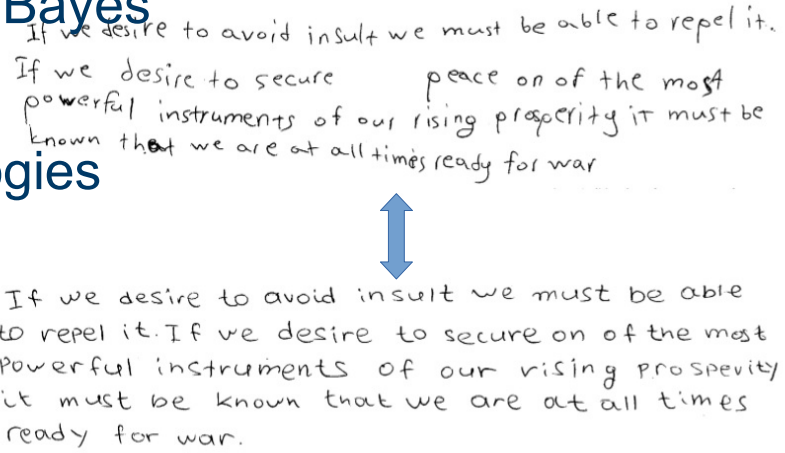
Writer Verification Visualization

- Highlight similar/dissimilar regions in writings online
- Local feature extraction + local naive Bayes NN
- Requires knowledge in Web-technologies
- 10 ECTS

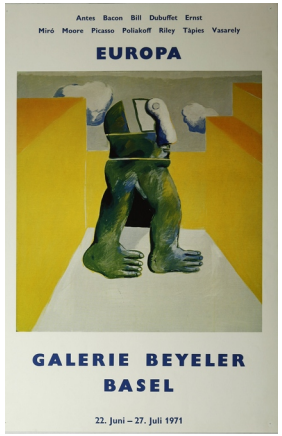
Contact: vincent.christlein@fau.de

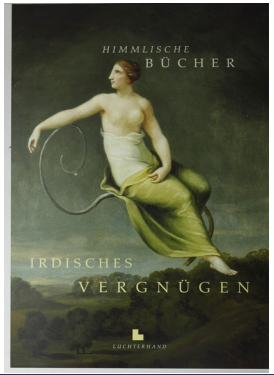


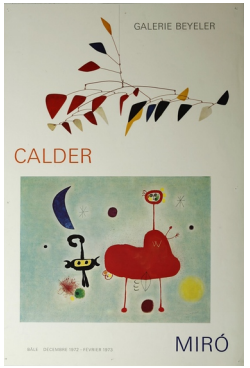
Style Classification in Posters

- Style classification using WikiArt
  - Crawl WikiArt (images+styles)
  - Train DL-based network w. WikiArt data
  - Apply to poster data

- 5/10 ECTS Project
- Contact: vincent.christlein@fau.de



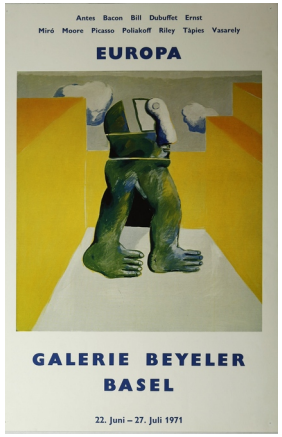


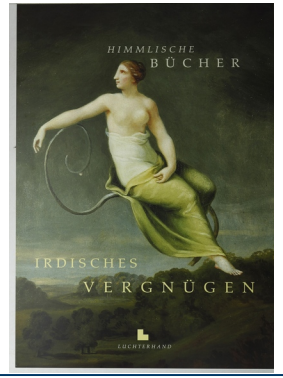


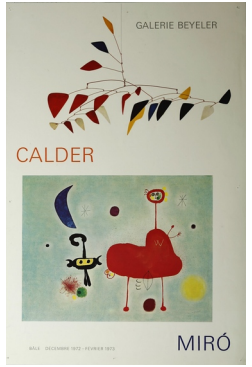
Genre/Motif Classification in Posters

- Scene text detection
- Topic modeling of text

- 5/10 ECTS Project
- Contact: vincent.christlein@fau.de

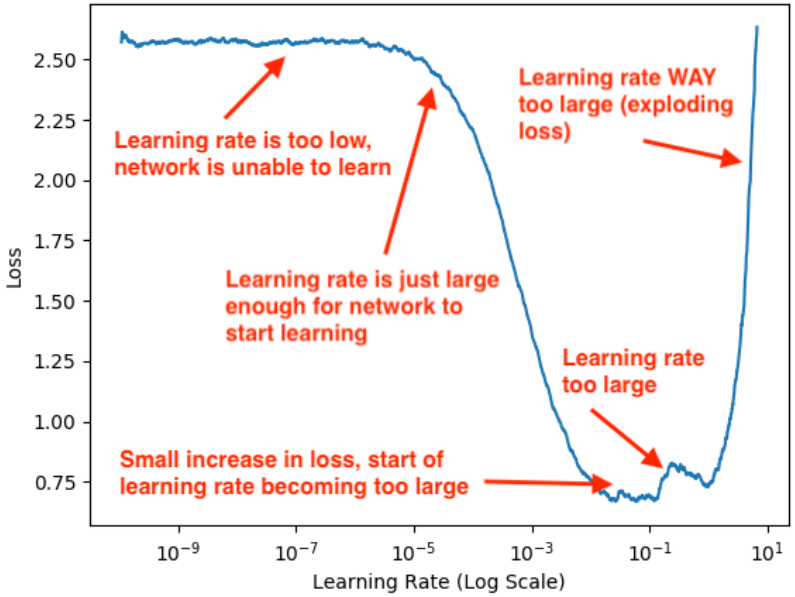






N-D Parameter Finder

- LR Finder (fastAi) is a nice algorithm to find an adequate starting LR (s. plot right)
- Task: expand to N-dimensions, e.g. incorporating weight decay, momentum, etc.
- 5 ECTS
- Contact: vincent.christlein@fau.de



Reconstruction-based Super-resolution

- Reconstruction-based superresolution
  - Implementation in PyTorch
  - Matlab/Python Code exists

- 5 ECTS Project
- Contact: vincent.christlein@fau.de

Jigsaw Puzzle Solving of Historical Fragments

- Implementation of deep learning-based jigsaw puzzle solver
- Evaluation on historical fragment dataset

- 5/10 ECTS Project / BT
- Contact: vincent.christlein@fau.de

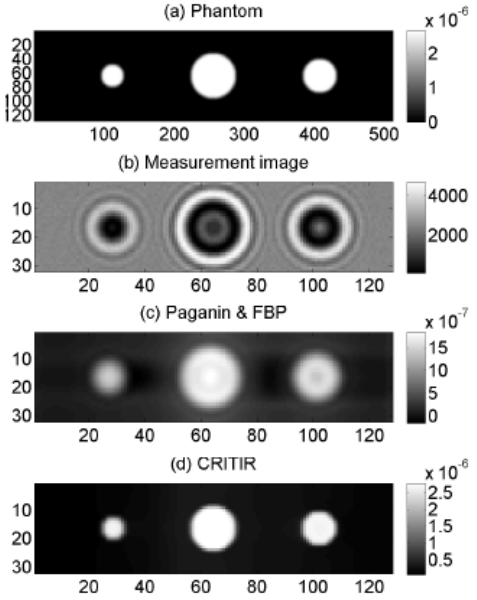
Direct Model-based Tomographic Reconstruction of the Complex Refraction

- Optimization-based approach (ADMM) to avoid reconstruction artifacts in phase tomography [1]
- Prototypical implementation in C is available

Research Project: (5 or 10 ECTS)

- Understand the ADMM optimization tasks
- Adjust the code and apply it to X-ray refraction scans at the material sciences department

Contact: Lina Felsner (lina.felsner@fau.de), C. Riess



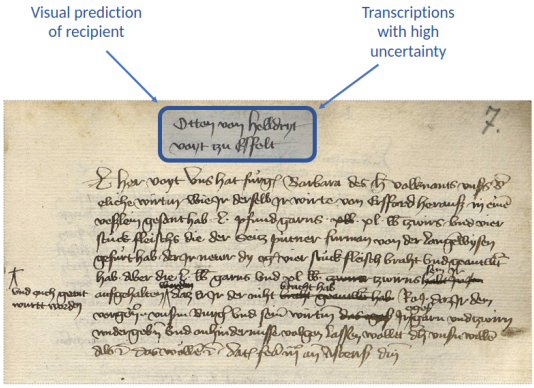
Example results from [1]

[1] K.A. Mohan, X. Xiao, and C. A. Bouman. *IEEE International Conference on Image Processing (ICIP)*, 2016.

Recipient Detection in Historical Documents

Fuse probabilities of transcriptions and visual features to detect recipients:

- Implement/use image segmentation architectures (U-Net) and seq2seq models for historical documents
- Development of tool with streamlit to integrate expert knowledge
- 5/10 ECTS Project
- Contact: martin.mayr@fau.de

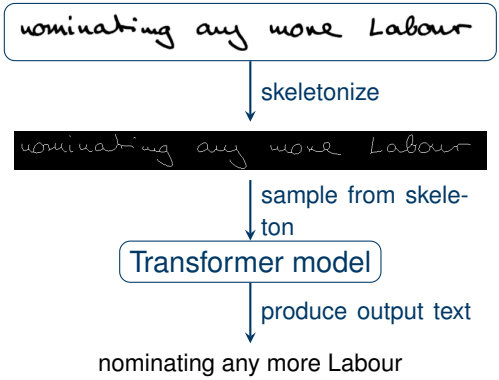


HTR-Transformer with Point Clouds

Implement an HTR-Transformer which uses point cloud data from the text lines instead of computing visual features with big feature encoder model:

- No training of feature encoder model is needed
- Sampled points are positional encoded
- Implicit data augmentation due to sampling

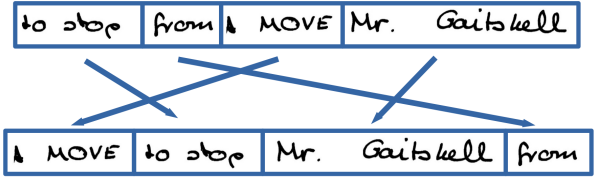
- 5/10 ECTS Project
- Contact: martin.mayr@fau.de



Self-Supervised Learning for HTR-Transformer

Implement and evaluate different self-supervised learning methods in the field of transformer models for HTR:

- Transformer models are hard to train, especially in combination with a huge feature encoder for visual inputs
- Self-supervised learning (subfield of unsupervised learning) is extensively used in many fields due to performance gains and increased training robustness.



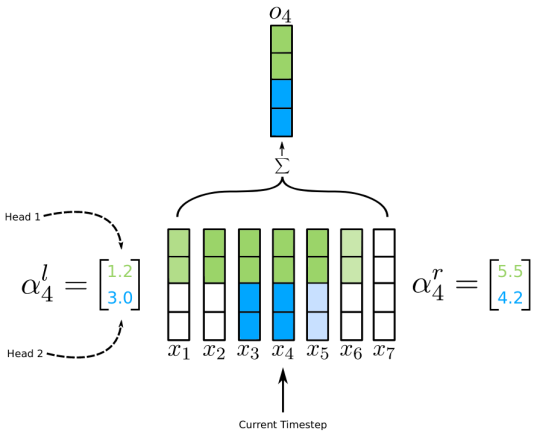
- 5/10 ECTS Project
- Contact: martin.mayr@fau.de

HTR-System with Time-aware Large Kernel (TaLK) Convolutions

Build an HTR system with TaLK convolutional layers:

- Attention models with TaLK convolutions are more efficient than transformer models ($O(n)$ vs $O(n^2)$)
- Neighbouring relation of letters in text line is modelled more reliable than in transformer models

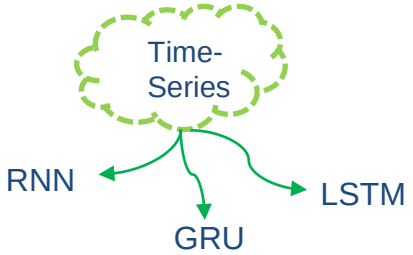
- 5/10 ECTS Project
- Contact: martin.mayr@fau.de



Sheet Metal Forming Limits Determination Using DL_Time-Series

- Growing interest in CO2 emission reduction, low usage of petrol and complex design of automobiles has lead the automotive industry to think of using new, high-strength, light weight materials that differ significantly from the conventional ones. This project uses deep learning methods to correctly define the forming capacity of the new materials.

- **Objective:** Sheet metal forming capacity determination
  Data: Recorded video sequence using Digital Image Correlation (DIC) systems/cameras and recorded vibration and sound via Piezoelectric wafer active sensors (PWAS) both during the formation procedures



- **Main Tasks:**
  - Image/ signal processing using **time-series** algorithms

- The tasks in this project are suitable for 5, 10, or 30 ECTS.
- **Interested?** Please contact Faezeh Nejati (**faezeh.nejati@fau.de**)
- **Requirements:**
  - B+ or higher python programming language skills,
  - Solid knowledge on deep learning basics and time series algorithms

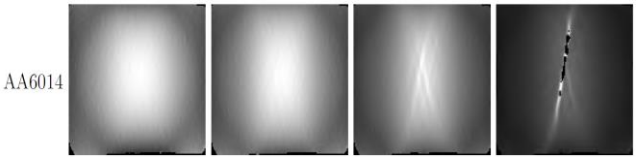


Figure1: Different formation stages of AA6014 (AA6014 is a light-weight aluminum alloy of the 6xxx series, that is used in car-body structures)

Sheet Metal Forming Limits Determination Using DL_Denoising

- **Objective:** Sheet metal forming capacity determination
  Data: Sound and vibration, recorded via Piezoelectric wafer active sensors (PWAS) during metal formation procedure

- **Main Tasks:**
  - State-of-the-art **denoising** algorithms for **signals**

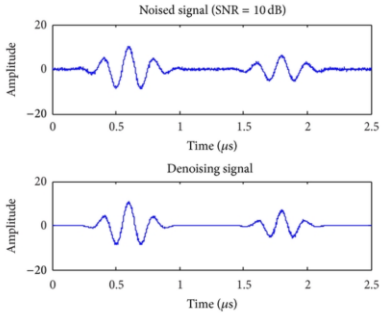


Figure 1: Noisy and Denoised signals [1]

- The tasks in this project are suitable for 5, 10, or 30 ECTS.
- **Interested?** Please contact Faezeh Nejati (**faezeh.nejati@fau.de**)
- **Requirements:**
  - B+ or higher python programming language skills,
  - Solid knowledge on deep learning basics and time series algorithms

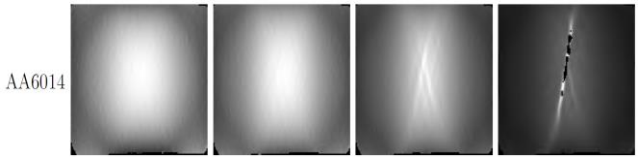


Figure 2: Different formation stages of AA6014 (AA6014 is a light-weight aluminum alloy of the 6xxx series, that is used in car-body structures)

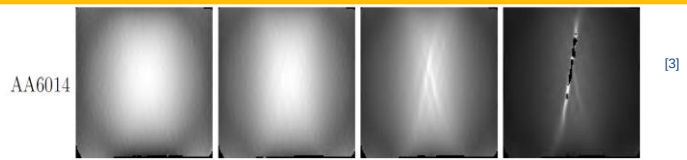
[1] Cai, Haichao, et al. "Study on the thick-walled pipe ultrasonic signal enhancement of modified S-transform and singular value decomposition." Mathematical Problems in Engineering 2015 (2015).

Sheet Metal Forming Limits Determination Using DL_FEM/ FEA

- Growing interest in CO2 emission reduction, low usage of petrol and complex design of automobiles has lead the automotive industry to think of using new, high-strength, light weight materials that differ significantly from the conventional ones. This project uses deep learning methods to correctly define the forming capacity of the new materials.

- **Main Tasks:**
  - **Simulation** using the Finite Element Methods (**FEM**)
    + Graph Neural Network
- A cool video related to **a similar study** to this project idea (Don't miss it! ;))**:**
  - https://www.youtube.com/watch?v=2Bw5f4vYL98

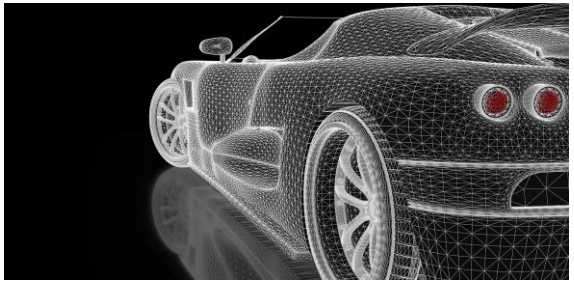
- The tasks in this project are suitable for 5, 10, or 30 ECTS.
- **Interested?** Please contact Faezeh Nejati (**faezeh.nejati@fau.de**)
- **Requirements:**
  - B+ or higher python programming language skills,
  - Solid knowledge on deep learning basics and time series algorithms



[3]

Figure 3: Different formation stages of AA6014 (AA6014 is a light-weight aluminum alloy of the 6xxx series, that is used in car-body structures)

[1]



[2]

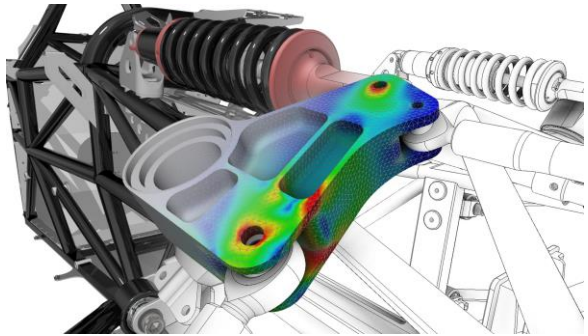
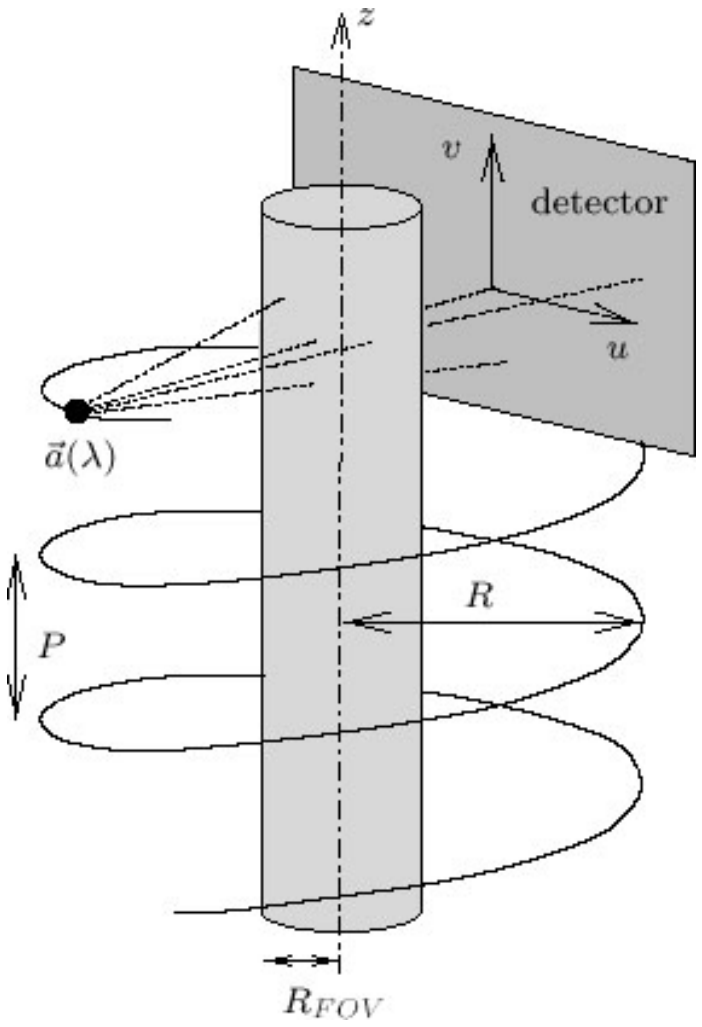


Figure1,2: Finite Element Analysis (FEA) Simulations
[1] https://www.fea-simulations.com,
[2] https://simonstoneengineering.com/services/simulation-analysis-fea/

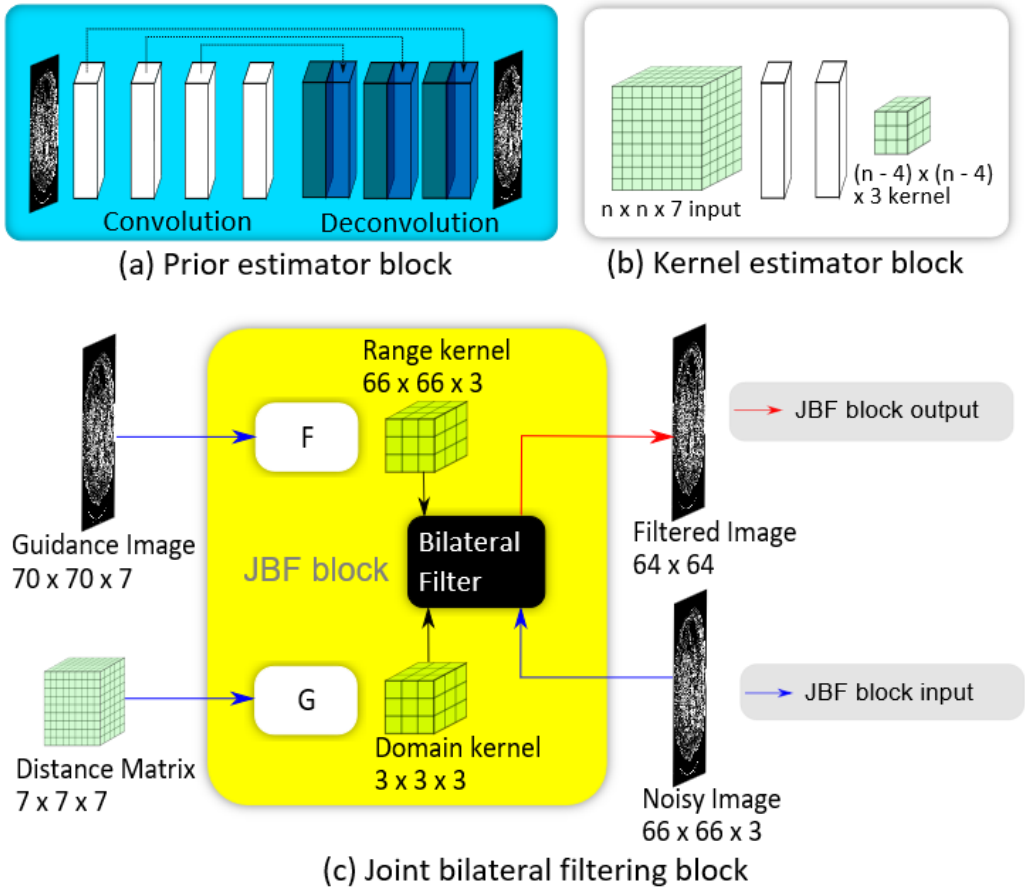
Reconstruction of spiral CT with deep reinforcement learning

- Research project worth 10 ECTS.
- Can be extended to a Master Thesis.
- Needs good Python and C++ skills. Some knowledge of CT physics is helpful.
- Contact: mayank.patwari@fau.de



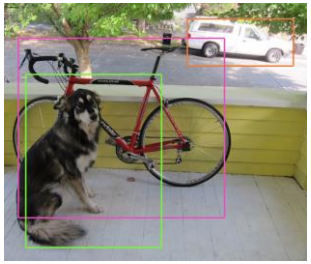
Deep Learning with very low number of parameters for CT noise removal

- Research project worth 10 ECTS.
- Can be extended to a Master Thesis.
- Needs good Python and C++ skills. Some knowledge of image processing is helpful. Previous experience with PyTorch is an asset.
- Contact: mayank.patwari@fau.de



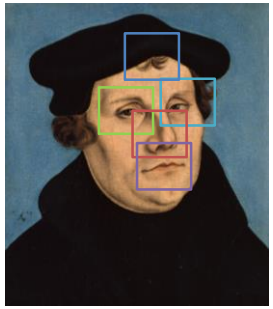
Object Detection in Historical Portraits

- Art workshops often reused their motifs directly or to some extend
- To compare visually striking image patches we need to detect their location as bounding boxes



Object detector (e.g. YOLO[1])

Transfer to paintings and prints



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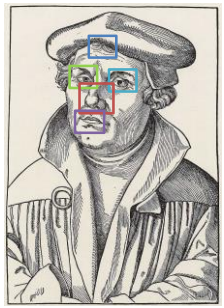


Ehemals Sammlung Liechtenstein

Bounding box detection

Research project task (5 ECTS):

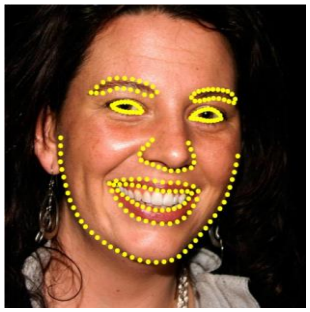
- Annotate bounding boxes of visually striking elements (such as eyes, mouth, hands) in paintings and prints
- Adapt and extend existing machine learning / deep learning methods for bounding box detection
- Implementation in Python (PyTorch or TensorFlow)

Contact:
Aline Sindel
Room 10.138
aline.sindel@fau.de

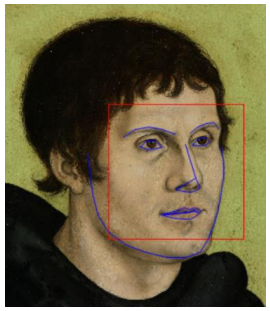
[1] J. Redmon, S. Divvala, R. Girshick and A. Farhadi, "You Only Look Once: Unified, Real-Time Object Detection," 2016 IEEE CVPR, 2016, pp. 779-788.
Image sources of paintings and prints: Lucas Cranach, Portrait of Martin Luther, Cranach Digital Archive (CDA) and Germanisches Nationalmuseum (GNM) Nürnberg

Face Detection in Historical Portraits

- Art workshops often reused their motifs directly or to some extend
- To align the faces of different portraits we need to detect their location as facial landmarks



Facial landmark detector (e.g. Dlib[1])



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Transfer to prints

DE_GNM_Mp_14637_a

Facial landmark detection

Research project task (5 ECTS):

- Annotate facial landmarks in prints
- Adapt and extend existing machine learning / deep learning methods for facial landmark detection
- Implementation in Python (PyTorch or TensorFlow)

Contact:
Aline Sindel
Room 10.138
aline.sindel@fau.de

[1] V. Kazemi and J. Sullivan, "One millisecond face alignment with an ensemble of regression trees," 2014 IEEE CVPR, 2014, pp. 1867-1874.
Image sources of paintings and prints: Lucas Cranach, Portrait of Martin Luther, Cranach Digital Archive (CDA) and Germanisches Nationalmuseum (GNM) Nürnberg