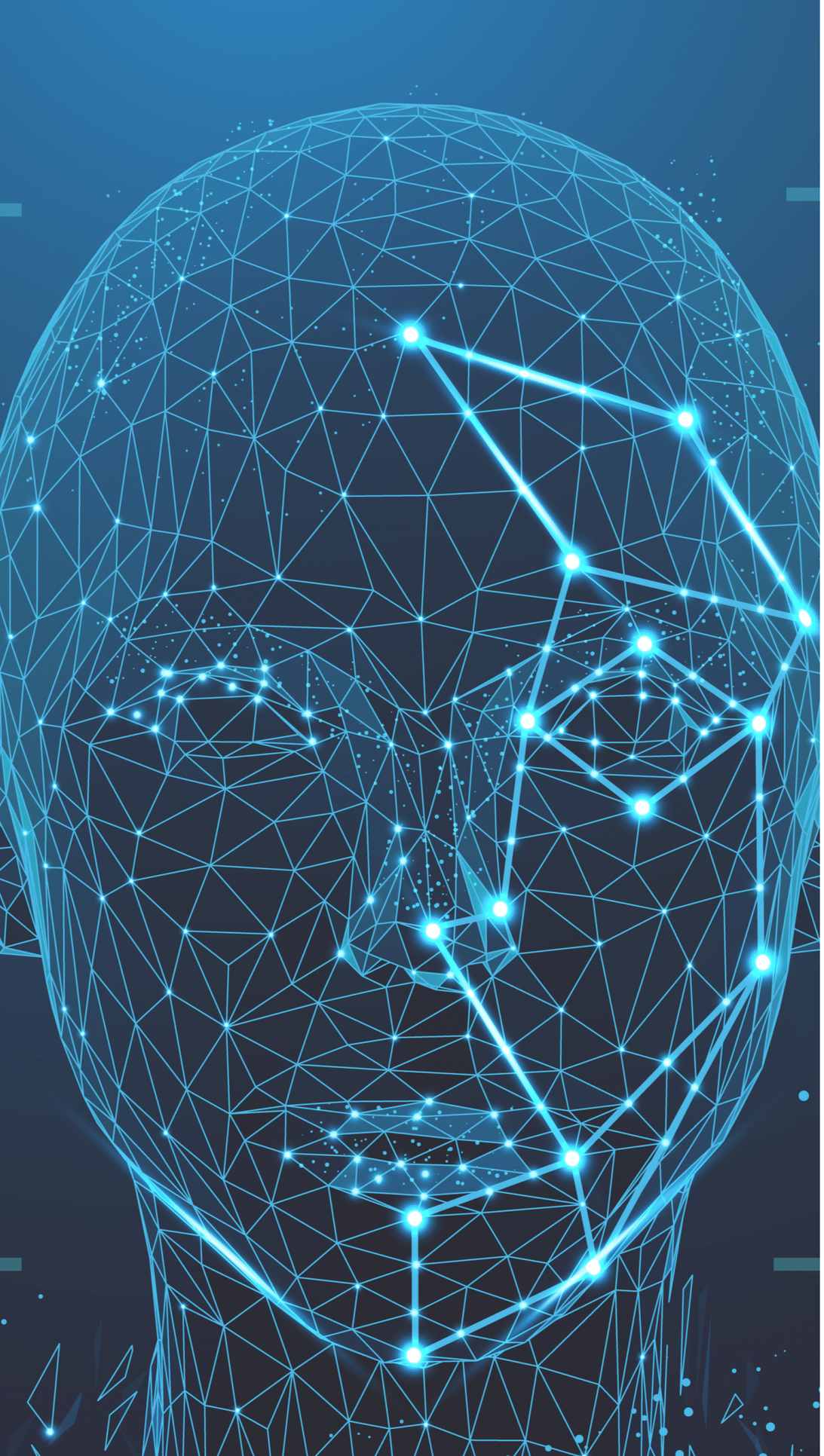

INCLUSIVE REPRESENTATION FOR FACE RECOGNITION ANALYSIS

AN EMPIRICAL INVESTIGATION ON CRITICAL ISSUES AND UNCOVERED OPPORTUNITIES

Supervisors
Prof. Antonio Vetrò
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Candidate
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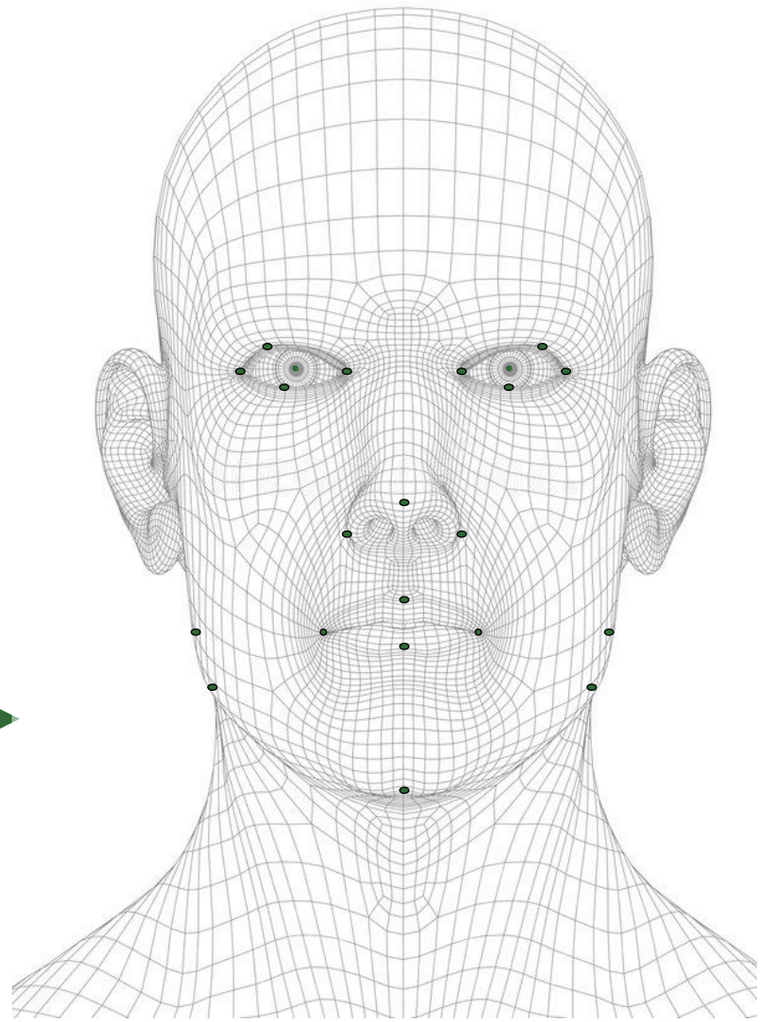
ACADEMIC YEAR 2022-2023

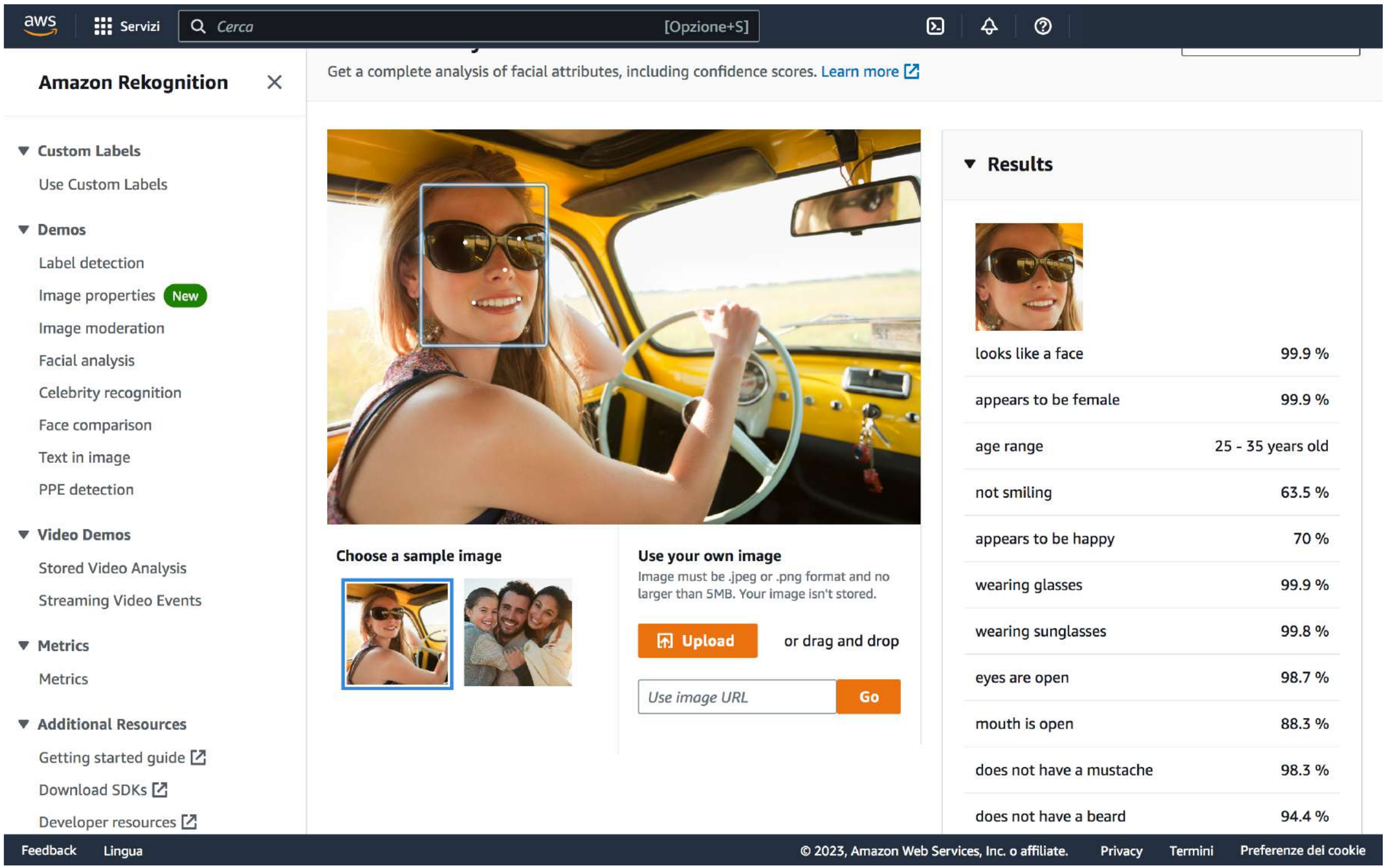
FACE RECOGNITION TECHNOLOGY

- **What is it?**
  - AI application used to identify people using biometric data
- **How does it work?**
  - Detection of human face
  - Visual *features* extraction
  - Recognition of the person

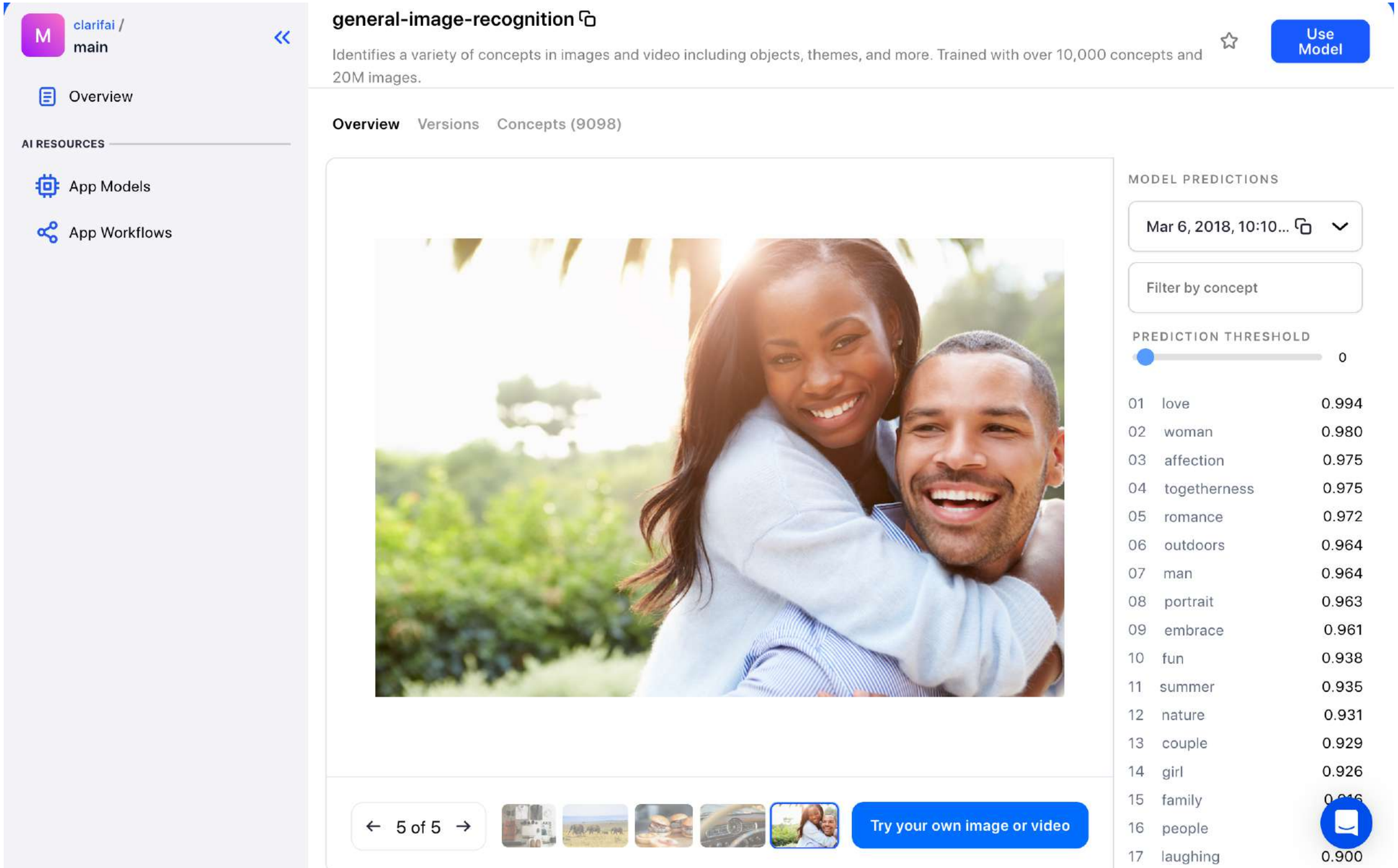


```
response:
  FaceDetails:
    0:
      BoundingBox:
        Width:        0.3076229393482208
        Height:       0.6556866765022278
        Left:         0.21634019911289215
        Top:          0.11871829628944397
      AgeRange:
        Low:          33
        High:         41
      Smile:
        Value:        true
        Confidence:   96.32563018798828
      Eyeglasses:
        Value:        false
        Confidence:   97.3408432006836
      Sunglasses:
        Value:        false
        Confidence:   99.99653625488281
      Gender:
        Value:        "Female"
        Confidence:   99.99974822998047
      Beard:
        Value:        false
        Confidence:   95.06346893310547
      Mustache:
        Value:        false
        Confidence:   98.34618377685547
      EyesOpen:
        Value:        true
        Confidence:   97.96922302246094
      MouthOpen:
        Value:        true
        Confidence:   95.30166625976562
      Emotions:
        0:
          Type:       "HAPPY"
          Confidence: 99.34334564208984
        1:
          Type:       "SURPRISED"
          Confidence: 6.293104648590088
        2:
          Type:       "FEAR"
          Confidence: 5.920518398284912
        3:
          Type:       "SAD"
          Confidence: 2.157266616821289
        4:
          Type:       "DISGUSTED"
          Confidence: 0.14215728640556335
        5:
          Type:       "ANGRY"
          Confidence: 0.12972576916217804
        6:
          Type:       "CONFUSED"
          Confidence: 0.08371972292661667
        7:
          Type:       "CALM"
          Confidence: 0.06177036464214325
      Landmarks:
        0:
          Type:       "eyeLeft"
          X:          0.31702902913093567
          Y:          0.39263492822647095
        1:
          Type:       "eyeRight"
          X:          0.45064085721969604
          Y:          0.3925168216228485
        2:
          Type:       "mouthLeft"
          X:          0.3292921185493469
          Y:          0.5790791511535645
        3:
          Type:       "mouthRight"
          X:          0.4410356879234314
          Y:          0.5788599252700806
        4:
          Type:       "nose"
          X:          0.39418867230415344
          Y:          0.49704939126968384
        5:
          Type:       "leftEyeBrowLeft"
          X:          0.26329728960990906
          Y:          0.34612882137298584
        6:
          Type:       "leftEyeBrowRight"
          X:          0.3479453921318054
          Y:          0.33680739998817444
```

AWS

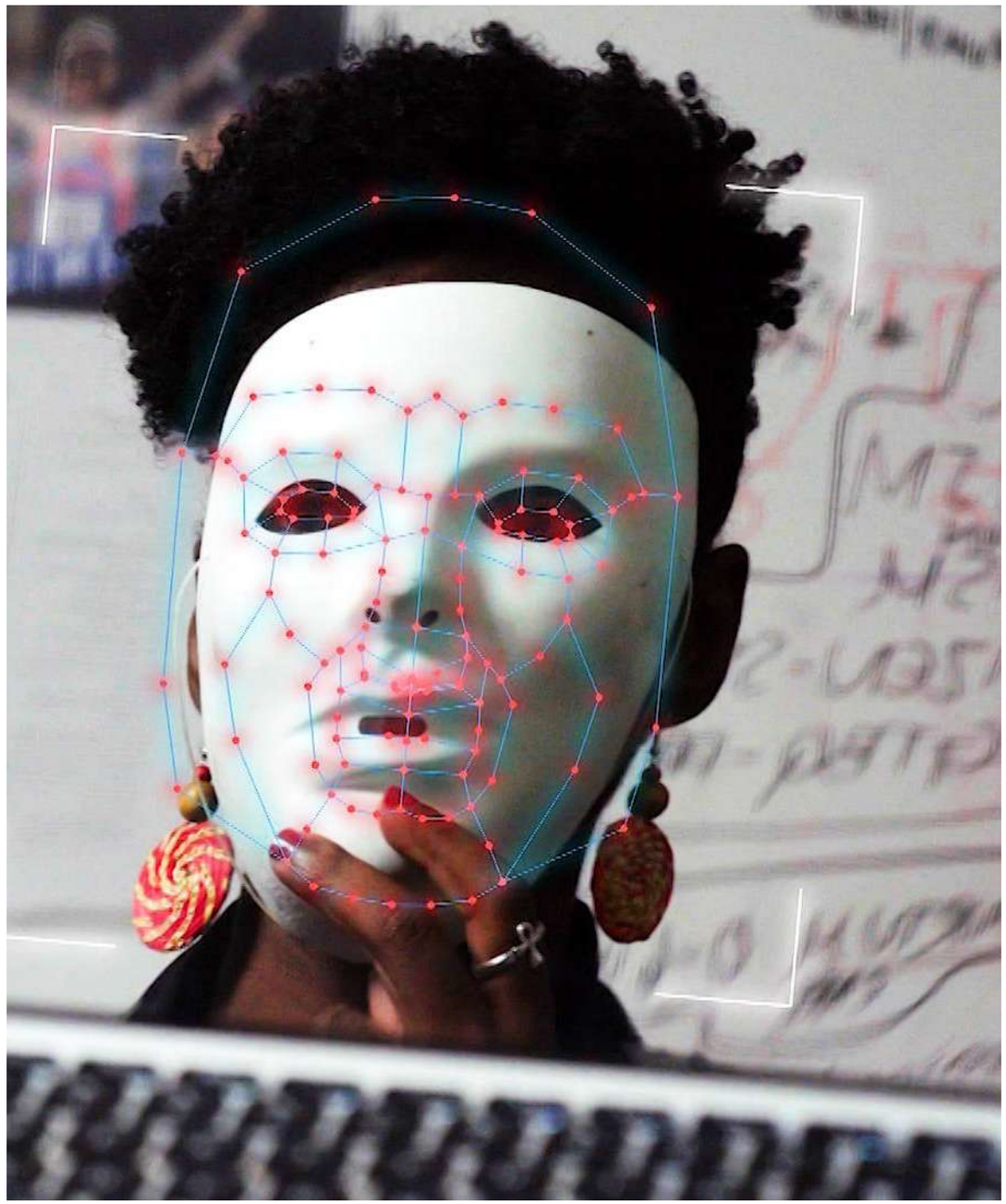

aws
Servizi
Cerca
[Opzione+S]
Amazon Rekognition
Get a complete analysis of facial attributes, including confidence scores. Learn more
Custom Labels
Use Custom Labels
Demos
Label detection
Image properties
New
Image moderation
Facial analysis
Celebrity recognition
Face comparison
Text in image
PPE detection
Video Demos
Stored Video Analysis
Streaming Video Events
Metrics
Metrics
Additional Resources
Getting started guide
Download SDKs
Developer resources
Choose a sample image
Use your own image
Image must be .jpeg or .png format and no larger than 5MB. Your image isn't stored.
Upload
or drag and drop
Use image URL
Go
Results
looks like a face 99.9 %
appears to be female 99.9 %
age range 25 - 35 years old
not smiling 63.5 %
appears to be happy 70 %
wearing glasses 99.9 %
wearing sunglasses 99.8 %
eyes are open 98.7 %
mouth is open 88.3 %
does not have a mustache 98.3 %
does not have a beard 94.4 %
Feedback
Lingua
© 2023, Amazon Web Services, Inc. o affiliate.
Privacy
Termini
Preferenze dei cookie

CLARIFAI


clarifai /
main
Overview
AI RESOURCES
App Models
App Workflows
general-image-recognition
Identifies a variety of concepts in images and video including objects, themes, and more. Trained with over 10,000 concepts and 20M images.
Use Model
Overview
Versions
Concepts (9098)
MODEL PREDICTIONS
Mar 6, 2018, 10:10...
Filter by concept
PREDICTION THRESHOLD
0
01 love 0.994
02 woman 0.980
03 affection 0.975
04 togetherness 0.975
05 romance 0.972
06 outdoors 0.964
07 man 0.964
08 portrait 0.963
09 embrace 0.961
10 fun 0.938
11 summer 0.935
12 nature 0.931
13 couple 0.929
14 girl 0.926
15 family
16 people
17 laughing 0.900
5 of 5
Try your own image or video

CRITICAL ISSUES

- Black people, in particular black women [1]
- LGBTQ+ community [2]
  Uber Case
- Tool of power in dictatorships



[1] J. Buolamwini and T. Gebru, “Gender shades: Intersectional accuracy disparities in commercial gender classification”
[2] O. Keyes, “The misgendering machines: Trans/HCI implications of automatic gender recognition”

UNCOVERED OPPORTUNITIES

*What about **disability**?*

ACCESSIBILITY

INCLUSION

"Various aspects of facial analysis software may not work well for people with conditions such as Down's syndrome, achondroplasia, cleft lip or palate, or other conditions that result in facial differences." [3]

Experimental group: Down Syndrome

[3] United Nations, General Assembly, Rights of person with disabilities, December 2021
[4] Ableism And Disability Discrimination in New Surveillance Technologies, Center for Democracy & Technology

RQ1:

How does the face recognition technology work, with images of Down syndrome people, regarding the predictions of **gender** and **age**?

RQ2:

Are the **labels** assigned differently to people with or without Down syndrome by specific algorithms?

DATASET

- **Experimental Group** - 200 images
  - Female - 100 images
  - Male - 100 images
- **Control Group** - 200 images
  - Female - 100 images
  - Male - 100 images

TOT: 400 images

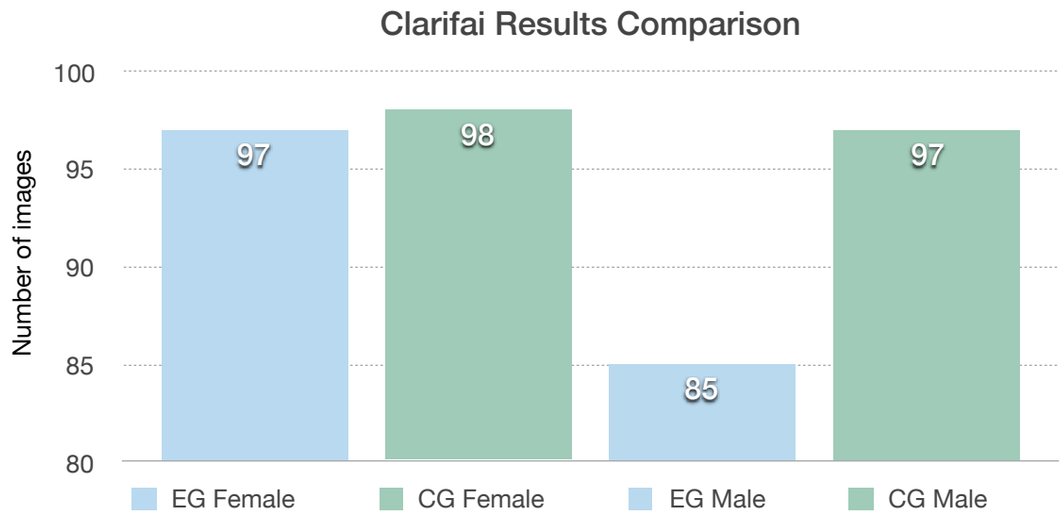
ALGORITHMS

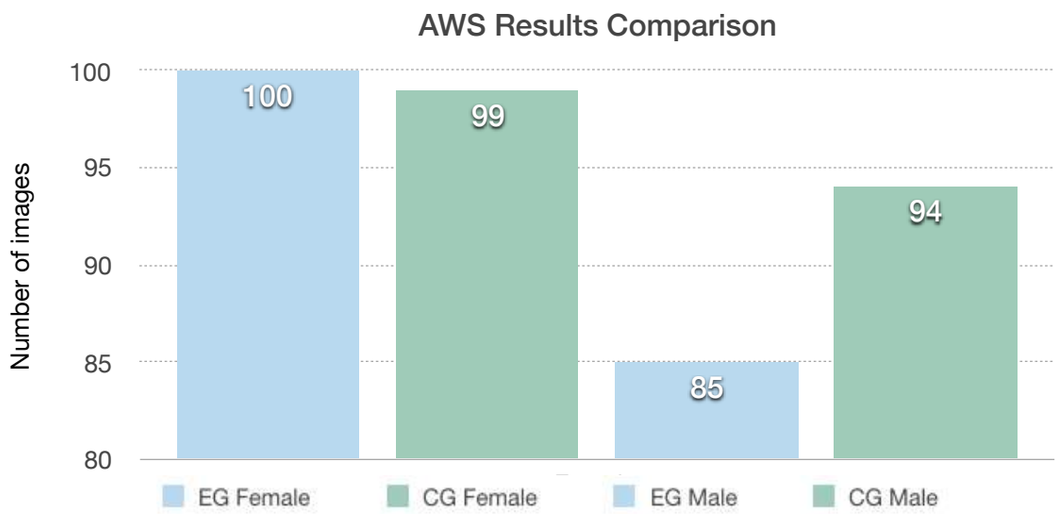
		GENDER	AGE	LABELS
aws	**MODEL NAME**	detect_face	detect_face	detect_labels
	OUTPUT LABELS	Female, Male	random ranges	20 over 3,000 labels
clarifai	**MODEL NAME**	gender-demographics-recognition	age-demographics-recognition	general-image-recognition
	OUTPUT LABELS	Feminine, Masculine	0-2, 3-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-100	20 over 10,000 labels

GENDER RECOGNITION

Performance Evaluation for Gender Prediction

Experimental Group: **Down Syndrome**						
Algorithm	ClarifAI					
	Female	**Male**	Accuracy	Precision	Recall	F1-score
Female	97	3	91%	87%	97%	92%
Male	15	85		97%	85%	90%
Algorithm	AWS					
	Female	**Male**	Accuracy	Precision	Recall	F1-score
Female	100	0	93%	87%	100%	93%
Male	15	85		100%	85%	92%





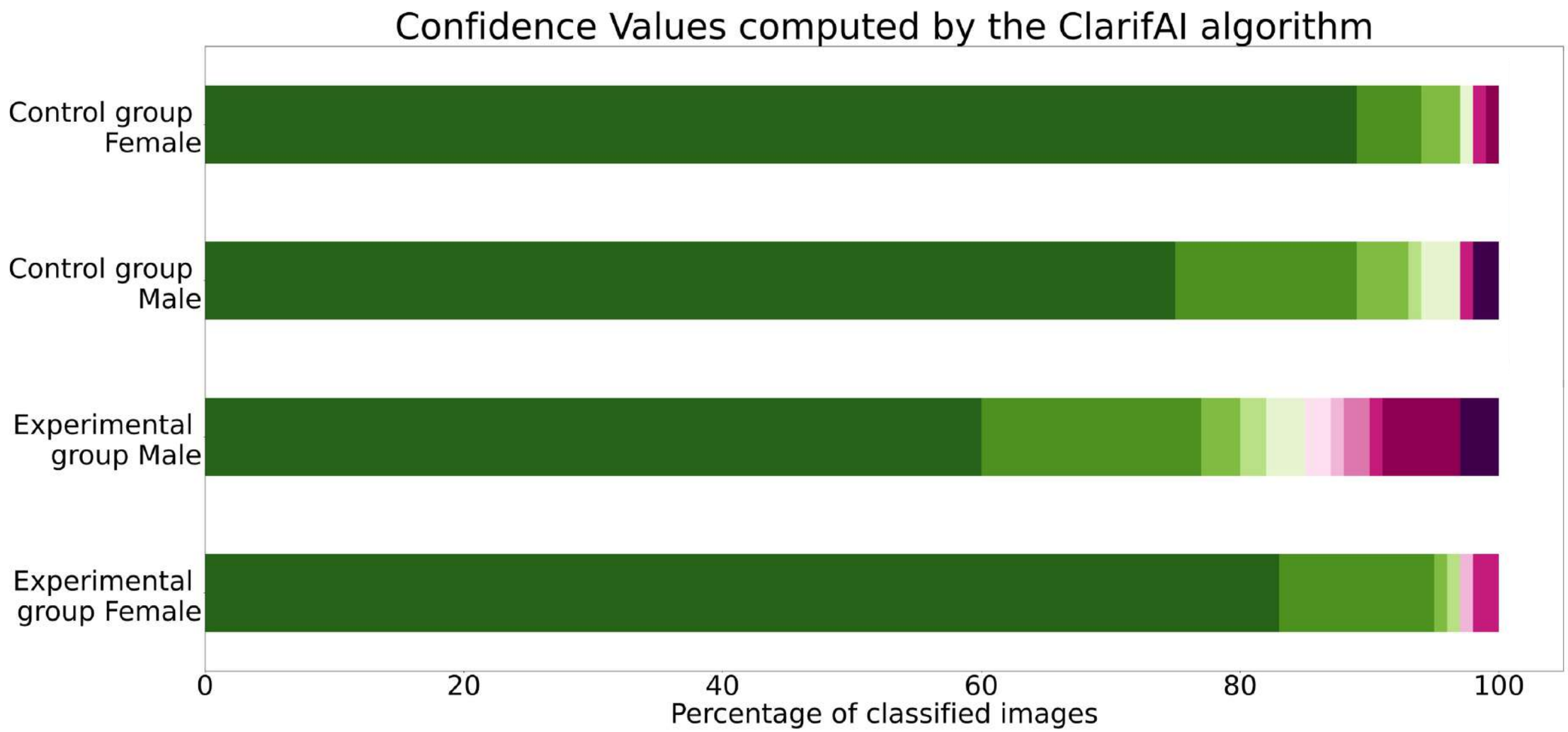
Control Group: **Male-Female**						
Algorithm	ClarifAI					
	Female	**Male**	Accuracy	Precision	Recall	F1-score
Female	98	2	98%	97%	98%	98%
Male	3	97		98%	97%	97%
Algorithm	AWS					
	Female	**Male**	Accuracy	Precision	Recall	F1-score
Female	99	1	97%	94%	99%	97%
Male	6	94		99%	94%	96%

GENDER RECOGNITION

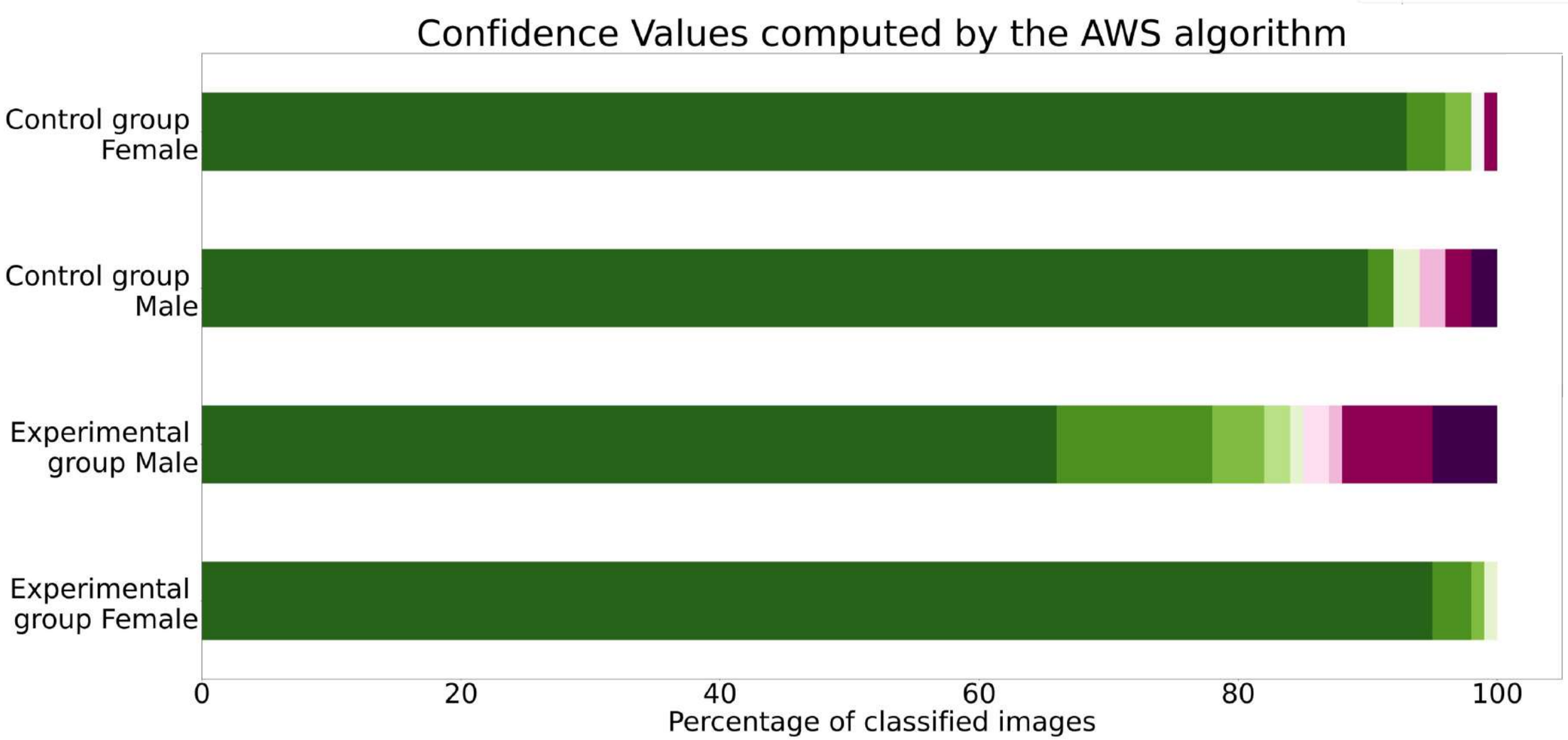
GUIDELINE OF THE AWS ALGORITHM:

"We recommend using a threshold of 99 or more for use cases where the accuracy of classification could have any negative impact on the subjects of the images"

GENDER RECOGNITION – CONFIDENCE LEVELS



GENDER RECOGNITION – CONFIDENCE LEVELS



GENDER RECOGNITION – CONFIDENCE LEVELS

FINAL RESULTS:

AWS

	Control Group	Experimental Group
Female	93%	95%
Male	90%	66%

CLARIFAI

	Control Group	Experimental Group
Female	89%	83%
Male	75%	60%

AGE PREDICTION

Age Prediction General Results

	ClarifAI	
	Experimental Group	*Control Group*
Correct Age	48%	49%
Incorrect Age	52%	51%

Experimental group

ClarifAI

TRUE \ PREDICTED RANGE	0-2	3-9	10-19	20-29	30-39	40-49	50-59	60-69	>70
0 - 2	2								
3 - 9	3	9							
10 - 19		4	15	9					
20 - 29		3	14	24	10				
30 - 39		2	2	9	6	3			
40 - 49			1	2	2	6	2		
50 - 59						1		1	
60 - 69									
> 70									

Control group

ClarifAI

TRUE \ PREDICTED RANGE	0-2	3-9	10-19	20-29	30-39	40-49	50-59	60-69	>70
0 - 2									
3 - 9		11	4						
10 - 19		5	13	7					
20 - 29			2	20	3				
30 - 39				9	15				
40 - 49				4	9	11	3		
50 - 59				3	6	9	10	3	
60 - 69					3	4	12	9	
> 70				1			7	11	6

Right Predictions **d1** **d2** **d3** **d4**

AGE PREDICTION

Age Prediction General Results

	AWS	
	Experimental Group	*Control Group*
Correct Age	52%	45%
Incorrect Age	48%	55%

Experimental group

AWS

TRUE \ PREDICTED RANGE	0-2	3-9	10-19	20-29	30-39	40-49	50-59	60-69	>70
0 - 2	1	1							
3 - 9	1	10	1						
10 - 19		3	14	9					
20 - 29			15	22	12	2			
30 - 39		1	2	10	9				
40 - 49				2	5	4	2		
50 - 59						1	1		
60 - 69									
> 70									

Control group

AWS

TRUE \ PREDICTED RANGE	0-2	3-9	10-19	20-29	30-39	40-49	50-59	60-69	>70
0 - 2									
3 - 9	1	9	5						
10 - 19		3	12	10					
20 - 29			3	21	1				
30 - 39			1	10	7	3			
40 - 49				2	6	17	2		
50 - 59					2	12	17		
60 - 69						4	15	6	1
> 70							6	15	3

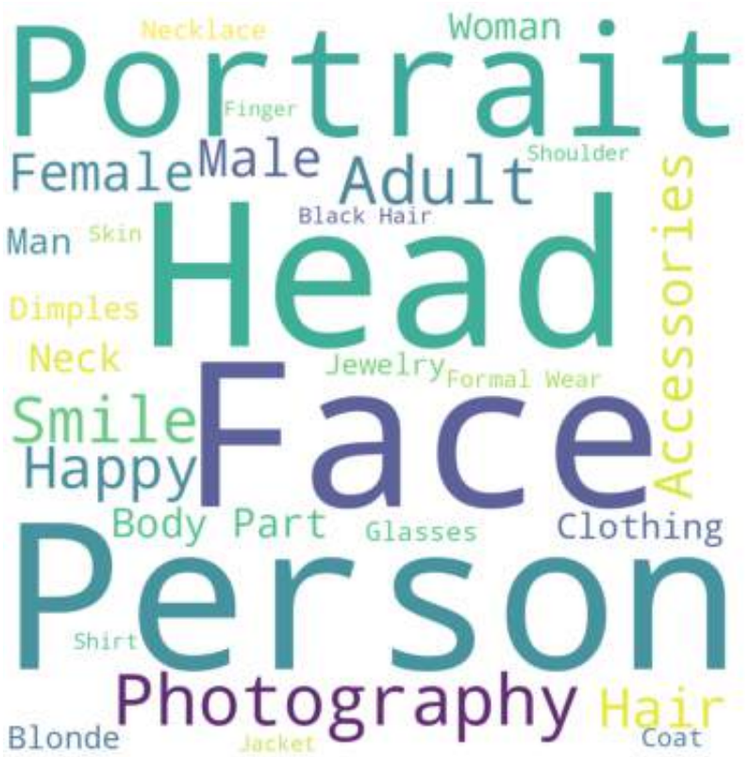
Right Predictions **d1** **d2** **d3** **d4**

GENERAL IMAGE RECOGNITION

AWS

Labels divided in 40 categories
(e.g. Education, Hobbies and Interests, Profession, Sports, Person Description etc.)

Category analyzed:
Person Description



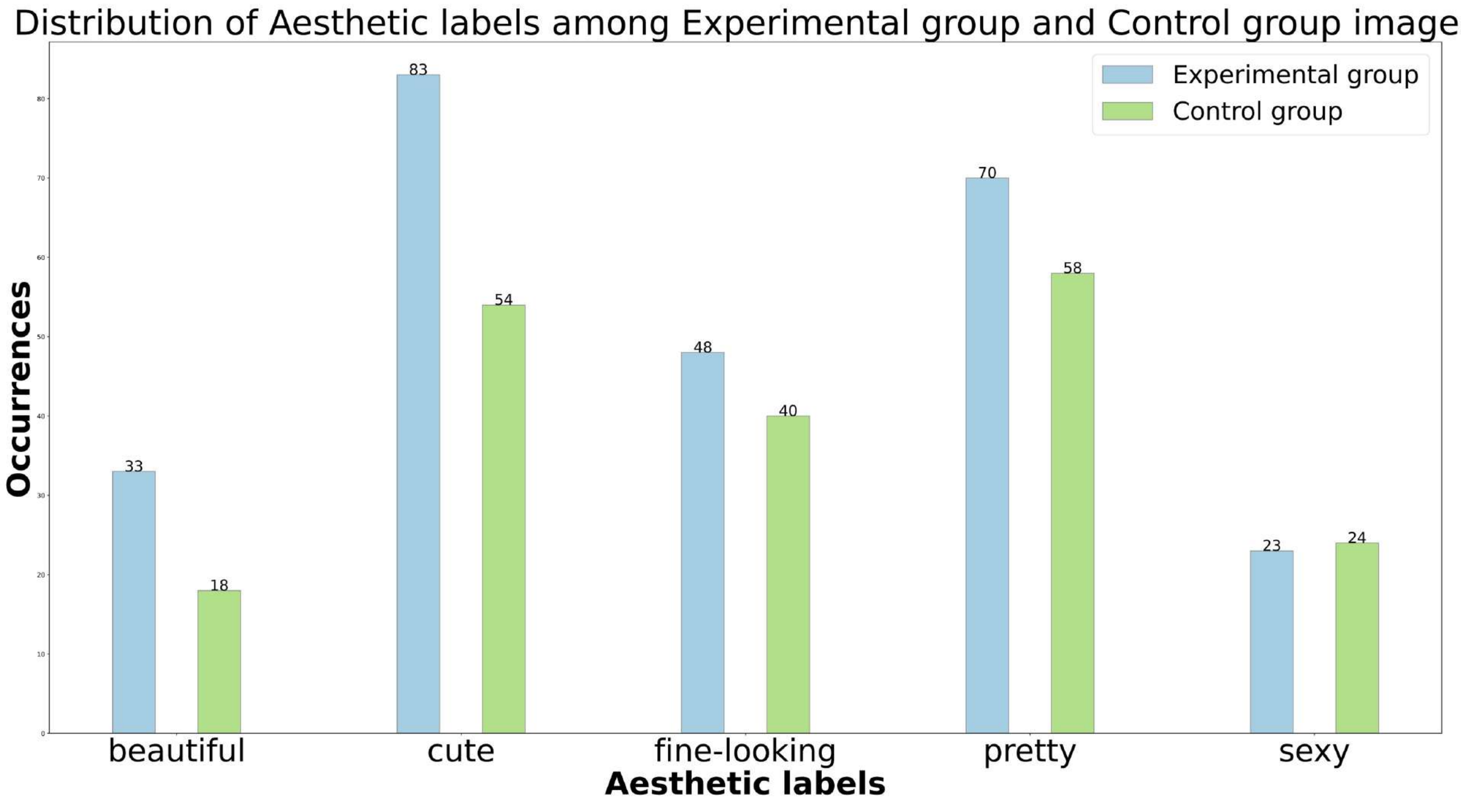
CLARIFAI

No category division

Creation of categories to analyze:
Aesthetics, Education, Person Description

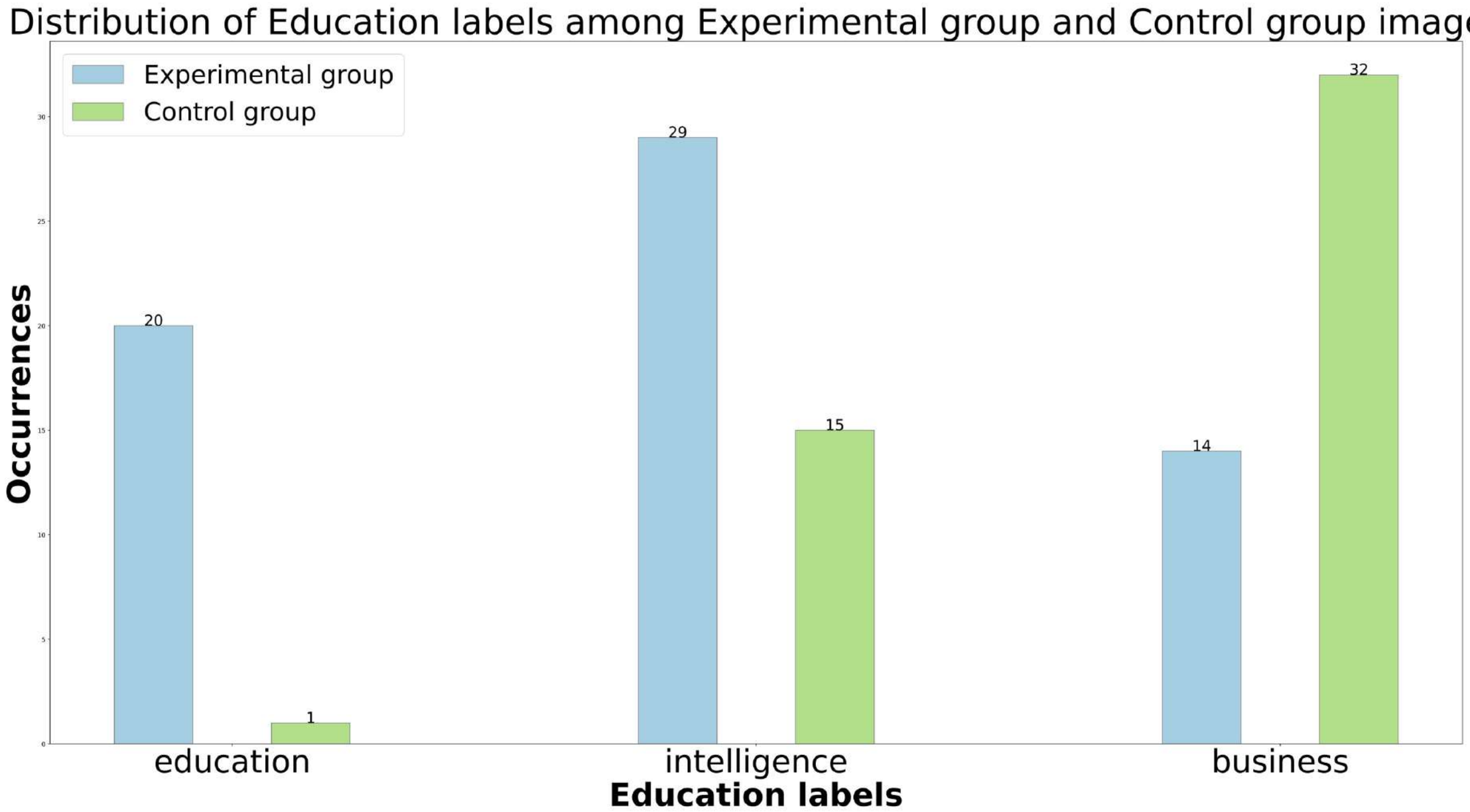
AESTHETICS

CLARIFAI



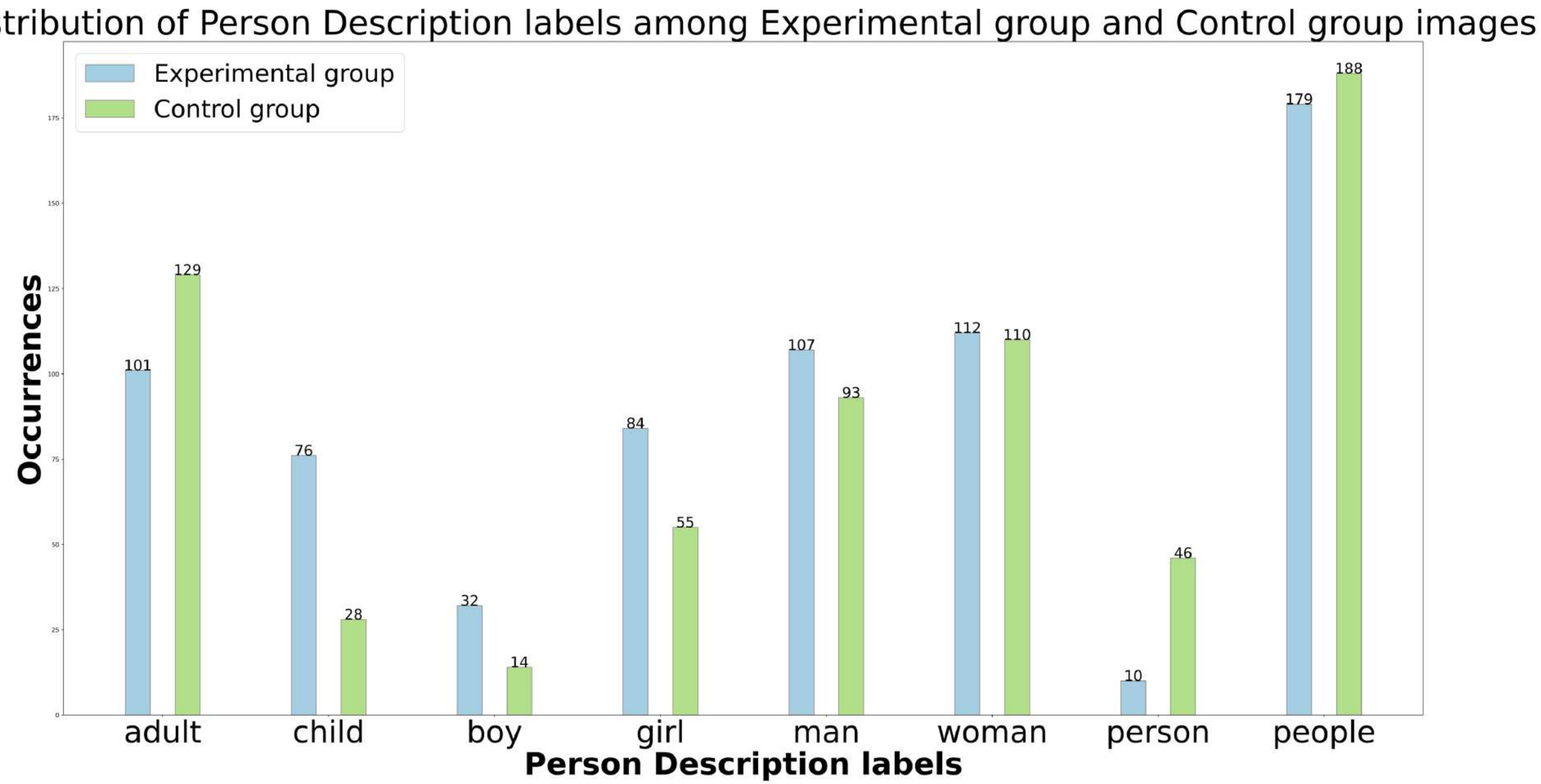
EDUCATION

CLARIFAI



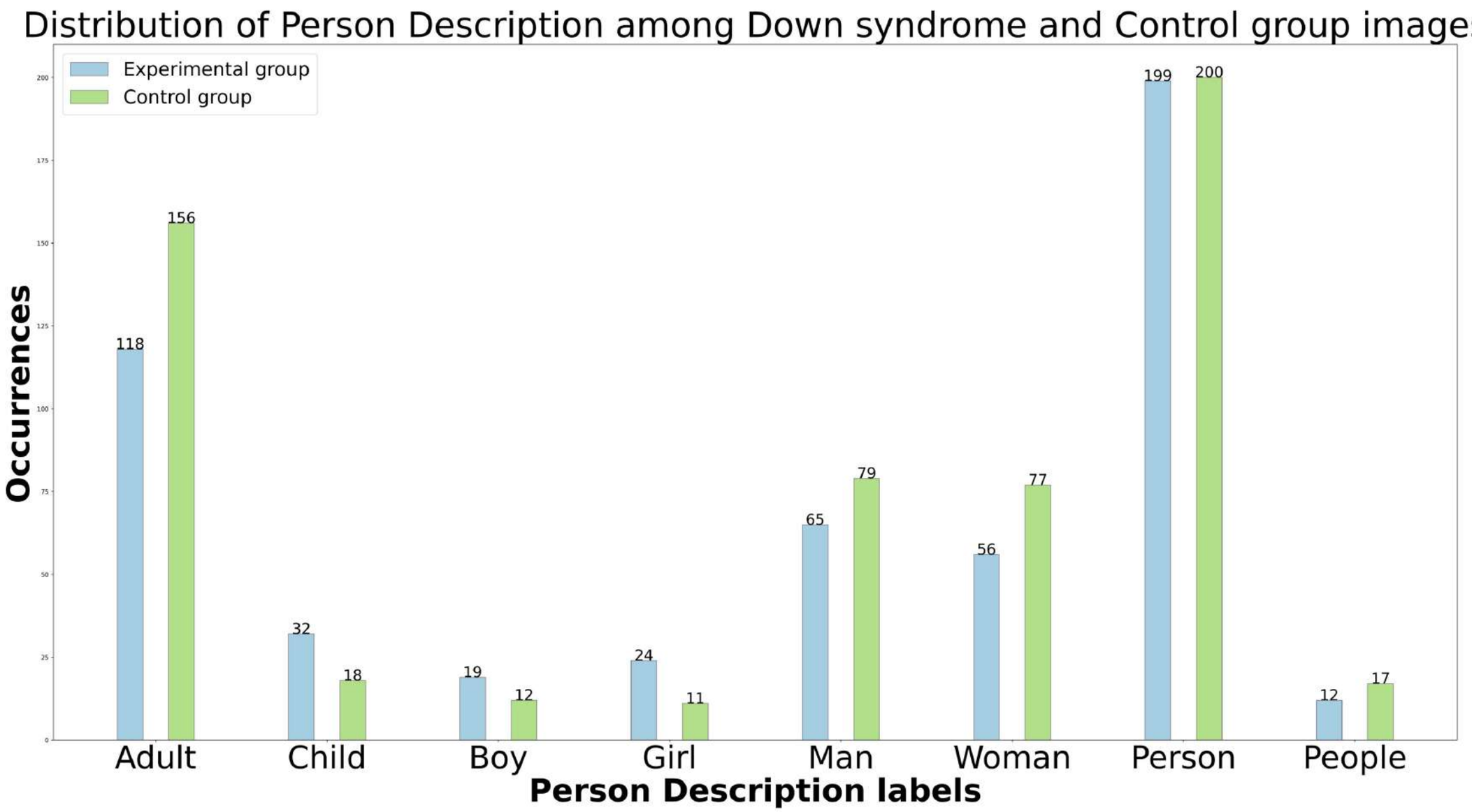
PERSON DESCRIPTION

CLARIFAI



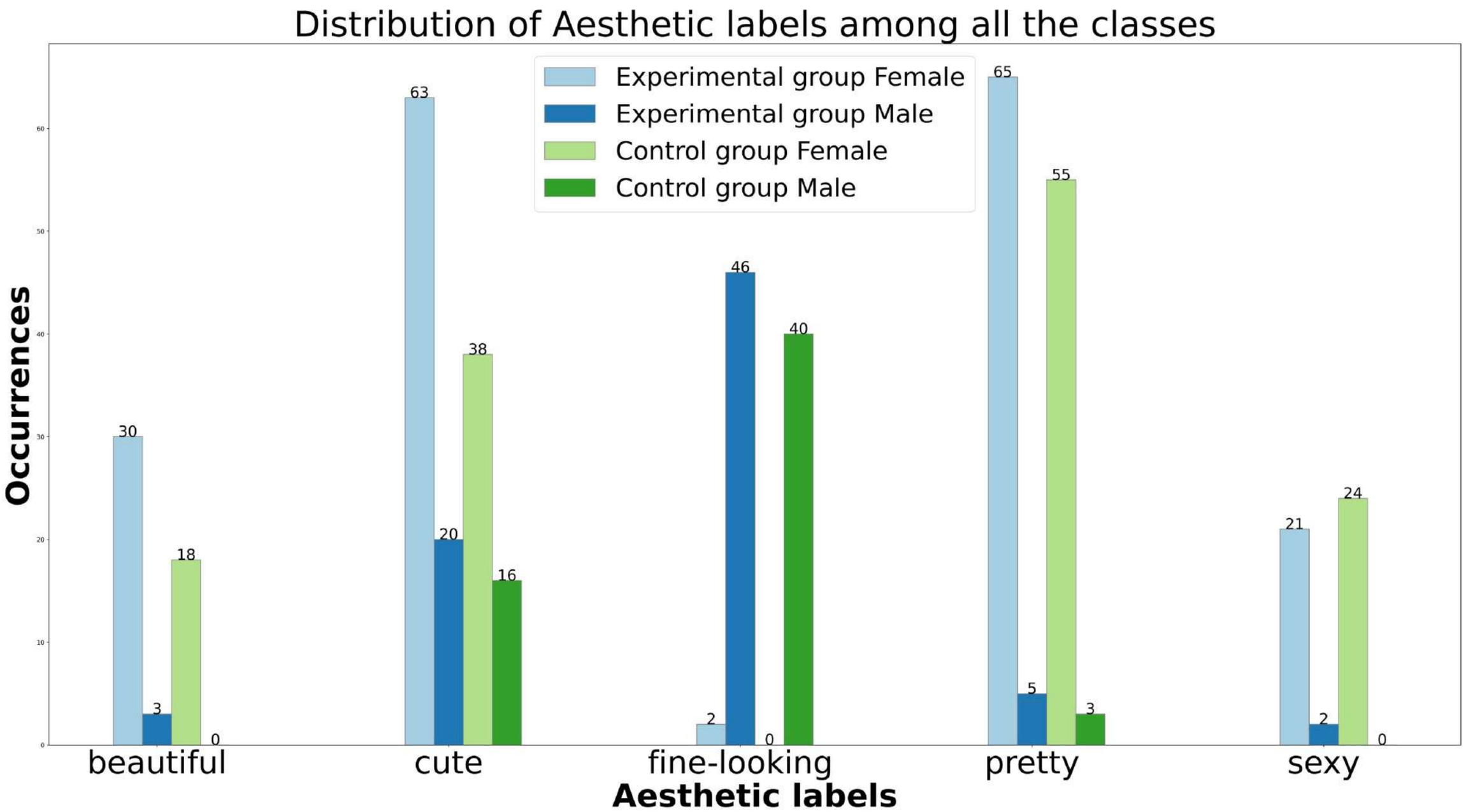
PERSON DESCRIPTION

A
W
S



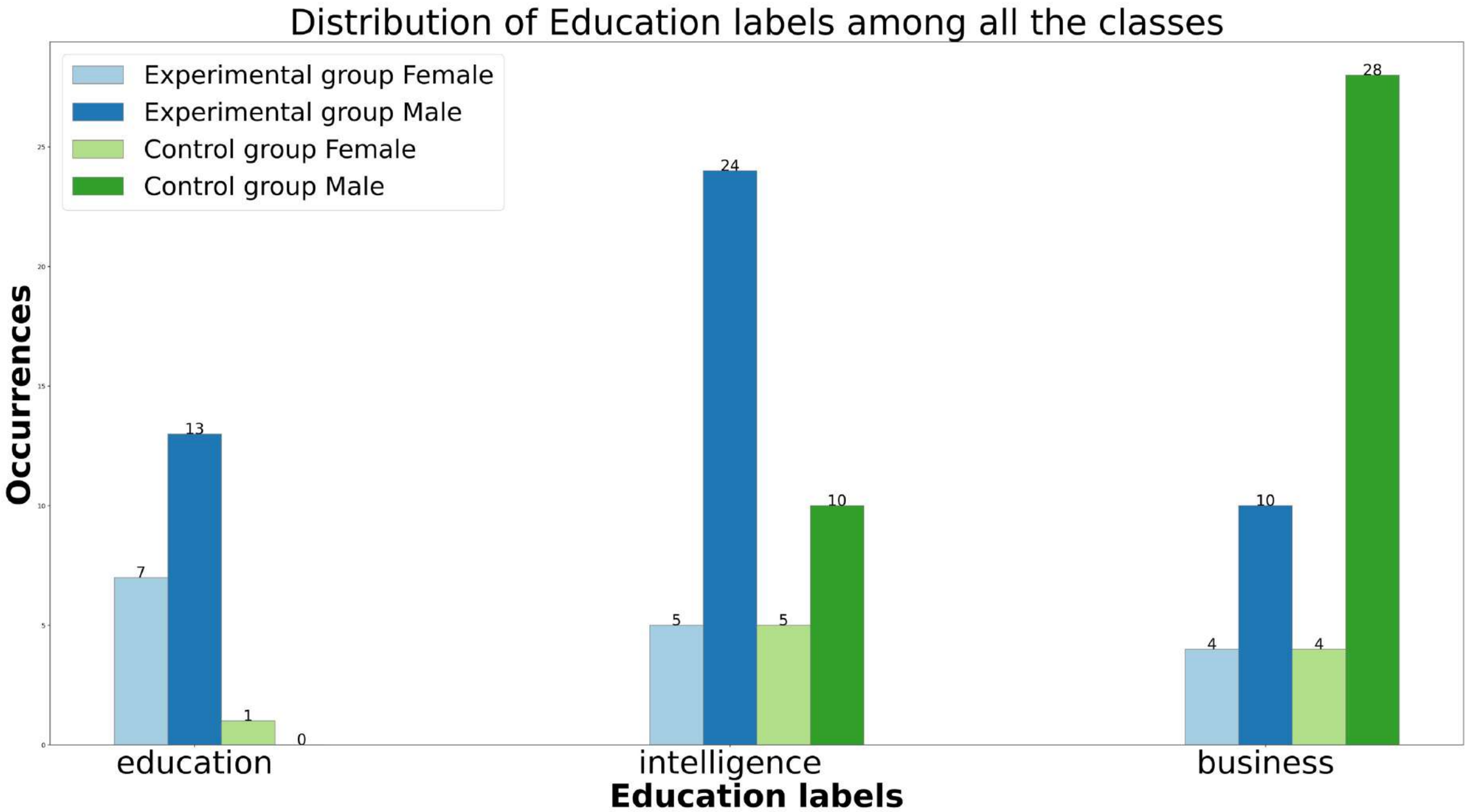
AESTHETICS

CLARIFAI



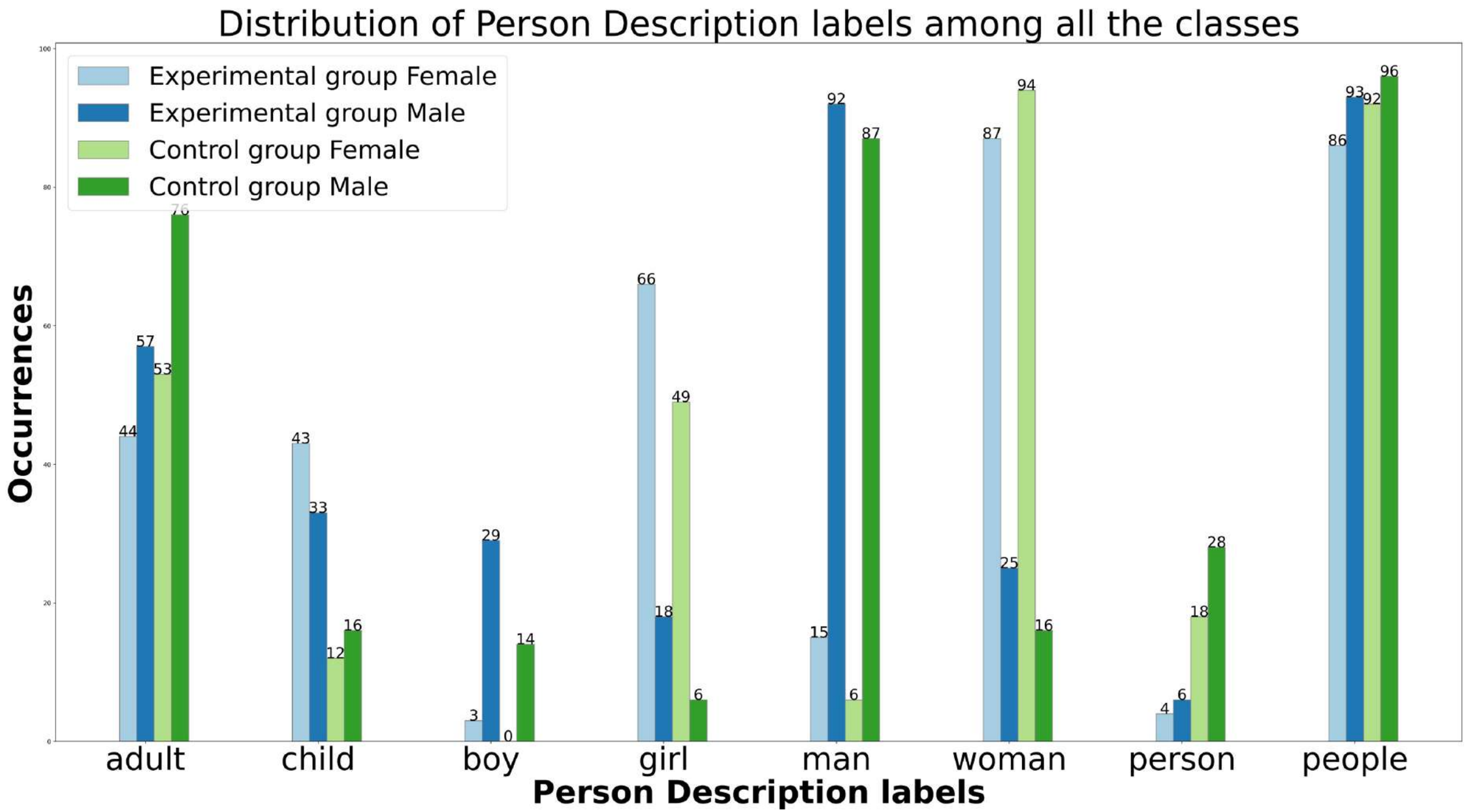
EDUCATION

CLARIFAI



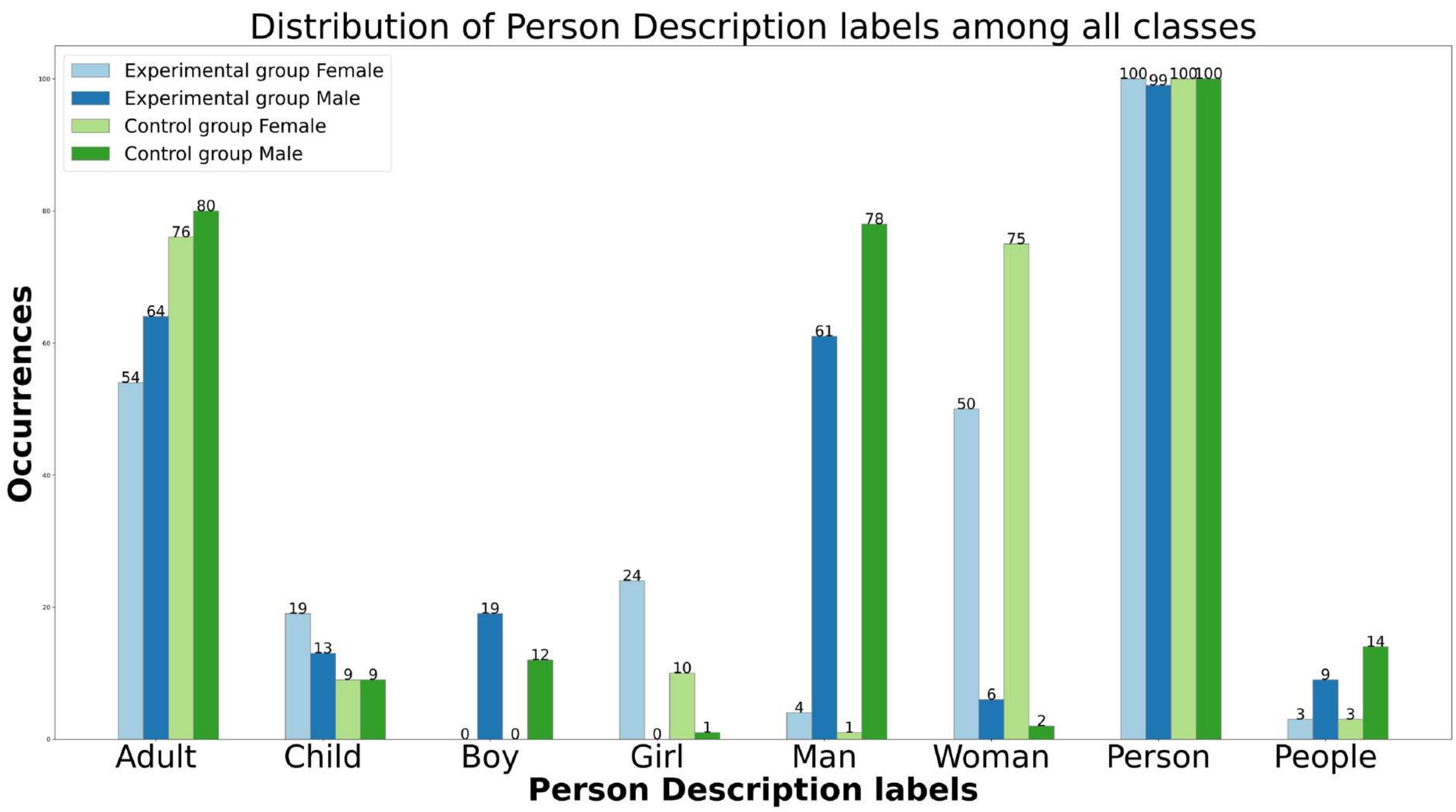
PERSON DESCRIPTION

CLARIFAI



PERSON DESCRIPTION

A
W
S



ANSWERS

- **RQ1:** Yes, there are differences for both predictions of gender and age.
  - GENDER: **Lower results** for gender prediction, in particular for the **experimental group male class**
  - AGE: Attribution of **child age range** to adult belonging to the experimental group
- **RQ2:** There are no significant differences between EG and CG but the differences between genders are more relevant

"THE CHALLENGE OF DIVERSITY COULD BE SOLVED BY BUILDING A DATA SET COMPRISED FROM THE FACE OF EVERY PERSON IN THE WORLD"

IBM Researchers