

Seleksi Magang Merdeka

Decision Support System (DSS)

Implementasi AHP dalam Pengambilan Keputusan Prioritas Pasien ICU



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Introduction

Kasus meninggalnya seorang pasien di RSUD Ternate karena terlambat dipindahkan ke ICU menyoroti pentingnya pengambilan keputusan yang tepat dalam prioritas pasien. Proyek ini mengimplementasikan metode **AHP** untuk meningkatkan akurasi dan efisiensi dalam menentukan prioritas pasien ICU, guna mencegah kejadian serupa dan meningkatkan kualitas pelayanan kesehatan.

Sumber Berita : indotimur.com

Pasien Meninggal, Keluarga Protes Pelayanan RSUD Chasan Boesorie Ternate

Pihak Rumah Sakit Klaim, Pelayanan Sudah Sesuai SOP

29 April 2023



Heri Pulhaupessy (anak pasien)

TERNATE, OT – Meninggalnya satu pasien di Rumah Sakit Umum Daerah (RSUD) Ternate, Maluku Utara (Malut) menjadi polemik.

Healthcare Dataset

Dummy data with Multi Category Classification Problem



kaggle

Data Card Code (54) Discussion (7) Suggestions (0)

About Dataset

Usability ⓘ

10.00

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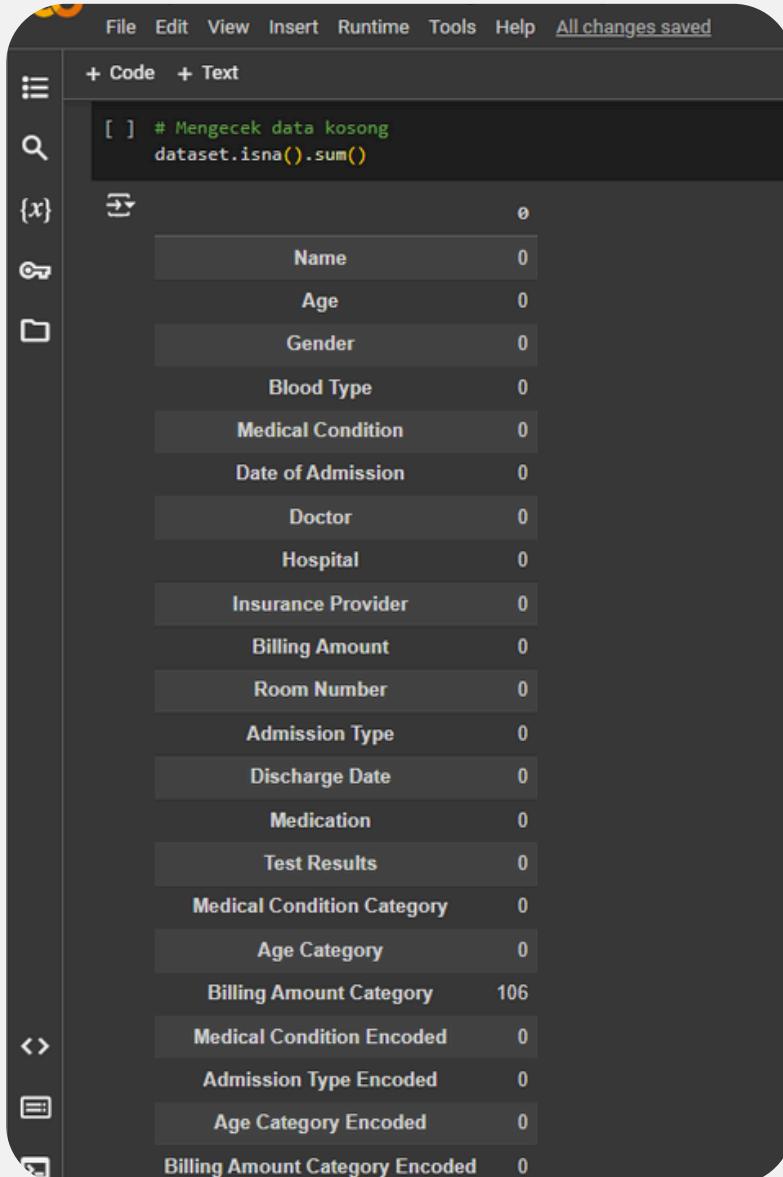
Expected update frequency

Dataset

| | Name | Age | Gender | Blood Type | Medical Condition | Date of Admission | Doctor | Hospital | Insurance Provider | Billing Amount | Room Number | Admission Type | Discharge Date | Medication | Test Results |
|-------|-------------------|-----|--------|------------|-------------------|-------------------|------------------|------------------------------|--------------------|----------------|-------------|----------------|----------------|-------------|--------------|
| 0 | Bobby JacksOn | 30 | Male | B- | Cancer | 2024-01-31 | Matthew Smith | Sons and Miller | Blue Cross | 18856.281306 | 328 | Urgent | 2024-02-02 | Paracetamol | Normal |
| 1 | LesLie TErRy | 62 | Male | A+ | Obesity | 2019-08-20 | Samantha Davies | Kim Inc | Medicare | 33643.327287 | 265 | Emergency | 2019-08-26 | Ibuprofen | Inconclusive |
| 2 | DaNnY sMitH | 76 | Female | A- | Obesity | 2022-09-22 | Tiffany Mitchell | Cook PLC | Aetna | 27955.096079 | 205 | Emergency | 2022-10-07 | Aspirin | Normal |
| 3 | andrEw waTtS | 28 | Female | O+ | Diabetes | 2020-11-18 | Kevin Wells | Hernandez Rogers and Vang, | Medicare | 37909.782410 | 450 | Elective | 2020-12-18 | Ibuprofen | Abnormal |
| 4 | adRIENNE bEll | 43 | Female | AB+ | Cancer | 2022-09-19 | Kathleen Hanna | White-White | Aetna | 14238.317814 | 458 | Urgent | 2022-10-09 | Penicillin | Abnormal |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 55495 | eLIZABeTH jaCkSoN | 42 | Female | O+ | Asthma | 2020-08-16 | Joshua Jarvis | Jones-Thompson | Blue Cross | 2650.714952 | 417 | Elective | 2020-09-15 | Penicillin | Abnormal |
| 55496 | KYle pEREz | 61 | Female | AB- | Obesity | 2020-01-23 | Taylor Sullivan | Tucker-Moyer | Cigna | 31457.797307 | 316 | Elective | 2020-02-01 | Aspirin | Normal |
| 55497 | HEAther WaNG | 38 | Female | B+ | Hypertension | 2020-07-13 | Joe Jacobs DVM | and Mahoney Johnson Vasquez, | UnitedHealthcare | 27620.764717 | 347 | Urgent | 2020-08-10 | Ibuprofen | Abnormal |
| 55498 | JENNiFER JOneS | 43 | Male | O- | Arthritis | 2019-05-25 | Kimberly Curry | Jackson Todd and Castro, | Medicare | 32451.092358 | 321 | Elective | 2019-05-31 | Ibuprofen | Abnormal |
| 55499 | jAMES GARCiA | 53 | Female | O+ | Arthritis | 2024-04-02 | Dennis Warren | Henry Sons and | Aetna | 4010.134172 | 448 | Urgent | 2024-04-29 | Ibuprofen | Abnormal |

55500 rows × 15 columns

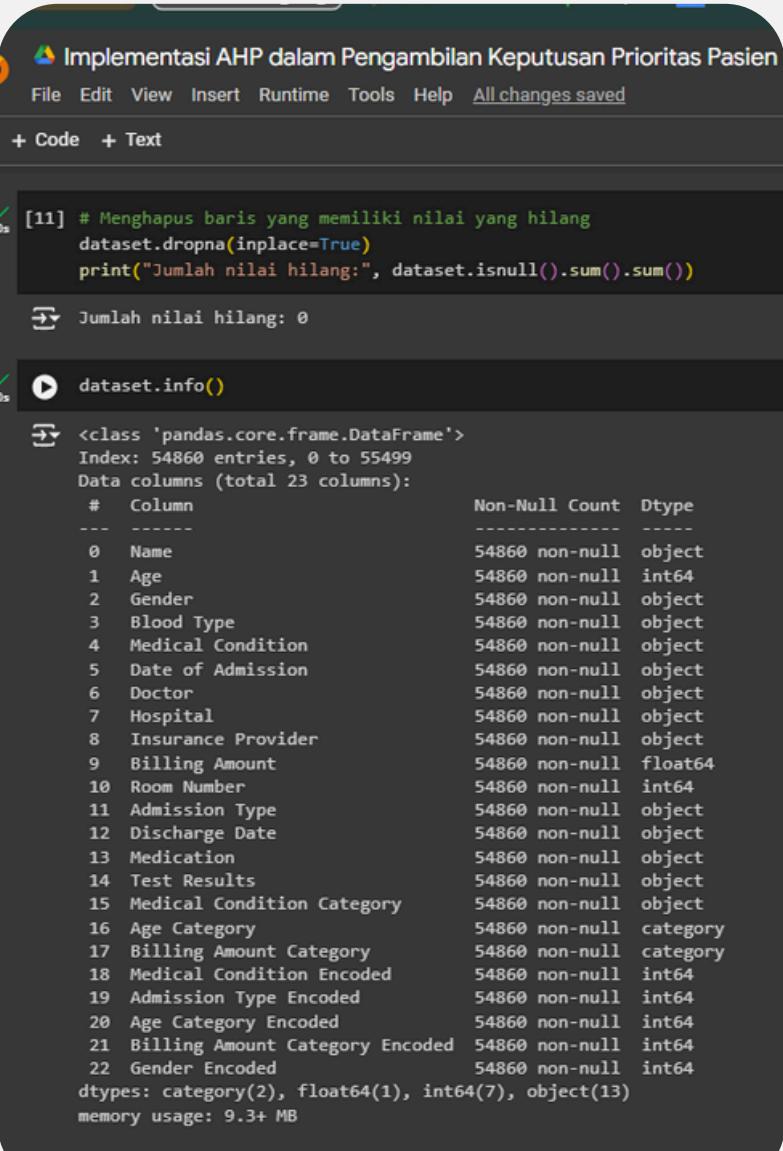
Data Collection & Preprocessing



```
[ ] # Mengecek data kosong  
dataset.isna().sum()
```

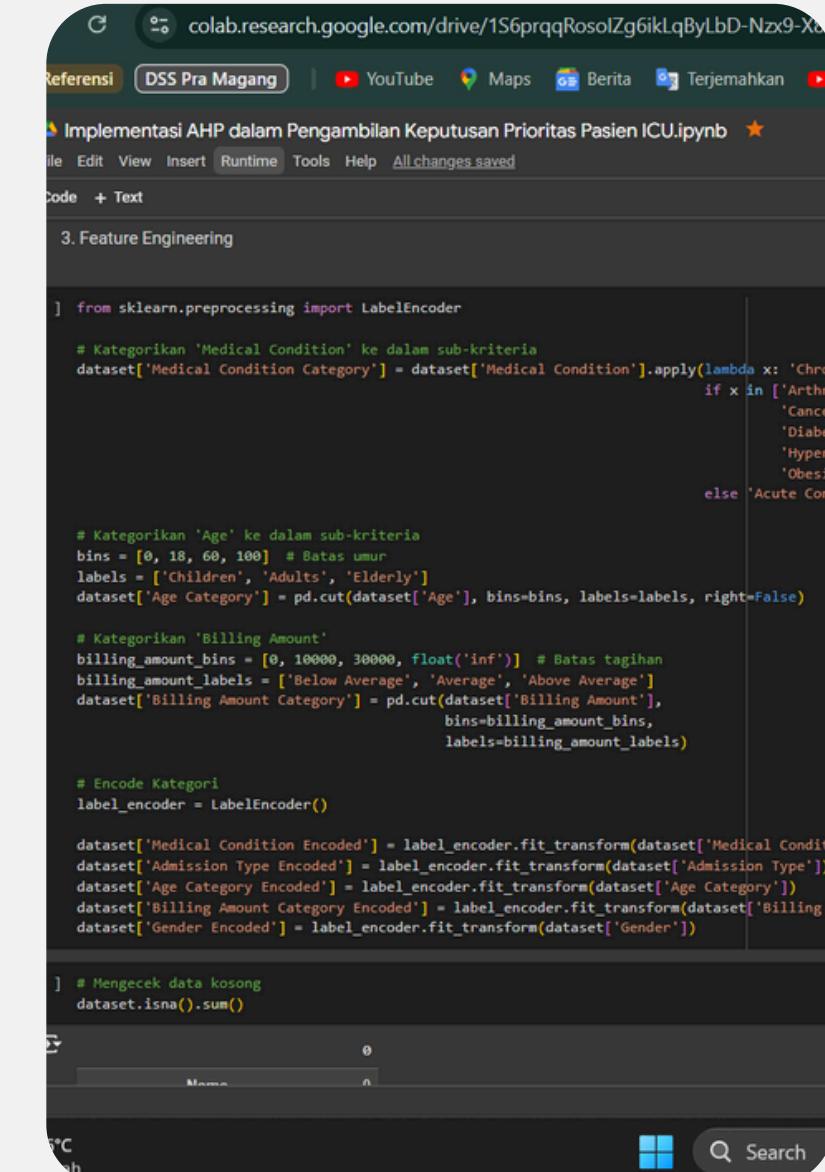
| | Count |
|---------------------------------|-------|
| Name | 0 |
| Age | 0 |
| Gender | 0 |
| Blood Type | 0 |
| Medical Condition | 0 |
| Date of Admission | 0 |
| Doctor | 0 |
| Hospital | 0 |
| Insurance Provider | 0 |
| Billing Amount | 0 |
| Room Number | 0 |
| Admission Type | 0 |
| Discharge Date | 0 |
| Medication | 0 |
| Test Results | 0 |
| Medical Condition Category | 0 |
| Age Category | 0 |
| Billing Amount Category | 106 |
| Medical Condition Encoded | 0 |
| Admission Type Encoded | 0 |
| Age Category Encoded | 0 |
| Billing Amount Category Encoded | 0 |

Pemeriksaan Data



```
[11] # Menghapus baris yang memiliki nilai yang hilang  
dataset.dropna(inplace=True)  
print("Jumlah nilai hilang:", dataset.isnull().sum().sum())  
  
Jumlah nilai hilang: 0  
  
dataset.info()  
  
<class 'pandas.core.frame.DataFrame'>  
Index: 54860 entries, 0 to 55499  
Data columns (total 23 columns):  
 # Column Non-Null Count Dtype  
---  
 0 Name 54860 non-null object  
 1 Age 54860 non-null int64  
 2 Gender 54860 non-null object  
 3 Blood Type 54860 non-null object  
 4 Medical Condition 54860 non-null object  
 5 Date of Admission 54860 non-null object  
 6 Doctor 54860 non-null object  
 7 Hospital 54860 non-null object  
 8 Insurance Provider 54860 non-null object  
 9 Billing Amount 54860 non-null float64  
 10 Room Number 54860 non-null int64  
 11 Admission Type 54860 non-null object  
 12 Discharge Date 54860 non-null object  
 13 Medication 54860 non-null object  
 14 Test Results 54860 non-null object  
 15 Medical Condition Category 54860 non-null object  
 16 Age Category 54860 non-null category  
 17 Billing Amount Category 54860 non-null category  
 18 Medical Condition Encoded 54860 non-null int64  
 19 Admission Type Encoded 54860 non-null int64  
 20 Age Category Encoded 54860 non-null int64  
 21 Billing Amount Category Encoded 54860 non-null int64  
 22 Gender Encoded 54860 non-null int64  
  
dtypes: category(2), float64(1), int64(7), object(13)  
memory usage: 9.3+ MB
```

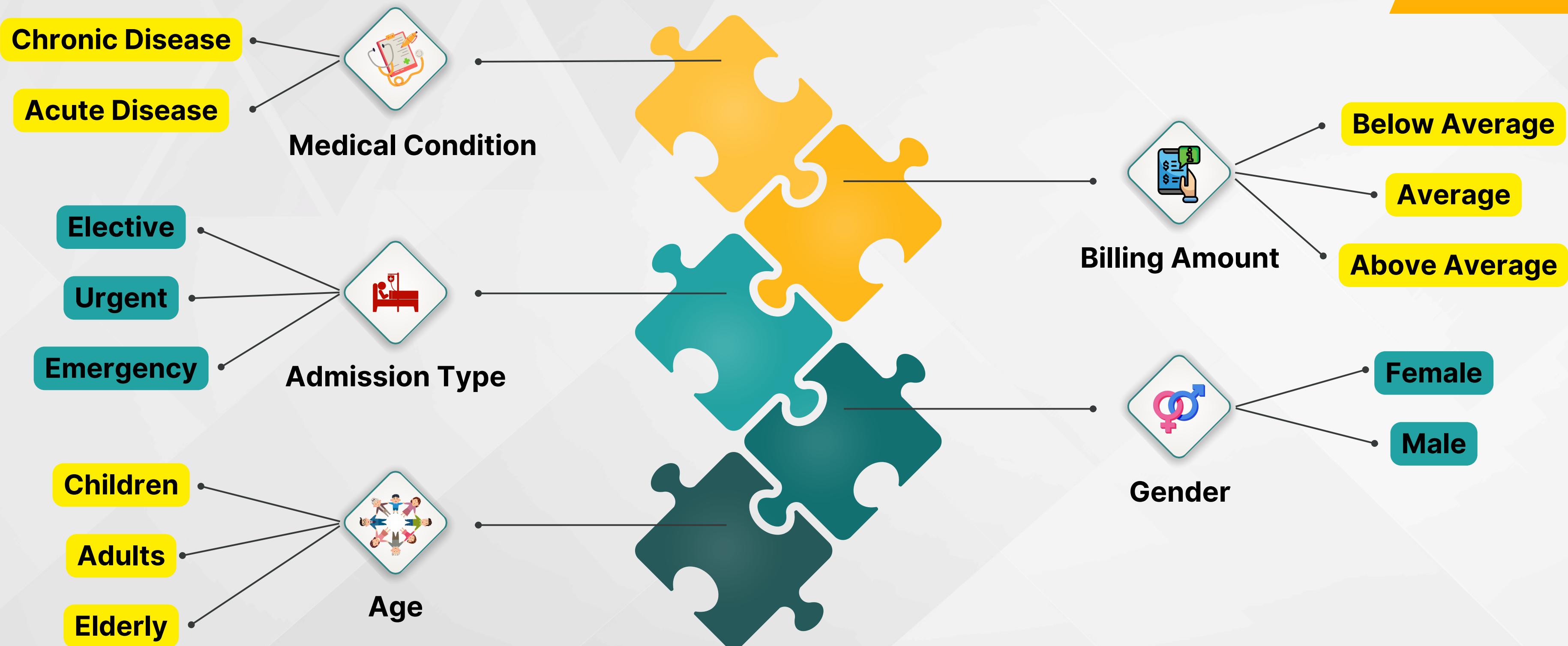
Penanganan Data



```
3. Feature Engineering  
  
from sklearn.preprocessing import LabelEncoder  
  
# Kategorikan 'Medical Condition' ke dalam sub-kriteria  
dataset['Medical Condition Category'] = dataset['Medical Condition'].apply(lambda x: 'Chronic' if x in ['Arthritis', 'Cancer', 'Diabetes', 'Hypertension', 'Obesity'] else 'Acute Condition')  
  
# Kategorikan 'Age' ke dalam sub-kriteria  
bins = [0, 18, 60, 100] # Batas umur  
labels = ['Children', 'Adults', 'Elderly']  
dataset['Age Category'] = pd.cut(dataset['Age'], bins=bins, labels=labels, right=False)  
  
# Kategorikan 'Billing Amount'  
billing_amount_bins = [0, 10000, 30000, float('inf')] # Batas tagihan  
billing_amount_labels = ['Below Average', 'Average', 'Above Average']  
dataset['Billing Amount Category'] = pd.cut(dataset['Billing Amount'], bins=billing_amount_bins, labels=billing_amount_labels)  
  
# Encode Kategori  
label_encoder = LabelEncoder()  
  
dataset['Medical Condition Encoded'] = label_encoder.fit_transform(dataset['Medical Condition'])  
dataset['Admission Type Encoded'] = label_encoder.fit_transform(dataset['Admission Type'])  
dataset['Age Category Encoded'] = label_encoder.fit_transform(dataset['Age Category'])  
dataset['Billing Amount Category Encoded'] = label_encoder.fit_transform(dataset['Billing Amount Category'])  
dataset['Gender Encoded'] = label_encoder.fit_transform(dataset['Gender'])  
  
# Mengecek data kosong  
dataset.isna().sum()
```

Feature Engineering

Kriteria dan Sub Kriteria





Informasi Data Sub Kriteria

| Chronic Disease | Acute Disease | Children | Adults | Elderly | Below Average | Average | Above Average | Elective | 18437 |
|--|---------------|----------|--------|---------|---------------|---------------|---------------|-----------|-------|
| Arthritis, Cancer, Diabetes, Hypertension, Obesity | Asthma | 0-17 | 18-59 | 60-100 | 0 - 9999 | 10000 - 29999 | >30000 | Urgent | 18353 |
| 45783 | 9077 | 116 | 338136 | 20908 | 116 | 338136 | 20908 | Emergency | 18070 |



Analytical Hierarchy Process (AHP)

Metode untuk memecahkan suatu situasi yang komplek tidak terstruktur kedalam beberapa komponen dalam susunan yang hirarki, dengan memberi nilai subjektif tentang pentingnya setiap variabel secara relatif, dan menetapkan variabel mana yang memiliki prioritas paling tinggi guna mempengaruhi hasil pada situasi tersebut.

Membuat Matriks Perbandingan

Perhitungan Nilai Inconsistency

Menghitung Bobot Kriteria & Sub Kriteria

Evaluasi Nilai Alternatif



Matriks Perbandingan & Normalisasi Kriteria

Gender | Admission Type | Medical Condition | Age | Billing Amount

Matriks Perbandingan Kriteria Berpasangan:

```
[[1.          1.          0.5          0.33333333 0.25      ],
 [1.          1.          2.          0.5          0.33333333],
 [2.          0.5          1.          0.33333333 0.25      ],
 [3.          2.          3.          1.          0.2          ],
 [4.          3.          4.          5.          1.          ]]
```

Matriks Normalisasi:

```
[[0.09090909 0.13333333 0.04761905 0.04651163 0.12295082],
 [0.09090909 0.13333333 0.19047619 0.06976744 0.16393443],
 [0.18181818 0.06666667 0.0952381 0.04651163 0.12295082],
 [0.27272727 0.26666667 0.28571429 0.13953488 0.09836066],
 [0.36363636 0.4          0.38095238 0.69767442 0.49180328]]
```

Billing Amount > Age > Medical Condition > Admission Type = Gender

Setiap elemen matriks normalisasi diperoleh dengan membagi elemen yang bersangkutan dari matriks perbandingan dengan total kolomnya.



Matriks Perbandingan & Normalisasi Sub Kriteria

• Medical Condition

| | Chronic Disease | Acute Condition |
|-----------------|-----------------|-----------------|
| Chronic Disease | 1.0 | 2.0 |
| Acute Condition | 0.5 | 1.0 |

Matriks Normalisasi Sub-Kriteria Medical Condition:
[[0.66666667 0.66666667]
 [0.33333333 0.33333333]]

• Admission Type

| | Elective | Urgent | Emergency |
|-----------|----------|--------|-----------|
| Elective | 1.0 | 0.5 | 0.333333 |
| Urgent | 2.0 | 1.0 | 0.500000 |
| Emergency | 3.0 | 2.0 | 1.000000 |

Matriks Normalisasi Sub-Kriteria Admission Type:
[[0.16666667 0.14285714 0.18181818]
 [0.33333333 0.28571429 0.27272727]
 [0.5 0.57142857 0.54545455]]

• Age

| | Adults | Elderly | Children |
|----------|--------|---------|----------|
| Adults | 1.0 | 2.0 | 10.0 |
| Elderly | 0.5 | 1.0 | 5.0 |
| Children | 0.1 | 0.2 | 1.0 |

Matriks Normalisasi Sub-Kriteria Age:
[[0.625 0.625 0.625]
 [0.3125 0.3125 0.3125]
 [0.0625 0.0625 0.0625]]



Matriks Perbandingan & Normalisasi Sub Kriteria

- Billing Amount

| | Above Average | Average | Below Average |
|---------------|---------------|----------|---------------|
| Above Average | 1.0 | 2.000000 | 5.0 |
| Average | 0.5 | 1.000000 | 3.0 |
| Below Average | 0.2 | 0.333333 | 1.0 |

```
Matriks Normalisasi Sub-Kriteria Billing Amount:  
[[0.58823529 0.6 0.55555556]  
 [0.29411765 0.3 0.33333333]  
 [0.11764706 0.1 0.11111111]]
```

- Gender

| | Female | Male |
|--------|--------|------|
| Female | 1.0 | 1.0 |
| Male | 1.0 | 1.0 |

```
Matriks Normalisasi Sub-Kriteria Gender:  
[[[0.5 0.5]  
 [0.5 0.5]]]
```



Menghitung Bobot

| | Kriteria | Bobot | Sub Kriteria | Bobot | Sub Kriteria | Nilai Kali |
|----|-------------------|--------|-----------------|----------|--------------|------------|
| 0 | Gender | 0.0883 | Female | 0.500000 | 0.044150 | |
| 1 | Gender | 0.0883 | Male | 0.500000 | 0.044150 | |
| 2 | Admission Type | 0.1297 | Elective | 0.163781 | 0.021242 | |
| 3 | Admission Type | 0.1297 | Urgent | 0.297258 | 0.038554 | |
| 4 | Admission Type | 0.1297 | Emergency | 0.538961 | 0.069903 | |
| 5 | Medical Condition | 0.1026 | Chronic Disease | 0.666667 | 0.068400 | |
| 6 | Medical Condition | 0.1026 | Acute Condition | 0.333333 | 0.034200 | |
| 7 | Age | 0.2126 | Adults | 0.625000 | 0.132875 | |
| 8 | Age | 0.2126 | Elderly | 0.312500 | 0.066438 | |
| 9 | Age | 0.2126 | Children | 0.062500 | 0.013288 | |
| 10 | Billing Amount | 0.4668 | Above Average | 0.581264 | 0.271334 | |
| 11 | Billing Amount | 0.4668 | Average | 0.309150 | 0.144311 | |
| 12 | Billing Amount | 0.4668 | Below Average | 0.109586 | 0.051155 | |



Random Consistency Index

| Ukuran Matriks (n) | Indeks Konsistensi Acak (RCI) | Ukuran Matriks (n) | Indeks Konsistensi Acak (RCI) |
|--------------------|-------------------------------|--------------------|-------------------------------|
| 1 | 0.00 | 9 | 1.45 |
| 2 | 0.00 | 10 | 1.49 |
| 3 | 0.58 | 11 | 1.51 |
| 4 | 0.90 | 12 | 1.48 |
| 5 | 1.12 | 13 | 1.56 |
| 6 | 1.24 | 14 | 1.57 |
| 7 | 1.32 | 15 | 1.59 |
| 8 | 1.41 | | |



Nilai Incosistency (Consistency Ratio)

| | CR | Hasil |
|-----------------------------------|--------|-----------|
| Kriteria | 0.0856 | KONSISTEN |
| Sub Kriteria Medical Condition | 0 | KONSISTEN |
| Sub Kriteria Admission Type | 0.0079 | KONSISTEN |

| | CR | Hasil |
|--------------------------------|--------|-----------|
| Sub Kriteria Age | 0 | KONSISTEN |
| Sub Kriteria Billing Amount | 0.0032 | KONSISTEN |
| Gender | 0 | KONSISTEN |

Maximum Eigenvalue Admission Type: 3.0092

CI = Max Eigenvalue - n / (n-1)

CI = $3.0092 - 3 / 2 = 0.0046$

CI = 0.0046

CR = CI / RCI

RCI = Index (n) = index (3) = 0.58

CR = $0.0046 / 0.58$

CR = 0.0079



Evaluasi Alternatif

| | Name | Gender | Admission Type | Medical Condition Category | Age Category | Billing Amount Category | Gender Score | Admission Score | Medical Score | Age Score | Billing Score | ICU Priority Score | ICU Priority Category |
|---|---------------|--------|----------------|----------------------------|--------------|-------------------------|--------------|-----------------|---------------|-----------|---------------|--------------------|-----------------------|
| 0 | Bobby JacksOn | Male | Urgent | Chronic Disease | Adults | Average | 0.04415 | 0.038554 | 0.0684 | 0.132875 | 0.144311 | 0.428291 | Prioritas |

1. Gender Score

- Bobot Gender = 0.0883
- Bobot Subkriteria Male = 0.5
- Skor Gender = $0.0883 \times 0.5 = \mathbf{0.04415}$

4. Age Score

- Bobot Age = 0.2126
- Bobot Subkriteria Adults = 0.625
- Skor Age = $0.2126 \times 0.625 = \mathbf{0.132875}$

2. Admission Type Score

- Bobot Admission Type = 0.1297
- Bobot Subkriteria Urgent = 0.297258
- Skor Admission Type = $0.1297 \times 0.297258 = \mathbf{0.038554}$

5. Billing Amount Score

- Bobot Billing Amount = 0.4668
- Bobot Subkriteria Average = 0.309150
- Skor Billing Amount = $0.4668 \times 0.309150 = \mathbf{0.144311}$

3. Medical Condition Score

- Bobot Medical Condition = 0.1026
- Bobot Subkriteria Chronic Disease = 0.666667
- Skor Medical Condition = $0.1026 \times 0.666667 = \mathbf{0.0684}$

6. Total Skor ICU Priority untuk Bobby JacksOn

- Total Skor ICU = $0.04415 + 0.038554 + 0.0684 + 0.132875 + 0.144311$

Total Skor ICU = **0.428291**



Evaluasi Alternatif

| | Name | Gender | Admission Type | Medical Condition Category | Age Category | Billing Amount Category | Gender Score | Admission Score | Medical Score | Age Score | Billing Score | ICU Priority Score | ICU Priority Category |
|---|---------------|--------|----------------|----------------------------|--------------|-------------------------|--------------|-----------------|---------------|-----------|---------------|--------------------|-----------------------|
| 0 | Bobby JacksOn | Male | Urgent | Chronic Disease | Adults | Average | 0.04415 | 0.038554 | 0.0684 | 0.132875 | 0.144311 | 0.428291 | Prioritas |

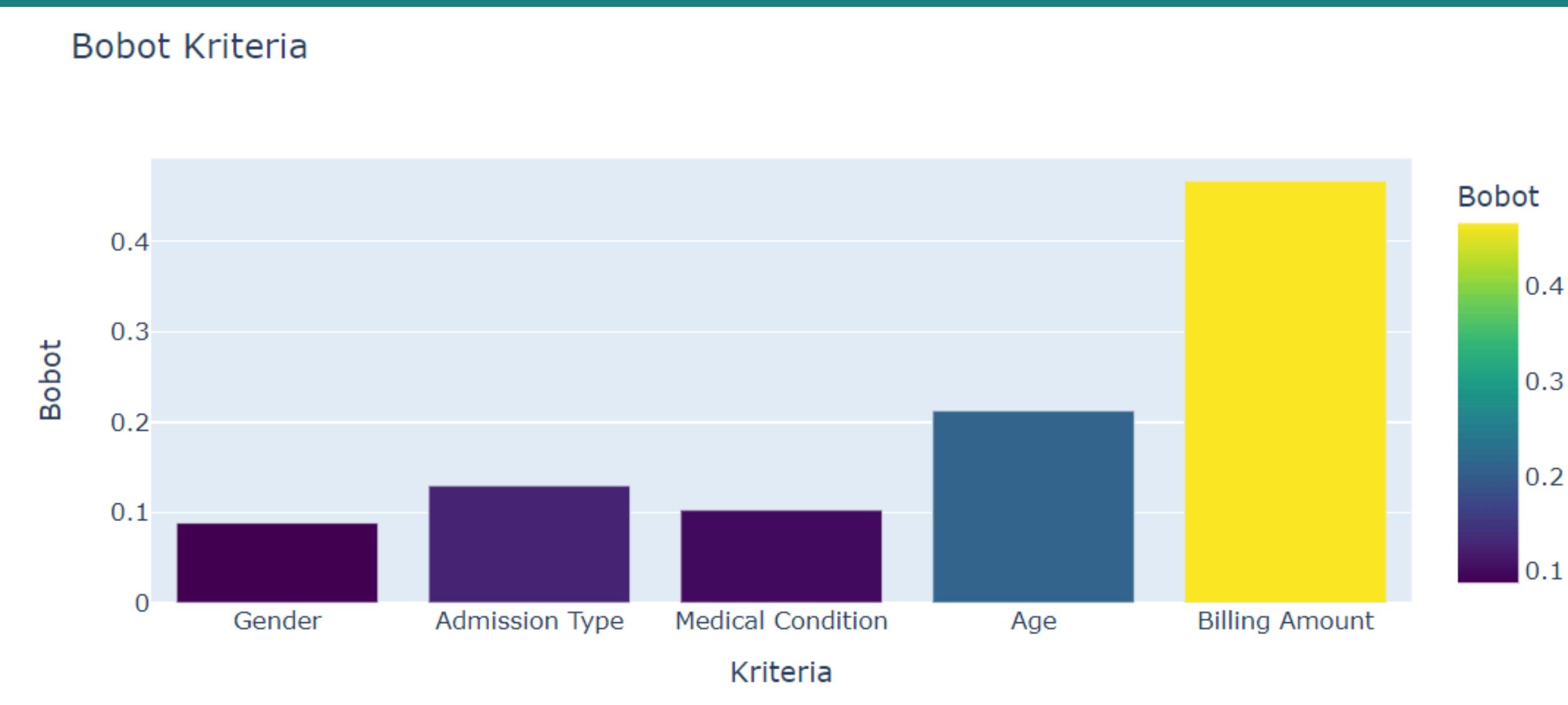
Total Skor ICU = **0.428291**

Rentang Nilai **Tidak Prioritas**: Skor < **0.3009340732**

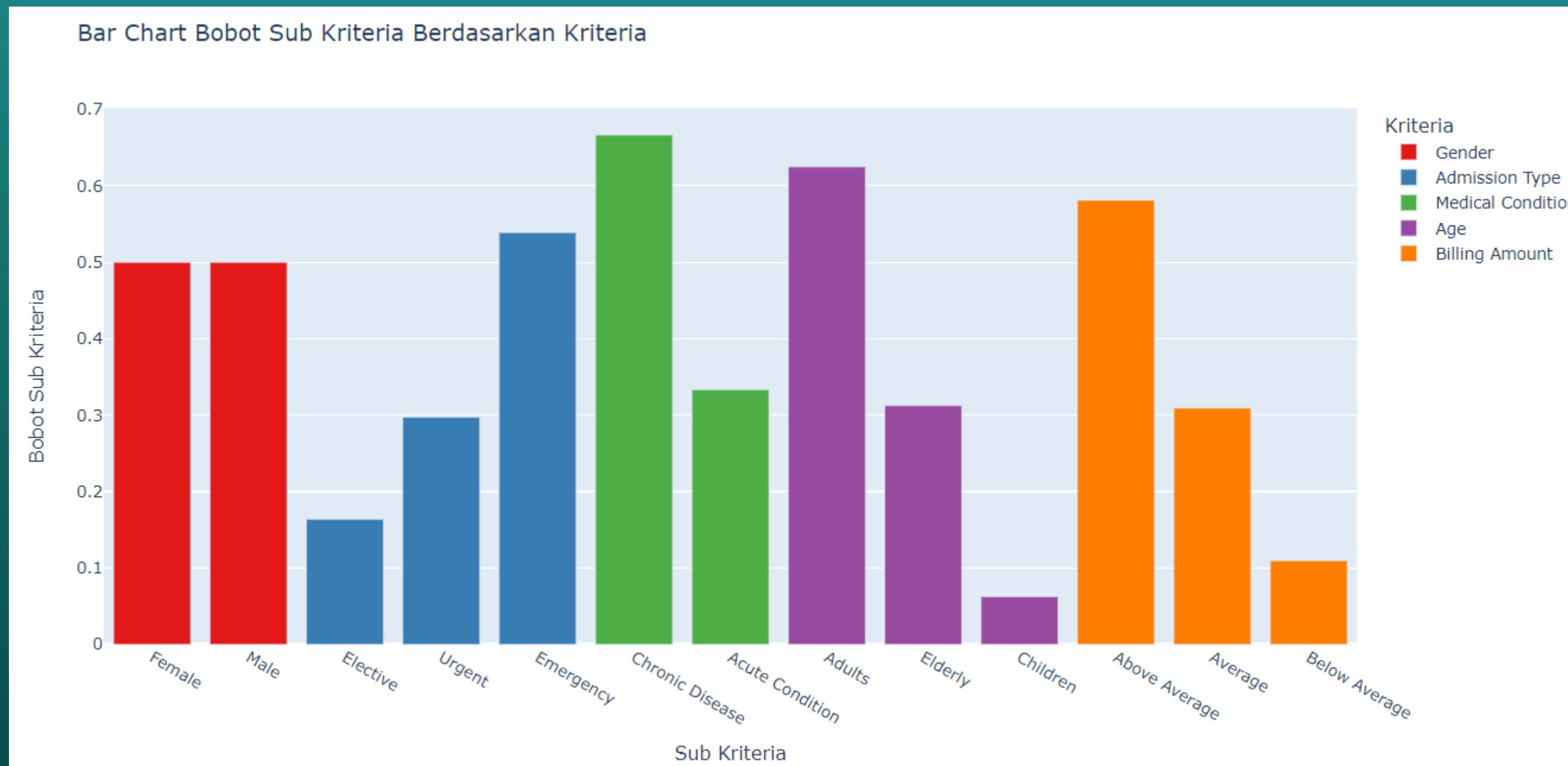
Rentang Nilai **Prioritas**: **0.3009340732** ≤ Skor < **0.4373638967**

Rentang Nilai **Sangat Prioritas**: Skor ≥ **0.4373638967**

Visualisasi Bobot Kriteria



Visualisasi Bobot Sub Prioritas



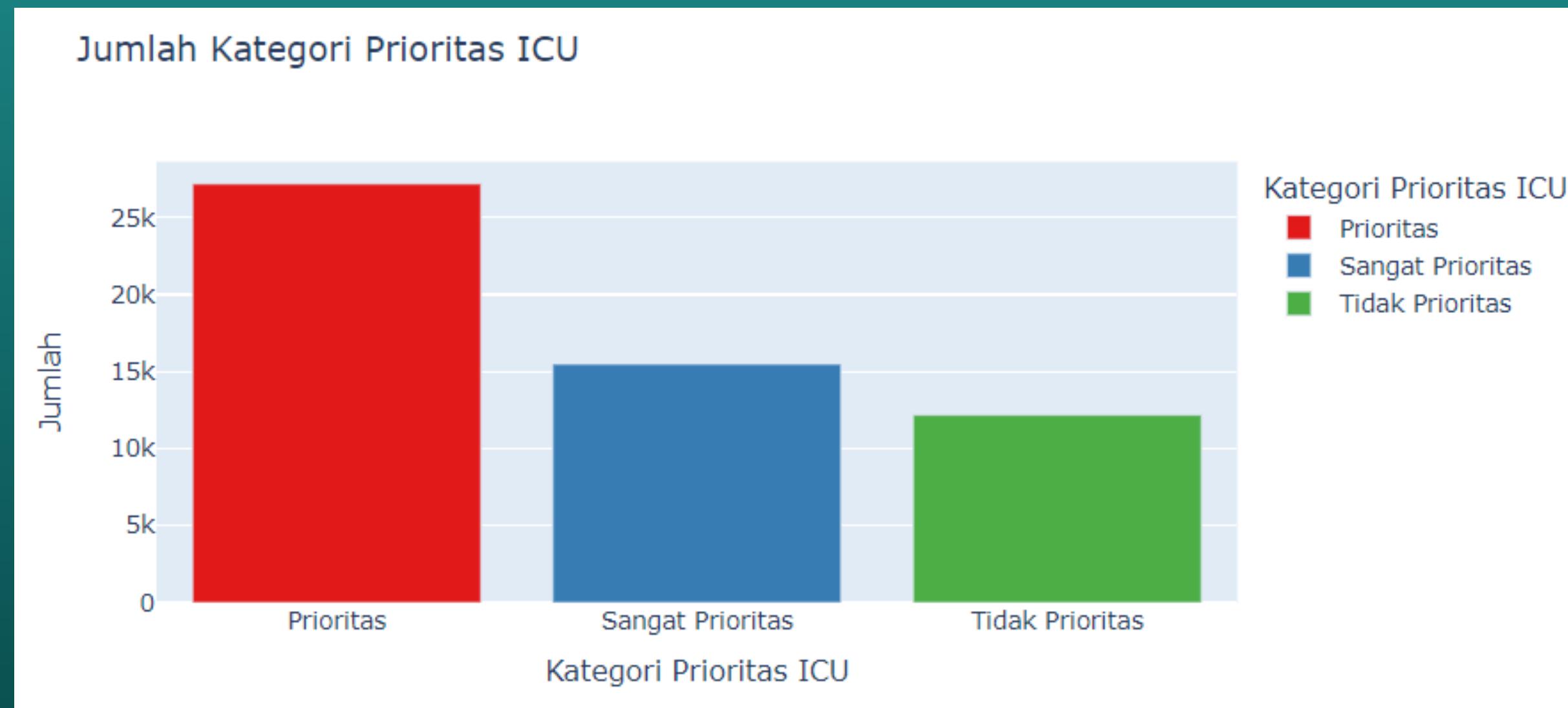
Visualisasi

Treemap Bobot Sub Kriteria Berdasarkan Kriteria



Visualisasi

Jumlah Kategori Prioritas ICU



Kesimpulan

Proyek ini telah berhasil mengimplementasikan metode Analytical Hierarchy Process (AHP) sebagai bagian dari sistem pendukung keputusan (DSS) untuk menentukan prioritas perawatan pasien ICU dengan mengintegrasikan berbagai kriteria klinis secara sistematis. Hasil perhitungan menunjukkan bahwa AHP efektif dalam memberi bobot dan mengategorikan pasien berdasarkan tingkat urgensinya menjadi "Sangat Prioritas", "Prioritas", dan "Tidak Prioritas", menyediakan alat bantu pengambilan keputusan yang transparan dan dapat dipertanggungjawabkan serta mendukung alokasi sumber daya medis yang efisien di rumah sakit. Implementasi teknologi Python memastikan bahwa model ini dapat direplikasi dan diintegrasikan ke dalam sistem manajemen yang ada.