**PENINGKATAN PERFORMA MODEL PREDIKSI TITIK PANAS MENGGUNAKAN ALGORITMA ENSEMBEL LEARNING**

**LAPORAN BOPTN UIN JAKARTA 2024**

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**Disusun Oleh**

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| **Husni Teja Sukmana, S.T., M.Sc., Ph.D.** | **:** | **Ketua** |
| **Saepul Aripiyanto, S.Kom., M.Kom.** | **:** | **Anggota** |
| **Aryajaya Alamsyah, S.Kom., M.Kom., MTA.** | **:** | **Anggota** |

**PROGRAM STUDI TEKNIK INFORMATIKA**

**FAKULTAS SAINS DAN TEKNOLOGI**

**UNIVERSITAS ISLAM NEGERI SYARIF HIDAYATULLAH JAKARTA**

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**BAB I   
PENDAHULUAN**

* 1. **Latar Belakang**

Kebakaran hutan dan lahan (karhutla) adalah peristiwa kebakaran, baik alami maupun oleh perbuatan manusia yang ditandai dengan api membakar semua bahan bakar secara bebas dan tidak terkendali pada area hutan dan lahan (Adinugroho *et al*. 2005; Syaufina 2008). Di Indonesia, karhutla merupakan salah satu bencana nasional karena

* 1. **Rumusan Masalah**
  2. **Batasan Masalah**
  3. **Tujuan Penelitian**
  4. **Manfaat Penelitian**
  5. **Sistematika Penulisan**

**BAB II  
LANDASAN TEORI**

**2.1 Titik Panas**

**2.2 Cuaca dan Iklim**

**2.3 El Niño–Southern Oscillation**

**2.4 Analisa Deret Waktu**

**2.5 Neural Network**

**2.5.1 Artificial Neural Network**

**2.5.2 Recurrent Neural Network**

**2.5.3 Long Short-Term Memory**

**2.5.4 Gated Recurrent Unit**

**2.6 Ensemble Learning**

**2.7 XGBoost**

**2.8 Hyperparameter Tuning**

**2.8.1 GridSearchCV**

**2.8.2 Random Search**

**2.9 Studi Literatur**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Peneliti** | **Rentang waktu** | **Faktor Iklim** | **Faktor ENSO** | **Algoritma** | **Parameters Tuning** |
| Robby *et al*. (2014) | 2001 – 2014 | x | x | ERNN SARIMA | x |
| Alkaff dan Yulianto (2019) | 2016 – 2018 | x | x | SARIMA | x |
| Slavia *et al*. (2019) | 2016 – 2019 | x | x | ARIMA | x |
| Anshori *et al*. (2019) | 2000 – 2003 | Suhu udara  Kelembaban udara  Kecepatan angin  Curah hujan | x | ELM  SVR  RF  LR | x |
| Liang *et al*. (2019) | 1990 – 2018 | Suhu udara  Curah hujan  Kecepatan angin  Arah angin  Ketebalan salju | x | BPNN  Vanila RNN  LSTM-RNN | x |
| Khaira *et al*. (2020) | 2002 – 2019 | x | x | LSTM-RNN | x |
| Natekar *et al*. (2021) | 2018 – 2019 | Radiasi matahari  Suhu udara  Kelembaban udara  Kecepatan angin  Curah hujan | x | LSTM-RNN | x |
| Mohan *et al*. (2021) | 1990 – 2018 | x | x | BPNN  Vanila RNN  LSTM-RNN | x |
| Yandi *et al*. (2022) | 2019 – 2021 | Suhu udara  Kelembaban udara | x | SVM | x |
| Dong *et al*. (2022) | 2000 – 2003 | Suhu udara  Kelembaban udara  Kecepatan angin  Curah hujan | x | RF  SVM  DT  XGBoost | x |
| Gopu *et al*. (2023) | 2000 – 2003 | Suhu udara  Kelembaban udara  Kecepatan angin  Curah hujan | x | ARIMA  SARIMA  LSTM-RNN  GRU-RNN | x |
| Sanjaya *et al*. (2023) | 2019 – 2022 | x | x | Prophet FB | X |
| Sukmana et al. (2024) | 2001 – 2020 | Radiasi matahari  Cura hujan  Suhu udara  Kelembaban udara  Kecepatan angin | SST Nino 3.4  Indeks SOI | Sudah di IPB  LSTM-RNN  Sudah saya lakukan  LSTM-XGBoost  Belum  GRU-RNN  SB-LSTM  SB-GRU  SB-LSTM-XGBoost  SB-GRU-XGBoost | Activation function  Optimizers  Learning Rate  Momentum  Decay  Dropout  Batch Size  Epoch |

**BAB III  
METODOLOGI PENELITIAN**

**3.1 Area Studi Penelitian**

**3.2 Peralatan Penelitian**

**3.3 Tahapan Penelitian**

**BAB IV  
HASIL DAN PEMBAHASAN**

**4.1 Pengumpulan Data**

**4.2 Praproses Data**

**4.3 Analisa Deret Waktu**

**4.4 Pembagian Data**

**4.4 Model Prediksi Titik Panas**

**4.4.1 Analisa Hyperparameter**

**4.4.1 Implementasi LSTM-RNN**

**4.4.1 Implementasi GRU-RNN**

**4.4.2 Implementasi SB-LSTM-RNN**

**4.4.3 Implementasi SB-GRU-RNN**

**4.4.5 Implementasi SB-LSTM-XGBoost**

**4.4.6 Implementasi SB-GRU-XGBoost**

**4.5 Evalsuasi Model**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Algoritma** | | **Evaluasi model prediksi** | | | | | | **Waktu** |
| **Data latih** | | | **Data uji** | | |
| **R** | **RMSE** | **MAPE** | **R** | **RMSE** | **MAPE** |
| **SB-LSTM-RNN** | |  |  |  |  |  |  |  |
|  | **Model 1** |  |  |  |  |  |  |  |
|  | **Model 2** |  |  |  |  |  |  |  |
|  | **Model 3** |  |  |  |  |  |  |  |
| **SB-GRU-RNN** | |  |  |  |  |  |  |  |
|  | **Model 4** |  |  |  |  |  |  |  |
|  | **Model 5** |  |  |  |  |  |  |  |
|  | **Model 6** |  |  |  |  |  |  |  |
| **SB-LSTM-XGBoost** | |  |  |  |  |  |  |  |
|  | **Model 7** |  |  |  |  |  |  |  |
|  | **Model 8** |  |  |  |  |  |  |  |
|  | **Model 9** |  |  |  |  |  |  |  |
| **SB-GRU-XGBoost** | |  |  |  |  |  |  |  |
|  | **Model 10** |  |  |  |  |  |  |  |
|  | **Model 11** |  |  |  |  |  |  |  |
|  | **Model 12** |  |  |  |  |  |  |  |

**BAB V  
KESIMPULAN DAN SARAN**

**5.1 Kesimpulan**

**5.2 Saran**

**DAFTAR PUSTAKA**

**LAMPIRAN**

**Tabel. Jumlah titik panas di Provinsi Sumatera Selatan**

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| **Tahun** | **Jan** | **Feb** | **Mar** | **Apr** | **Mei** | **Jun** | **Jul** | **Ags** | **Sep** | **Okt** | **Nov** | **Des** |
| 2001 | 3 | 5 | 10 | 20 | 39 | 8 | 192 | 171 | 141 | 20 | 13 | 4 |
| 2002 | 25 | 12 | 5 | 14 | 22 | 78 | 211 | 3324 | 2826 | 3724 | 237 | 17 |
| 2003 | 17 | 4 | 26 | 22 | 101 | 346 | 418 | 1584 | 1504 | 309 | 16 | 12 |
| 2004 | 13 | 6 | 13 | 26 | 36 | 224 | 186 | 2256 | 3659 | 2070 | 562 | 5 |
| 2005 | 32 | 9 | 9 | 26 | 46 | 70 | 280 | 1211 | 1616 | 264 | 34 | 33 |
| 2006 | 4 | 17 | 18 | 24 | 55 | 104 | 507 | 3585 | 7640 | 8662 | 1072 | 154 |
| 2007 | 14 | 22 | 17 | 26 | 53 | 92 | 238 | 1312 | 2377 | 988 | 107 | 18 |
| 2008 | 30 | 9 | 13 | 54 | 223 | 254 | 583 | 932 | 1760 | 269 | 36 | 5 |
| 2009 | 13 | 15 | 75 | 109 | 195 | 304 | 1044 | 2453 | 4372 | 401 | 81 | 17 |
| 2010 | 8 | 9 | 11 | 39 | 56 | 62 | 187 | 456 | 371 | 356 | 35 | 43 |
| 2011 | 9 | 49 | 19 | 30 | 145 | 218 | 642 | 2366 | 5726 | 529 | 243 | 34 |
| 2012 | 68 | 22 | 53 | 117 | 165 | 674 | 800 | 2699 | 5141 | 1719 | 73 | 8 |
| 2013 | 26 | 13 | 63 | 17 | 66 | 230 | 130 | 1122 | 789 | 326 | 76 | 9 |
| 2014 | 1 | 38 | 76 | 45 | 135 | 194 | 543 | 1038 | 4484 | 4306 | 1749 | 22 |
| 2015 | 26 | 40 | 32 | 40 | 181 | 332 | 891 | 2776 | 14181 | 14416 | 1533 | 78 |
| 2016 | 36 | 13 | 28 | 22 | 18 | 70 | 93 | 229 | 165 | 54 | 15 | 7 |
| 2017 | 12 | 3 | 19 | 20 | 41 | 62 | 107 | 158 | 264 | 61 | 21 | 26 |
| 2018 | 26 | 13 | 8 | 29 | 34 | 28 | 147 | 182 | 411 | 352 | 38 | 26 |
| 2019 | 10 | 7 | 18 | 21 | 75 | 44 | 115 | 732 | 3962 | 3913 | 1735 | 44 |
| 2020 | 27 | 24 | 59 | 60 | 27 | 24 | 29 | 65 | 29 | 40 | 30 | 8 |
| 2021 |  |  |  |  |  |  |  |  |  |  |  |  |
| 2022 |  |  |  |  |  |  |  |  |  |  |  |  |
| 2023 |  |  |  |  |  |  |  |  |  |  |  |  |

**Lampiran 2**

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| **Tahun** | **Jan** | **Feb** | **Mar** | **Apr** | **Mei** | **Jun** | **Jul** | **Ags** | **Sep** | **Okt** | **Nov** | **Des** |
| **2001** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2002** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2003** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2004** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2005** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2006** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2007** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2008** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2009** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2010** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2011** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2012** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2013** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2014** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2015** |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Tahun** | **Jan** | **Feb** | **Mar** | **Apr** | **Mei** | **Jun** | **Jul** | **Ags** | **Sep** | **Okt** | **Nov** | **Des** |
| **2016** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2017** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2018** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2019** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2020** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2021** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2022** |  |  |  |  |  |  |  |  |  |  |  |  |
| **2023** |  |  |  |  |  |  |  |  |  |  |  |  |