KhavrSVR\_Micro\_modeltune\_Cu\_RS\_Landsat

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

4 0.5

- best performance: 0.08325191

KhavrSVR\_Micro\_Cu\_RS\_Landsat

Call:

svm(formula = Cu ~ b2\_reflectance + b3\_reflectance + b4\_reflectance + b5\_reflectance + b6\_reflectance + b7\_reflectance + ci\_mean\_kh +

gndvi\_mean\_kh + ndvi\_mean\_kh + satind\_mean\_kh + sgsi\_mean\_kh, data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario,

], kernel = "radial", cost = 0.5, gamma = 4)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 0.5

gamma: 4

epsilon: 0.1

Number of Support Vectors: 46

goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Internal , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 0.5984492 0.6493274 0.03237608 0.1799336 -0.002821242

> # externalvalidation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Landsat\_External , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 -0.1294574 -0.03092503 0.09131753 0.3021879 0.08361195

#training

> nrmse(KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 62.7

> MAPE(KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.1123304

> ##testing

> nrmse(KhavrSVR\_Micro\_Cu\_RS\_Landsat\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 103.7

> MAPE(KhavrSVR\_Micro\_Cu\_RS\_Landsat\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.2488069

KhavrSVR\_Micro\_modeltune\_Cu\_RS\_Sentinel

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

4 2

- best performance: 0.08170133

KhavrSVR\_MicroCu\_RS\_Sentinel

Call:

svm(formula = Cu ~ Sen\_B02\_30m\_aoi + Sen\_B03\_Mean\_30m\_aoi + Sen\_B04\_Mean\_30m\_aoi + Sen\_B05\_Mean\_30m\_aoi + Sen\_B06\_Mean\_30m\_aoi +

Sen\_B07\_Mean\_30m\_aoi + Sen\_B08\_Mean\_30m\_aoi + Sen\_B08A\_Mean\_30m\_aoi + Sen\_B11\_Mean\_30m\_aoi + Sen\_B12\_Mean\_30m\_aoi + ClayInd\_Mean\_Sentinel\_khavr +

GNDVI\_Mean\_Sentinel\_khavr + MSAVI2\_Mean\_Sentinel\_khavr + NDVI\_Mean\_Sentinel\_khavr + Saturation\_Mean\_Sentinel\_khavr + SGSI\_Mean\_Sentinel\_khavr,

data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario, ], kernel = "radial", cost = 2, gamma = 4)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 2

gamma: 4

epsilon: 0.1

Number of Support Vectors: 45

goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_MicroCu\_RS\_Sentinel\_Internal , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 0.9814542 0.9685754 0.001495307 0.0386692 -0.004389064

> # externalvalidation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_MicroCu\_RS\_Sentinel\_External, plot.it = TRUE)

R2 concordance MSE RMSE bias

1 -0.07754369 -0.004853356 0.08712026 0.2951614 0.07617527

> #training

> nrmse(KhavrSVR\_MicroCu\_RS\_Sentinel\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 13.5

> MAPE(KhavrSVR\_MicroCu\_RS\_Sentinel\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.02677162

> ##testing

> nrmse(KhavrSVR\_MicroCu\_RS\_Sentinel\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 101.3

> MAPE(KhavrSVR\_MicroCu\_RS\_Sentinel\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.2413487

KhavrSVR\_Micro\_modeltune\_Cu\_RS\_Landsat\_Sentinel

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

4 4

- best performance: 0.08295221

KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Sentinel

Call:

svm(formula = Cu ~ b2\_reflectance + b3\_reflectance + b4\_reflectance + b5\_reflectance + b6\_reflectance + b7\_reflectance + ci\_mean\_kh +

gndvi\_mean\_kh + ndvi\_mean\_kh + satind\_mean\_kh + sgsi\_mean\_kh + Sen\_B02\_30m\_aoi + Sen\_B03\_Mean\_30m\_aoi + Sen\_B04\_Mean\_30m\_aoi +

Sen\_B05\_Mean\_30m\_aoi + Sen\_B06\_Mean\_30m\_aoi + Sen\_B07\_Mean\_30m\_aoi + Sen\_B08\_Mean\_30m\_aoi + Sen\_B08A\_Mean\_30m\_aoi + Sen\_B11\_Mean\_30m\_aoi +

Sen\_B12\_Mean\_30m\_aoi + ClayInd\_Mean\_Sentinel\_khavr + GNDVI\_Mean\_Sentinel\_khavr + MSAVI2\_Mean\_Sentinel\_khavr + NDVI\_Mean\_Sentinel\_khavr +

Saturation\_Mean\_Sentinel\_khavr + SGSI\_Mean\_Sentinel\_khavr, data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario,

], kernel = "radial", cost = 4, gamma = 4)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 4

gamma: 4

epsilon: 0.1

Number of Support Vectors: 46

goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Sentinel\_Internal , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 0.9899734 0.9733908 0.0008084177 0.02843269 -0.001024802

> # externalvalidation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Sentinel\_External, plot.it = TRUE)

R2 concordance MSE RMSE bias

1 -0.08460414 0.0005470987 0.08769111 0.2961268 0.08299316

#training

> nrmse(KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Sentinel\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 9.9

> MAPE(KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Sentinel\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.02523762

> ##testing

> nrmse(KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Sentinel\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 101.6

> MAPE(KhavrSVR\_Micro\_Cu\_RS\_Landsat\_Sentinel\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.2440694

KhavrSVR\_Micro\_modeltune\_Cu\_RS\_Topographic

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

4 1

- best performance: 0.08594547

KhavrSVR\_Micro\_Cu\_RS\_Topographic

Call:

svm(formula = Cu ~ b2\_reflectance + b3\_reflectance + b4\_reflectance + b5\_reflectance + b6\_reflectance + b7\_reflectance + ci\_mean\_kh +

gndvi\_mean\_kh + ndvi\_mean\_kh + satind\_mean\_kh + sgsi\_mean\_kh + Sen\_B02\_30m\_aoi + Sen\_B03\_Mean\_30m\_aoi + Sen\_B04\_Mean\_30m\_aoi +

Sen\_B05\_Mean\_30m\_aoi + Sen\_B06\_Mean\_30m\_aoi + Sen\_B07\_Mean\_30m\_aoi + Sen\_B08\_Mean\_30m\_aoi + Sen\_B08A\_Mean\_30m\_aoi + Sen\_B11\_Mean\_30m\_aoi +

Sen\_B12\_Mean\_30m\_aoi + ClayInd\_Mean\_Sentinel\_khavr + GNDVI\_Mean\_Sentinel\_khavr + MSAVI2\_Mean\_Sentinel\_khavr + NDVI\_Mean\_Sentinel\_khavr +

Saturation\_Mean\_Sentinel\_khavr + SGSI\_Mean\_Sentinel\_khavr + FlowAcc\_kh + PlanCur\_kh + ProflCur\_kh + slope\_kh + spi\_kh +

Twi\_kh + aoi\_dem\_clip\_khavr, data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario, ], kernel = "radial",

cost = 1, gamma = 4)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 1

gamma: 4

epsilon: 0.1

Number of Support Vectors: 46

|  |
| --- |
| goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Internal , plot.it = TRUE)  R2 concordance MSE RMSE bias  1 0.8725329 0.8957323 0.01027736 0.1013773 -0.01279128  > # externalvalidation  > goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Topographic\_External, plot.it = TRUE)  R2 concordance MSE RMSE bias  1 -0.06117701 -3.468478e-09 0.085797 0.2929113 0.07032929 |
|  |
| |  | | --- | | > #training  > nrmse(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])  [1] 35.3  > MAPE(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])  [1] 0.05366223  > ##testing  > nrmse(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])  [1] 100.5  > MAPE(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])  [1] 0.2381008 | |

KhavrSVR\_Micro\_modeltune\_Cu\_RS\_Topographic\_Climate

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

4 2

- best performance: 0.08497375

KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate

Call:

svm(formula = Cu ~ b2\_reflectance + b3\_reflectance + b4\_reflectance + b5\_reflectance + b6\_reflectance + b7\_reflectance + ci\_mean\_kh +

gndvi\_mean\_kh + ndvi\_mean\_kh + satind\_mean\_kh + sgsi\_mean\_kh + Sen\_B02\_30m\_aoi + Sen\_B03\_Mean\_30m\_aoi + Sen\_B04\_Mean\_30m\_aoi +

Sen\_B05\_Mean\_30m\_aoi + Sen\_B06\_Mean\_30m\_aoi + Sen\_B07\_Mean\_30m\_aoi + Sen\_B08\_Mean\_30m\_aoi + Sen\_B08A\_Mean\_30m\_aoi + Sen\_B11\_Mean\_30m\_aoi +

Sen\_B12\_Mean\_30m\_aoi + ClayInd\_Mean\_Sentinel\_khavr + GNDVI\_Mean\_Sentinel\_khavr + MSAVI2\_Mean\_Sentinel\_khavr + NDVI\_Mean\_Sentinel\_khavr +

Saturation\_Mean\_Sentinel\_khavr + SGSI\_Mean\_Sentinel\_khavr + FlowAcc\_kh + PlanCur\_kh + ProflCur\_kh + slope\_kh + spi\_kh +

Twi\_kh + aoi\_dem\_clip\_khavr + srad\_khavr + bio\_15\_khavr + bio\_12\_khavr + bio\_1\_khavr, data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario,

], kernel = "radial", cost = 2, gamma = 4)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 2

gamma: 4

epsilon: 0.1

Number of Support Vectors: 46

goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Internal , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 0.9816131 0.9686648 0.001482488 0.0385031 -0.004335285

> # externalvalidation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_External, plot.it = TRUE)

R2 concordance MSE RMSE bias

1 -0.07677254 8.933446e-11 0.08705791 0.2950558 0.07878528

#training

> nrmse(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 13.4

> MAPE(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.02682737

> ##testing

> nrmse(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 101.3

> MAPE(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.241962

KhavrSVR\_Micro\_modeltune\_Cu\_RS\_Topographic\_Climate\_Soil

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

4 4

- best performance: 0.08453098

KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Soil

Call:

svm(formula = Cu ~ b2\_reflectance + b3\_reflectance + b4\_reflectance + b5\_reflectance + b6\_reflectance + b7\_reflectance + ci\_mean\_kh +

gndvi\_mean\_kh + ndvi\_mean\_kh + satind\_mean\_kh + sgsi\_mean\_kh + Sen\_B02\_30m\_aoi + Sen\_B03\_Mean\_30m\_aoi + Sen\_B04\_Mean\_30m\_aoi +

Sen\_B05\_Mean\_30m\_aoi + Sen\_B06\_Mean\_30m\_aoi + Sen\_B07\_Mean\_30m\_aoi + Sen\_B08\_Mean\_30m\_aoi + Sen\_B08A\_Mean\_30m\_aoi + Sen\_B11\_Mean\_30m\_aoi +

Sen\_B12\_Mean\_30m\_aoi + ClayInd\_Mean\_Sentinel\_khavr + GNDVI\_Mean\_Sentinel\_khavr + MSAVI2\_Mean\_Sentinel\_khavr + NDVI\_Mean\_Sentinel\_khavr +

Saturation\_Mean\_Sentinel\_khavr + SGSI\_Mean\_Sentinel\_khavr + FlowAcc\_kh + PlanCur\_kh + ProflCur\_kh + slope\_kh + spi\_kh +

Twi\_kh + aoi\_dem\_clip\_khavr + srad\_khavr + bio\_15\_khavr + bio\_12\_khavr + bio\_1\_khavr + Clay\_khavr + pH\_khavr + Sand\_khavr,

data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario, ], kernel = "radial", cost = 4, gamma = 4)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 4

gamma: 4

epsilon: 0.1

Number of Support Vectors: 46

goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Soil\_Internal , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 0.9899848 0.9733974 0.0008074986 0.02841652 -0.001035146

> # externalvalidation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Soil\_External, plot.it = TRUE)

R2 concordance MSE RMSE bias

1 -0.0833389 3.308052e-11 0.08758881 0.2959541 0.08208542

#training

> nrmse(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Soil\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 9.9

> MAPE(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Soil\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.0252176

> ##testing

> nrmse(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Soil\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 101.6

> MAPE(KhavrSVR\_Micro\_Cu\_RS\_Topographic\_Climate\_Soil\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.2435635

KhavrSVR\_Micro\_modeltune\_Cu\_Topographic

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

0.5 0.5

- best performance: 0.08169718

KhavrSVR\_Micro\_Cu\_Topographic

Call:

svm(formula = Cu ~ FlowAcc\_kh + PlanCur\_kh + ProflCur\_kh + slope\_kh + spi\_kh + Twi\_kh + aoi\_dem\_clip\_khavr, data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario,

], kernel = "radial", cost = 0.5, gamma = 0.5)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 0.5

gamma: 0.5

epsilon: 0.1

Number of Support Vectors: 45

goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_Topographic\_Internal , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 0.4560161 0.51627 0.04386012 0.2094281 -0.003502637

> # externalvalidation

>

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_Topographic\_External, plot.it = TRUE)

R2 concordance MSE RMSE bias

1 -0.04219769 0.08931377 0.08426251 0.2902801 0.08412506

#training

> nrmse(KhavrSVR\_Micro\_Cu\_Topographic\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 73

> MAPE(KhavrSVR\_Micro\_Cu\_Topographic\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.1324695

> ##testing

> nrmse(KhavrSVR\_Micro\_Cu\_Topographic\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 99.6

> MAPE(KhavrSVR\_Micro\_Cu\_Topographic\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.23349

KhavrSVR\_Micro\_modeltune\_Cu\_Climate

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

2 2

- best performance: 0.06934236

> KhavrSVR\_Micro\_Cu\_Climate

Call:

svm(formula = Cu ~ srad\_khavr + bio\_15\_khavr + bio\_12\_khavr + bio\_1\_khavr, data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario,

], kernel = "radial", cost = 2, gamma = 2)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 2

gamma: 2

epsilon: 0.1

Number of Support Vectors: 42

# Internal validation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_Climate\_Internal , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 0.9695692 0.9620525 0.002453562 0.04953344 -0.002829698

> # externalvalidation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_Climate\_External, plot.it = TRUE)

R2 concordance MSE RMSE bias

1 -0.01259906 0.2736476 0.08186944 0.2861284 0.1056172

#training

> nrmse(KhavrSVR\_Micro\_Cu\_Climate\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 17.3

> MAPE(KhavrSVR\_Micro\_Cu\_Climate\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.0339928

> ##testing

> nrmse(KhavrSVR\_Micro\_Cu\_Climate\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 98.2

> MAPE(KhavrSVR\_Micro\_Cu\_Climate\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.2587769

KhavrSVR\_Micro\_modeltune\_Cu\_Soil

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

0.25 0.125

- best performance: 0.0796185

KhavrSVR\_Micro\_Cu\_Soil

Call:

svm(formula = Cu ~ b2\_reflectance + Clay\_khavr + pH\_khavr + Sand\_khavr, data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario,

], kernel = "radial", cost = 0.125, gamma = 0.25)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 0.125

gamma: 0.25

epsilon: 0.1

Number of Support Vectors: 45

|  |
| --- |
| # Internal validation  > goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_Soil\_Internal , plot.it = TRUE)  R2 concordance MSE RMSE bias  1 0.2186574 0.272116 0.06299779 0.2509936 0.02544239  > # externalvalidation  > goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_Soil\_External, plot.it = TRUE)  R2 concordance MSE RMSE bias  1 -0.1270421 0.1023608 0.09112225 0.3018646 0.1273223 |
|  |
| |  | | --- | | > | |

#training

> nrmse(KhavrSVR\_Micro\_Cu\_Soil\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 87.4

> MAPE(KhavrSVR\_Micro\_Cu\_Soil\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.1839443

> ##testing

> nrmse(KhavrSVR\_Micro\_Cu\_Soil\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 103.6

> MAPE(KhavrSVR\_Micro\_Cu\_Soil\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.2615099

KhavrSVR\_Micro\_modeltune\_Cu\_Rec\_Fea\_Elimination

Parameter tuning of ‘svm’:

- sampling method: 10-fold cross validation

- best parameters:

gamma cost

4 4

- best performance: 0.08475451

KhavrSVR\_Micro\_Cu\_Rec\_Fea\_Elimination

Call:

svm(formula = Cu ~ b2\_reflectance + b3\_reflectance + b4\_reflectance + b5\_reflectance + b6\_reflectance + b7\_reflectance + ci\_mean\_kh +

gndvi\_mean\_kh + ndvi\_mean\_kh + satind\_mean\_kh + sgsi\_mean\_kh + Sen\_B02\_30m\_aoi + Sen\_B03\_Mean\_30m\_aoi + Sen\_B05\_Mean\_30m\_aoi +

Sen\_B06\_Mean\_30m\_aoi + Sen\_B07\_Mean\_30m\_aoi + Sen\_B08\_Mean\_30m\_aoi + Sen\_B08A\_Mean\_30m\_aoi + Sen\_B11\_Mean\_30m\_aoi + Sen\_B12\_Mean\_30m\_aoi +

ClayInd\_Mean\_Sentinel\_khavr + GNDVI\_Mean\_Sentinel\_khavr + MSAVI2\_Mean\_Sentinel\_khavr + NDVI\_Mean\_Sentinel\_khavr + Saturation\_Mean\_Sentinel\_khavr +

SGSI\_Mean\_Sentinel\_khavr + FlowAcc\_kh + PlanCur\_kh + ProflCur\_kh + slope\_kh + spi\_kh + Twi\_kh + aoi\_dem\_clip\_khavr + bio\_15\_khavr +

bio\_12\_khavr + bio\_1\_khavr + Clay\_khavr + pH\_khavr + Sand\_khavr, data = SVR\_Micro\_Scenario\_models\_dataset[Training\_SVR\_Micro\_scenario,

], kernel = "radial", cost = 4, gamma = 4)

Parameters:

SVM-Type: eps-regression

SVM-Kernel: radial

cost: 4

gamma: 4

epsilon: 0.1

Number of Support Vectors: 46

# Internal validation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_Rec\_Fea\_Elimination\_Internal , plot.it = TRUE)

R2 concordance MSE RMSE bias

1 0.9899815 0.9733955 0.0008077665 0.02842123 -0.001035146

> # externalvalidation

> goof(observed = SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario], predicted = KhavrSVR\_Micro\_Cu\_Rec\_Fea\_Elimination\_External, plot.it = TRUE)

R2 concordance MSE RMSE bias

1 -0.0833389 -1.044947e-10 0.08758881 0.2959541 0.08208542

#training

> nrmse(KhavrSVR\_Micro\_Cu\_Rec\_Fea\_Elimination\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 9.9

> MAPE(KhavrSVR\_Micro\_Cu\_Rec\_Fea\_Elimination\_Internal, SVR\_Micro\_Scenario\_models\_dataset$Cu[Training\_SVR\_Micro\_scenario])

[1] 0.025221

> ##testing

> nrmse(KhavrSVR\_Micro\_Cu\_Rec\_Fea\_Elimination\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 101.6

> MAPE(KhavrSVR\_Micro\_Cu\_Rec\_Fea\_Elimination\_External, SVR\_Micro\_Scenario\_models\_dataset$Cu[-Training\_SVR\_Micro\_scenario])

[1] 0.2435635