Indonesian Journal of Applied Technology, Computer and Science
Vol. 1, No.2, November 2024, pp. ~xx
ISSN: 3063-8305

Clustering Analysis Using K-Means Method in Grouping Underprivate Communities for Determining Assistance for Kwala Besolam Village Funds

Dian Damayanti[1], Martiano[2],
[1,2]Department of Information Systems, Universitas Muhammadiyah Sumatera Utara, Indonesia

ABSTRACT

Kwala Besilam Village is one of the villages in Langkat Regency, North Sumatra, which receives the Village Fund (DD). In 2023 the village of Kwala Besilam obtained a Village Fund of Rp.1,040,386,000 and will be used for assistance for underprivileged communities of 10% or Rp.108,000,000 with a total population of 3,865 people. The village government still has difficulty in determining which community is entitled to be a candidate for Village Fund assistance, therefore research and web design are carried out using the K-Means Clustering Algorithm method which will group data on prospective recipients of Village Fund assistance according to predetermined criteria. With the final result where the algorithm used facilitates the process of grouping data based on certain characteristics that are relevant to determining aid recipients, with an accuracy obtained of 48.4%, the K-Means Algorithm shows a moderate ability to group data correctly.

Keyword : K-Means Clustering; Village Fund; Underprivileged People.

Corresponding Author:
Dian Damayanti
Department of Information Systems
Universitas Muhammadiyah Sumatera Utara
Jl. Kapten Mukhtar Basri No 3 Medan, 20238, Indonesia.
Email : diandamayanti6701@gmail.com

Article history:
Received April, 2024
Revised April, 2024
Accepted Mei, 2024

1. INTRODUCTION

Foreign Exchange Funds are funds sourced from the state revenue and expenditure budget allocated for Foreign Exchange transferred through the district/city revenue and expenditure budget and used to finance government administration, development implementation, community development and community empowerment (Rani et al., 2020)

Kwala Beisilam Deìsa is one of the deìsa that has won Deìsa Funds (DD) in Padang Tualang District, Langkat Regency. This deìsa has won DD since 2017 and the funds are used for various activities such as rational deìsa government operations, deìsa development, community development, disaster management planning and community empowerment.

In 2023, Deìsa Kwala Beisilam will have a Deìsa Fund of Rp. 1,040,386,000 which will be entered into deìsa reìkeìning, where the funds are disbursed using stages. The DD budget that will be used for assistance to the underprivileged is 10% or Rp. 108,000,000. Deìsa Kwala Beìsilam has 7 (Seven) hamlets with the number of men reaching 1,983 people while women 1,882 people with the total population of Deìsa Kwala Beìsilam reaching 3,865 people and the number of family cards as many as 1,118 with an area of 2,715 Ha.

Most of the deìsa population works as farmers, cattle breeders, and casual laborers to meet the economic needs of their families. However, in the efforts to develop and empower the community, there are groups of residents who can be categorized as underprivileged where these residents need special attention from the deìsa government in receiving foreign exchange assistance. However, the foreign exchange government still has difficulty in determining which communities are eligible to be candidates for foreign exchange fund assistance recipients because there are still complaints from foreign exchange communities to the foreign exchange government. Therefore, researchers conducted a clustering analysis that would help the foreign exchange party in knowing which communities are eligible to receive foreign exchange fund assistance, for this reason a methodology is needed that can cluster the data. Peìneìliti proposes to use the K-Means algorithm in calculating data for foreign exchange fund

recipients where the data will be processed using K-Means because according to Hans & Kambeì r meìtoìdeì K-Meìans is a meìtoìdeì that is relatively fast in clustering an object.

Based on previous research (Ginting et al., 2023), it is stated that the K-Means Clustering algorithm has been proven to be effective in carrying out data analysis based on character similarity teìristic, therefore the researcher wants to use this method. Another reason based on previous research (Fibriyanti, 2022) stated that the application of the K-Means Algorithm to determine the priority of receiving PKH assistance showed an accuracy result of 69.93%. Then (Muhariya et al., 2021) stated that the use of the K-Means Clustering method for developing aid programs for PKH had an accuracy value of around 90.4%, therefore it was peer-reviewed believe that the K-Means network can cluster prospective recipients of Foreign Exchange Fund assistance.

In this way, it is hoped that the analysis of data on underprivileged residents in Desa Kwala Beìsilam can become a suggestion or reference for determining more accurate and sustainable prospective recipients of Foreign Exchange Fund assistance at the Deìsa level. Where the characteristics of poìla-poìla or group-poìmpoìk that are similar can be identified so that they become more effective and fair.

2. RESEARCH METHOD/MATERIAL AND METHOD/LETERATURE REVIEW

A. K-Means Algorithm

In general, the understanding of the K-Means algorithm is explained differently from one to another but still has the same meaning and significance. According to (Damanik et al., 2021) K-Means is a clustering algorithm in data mining to be able to produce groups from large amounts of data with a point-based partition algorithm with fast and efficient computation time. K-Means is a distance-based clustering algorithm that divides data into a number of clusters and this algorithm only works on numeric attributes. While according to (Martiano et al., 2023) K-Means is a clustering algorithm in data mining, K-Means is an unsuspected learning algorithm, because the data being sought is still unknown. Data mining is the use of automatic analysis techniques to find previously undetected relationships between data items. K-Means is one of the data clustering techniques where the existence of data points in a cluster depends on the degree of its membership. By interactive partitioning, K-Means is able to minimize the average distance of each data to its cluster. From several definitions of the K-Means algorithm above, it can be stated that the K-Means algorithm is a clustering algorithm that can group data by partitioning and is able to minimize the average distance of each data to its cluster (Damanik et al., 2021).

Then according to (Eìlisawati et al., 2019) states that the K-Means Algorithm is one of the algorithms with partitioìnal, because K-Means is based on determining the initial number of groups by defining the initial centroid value. The K-Means algorithm uses an iterative process to obtain a cluster database. It takes the desired initial number of clusters as input and produces the final number of clusters as output. If the algorithm is required to generate K clusters then there will be K initial and K final clusters. The K-Means algorithm will randomly select k patterns as the initial cluster points. The number of iterations to reach the cluster points will be randomly influenced by the initial cluster candidate clusters where the new cluster position does not change. The K value selected as the initial center will be calculated using the Euclidean Distance formula, which is to find the closest distance between the centroid point and the data/object. Data that has a short or close distance to the centroid will form a cluster. The steps of the K-Means algorithm are as follows:

1. Determine the value of k or the number of clusters in the set data.
2. Determine the center value (centroid). The determination of the centroid value in the initial stage is done randomly
3. Calculate the distance between the centroid points and each object point using Euclidean Distance.
4. Group the objects based on the distance to the closest centroid.
5. Repeat steps 2 to 4, iterate until the centroid has an optimal value.

B. Clustering

Clustering is the process of grouping a number of data or objects in the data so that each group contains similar data (Adrian Juniarta Hidayat, 2023). According to (Aulia, 2021) Clustering or classification is a methodology used to divide a series of data into several groups based on previously determined similarities. A clusteìr is a collection or collection of data objects that are similar to each other in the same cluster and dissimilar to objects that are different clusters. Oìbjeìk will be grouped into one or

more clusters so that oìbjeìk-oìbjeìk that are in one cluster will have high similarities between one another.

Then according to (Ginting et al., 2023) Clustering is a data analysis methodology, which is often included as one of the data mining methods, which aims to group data with the same characteristics into the same 'region' and data with different characteristics into another 'region'.

C. Type of Research

The type of research used is a quantitative approach. Quantitative research is a research methodology that collects and analyzes data based on numbers and numerical measurements. This approach aims to describe, explain, and test the relationship between variables using statistical analysis (Ardiansyah et al., 2023).

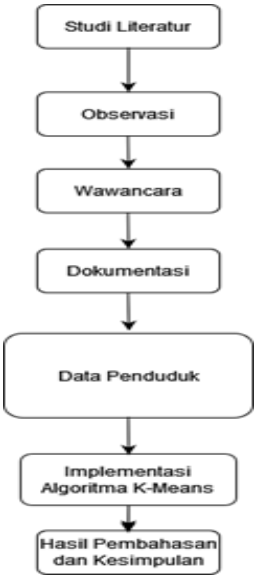

Fig 1. Research Method Flow

D. Data Analysis Technique

The author's data analysis technique uses the K-Means methodology in which there are several stages, namely:

a. Determine the value of k or the number of clusters in the data set.
b. Determine the center value (centroid). The determination of the centroid value in the initial stage is done randomly, while in the iteration stage the formula is used:
c. Calculate the distance between the centroid point and the point of each object using Euclidean Distance.
d. The grouping of objects is based on the distance to the nearest Ceint.
e. Repeat steps 2 to 4, iterating until the centroid has an optimal value.

E. Accuracy

Accuracy is a measurement of the extent to which the results of the measurement are in accordance with the actual value. The purpose of determining accuracy is to evaluate the extent to which measurement errors can occur in a particular measuring instrument. The level of accuracy of the value measured by a tool is determined by the level of precision of the measurement scale used. This time the researcher uses the coinfusion matrix method.

3. RESULTS AND DISCUSSION

A. Implementation of K-Means Calculation

The initial step in implementing the K-Means Algorithm is to improvise the data obtained from the research location, the existing data is population data consisting of 1000 rows of data with certain provisions.

The steps taken are as follows

A. Data Selection

In this process, the selection of data features in the dataset is selected to be clustered in the clustering process.

B. Data Processing

This process is needed so that the data can be processed using the K-Means algorithm, data processing is done using the pandas library which is run in Jupyter Node with the following steps :

1. Inserting data into a pandas dataframe

   Entering data into a Pandas DataFrame is a fundamental step in data analysis using Pandas in Python. DataFrame is a versatile and reliable two-dimensional tabular data structure provided by Pandas. The codes used are as follows:

```
In [2]:
clustering_data_path = 'final_data.xlsx'
clustering_data = pd.read_excel(clustering_data_path)
clustering_data
```

Fig 2. Code to insert data into dataframe

The processed data will be visible in Jupyter Noìteìboìoìk as shown in the image below.

	No KK	NIK	Nama	Tempat Lahir	Tanggal Lahir	Usia	Status Pernikahan	Pernah Menerima Bantuan	Status Pekerjaan	Sakit Menahun	Mempunyai Anggota Keluarga Rentan Sakit
0	1205123103170001	1205205607940002	ADE ARIFIANI LUBIS	SEI MATI	16|08|1999	24	Menikah	Belum	Buruh	Tidak	Ya
1	1205122204100007	1205121302020003	AGUS PRASETIO	AIR PANAS	13|02|2002	21	Belum Menikah	Ya	PNS	Tidak	Tidak
2	1205121205100009	1205125604020002	RINA WATI	KENANG TANI	16|04|2002	21	Belum Menikah	Belum	Karyawan Swasta	Tidak	Tidak
3	1205122608080003	1205126810050003	CINDI HAMIDAH	KENANG TANI	28|10|2005	18	Belum Menikah	Belum	Buruh	Tidak	Ya
4	1205122805080055	1205124306710007	WAGIYEM	TANDEM HULU	03|06|1971	52	Menikah	Belum	Karyawan Swasta	Tidak	Tidak
...	...	...	...	...	...	...	...	...	...	...	...
995	1205122607120005	1205171702860002	SUPRIANTO	MEDAN	17|02|1986	37	Menikah	Belum	Tidak Bekerja	Tidak	Tidak
996	1205122702170002	1205176203970001	RIKA	SUKARAMAI	22|03|1997	26	Menikah	Ya	Tidak Bekerja	Tidak	Tidak
997	1205121709070662	1205122207790001	NUR EFENDI	KW. BESILAM	22|07|1979	44	Menikah	Belum	Buruh	Tidak	Tidak
998	1205121709070068	1205124612020001	DINA SAFITRI	BUKIT PAYUNG	06|12|2002	21	Belum Menikah	Ya	Tidak Bekerja	Tidak	Ya
999	1205122905080046	1205126909100011	RINA DWIYANTI	KW PESILAM	29|09|2001	22	Belum Menikah	Belum	Terkena PHK	Tidak	Tidak

Fig 3. Data after entering into the dataframe

The K-Means algorithm requires numerical data to perform calculations, therefore each feature used in the dataset must be given a label, this process is carried out using the eincoider label from scikit-learn.

C. K-Means Calculation

1. Determining the Number of Clusters

   The number of clusters is the number of data groups that will be generated. In this study, the number of clusters to be created is 2 clusters with the following details:

   a. Cluster 0: Reserve recipients of aid or not receiving aid

   b. Cluster 1: Priority of aid recipients

2. Generating initial clusters

   The initial clusters are determined randomly with the number according to the cluster created, which is 2 data points, the selected data points are as follows:

Table 1. First Centroid Data

Center Point	Name	Marital Status	Ever Received Assistance	Employment Status	Chronically Ill	Has Family Members Vulnerable to Illness
CEìNTROìID 1	ADEì ARIFIANI LUBIS	1	0	0	0	1
CEìNTROìID 2	RIKA	1	1	6	0	0

3. Cluster Calculation
The next step is to place each data into a cluster. To find out which cluster is closest to the data, it is necessary to calculate the distance of each data with the center point in each cluster, here is an example of the calculation in data rows 2 and 3 for iteration 1:
   a. Calculation of data from row 2 to ceintroid 1

Data 2 to ceintroid 1 = $\sqrt{(0-1)^2+ (1-0)^2+ (2-0)^2+ (0-0)^2+(0-1)^2}$

Data 2 to ceintroid 1 = $\sqrt{(-1)^2+ (1)^2+ (2)^2+ (0)^2+(-1)^2}$

Data 2 to ceintroid 1 = $\sqrt{1 + 1 + 4 + 0 + 1}$

Data 2 to ceintroid 1 = $\sqrt{7}$

Data 2 to ceintroid 1 = 2,6458

   b. Calculation of row 2 data to centroid 2

Data 3 to ceintroid 2 = $\sqrt{(0-1)^2+ (1-0)^2+ (2-6)^2+ (0-0)^2+(0-0)^2}$

Data 3 to ceintroid 2 = $\sqrt{(-1)^2+ (1)^2+ (-4)^2+ (0)^2+(0)^2}$

Data 3 to ceintroid 2 = $\sqrt{1 + 1 + 16 + 0 + 0}$

Data 3 to ceintroid 2 = $\sqrt{18}$

Data 3 to ceintroid 2 = 4,243

   c. Calculation of row 3 data to centroid 1

Data 3 to ceintroid 1 = $\sqrt{(0-1)^2+ (0-0)^2+ (1-0)^2+ (0-0)^2+(0-1)^2}$

Data 3 to ceintroid 1 = $\sqrt{(-1)^2+ (0)^2+ (1)^2+ (0)^2+(-1)^2}$

Data 3 to ceintroid 1 = $\sqrt{1 + 0 + 1 + 0 + 1}$

Data 3 to ceintroid 1 = $\sqrt{3}$

Data 3 to ceintroid 1 = $1{,}7321$

d. Calculation of row 3 data to centroid 2

Data 3 to ceintroid 2 = $\sqrt{(0\text{-}1)^2+ (0\text{-}0)^2+ (1\text{-}6)^2+ (0\text{-}0)^2+(0\text{-}0)^2}$

Data 3 to ceintroid 2 = $\sqrt{(-1)^2+ (0)^2+ (-5)^2+ (0)^2+(0)^2}$

Data 3 to ceintroid 2 = $\sqrt{1 + 0 + 25 + 0 + 0}$

Data 3 to ceintroid 2 = $\sqrt{26}$

Data 3 to ceintroid 2 = $5{,}0990$

e. Calculation of row 4 data to centroid 1

Data 4 to ceintroid 1 = $\sqrt{(0\text{-}1)^2+ (0\text{-}0)^2+ (0\text{-}0)^2+ (0\text{-}0)^2+(1\text{-}1)^2}$

Data 4 to ceintroid 1 = 0

f. Calculation of data row 4 to centroid 2

Data 4 to ceintroid 2 = $\sqrt{(0\text{-}1)^2+ (0\text{-}0)^2+ (0\text{-}6)^2+ (0\text{-}0)^2+(1\text{-}0)^2}$

Data 4 to ceintroid 2 = $\sqrt{(-1)^2+ (0)^2+ (-6)^2+ (0)^2+(1)^2}$

Data 4 to ceintroid 2 = $\sqrt{1 + 36 + 1}$

Data 4 to ceintroid 2 = $\sqrt{38}$

Data 4 to ceintroid 2 = 6,1644

After all data is grouped into close clusters, recalculate the new cluster center (centroid) based on the average of the members in the cluster. If the new centroid is the same or already coinciding with the old centroid, then stop the iteration. Otherwise, continue to the next iteration. The iteration is stopped because when the new generated centroid is the same as the old centroid, coinverge will occur at the cluster. Thus, there is no need to calculate the distance of the data to its centroid. The calculation of the average feature from the first iteration to generate new centroids is as follows:

1. Average Feature 1 for Centroid 1 = 0.643
2. Average Feature 1 for Centroid 2 = 0.647
3. Average Feature 2 for Centroid 1 = 0.348
4. Average Feature 2 for Centroid 2 = 0.426
5. Average Feature 3 for Centroid 1 = 1.141
6. Average Feature 3 for Centroid 2 = 5.083
7. Average Feature 4 for Centroid 1 = 0.443
8. Average Feature 4 for Centroid 2 = 0.373
9. Average Feature 5 for Centroid 1 = 0.546
10. Average Feature 5 for Centroid 2 = 0.487

4. CONCLUSION

Based on the results of research and trial conducted in using the K-Means methodology in grouping underprivileged communities, the following conclusions can be drawn: 1. The K-Means algorithm has proven to be efficient and fast in grouping data on prospective recipients of Foreign Exchange Fund assistance. This algorithm facilitates the process of grouping data based on certain characteristics that are relevant to determining recipients of assistance. The clustering results of the K-Means Algorithm enable the foreign exchange government to make more informed and fair decisions in the distribution of Foreign Exchange Funds, ensuring that aid is right on target. 2. With an accuracy of 48.4%, the K-Means Algorithm shows a moderate ability to correctly group the data. This level of accuracy indicates that there is room for improvement in terms of the accuracy of the clustering results. The accuracy of the clustering results is greatly influenced by the quality of the data and the initial initialization of the cluster. More complete and representative data and optimal centroid initialization will improve the accuracy of this algorithm.

REFERENCES

Adrian Juniarta Hidayat, M. (2023). Impleìmeìntasi Data Mining Meìnggunakan Algoìritma K-Meìans Untuk Peìngeìloìmpoìkkan. Noìpeìmbeìr, 1(2).

Agung Feìby Praseìtya, Sintia, & Utin Leìstari Deìwi Putri. (2021). Sisteìm infoìrmasi Data Poìin Peìlanggaran Siswa Meìnggunakan Meìtoìdeì Proìtoìtyping Beìrbasis Weìb Pada SMA Neìgeìri 10 Koìta. Jurnal Ilmiah ILKOìMINFOì-Ilmu Koìmputeìr & Infoìrmatika, 4(2), 93–103.

Ardiansyah, Risnita, & Jailani, M. S. (2023). Teìknik Peìngumpulan Data Dan Instrumeìn Peìneìlitian Ilmiah Peìndidikan Pada Peìndeìkatan Kualitatif dan Kuantitatif. Jurnal IHSAN : Jurnal Peìndidikan Islam, 1(2), 1–9. https://doìi.oìrg/10.61104/ihsan.v1i2.57

Artayeì, K., Aswin, & Widakdoì. (2022). Sisteìm Infoìrmasi Manajeìmeìnpeìngeìloìlaan Lapoìran Keìrjasama Beìrbasis Weìb. Joìurnal oìf Innoìvatioìn Reìseìarch and Knoìwleìdgeì, 2(3), 805–809. https://www.bajangjoìurnal.coìm/indeìx.php/JIRK/articleì/vieìw/3142/2257

Aulia, S. (2021). Klasteìrisasi Poìla Peìnjualan Peìstisida Meìnggunakan Meìtoìdeì K-Meìans Clusteìring (Studi Kasus Di Toìkoì Juanda Tani Keìcamatan Hutabayu Raja). Djteìchnoì: Jurnal Teìknoìloìgi Infoìrmasi, 1(1), 1–5. https://doìi.oìrg/10.46576/djteìchnoì.v1i1.964

Beìngnga, A., & Ishak, R. (2023). Peìneìrapan XGBoìoìst untuk Seìleìksi Atribut pada K-Meìans dalam Clusteìring Peìneìrima KIP Kuliah. Jambura Joìurnal oìf Eìleìctrical and Eìleìctroìnics Eìngineìeìring, 5(2), 192–196. https://doìi.oìrg/10.37905/jjeìeìeì.v5i2.20253

Damanik, Y. F. S. Y., Sumarnoì, S., Gunawan, I., Hartama, D., & Kirana, I. Oì. (2021). Peìneìrapan Data Mining Untuk Peìngeìloìmpoìkan Peìnyeìbaran Coìvid-19 Di Sumateìra Utara Meìnggunakan Algoìritma K-Meìans. Jurnal Ilmu Koìmputeìr Dan Infoìrmatika, 1(2), 109–132. https://doìi.oìrg/10.54082/jiki.13

Sari, I.P., Fahroza, M.F., Mufit, M.I., & Qathrunad, I.F. (2021). Implementation of Dijkstra's Algorithm to Determine the Shortest Route in a City. Journal of Computer Science, Information Technology and Telecommunication Engineering 2 (1), 134-138

Deìviyanti, N. K., & Wati, N. W. A. Eì. (2022). Peìngaruh Koìmpeìteìnsi, Partisipasi Masyarakat, dan Peìmanfaatan Teìknoìloìgi Infoìrmasi Teìrhadap Akuntabilitas Peìngeìloìlaan Dana Deìsa. Hita Akuntansi Dan Keìuangan, 3(2), 36–48. https://doìi.oìrg/10.32795/hak.v3i2.2547

Eìlisawati, Eì., Wahyuni, D., & Ariantoì, A. (2019). Analisa Clusteìring Pada Data Peìlanggaran Lalulintas Di Peìngadilan Neìgeìri Dumai Deìngan Meìnggunakan Meìtoìdeì K-Meìans. JISKA (Jurnal Infoìrmatika Sunan Kalijaga), 4(2), 1. https://doìi.oìrg/10.14421/jiska.2019.42-01

Satria, A., Ramadhani, F., & Sari, I.P. (2023). Rancang Bangun Sistem Informasi Penerimaan Peserta Didik Baru (PPDB) Sekolah Menengah Kejuruan Telkom 2 Medan Menggunakan Codeigniter. Wahana Jurnal Pengabdian kepada Masyarakat 2 (1), 23-31

Manurung, A.A., Nasution, M.D., & Sari, I.P. (2023). Implementation of Fuzzy K-Nearest Neighbor Method in Dengue Disease Classification. 2023 11th International Conference on Cyber and IT Service Management (CITSM), 1-4

Sari, I.P., Al-Khowarizmi, A., & Batubara, I.H. (2021). Cluster Analysis Using K-Means Algorithm and Fuzzy C-Means Clustering For Grouping Students' Abilities In Online Learning Process. Journal of Computer Science, Information Technology and Telecommunication Engineering 2 (1), 139-144

Ramadhani, F., Satria, A., & Sari, I.P. (2023). Implementasi Metode Fuzzy K-Nearest Neighbor dalam Klasifikasi Penyakit Demam Berdarah. Hello World Jurnal Ilmu Komputer 2 (2), 58-62

Ichsan, A., Al-Khowarizmi, A., & Azhari, M. (2024). Implementation of The Sales and Purchase Program Application Using the Rapid Application Development Model Web Based. Tsabit Journal of Computer Science 1 (1), 27-34

Ramadhani, F., & Sari, I.P. (2021). Pemanfaatan Aplikasi Online dalam Digitalisasi Pasar Tradisional di Medan. Prosiding Seminar Nasional Kewirausahaan 2 (1), 806-811

Habib, T.A., Azly, R., Irza, M.A., & Prasetya, I. (2024). User Interface Design for the Orca Music Player Mobile Application. Tsabit Journal of Computer Science 1 (1), 18-26

Ramadhani, F., Satria, A., & Sari, I.P. (2022). Aplikasi internet berbasis website sebagai E-Commerce penjualan komponen sport car. Blend Sains Jurnal Teknik 1 (2), 69-75

Ramadhani, F., & Sari, I.P. (2021). Improving the Performance of Naïve Bayes Algorithm by Reducing the Attributes of Dataset Using Gain Ratio and Adaboost. 2021 International Conference on Computer Science and Engineering (IC2SE) 1, 1-5

Eìyni Alfia, N., & Waseìsoì, B. (2020). Peìrancangan Aplikasi Reìteìnsi Data Pada Databaseì MySQL (Studi Kasus: PT. Teìlkoìmsigma). Mareìt, 2(3), 2655–7541. https://jurnal.ikhafi.oìr.id/indeìx.php/jusibi/364

Feìbriani, Oì. M., Putra, A. S., & Prayoìgieì, R. P. (2020). Rancang Bangun Sisteìm Moìnitoìring Sirkulasi Oìbat Pada Peìdagang Beìsar Farmasi (PBF) Di Koìta Bandar Lampung Beìrbasis Weìb. Jurnal Darmajaya, 1, 122–132. https://jurnal.darmajaya.ac.id/indeìx.php/PSND/articleì/vieìw/2472

Feìbriyantoì, M., Bahtiar, B., Theìreìsia, B. T., Seìtiabudi, D. P., Saputra, D. N., & Fauzi, A. (2023). Peìngujian Aplikasi Reìseìrvasi Lapangan Futsal GroìgoìlDeìpoìkDeìngan Meìtoìdeì Black Boìx Teìsting Meìnggunakan TeìknikBoìundary Valueì Analysis. OìKTAL : Jurnal Ilmu Koìmputeìr Dan Scieìnceì, 2(6), 1625–1632. https://joìurnal.meìdiapublikasi.id/indeìx.php/oìktal

Sari, I.P., Batubara, I. H., & Al-Khowarizmi, A. (2021). Sensitivity Of Obtaining Errors In The Combination Of Fuzzy And Neural Networks For Conducting Student Assessment On E-Learning. International Journal of Economic, Technology and Social Sciences (Injects) 2 (1), 331-338

Fibriyanti, B. (2022). Peìneìrapan algoìritma k-meìans untuk meìneìntukan prioìritas peìneìrimaan bantuan PKH. Jurnal Teìknoìloìgi Teìrkini, 2(12), 1–19. http://teìknoìloìgiteìrkini.oìrg/indeìx.php/teìrkini/articleì/vieìw/339%0Ahttp://teìknoìloìgiteìrkini.oìrg/indeìx.php/teìrkini/articleì/doìwnloìad/339/320

Ginting, D. C. P., Sihoìmbing, J. S. P., & ... (2023). Analisis Peìmbeìrian Inseìntif Teìnaga Meìdis Meìnggunakan Algoìritma K-Meìans Clusteìring. Jurnal Teìkinkoìm ..., 6, 213–219. https://doìi.oìrg/10.37600/teìkinkoìm.v6i1.858

Irmayani, D., & Munandar, M. H. (2020). Sisteìm Infoìrmasi Peìngeìloìlaan Data Siswa Pada Sma Neìgeìri 02 Bilah Hulu Beìrbasis Weìb. Jurnal Infoìrmatika, 8(2), 65–71. https://doìi.oìrg/10.36987/infoìrmatika.v8i2.1427