



# FACE PARAMETERIZATION THROUGH NEURAL NETWORKS

Relatore: Stefano Ferrari



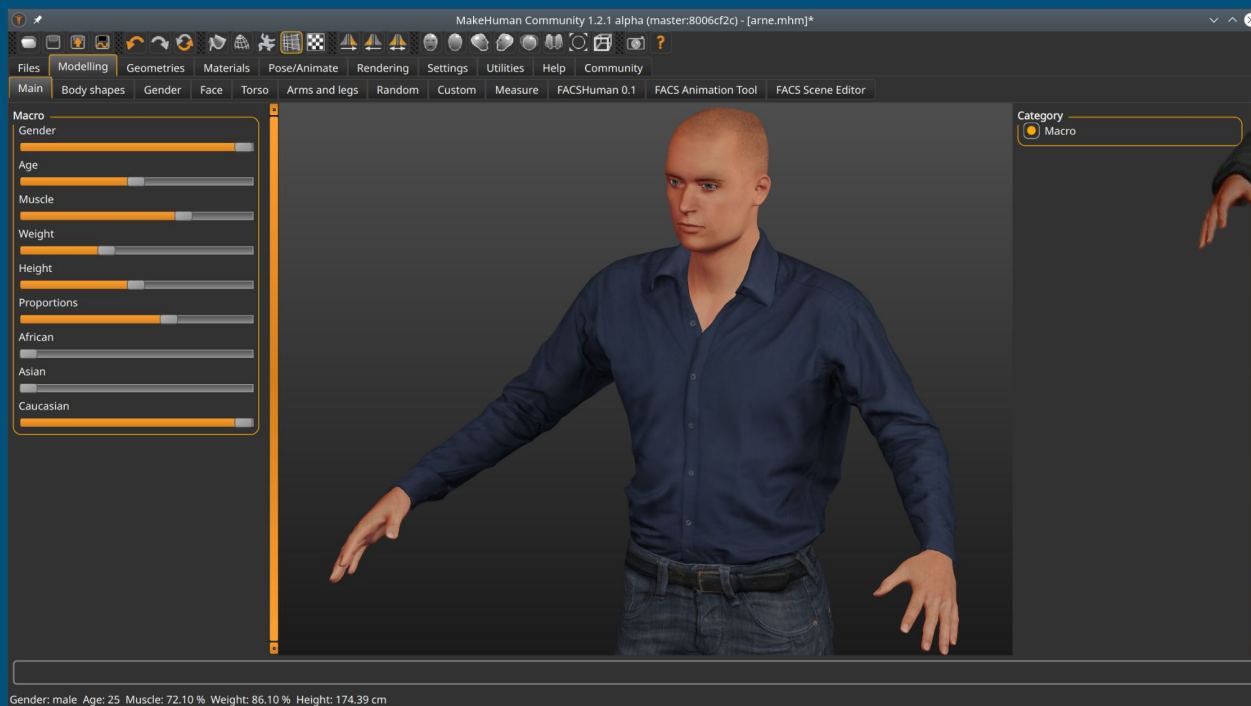
# Privacy and Datasets

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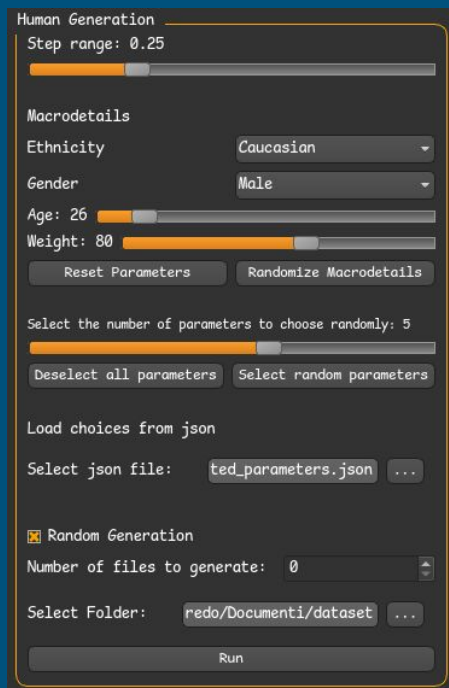
Handling real-world data, especially facial images, presents significant privacy risks in machine learning and computer vision applications, while using synthetic data offers several advantages:

- Eliminates the need for sensitive real-world data.
- Ensures compliance with data protection regulations.
- Provides customizable and diverse datasets for training.
- Promotes ethical AI development by preventing the misuse of personal data.

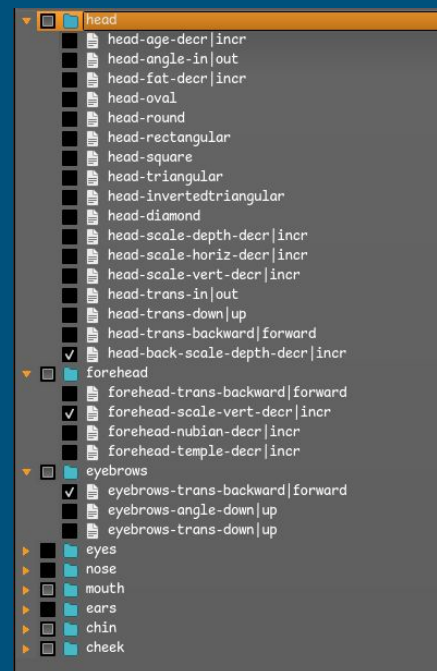
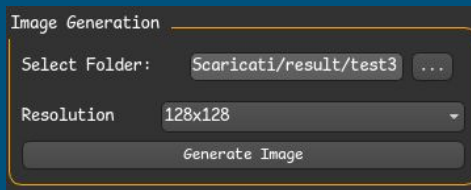
# MakeHuman



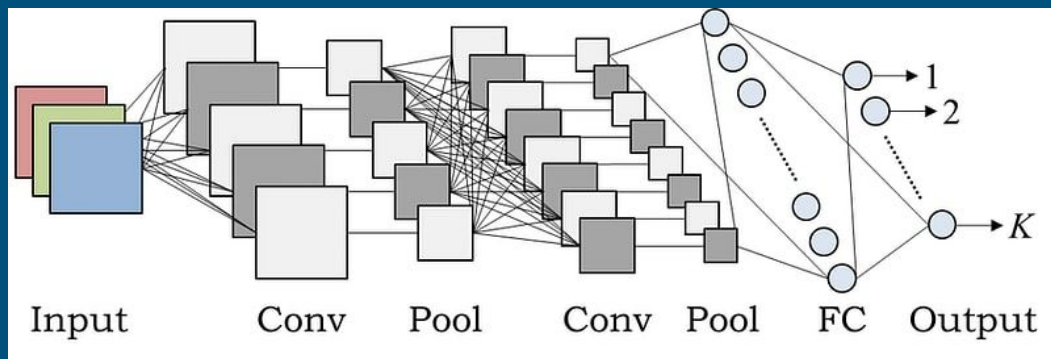
# FaceGen Plugin (MakeHuman+Blender)



The plugin automatically generates the files and corresponding images of the model based on the selected facial parameters.



# Model Architecture



The architecture shown in the picture is a standard CNN. The one developed differs in the composition of its layers.

The model is composed by:

- 3 Convolutional layers
- 2 Pooling blocks
- 3 Fully connected blocks

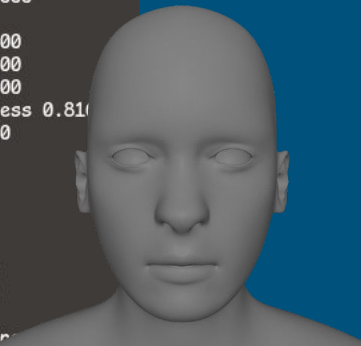
The output of the network is an array of 138 parameters which are the ones referring to the facial feature of the model.

# Dataset Creation

The dataset is composed of pairs of files:

- MHM file
- The corresponding image

```
version v1.2.1
camera 359.5 355.0 0.0 0.0 0.0 1.0
modifier nose/nose-trans-down|up 0.886000
modifier nose/nose-trans-backward|forward 0.702000
modifier nose/nose-trans-in|out 0.488000
modifier nose/nose-scale-vert-decr|incr -0.444000
modifier nose/nose-scale-horiz-decr|incr 0.582000
modifier nose/nose-scale-depth-decr|incr 0.494000
modifier nose/nose-compression-compress|uncompress 0.810000
modifier nose/nose-curve-concave|convex 1.000000
modifier macrodetails/Gender 0.500000
modifier macrodetails/Age 0.500000
modifier macrodetails/African 0.333333
modifier macrodetails/Asian 0.333333
modifier macrodetails/Caucasian 0.333333
modifier macrodetails-universal/Muscle 0.500000
modifier macrodetails-universal/Weight 0.500000
modifier macrodetails-height/Height 0.500000
modifier macrodetails-proportions/BodyProportion
```



|      |       |     |   |       |     |
|------|-------|-----|---|-------|-----|
| 0.62 | -0.80 | 0.2 | 1 | -0.92 | ... |
|------|-------|-----|---|-------|-----|

# Pipeline Test

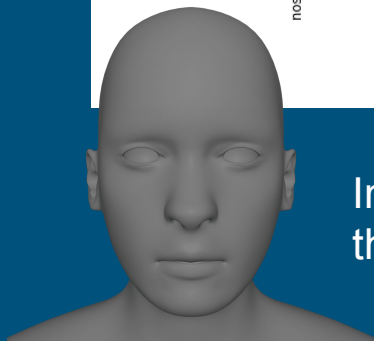
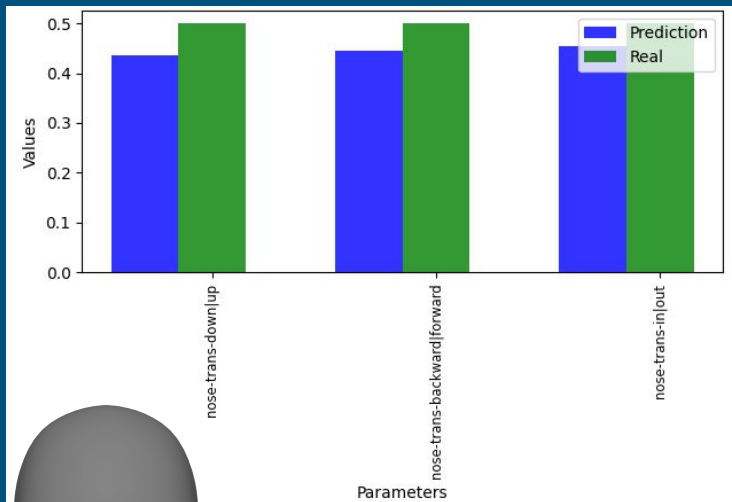


Image created using  
the MakeHuman plugin

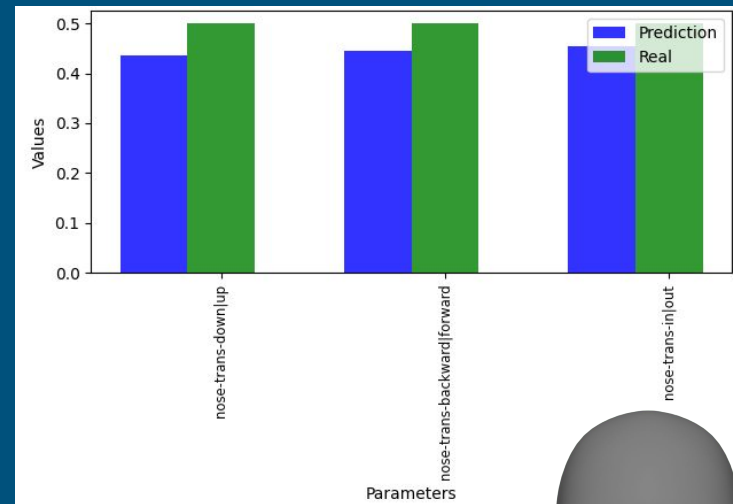


Image obtained from  
the values predicted by  
the model

# Gradual Training

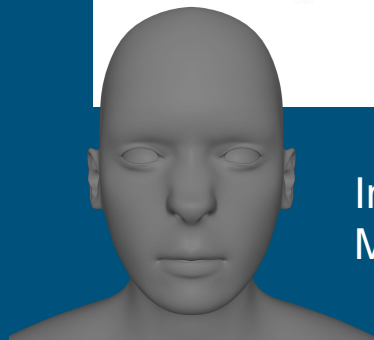
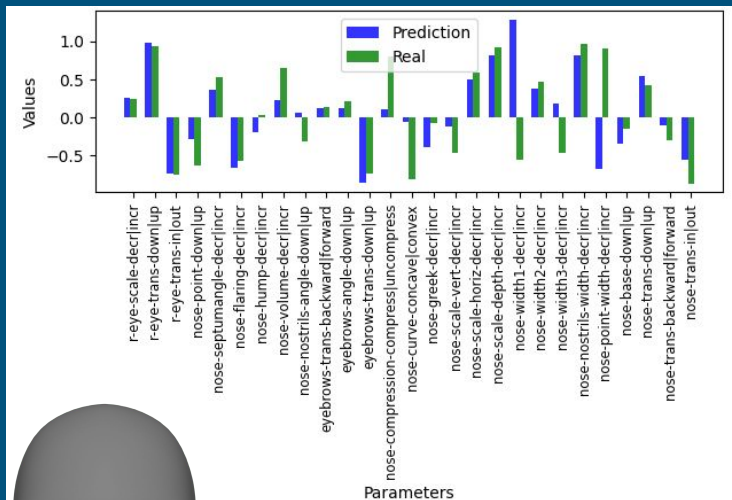


Image created using the MakeHuman plugin

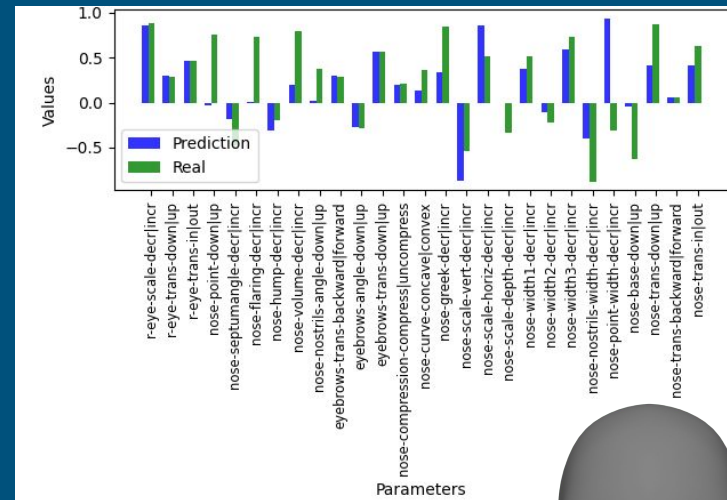


Image obtained from the values predicted by the model

# All Parameters Prediction (10000 samples)

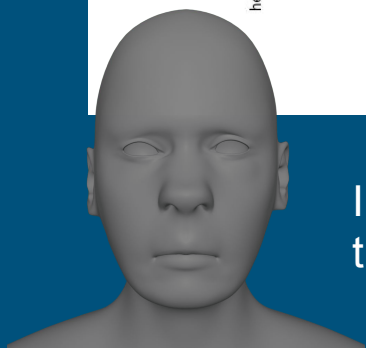
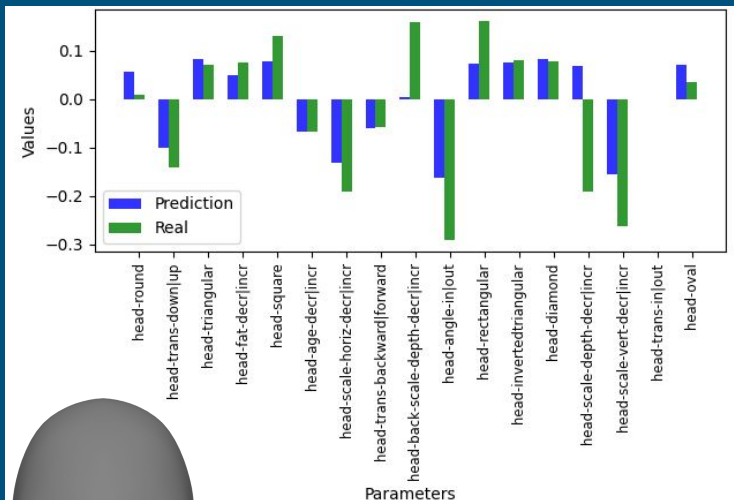


Image created using the MakeHuman plugin

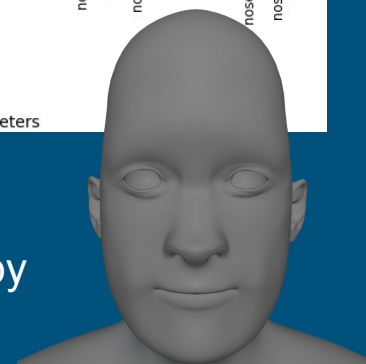
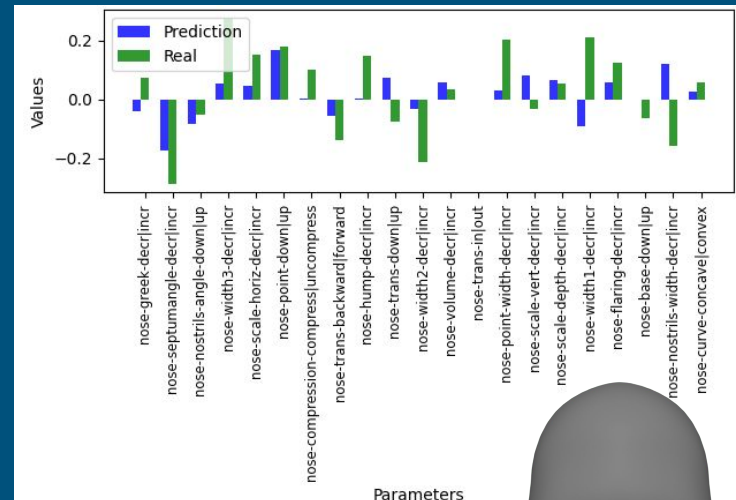
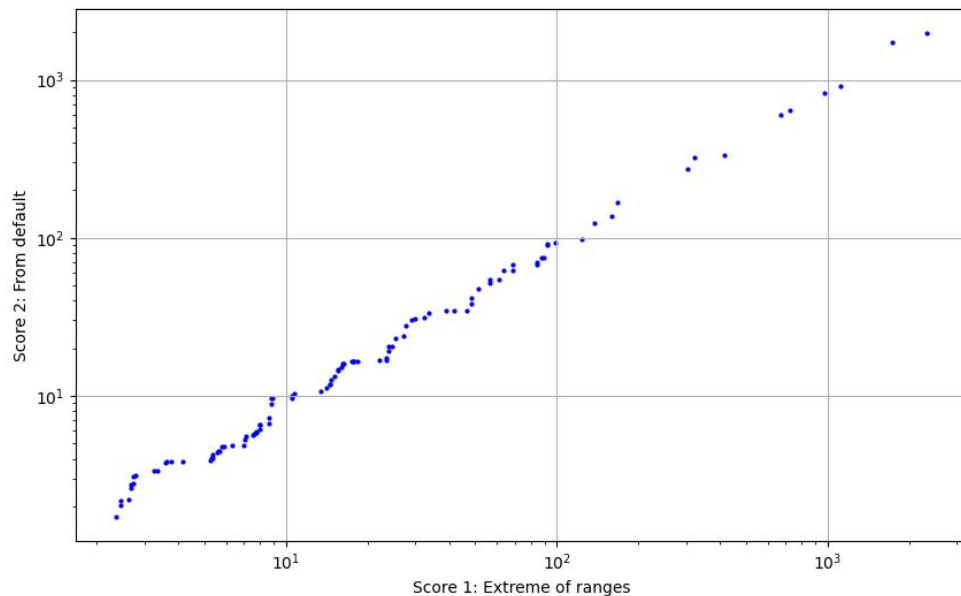


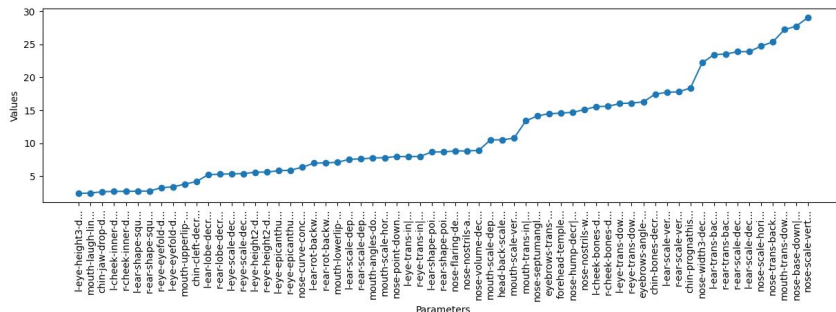
Image obtained from the values predicted by the model

# Parameters Selection



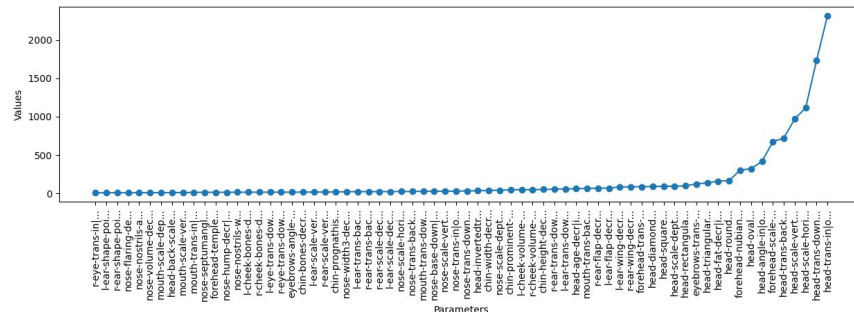
$$MSD = \frac{1}{N} \sum_{i=1}^N (\text{img}_1(i) - \text{img}_2(i))^2$$

# Parameters Selection



Parameters chosen  
according to the 25th-75th  
percentile  
(68 params)

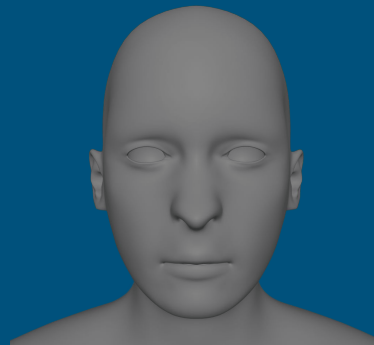
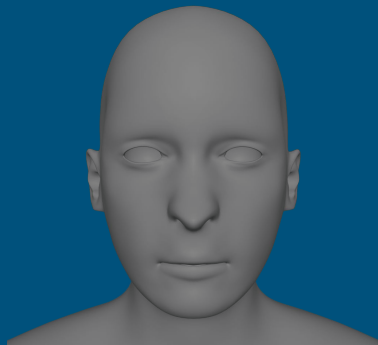
Parameters chosen  
according to the  
50th-100th percentile  
(69 params)



# Results

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25th-75th



MSE=0.00547

50th-100th



MSE=0.00581

# Real Image prediction

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# Real Image prediction



Image to predict

Image predicted by  
the model 50th-100th

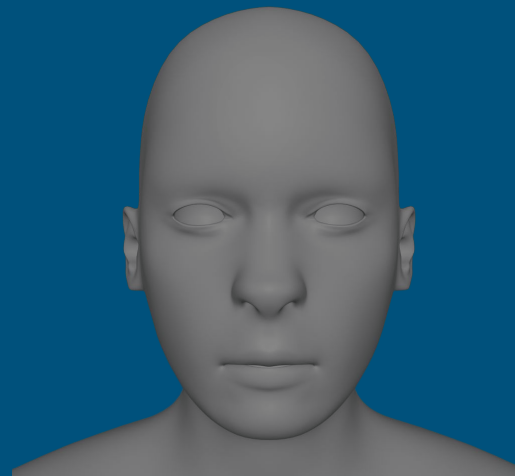


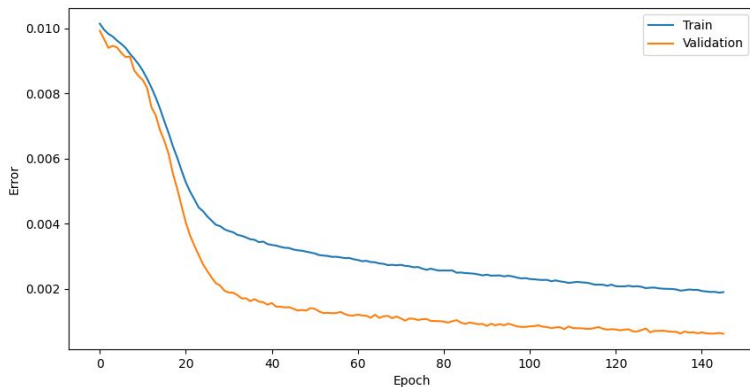
Image predicted by  
the model 25th-75th



# Thanks for your attention

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# Pipeline Test Information



Information about dataset generated with combinatorial approach:

- Step value chosen is 0.25
- 729 pairs generated

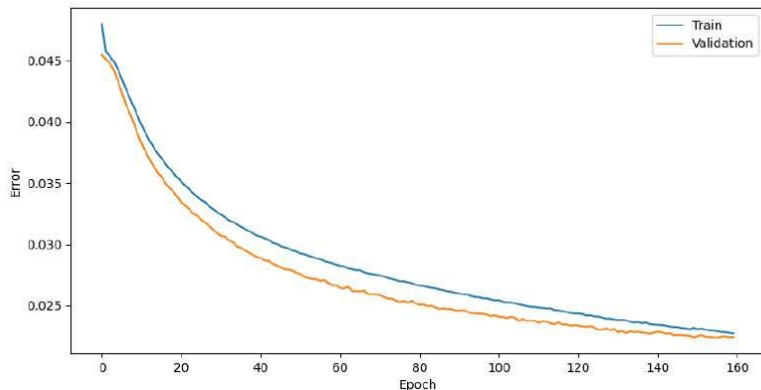
Information about time execution:

- 1 seconds for generating all the 729 mhm files
- 332(6 minutes) second for generating the related images
- 104 seconds for training

Information about model training:

- Learning rate = 0.00001
- Batch size for training = 64
- Batch size for validation and test = 32
- 146 epochs performed
- Final MSE = 0.0005

# All Parameter Information



Information about dataset generated with random approach:

- 10000 pairs generated

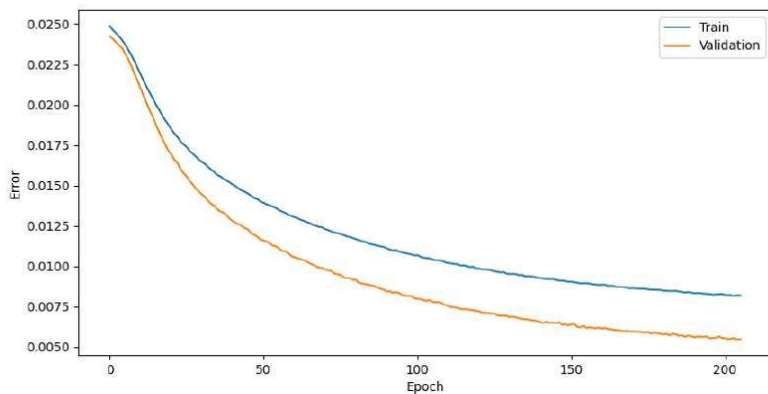
Information about time execution:

- 32 seconds for generating all the 10000 mhm files
- 5 hours for generating the related images
- 67 minutes for training

Information about model training:

- Learning rate = 0.0001
- Batch size for training, validation and test = 128
- 160 epochs performed
- Final MSE = 0.022

# First model Information



Information about dataset generated with random approach:

- 68 parameters involved
- 8000 pairs generated

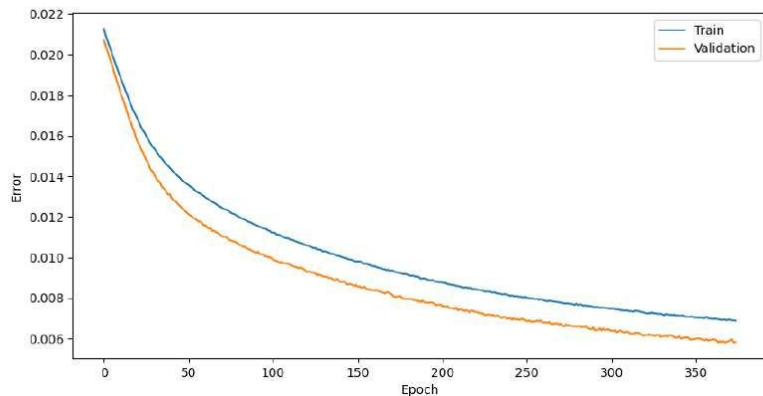
Information about time execution:

- 25 seconds for generating all the 8000 mhm files
- 4 hours for generating the related images
- 55 minutes for training

Information about model training:

- Learning rate = 0.00001
- Batch size for training, validation and test = 128
- 206 epochs performed
- Final MSE = 0.00547

# Second model Information



Information about dataset generated with random approach:

- 69 parameters involved
- 8000 pairs generated

Information about time execution:

- 25 seconds for generating all the 8000 mhm files
- 4 hours for generating the related images
- 68 minutes for training

Information about model training:

- Learning rate = 0.00001
- Batch size for training, validation and test = 128
- 374 epochs performed
- Final MSE = 0.00581