

Handwritten character recognition using elastic matching based on a class-dependent deformation model

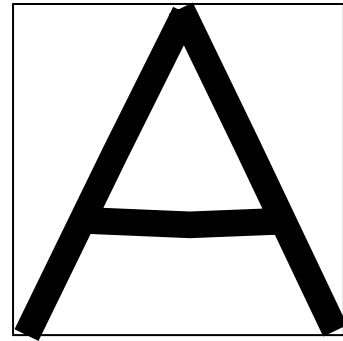
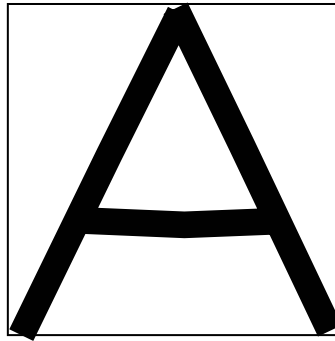
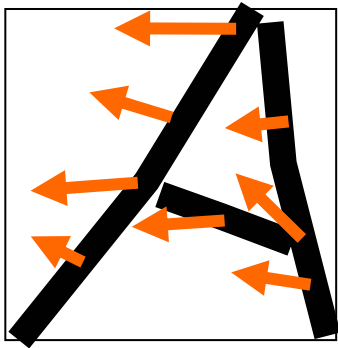
S. Uchida and H. Sakoe
Kyushu University, Japan

Introduction

Elastic matching

displacement

field ν



input pattern

input fitted to
reference

reference

Conventional EM techniques

- = category-**in**dependent
- = it is assumed that **all classes have the same deformation tendency**

however



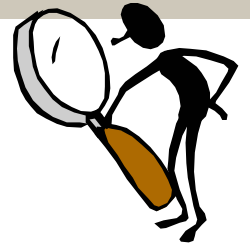
may cause
overfitting to "A" !

Our purpose



develop new EM where class-dependent deformation tendency(= **eigen-deformation**) is considered

Two tasks



- How to get the eigen-deformations?

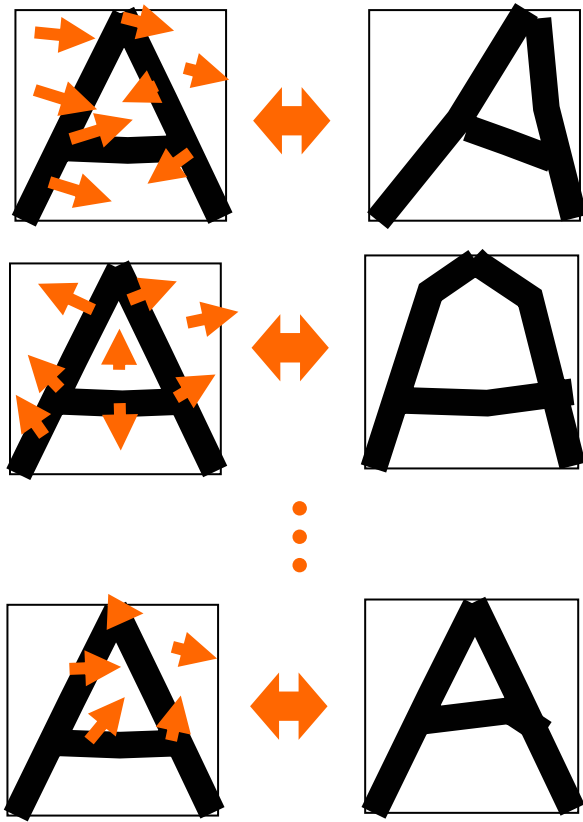
Reported already

[Uchida and Sakoe, *Pattern Recognition*, 2003]

- How to utilize the eigen-deformations in EM?

Estimation of Eigen-Deformations

collection of displacement fields using (conventional) EM

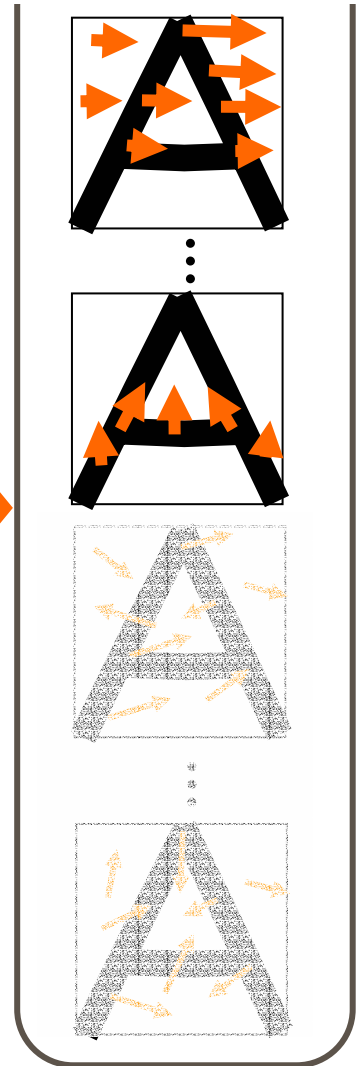


reference

training patterns

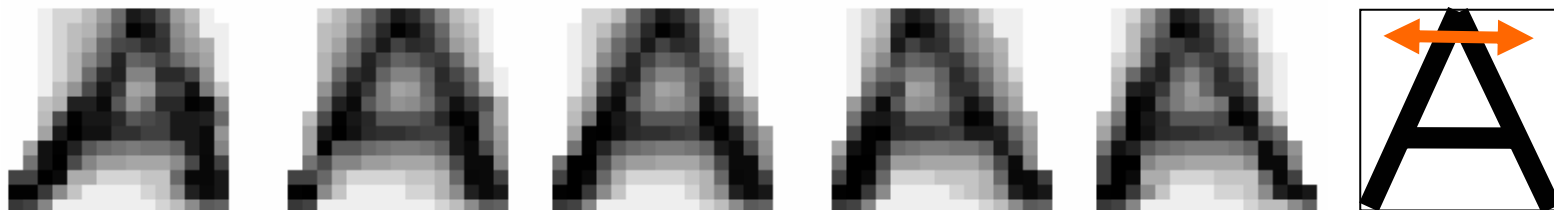
Principal
Component
Analysis

eigen-deformations

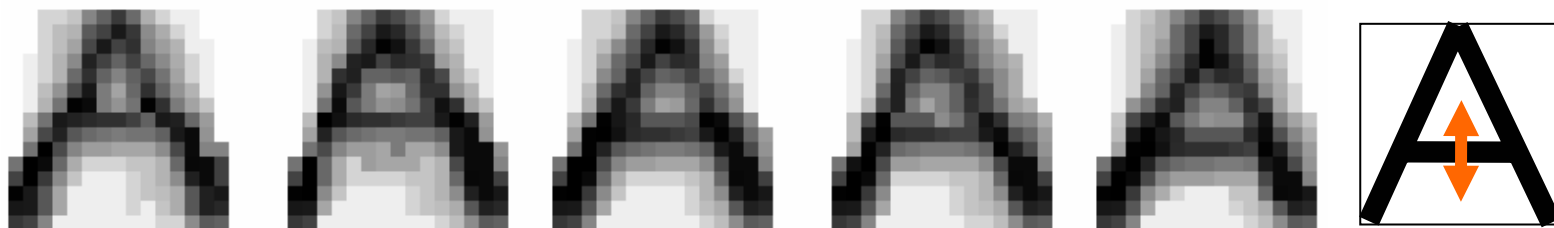


Estimated eigen-deformations

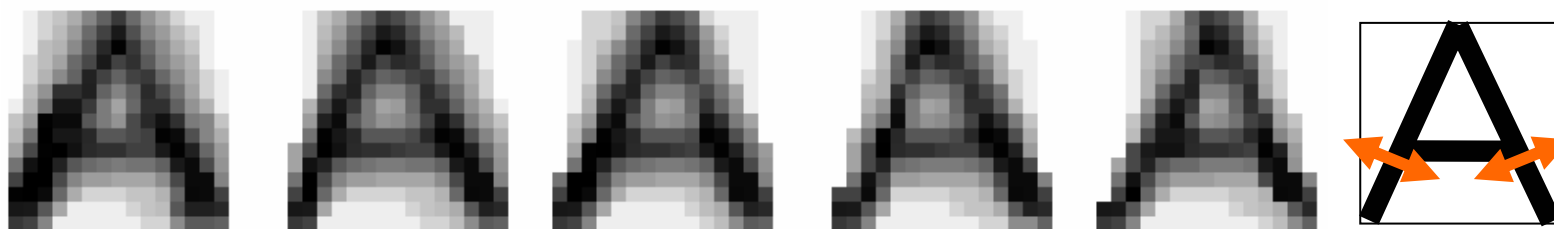
u_1



u_2



u_3



apply
negatively

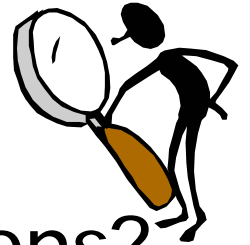


0



apply
positively

Two tasks



■ How to estimate the eigen-deformations?

Reported already

[Uchida and Sakoe, *Pattern Recognition*, 2003]

■ How to utilize the eigen-deformations in EM?

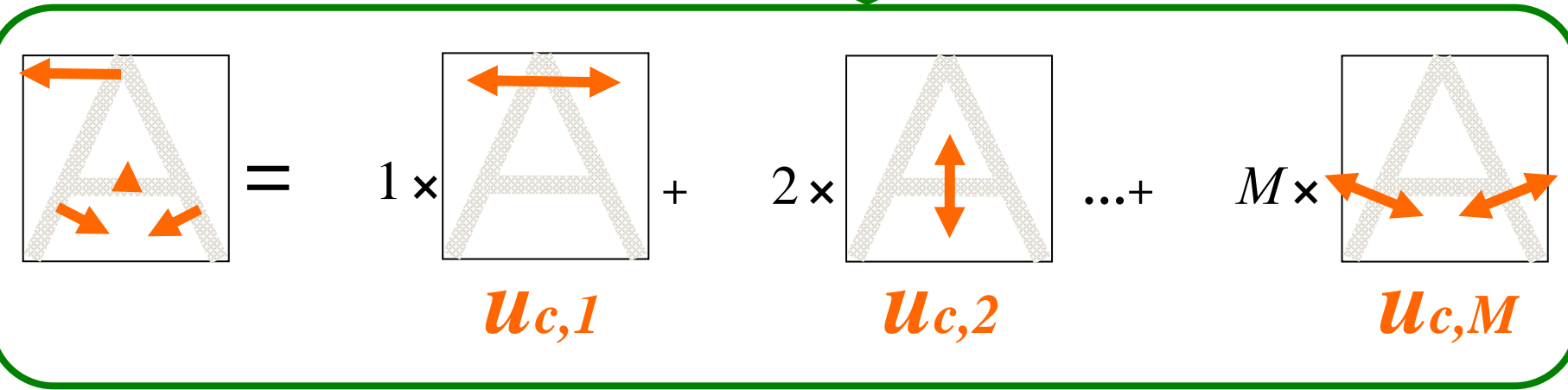
Topic of this presentation

Outline of proposed technique

Class-dependent deformation model

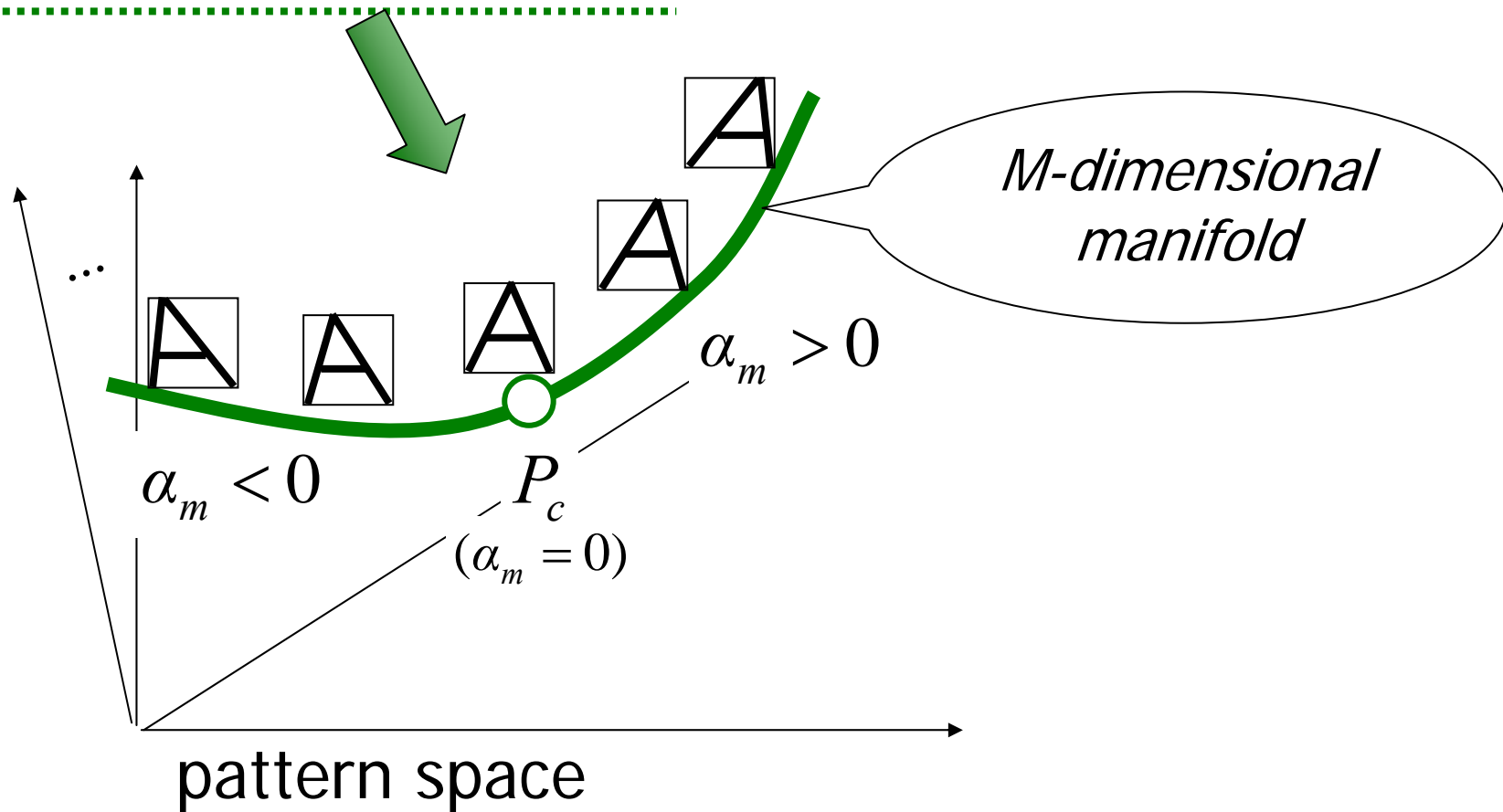
Deformation model of reference pattern $P_c(x, y)$ (class c)

$$P_c \left((x, y) + \sum_{m=1}^M \alpha_m u_{c,m} (x, y) \right)$$



Geometric interpretation

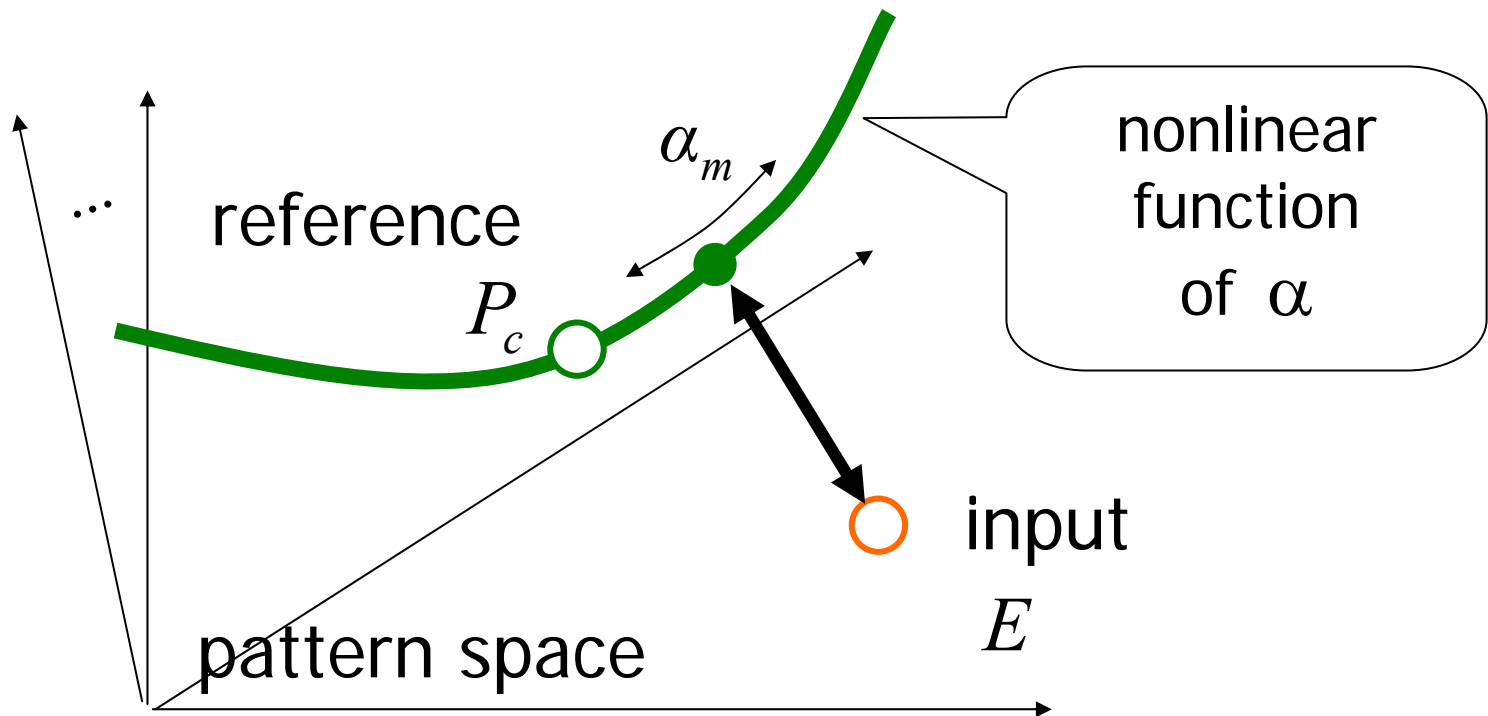
$$P_c \left((x, y) + \sum_{m=1}^M \alpha_m u_{c,m}(x, y) \right)$$



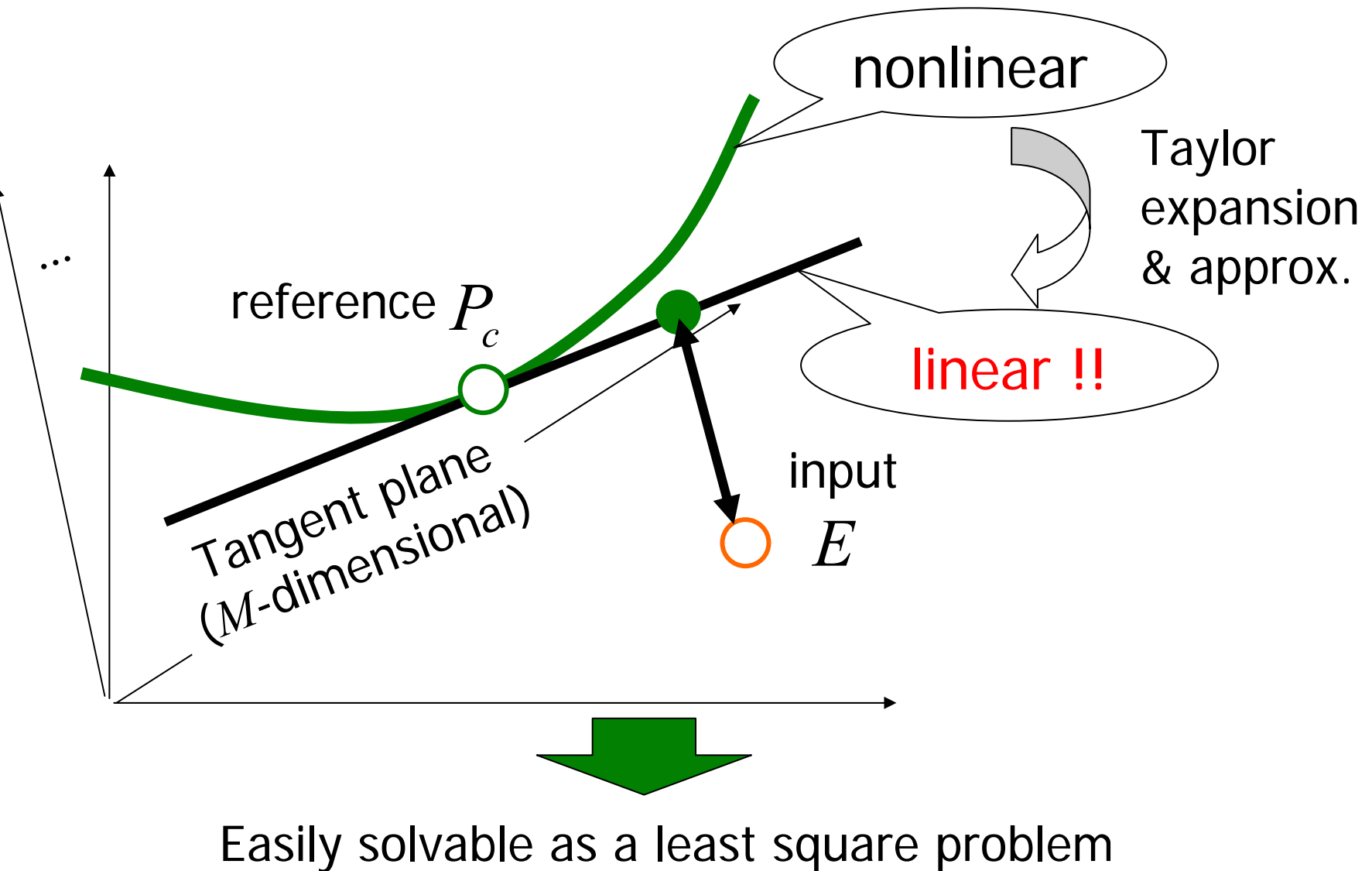
EM based on class-depend. deform. model

$$\int \left(\underbrace{E(x, y)}_{\text{orange dotted}} - \underbrace{P_c \left((x, y) + \sum_{m=1}^M \alpha_m u_{c,m}(x, y) \right)}_{\text{green dotted}} \right)^2 dx dy$$

→ minimize w.r.t. α_m



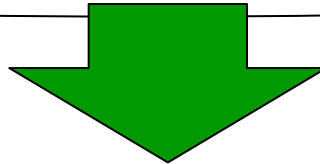
Solution via linear approximation



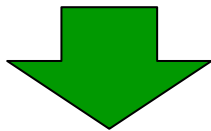
Experimental Results

Database

English capitals from ETL6
1100 samples \times 26classes

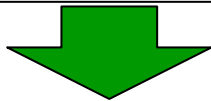


preprocessing
linear scaling, etc.

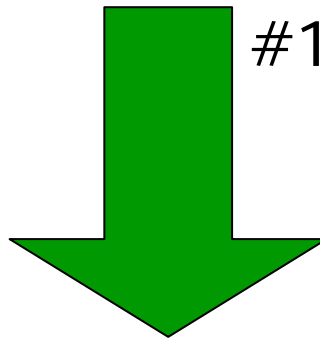


#1-100

average

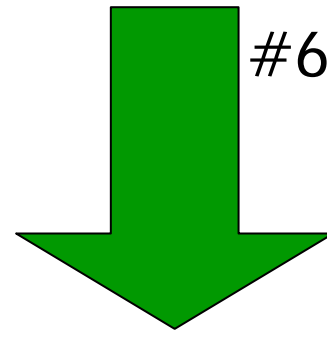


reference



#101-600

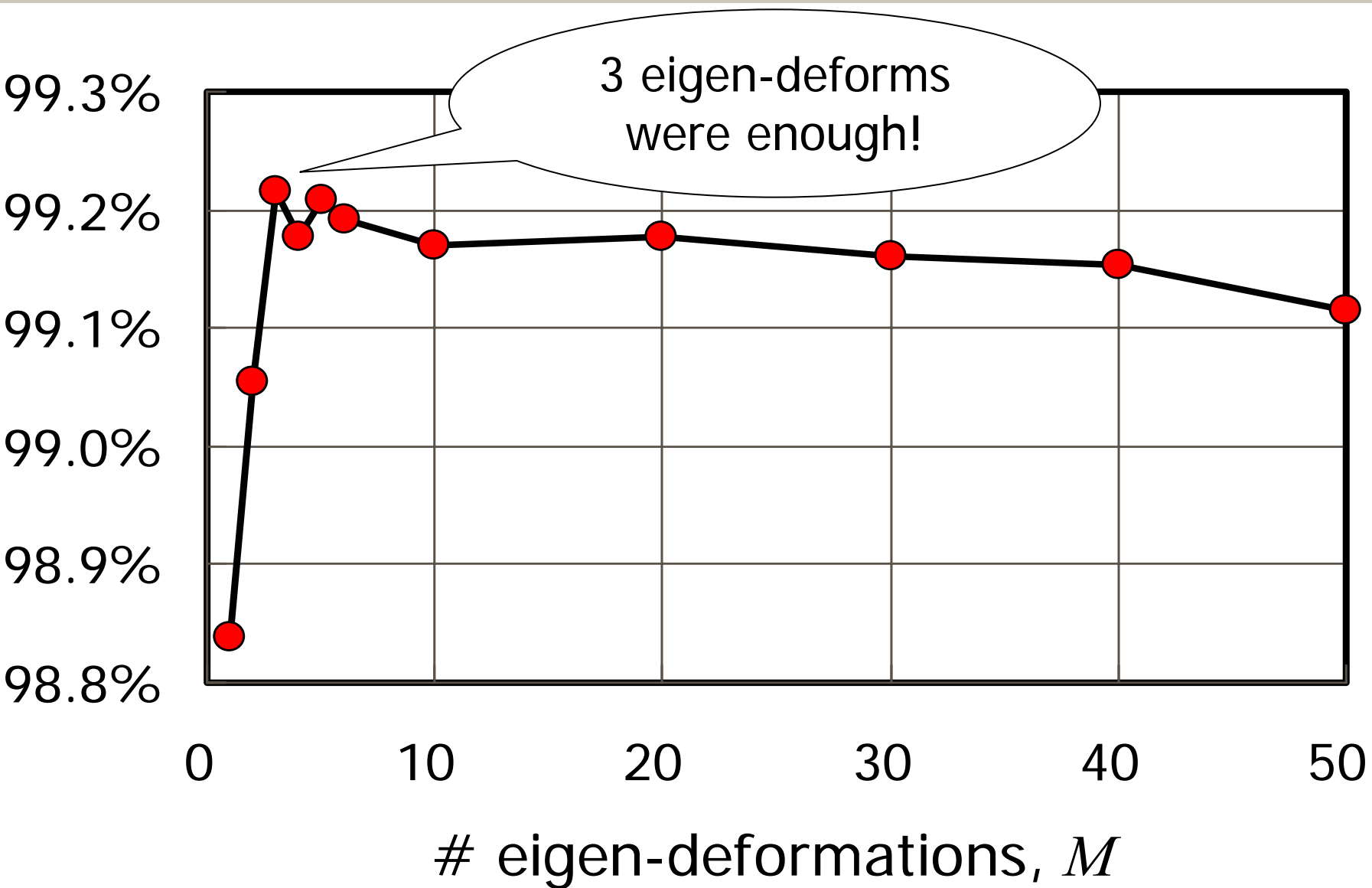
training patterns
to estimate eigen-d



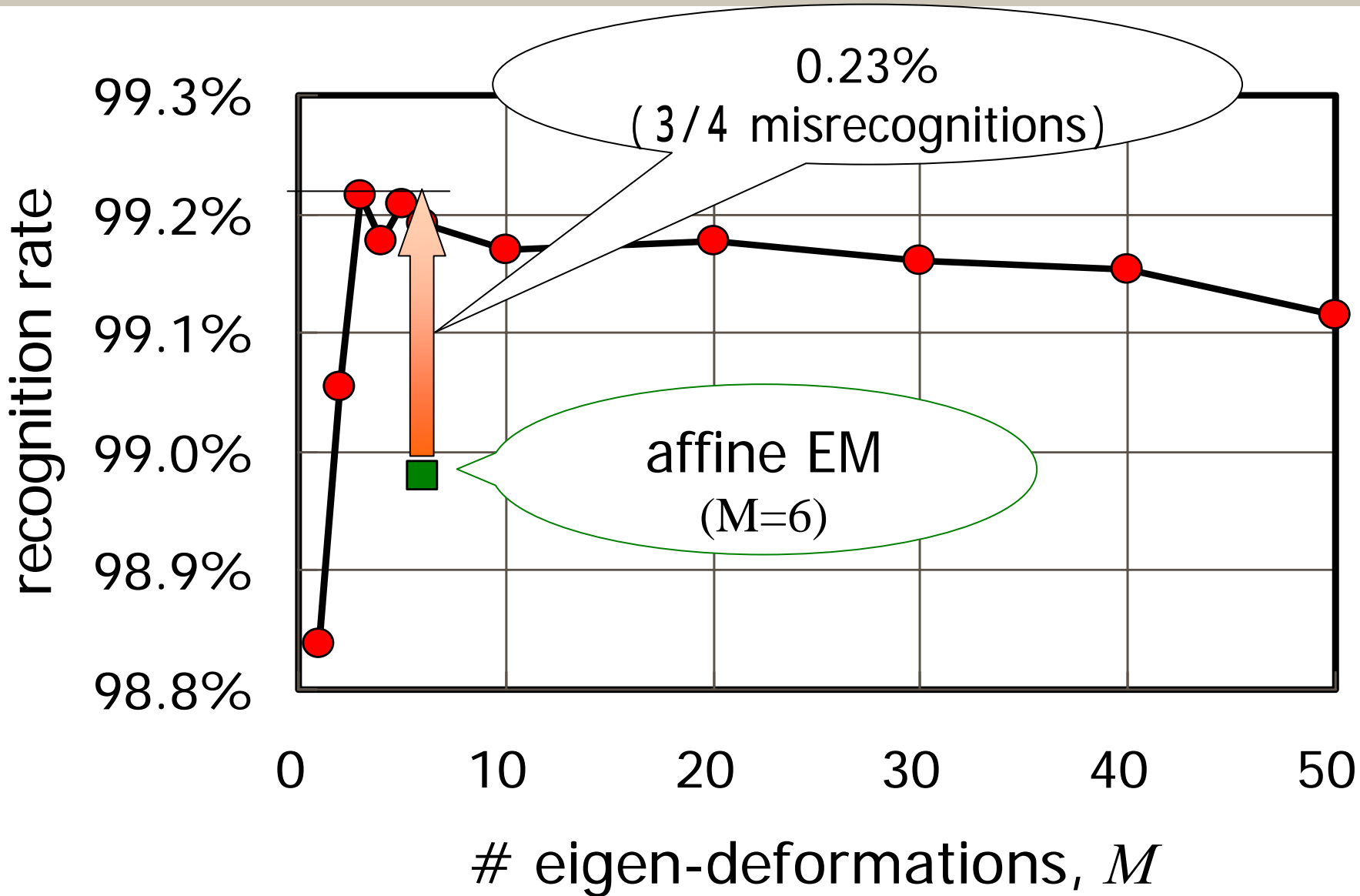
#601-1100

test patterns
in recog. exp.

Recognition rate



Comparison to class-independent EM (1)



Conclusion & Future work

■ Conclusion

- EM based on a class-dependent deformation model was developed
- High accuracy and efficiency were shown through character recognition experiment

■ Future work

- Solution strategies other than linear approx.
- Relation to the sub-space methods