



# VISUAAL

Privacy-Aware and Acceptable Video-Based Technologies  
and Services for Active and Assisted Living

## Context Recognition for the Application of Visual Privacy

ESR 14

University of Alicante

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Universitat d'Alacant  
Universidad de Alicante

Project Coordinator

RWTH AACHEN  
UNIVERSITY



Stockholm  
University



Trinity College Dublin  
Coláiste na Tríonóide, Baile Átha Cliath  
The University of Dublin



- 29 years old, from Iran
- Joined in April 2021, Alicante
- B.Sc. in Electrical & Telecommunication Engineering
- MSc in Digital Signal Processing
- 2 Years Experience as Machine Learning Engineer
- My Areas of Interest
  - Computer vision and Deep Learning
  - Action Recognition
  - Semantic Segmentation



# Introduction

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- Demographic changes
- Burden to care personnel and facilities
- Damage to autonomy, self-esteem and spirit
- Ambient-assisted living (AAL) and sensors
- Video-based technology
- The most directed and natural way to record events
- Provide richer information
- Easy to interpret by unauthorized viewers



## Research project: Context recognition for the application of visual privacy

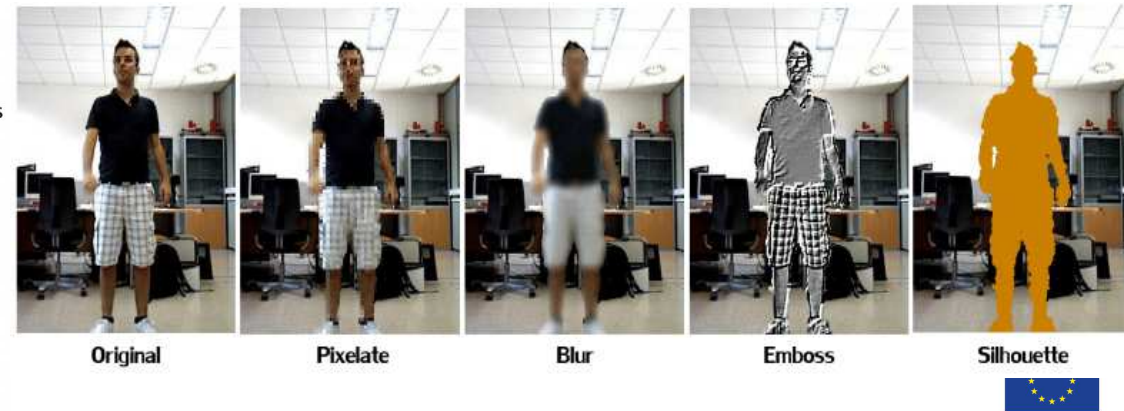
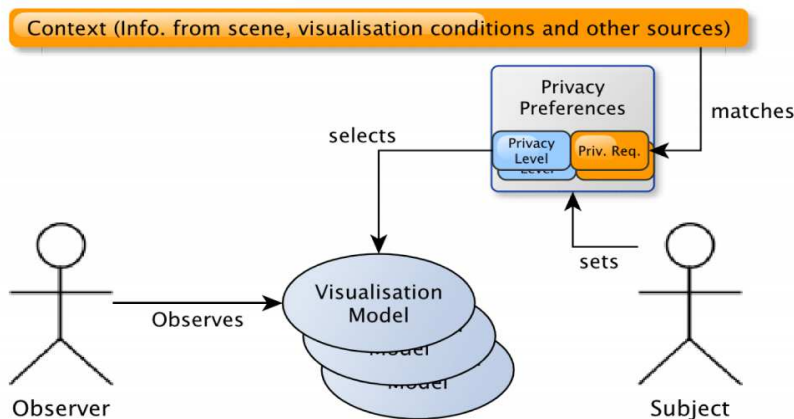
- Balance between privacy-intelligibility in video
- Can we find a method to make the balance? Understand what is happening and preserve privacy
- Previous works and privacy-by-context
- Privacy is subjective
- Level-based visualisation, selected according to the context

# Introduction

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## Research project: Context recognition for the application of visual privacy

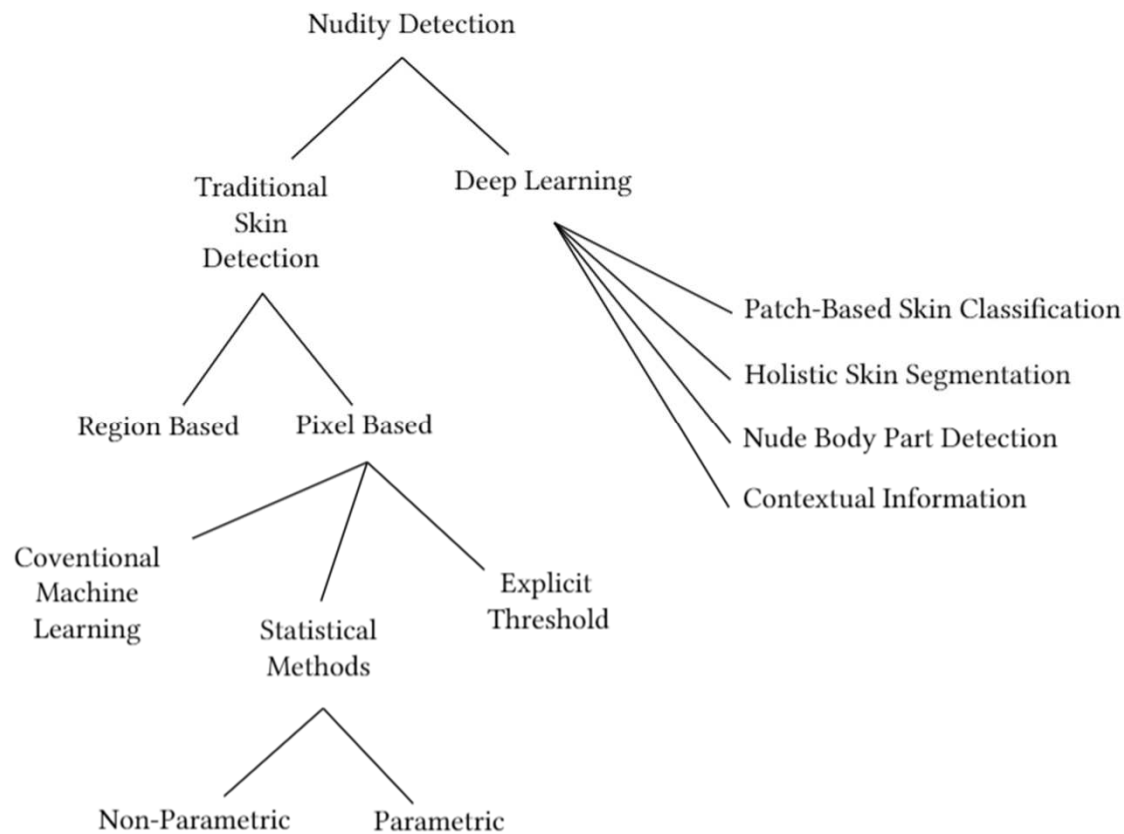
- Estimate the variables automatically to be used along with preferences for different visualisation
- Extract rich information from the context to empower people to adapt privacy
- Computer vision algorithms for continuous estimation of the context
- context can be defined by variables: Appearance, Activity, Event, Place, ...



# Appearance Recognition

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- Serial
- Appearance
- Content
- Skin
- Estimation



led in a video  
detection in the

on



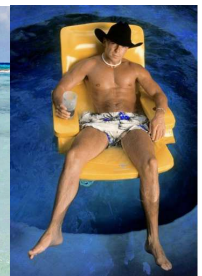
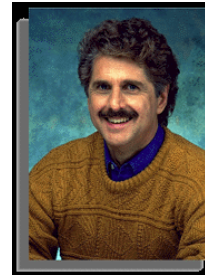
# Nudity Detection - Review

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## Appearance and Nudity Detection Approaches:

- Obscene image Classification

- Naïve approach
- No level-based classification
- Subjective
- Fail to generalize the problem



- Skin Detection

- The act of separating skin pixels (or regions) in an image from non-skin ones (garments, hair, background)
- First cue regarding the nudity perception
- The most natural way
- ROI for nudity detection
- Detecting nudity by ratio and classification



## Skin Detection Challenges

- Nonlinear illumination
- Aging
- Makeup
- Skin-like background
- Camera variations
- Skin colors
- Lack of standard datasets

## Problems

- High Error Rate
- Wrong ROI
- Interpreting Nudity Level



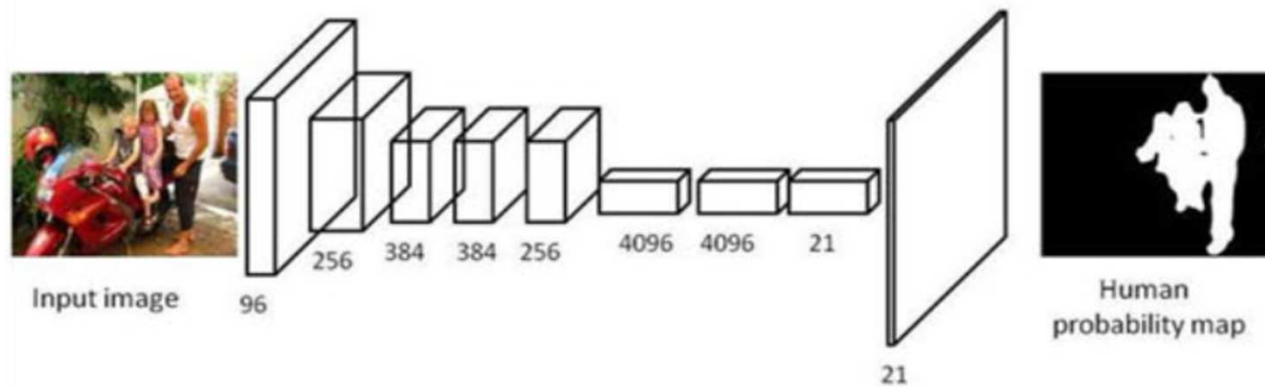


# Skin Segmentation

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## Skin Segmentation Methods

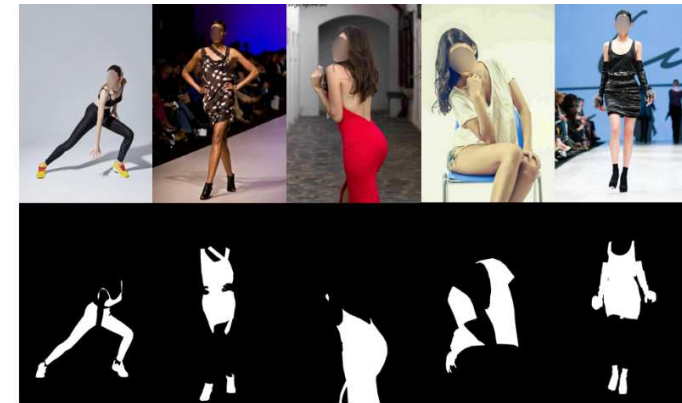
- Traditional Approaches
  - Statistical Methods
  - Explicit Threshold
  - Conventional Machine Learning and feature extraction
- Semantic Segmentation and Deep Learning



# Human Skin Dataset

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- Skin datasets are either limited or low quality
- Alternative solution is needed
- Fashion datasets have garment segmentation

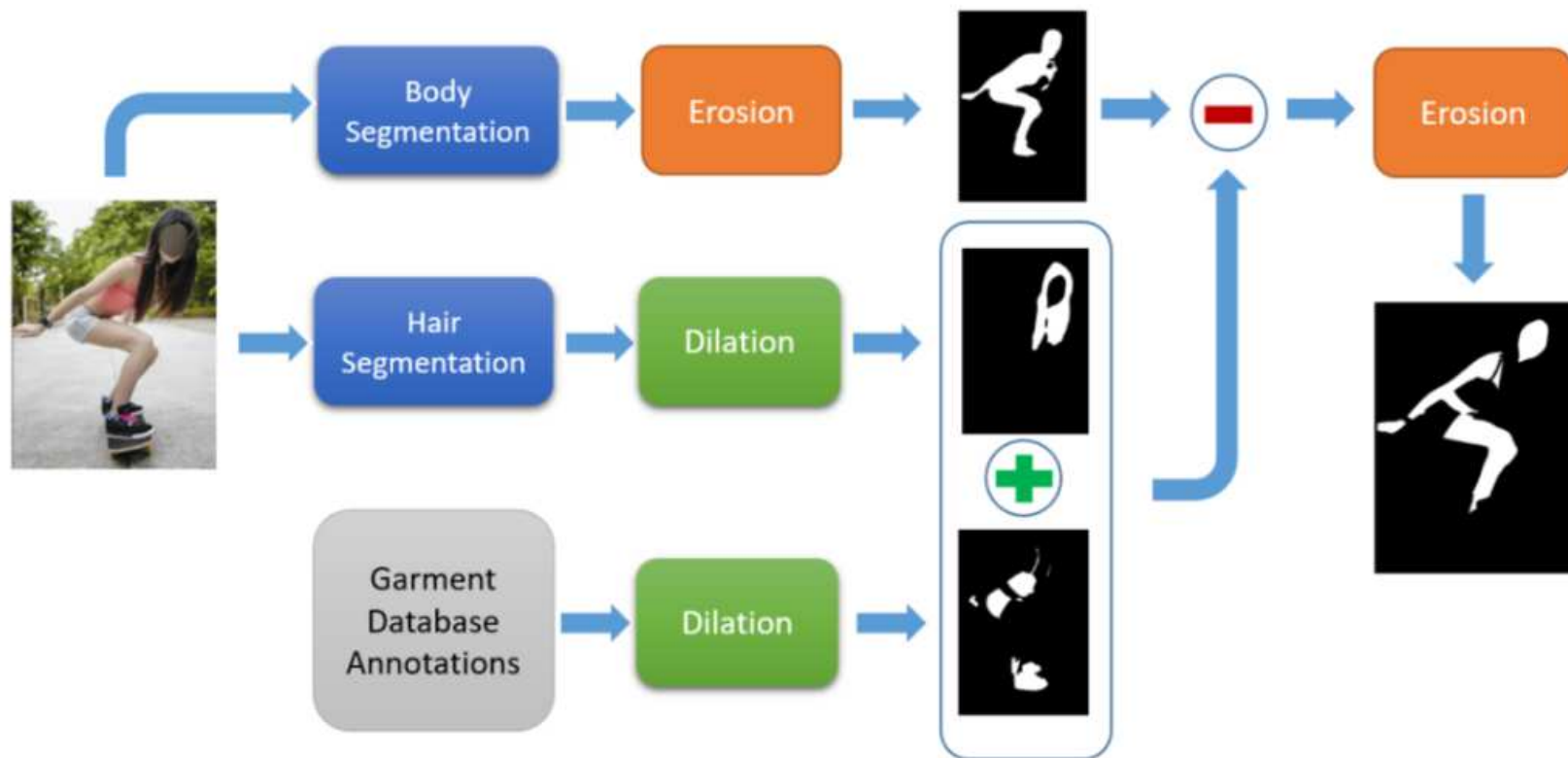


| Dataset    | Year | Number of images | Annotation Quality |
|------------|------|------------------|--------------------|
| Compaq     | 2002 | 13,640           | Imprecise          |
| TDSD       | 2004 | 554              | Imprecise          |
| ECU        | 2005 | 6,000            | Precise            |
| Schmugge   | 2007 | 845              | Imprecise          |
| MCG        | 2011 | 1,000            | Imprecise          |
| HGR        | 2012 | 1,558            | Precise            |
| Pratheepan | 2012 | 78               | Precise            |
| SFA        | 2013 | 1,118            | Precise            |

|             | WTBI    | DARN    | DeepFashion | ModaNet  | FashionAI | DeepFashion2 |
|-------------|---------|---------|-------------|----------|-----------|--------------|
| year        | 2015[5] | 2015[7] | 2016[14]    | 2018[21] | 2018[1]   | now          |
| #images     | 425K    | 182K    | 800K        | 55K      | 357K      | 491K         |
| #categories | 11      | 20      | 50          | 13       | 41        | 13           |
| #bboxes     | 39K     | 7K      | ×           | ×        | ×         | 801K         |
| #landmarks  | ×       | ×       | 120K        | ×        | 100K      | 801K         |
| #masks      | ×       | ×       | ×           | 119K     | ×         | 801K         |
| #pairs      | 39K     | 91K     | 251K        | ×        | ×         | 873K         |

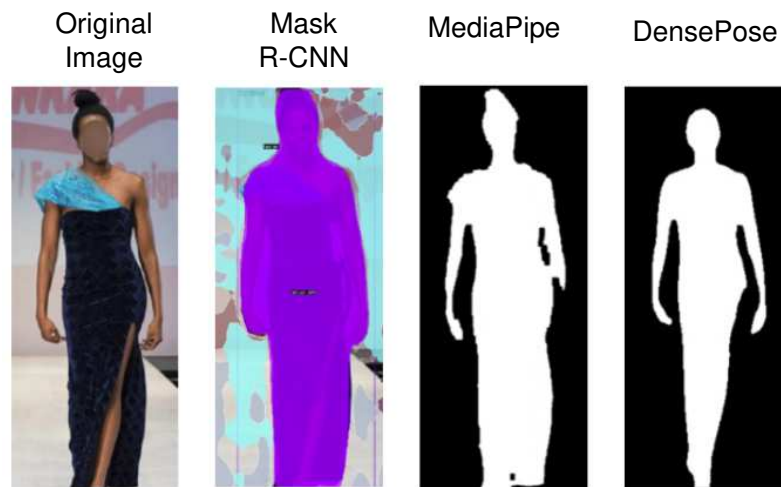
# Skin Dataset Pipeline

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# Human Body and Hair Segmentation

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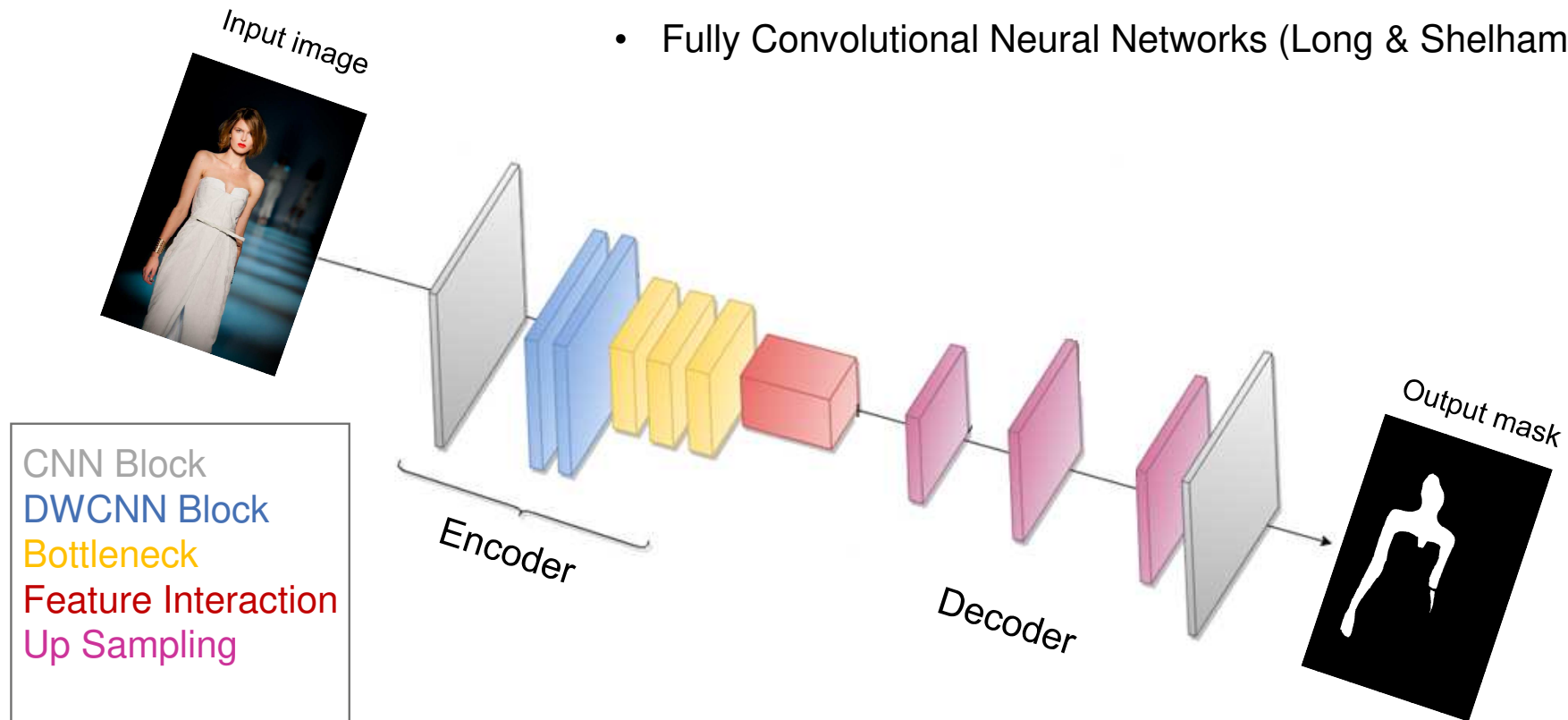
# Samples of the Dataset

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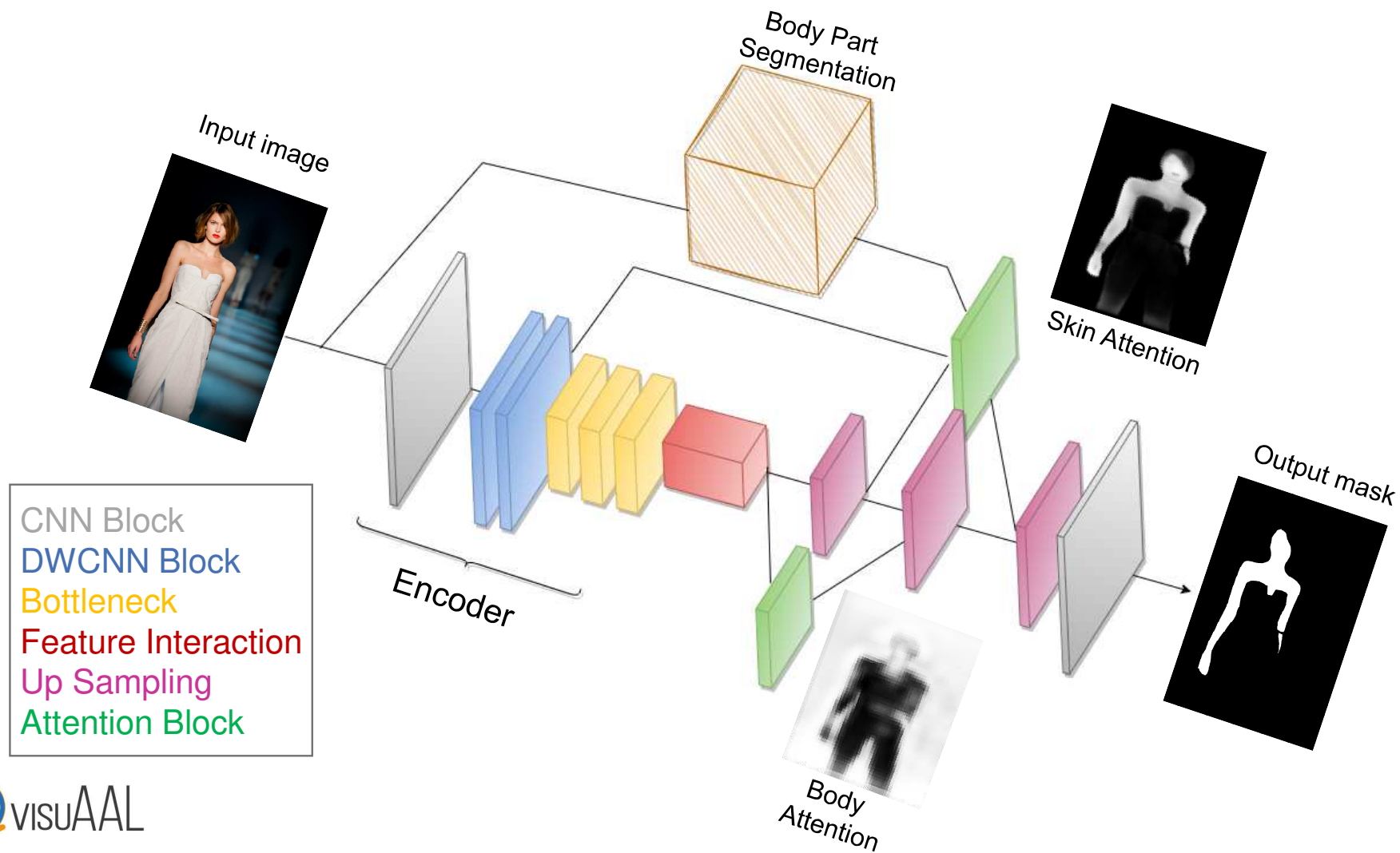


- Extracting garment masks
- Detecting body boundaries
- Detecting hair and subtracting hair area
- Subtracting clothing area
- Implementation and noise removal
- Manual validation segmentation
- Choosing metrics and evaluation

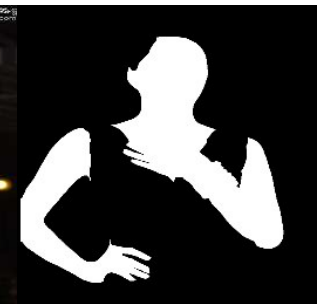
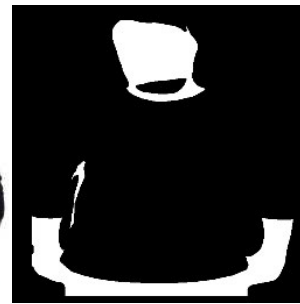
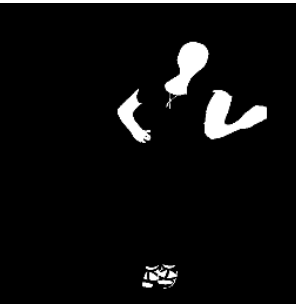


# Architecture

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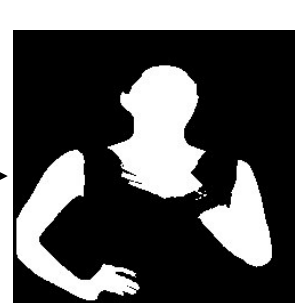


- Dataset noise
- Recursive Training Strategy and Weakly Supervised Learning



# Training

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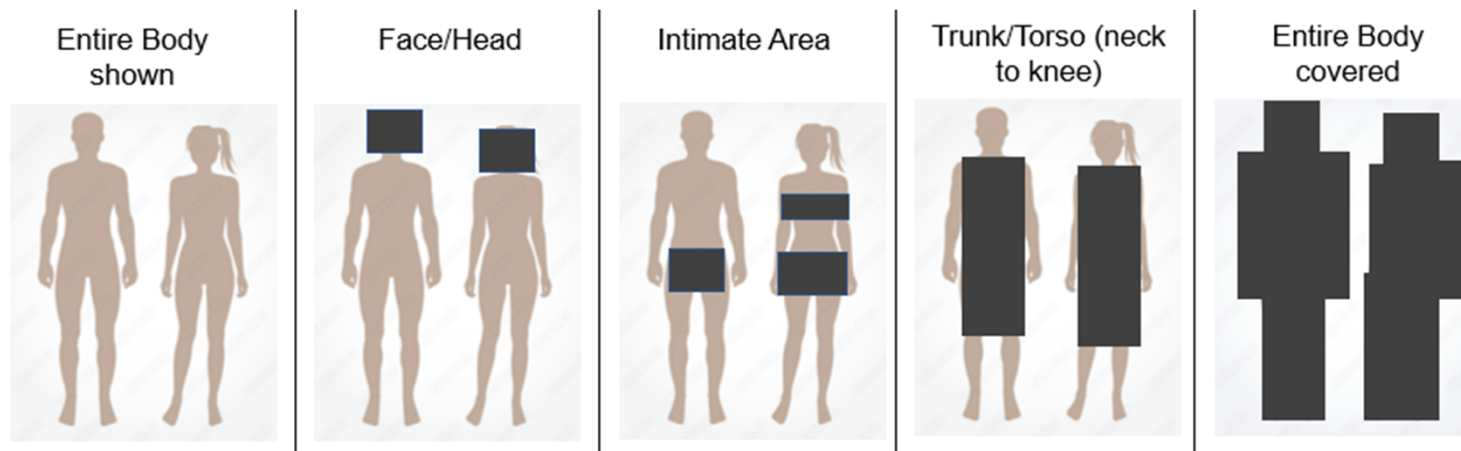


# Appearance in AAL

## How to Define Nudity?

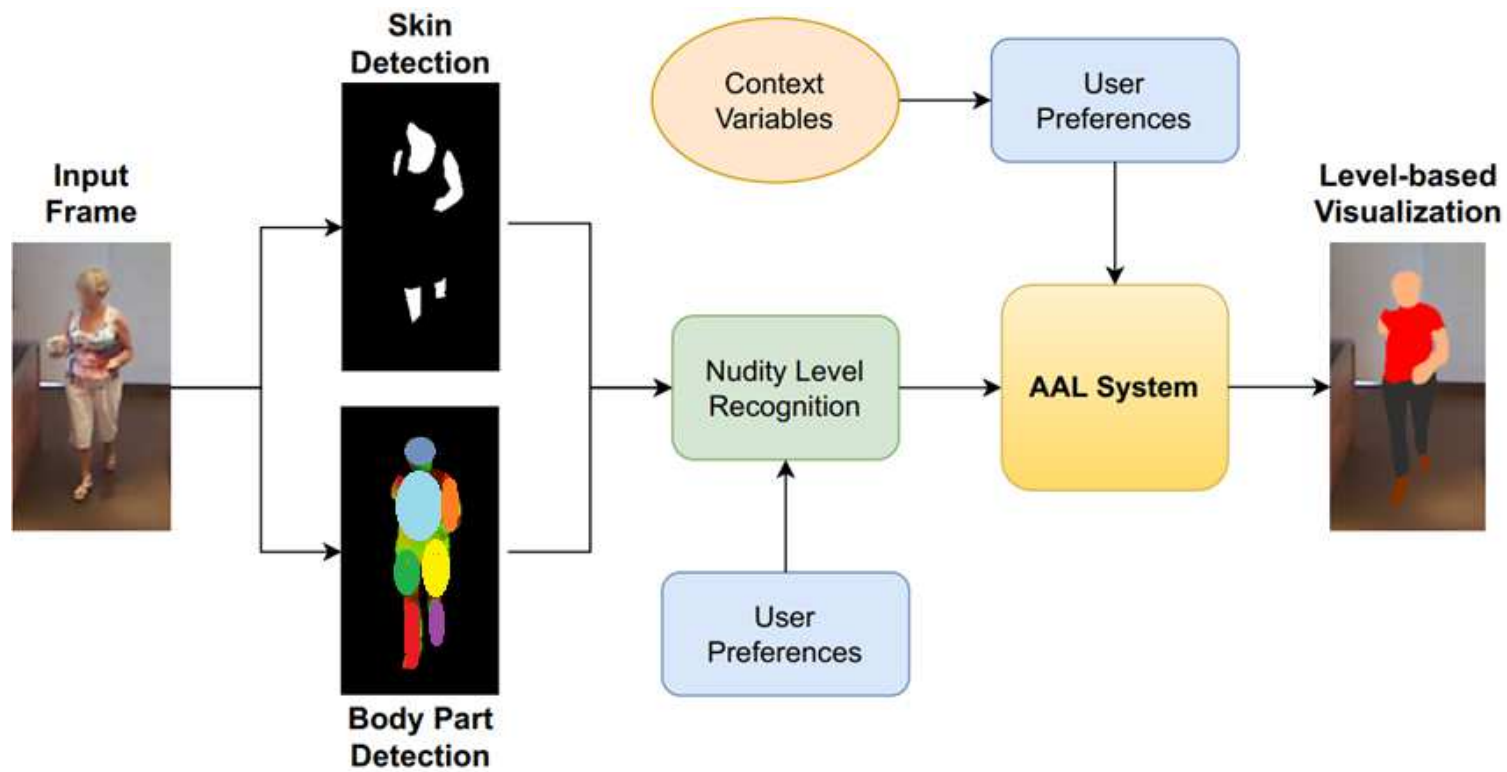
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| Nudity Level | Description                                |
|--------------|--|
| 1            | <i>Completely covered</i>                  |
| 2            | <i>Covered torso (neck to knee)</i>        |
| 3            | <i>Covered intimate areas</i>              |
| 4            | <i>Covered faces</i>                       |
| 5            | <i>Full body or exposed intimate areas</i> |



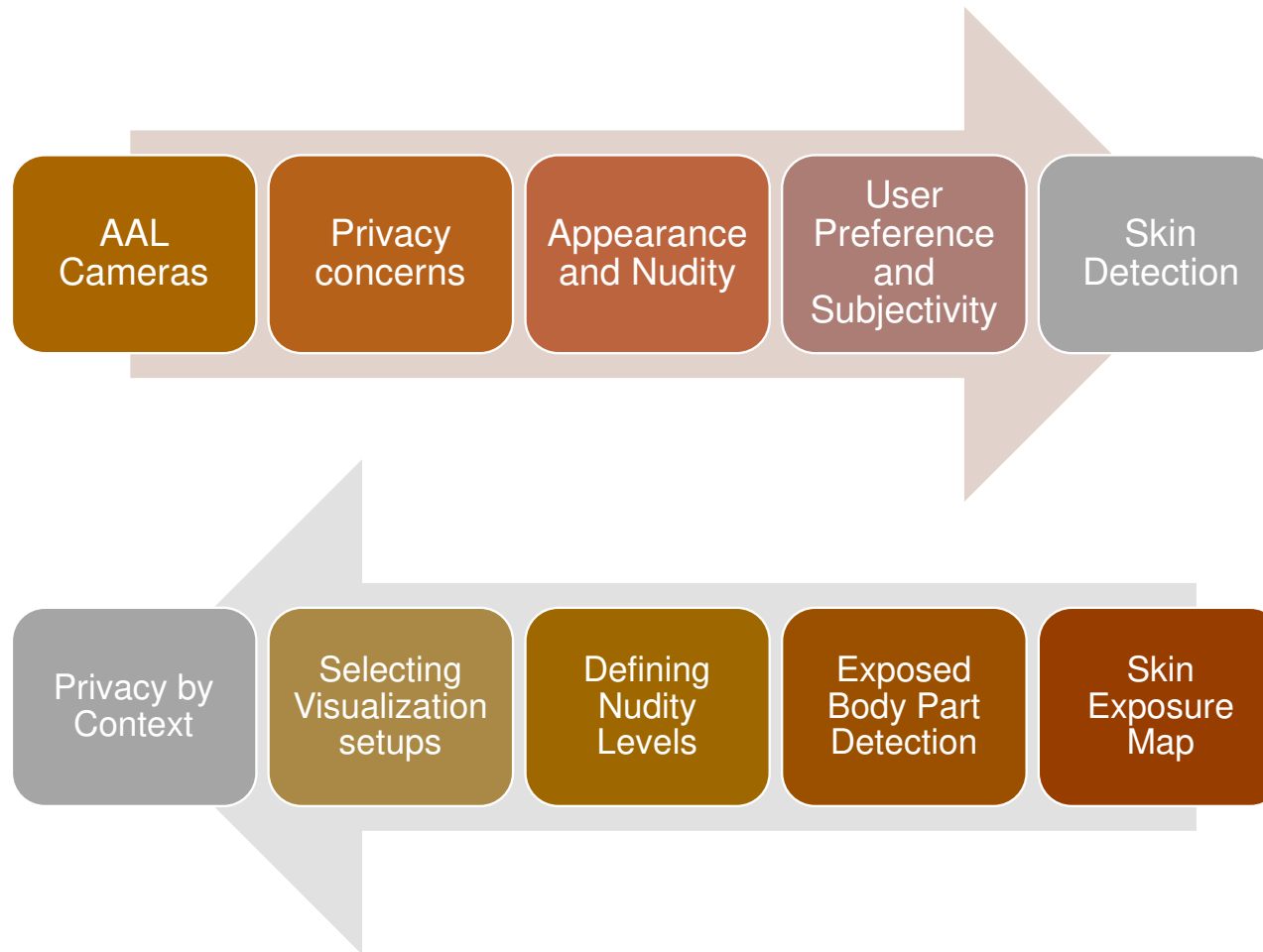
# Appearance in AAL

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# Adaptive Privacy by Appearance

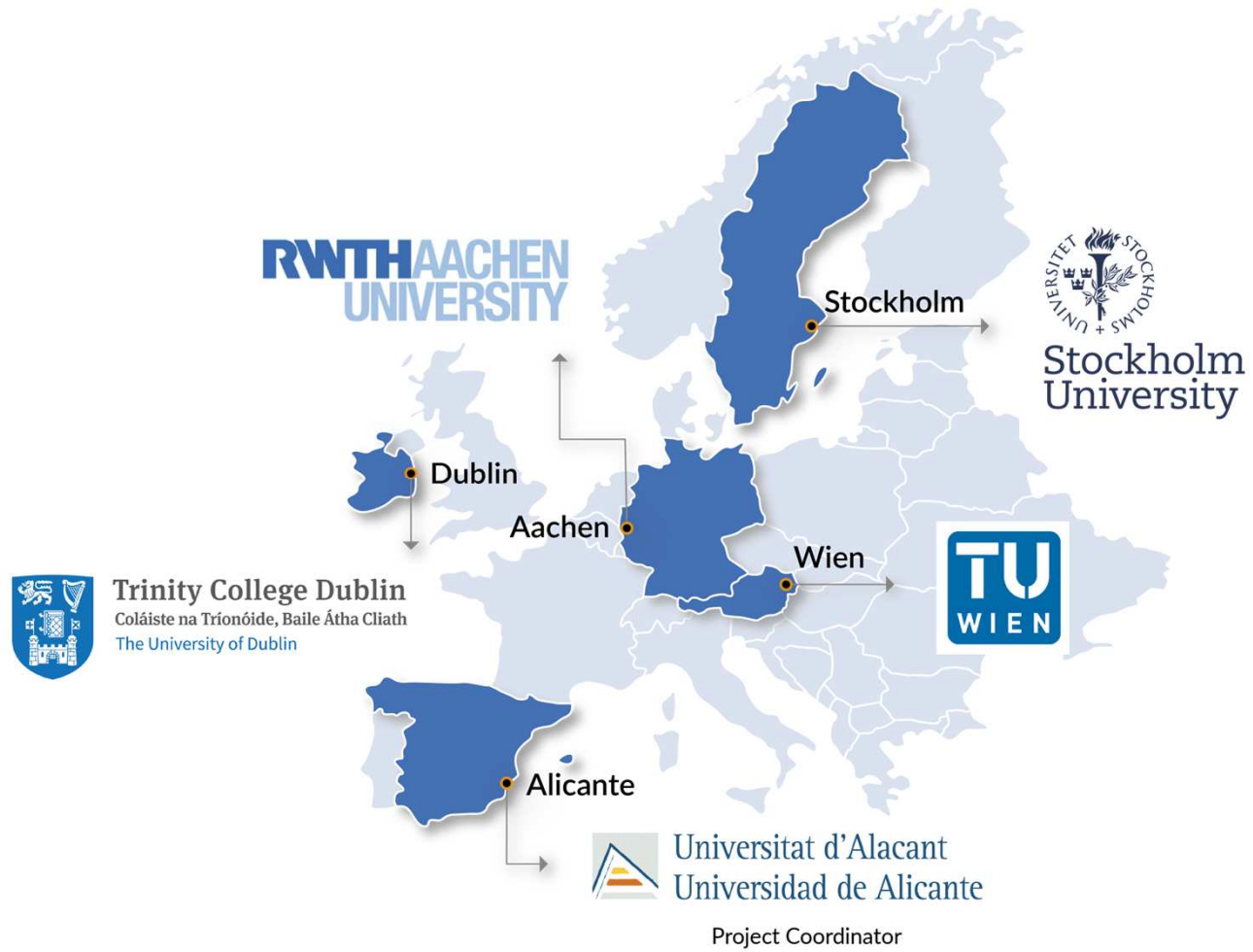
20



- Underneath Your Clothes: A Social and Technological Perspective on Nudity in The Context of AAL Technology (Petra 2022 workshop)
- From Garment to Skin: The visuAAL Skin Segmentation Dataset (ICIAP 2022 workshop)
- Method paper: Human Skin Segmentation using Guided Attention Modules

- Finish appearance detection
- Daily activity recognition
- Dataset for activities
- Foreseen research: study of related variables, develop algorithms
- Training: Computer Vision, Psychological perspective
- Collaboration with other ESRs in other fields
- Secondments:
  - 1- Trinity College Dublin
    - Training on healthcare applications
    - Integrating my methods in healthcare systems
  - 2- Technical training in a computer vision company





# Thank you!

**Kooshan Hashemifard**

**University of Alicante**

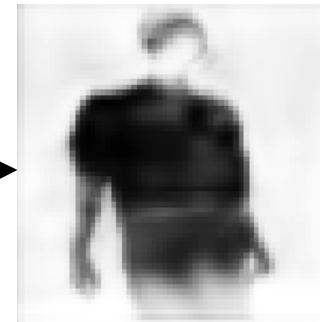
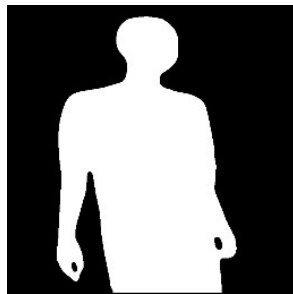
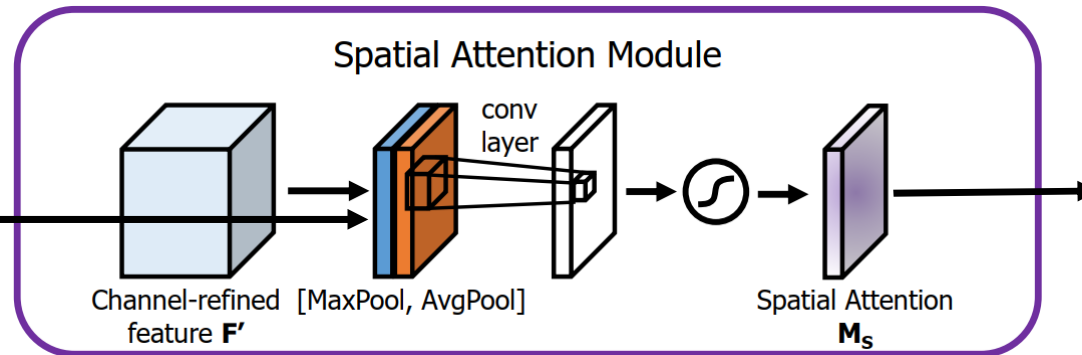
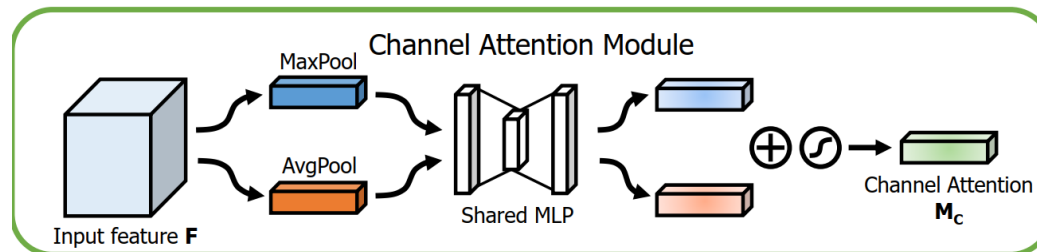
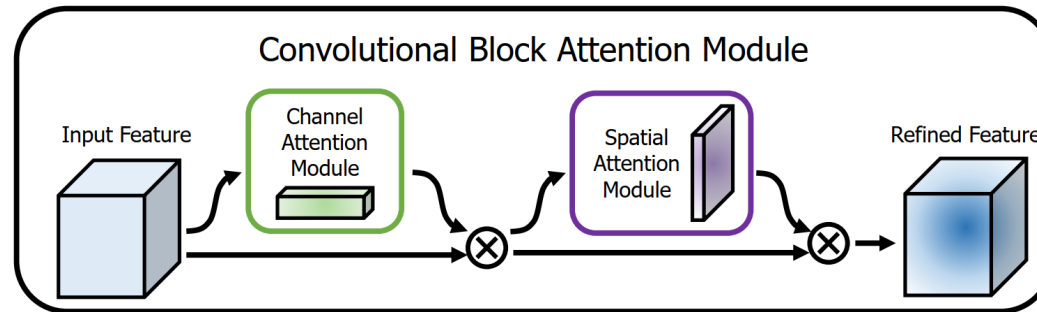
k.hashemifard@ua.es

# Attention Modules

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## Body Attention

$$\mathbf{F}' = \mathbf{M}_c(\mathbf{F}) \otimes \mathbf{F},$$
$$\mathbf{F}'' = \mathbf{M}_s(\mathbf{F}') \otimes \mathbf{F}',$$



# Attention Modules

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## Skin Attention

