**Modelling Data AAK (*Regression Case*) menggunakan MLP Regressor**

1. Konfigurasi *neurons* (8-16)

Validasi:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *neurons* | MSE | RMSE | MAE | R2 | Breusch-Pagan  Test Statistic | Breusch-Pagan  p-value |
| 8 | 0.133032 | 0.364736 | 0.272875 | -0.202540 | 7.533108 | 0.375555 |
| 9 | 0.124096 | 0.352273 | 0.254574 | -0.121764 | 6.981827 | 0.430774 |
| 10 | 0.106264 | 0.325982 | 0.231283 | 0.039430 | 7.864285 | 0.344713 |
| 11 | 0.116069 | 0.340689 | 0.252536 | -0.049198 | 6.687852 | 0.462087 |
| 12 | 0.086268 | 0.293714 | 0.214810 | 0.220184 | 6.834934 | 0.446266 |
| 13 | 0.109435 | 0.330810 | 0.246849 | 0.010762 | 5.398801 | 0.611416 |
| 14 | 0.105754 | 0.325199 | 0.243254 | 0.044040 | 9.296493 | 0.232064 |
| 15 | 0.107648 | 0.328097 | 0.253219 | 0.026923 | 5.342367 | 0.618259 |
| 16 | 0.170648 | 0.413096 | 0.310840 | -0.542567 | 17.215907 | 0.016055 |

Test:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *neurons* | MSE | RMSE | MAE | R2 | Breusch-Pagan  Test Statistic | Breusch-Pagan  p-value |
| 8 | 0.125173 | 0.353798 | 0.280785 | -0.168637 | 18.565359 | 0.009663 |
| 9 | 0.115388 | 0.339688 | 0.260061 | -0.077279 | 12.725760 | 0.079078 |
| 10 | 0.110864 | 0.332963 | 0.249052 | -0.035045 | 10.588772 | 0.157589 |
| 11 | 0.125576 | 0.354368 | 0.274813 | -0.172403 | 12.20278 | 0.094084 |
| 12 | 0.090367 | 0.300612 | 0.220819 | 0.156315 | 16.744093 | 0.019122 |
| 13 | 0.096716 | 0.310992 | 0.222536 | 0.097042 | 10.933424 | 0.141549 |
| 14 | 0.123103 | 0.350861 | 0.267037 | -0.149311 | 11.695947 | 0.111011 |
| 15 | 0.112331 | 0.335159 | 0.259050 | -0.048743 | 18.247843 | 0.010900 |
| 16 | 0.150107 | 0.387437 | 0.309738 | -0.401423 | 32.611364 | 0.003127 |

Berdasrkan percobaan di atas, maka konfigurasi yang akan digunakan selanjutnya yaitu: **13 *neurons*, adam, constant.**

1. Konfigurasi *layer’s depth* (1-9)

Validasi:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Dense layer’s depth* | MSE | RMSE | MAE | R2 | Breusch-Pagan  Test Statistic | Breusch-Pagan  p-value |
| 1 | 0.162070 | 0.402580 | 0.310083 | -0.465027 | 6.487691 | 0.484091 |
| 2 | 0.099629 | 0.315640 | 0.235849 | 0.099410 | 6.766556 | 0.453584 |
| 3 | 0.109435 | 0.330810 | 0.246849 | 0.010762 | 5.398801 | 0.611416 |
| 4 | 0.089254 | 0.298751 | 0.217952 | 0.193186 | 5.422261 | 0.608576 |
| 5 | 0.109662 | 0.331153 | 0.256150 | 0.008712 | 6.032790 | 0.535925 |
| 6 | 0.089938 | 0.299898 | 0.222695 | 0.187003 | 6.348390 | 0.499708 |
| 7 | 0.085841 | 0.292986 | 0.207943 | 0.224045 | 6.850935 | 0.444563 |
| 8 | 0.086710 | 0.294466 | 0.215999 | 0.216187 | 6.024954 | 0.536838 |
| 9 | 0.097511 | 0.312267 | 0.218024 | 0.118555 | 10.714637 | 0.151559 |

Test:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Dense layer’s depth* | MSE | RMSE | MAE | R2 | Breusch-Pagan  Test Statistic | Breusch-Pagan  p-value |
| 1 | 0.136507 | 0.369468 | 0.294961 | -0.274449 | 13.228622 | 0.066730 |
| 2 | 0.104487 | 0.323244 | 0.242227 | 0.024492 | 17.442600 | 0.014754 |
| 3 | 0.096716 | 0.310992 | 0.222536 | 0.097042 | 10.933424 | 0.141549 |
| 4 | 0.092804 | 0.304638 | 0.217673 | 0.133561 | 15.469837 | 0.030426 |
| 5 | 0.100941 | 0.317712 | 0.240772 | 0.057596 | 19.776877 | 0.006072 |
| 6 | 0.090179 | 0.300298 | 0.216751 | 0.158075 | 15.140707 | 0.0342374 |
| 7 | 0.087672 | 0.296095 | 0.202801 | 0.181477 | 12.002047 | 0.100491 |
| 8 | 0.090520 | 0.300865 | 0.213214 | 0.154891 | 13.610676 | 0.058555 |
| 9 | 0.090436 | 0.300727 | 0.202228 | 0.155669 | 11.208736 | 0.129769 |

Berdasarkan hasil eskperimen pada tabel validasi dan tabel test, konfigurasi dengan 7 dense layer merupakan konfigurasi terbaik. Maka, selanjutnya konfigurasi yang akan digunakan yaitu : **13 neurons, 7 dense layer, constant.**

1. Konfigurasi *optimizers* (adam, sgd, lbfgs)

Validasi:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Optimizers* | MSE | RMSE | MAE | R2 | Breusch-Pagan  Test Statistic | Breusch-Pagan  p-value |
| adam | 0.085841 | 0.292986 | 0.207943 | 0.224045 | 6.850935 | 0.444563 |
| sgd | 0.111789 | 0.334349 | 0.252168 | -0.010515 | 11.328200 | 0.124929 |
| lbfgs | 0.094406 | 0.307255 | 0.218354 | 0.146623 | 6.927729 | 0.436443 |

Test:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Optimizers* | MSE | RMSE | MAE | R2 | Breusch-Pagan  Test Statistic | Breusch-Pagan  p-value |
| adam | 0.097511 | 0.312267 | 0.218024 | 0.118555 | 10.714637 | 0.151559 |
| sgd | 0.110704 | 0.332722 | 0.250531 | -0.033552 | 9.507533 | 0.218240 |
| lbfgs | 0.103840 | 0.322242 | 0.227131 | 0.030534 | 22.565600 | 0.002028 |

1. Konfigurasi *learning rate* (constant, invscaling, adaptive)

Validasi:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Learning*  *rate* | MSE | RMSE | MAE | R2 | Breusch-Pagan  Test Statistic | Breusch-Pagan  p-value |
| constant | 0.085841 | 0.292986 | 0.207943 | 0.224045 | 6.850935 | 0.444563 |
| invscaling | 0.085841 | 0.292986 | 0.207943 | 0.224045 | 6.850935 | 0.444563 |
| adaptive | 0.085841 | 0.292986 | 0.207943 | 0.224045 | 6.850935 | 0.444563 |

Test:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Learning*  *rate* | MSE | RMSE | MAE | R2 | Breusch-Pagan  Test Statistic | Breusch-Pagan  p-value |
| constant | 0.097511 | 0.312267 | 0.218024 | 0.118555 | 10.714637 | 0.151559 |
| invscaling | 0.087672 | 0.296095 | 0.202801 | 0.181477 | 12.002047 | 0.100491 |
| adaptive | 0.087672 | 0.296095 | 0.202801 | 0.181477 | 12.002047 | 0.100491 |

Berdasarkan hasil eksperimen pada tabel validasi dan tes, konfigurasi *learning rate* tidak berpengaruh signifikan dalam menurunkan MSE, RMSE, dan MAE dalam fase test, namun berpengaruh untuk meningkatkan nilai koefisien determinasi dan nilai uji heteroskedastisitas model.