R&D PROJECT

Hemoglobin Level Estimation from Photographic images

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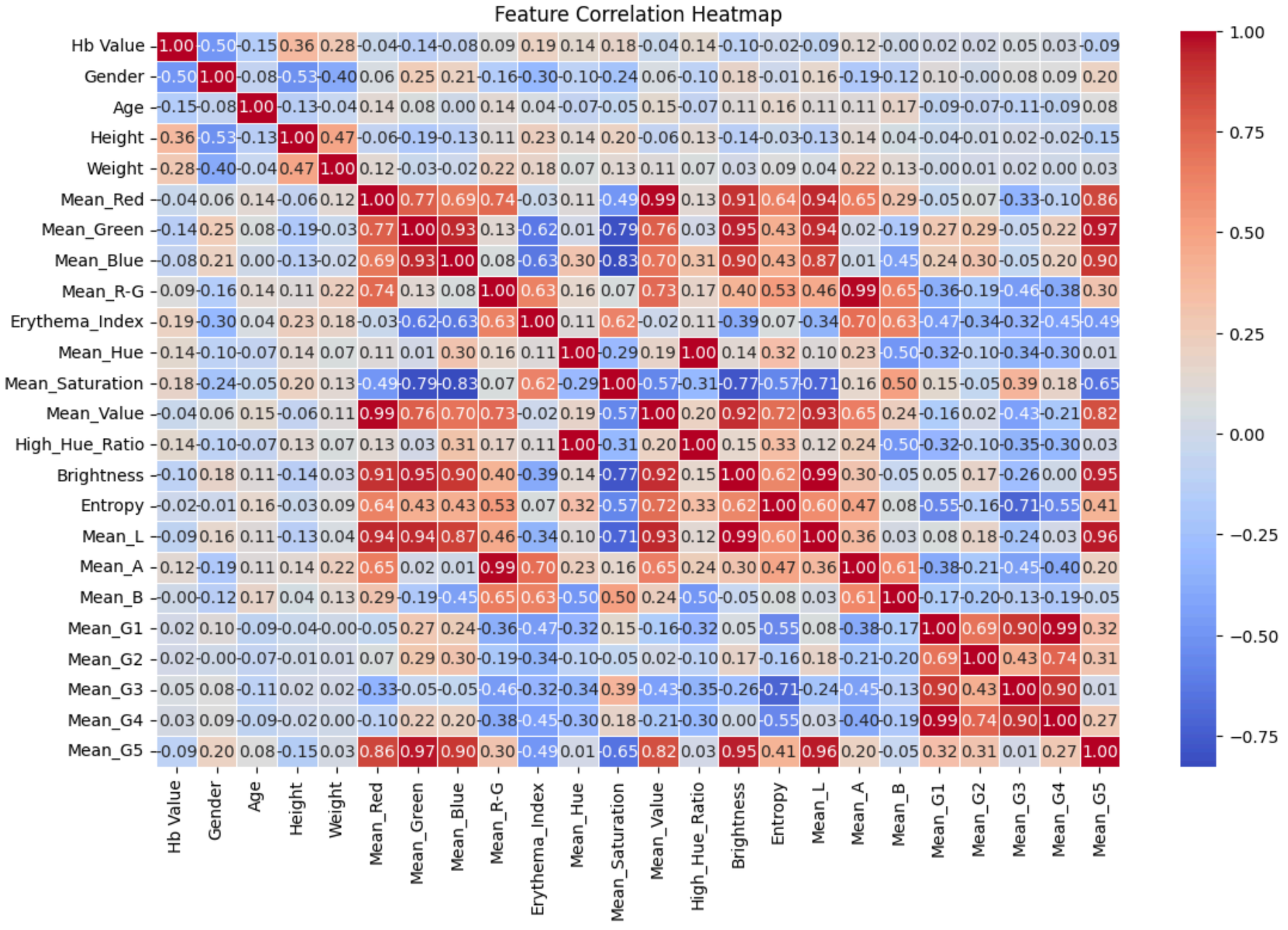
DH 307

Feature Extraction

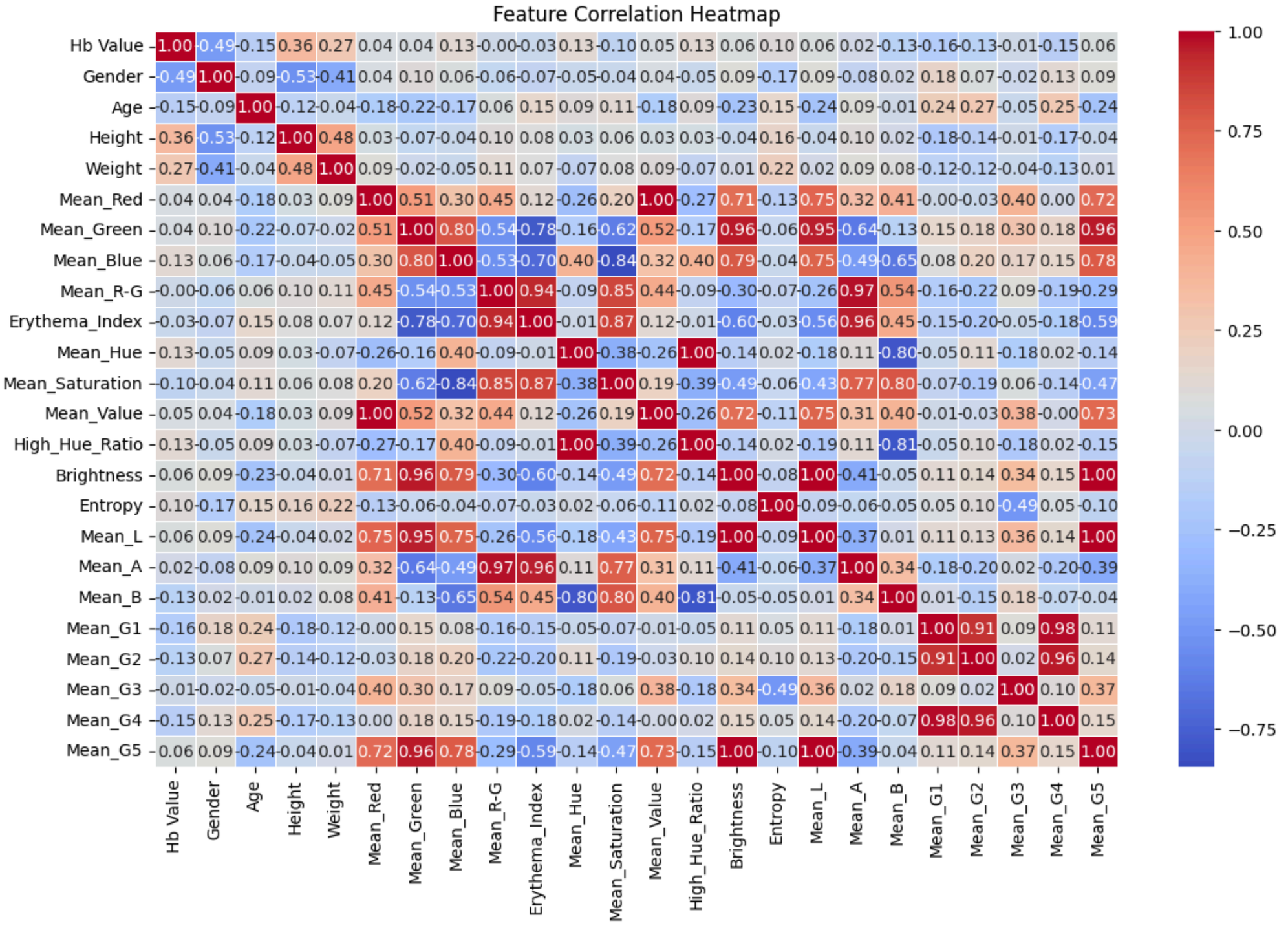
- Mean of all Red pixels
- Mean of all Blue pixels
- Mean of all Green pixels
- Mean of all Red-Green pixels
- Erythema Index
- Mean of Hue of all pixels
- Mean of Saturation of all pixels
- Mean of Value of all pixels
- Brightness
- Entropy
- Weight
- Mean of all G1 features
- Mean of all G2 features
- Mean of all G3 features
- Mean of all G4 features
- Mean of all G5 features
- Mean of all Lightness (L*) values
- Mean of all a* values
- Mean of all b* values
- Age
- Height
- Gender

Correlation

For Eye:

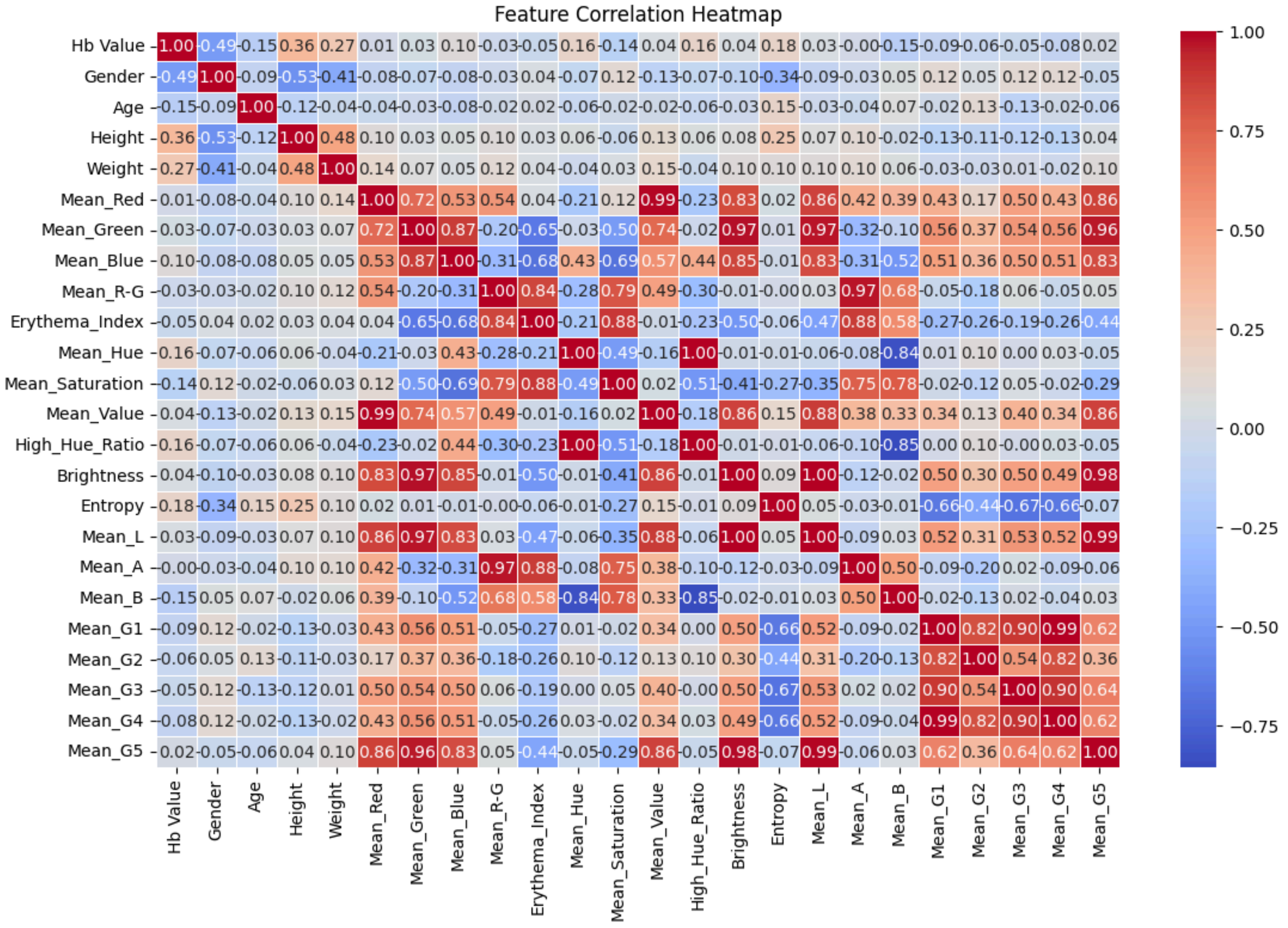


Correlation For Palm:

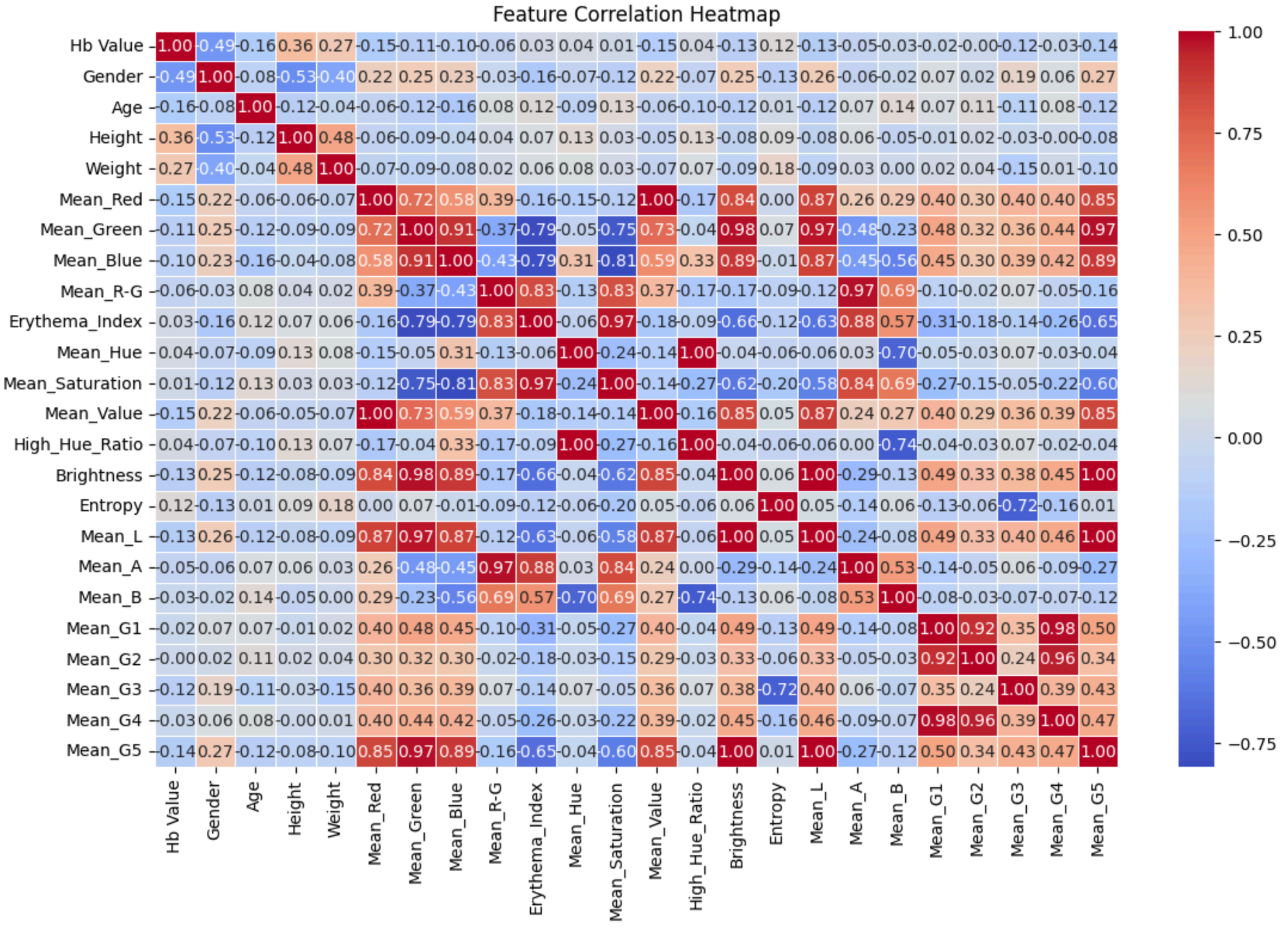


Correlation

For Fingernail:



Correlation For Tongue:



Feature Selection for EYE

MRMR selected features

- 'Gender'
- 'High_Hue_Ratio'
- 'Height'
- 'Erythema_Index'
- 'Weight'
- 'Age'
- 'Mean_Hue'
- 'Mean_Green'
- 'Mean_A'
- 'Mean_Saturation'

Model	MAE	MSE	R2 Score
Linear Regression	1.108915	2.095872	0.384706
Ridge Regression	1.114775	2.111338	0.380166
Random Forest	1.250753	2.440041	0.283667
Neural Network	1.255255	2.942724	0.136092
Polynomial Regression (Degree=2)	1.265584	2.583902	0.241433

Feature Selection for EYE

MRMR selected features

- 'Gender'
- 'High_Hue_Ratio'
- 'Height'
- 'Erythema_Index'
- 'Weight'
- 'Age'
- 'Mean_Hue'
- 'Mean_Green'
- 'Mean_A'
- 'Mean_Saturation'

Model	MAE	MSE	R2 Score
ElasticNet	1.278361	2.526151	0.258388
Gradient Boosting	1.307162	2.589840	0.239690
Lasso Regression	1.310444	2.592338	0.238957
Support Vector Regressor	1.366580	2.849869	0.163352
XGBoost Regressor	1.372425	2.843260	0.165292
KNN Regressor	1.466173	3.341906	0.018903
Decision Tree	1.760494	5.003457	-0.468885

Feature Selection for FingerNail

MRMR selected features

- Gender'
- 'Erythema_Index'
- 'Height'
- 'Mean_Hue'
- 'Weight'
- 'Entropy'
- 'Age'
- 'High_Hue_Ratio'
- 'Mean_B'
- 'Mean_Saturation'

Model	MAE	MSE	R2 Score
Ridge Regression	1.217108	2.515464	0.303599
Linear Regression	1.219579	2.525247	0.300891
Random Forest	1.221095	2.619943	0.274674
Neural Network	1.256165	2.66868	0.261179
Gradient Boosting	1.311424	3.100313	0.141685

Feature Selection for FingerNail

MRMR selected features

- Gender'
- 'Erythema_Index'
- 'Height'
- 'Mean_Hue'
- 'Weight'
- 'Entropy'
- 'Age'
- 'High_Hue_Ratio'
- 'Mean_B'
- 'Mean_Saturation'

Model	MAE	MSE	R2 Score
KNN Regressor	1.388333	3.077890	0.147892
ElasticNet	1.397545	3.089302	0.144733
Lasso Regression	1.421358	3.151208	0.127594
Support Vector Regressor	1.424869	3.037789	0.158994
XGBoost Regressor	1.440294	3.611758	0.000092
Polynomial Regression (Degree=2)	1.479548	3.539077	0.020214
Decision Tree	1.913095	5.934881	0.643060

Feature Selection for Palm

MRMR selected features

- 'Gender'
- 'Mean_B'
- 'Age'
- 'Height'
- 'Weight'
- 'Mean_Hue'
- 'Entropy'
- 'Mean_G1'
- 'Mean_Blue'
- 'High_Hue_Ratio'

Model	MAE	MSE	R2 Score
Linear Regression	1.342198	3.149976	0.299870
Ridge Regression	1.344493	3.153133	0.299169
Random Forest	1.351417	3.209592	0.286620
Gradient Boosting	1.367732	3.347506	0.255966
Polynomial Regression (Degree=2)	1.512719	3.754242	0.165563

Feature Selection for Palm

MRMR selected features

- 'Gender'
- 'Mean_B'
- 'Age'
- 'Height'
- 'Weight'
- 'Mean_Hue'
- 'Entropy'
- 'Mean_G1'
- 'Mean_Blue'
- 'High_Hue_Ratio'

Model	MAE	MSE	R2 Score
XGBoost Regressor	1.562053	4.209574	0.064359
ElasticNet	1.608555	3.851002	0.144057
Lasso Regression	1.620262	3.898667	0.133462
KNN Regressor	1.647857	4.109014	0.086709
Support Vector Regressor	1.681688	4.070006	0.095380
Decision Tree	1.888095	5.908095	-0.313164
Neural Network	3.975908	25.355971	-4.635748

Feature Selection for Tongue

MRMR selected features

- 'Gender'
- 'Height'
- 'Mean_Red'
- 'Weight'
- 'Age'
- 'Mean_Value'
- 'Entropy'
- 'Mean_G5'
- 'Mean_L'
- 'Brightness'

Model	MAE	MSE	R2 Score
Random Forest	1.243798	2.680621	0.298180
Polynomial Regression (Degree=2)	1.258312	2.859916	0.251238
Linear Regression	1.275745	2.702449	0.292465
Ridge Regression	1.276065	2.698845	0.293409
Gradient Boosting	1.319261	2.782841	0.271418

Feature Selection for Tongue

MRMR selected features

- 'Gender'
- 'Height'
- 'Mean_Red'
- 'Weight'
- 'Age'
- 'Mean_Value'
- 'Entropy'
- 'Mean_G5'
- 'Mean_L'
- 'Brightness'

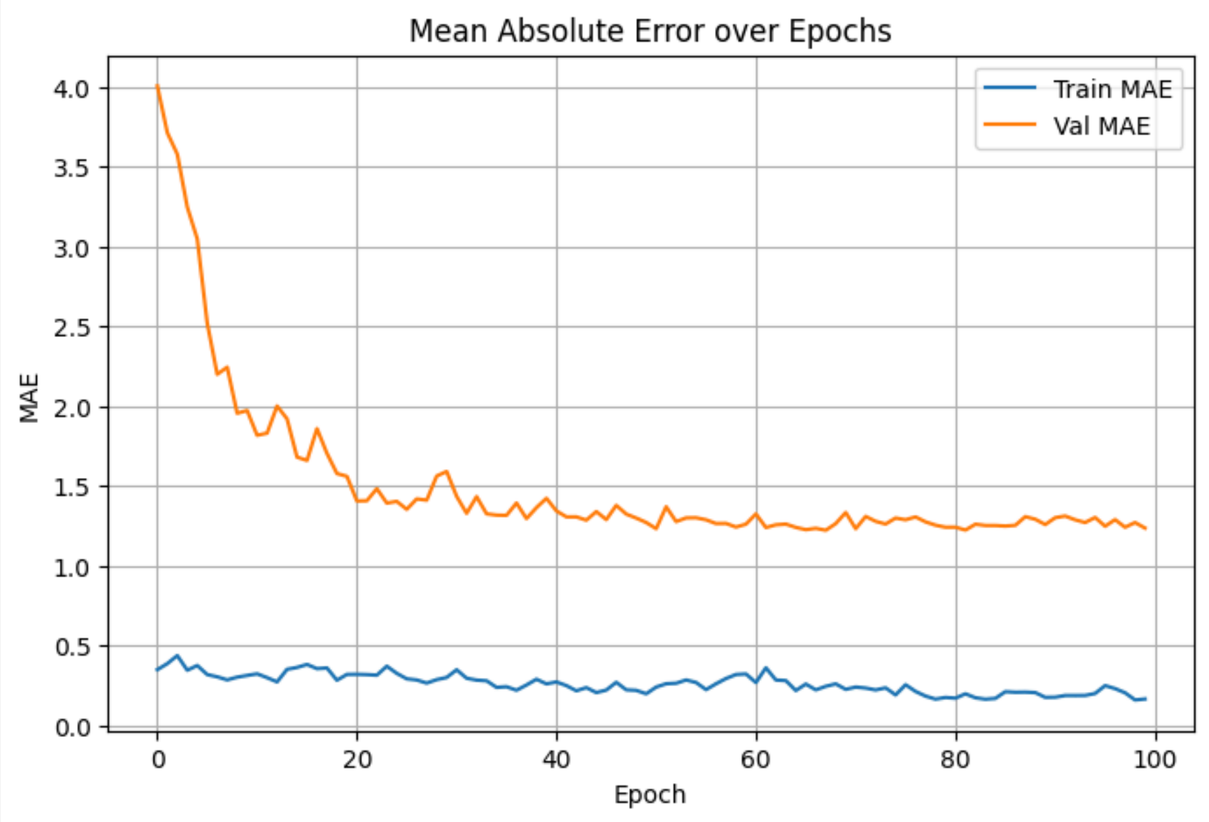
Model	MAE	MSE	R2 Score
XGBoost Regressor	1.364504	2.935020	0.231575
KNN Regressor	1.371667	2.993376	0.216297
Neural Network	1.441117	3.024543	0.208137
ElasticNet	1.448644	3.201946	0.161691
Lasso Regression	1.460570	3.241669	0.151291
Support Vector Regressor	1.478408	3.347038	0.123704
Decision Tree	1.710714	4.789643	0.253988

Feature Selection by MRMR Conclusion

	Best Model	MAE
EYE	Linear Regression	1.108915
FingerNail	Ridge Regression	1.217108
Tongue	Random Forest	1.243798
Palm	Linear Regression	1.342198

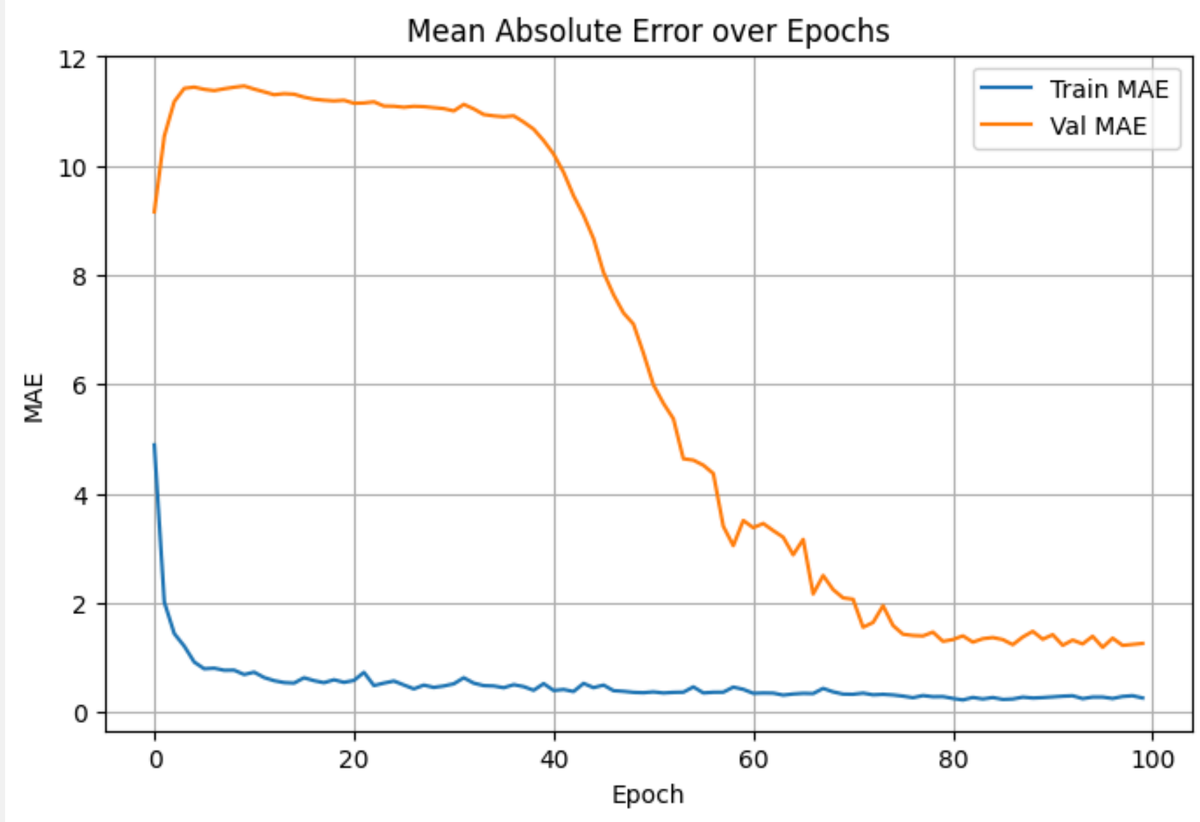
Eye Model : ResNet-50

Basic ResNet



Train MAE: 0.1924
Validation MAE: 1.2367
Test MAE: 1.57

Custom ResNet

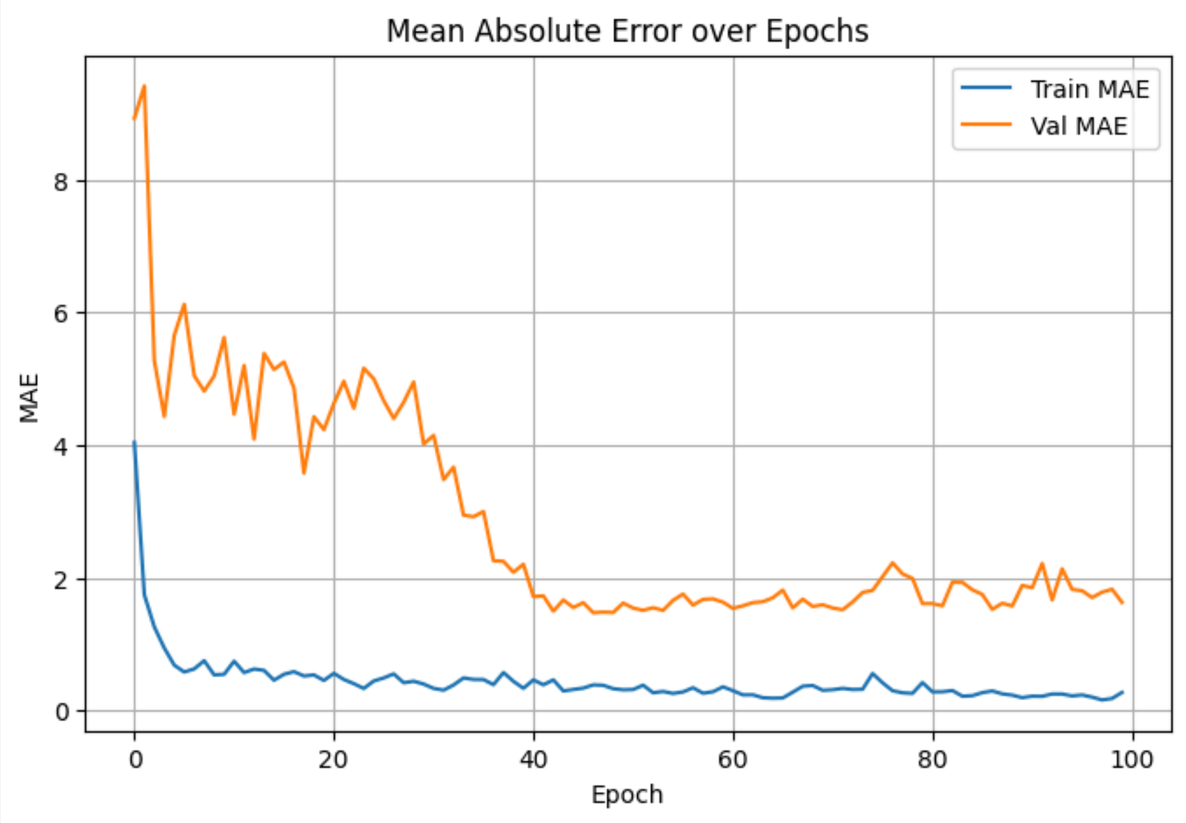


Train MAE: 0.2467

Validation MAE: 1.2569

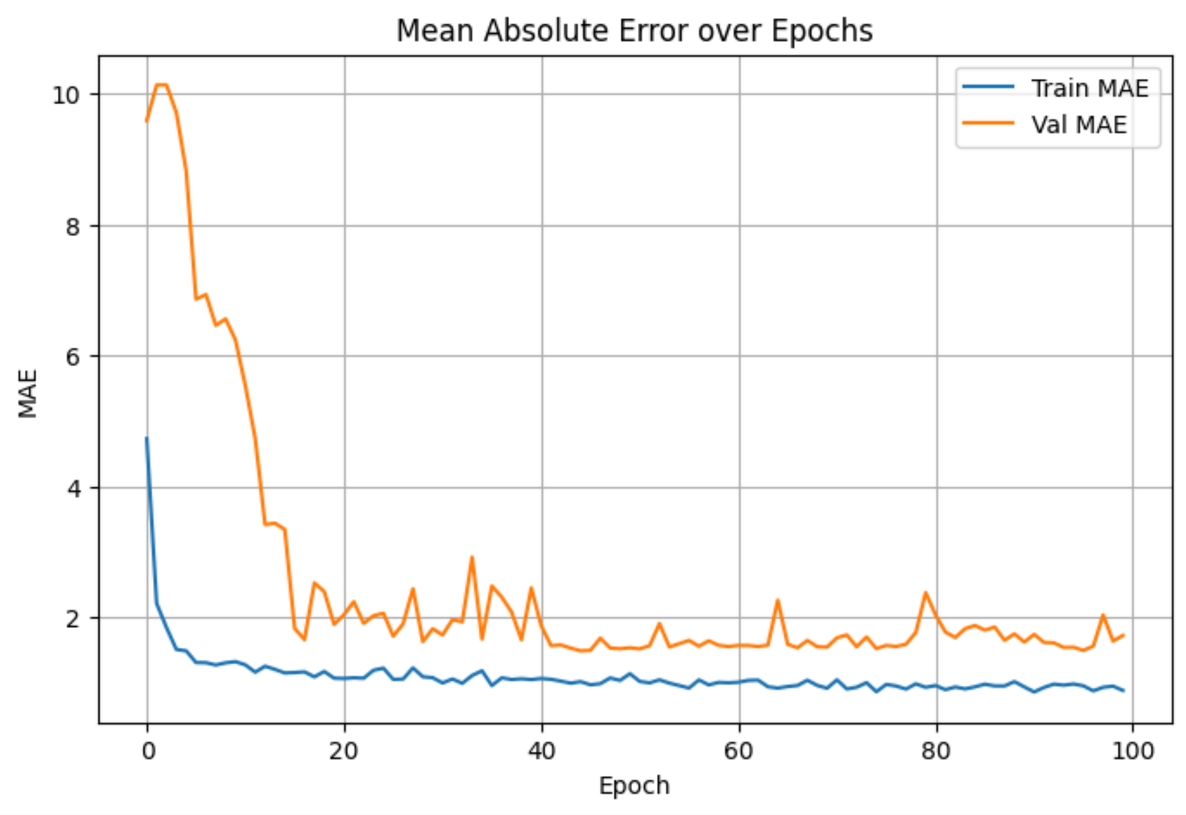
Fingernail Model : ResNet-50

Basic ResNet



Train MAE: 0.3263
Validation MAE: 1.6327
Test MAE: 1.474

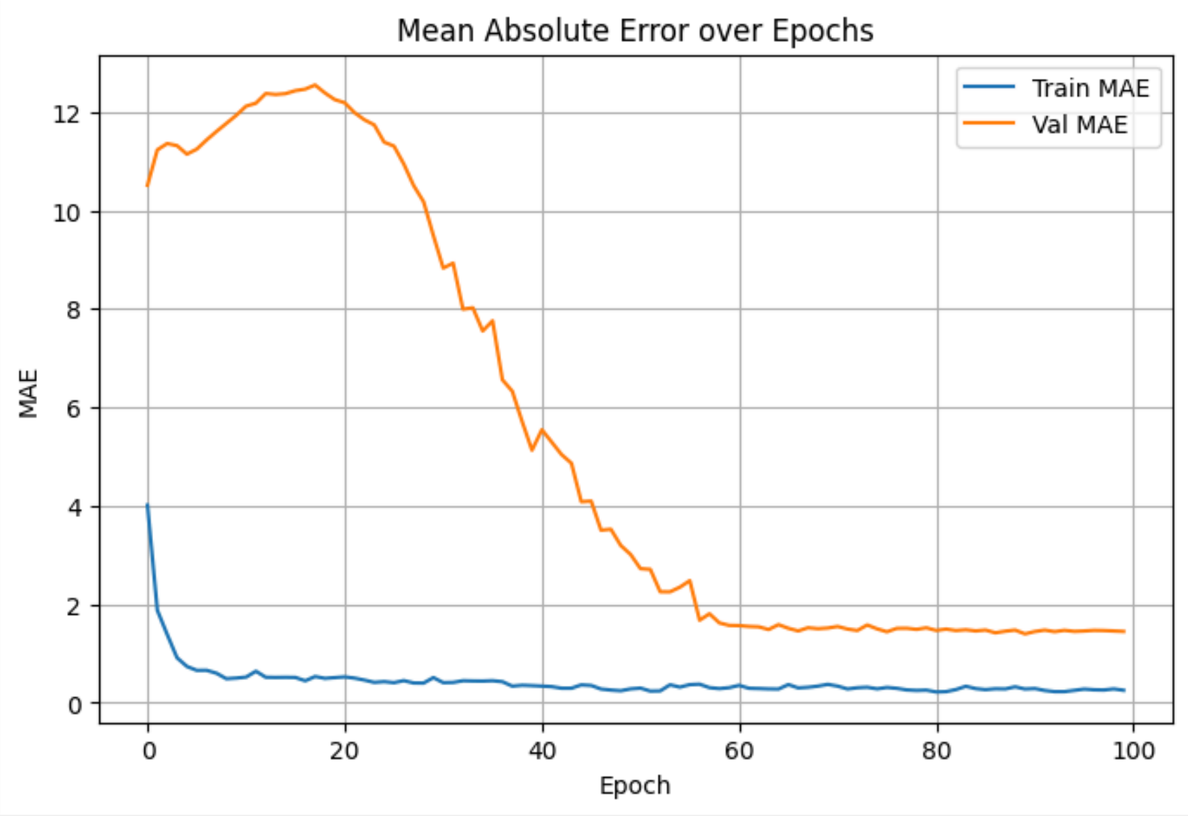
Custom ResNet



Train MAE: 0.8644
Validation MAE: 1.7246
Test MAE: 1.5984

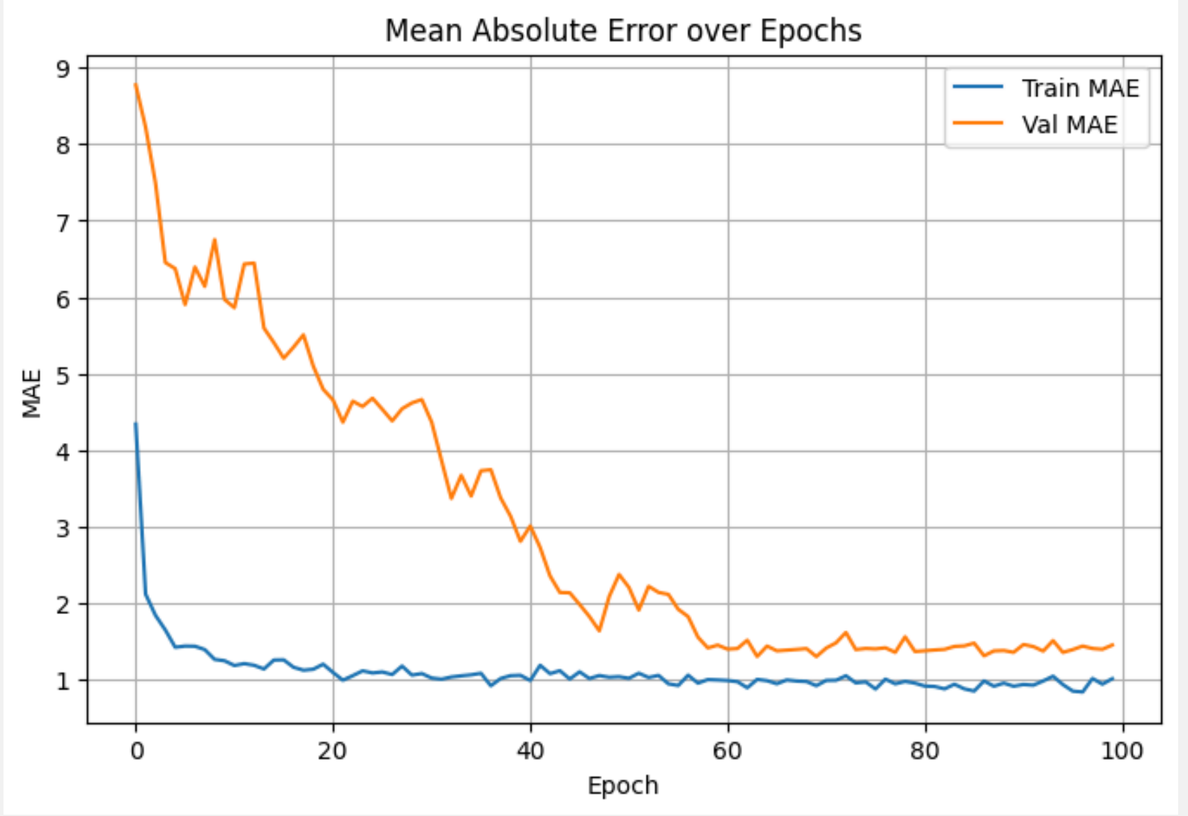
Palm Model : ResNet-50

Basic ResNet



Train MAE: 0.2301
Validation MAE: 1.4481
Test MAE: 1.65689

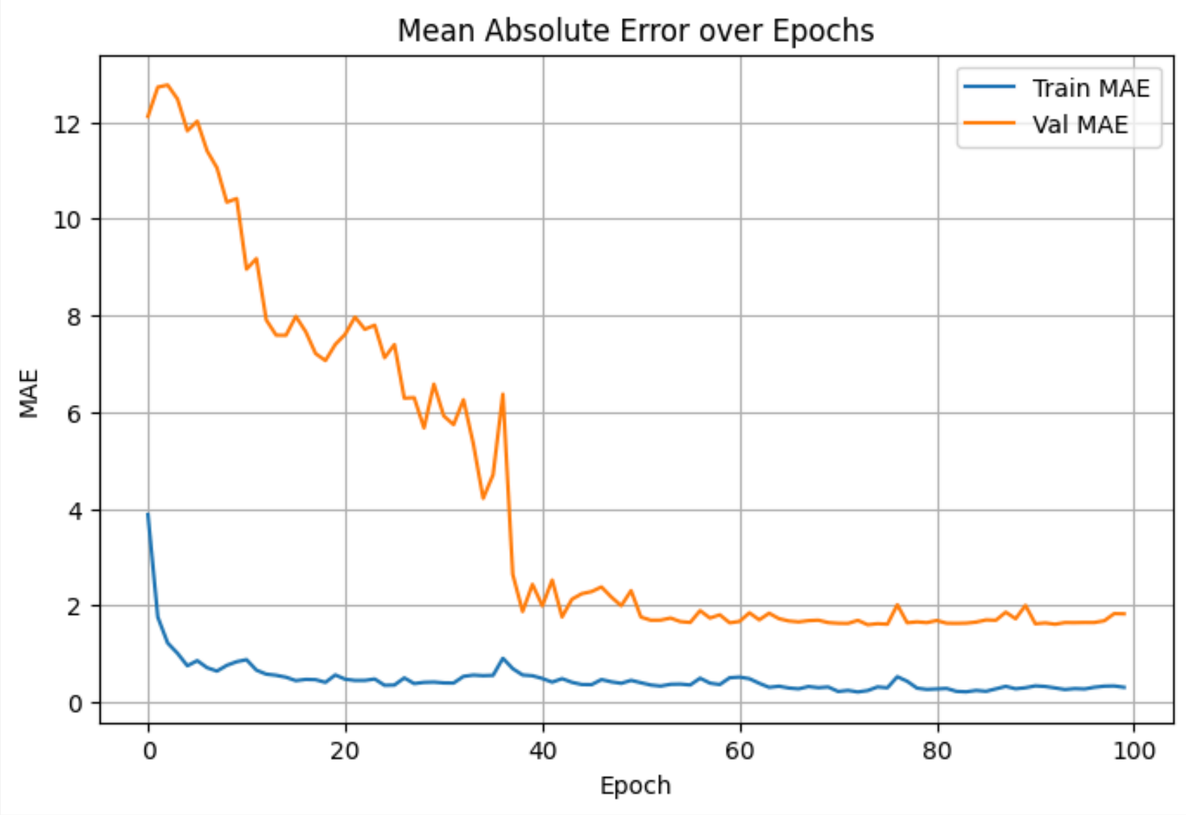
Custom ResNet



Train MAE: 1.0186
Validation MAE: 1.4521
Test MAE: 1.6978

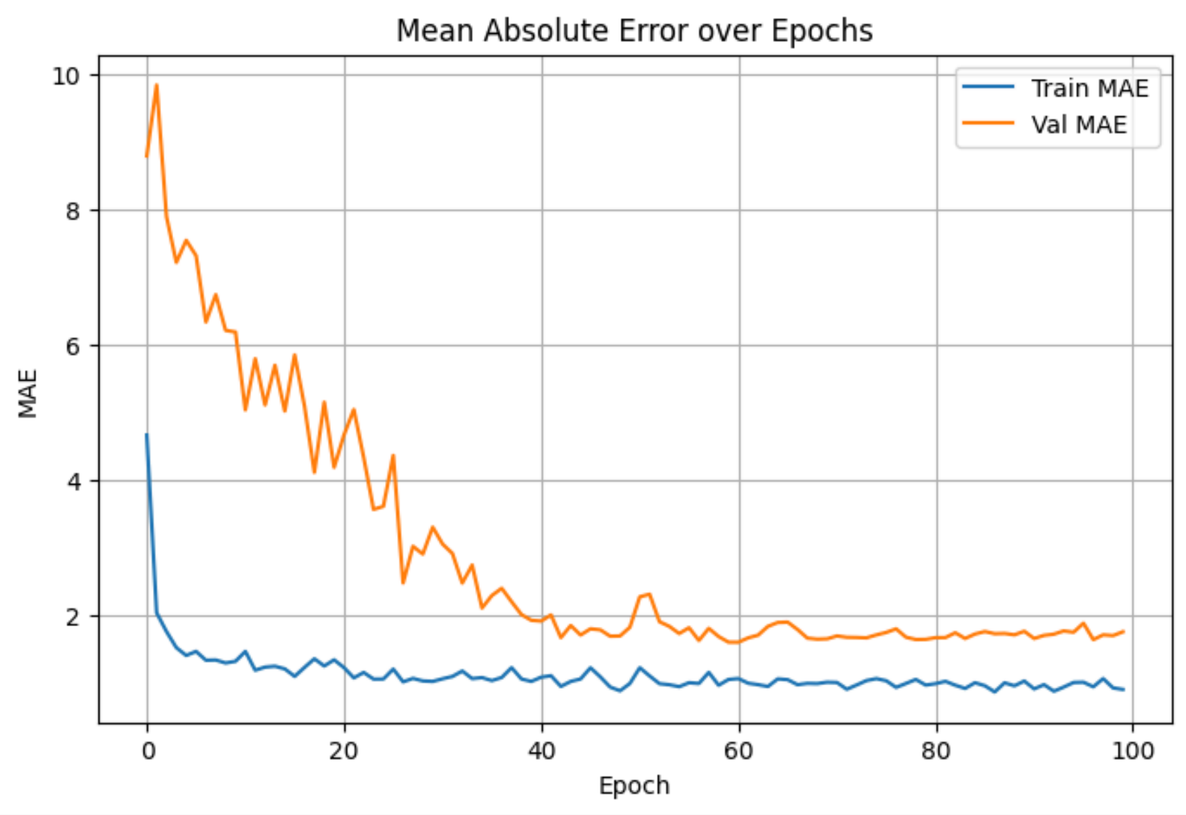
Tongue Model : ResNet-50

Basic ResNet



Train MAE: 0.3224
Validation MAE: 1.8278
Test MAE: 1.8813

Custom ResNet



Train MAE: 0.8967
Validation MAE: 1.7453
Test MAE: 1.99

Resnet-50 Conclusion

	Train MAE	Validation MAE	Test MAE
FingerNail	0.3263	1.6327	1.474
EYE	0.1924	1.2367	1.57
Palm	0.2301	1.4481	1.656
Tongue	0.3224	1.82	1.88

Resnet-50 + MRMR : EYE

Model	Validation MAE	Test MAE
Lasso	1.1232	1.5344
SVR	1.4908	2.0039
AdaBoost	1.7615	2.0239
XGBoost	1.7348	2.0379
Ridge	1.5815	2.0949
GradientBoosting	1.706	2.126
RandomForest	1.6443	2.1348
KNN	1.6682	2.1761
LinearRegression	1.733	2.3213
DecisionTree	1.9049	2.3885

Resnet-50 + MRMR : FingerNail

Model	Validation MAE	Test MAE
KNN	1.7714	1.6162
SVR	1.7506	1.639
Lasso	1.6306	1.6607
Ridge	1.8254	1.6672
GradientBoosting	1.7722	1.6678
RandomForest	1.7732	1.6718
AdaBoost	1.8088	1.681
LinearRegression	1.8534	1.6978
XGBoost	1.731	1.7306
DecisionTree	1.8841	1.7698

Resnet-50 + MRMR : Palm

Model	Validation MAE	Test MAE
LinearRegression	1.5522	1.6106
KNN	1.5368	1.6184
Ridge	1.5024	1.6202
SVR	1.5038	1.6224
GradientBoosting	1.5165	1.6581
RandomForest	1.4889	1.6775
XGBoost	1.4881	1.7074
AdaBoost	1.4912	1.7139
DecisionTree	1.5397	1.7889
Lasso	1.4666	1.7984

Resnet-50 + MRMR : Tongue

Model	Validation MAE	Test MAE
Lasso	1.6386	1.5861
AdaBoost	1.7033	1.7561
XGBoost	1.801	1.7613
KNN	1.7492	1.7775
Ridge	1.7738	1.7853
SVR	1.7711	1.7904
GradientBoosting	1.7213	1.7944
LinearRegression	1.7953	1.8011
RandomForest	1.7476	1.8181
DecisionTree	2.0254	2.0206

Future Research

RECOMMENDATION FOR NEXT RESEARCH

- Do color calibration using the extracted color palette

Thank you