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Analysis Of Licensing Data Using Naive Bayes And Decision Tree Algorithms To Evaluate The Performance Of Digital Public Services (Case Study: Invesment and One-Stop Integrated Services Office Of Medan City)

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ABSTRACT
Digital public services have become increasingly essential with the rapid development of technology and information. Over the past six years, the digital transformation of public services at the Investment and One-Stop Integrated Services Office (DPMPTSP) of Medan City has been highly significant. This can be observed from the national implementation of Online Single Submission (OSS) and the "Si Cantik" online application by the Ministry of Communication and Information in 2018, the launch of the "Sipandu" digital service application in Medan City in 2022, and the inauguration of the Public Service Mall and "Si Medan Pantas" application in 2024. In this digital era, innovation in public service is a necessity that cannot be overlooked, especially in efforts to improve the efficiency and effectiveness of licensing processes. This study aims to evaluate digital public service performance by analyzing licensing data in Medan City. The methods applied in this research are Naive Bayes and Decision Tree algorithms, utilizing the Orange data mining tool to optimize the assessment of digital public service performance.The main findings of this study highlight the evaluation of public service performance and identify potential areas for innovation, ideas, or new insights to enhance future public service delivery..

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INTRODUCTION

In the current digital era, technological advancements have brought significant changes to various aspects of life, including public administration (Rizky et al., 2025). The digitalization of public services enables a more transparent, efficient, and data-driven system as part of bureaucratic reform aimed at improving service efficiency for the public (Yani et al., 2024). Moreover, if licensing services are able to optimally meet the needs of the community, these services can be considered effective in supporting the advancement of digital public service delivery (Supriadi et al., 2025).

The ease and convenience of using technology significantly influence the public's interest in utilizing digital services. This plays an important role in increasing individuals'

willingness to adopt technology in public service delivery (Asfendi et al., 2025). In this context, the evaluation of public service performance becomes a crucial element for identifying problems, supporting continuous improvement processes, and enhancing service efficiency (Adityantoro et al., 2025),(Farasi et al., 2025). These efforts are in line with the implementation of the principles of Good Governance, which prioritize fairness, transparency, and accountability in public administration (Asyari, 2022). Service performance can be assessed using a scale of 1 to 4: (1 = Poor, 2 = Fair, 3 = Good, 4 = Very Good) (Abnur Asman, 2017).

To provide deeper insights into the performance of digital-based public services, data processing can be conducted using a data mining approach. Data mining enables the extraction of valuable information from complex datasets to identify patterns, make predictions, and evaluate services (Putri et al., 2025) Two algorithms that are relevant for this analysis are Decision Tree and Naïve Bayes. The Decision Tree is a classification and prediction algorithm that transforms data into a decision tree representation, dividing the data into meaningful subgroups (Septhya et al., 2023). Meanwhile, Naïve Bayes is a simple yet effective probabilistic classification algorithm that is widely used in machine learning applications across various sectors(Hayami & Gunawan, 2022).

Through the application of these two algorithms, licensing data from the Investment and One-Stop Integrated Services Office (DPMPTSP) of Medan City can be analyzed to assess the performance of digital public services. This study is expected to contribute to a better understanding of the effectiveness of digital public services, while also supporting innovations toward more efficient and adaptive services that meet the needs of society in the digital era.

METHODS

The research methodology consists of several systematic steps to ensure the accuracy and validity of the analysis results, as follows:

1. Collection of licensing data through secondary data from the Investment and One-Stop Integrated Services Office (DPMPTSP) of Medan City. The data collected pertains to licensing activities in the year 2024. Secondary data refers to data obtained or gathered from existing sources, rather than directly from primary research or firsthand observation. This type of data is typically collected by other parties and can be reused for new analytical purposes.
2. Searching for and collecting journals on the application of the Naïve Bayes and Decision Tree algorithms related to the assessment of public service performance; (Parhusip et al., 2024; Parhusip & Iqbal, 2025).
3. Performing preprocessing by cleaning the data, eliminating duplicates, checking for inconsistencies, and correcting data errors such as misspellings, incorrect entries, anomalies, enrichment processes, or the addition and updating of data. This also involves supplementing additional information from other sources to improve the quality and value of the data and selecting relevant operational data; (Sulianta, 2023).

4. Creating models and analysis using the Naïve Bayes and Decision Tree algorithms with the Orange tool, an open-source software platform for data analysis and machine learning based on a visual user interface (GUI) (Yunardi et al., 2022).
5. Finally, the analysis results will be presented in the form of graphs and tables to facilitate understanding. Data visualization is an important part of the analysis as it helps in communicating findings to stakeholders in a clearer and more understandable way. Thus, this research methodology is designed to provide comprehensive and informative results regarding the assessment of digital public service performance.

RESULTS AND DISCUSSION

1. Datta Collection

NO	NO RESI	ALAMAT	JENIS KELAMIN	PENDIDIK	PEKERJAAN	JENIS LAYANAN	TGL PENGAJUA	TGL TERBIT	TGL IKM	U1	U2	U3	U4	U5	U6	U7	U8	U9
1	0246/SIP/2023	MEDAN TUNTUNGAN	Perempuan	S1/D-IV	GURU	IZIN PENDIRIAN SATUAN PENDIDIKAN FORMAL	12/09/2023	02/01/2024	02/01/2024	4	4	4	4	4	4	4	4	4
2	1161/CBT/2023	MEDAN SELAYANG	Perempuan	S1/D-IV	SWASTA	PENCABUTAN IZIN TENAGA KESEHATAN	05/12/2023	02/01/2024	02/01/2024	3	4	3	4	3	3	3	4	4
3	8522/SIP/2023	MEDAN BARU	Perempuan	S3	PNS	IZIN PRAKTIK TENAGA KESEHATAN	30/10/2023	02/01/2024	02/01/2024	4	2	4	4	3	3	3	3	3
4	8597/SIP/2023	MEDAN MAIMUN	Perempuan	S3	PNS	IZIN PRAKTIK TENAGA KESEHATAN	01/11/2023	02/01/2024	02/01/2024	3	2	4	4	3	3	3	3	3
5	8600/SIP/2023	MEDAN PETISAH	Perempuan	S3	PNS	IZIN PRAKTIK TENAGA KESEHATAN	01/11/2023	02/01/2024	02/01/2024	3	2	4	4	3	3	3	3	3
6	0324/SIP/2023	MEDAN LABUHAN	Laki-laki	S1/D-IV	SWASTA	IZIN PENDIRIAN SATUAN PENDIDIKAN FORMAL	15/11/2023	02/01/2024	02/01/2024	4	4	4	4	4	4	4	4	4
7	9065/SIP/2023	MEDAN AREA	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	15/11/2023	02/01/2024	02/01/2024	4	4	3	4	3	4	4	4	4
8	9233/SIP/2023	MEDAN DENAI	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	21/11/2023	02/01/2024	03/01/2024	4	4	4	4	4	4	4	4	4
9	9399/SIP/2023	MEDAN DENAI	Perempuan	S1/D-IV	DOKTER UMUM	IZIN PRAKTIK TENAGA KESEHATAN	24/11/2023	02/01/2024	06/01/2024	3	4	3	4	3	3	3	3	3
10	9236/SIP/2023	MEDAN SUNGGAL	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	21/11/2023	02/01/2024	02/01/2024	3	3	3	4	3	3	3	3	4
11	9254/SIP/2023	MEDAN TUNTUNGAN	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	21/11/2023	02/01/2024	02/01/2024	2	2	2	3	2	2	2	2	2
12	10056/SIP/2023	MEDAN HELVETIA	Perempuan	S1/D-IV	DOKTER INTERNSHIP	IZIN PRAKTIK TENAGA KESEHATAN	14/12/2023	02/01/2024	02/01/2024	4	4	4	4	4	4	4	4	4
13	9580/SIP/2023	MEDAN KOTA	Laki-laki	S1/D-IV	PNS	IZIN PRAKTIK TENAGA KESEHATAN	29/11/2023	02/01/2024	02/01/2024	3	3	3	4	3	3	3	3	4
14	9607/SIP/2023	MEDAN SELAYANG	Laki-laki	S1/D-IV	PNS	IZIN PRAKTIK TENAGA KESEHATAN	30/11/2023	02/01/2024	02/01/2024	3	3	3	4	3	3	3	3	4
15	9921/SIP/2023	MEDAN POLONIA	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	11/12/2023	02/01/2024	03/01/2024	3	3	3	4	3	3	3	3	4
16	9697/SIP/2023	MEDAN SUNGGAL	Laki-laki	S2	PERAWAT	IZIN PRAKTIK TENAGA KESEHATAN	04/12/2023	02/01/2024	03/01/2024	3	3	3	4	3	3	3	3	1
17	9712/SIP/2023	MEDAN HELVETIA	Perempuan	S2	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	04/12/2023	02/01/2024	02/01/2024	3	3	3	4	3	3	3	3	4
18	9747/SIP/2023	MEDAN MAIMUN	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	05/12/2023	02/01/2024	03/01/2024	4	4	4	4	4	4	4	4	4
19	9795/SIP/2023	MEDAN PETISAH	Laki-laki	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	06/12/2023	02/01/2024	03/01/2024	4	4	4	4	4	4	4	4	4
20	9799/SIP/2023	MEDAN JOHOR	Perempuan	S1/D-IV	DOKTER SPESIALIS	IZIN PRAKTIK TENAGA KESEHATAN	06/12/2023	02/01/2024	02/01/2024	4	4	4	4	4	4	4	4	4
21	9887/SIP/2023	MEDAN TIMUR	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	08/12/2023	02/01/2024	08/01/2024	3	3	3	4	3	3	3	3	4
22	9957/SIP/2023	MEDAN MARELAN	Perempuan	D3	BIDAN PELAKSANA	IZIN PRAKTIK TENAGA KESEHATAN	12/12/2023	02/01/2024	02/01/2024	3	3	3	4	3	3	3	3	3
23	10066/SIP/2023	MEDAN TIMUR	Perempuan	D3	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	15/12/2023	02/01/2024	03/01/2024	3	3	3	3	3	3	3	3	4
24	9973/SIP/2023	MEDAN MAIMUN	Perempuan	D3	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	12/12/2023	02/01/2024	02/01/2024	4	4	4	4	4	4	4	4	4
25	10026/SIP/2023	MEDAN DENAI	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	13/12/2023	02/01/2024	02/01/2024	3	3	3	4	3	3	3	3	4
26	10112/SIP/2023	MEDAN MAIMUN	Perempuan	S1/D-IV	SWASTA	IZIN PRAKTIK TENAGA KESEHATAN	18/12/2023	02/01/2024	03/01/2024	4	4	4	4	4	4	4	4	4

DATA PERIZINAN | Tabel Trend Penilaian Kinerja | Tabel Trend Frekuensi | PRAPROCESSING | Sheet6

Figure 1. Licensing Data from DPMPTSP Medan City

2. Preprocessing

   This stage is crucial for data analysis, as it involves transforming initial or raw data into a more structured and meaningful form. This process enhances model accuracy and efficiency, accelerates training time in various applications such as machine learning, data mining, and statistical analysis, and improves the understanding of patterns and relationships within the data. Raw or initially collected data is often incomplete, contains duplicate records, inconsistencies, errors, or noise.

   The preprocessing stage of the licensing data consists of the following steps:

   a. Filtering, sorting, and extracting licensing data, such as removing unnecessary numbers, letters, punctuation marks, and special characters;
   b. Converting all text to lowercase or uppercase to avoid treating the same word in different forms as different entries, ensuring consistency in word representation;

c. Standardizing words with different writing variations but the same meaning, and converting words to their root or base form;
d. Selecting and scaling the features used to train and improve the performance of the model;
e. Splitting the data into two sets, with 80% for the training dataset and 20% for the testing dataset;

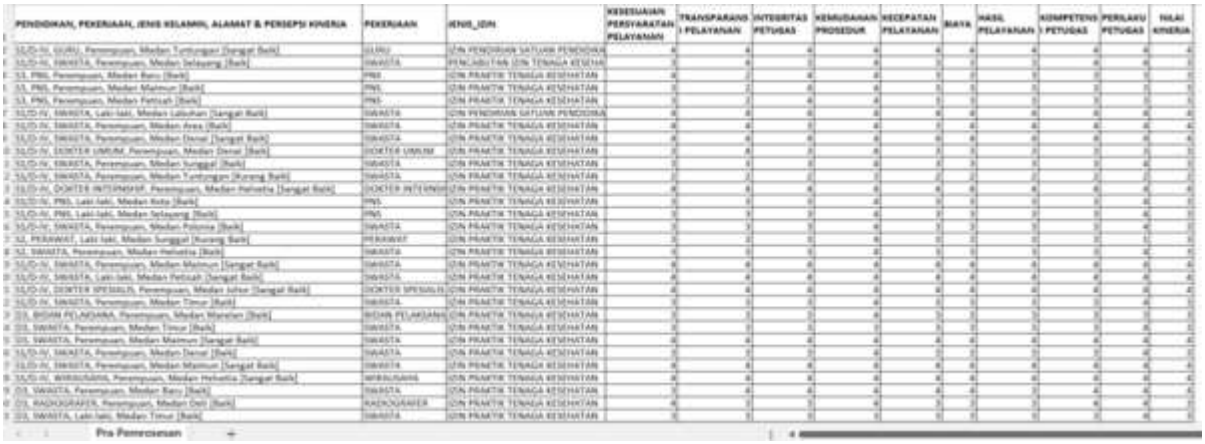


Figure 2. Preprocessing

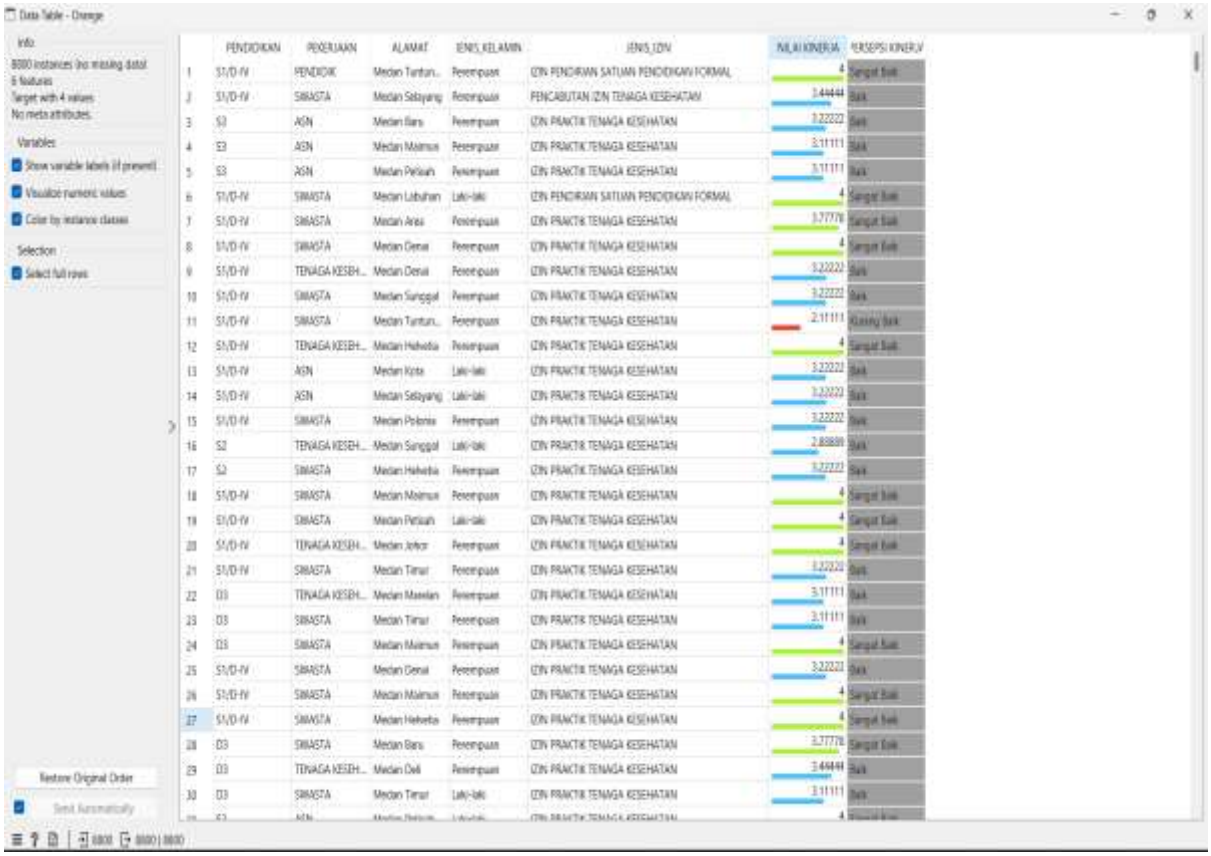


Figure 3. Further Pre-processing

3. Modeling and Analysis
   a. Naive Bayes:

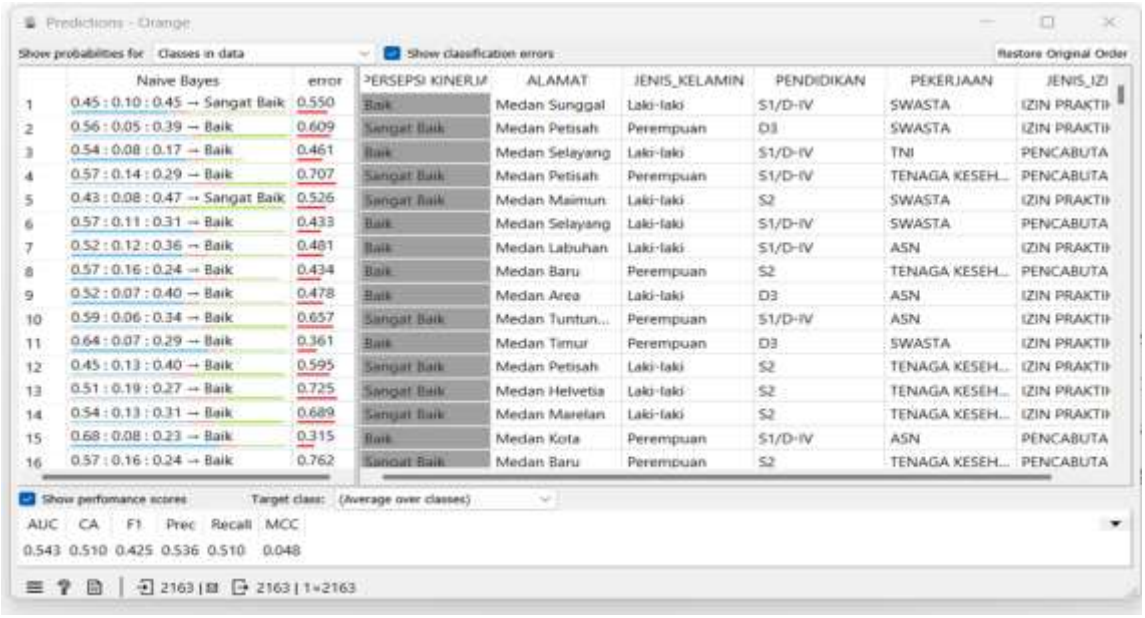


Figure 4. Training of Licensing Data Using the Naive Bayes Algorithm

The results of classification prediction and training data evaluation show performance scores of Vey Good = 4 and Good = 3, where the target/label variables are PERFORMANCE PERCEPTION and EDUCATION, OCCUPATION, ADDRESS, GENDER, LICENSE_TYPE are the features used by the model to make predictions. The classification error values for Naïve Bayes, as seen in the first five rows of the table above, are 0.550, 0.609, and 0.707.

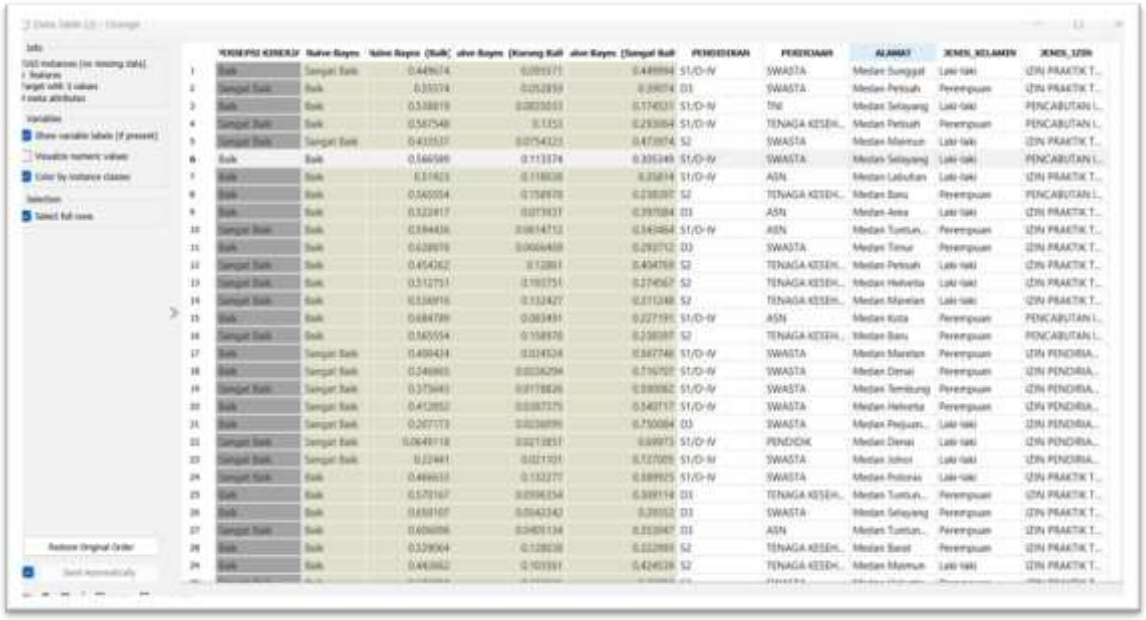
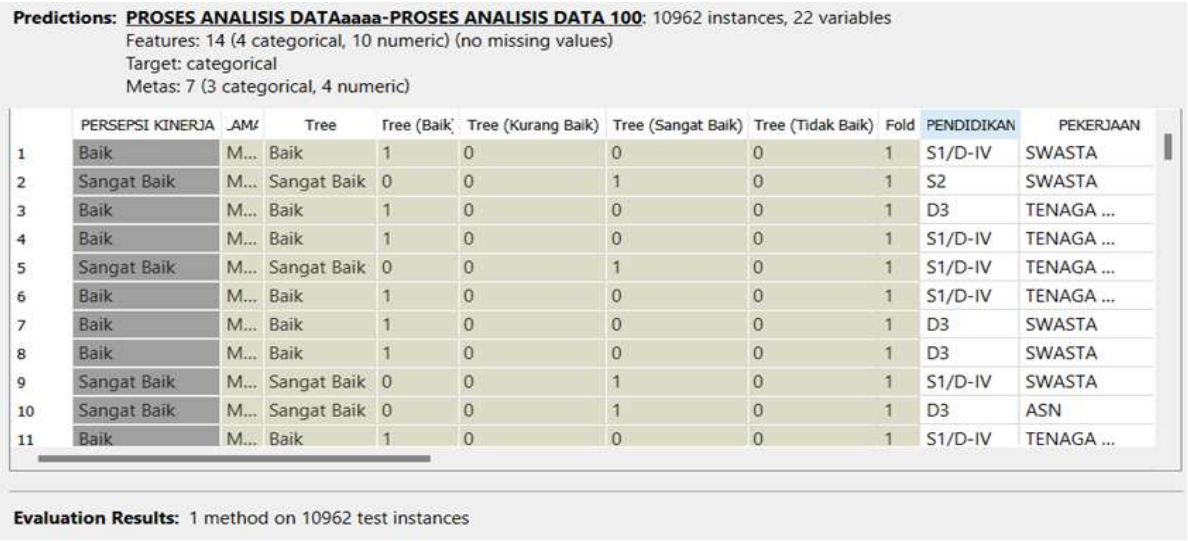


Figure 5. Training Data Table

New information that can be shown by the Naïve Bayes model on the above data is:

1. Anomaly detection, identifying patterns that are unusual or deviate from the normal pattern in the data. In the example you provided, if the actual performance perception result is 'Good' but the Naive Bayes method's prediction is 'Very Good,' this could be considered an anomaly. This suggests that there might be other factors influencing performance perception beyond the factors considered by Naive Bayes. Let's look at row 1: ID: 1, PERFORMANCE PERCEPTION: Good, EDUCATION: Bachelor's (S1), OCCUPATION: Private Sector, ADDRESS: Medan Sunggal, GENDER: Male, LICENSE TYPE: Health Professional Practice License.
2. Performance evaluation polarization with the Naïve Bayes model at the Bachelor's (S1/D4) education level shows a trend of 'Very Good,' while at the Master's (S2) and Diploma (D3) levels the trend is 'Good.' This shows a discrepancy with the actual performance perception evaluation. From this, we can conclude that there is an error made by the Naïve Bayes method in the performance evaluation, even though the results still tend to lean towards a positive trend.

b. Decision Tree



Predictions: PROSES ANALISIS DATAaaaa-PROSES ANALISIS DATA 100: 10962 instances, 22 variables
Features: 14 (4 categorical, 10 numeric) (no missing values)
Target: categorical
Metas: 7 (3 categorical, 4 numeric)

	PERSEPSI KINERJA	AMA	Tree	Tree (Baik)	Tree (Kurang Baik)	Tree (Sangat Baik)	Tree (Tidak Baik)	Fold	PENDIDIKAN	PEKERJAAN
1	Baik	M...	Baik	1	0	0	0	1	S1/D-IV	SWASTA
2	Sangat Baik	M...	Sangat Baik	0	0	1	0	1	S2	SWASTA
3	Baik	M...	Baik	1	0	0	0	1	D3	TENAGA ...
4	Baik	M...	Baik	1	0	0	0	1	S1/D-IV	TENAGA ...
5	Sangat Baik	M...	Sangat Baik	0	0	1	0	1	S1/D-IV	TENAGA ...
6	Baik	M...	Baik	1	0	0	0	1	S1/D-IV	TENAGA ...
7	Baik	M...	Baik	1	0	0	0	1	D3	SWASTA
8	Baik	M...	Baik	1	0	0	0	1	D3	SWASTA
9	Sangat Baik	M...	Sangat Baik	0	0	1	0	1	S1/D-IV	SWASTA
10	Sangat Baik	M...	Sangat Baik	0	0	1	0	1	D3	ASN
11	Baik	M...	Baik	1	0	0	0	1	S1/D-IV	TENAGA ...

Evaluation Results: 1 method on 10962 test instances

Figure 6. Data Licensing Training

The potential new information that can be shown by the Decision Tree model on the above data is:

a. The comparison of performance values using the Decision Tree method against actual performance perceptions can be seen through the "PERFORMANCE PERCEPTION" column (as the actual value) alongside the evaluation columns using the Decision Tree method ("Tree (Good)", "Tree (Very Good)", etc.). This allows us to assess how well the

model evaluates performance perception. For example, in the first row, the actual perception is "Good," and the corresponding "Tree (Good)" value is noted, and similarly for subsequent rows. In other words, the Decision Tree method has been successfully applied to assess performance in this dataset.

b. Model evaluation: The performance of the Decision Tree model has been evaluated using test data, providing an indication of its generalization ability.

c. Model interpretability potential: The nature of the Decision Tree allows for the interpretation of the decision rules underlying the predictions, for example, "If EDUCATION is S1/D-IV and JOB is PRIVATE, then PERFORMANCE PERCEPTION is likely to be Good.

4. Assessment and Evaluation Results

   a. Naive Bayes:

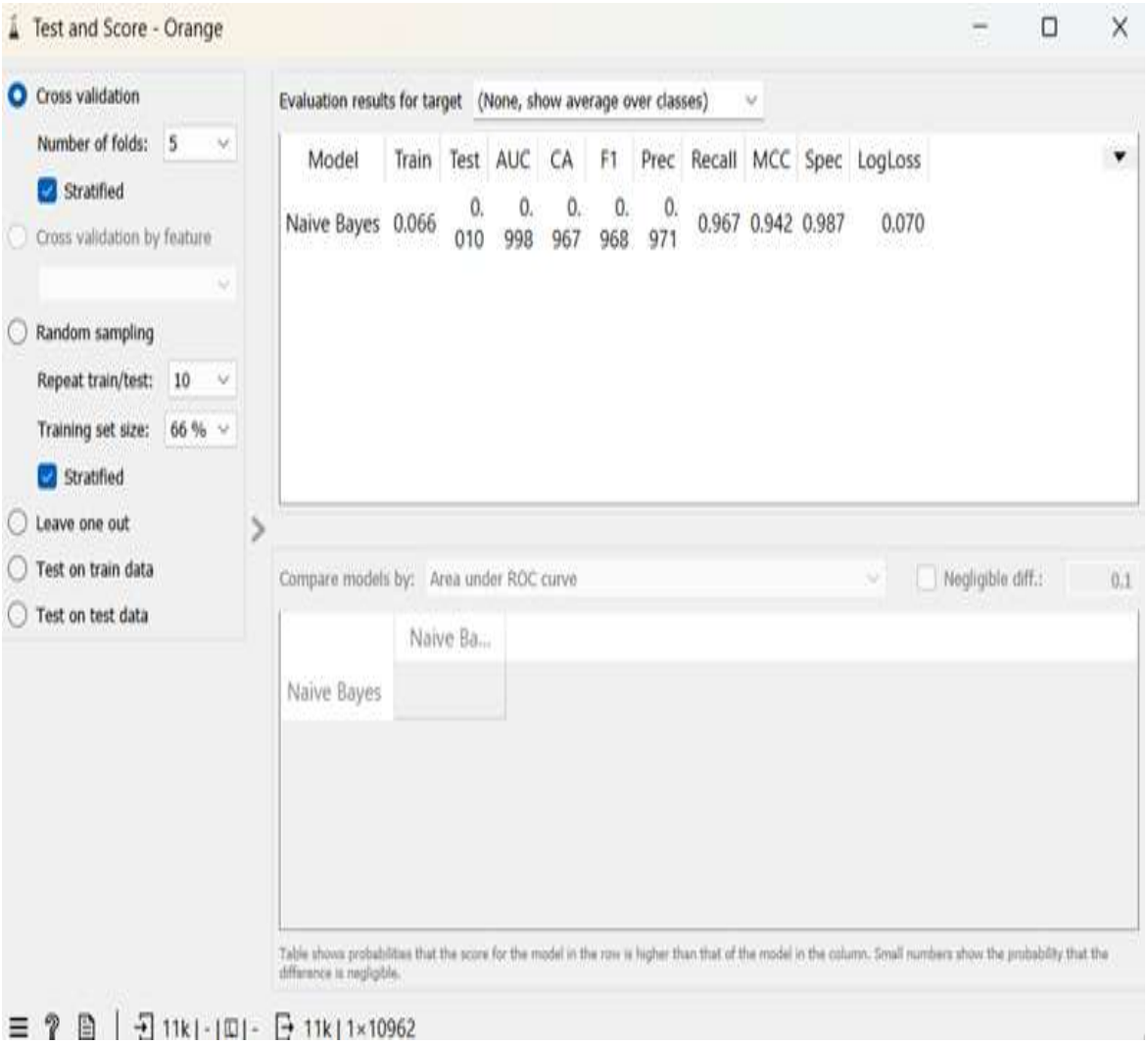


Figure 7. Test dan Score

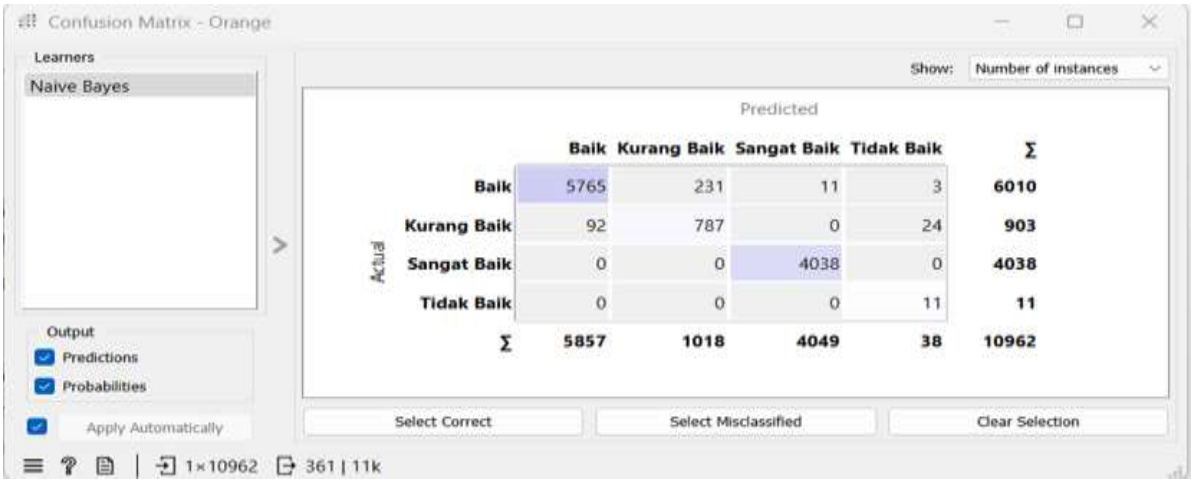


Figure 8. Confusion Matrix with Naïve Bayes

The Naive Bayes algorithm modeling displays the Confusion Matrix in the Orange application, providing detailed information about its performance in classifying data.
Structure of the Confusion Matrix:

1. The Actual Rows represent the true classes or actual labels of the data, which consist of four performance rating classes: Very Good with a score of 4, which includes 4,038 applicants; Good with a score of 3, which includes 6,010 applicants; Fair with a score of 2, which includes 903 applicants; and Poor with a score of 1, which includes 11 applicants.
2. The Predicted Columns represent the predicted classes or labels of the data, which also consist of four performance rating classes: Very Good with a score of 4, which includes 4,049 applicants; Good with a score of 3, which includes 5,857 applicants; Fair with a score of 2, which includes 1,018 applicants; and Poor with a score of 1, which includes 38 applicants.

b. Decision Tree

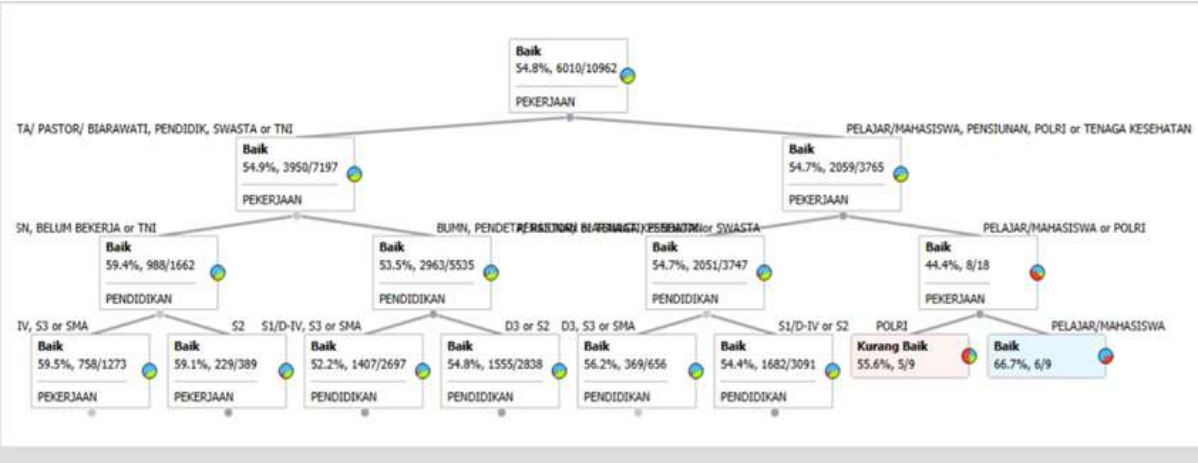


Figure 9. Decision Tree

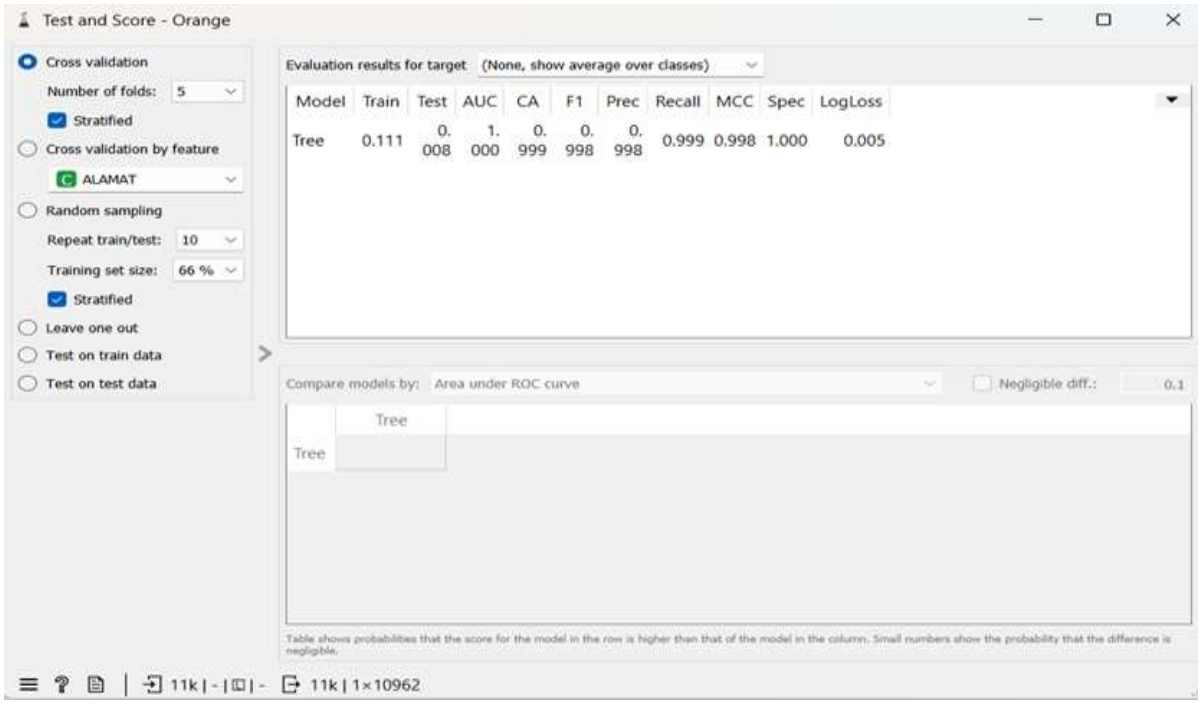


Figure 10. Test and Score with Decision Tree

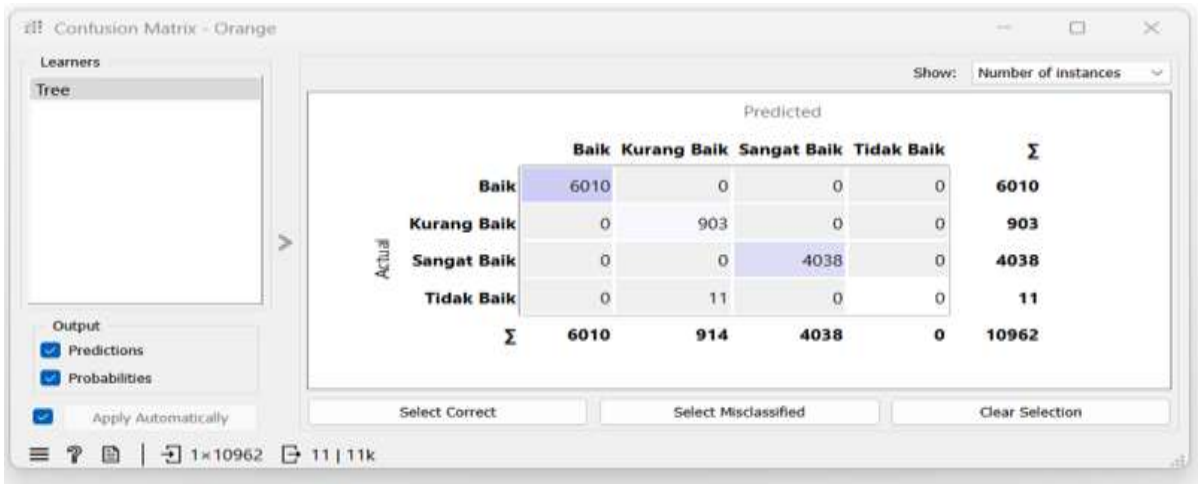


Figure 11. Test and Score with Decision Tree

Modeling the Decision Tree algorithm displays the Confusion Matrix in the Orange application, providing detailed information about performance in classifying data:
Structure of the Confusion Matrix:

1. Actual Rows: Shows the actual class or true labels of the data, which are four performance rating classes: Very Good with a score of 4, having 4,038 applicants; Good with a score of 3, having 6,010 applicants; Fair with a score of 2, having 903 applicants; and Poor with a score of 1, having 11 applicants.
2. Prediction Columns show the actual class or true labels of the data, which are four performance rating classes: Very Good with a score of 4, having 4,038 applicants;

Good with a score of 3, having 6,010 applicants; Fair with ascore of 2, having 914 applicants; and Poor with a score of 1, having none or 0.

Table 1. Confusion Matrix

Confusion Matrik	**Kinerja Aktual**				**Kinerja Prediksi**			
Pemohon = 10.962	Sangat Baik = 4	Baik = 3	Kurang Baik = 2	Tidak Baik = 1	Sangat Baik = 4	Baik = 3	Kurang Baik = 2	Tidak Baik = 1
Naive Bayes	4.038	6.010	903	11	4.049	5.857	1.018	38
Decision Tree	4.038	6.010	903	11	4.038	6.010	914	0

Table 2. Test & Score

Test & Score	Train	Tes	F1	Prec	Recall	AUC	CA	MCC	Spec	Log Loss
Naive Bayes	0.066	0.010	0.968	0.971	0.967	0.998	0.967	0.942	0.987	0.070
Decision Tree	0.111	0.006	0.998	0.998	0.999	1.000	0.999	0.998	1.000	0.005

CONCLUSION

Based on the evaluation results, the Decision Tree algorithm demonstrates superior performance in assessing the quality of digital public services at the Investment and One-Stop Integrated Services Office (DPMPTSP) of Medan City. This is reflected in its higher F1-score of 0.998, compared to 0.968 achieved by the Naive Bayes model. The F1-score represents a harmonic mean between precision and recall, and a higher value indicates better overall model performance.In terms of precision, the Decision Tree achieves 0.998, slightly outperforming Naive Bayes at 0.971. Precision indicates the accuracy of the model in predicting positive classes. Furthermore, the recall score of the Decision Tree reaches 0.999,

also higher than Naive Bayes at 0.967. Recall measures the model's ability to identify all actual positive cases. These results highlight that the Decision Tree model is more effective in correctly assessing performance, minimizing misclassification errors, and successfully identifying the majority of actual positive instances. Therefore, it can be concluded that the Decision Tree algorithm provides a more reliable and accurate evaluation of public service performance in this context.

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