Age Classification from Hand Vein Patterns

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Problem

- Automatic Age Estimation from Biological Features of Humans.
- Application Areas:
  - HCI Systems
  - Security Applications
  - Forensics
  - etc.

Our Goal

- Age Estimation from Hand Vein Patterns
- Data To Be Used:
  - Hand Vein Image Data of 30 Persons mixed gender.
  - Age classes are as follows.
    - (15-20) 5 People, (20-25) 5 People, (25-30) 5 People,(30-35) 5 People, (35-45) 5 People, (45+) 5 People.

Methods

- TEAK
  - ***effort estimator TEAK (short for "Test Essential Assumption Knowledge") that has been proposed by Ekrem Kocaguneli and Ayse Bener [1].***
- k-nearest neighbor
- PCA

TEAK(The Essential Assumption Knowledge)

- It applied the easy path in five steps:
- *1) Select a prediction system:* As prediction system ABE is used.
- *2) Identify the predictor's essential assumption(s):*

Assumption One: Locality implies uniformity.

This assumption holds for project training data with the following property:

- The K-nearest training projects with effort values $E_1, E_2, .., E_k$ have a mean value $\mu = \left(\sum_i^k E_i\right)/k$ and a variance $\sigma^2 = \left(\sum_i^k (E_i - \mu)^2\right)/(k-1)$.
- By *Assumption One*, decreasing k also decreases σ^2.

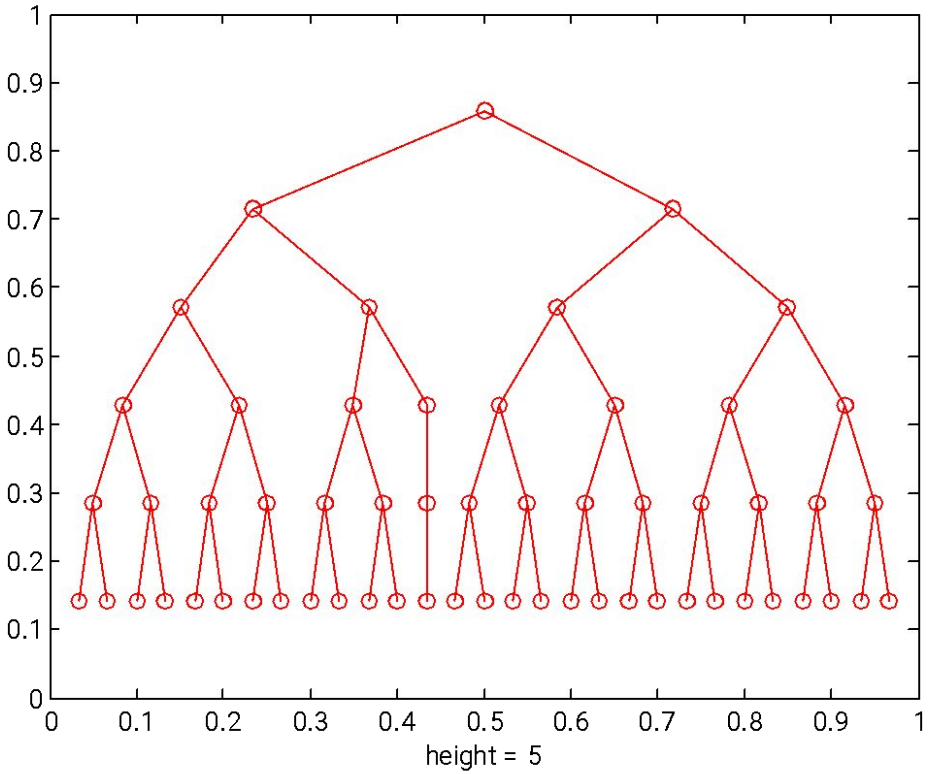
TEAK(The Essential Assumption Knowledge)

- *3) Recognize when those assumption(s) are violated:* Greedy Agglomerative Clustering (GAC) and the distance measure of equation (Euclidean) is used to identify Assumption Violation.

$$Distance = \sqrt{\sum_{i=1}^{n} w_i(x_i - y_i)^2}$$

TEAK(The Essential Assumption Knowledge)

- GAC executes bottom-up by grouping test data, which are closest, together at a higher level.



TEAK(The Essential Assumption Knowledge)

TRAVERSE can test *Assumption One*. Let some current vertex x have children y and z. We say that:

- The sub-trees starting at x, y, z have leaves L_x, L_y, L_z (and $L_x = L_y \cup L_z$).
- The number of sub-tree leaves is $k_x = k_y + k_Z$.
- The variance of the leaves' efforts are $\sigma_x^2, \sigma_y^2, \sigma_z^2$.
- After C4.5 [47], we say the variance of the trees below x (denoted σ_{yz}^2) is the weighted sum:

$$\sigma_{yz}^2 = \frac{k_y}{k_x}\sigma_y^2 + \frac{k_z}{k_x}\sigma_z^2$$

$$\forall x \in T : \sigma_x^2 > \sigma_{yz}^2$$

TEAK(The Essential Assumption Knowledge)

- *4) Remove those situations:* When the violation situation find, tree is pruned to remove those violations. There are three types of prune policy:

1) more than α times the parent variance;
2) more than $\beta * max(\sigma^2)$;
3) more than $R^\gamma * max(\sigma^2)$, where R is a random number $0 \leq R \leq 1$.

- *5) Execute the modified prediction system.*

TEAK Algorithm

```
normalizeValues(images);
TestImage=selectTestImage(images);
//Put all test images to the leaves of tree
//Generate GAC from bottom to up
GAC1=GenerateGACTree(TrainingImages);
//Traverse tree and prune if needed
prototaypeImages=TraversIPrune(GAC1,TestImage);
//Generate Second GAC tree
GAC2=GenerateGACTree(prototaypeImages);
//Compute, estimate, the median
estimatedAge=Traverse(GAC2,TestImage);
```

Features

- Mean of colors
- Number of points that is smaller than mean of colors of a picture

data <30x3 double>

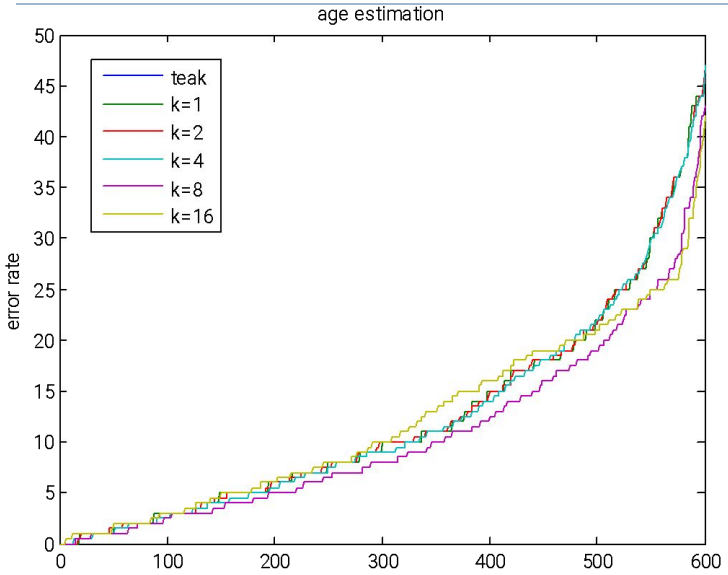
	1	2	3
1	137	4709	37
2	158	4866	32
3	175	5180	25
4	145	4687	47
5	168	4681	27
6	152	4865	24
7	159	4858	31
8	149	4846	37
9	149	4884	44
10	154	4835	29
11	132	4838	46
12	144	4226	54
13	158	4603	16
14	144	4510	63
15	160	3983	19
16	141	5170	30
17	160	4679	45
18	154	4935	26
19	147	5012	46
20	153	4516	27
21	164	4605	30
22	142	5088	30
23	155	5273	25
24	145	4780	27
25	156	4697	22
26	142	4463	22
27	158	4776	45
28	145	5090	19
29	155	4933	20
30	156	5128	20

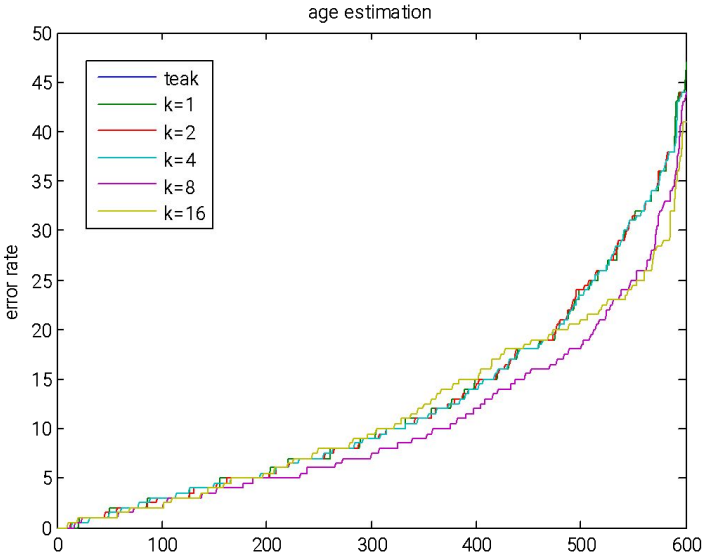
RESULTS

- Result has been evaluated by using AE(absolute Error) and MAE (Mean AE)

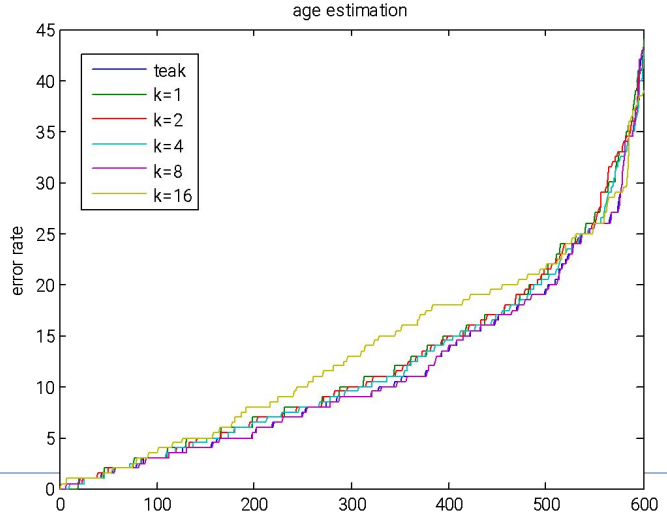
$$\mathrm{MAE} = \frac{1}{n}\sum_{i=1}^{n}|f_i - y_i| = \frac{1}{n}\sum_{i=1}^{n}|e_i|\,.$$

RESULTS (teak+kNN)



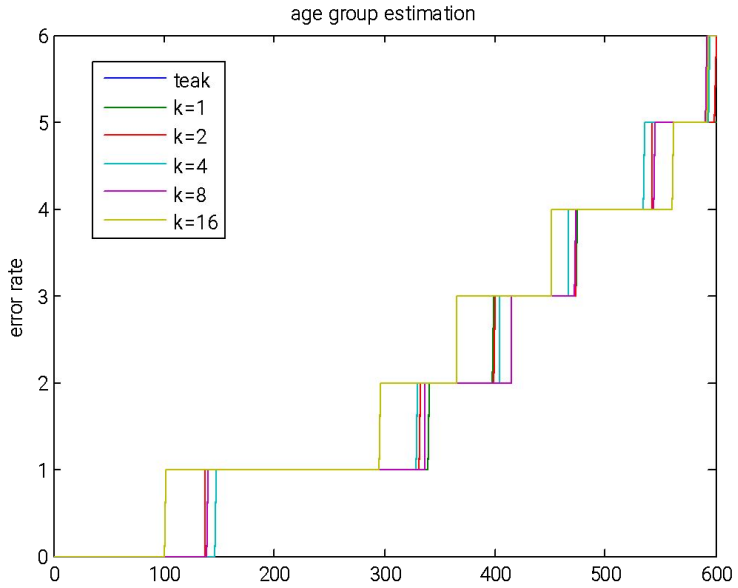


mean color

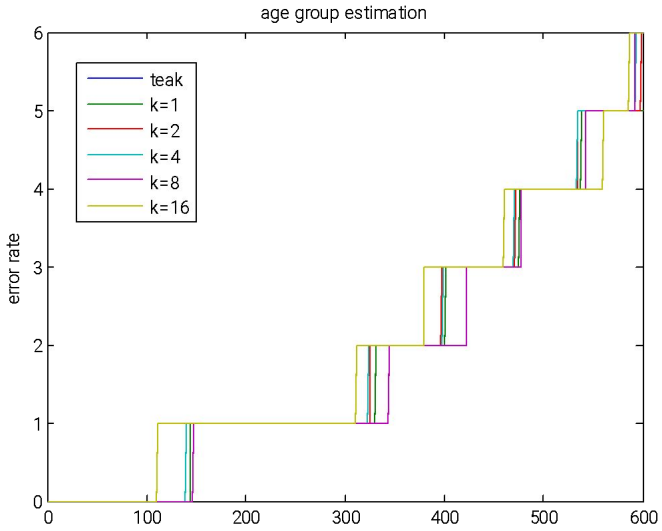


<total mean color

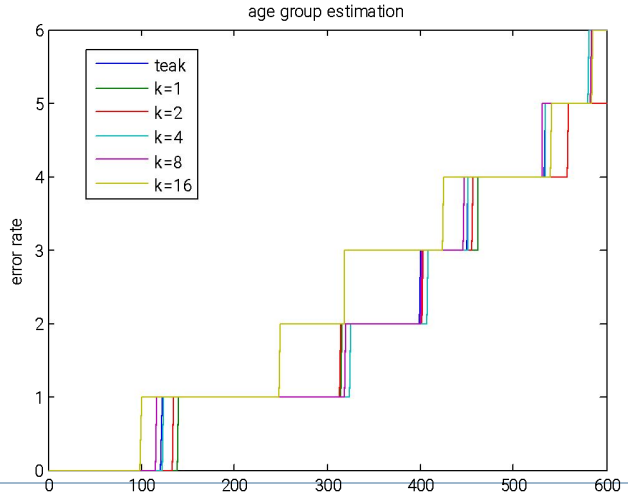
RESULTS (teak+kNN)



mean color



<total mean color



RESULTS (teak+kNN)

age estimation

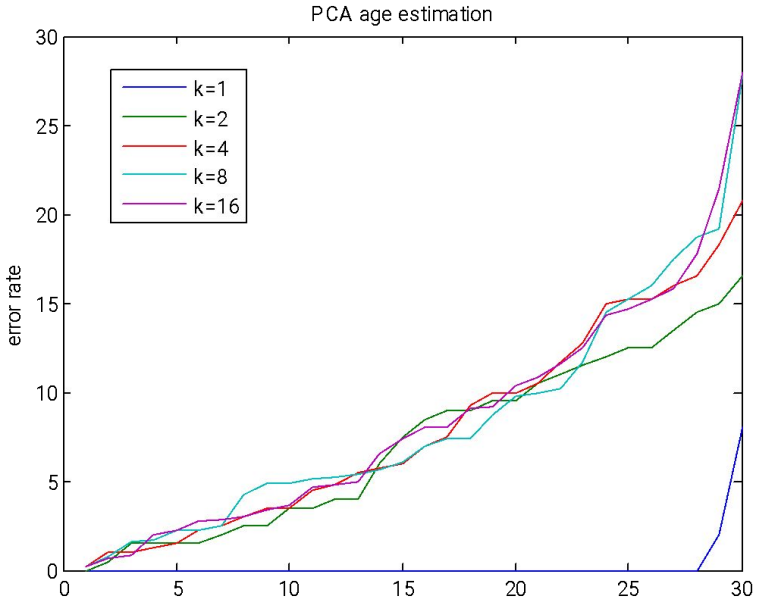
Approach	Mean C. F.	<Mean C. F.	2 features
TEAK	12.1517	12.3683	11.2483
K=1	12.1517	12.3408	12.1383
K=2	12.1467	12.32	12.0608
K=4	12.15	10.3717	11.7633
K=8	10.6783	11.5933	11.2092
K=16	11.8383	12.3683	13.3467

age group estimation

Approach	Mean C. F.	<Mean C. F.	2 features
TEAK	1.8317	1.8567	1.99
K=1	1.8317	1.8567	1.865
K=2	1.8667	1.895	1.895
K=4	1.86	1.9067	1.9683
K=8	1.8483	1.795	2.0083
K=16	2.0633	1.9917	2.3117

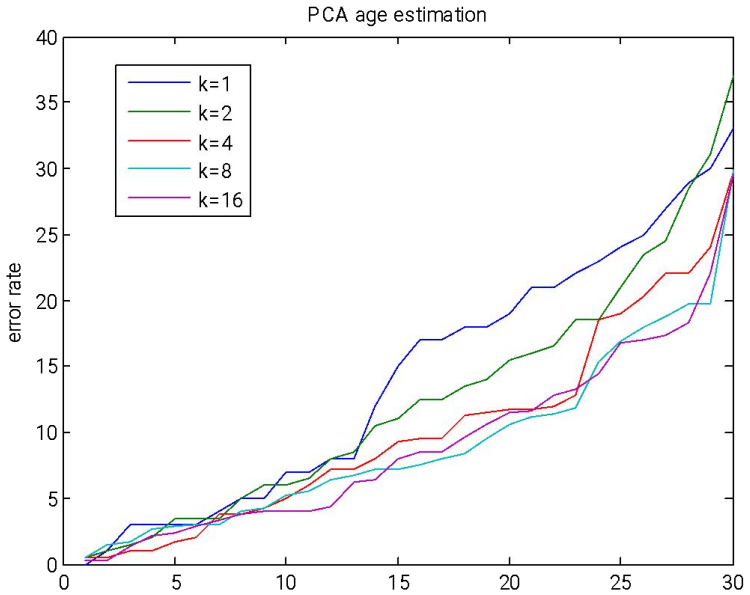
RESULTS (PCA)

+own age



PCA	MAE
K=1	0.3333
K=2	7.2333
K=4	8.0667
K=8	8.4667
K=16	8.5604

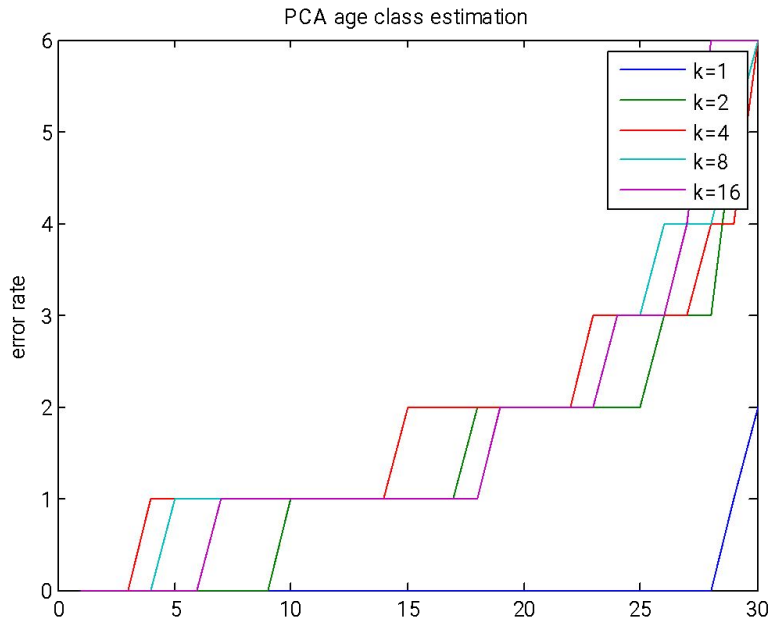
-own age



PCA	MAE
K=1	14.2667
K=2	12.6667
K=4	10.2250
K=8	9.2875
K=16	9.1875

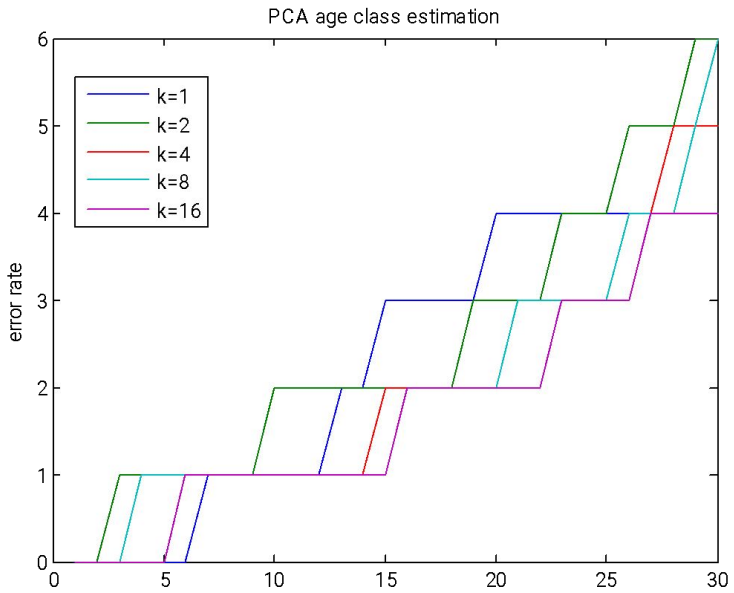
RESULTS (PCA)

+own age



PCA	MAE
K=1	0.1000
K=2	1.4667
K=4	1.8667
K=8	1.7667
K=16	1.7667

-own age



PCA	MAE
K=1	2.4000
K=2	2.5333
K=4	1.8667
K=8	2.0000
K=16	1.7333

RESULTS SUMMARY

Approach	Mean C. F.	<Mean C. F.	2 features	PCA (+own)	PCA (-own)
TEAK	12.1517	12.3683	11.2483	-	-
K=1	12.1517	12.3408	12.1383	0.3333	14.2667
K=2	12.1467	12.32	12.0608	7.2333	12.6667
K=4	12.15	10.3717	11.7633	8.0667	10.2250
K=8	10.6783	11.5933	11.2092	8.4667	9.2875
K=16	11.8383	12.3683	13.3467	8.5604	9.1875

Approach	Mean C. F.	<Mean C. F.	2 features	PCA (+own)	PCA (-own)
TEAK	1.8317	1.8567	1.99	-	-
K=1	1.8317	1.8567	1.865	0.1000	2.4000
K=2	1.8667	1.895	1.895	1.4667	2.5333
K=4	1.86	1.9067	1.9683	1.8667	1.8667
K=8	1.8483	1.795	2.0083	1.7667	2.0000
K=16	2.0633	1.9917	2.3117	1.7667	1.7333

Methods

- Correlation-Based k-NN (image)
- Correlation of Derivative-Based k-NNs (image)
- Linear Weighted Derivative-Based k-NN (image)
- Simple k-NN (1 feature)

Simple k-NN feature

- Take 3x3 window which finds min and max values in the image.
- Threshold (max-min)

- Data Set Used: Hand Palm

Results

Approach	Correlation	Derivative	2nd Deriv.	2nd Der. Linear Weight	Feature Threshold = 18	Feature Test Data
K=1	13.9667	14.8	14.1667	14.1667	9.5	15.3667
K=2	12.5667	11.4667	11.5667	11.8333	7.06667	11.4
K=4	11.0333	11.3667	10.9667	10.5333	8.23333	10.4333
K=8	10.9667	10.3333	10.0667	10.1667	9	10.1667
K=16	9.73333	9.6333	9.36667	9.63333	9.76667	9.76667

Feature with T=18 and k=2.

REAL	EST.	REAL	EST.	REAL	EST.	REAL	EST.	REAL	EST.
37	38	37	28	19	28	30	28	20	28
32	26	44	46	30	19	25	24	20	22
25	29	29	35	45	45	27	28		
47	44	46	44	26	25	22	28		
27	28	54	22	46	42	22	27		
24	28	16	41	27	28	45	28		
31	26	63	27	30	28	19	25		

Result of AGES Algorithm(face)

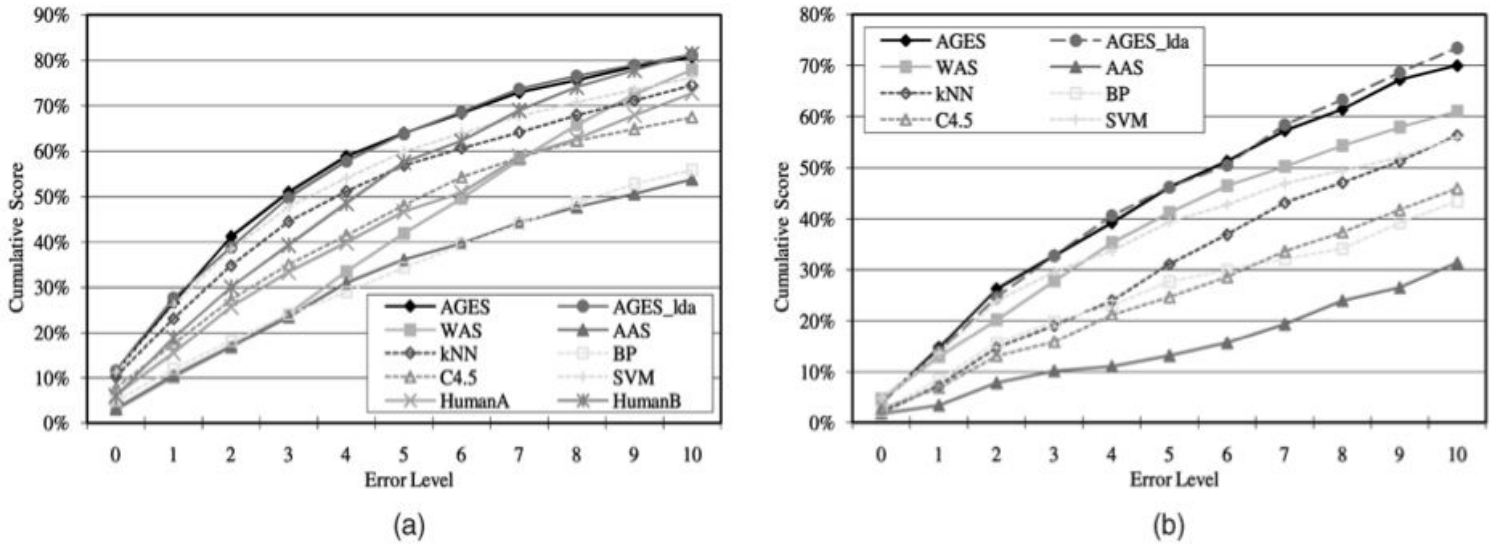


Fig. 4. Cumulative scores of standard age estimation on (a) FG-NET (LOPO) and (b) MORPH (Test Set).

TABLE 2
MAE of Standard Age Estimation on FG-NET and MORPH

Method	AGES	$AGES_{lda}$	WAS	AAS	kNN	BP	C4.5	SVM	HumanA	HumanB
FG-NET (LOPO)	**6.77**	**6.22**	**8.06** (1, 1)	14.83 (1, 1)	8.24 (1, 1)	11.85 (1, 1)	9.34 (1, 1)	**7.25** (1, 1)	8.13 (1, 1)	6.23 (-1, 0)
MORPH (Test Set)	8.83	**8.07**	9.32 (1, 1)	20.93 (1, 1)	11.30 (1, 1)	13.84 (1, 1)	12.69 (1, 1)	9.23 (1, 1)	— —	— —

Results of AAM with SVR(face)

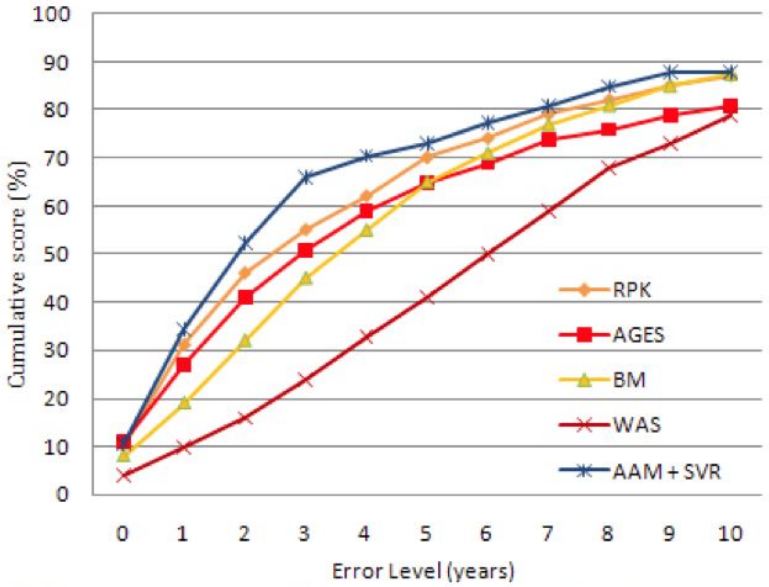


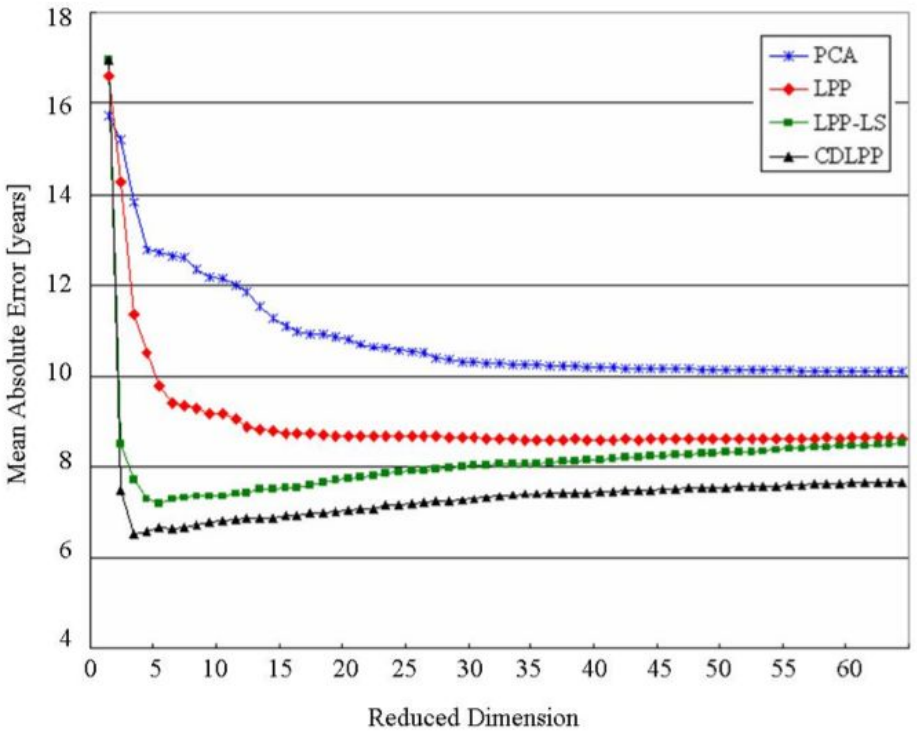
Fig. 4. Comparison of cumulative scores of age estimation methods at error levels from 0 to 10 years in FG-NET database

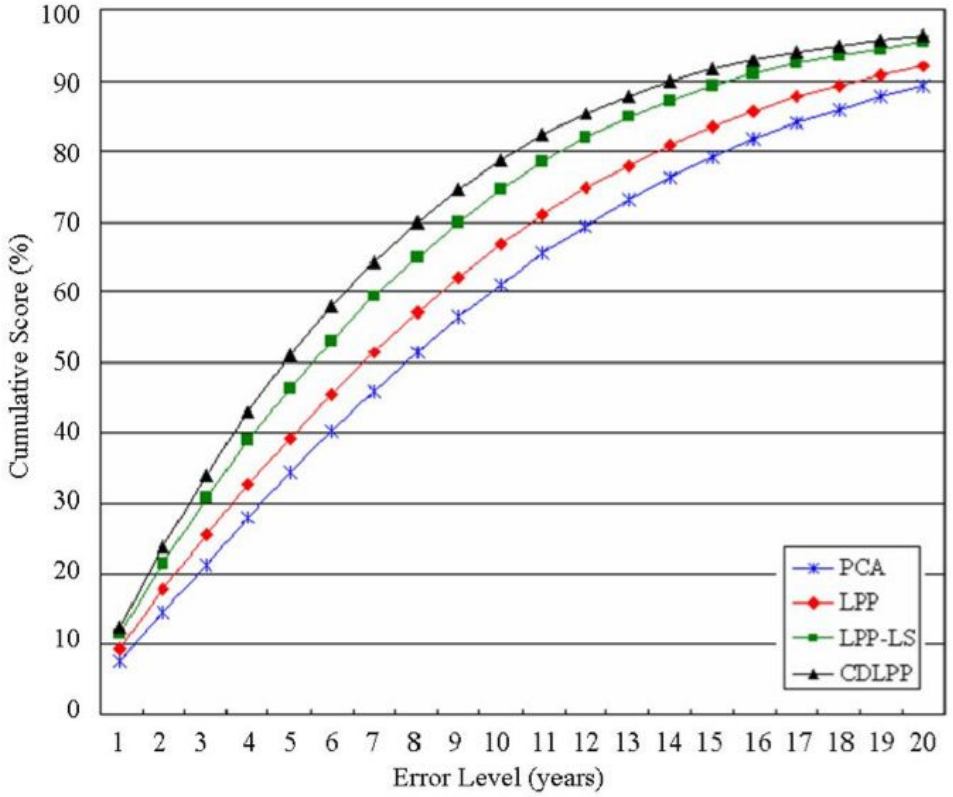
Methods	MAEs
Our proposed method	4.37
RPK [11]	4.95
AGES [15]	6.77
BM [23]	5.33
WAS [13]	8.06

Table 3. Comparison of estimation results on FG-NET database with ages from 0 to 69 years

Results of Dimensionality Reduction(face)

	female		male	
	MAE	dimension	MAE	dimension
PCA	10.10	64	8.66	64
LPP	8.60	34	7.18	58
LPP-LS	7.19	5	6.32	25
CDLPP	6.54	3	5.92	6





References

- [1] E. Kocaguneli and A. Bener, JOURNAL OF IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, VOL. X, NO. Y, SOMEMONTH 201Z, 2010.

Thank You.

Questions