A novel framework for evaluation of ID photo quality

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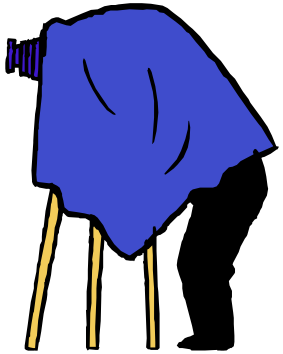
Outline

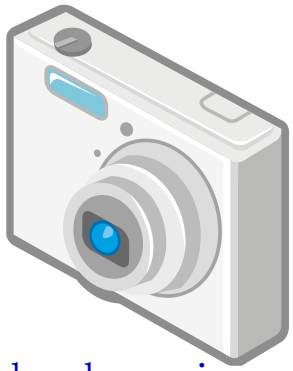
- **Motivation**
  - Existing ways to evaluate ID photo quality and problems
  - A concept of developing a novel framework for ID photo quality evaluation
- **Method**
  - How to design an evaluation function for ID photo quality
- **Experiments**
  - A paired comparison method is applied to the proposed framework
  - Classification experiments are conducted
- **Conclusions**

Ways to make an ID photo

ID photo booth



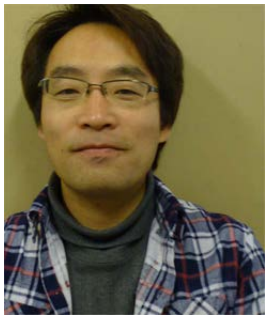
Specialized shop for ID photo



Handmade using digital camera and printer for home use

Good quality

blurred



Improper layout

Weak printing

In the case of handmade, the ID photo quality varies considerably.

Factors and Standard of ID photo quality

- **Factors of ID photo quality**
  - Photographing conditions
    - Layout, yaw angle, hairstyle, shadow, accessory, etc.
  - Printing and display
    - Size, Position, Brightness, Color, Contrast, etc.
  - Digital data format
    - Number of pixels, Bits per pixel, Compression method, File format, etc.
- **Standardization of ID photo quality**
  - ISO/IEC 19794-5
    - defines what a good quality ID photo is.
      - Some of the evaluation values have to be determined by subjective factors of human inspector.
  - ISO/IEC TR 29794-5
    - Provides supporting information on ID photo quality
      - It provides some specific examples for ID photo quality evaluation, but it is not enough to evaluate ID photo appropriately.

Existing Ways to evaluate ID photo quality

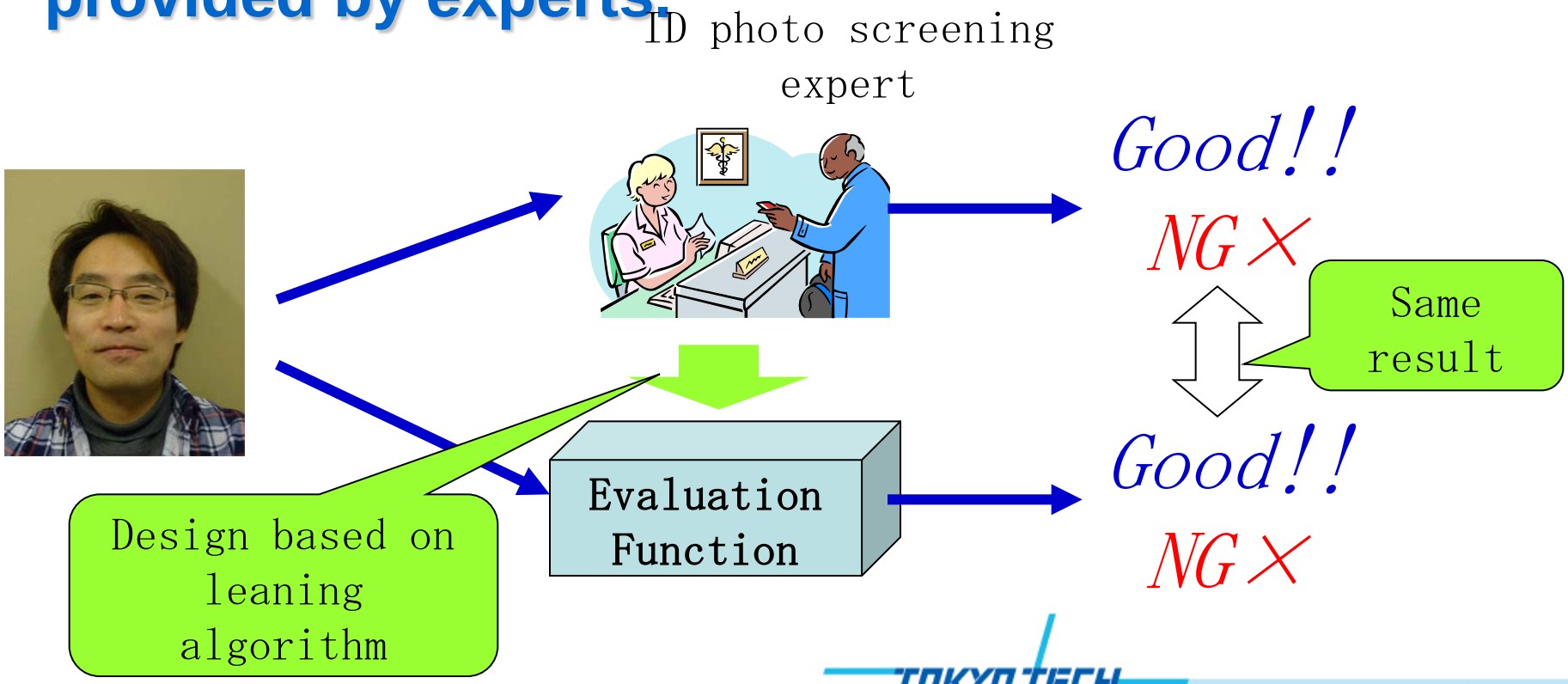
- **Subjective evaluation by screening experts**
  - A mainstream way of ID photo quality evaluation
  - It requires manpower
- **Automatic evaluation using evaluation software**
  - The reliability of evaluation results is not so high

Table. An example of evaluation values by evaluation software

Photographing condition	Expected varied value	Actual varied value
Smile	**Mouth Closed**	**Mouth Closed** Eye Tinted Gray Scale Density Hot Spot
Out of Focus	**Sharpness**	Eye Open Eye Gaze Frontal Eye Tinted Gray Scale Density

Purpose

- **To develop a framework for evaluation of ID photo quality, which can output appropriate evaluation values that are equivalent to those provided by experts.**



Subject in this study

- **To examine the possibility of applying the proposed framework to a paired comparison method.**

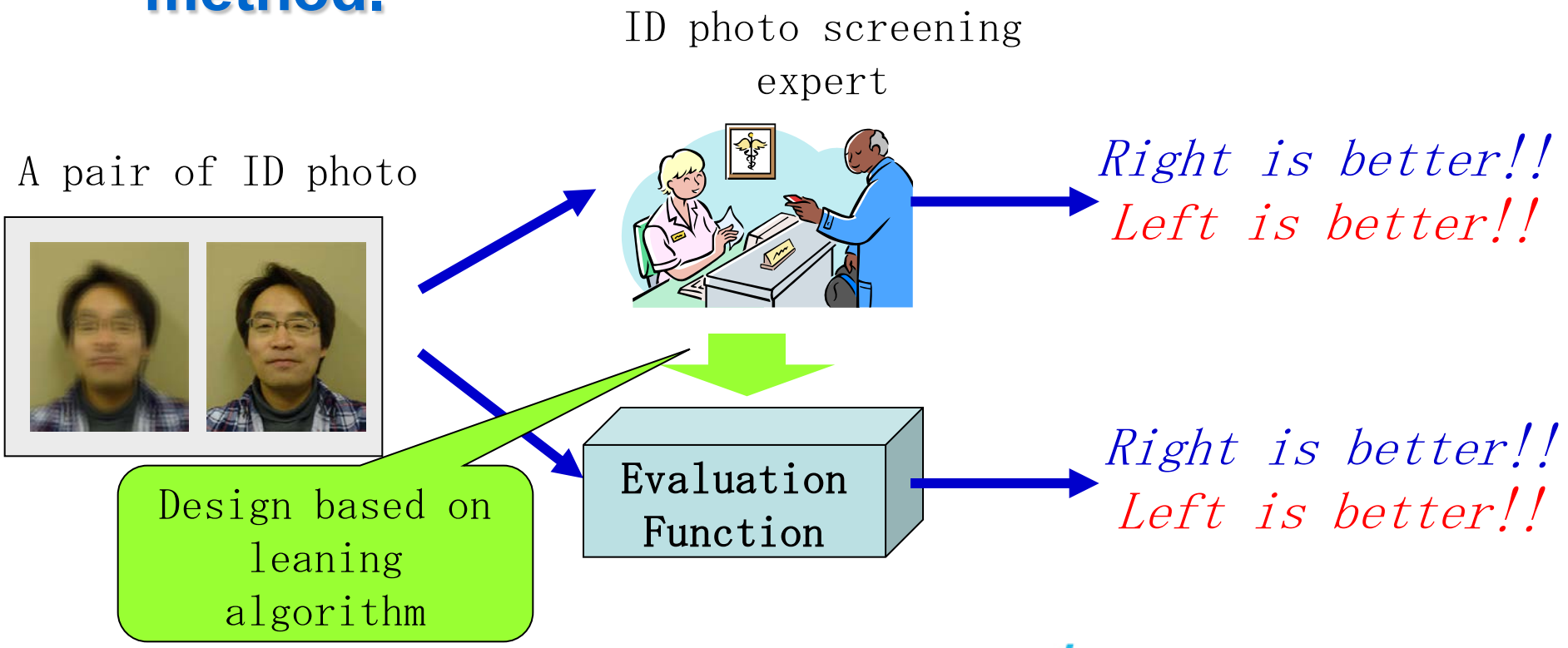
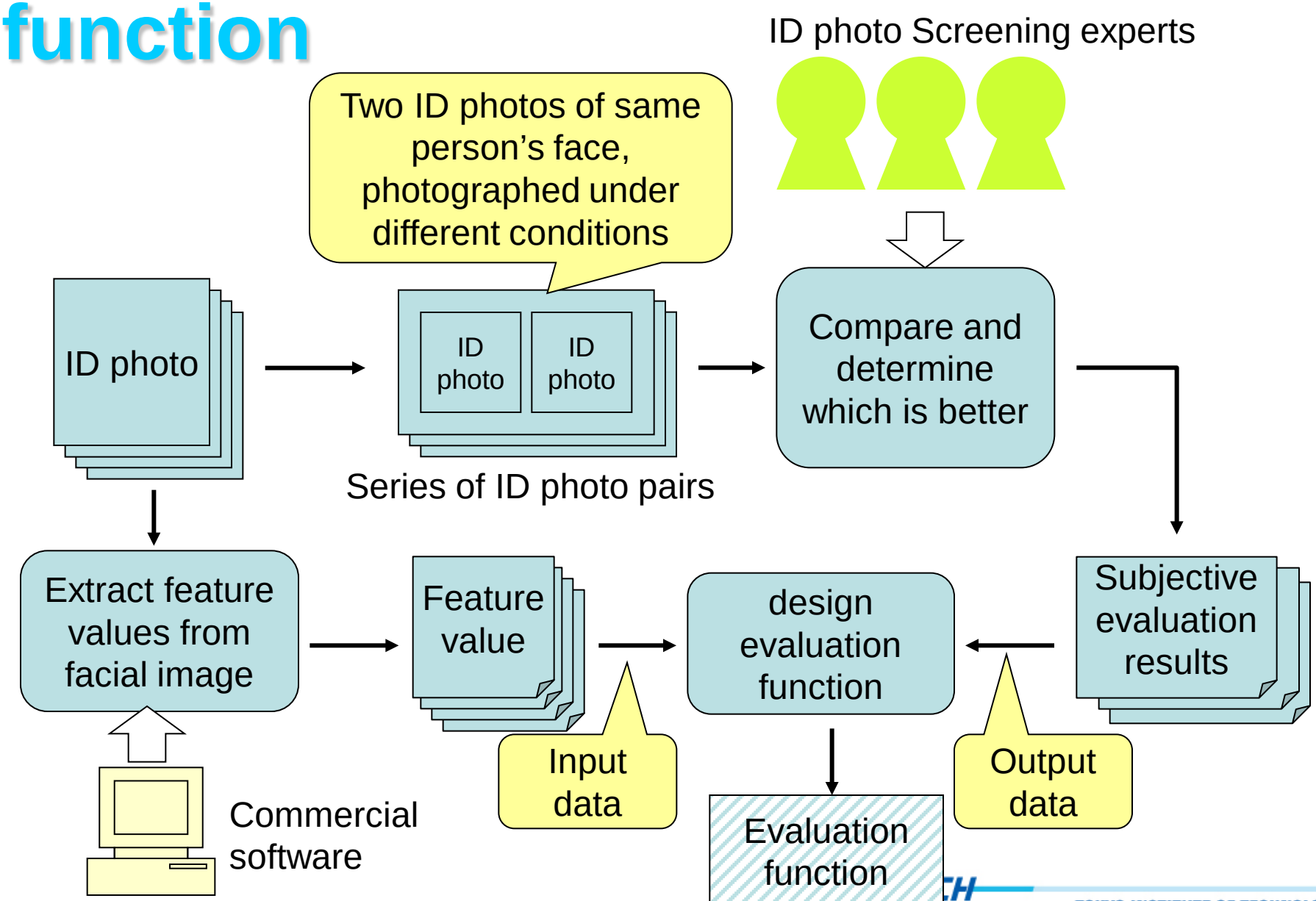


Diagram to design evaluation function



Photographing ID photos for experiments

- **11 ID photos per a person, including one best practice and ten non-standard facial images**
  - Best practice
    - In accordance with ISO/IEC 19794-5
  - Non-standard
    - Smile (two types), eyeglasses (two types), blurred (two types), high exposure, cast shadow, background shadow, hair in front of face
- **Acquired from nine men and seven women**

Best practice | Smile | Glasses | High exposure | Cast shadow | Background shadow

Photographing set up

Subjective experiments by experts and quantification

- **A pair of same person's ID photos that are photographed under different conditions are printed on a piece of photo paper.**
- **Four experts, who are engaged in ID photo screening operation, determine which ID photo is better.**
- **Scores are assinged according to the right table.**

Table. Quantification of subjective evaluation resu

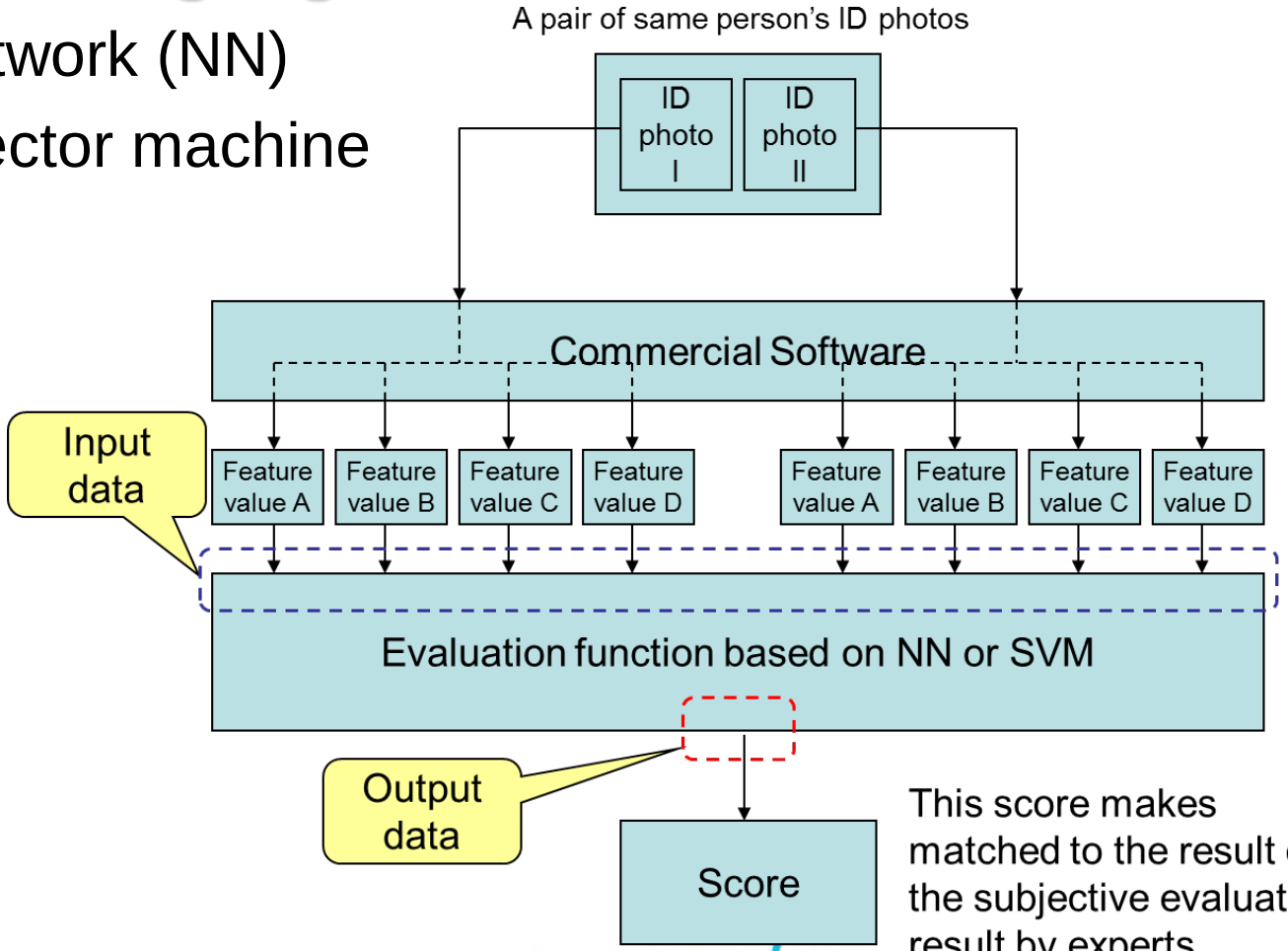
Score	Subjective evaluation result
-2	Four experts say "right ID photo is better than left one"
-1	Three experts say "right ID photo is better than left one" One expert says "left ID photo is better than right one"
0	Two experts say "right ID photo is better than left one" Two experts say "left ID photo is better than right one"
1	One expert says: "right ID photo is better than left one" Three experts say "left ID photo is better than right one"
2	Four experts say "left ID photo is better than right one"

Extract feature values from facial image

- **In this experiments, output date of commercial software are applied as feature values of a facial image**
  - We uses three commercial software products
    - Preface, Aware, Inc.
    - FaceIT, L-1 Identity Solutions, Inc.
    - FaceVACS, Cognitec Systems GmbH
  - Several evaluation items that are closely-linked to the ID photo quality such as below are used for designing the evaluation function
    - Position, yaw, eye opening level, noise, lighting uniformity, background uniformity, contrast

Designing evaluation function

- **Evaluation function is designed based on two types of learning algorithm**
  - Neural Network (NN)
  - Support vector machine (SVM)



Experiments

- **Classification experiments using the designed evaluation functions are conducted**
- **Number of ID photo pairs**
  - For learning: 760 pairs (maximum)
  - For classification: 780 pairs, non-overlapping with ID photos for learning
- **Evaluation software products and number of feature values**
  - Preface (8 feature values), FaceVACS (17 feature values), FaceIT (21 feature values)
- **Learning algorithms**
  - NN
    - Feed forward NN based on three layer perceptron
  - SVM
    - Three types of kernel functions, linear, polynomial, and Gaussian

Multiple classification and binary classification

ID photo Screening experts

ID photo I

ID photo II

Subjective evaluation

Score

2

1

0

-1

-2

Classification by experts

Classification by evaluation function

ID photo I

ID photo II

Evaluation function

Score

2

1

0

-1

-2

Multiple classification

Evaluation function

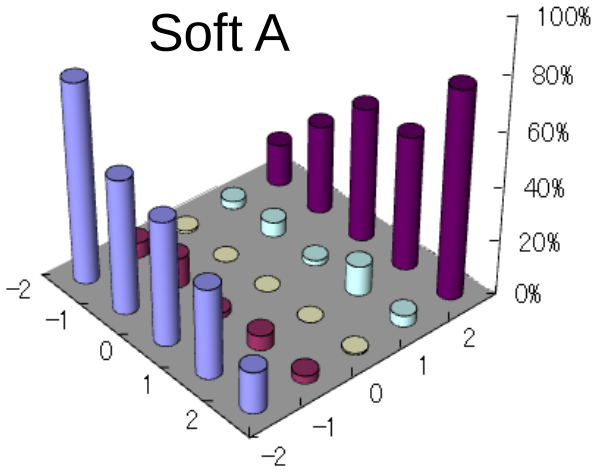
Score

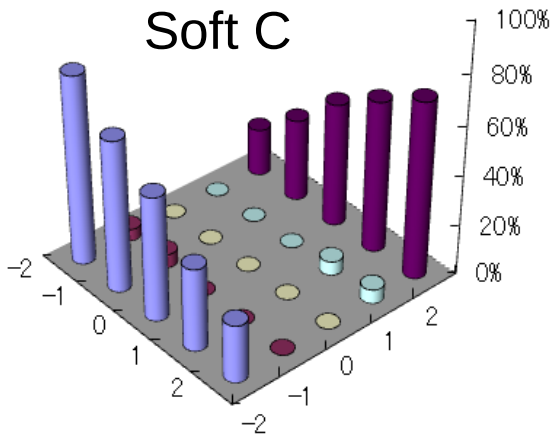
positive

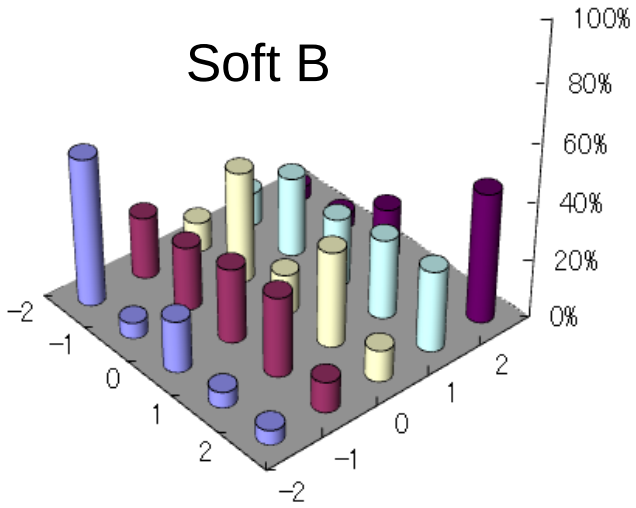
negative

Binary classification

Experimental Results (Multi classification by SVM)





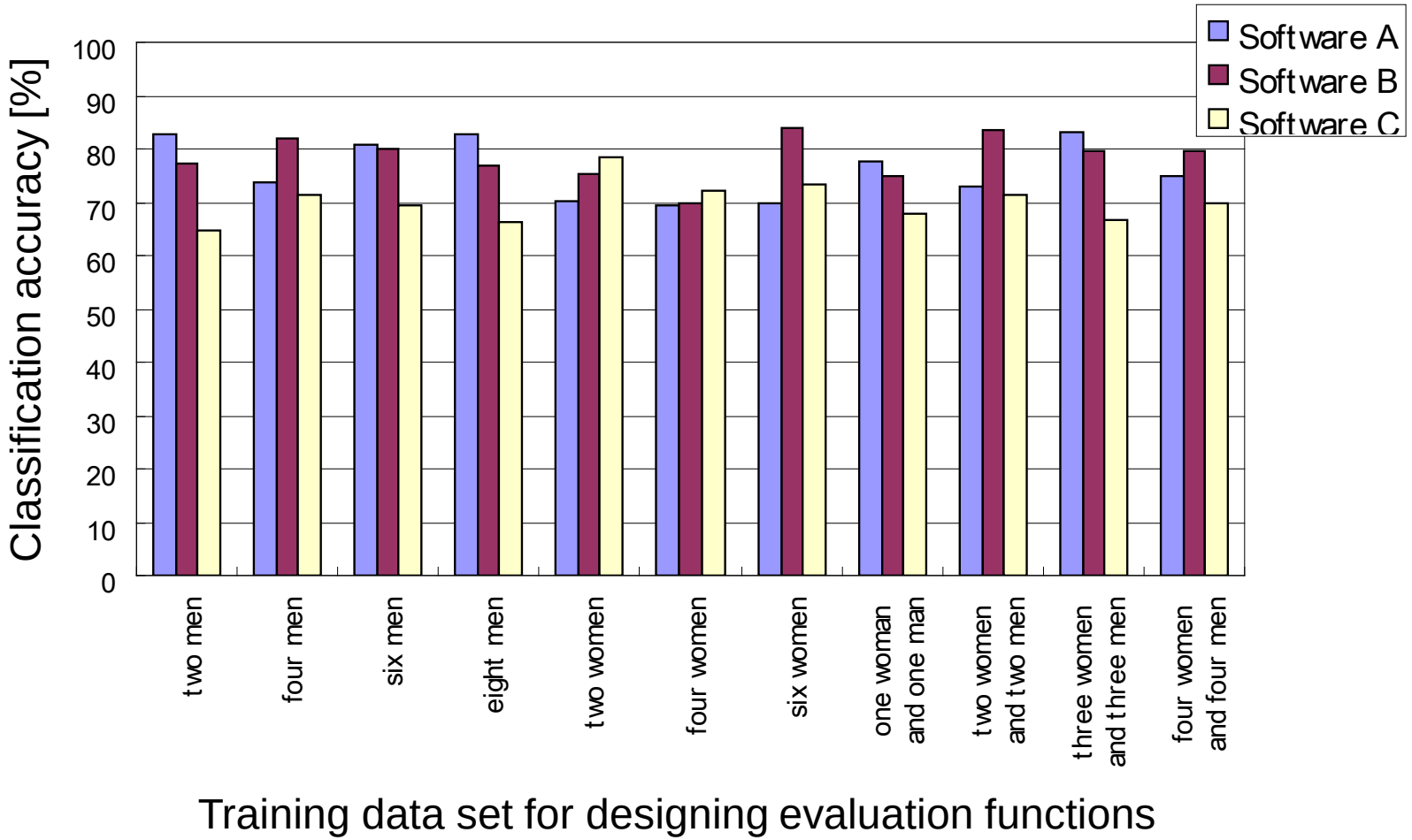


Bottom left axis: score of input data

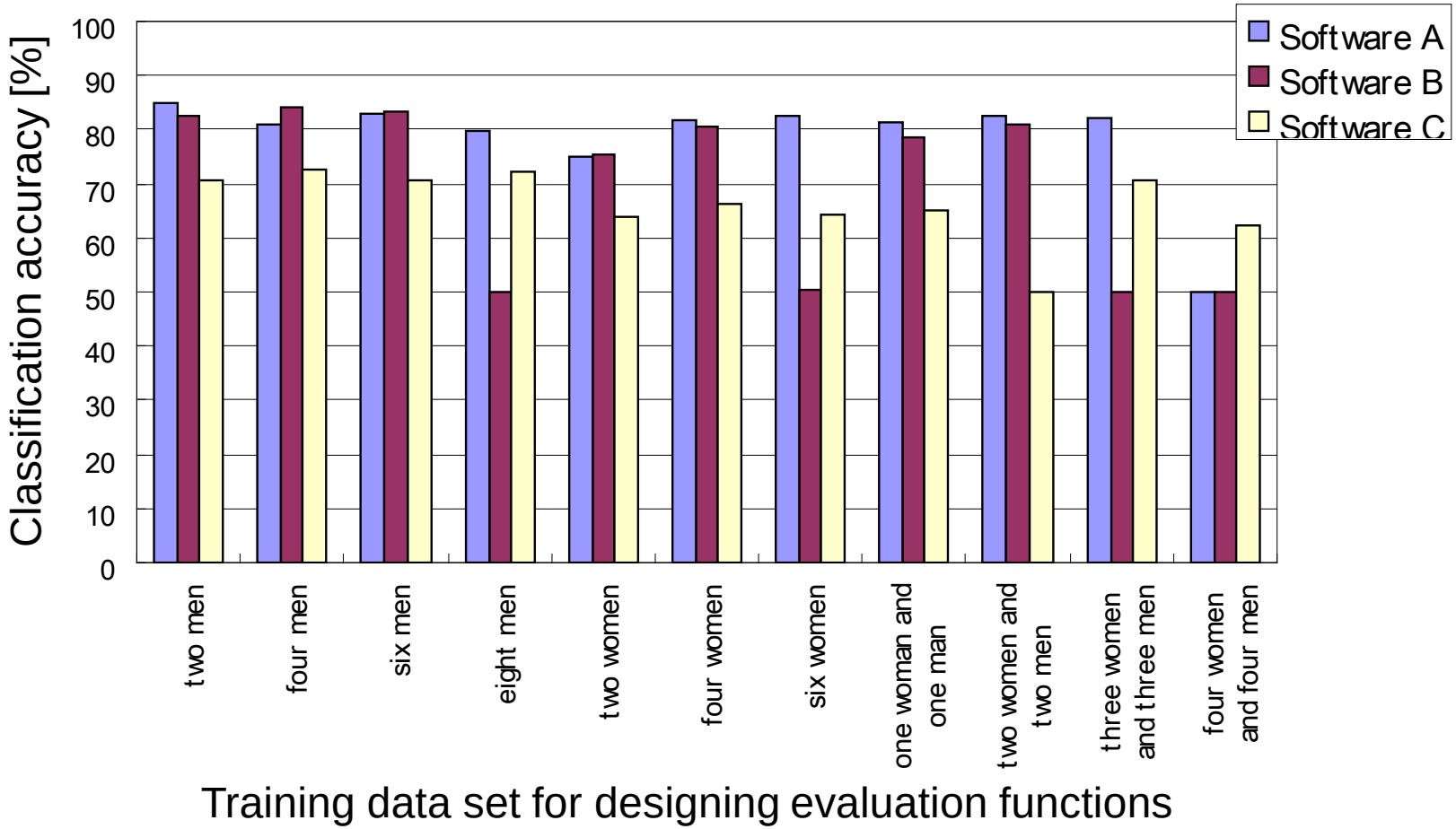
Bottom right axis: output score

Vertical axis: Classification accuracy

Experimental results (binary classification by SVM)



Experimental results (binary classification by NN)

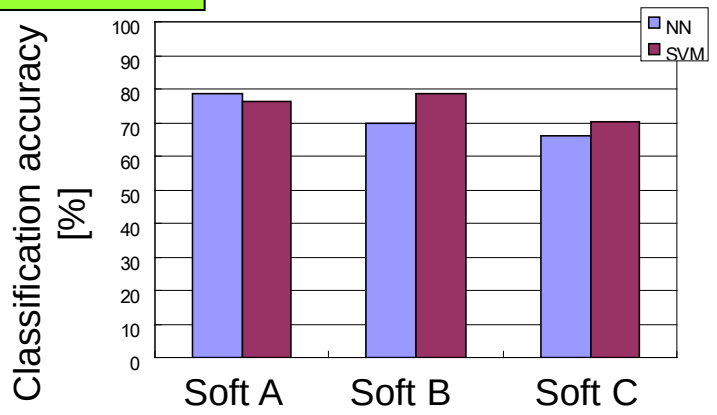


Comparison of SVM vs. NN

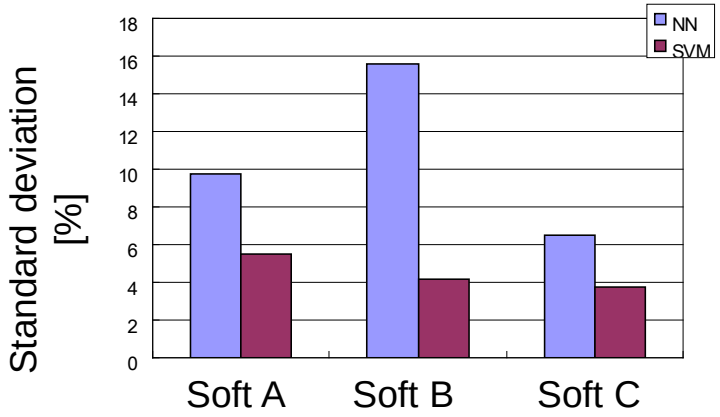
- **SVN and NN is compared in maximum, average, standard deviation of the classification accuracy with the variety of the training set for designing evaluation functions.**

Max

Average



Std. dev.



: NN

: SVM

Summary of experiments

- **About 80% accuracy is obtained in binary classification, while the classification accuracy in multiple classification is not so high.**
- **SVM is superior to NN in terms of generalization capability for unknown data.**
  - The classification accuracy of SVM is almost constant regardless of the training data set, while the one of NN sometimes drops significantly.
- **There is little difference in the classification accuracy between three commercial software products.**

Conclusions

- **We have proposed a framework for designing a evaluation function for ID photo quality**
  - It can output an evaluation value equivalent to those are provided by experts .
- **The proposed framework has been applied to a paired comparison method**
  - The effectiveness has been shown by conducting numerical experiments.
- **We plan to develop an evaluation function which can actually evaluate ID photo quality.**

THANK YOU FOR YOU KING ATTENTION!!

Acknowledgement

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