

Automatic Real and Apparent Age Estimation in Still Images

Master in Artificial Intelligence

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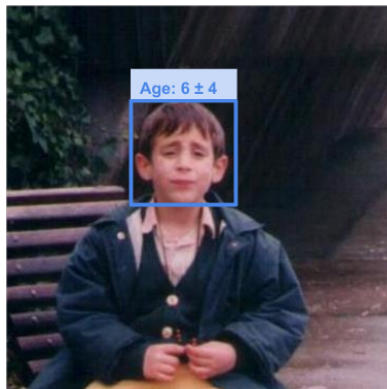
30th April 2015

Introduction

Applications

Automatic Age Estimation has many different applications such as:

- Security Control
- Biometrics
- Age-based Databased Indexing
- E-commerce and HCI



Goals

Age definitions

- *Real Age*: The actual age (DNI).
- *Apparent Age*: Perceived age by humans.
- *Estimated Age*: The predicted age by a machine.

The main objectives of this project were two:

Objectives

- New Face Image Database containing real and apparent age annotations.
- Analyse and compare real age estimation vs apparent age estimation using state of the art approaches.

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Outline

State of the Art

Data Collection

Web-Application, Database Analysis

Method

Preprocessing, BIF Method, CNN Method

Results

Databases, Evaluation Metrics, Analysis of the Experiments

Conclusions and Future Work

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State of the Art

The age estimation problem has generally two stages or blocks.
The first one is the **age representation** and the second one the **learning algorithm**.

Age Representation

- Anthropomorphic Models
- Active Appearance Models
- Ageing Pattern Subspace
- Age Manifold
- Appearance Models

Learning Algorithm

- Classification Methods
- Regression Methods
- Hybrid Methods

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Data Collection


A web-based application using *Facebook's API* was created to collect face images and annotate them in a gamified and collaborative fashion.


Database Characteristics

- Thousands of faces labelled by many users.
- Images with background.
- Non-controlled environments.
- Non-labelled faces neither landmarks, making the estimation problem even harder.
- The first datasets in the literature including apparent age labelled by many users.


Web-Application I


 Age Recognition

 PROFILE GAME ACHIEVEMENTS GALLERY RANKING




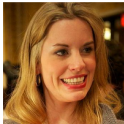
Input the age:







Input the age:






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










Input the age:

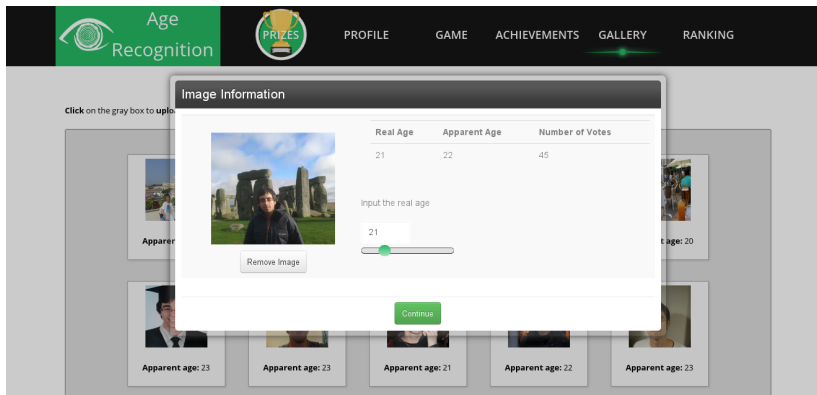


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Collaborators:




Web-Application II



Web-Application III

 Age
Recognition




PROFILE

GAME

ACHIEVEMENTS

GALLERY

 RANKING

RANKING

Friend's Ranking

#	Player	Score	#Votes	#Uploaded Images
1	Gerard Canal Camprodon	14834	607	101
2	Jordi González	11755	644	16
3	Pablo Pg	10699	647	18
4	Marc Oliu Simón	7507	136	104
5	Jeroni Bosch	6018	206	40
6	Juan Jose Pardo Pardo	4315	268	2
7	Cristina Palmero	4128	155	8
8	Iosu Mendizabal Borda	3489	156	0
9	Isabelle Guyon	3297	180	13

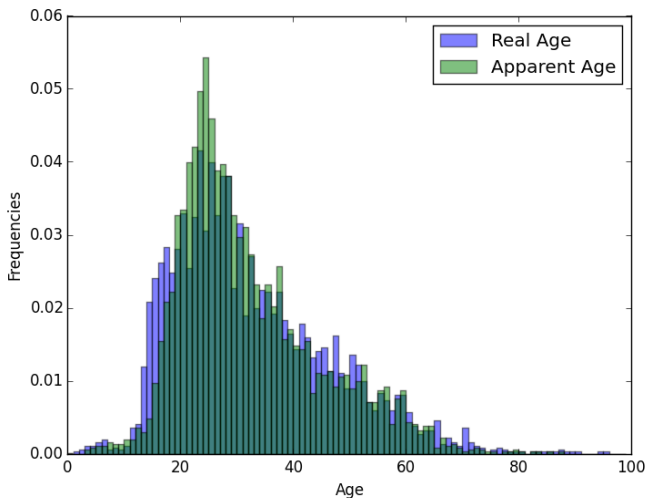
Database Analysis I

Features		HuPBA ¹	AgeGuess ²	Total
Images		1506	3359	4865
Users	female	44	1828	1872
	male	110	1143	1253
	Total	154	2971	3125
Votes	female	1753	75136	76889
	male	14897	53117	68004
	Total	16640	128253	144893

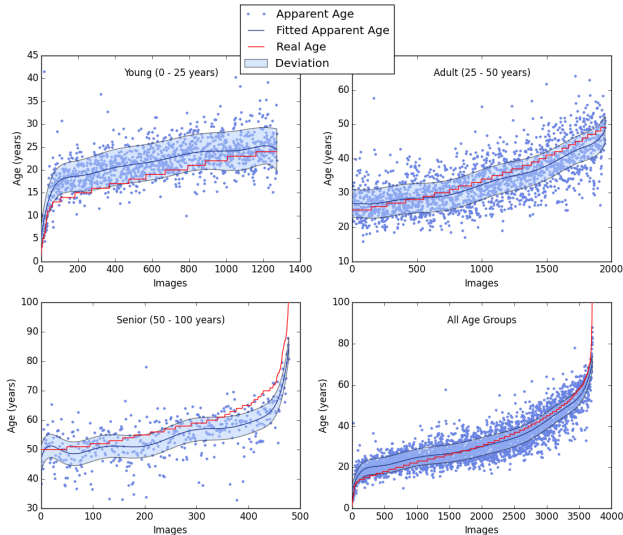
¹HuPBA web application: <http://sunai.uoc.edu:8005>

²AgeGuess web application: <http://www.ageguess.org/>

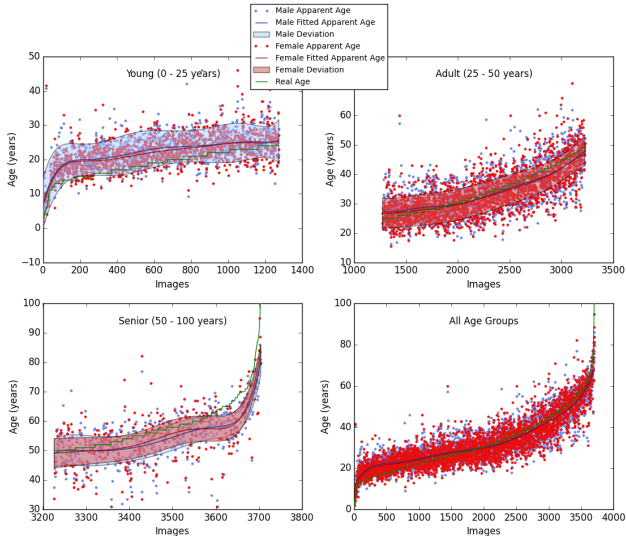
Database Analysis II



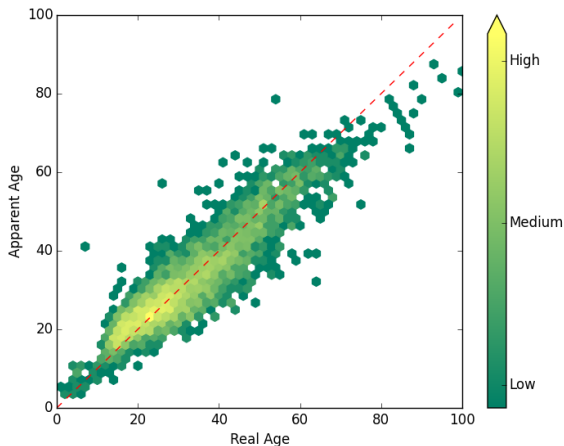
Database Analysis III



Database Analysis IV



Database Analysis V



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Proposed Method

Two methods were proposed:

- **Biologically Inspired Method:** based on Biologically Inspired Features (BIF)³.
- **Deep Learning Method:** based on Convolutional Neural Networks (CNN)⁴.

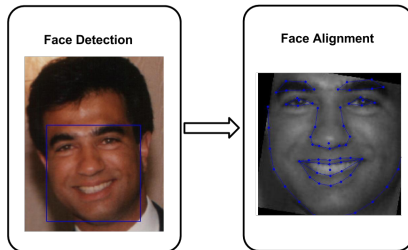
Both methods have the same preprocessing step.

³Guo, Guodong and Mu, Guowang and Fu, Yun and Huang, Thomas S., *Human age estimation using bio-inspired features.*, booktitle *CVPR*, published by IEEE.

⁴Alex Krizhevsky and Sutskever, Ilya and Geoffrey E. Hinton, *ImageNet Classification with Deep Convolutional Neural Networks*, published by Curran Associates, Inc. in 2012.

Preprocessing

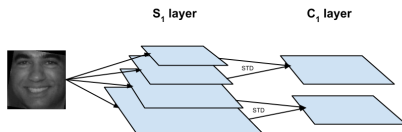
- **Face Detection:** OpenCV Viola & Jones implementation⁵.
- **Grey Scale:** Transform RGB to grey scale.
- **Face Alignment:** Shape regressor using 68 facial landmarks by Shaoqing et al.⁶.



⁵Bradski, G. published at *Dr. Dobb's Journal of Software Tools* in 2000

⁶Ren, Shaoqing and Cao, Xudong and Wei, Yichen and Sun, Jian, *Face Alignment at 3000 FPS via Regressing Local Binary Features*, CVPR 2014

Biologically Inspired Features



S_1 layer

- Battery of Gabor filters.
- 8 different orientations and 16 different scales.

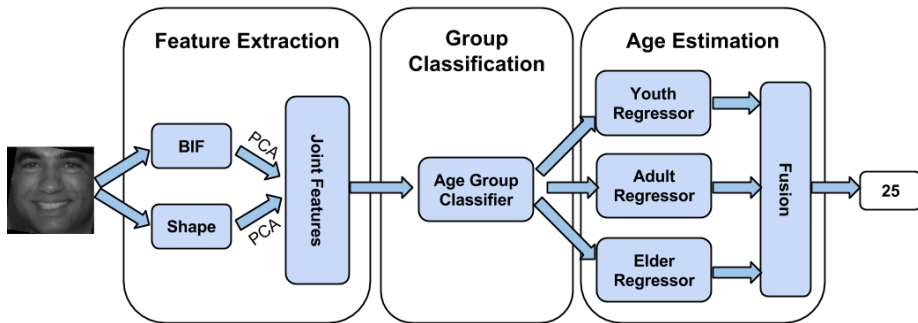
C_1 layer

“STD” pooling operator rather than “MAX”.

$$std_{j,j+1} = \sqrt{\frac{1}{q \times q} \sum_{i=1}^{q \times q} (F_i - \bar{F})^2},$$

$$F_i = \max(x_i^j, x_i^{j+1}),$$

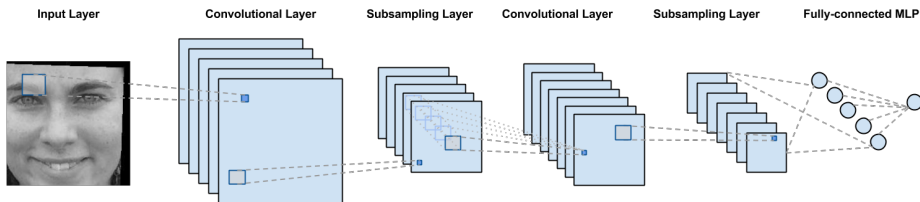
Biologically Inspired Method I



Biologically Inspired Method II

- **Feature Extraction:** Calculate the BIF features and the 68 facial landmark and perform PCA.
- **Group Classification:** Linear SVM to classify the input image into 3 age groups (young: 0 - 18, adult: 19 - 45 and senior: 46 - 100).
- **Age Estimation:** Three SVR with RBF kernel to regress the estimated age for each of the previous age groups.

Convolutional Neural Networks



CNN Method

Layer	Input size	Output size	Filter size	Pooling size
Conv1	200×200	190×190	$10 * (11 \times 11)$	-
Pool1	190×190	95×95	-	(2, 2)
Conv2	95×95	89×89	$20 * (7 \times 7)$	-
Pool2	89×89	44×44	-	(2, 2)
Conv3	44×44	40×40	$40 * (5 \times 5)$	-
Pool3	40×40	20×20	-	(2, 2)
Full1	16,000	500	-	-
Full2	500	200	-	-
Full3	200	1	-	-

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Results: Used Databases

FG-NET⁷



HuPBA-AgeGuess



⁷Lanitis, A., *FG-NET Aging Data Base* at 2007

Results: Evaluation Metrics

Mean Absolute Error (MAE)

$$MAE = \frac{1}{n_s} \sum_{i=0}^{n_s-1} |\hat{y}_i - y_i|,$$

Cumulative Score (CS)

$$CS(t) = \left(1 - \frac{1}{n_s} \sum_{i=0}^{n_s-1} h(|\hat{y}_i - y_i| - t)\right) \cdot 100$$

$$h(x) = \begin{cases} 1, & \text{if } x \geq 0 \\ 0, & \text{otherwise,} \end{cases}$$

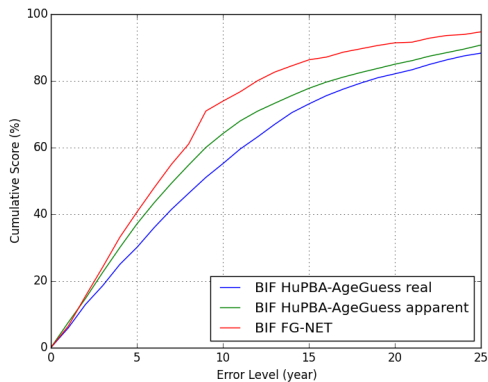
Results: Experiments I

Face Detection and Alignment

- The face detection was 92.52% accurate.
- The face alignment was approximately 84.54% accurate (visual inspection).
- Finally, 78.26% of the images were successfully detected and aligned.



Results: Experiments II

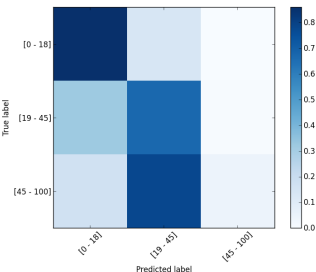


Biologically Inspired Method

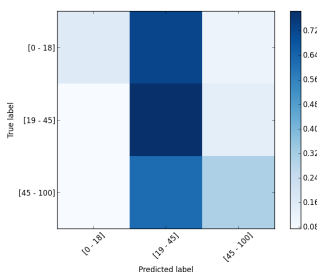
Database	MAE
FG-NET	7.99
Real age	10.73
Apparent age	9.34

Results: Experiments III

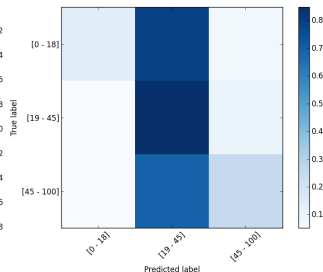
Confusion Matrix of the group classification.



1) FG-NET
89.5% acc.



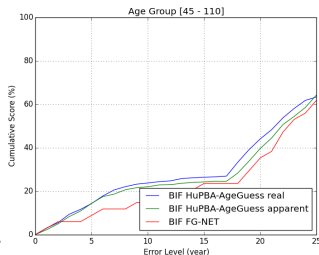
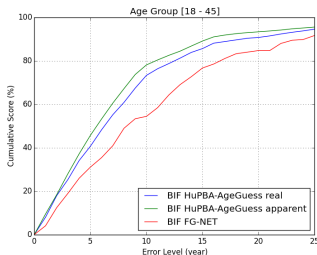
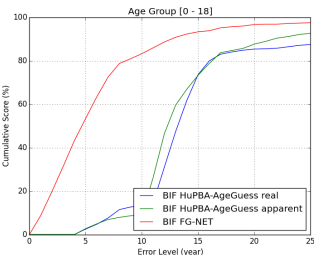
2) Real Age
87% acc.



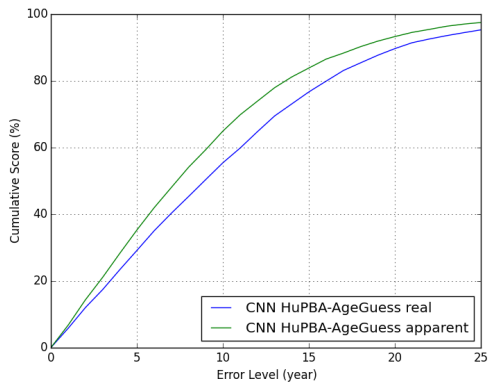
3) Apparent Age
87% acc.

Results: Experiments III

Cumulative Score by age groups achieved by the BIF method.



Results: Experiments IV

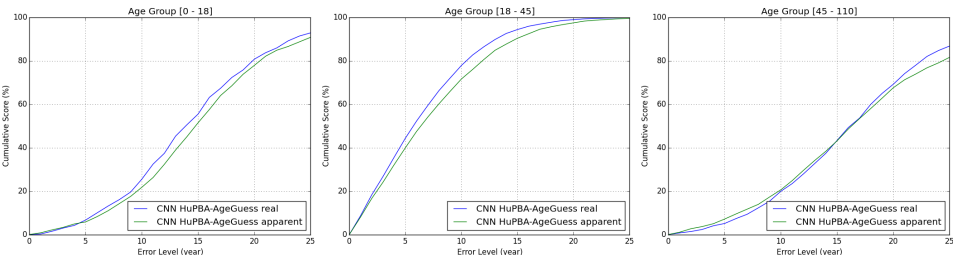


CNN Method

Database	MAE
FG-NET	-
Real age	10.29
Apparent age	8.71

Results: Experiments V

Cumulative Score by age groups achieved by the CNN method.



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- **First state of the art database for automatic age estimation** was created in this thesis.
- As suggested in the initial hypothesis both proposed methods work better estimating apparent age rather than real age.
- CNN achieved better results than BIF. This may be because the CNN learn features by itself.
- Initial results regarding the database and the methods presented in this work have been published in the IJCNN conference next July in Ireland⁸.

⁸S. Escalera, J. Gonzalez, X. Baro, P. Pardo, J. Fabian, M. Oliu, H. Escalante, I. Huerta, I. Guyon, *ChaLearn Looking at People 2015 new competitions: Age Estimation and Cultural Event Recognition*, Proceedings of the 2015 IJCNN, 2015, IEEE

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Conclusion

- We are organising an international challenge with the collaboration of ChaLearn that will launch the 1st of June. The challenge is sponsored by Google, Microsoft Research, Amazon among others.
- The result of this challenge will be presented in a workshop in the ICCV 2015 conference (under revision).



Microsoft



Future Work

- Improve Web-Application to increase engagement and collect more information.
- The proposed methods can be improved in many ways:
 - Improve Face Detection and the Landmark Regression.
 - Face Frontalization.
 - Local Multi-scale patch BIF.
 - Use Multi-model data (depth, thermal, ...).

Thank you