da/sec
BIOMETRICS & SECURITY
RESEARCH GROUP

Seminar-Preparation

Biometric Systems (FBI 41.5094 and 84.2025)

Christoph Busch

Janier Gonzalez-Soler

Biometrics

*"Automated recognition of individuals based on their **behavioural** and **biological** characteristics"*

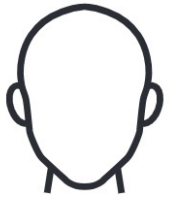
Behavioural

Gait

Signature

Keystroke

Biological



Face

Fingerprint

Iris

Mixed

Voice

Supervisors

- Seminar supervision
  - Christoph Busch (christoph.busch@h-da.de)
  - Janier Gonzalez-Soler (lazaro-janier.gonzalez-soler@h-da.de).
- General questions + topic specific questions

Supervisors

- Additional topic-specific supervision:
  - Juan Tapia – juan.tapia-farias@h-da.de.
  - Florian Bayer– florian.bayer@h-da.de.
  - Andre Doersch – andre.doersch@h-da.de.
  - Ana Estrada-Real – ana.estrada-real@h-da.de.
  - Hans Geissner - hans.geissner@h-da.de.
  - Torsten Schlett – torsten.schlett@h-da.de.
  - Robert Nichols - robert.Nichols@h-da.de.

Seminar Scope

- Students are invited to join research on Biometrics.
  - Topics are aligned with our research work.

  https://www.dasec.h-da.de.

- Term paper summarises your own personal research.

Term paper topics (18)

- See syllabus document on the course website
  - Fingerprint.
  - Biometric Security.
  - Tattoos.
  - Face.
  - Iris/Periocular.
  - Other.

Term paper topics (18)

Term paper topic presentation (1 min-intro + 2 min-topic):

1. Lazaro Janier Gonzalez-Soler (AMD, QPD, OGT).
2. Christoph Busch (MBL).
3. Juan Tapia (GCI).
4. Ana Real (LMF, CFR).
5. Florian Bayer (QFE, MPB).
6. Torsten Schlett (JXL, FCC, EFS).
7. Andre Dörsch (TFP, DGO).
8. Hans Geißner (ICS, SBC).
9. Robert Nichols (OSC, PNR).

Lazaro J. Gonzalez-Soler

Senior Researcher

- D19 room 2.01 (Schöfferstrasse 10 – second floor)
- Languages: Spanish, English, some German
- Term paper topics: AMD, QPD and OGT

Research interests:

- Biometric Security
- Presentation Attack Detection.
- Image Forensics.
- Biometric and Multi-biometric Systems.

Analysis of Age Gap for Face Morphing Attack Detection (AMD)

Motivation:

- A morph image may be perceptually similar in terms of age to the accomplice, but there is a gap with the criminal.
- Analysis of the age difference in the morph image created between the criminal and the accomplice.

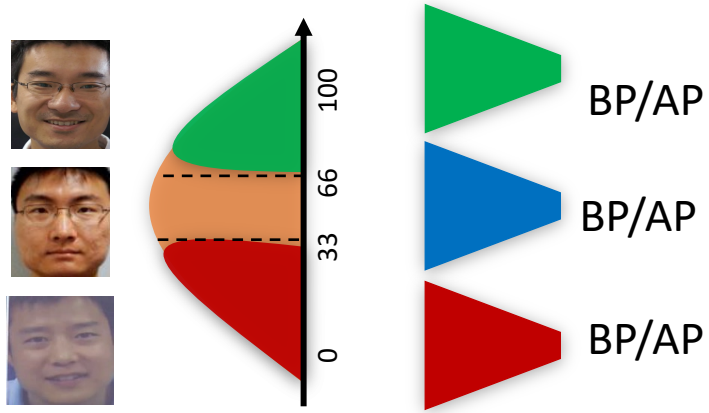
Tasks:

- Compute the the features embeddings for two provided databases using different face recognition systems (at least two).
- Benchmark the risk of the morphing image when it is close, in terms of age, to the criminals.

Exploring Sample Quality for Face Presentation Attack Detection (QPD)

Motivation:

- PAD algorithms exhibit varied performance depending on the image quality.
- The separated training per image quality range might improve overall detection.



MagFace

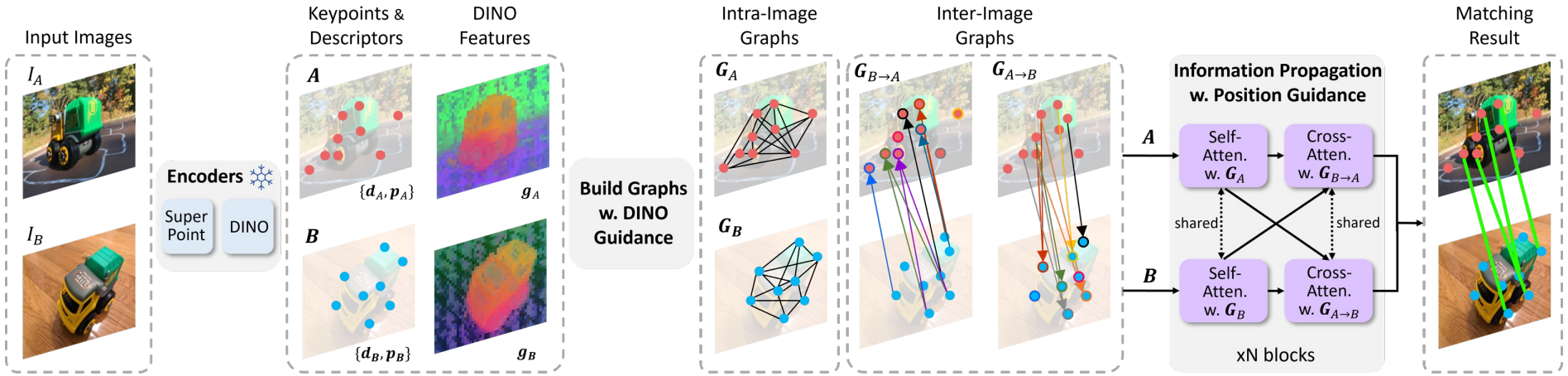
Tasks:

- Define sample quality ranges and split provided databases per quality range
- Train the provided DNN for each sample quality range on one database and evaluate it.

Feature Matching with Foundation Model Guidance for Tattoo Retrieval (OGT)

Motivation:

- Tattoo retrieval systems require mainly previous training steps.
- OmniGlue is agnostic to the input images.



Tasks:

- Get OmniGlue running.
- Evaluate it for tattoo retrieval on two provided databases and benchmark against SOTA.

Christoph Busch

Professor

- D19 room 2.07 (Schöfferstrasse 10 – second floor right)
- Languages: English, German
- Term paper topics: MBL

Research interests:

- Biometric sample quality
- Face recognition
- Fingerprint recognition
- Iris recognition

Motion Blur Labelling (MBL)

Motivation:

- Learn about motion blur in face images
- Learn about face image quality assessment

Quality Measure Value: 70

Quality Measure Value: 20

Tasks:

- Label a small dataset with motion blur ratings
- Use an algorithm to measure the motion blur

Juan Tapia

Senior Researcher

- D19 room 2.02 (Schöfferstrasse 10 – second floor)
- Languages: English, Spanish, Portuguese
- Term paper topics: GCI

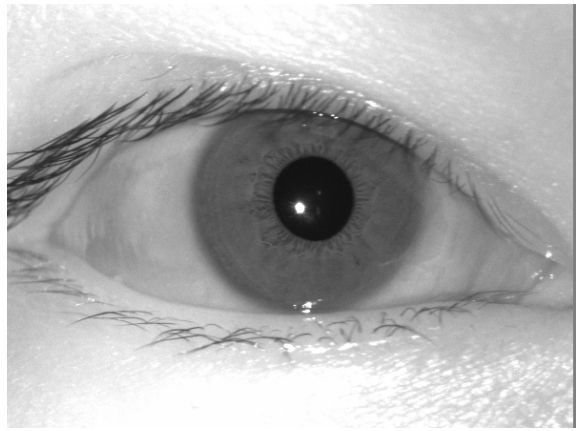
Research interests:

- Face/Iris recognition
- Presentation Attack Detection
- Digital Manipulation Attack

Gender Classification and Visualization using NIR periocular Iris Images (GCI)

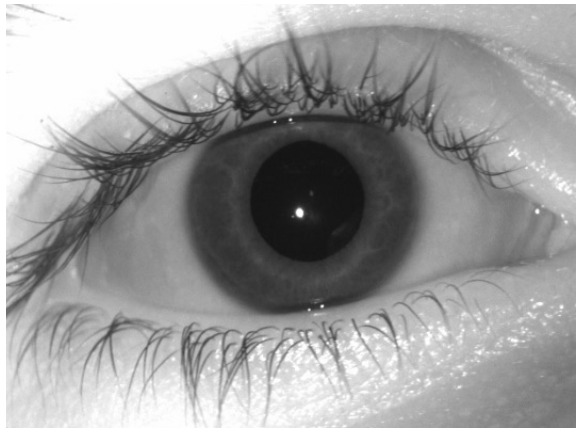
Motivation:

- Gender classification and visualization using Iris images is an innovative approach that leverages biometric features for identifying gender traits.



Tasks:

- Train a Periocular iris gender classification based on VisionTransformer (MobileVIT or Another)
- Evaluated gender classification.
- Explore visualization of relevant areas according to parameters (Attention Block).
- Report/compare results using the D-EER, and DET curves.



Ana Real

PhD Candidate

- D19 room 2.02 (Schöfferstrasse 10 – second floor)
- Languages: English, Spanish
- Term paper topics: LMF, CFR

Research interests:

- Explainability for biometric systems.
- Face quality assessments and facial recognition interpretation.
- Explainable capabilities for diverse users.

Training Large Language Models for Face Quality Assessments (LMF)

Motivation:

- With the increased use of biometrics in our daily life (e.g. border control, criminal justice, healthcare services), and the known limitations of face recognition algorithms (bias, incomplete data, manipulated data) it is important to get explanations from the algorithms that are making decisions based on our data.
- The design of these explanations is still under development.

Tasks:

- Get familiarized with the OFIQ Quality measures.
- Train the LLM to be able to describe facial images based on this assessment (e.g. illumination, sharpness, eyes open…).
- Evaluation of the answers.

Based on the image:

- **Illumination:** The lighting appears soft and even, likely from a diffused light source, as there are no harsh shadows or highlights.
- **Sharpness:** The image is sharp, with clear details in facial features, hair, and clothing.
- **Eyes:** The eyes are open.
- **Expression:** The expression appears neutral, with no strong emotions such as smiling or frowning.
- **Motion:** The image is still, with no visible motion blur, indicating it is a posed or captured portrait.

Descriptive Chatbot for face recognition (CFR)

Motivation:

- To improve trust and compliance with the right of reply (GDPR), algorithms should be able to explain themselves regarding decisions that affect users.
- These explanations should be clear and understandable to different profiles of users.

Tasks:

- Design a user interactive model that describe the differences between two facial images in terms of their different parts (semantic segmentation) and finally give a comparison score (0%-100%) between the two identities (using synthetic data or images of public figures).
- Evaluate the accuracy of the descriptions.

Image S108161842
* Face shape: Oval
* Age range: 25-35 years old
* Skin tone: Fair, with prominent cheekbones
* Eye features:
+ Left eye: Closed eye with a slight upward tilt at the outer corner
+ Right eye: Opened eye with a subtle upward tilt and a faint sparkle in the pupil
* Hair color: Dark brown, straight, and relatively fine
* Body shape: Thin, athletic build
* Facial expression: Neutral, with no obvious emotions

Image S113923411
* Face shape: Round
* Age range: 18-25 years old
* Skin tone: Medium, with a warm glow
* Eye features:
+ Left eye: Opened eye with a bright and sparkling pupil
+ Right eye: Closed eye with a slight downward tilt at the outer corner
* Hair color: Light brown, wavy, and relatively thick
* Body shape: Lean, slender build
* Facial expression: Warm, cheerful smile

Face Shape: 20
Age Range: 30
Skin Tone: 15
Eye Features: 10
Hair Color: 5
From 1 to 100 how similar the pictures are?
Based on my previous comparison, I would rate the similarity between the two images as around **25-30.**

Florian Bayer

PhD Candidate

- D19 room 2.08 (Schöfferstrasse 10 – second floor)
- Languages: English, Spanish
- Term paper topics: MPB, QFE

Research interests:

- (Multi)-Biometric Template Protection
- Homomorphic Encryption
- Workload Reduction

Secure Multi-Party Computation for Biometrics (MPB)

Motivation:

- Multi-Party Computation provides security guarantees, even in the presence of corrupt parties at the cost of communication overhead
- Multiparty Homomorphic Encryption (MHE) has been proposed as a solution to the shortcomings of existing methods (communication overhead, interactivity)

Tasks:

- Implement biometric template comparison using MHE
- Benchmark performance metrics (accuracy, communication, time)
- Evaluate security properties (ISO/IEC 24745)

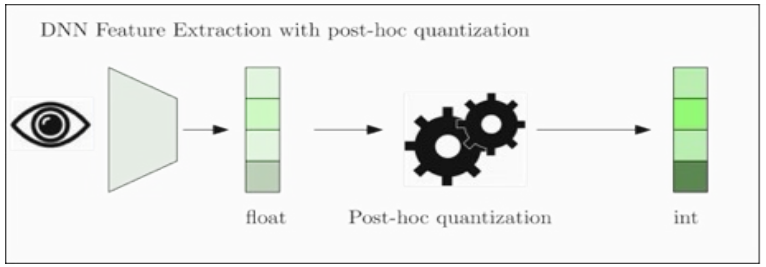
Quantized Deep Feature Extractors for Biometrics (QFE)

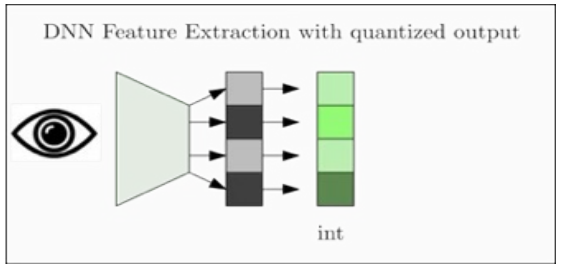
Motivation:

- Homomorphic Encryption (HE) is a promising tool for biometric information protection but introduces a significant computational overhead
- HE Schemes operating on integer or binary data demonstrate significantly superior performance in comparison to those utilizing approximate numbers.

Tasks:

- Modify an existing (pre-trained) face recognition model to produce quantized outputs (INT8, INT4, BIN)
- Evaluate biometric performance and compare with post-hoc quantization schemes





Torsten Schlett

PhD Student

- Darmstadt
- Languages: English, German
- Term paper topics: EFS, FCC, JXL

Research interests:

- Face Image Quality Assessment
  - Evaluation
  - Explainability
- Face Recognition

Explainable Face Recognition Survey (EFS)

Motivation:

For this topic “explainability” refers to 1. being able to explain how face image input is processed into the output, or 2. being able to explain what parts of the output mean.

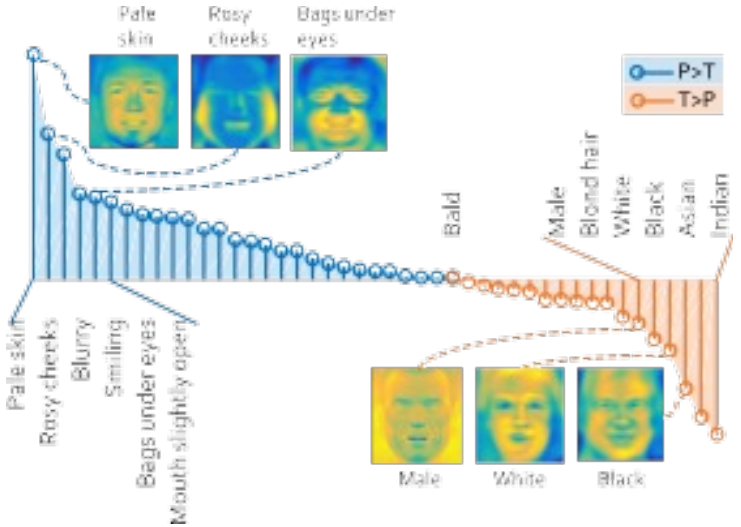
Face recognition and face image quality assessment approaches are not necessarily very explainable, but there are works that aim to improve the explainability.

Tasks:

Search for explainable face recognition and/or face image quality assessment literature.

Summarize the approaches and highlight (dis)similarities.

For face recognition literature, consider whether the approach could help with quality assessment in some way.



“Exploring Disentangled Feature Representation Beyond Face Identification”

Lossy Face Image Compression Comparison (FCC)

Motivation:

- Lossy image compression can substantially reduce the file size of face images, but this can affect the face recognition performance.
- There are various more recently developed codecs, which should be investigated in this context.

Tasks:

- Compare JPEG XL, HEIC, and AVIF across a set of file size limits in terms of the effect on face recognition comparison scores (similar to the starting material paper).
- Optional extensions: Investigate the effect on quality assessment, compare (de)compression speed, add other interesting codecs, compare different settings, ...

JPEG XL Compression Detection for Face Images (JXL)

Motivation:

- JPEG XL is a relatively new compression format.
- Face images may be converted between multiple formats.
- A model being able to estimate the JPEG XL compression quality from the decoded RGB image data may be useful.
- Results could become relevant for future face image quality assessment ISO standard revisions.

https://jpeg.org/jpegxl/

Tasks:

- Develop one or more models that assess the quality of a single image in terms of the effect of JPEG XL compression that may have been applied to the image.
- Evaluate the predictive performance of the models, regarding the compression strength.
- Optionally also examine the predictive performance regarding biometric utility, using e.g. FNM-EDC (False Non-Match - Error versus Discard Characteristic) curves.

Andre Dörsch

A picture of you of approximately these dimensions

PhD Student

- Darmstadt
- Languages: English, German
- Term paper topics: DGO, TFP

Research interests:

- Generative AI.
- Fairness in Biometrics.
- Face Image Quality Assessment.

Synthetic Data Generation for specific OFIQ Measures(DGO)

Motivation:

- For this topic “explainability” refers to 1. being able to explain how face image input is processed into the output, or 2. being able to explain what parts of the output mean.
- Face recognition and face image quality assessment approaches are not necessarily very explainable, but there are works that aim to improve the explainability.

Tasks:

- Search for explainable face recognition and/or face image quality assessment literature.
- Summarize the approaches and highlight (dis)similarities.
- For face recognition literature, consider whether the approach could help with quality assessment in some way.

Text-Guided Face PAD Survey Paper (TFP)

Motivation:

- It is a great topic to explore the intersection of natural language processing and facial recognition for presentation attack detection methods.

Tasks:

- Get familiar with Face PAD
- Research current state-of-the-art text-guided PAD methods, including NLP approaches.

Hans Geißner

PhD Student

- Darmstadt
- Languages: English, German
- Term paper topics: ICS, SBC

Research interests:

- Biometric Template Protection
- Biometric Cryptosystems
- Multi-Biometric Systems

Multi-Sample Fuison in Blometric Cryptosystems (SBC)

Motivation:

- Biometric Data is sensitive Data
- Biometric Cryptosystems (BCS) provide mechanisms to protect biometric data
- However within BCS performance is an issue.
- Multi-Sample Fusion might be able to increase the performance without reducing convenience

Tasks:

- Select 2 or 3 feature-level fusion methods
- Conduct a case study evaluating the chosen methods against a baseline system (single-sample enrolment).
- Compare the methods in terms of performance and security

Multi-Instance Fuison in Blometric Cryptosystems (ICS)

Motivation:

- Biometric Data is sensitive Data
- Biometric Cryptosystems (BCS) provide mechanisms to protect biometric data
- Entropy of Characteristic is often limited
- Within BCS performance is an issue
- Multi-Instance Fusion increases the total entropy and thereby performance

Tasks:

- Transform fingerprint embeddings to be compatible with the fuzzy vault scheme
- Simulate mated and non-mated comparisons for different scenario (1, 2, and 4 fingerprints).
- Evaluate the systems for performance and security.

Robert Nichols

PhD Student

- Weinheim, Germany
- Languages: English, German
- Term paper topics: OSC, PNR

Research interests:

- Face Recognition, Face manipulation & detection
- Human (Face) Perception (Experimental Psychology)
- Bias & Fairness
- Synthetic data

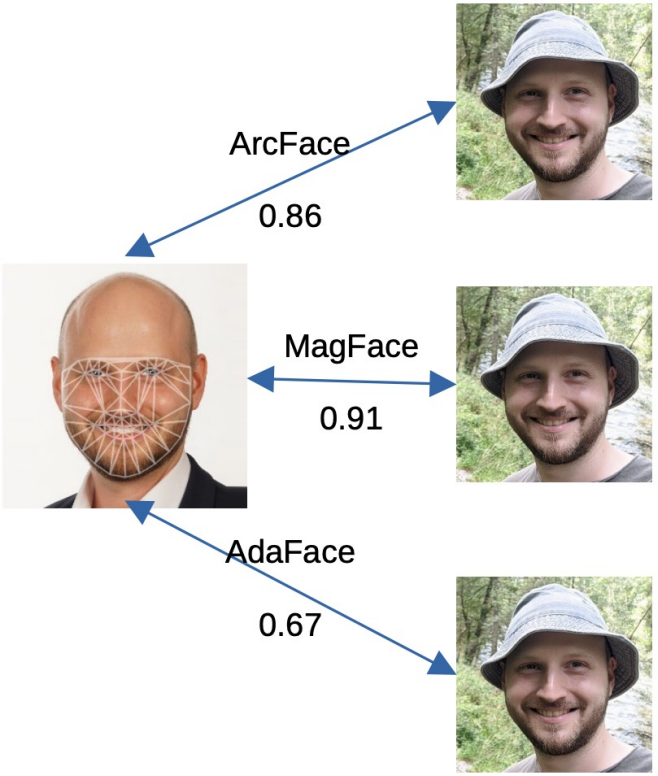
Open-Source Face Recognition Comparison (OSC)

Motivation

- Face recognition systems reach impressive performance levels
- Performance differences commercial vs. opensource
- Are open-source performance claims still valid in realistic use-cases?

Tasks

- Conduct a performance evaluation on contemporary open-source face recognition systems: ArcFace, MagFace, and AdaFace.
- Devise a testing protocol with the aim of modeling realistic use cases (challenging test data will be provided)



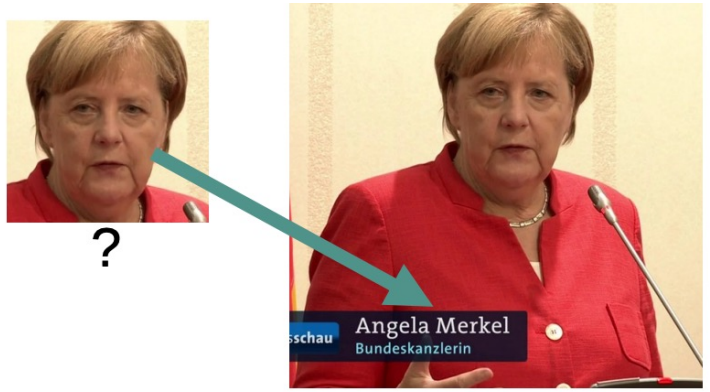
Person Name Recognition (PNR)

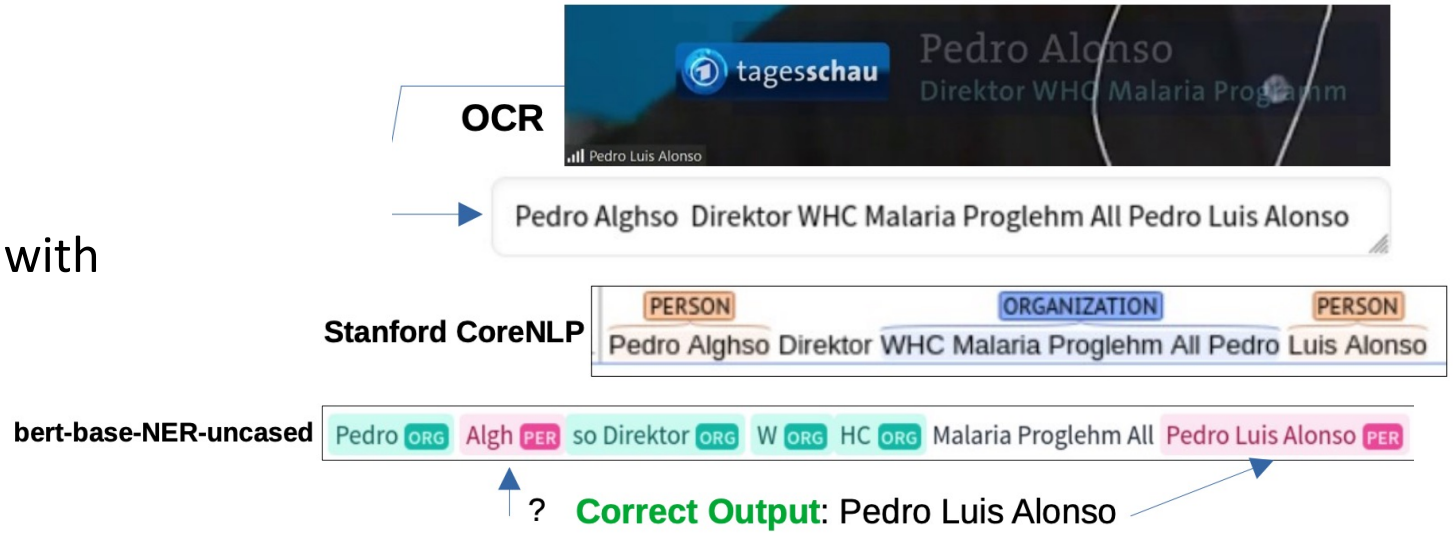
Motivation

- Individuals are (also) identified by their names
- Automated identification: multi-modal/multifactor
- Identity resolution: Who does this face belong to?
- Manual input vs. automated recognition
- Hard task for noisy, multilingual input

Tasks

- Research and select one solution.
- Generate or label supplied noisy data with corrections (data will be provided).
- Evaluate the selected approach for challenging use case (OCR).





Process for seminar term paper

- Read and analyse topic catalogue.
- Register for a topic before April 22nd, 2025:
  - https://cloud.h-da.de/apps/polls/s/4ErQp0YU . (First come, first served)
- Work on your topic and compose findings:
  - Refer to state of the art.
  - Do not duplicate the content from the lecture.

Process for seminar term paper

- Regular status update:
  - “Seminar status report” (Mandatory):
    - To present to the team a short report about your progress.
  - First update: April 28th, 2025.

Term paper submission

- Draft paper submission June 09th, 2025 – 23:59h:
  - Align with harmonised vocabulary
    https://www.christoph-busch.de/standards.html
  - Submit to CMT.
- Review term papers from your course mates by 16th June, 2025:
  - The review shall help to improve the work.
  - Your comments will not influence the grades of your mates.

Term paper submission

- Improve your paper:
  - Submit the final version on June 20th, 2025.
- Generate slides for your presentation by June 22nd, 2025.
- Provide data and collected papers
  - You will get a link to upload a zip-file.

Term paper presentation

- Present your work to other students and da/sec staff.
- Presentations are scheduled at the end of semester.
- Participation is mandatory on all dates.
- Detailed schedule will follow.

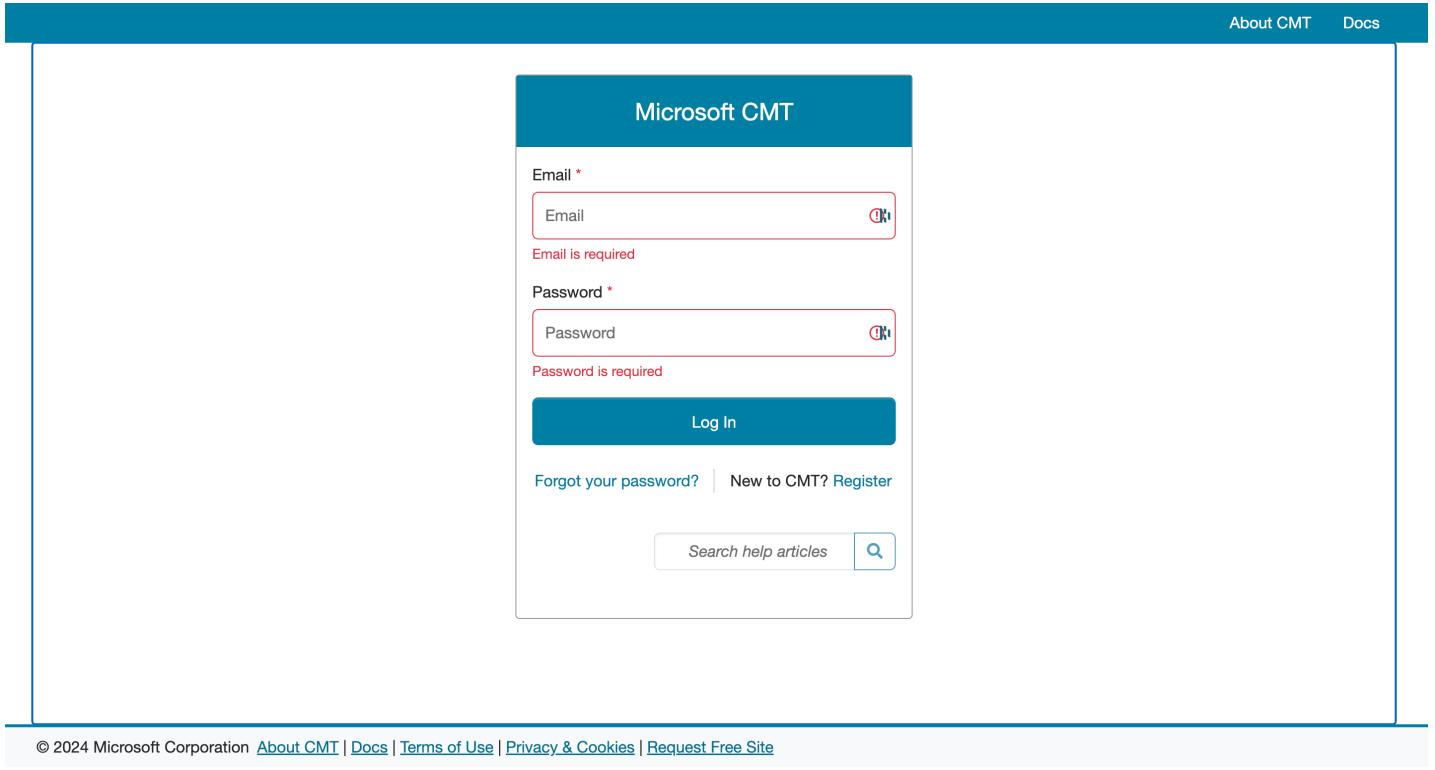
Grading

- Grading of the seminar is based on:
  - Final exam – 1.5 hours (50%).
  - Term paper and oral presentation of the results (50%).

Respect academic integrity

CMT system

- Register at:
  https://cmt3.research.microsoft.com/HDABIO2025.



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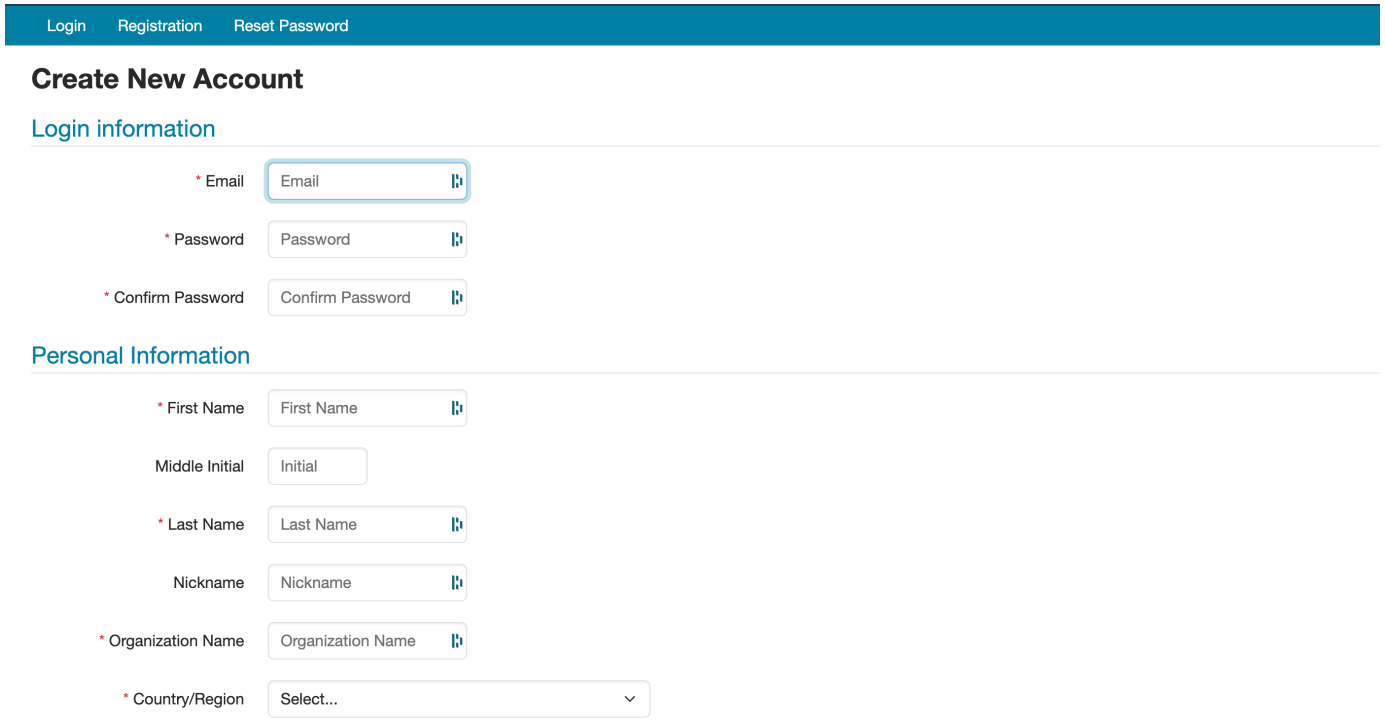

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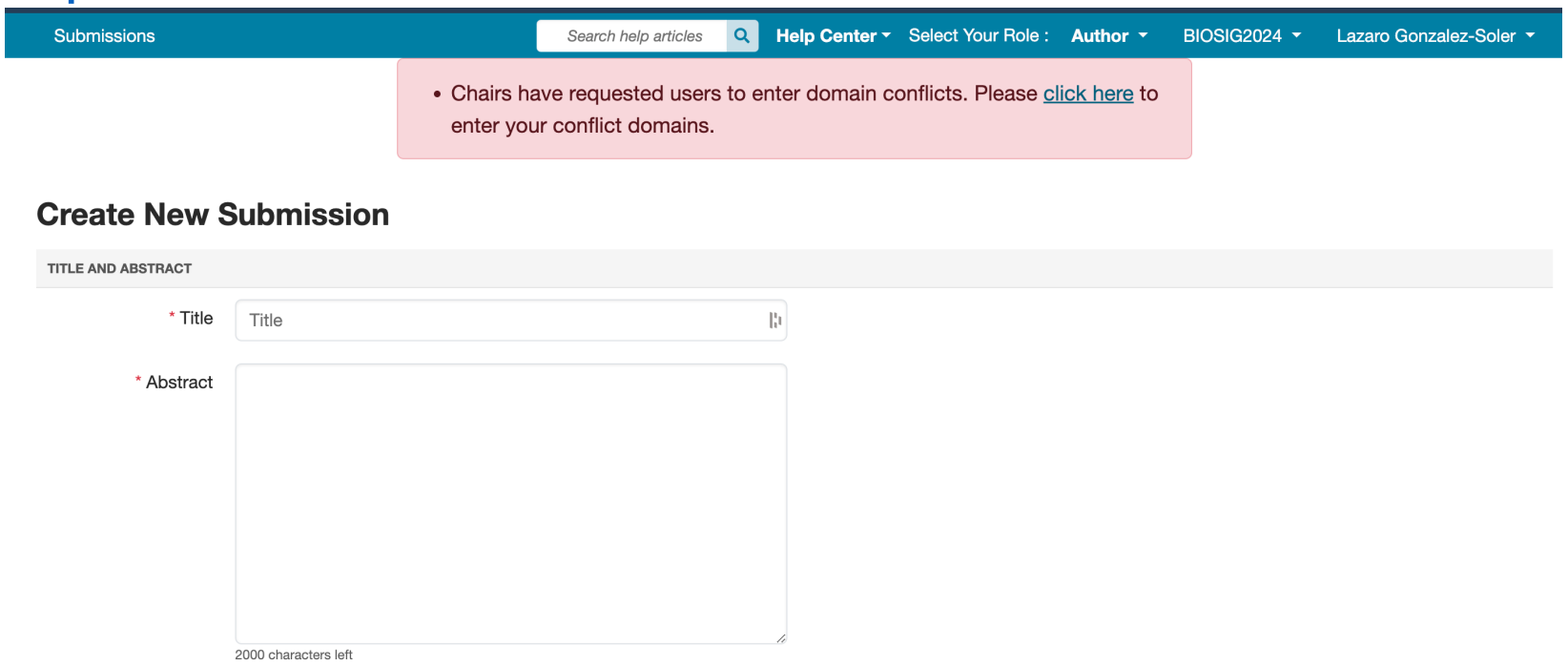

CMT system

- Register at:
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Primary Contact	Email	First Name	Last Name	Organization	Country/Region
◉	lazaro-janier.gonzalez-soler@h-da.de	Lazaro	Gonzalez-Soler	Hochschule Darmstadt	Germany

Email + Add

Enter email to add new author.

SUBJECT AREAS*

You may select up to 3 secondary subject areas.

Primary	Secondary		Primary	Secondary	
☐	☐	Aging of reference data	☐	☐	Mobile-based biometrics
☐	☐	Biometric and multimedia forensics	☐	☐	Morphing
☐	☐	Biometric performance measurement	☐	☐	Multimodal and multi-biometric fusion
☐	☐	Biometric sample quality	☐	☐	On-card comparison

FILES

You can upload from 1 to 3 files. Maximum file size is 10 Mb. We accept **doc, docx, pdf** formats.

Drop files here
-or-
Upload from Computer

Submit Cancel

Now

- Read syllabus document.
- Talk / ask about the term paper topics.
- Read complementary documents on how to approach task
  - bio-00-efficient-reading.pdf.
  - bio-00-paper-preparation-tips.pdf.
  - bio-00-Okoli-WritingLiteratureReview-2010.pdf.
  - bio-00-Pautasso-WritingLiteratureReview-2013.pdf.

Important dates

- April 22nd, 2025 – topic selection (doodle).
- June 09th, 2025 – term paper submission (CMT).
- June 16th, 2025 – review submission (CMT).
- June 20th, 2025 – upload final paper version (CMT).
- June 25th, 2025 – upload slides for presentation (CMT).
- June 22nd, 2025 – seminar presentations.
- June 23rd, 2025 – seminar presentations.