourcing Engine for Indonesian Cultural Heritage	605
	Session	242	Prototype Of Feeding Devices ,Temperatures And Humidity Monitoring At Broiler Chickens Breeders With The Internet Of Things Concept	611
	Chair: <b>Eri Prasetyo</b>	298	Data Comparison of NFC PN532 on Wemos D1 and MKR1000 Board through MQTT Protocol	616
		306	Application Development Based on Mobile Learning Framework on Rice and Vegetable Agriculture	621
TS-5	1	146	Developing a QR Code-based Library Management System with Case Study of Private School in Surakarta City Indonesia	627
10.55- 12.40	Session	153	Safe Distance Detector to Watching Television	633
	Chair: <b>Prihandoko</b>	198	Term Frequency Method For Automated Text Summarization Application Of Indonesian News Article	638
		297	Security Scheme for Medical Images Based on Dual-Layer Fragile Watermarking	645
	2	186	Development of a website-based decision tree system in data mining concept	650
		221	Robotic Arm of Goods Sorter in Factory Based on Color Using TCS3200 Sensor With Monitoring System Based on Web	654



Session Chair:	253	The Physical and Engineering Requirements of Scalable, Decentralised, Distributed, Large-Scale MIMO	6
A. Benny Mutiara	264	Data Processing Architecture using Open source Bigdata Technology to Increase Transaction Speed	6
3	103	Assessment of Teacher Performance Using Technique For Other Preference By Similarity To Ideal Solution (TOPSIS)	6
Session	138	Identifying The Relevant Indexed Term Related with The Book Domain Using Semantic Relatedness Approach	6
Chair: A. Nizar H.	149	Detecting Learning Style Based on Level of Knowledge	6
	157	Visual Based Path Detection for Obstacle Avoidance	6
4	111	User Experience Measurement On Go-Jek Mobile App In Malang City	6
Session	169	Modelling of Schools ICT Utilisation: An Empirical Study in Indonesia	6
Chair: Betty	206	Challenges and Issues of E-Participation Implementation: A Case Study of E-Complaint Indonesia	7
Purwanuari	231	Comparison Method Topsis Saw and in The Selection of Attractions in Indonesia	7
5	258	System Using Heuristic Evaluation and User Experience Questionnaire (UEQ)	7:
Session Chair: <b>Suryono</b>	167	An Integrated Business Intelligence and Visualization Framework to Investigate Factors Influencing Customer's Engagement on Instagram Contents: A Lesson Learned from a Local Instagram Business Account in Indonesia	7
	155	Measurement of Employee Information Security Awareness: Case Study At The Directorate General of Resources Management and Postal and Information Technology Equipment Ministry of Communications and Information Technology	7



6	40	Comparative Analysis of Test Automation Framework Performance for Functional Testing in Android-Based Applications Using The Distance To The Ideal Alternative Method	739
Session	99	Software Verification and Validation on Object Oriented Software Development using Traceability Matrix	745
Chair: <b>Opim Salim</b>	165	The Design Of IT Development Based On EA Model For Islamic Boarding School	750
	292	Revealed-Preference Activity Rule in Combinatorial Clock Spectrum Auction: A Review and New Research Opportunities	756



# Data Mining Classification of Intelligence Quotient in High School Students

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Abstract—An educational institution of "SMA Negeri 1 Padang" has been conducting psychological tests using the Intelligenz Structure Test (IST) in determining the classification of Intelligence Quotient (IQ) of their own students high school. Up to this day classification process of student IQs has been handled manually by psychologists and took an average of 15 days. This study applies data mining study which is a series of processes of getting knowledge or pattern from data set using method of classification that is C4.5 algorithm, which is useful to simplify and save time for psychologists. This study consisted of 10 criteria involving 270 data and resulted in output in the form of four kinds of student'IO classification consisting of very superior, superior, above average and average categories. Based on the test results classification of student IQs is obtained as 84%.

Keywords- Intelligenz Structure Test, Intelligence Quotient, C4.5 Algorithm

#### I. INTRODUCTION

An educational institution of SMA Negeri 1 (State High School) Padang has been conducting Senior psychological tests using IST as a psychology test in determining the classification of their student IQs. The IST test used is a Rudolf Amthaeur instrument which consists of 10 subtests: age, completing sentence (SE), word equation (WA), verbal analogy (AN), character similarity (GE), numerical ability (RA), number series (ZR), selecting image (FA), cube drill (WU), and memories (ME) and to determine the scale of the IQ student classification, they use David Wechsler's scale which consists of 7 categories: highly superior, superior, above average, average, below average, borderline and mentally retarded. Up to this day classification process of students IQs has been handled manually by psychologists and took an average of 15 days. This study applies data mining study which is a series of processes of getting knowledge or pattern from data set using method of classification algorithm C4.5, which is useful to simplify and save time for psychologists.

The growth of information technology is so much advanced today, causing the level of accuracy of a data is highly needed in everyday life. Each information that dissaminates becomes an important thing to determine on every decision in a particular situation. This leads to the provision of information to be analyzed and summarized into a knowledge of useful data when a decision is made, ie data mining.

Data mining is a set of processes to gain knowledge or patterns from data set using a particular technique or method. The classification method used is the Decision Tree, which is one of the easy classification method for human interpretation. The structure resembles a tree, where the node signifies an attribute, the branch is the value of the attribute and the leaf is the class. The algorithm used is C4.5 algorithm. C4.5 algorithm is used to form decision trees. This algorithm can also simplify the knowledge of the system so that the inference process can be faster [1].

The results of the study and modeling process using Decision Tree C4.5 algorithm conducted on the data of contraceptive use in Pratama Hasanah Pekanbaru clinic can be drawn conclusion that the results of training data study of contraceptive usage tools can form knowledge in the form of decision tree models that transform data into decision trees that represent the rules. Accuracy rate obtained from data processing reach 93.15% which can be classified Excellent so that this result can be a reference for midwife in advise patient in choosing contraception [2].

#### II. LITERATURE REVIEW

#### A. Intelligence Quotient

Intelligence quotient (IQ) is a collection or the totality of a person's ability to act in a certain purpose, think rationally, and face the surrounding environment effectively. One of the most common ways used to express high IQ level is to translate the

intelligence test results into numbers that can be indicative of a person's IQ level when relatively compared to a norm [3].

#### *B.* Intelligence Structure Test (IST)

IST test is one of the psychological tests used to measure individual intelligence [4]. IST consists of nine subtests totaling 176 items. The nine subtests in the IST are Satzerganzung (SE) completing the sentence, Wortauswahl (WA) word equation, Analogien (AN) verbal analogy, Gemeinsamkeiten (GE) character similarity, Rechhenaufgaben (RA) numerical ability, Zahlenreihen (ZR) number series, Figurenauswahl FA) selecting image, Wurfelaufgaben (WU) cube drills, and Merkaufgaben (ME) memories [5].

TABLE 1. CLASSIFICATION OF IQ BASED ON DAVID WECHSLER SCALE [5]

IST	IQ	Category
<u>&gt; 120</u>	<u>&gt; 130</u>	Very superior
113 – 119	120 - 129	Superior
107 - 112	110 - 119	Above average
93 - 106	90 - 109	Average
87 - 92	80 - 89	Below average
80 - 86	70 – 79	Borderline
<u>&lt;</u> 79	<u>&lt; 69</u>	Mentally retarded

#### C. Data Mining

Data mining is a series of processes to gain knowledge or patterns from data set [6]. Data Mining solves the problem by analyzing the data which is already in the database. Data Mining, often called knowledge discovery in databases (KDD), is an activity that includes data collection, usage of historical data to find patterns of regularity and relationship patterns in large data sets [7]. The output of data mining can be used to improve future decision making.

#### D. Classification

The classification technique is a systematic approach to construct a classification model of an input data set [8]. Classification is the learning process of a goal or a target function that maps each set of x attributes to one of the previously defined y labels. The target function is also called the classification model.

#### E. Decision Tree

The decision tree is used as a reasoning procedure to get answers to the problems that are entered [6]. The tree formed is not always a binary tree. If all the features in the data set use 2 kinds of categorical values then the tree form shown is a binary tree. If the feature contains more than 2 kinds of categorical values or uses numeric type then the form of the tree shown is usually not a binary tree.

#### F. C4.5 Algorithm

The C4.5 algorithm was introduced by Quinlan in 1995 as an improved version of ID3. Generally the C4.5 algorithm for decision tree building is as follows [6]:

- 1. Select an attribute as root.
- 2. Create a branch for each value.
- 3. Distributing cases in the branch.
- 4. Repeat the process for each branch until all the cases on the branch have the same class.

Entrophy is used to determine how informative an entered attribute is to generate an attribute. The basic formula of entropy is as follows [6]:

$$Entropy(S) = \sum_{i=1}^{k} - p_i * \log_2 p_i$$
(1)

Information :

S = case set.

k = number of S partitions.

pi = The proportion of Si to S.

To select an attribute as a root, based on the highest gain value of the attributes. To calculate the gain, the following formula given is as follows [6]:

$$Gain(S, A) = Entropy(S) - \sum_{i=1}^{k} \frac{|S_i|}{|S|} * Entropy(S_i)$$
(2)

Information :

S = Case set.

A = Attribute.

k = Number of attribute partitions A.

 $|S_i| =$  Number of cases on i partition.

|S| = Number of cases in S

#### G. Accuracy

A classification system is expected to classify all data sets correctly. However, it can not be denied that the performance of a system can not work 100% correctly [6]. Therefore, a classification system should also be measured for performance. Generally measuring classification performance uses confusion matrix. The confusion matrix is a table that records the results of classification work.

$$Accuracy = \frac{\text{the amount of data predicted correctly}}{\text{number if predictions performed}}$$
(3)

#### III. RESEARCH METHODOLOGY

#### A. Data Colleting

The data collection techniques required in the classification of IQs, obtained from interviews and literature study.

- Interviews, conducted to collect information that would be useful in classifying student IQs. The interview was conducted on psychologists who organize psychology tests in SMA Negeri 1 Padang.
- Literature study, collecting data by searching and studying from various sources related to the problems studied in the preparation of this thesis, both from

books, scientific journals and from other readings that can be accounted for.

#### IV. RESULTS AND DISCUSSIONS

From the explanation of the analysis and the design that has been done in the previous chapter related, the next stage is to implement and test the system by testing black box which is a test that focuses on the functional requirements of the software. Thus, enabling software engineers to obtain a set of input conditions that fully utilize all functional requirements of a program. Then by testing end users to get good results leading to the final objective of the initial plan of the system.

#### A. C4.5 Algorithm Testing

On the C4.5 algorithm testing using 270 student data, the training data is used to classify IQ classes consisting of 4 categories namely very superior ( $\geq$  130), superior (120 - 129), above average (110 - 119), and average (90 - 109). There are 10 criteria used for IQ classification with C4.5 algorithm, with details as follow:

- WA criteria (word equation), consisting of 6 categories that are very superior (≥ 120), superior (113 119), above average (107 112), average (93 106), below average 87 92), and borderline (80 86).
- AN Criteria (verbal analogy), consisting of 6 categories such very superior (≥ 120), superior (113 - 119), above average (107 - 112), average (93 - 106), below average (87 - 92), and borderline (80 - 86).
- ME criteria (memory), consisting of 6 categories which are very superior (≥ 120), superior (113 - 119), above average (107 - 112), average (93 - 106), below average 87 - 92), and borderline (80 - 86).
- GE criteria (the same nature), consisting of 6 categories with very superior ( $\geq 120$ ), superior (113 119), above average (107 112), average (93 106) (87 92), and borderline (80 86).
- RA criterion, consisting of 6 categories, they are very superior (≥ 120), superior (113 119), above average (107 112), average (93 106), below average (87 92), and borderline (80 86).
- WU criteria (cube exercises), consisting of 6 categories: very superior (≥ 120), superior (113 - 119), above average (107 - 112), average (93 - 106), below average (87 - 92), and borderline (80 - 86).
- ZR criteria (series of numbers), consisting of 6 categories: very superior (≥ 120), superior (113 - 119), above average (107 - 112), average (93 - 106), below average (87 - 92), and borderline (80 - 86).
- FA Criteria (selecting images), consisting of 6 categories: very superior (≥ 120), superior (113 - 119), above average (107 - 112), average (93 - 106), below average (87 - 92), and borderline (80 - 86).
- SE criteria (complete sentence), consists of 6 categories: very superior (≥ 120), superior (113 - 119), above average (107 - 112), average (93 - 106), below average (87 - 92), and borderline (80 - 86).

- Age criteria, consisting of 4 categories ie age 13, age 14, age 15, and age 16.
  - 1. Entrophy Value Calculation

The foremost step of the C4.5 algorithm is to find the entrophy value. First is to determine the total entropy value in the case. The entropy counts on each criterion. Next is to calculate the gain value for each criterion.

- 2. Gain Value Calculation After all entrophy calculations on each criterion are completed, then the gain value is calculated. The highest gain value of 0.3503 is made as the first root node. For the next root node, calculation will be done again until all formed patterns are met.
- 3. Determining the Root

From the calculation to find the value of entropy and gain value, it can be identified that attribute with highest gain is ZR which is equal to 0.3575. Therefore ZR becomes the root node. The data will then be broken down into 6 groups: "very superior", "superior", "above average", "average", "below average", and "borderline". The following decision tree is formed for node 1:

- B. System Testing
  - 1. Value input of each criterion

Registration Number *	9 / IQ / VIII / 2018
NISN *	3456789012
Student Name *	Dewr Sartika
Test Date *	24-08-2018
Word Equation (WA) *	124
Verbal Analogy (AN) *	104
Memories (ME) *	124
Character Similarity (GE) *	115
Numerical Ability (RA) *	84
Cube Drill (WU) *	116
Number Series (ZR) *	114
Selecting Image (FA) *	115
Completing Sentence (SE)*	94
Age *	14

Fig 1. Criterion Value Input

From Fig 1, it can be explained that the input of criterion value is the same as the criterion in manual test.

#### 2. High School Students'IQ Classification Output

Regulation Number	W / IQ / VIII / 2018
NISN	5456780012
Test Oate	24.08-2018
Word Equation (WA)	= 124 (Highly Superior)
Werbal Analogy (AN)	10( (Average )
Idematias (ME)	124 (Highly Soperior)
Character Similarity (GE)	= 115 (Superior)
Numerical Ability (RA)	: 94 ( Borderline )
Gabe Drill (WU)	116 (Superar)
Number Series (ZR)	114 (Superior)
Beteching Image (FA)	115 (Seperior)
Completing Sentence (SE)	- 94 ( Average )
Age	:: 14 Voor
RULE	.3F ar (Superior) AND se (Average) AND wu (Superior) AND me (Highly Superior) THEN IQ (Superior)
DecisionS (IQ)	- Superior

Fig 2. System Calculation Result

From Fig 2, it can be concluded that the results of the calculation process on the system are similar with the manual calculation results.

#### C. Conclusive results on System Testing

The test was performed using 50 IST test result data. The IST test result data is compared with the results of the classification performed by the system.

TABLE 2. TEST DATA							
Data	Classification by Psychologists	Classification by System	Information				
1	Average	Average	Suitable				
2	Above average	Above average	Suitable				
3	Average	Average	Suitable				
4	Average	Average	Suitable				
5	Superior	Superior	Suitable				
6	Average	Average	Suitable				
7	Average	Average	Suitable				
8	Average	Average	Suitable				
9	Average	Unknow	Not Suitable				
10	Superior	Superior	Suitable				
11	Average	Average	Suitable				
12	Above average	Unknow	Not Suitable				
13	Very Superior	Unknow	Not Suitable				
14	Average	Average	Suitable				
15	Very Superior	Unknow	Not Suitable				
16	Average	Superior	Not Suitable				

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48AverageAverageSuitable49AverageAverageSuitable50AverageAverageSuitable	47	Superior	Superior	Suitable
49AverageAverageSuitable50AverageAverageSuitable	48	Average	Average	Suitable
50 Average Average Suitable	49	Average	Average	Suitable
	50	Average	Average	Suitable

The following is a table of confusion matrix:

TABLE 3. ACCURACY OF CONFIRMATION MATRIX

		Hasil Prediksi				
		Ave rage	Above Average	Superi or	Very Superi or	Unknown
Origin al Class	Average	26	0	1	0	3
	Above Average	0	7	0	0	1
	Superior	0	0	8	0	0
	Very Superior	0	0	0	1	3
	Unknown	0	0	0	0	0

After the system classifies, then it calculates the value of its accuracy. The formula of accuracy is:

Accuracy = 
$$\frac{\text{the amount of data predicted correctly}}{\text{number if predictions performed}}$$
$$= \frac{\frac{26+7+8+1}{26+1+3+7+1+8+1+3}}{\frac{42}{50}}$$
$$= 0.84$$

The accuracy test data used in table 3 was 50 data, the IQ classification result by psychologist consisted of 30 "Average" IQ category, 8 "Above Average" IQ category, 8 "Superior" IQ category, and 4 "Very Superior" IQ category. The results of the classification performed by the system were as many as 50 data consisting of 26 "Average" IQ category, 7 "Above Average" IQ category, 9 "Superior" IQ category, 1 "Very Superior" IQ category and 7 "Unknown" IQ category. Then the number of classifications with the correct system is 42 classification of student IQs based on IST test result. Based on the accuracy test, the classification system of high school student IQs based on IST test results from 50 test data is 84%. As we all can see that C4.5 algorithm can be used as classification algorithm for student IQs test based on IST test results due to its high accuracy.

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## Des Suryani

Data Mining Classification of Intelligence Quotient in High School Students

Presenter for his/her participation as a in

The Third International Conference on Informatics and Computing (ICIC 2018)

at Aryaduta Hotel, Palembang-Indonesia

on 17-18 October 2018

Prof. Teddy Mantoro, PhD **General** Chair











2018



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Ketua APTIKOM