

J48 and Naive Bayes Algorithm Approach for Marketing Communication Strategy Analysis and Predicting Interest of New Students

Rayung Wulan¹, Fit Yanuar²

¹Department of Informatics Engineering, University of Indraprasta PGRI, Jakarta, Indonesia

²Department of Communications, University of Sahid, Jakarta, Indonesia

Abstract – Investment in the world of higher education is a part that supports marketing strategies in marketing efforts in higher education. In the first year of admitting new students, odd and even periods have become a trend for universities to see the enthusiasm of incoming students in selecting study programs that are trendy and in demand. The research objective is to apply the 8P marketing strategy in developing the potential readiness of universities in accepting new students. The J48 algorithm can process discrete and continuous data, and can handle missing attribute values. Naive Bayes algorithm carries out data mining classification which can be used to provide possible results that will occur in the future from the classification results. The results obtained through a series of trials showed that Naive Bayes had an accuracy rate of 75.8% and the J48 algorithm 98.0%. The marketing strategy is suitable for using the highest level of accuracy approach.

Keywords – marketing strategy, data mining, J48 algorithm, Naive Bayes, study program specialization.

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Corresponding author: Rayung Wulan,
Department of Informatics Engineering, University of
Indraprasta PGRI, Jakarta, Indonesia
Email: rayung_wulan@unindra.ac.id

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1. Introduction

Various data mining technique models use machine learning combined with various algorithms, including the J48 algorithm. The J48 algorithm itself is part of the C.45 algorithm family which has a proven level of accuracy and is used for business analysis, strategy or company input efforts. The J48 algorithm has accuracy [1] in interpretation and can help in determining decisions [3]. The J48 algorithm processes continuous discrete data results [2], and is able to see incomplete attribute noise for training data, has rules and is easy to set attributes, confusion matrices and calculate the presentation of data requirements. The machine learning tool that is suitable for using the J48 and Naive Bayes algorithms is usually the Weka application [4]. Inform, persuade, and remind consumers either directly or indirectly about the products and brands they sell [5]. The Naive Bayes algorithm works by setting the classification first and is usually used in conjunction with Bayes' theorem. The way it works is by assuming naivety where the data set in the feature is within the data and is referred to as independent data, one from another. Assuming the data is part of the overall results that can be fulfilled based on the results to determine the set of attributes. Naive Bayes is well known in implementing strategies in the business world as input for production and business in various industrial fields [6].

The classification method produces precision values that are used as predictions for the Naive Bayes algorithm model [7]. The Naive Bayes algorithm became popular in the world of education business during the industrial revolution 5.0 era, especially in scientific data because it is part of the machine learning model which has data calculation speed and accuracy [8].

Marketing communications is part of the main means used by companies as an effort to inform, persuade and remind consumers, either directly or indirectly, about a situation where marketers have to master three things from consumers, namely mind, heart and spirit refer to open, electronic-based marketing on digital platforms [9].

Efforts to develop a marketing communication strategy with Marketing Mix 8P (product, price, place, promotion, people, physical evidence, productivity and quality, process) and audience satisfaction determine a study program that is branded and attractive to new students who will continue to work in the future [10].



Figure 1. Students by Field of Specialization 2022

The data can be seen based in Figure 1. Students are based on area of expertise. The trend model in selecting study programs for new students at the tertiary level has become a hot topic of discussion among academics, especially for tertiary institutions preparing to advance their campuses to become the best campuses that are popular with high-level graduate students who will become new students [11]. Trends and current trends in determining the study program to be chosen are a reference for universities in preparing all the needs if there are many interested study programs [12].

This approach becomes a reference and prediction using the J48 Algorithm and Naive Bayes in analyzing marketing communication strategies at the tertiary level, seeking steps that will be used as a reference in today's world of digitalization taking off [13]. Data mining applies the concept of data collection to have the aim of processing data to be interpreted into information used in databases and is part of Knowledge Discovery in Databases (KDD) to obtain information models and relationship patterns that can be used in data mining [14].

The strategy is a part of the marketing pattern in marketing educational investments by using a touch of digital-based marketing communications for universities in building educational investments following the marketing communications patterns in each trend. Marketing communications in the era of digital technology trends has AISAS response stages as stated in Kottler's book [15].

The AISAS pattern determines sequentially by establishing a consumer model in assessing products, services, promotions that attract attention, in order to gain interest in digging deeper into information data related to consumer desires. Searching for information can be done by accessing the internet and accessing digital platforms managed by the management [16].

2. Methodology Section

The method used in this research uses the J48 algorithm approach and Naive Bayes, by classifying the highest level of accuracy of the two algorithms.

2.1. Dataset Classification

Collecting and classifying data is used to integrate the data used into a dataset [17]. The data set taken was 1150, and in Table 1 research attribute data are from the Pddikti report at University.

The attributes used are study program, npm, name, gender, religion, city, occupation, year of graduation and chosen study program. The attribute data used is presented in the table below.

Table 1. Research Attribute Data

1	Prodi Piliha	Npm	Nama	jenis Kelam	Agama	Kota Asal	Pekerjaan	Tln Lulus	Waktu Kuliah
2	bk	2020011790	Syifa Aulia	P	Islam	Depok	Staff	2020	Ekstensi A
6	bk	2020011790	Cholilatul Awwaliyya	P	Islam	Bekasi	Guru BK	2018	Ekstensi A
24	inggris	2020121790	Rahma Agustina Sa	P	Islam	Jakarta Timur	Operator Produksi	2020	Ekstensi A
135	informatika	2020431790	ANGGI SAPUTRA	L	Islam	Tangerang Selatan	ENGINEER	2019	Ekstensi A
136	informatika	2020431790	Arton Apraisal	L	Islam	Jakarta Timur	Officer	2019	Reguler
634	visual	2020461790	Fikri Azmi	L	Islam	Cilegon	Pelaksana	2020	Sore
675	sejarah	2020151790	Nina Faujiah	P	Islam	Bekasi	Guru	2004	Ekstensi A
689	bk	2020011790	Amelia Wulandari	P	Islam	Tangerang	GURU	2016	Ekstensi A
690	bk	2020011790	Cica Kusnita	P	Islam	Bekasi	Guru	2016	Ekstensi B
693	bk	2020011790	DESI YULIANA	P	Islam	Jakarta Utara	ADMIN	2016	Ekstensi B
713	informatika	2020431791	Dwi Joko Widodo	L	Kristen	Depok	PELAKSANA	2017	Sore
753	informatika	2020431791	Hawwin Rizki Herlia	L	Islam	Ciamis	Pelaksana	2017	Sore
775	inggris	2020121790	Lizda Mala Aristiyar	P	Islam	Cirebon	Guru	2017	Reguler
776	inggris	2020121790	Siti Fatimah Nurhay	P	Islam	Jakarta Timur	Guru	2017	Reguler
779	inggris	2020121790	Muhammad Yashfi	L	Islam	Sumedang	Guru	2021	Ekstensi B
780	matematika	2020131790	Isna Lathifah	P	Islam	Bekasi	Guru	2014	Ekstensi B
781	matematika	2020131790	Mohamad Yoga Fat	L	Islam	Jakarta Selatan	Guru Matematika	2021	Reguler
826	informatika	2020732901	Wiwit Haryanti	P	Islam	Bekasi	Guru Mata Pelajaran	2015	Ekstensi B
1147	inggris	2020121790	Asya Walimanti	P	Islam	Banten	Staff	2019	Ekstensi A
1148	informatika	2020121790	Dewi Illa	P	Islam	Denpasar	Belum Bekerja	2019	Reguler
1149	informatika	2020121790	Wiska	P	Islam	Cikarang	Belum Bekerja	2019	Reguler
1150	inggris	2020121790	Haiden Jilatti Isma	P	Islam	Bandung	Belum Bekerja	2019	Reguler

It can be seen in the data set display that they will be used to provide input in marketing promotion strategies.

Classification was carried out by cleaning the initial data set of 1150 data sets, testing data sets for which attributes could be created or complete data sets that could be used as many as 813 data sets for testing.

Analysis that becomes a reference in study program specialization is using the Weka 3.9.6 application. This can be seen in the attributes below, in Table 2. Here are the set of attributes.

Table 2. Set of attributes

Label	Count	Weight
1 bk	99	99
2 inggris	42	42
3 matematika	184	184
4 arsitektur	133	133
5 informatika	329	329
6 visual	26	26

2.2. Naive Bayes Algorithm

The working concept of the Naive Bayes algorithm flow is:

1. Calculate the total probability value of new cases that can be used as a reference for each hypothesis with the existing class (label).
2. Calculate the accumulated opportunity value of each class.
3. Calculating the probability value.
4. Determining classes based on new cases that will be used as references.

Evaluation stage testing with the help of the confusion matrix obtained very significant results in terms of Accuracy, Precision, Recall, and F-Measure. The result of attributes classification using the Naive bayes algorithm are shown in Table 3.

Table 3. Naive Bayes classification attributes

Naive Bayes Classifier							
Attribute	Class	bk	inggris	matematika	arsitektur	informatika	visual
		(0.12)	(0.05)	(0.23)	(0.16)	(0.4)	(0.03)
pmb							
FMB		47.0	21.0	100.0	81.0	187.0	17.0
FMBK		54.0	23.0	86.0	54.0	144.0	11.0
[total]		101.0	44.0	186.0	135.0	331.0	28.0

2.3. J48 Algorithm

The J48 Decision Tree algorithm reads noise quickly, and if it sees incomplete data in the training set process, it immediately removes the incomplete data into noise, unused. The J48 algorithm pattern traces and then divides the data into parts based on the attribute values of the items, the training dataset classifier model (full training set) in Figure 2. The J48 pattern divides the classification of the final decision tree results by summarizing the decision tree values and determining the rules obtained from the decision tree.

```

=== Classifier model (full training set) ===

J48 pruned tree
-----

npm <= 202072290143
| npm <= 202042179007
| | npm <= 202012179053
| | | npm <= 202001179058: bk (41.0)
| | | npm > 202001179058: inggris (40.0)
| | npm > 202012179053
| | | npm <= 202014179074: matematika (69.0)
| | | npm > 202014179074
| | | | npm <= 202021179017: bk (19.0)
| | | | npm > 202021179017
| | | | | npm <= 202041179008: arsitektur (7.0)
| | | | | npm > 202041179008
| | | | | | npm <= 202042179005: matematika (5.0)
| | | | | | npm > 202042179005: inggris (2.0)
| | npm > 202042179007
| | | npm <= 202044179047
| | | | npm <= 202043179217: informatika (181.0)
| | | | npm > 202043179217: bk (39.0)
| | | npm > 202044179047
| | | | npm <= 202046179040
| | | | | npm <= 202045179018: arsitektur (15.0)
| | | | | npm > 202045179018: visual (26.0)
| | | | | npm > 202046179040: informatika (148.0)
| npm > 202072290143
| | npm <= 202073290244: matematika (110.0)
| | npm > 202073290244: arsitektur (111.0)

Number of Leaves :    14
Size of the tree :    27
    
```

Figure 2. Full training set attributes of the J48 Algorithm

The results of applying the Naive Bayes attribute classification show that the study program chosen by new students based on class and type of information model chooses the PMB or PMBK campus entry route.

3. Results

The stage continues with the machine learning process using the Weka 3.9.6 application, as can be seen at the display in Table 4. Selection of lecture times, results in the Weka 3.9.6 application, the strategy pattern used in the attribute set is divided into specialization study programs, lecture time and university entry routes which will later be calculated and divided into classifications with the total calculation of the results obtained.

Table 4. Selection of lecture times

mean	2014.0191	2017.4342	1998.2732	2018.0631	2000.5056
std. dev.	7.077	3.781	1.5433	2.169	6.121
kuliah					
Karyawan B	34.8735	85.6573	1.0305	96.1098	9.7266
Sore	1	17.023	3.9943	134	1.0106
Reguler	34.0163	31.1052	1.8673	39.9999	1.1211
Karyawan A	87.7821	6.0012	1.865	2.9998	3.1389
[total]	157.6719	139.7868	8.7571	273.1095	14.9972

Classification of lecture time selection by looking at the mean, average value and standard deviation can be seen in the display of lecture times in Table 4, and they are the most popular with new students. Adjusted study times are popular and are the choice of prospective new students as shown in the table.

3.1. Naive Bayes Algorithm Model

The Naive Bayes model interprets the area of the curve (AUC) to track the attributes used and assesses the accuracy of the data set.

Bayes' theorem is assumed to be naive where all features in the data are said to be independent of one another convergence across experiments [18]. The results of the AUC cur classification accuracy table are in the following table:

Table 5. Naive Bayes confusion matrix

```

=== Confusion Matrix ===
  a  b  c  d  e  f  <-- classified as
80  0  11  0  8  0 | a = bk
 2  37  2  0  1  0 | b = inggris
16  14 110 27  17  0 | c = matematika
 6  0  3 108 16  0 | d = arsitektur
 1  0  1 39 288  0 | e = informatika
 0  0  0  0  0 26 | f = visual
    
```

It can be seen in the confusion matrix in Table 5, which consists of 6 study program set attributes consisting of 813 data sets which are used for calculations and classifying the results into the matrix.

Table 6. Accuracy level of MCC ROC Naive Bayes area

```

=== Detailed Accuracy By Class ===
      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC   ROC Area  PRC Area  Class
0.808  0.035  0.762  0.808  0.784  0.754  0.975  0.881  bk
0.881  0.018  0.725  0.881  0.796  0.788  0.987  0.885  inggris
0.598  0.027  0.866  0.598  0.707  0.658  0.956  0.783  matematika
0.812  0.097  0.621  0.812  0.704  0.645  0.935  0.842  arsitektur
0.875  0.087  0.873  0.875  0.874  0.788  0.957  0.950  informatika
1.000  0.000  1.000  1.000  1.000  1.000  1.000  1.000  visual
Weighted Avg.  0.798  0.062  0.813  0.798  0.797  0.738  0.958  0.884
    
```

Accuracy Precision, Recall, F-Measure, MCC, ROC levels are listed in Table 6. The ROC value is an area to measure the lecture time that is most popular with prospective new students.

Table 8. Accuracy by class ROC Area

```

=== Detailed Accuracy By Class ===
      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC   ROC Area  PRC Area  Class
0.960  0.003  0.979  0.960  0.969  0.965  0.978  0.945  bk
0.929  0.004  0.929  0.929  0.929  0.925  0.974  0.886  inggris
0.984  0.008  0.973  0.984  0.978  0.972  0.990  0.976  matematika
0.977  0.004  0.977  0.977  0.977  0.973  0.987  0.959  arsitektur
0.994  0.004  0.994  0.994  0.994  0.990  0.995  0.990  informatika
0.962  0.001  0.962  0.962  0.962  0.960  0.980  0.926  visual
Weighted Avg.  0.980  0.005  0.980  0.980  0.980  0.976  0.989  0.969
    
```

The ROC Curve value displays the positive class in curve form. Testing is carried out by calculating the AUC (Area Under Curve) value.

The four lecture times presented on campus make prospective students more flexible in choosing lecture times and classes to calculate the total number of people interested in study programs that are in great demand.

3.2. J48 Algorithm Model

The J48 algorithm model has nodes that determine attributes, each branch explains the results of the attribute to be tested and each class attribute is a decision tree structure that determines the predictor output class. Table 7 displays the confusion matrix values based on the accuracy of predictions for study programs with the highest interest, such as informatics, mathematics, and others, as shown in the data below.

Table 7. J 48 Confusion matrix

```

=== Confusion Matrix ===
  a  b  c  d  e  f  <-- classified as
34  0  0  0  0  0 | a = bk
 0  4  2  0  0  0 | b = inggris
 0  1 51  0  0  0 | c = matematika
 0  0  0 48  0  0 | d = arsitektur
 0  0  2  0 127  0 | e = informatika
 0  0  0  0  0  7 | f = visual
    
```

The accuracy value is summed up based on the overall data set which appears to have the highest value of study program interest. The total accuracy value obtained is seen from the factors that cause the model to become a reference. Test implementation can be measured from the ROC Curve value. The results were obtained in Table 8 accuracy by class ROC area.

The higher the AUC and ROC Curve values, the better the classification model formed.

4. Discussion

The results obtained using the Naive Bayes and J48 algorithms, by looking at the total presentation of the number of study program enthusiasts with the most interest by looking at adjusting to the lecture time provided become material for a marketing promotion strategy in mapping the concept of study programs that are requested in the future as a marketing strategy in College.

The promotion was carried out as an effort by the campus to break through increasingly stringent digitalization in the future.

The current online sales marketing communication strategy prioritizes digital platforms as a medium for promotional activities and utilizes them by uploading product photos and also to build consumer confidence, so that they continue to choose products that suit their future needs.[19]

The marketing mix-8P's strategy is a marketing model that has attributes that make branding in the world of higher education, most importantly in future marketing patterns predictable [20].

Business strategy really needs marketing strategy in a great and dynamic marketing mix so that it is attractive and in line with the needs of the digital world today and in the future. Marketing strategy is a part of the life of marketing and its development has to be increasing and dynamic [21].

Mix-8P's Marketing Pattern Model 8P comprises: products offered, competitive prices, product promotion, strategic location, consumers, results, and tangible form, and sustainability of quality of results.

- 1) Products offered: As a form of offer that presents a variety of superior products that consumers are interested in.
- 2) Price: Part of the competition between universities in labelling the set price benchmarks.
- 3) Product Promotion: A series of strategies for interaction between consumers who have become subscribers and selected universities.
- 4) Strategic location: Concerns consumers in the availability of places and reach of locations.
- 5) Consumers: Extra service reaches consumers to become customers and goes viral by itself.
- 6) Results: Part of a series of efforts to determine the value of a university's success.
- 7) Tangible results: Many enthusiasts who promote themselves as successful actors.
- 8) Quality Performance: The sustainability of the university is seen from the quality produced, the results increase sustainability at all times.

Table 9. Summary cross Validation Algorithm J48

=== Stratified cross-validation ===		
=== Summary ===		
Correctly Classified Instances	797	98.032 %
Incorrectly Classified Instances	16	1.968 %
Kappa statistic	0.9734	
Mean absolute error	0.0066	
Root mean squared error	0.0795	
Relative absolute error	2.6576 %	
Root relative squared error	22.6314 %	
Total Number of Instances	813	

Summary validation can be seen in the final calculation table of the J48 algorithm in Table 9, correctly classified instances and incorrectly classified instances with a value of 1.968%.

Table 10. Summary cross Validation Algorithm Naive Bayes

=== Summary ===		
Correctly Classified Instances	617	75.8918 %
Incorrectly Classified Instances	196	24.1082 %
Kappa statistic	0.6676	
Mean absolute error	0.1639	
Root mean squared error	0.2906	
Relative absolute error	44.8475 %	
Root relative squared error	67.9773 %	
Total Number of Instances	813	

Meanwhile, based on the summary stratified cross algorithm, the Naive Bayes in Table 10, incorrectly classified instances has a value of 24.108%.

Table 11. Learning Test Model Performance Results

Results of Naive Bayes Algorithm Model Analysis & J48 Algorithm				
	Naive Bayes		J48	
Correctly Classified Instances	617	75.8 %	797	98.0 %
Incorrectly Classified Instances	196	24.1 %	16	1.96 %
Total Number of Instances	813			
Precision	0.816		0.979	
Recall	0.706		0.960	
F-Measure	0.757		0.969	
ROC Area	0.915		0.978	

Analysis of the Naive Bayes algorithm model and the J45 algorithm used in calculating the results was carried out on a Core i7, 64 bit, Windows 10 laptop and adopted the help of the Weka 3.9.6 application software. The results area obtained are shown in Table 11. Result of Naive Bayes algorithm model analysis J48 algorithm.

A series of tests on data sets, attributes and their corresponding data showed that the Naive Bayes analysis model had an accuracy rate of 75.8% and the J.48 algorithm 98.0%. Referring to the highest percentage results using the J48 algorithm, a Marketing Strategy Analysis model in Marketing can be created by predicting the data in the J.48 model attributes. We created a model using the marketing mix'8P approach by formulating the largest percentage of results data.

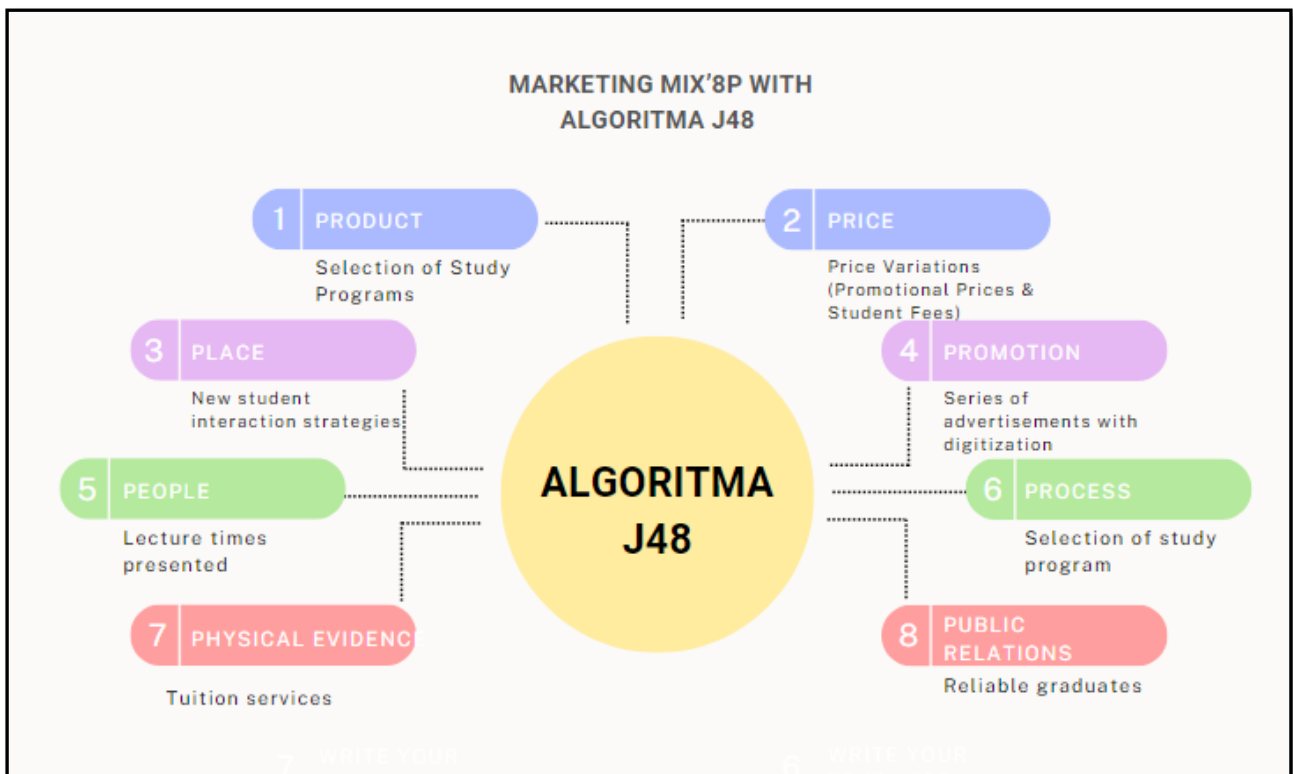


Figure 3. Models Marketing MIX 8P with algorithm J48

Based on these comparison results, the J48 algorithm has quite high accuracy. So the results are applied in the 8P marketing mix model, following the 8p marketing model, shown in Figure 3.

5. Conclusion

The J48 algorithm model is needed as a marketing strategy analysis, and as a marketing promotion that is able to attract the purchasing power of students interested in study programs who will be taken to college.

Figure 2 illustrates the Marketing MIX 8P model using the J48 algorithm, where various study durations and corresponding study programs are currently being used to determine marketing strategies for maximizing higher education marketing.

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