
INSTITUT TEKNOLOGI BANDUNG
1920

Modul 2: Pattern Recognition System

01 Knowledge-based Recognition System

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Pengenalan Pola
(*Pattern Recognition*)

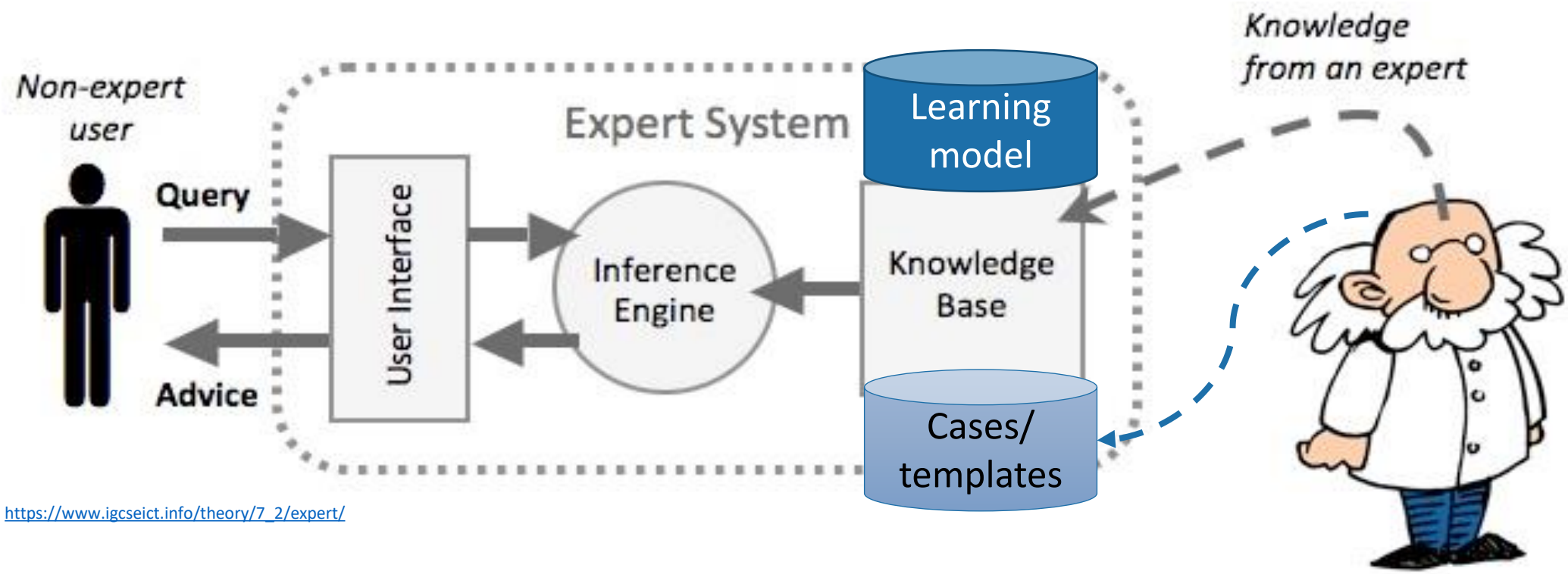
Pattern Recognition Approaches

Knowledge-based

Template matching	Statistical decision	Structural/syntactic	Neural Networks
• Recognition function: similarity measure	• Recognition function: Discriminant function	• Recognition function: rules, grammar	• Recognition function: neural networks

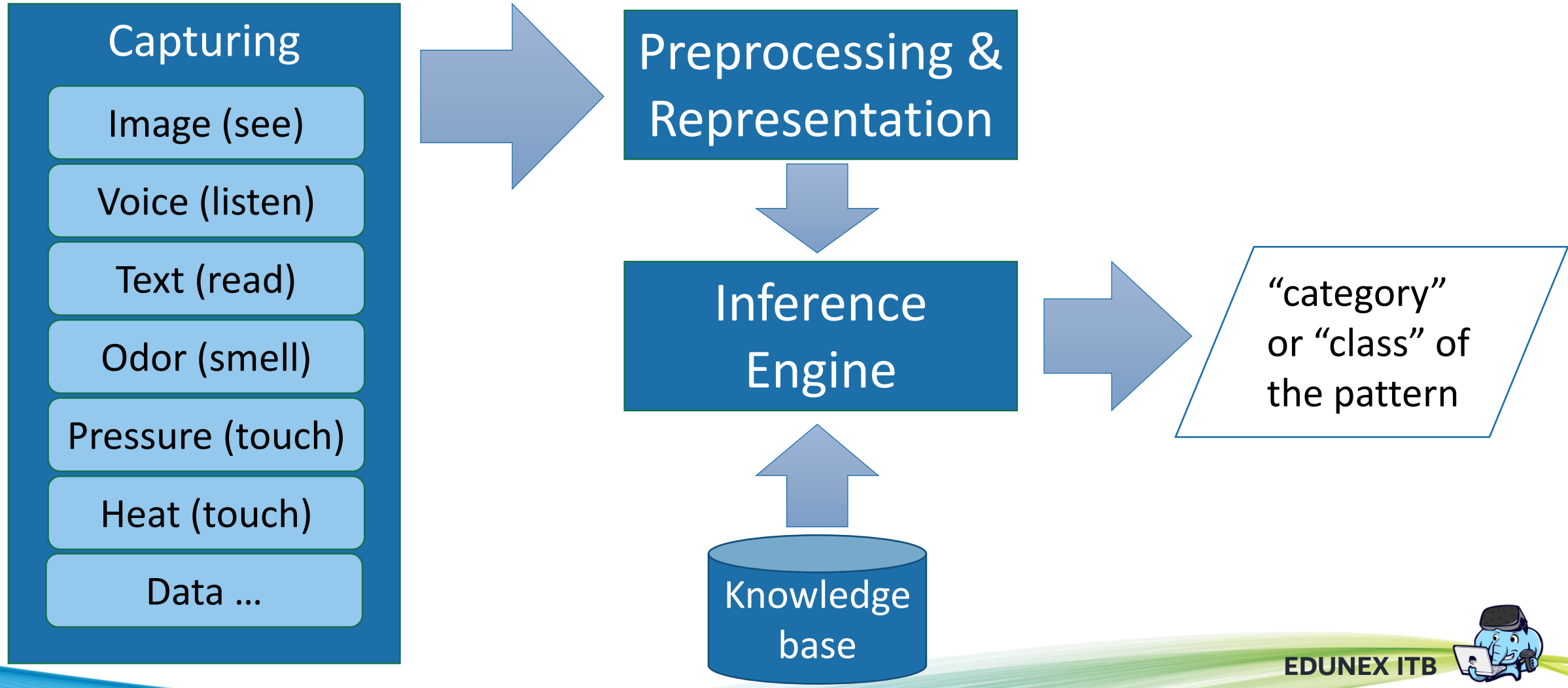
Machine learning

Knowledge-based System ≠ Expert System

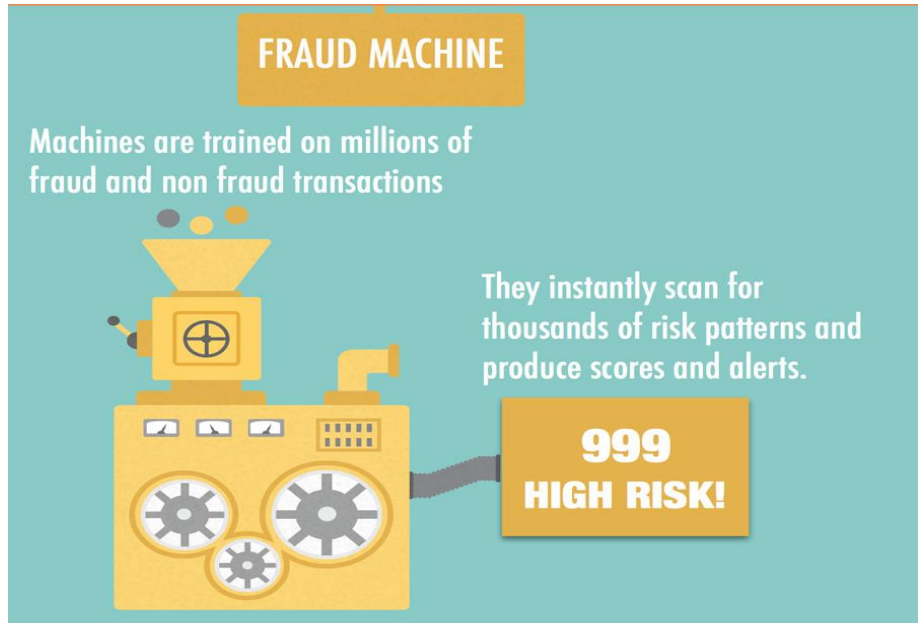


https://www.igcseict.info/theory/7_2/expert/

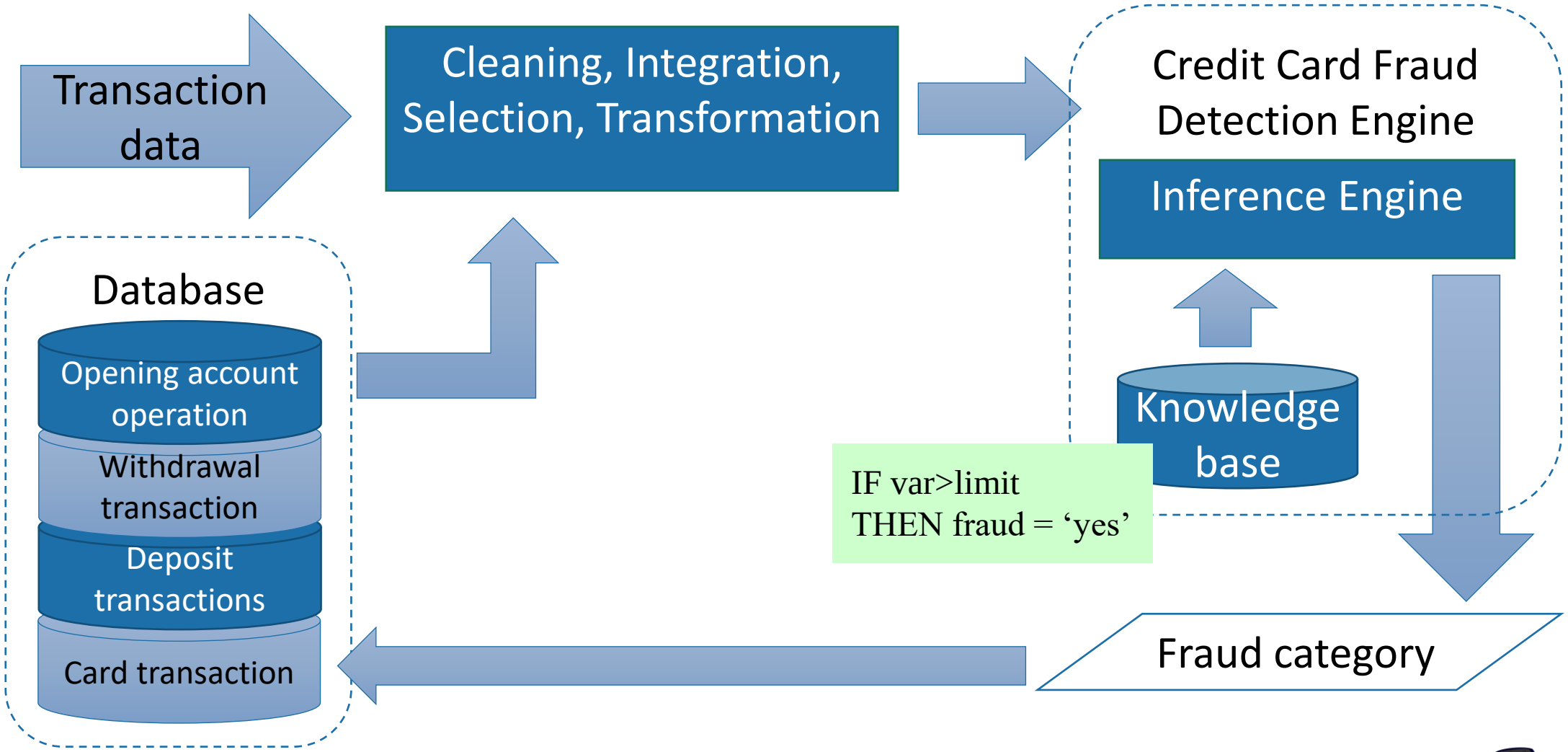
Knowledge-based Recognition System



Example: Credit Card Fraud Detection



Example: Credit Card Fraud Detection



Ogwueleka, F. N. (2011). Data mining application in credit card fraud detection system. *Journal of Engineering Science and Technology*, *6*(3), 311-322.

Data Mining Process

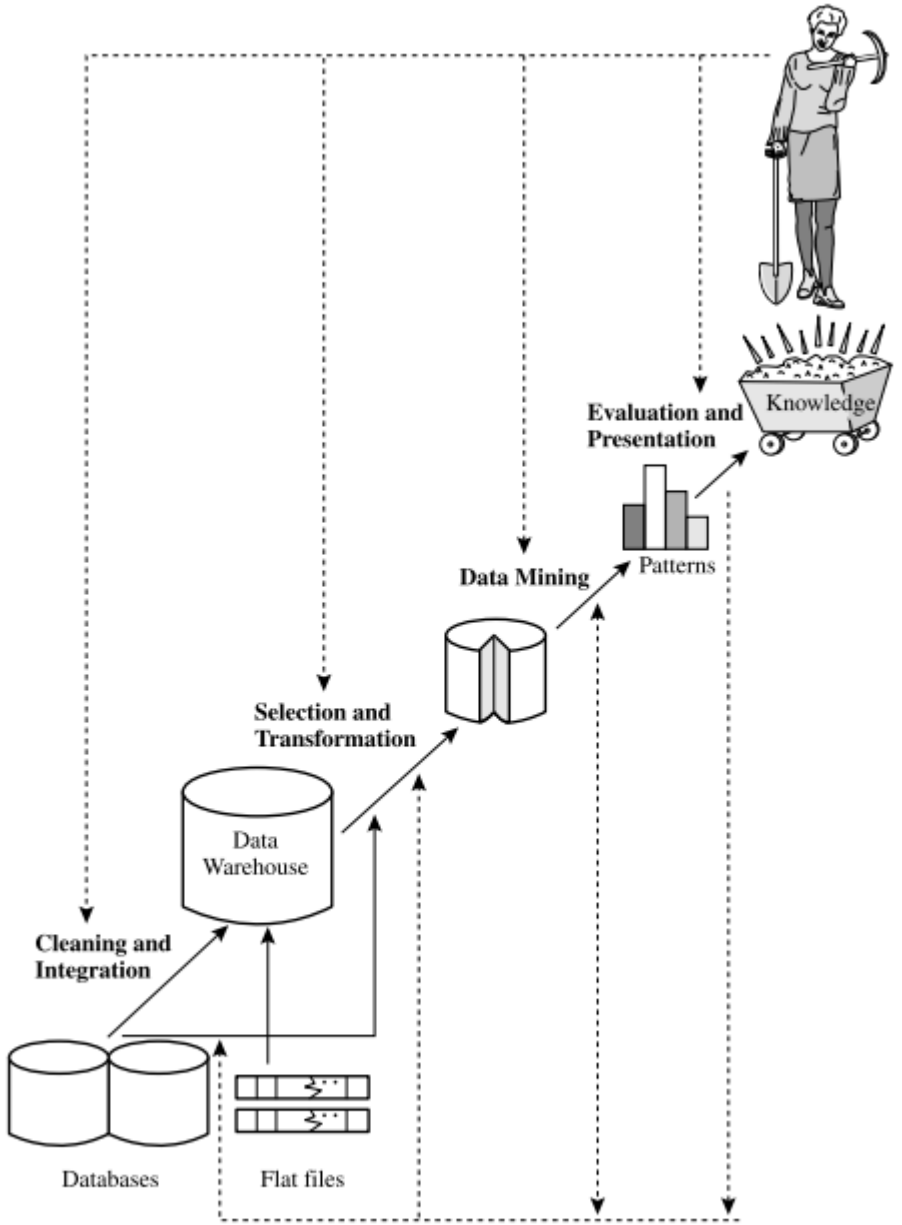
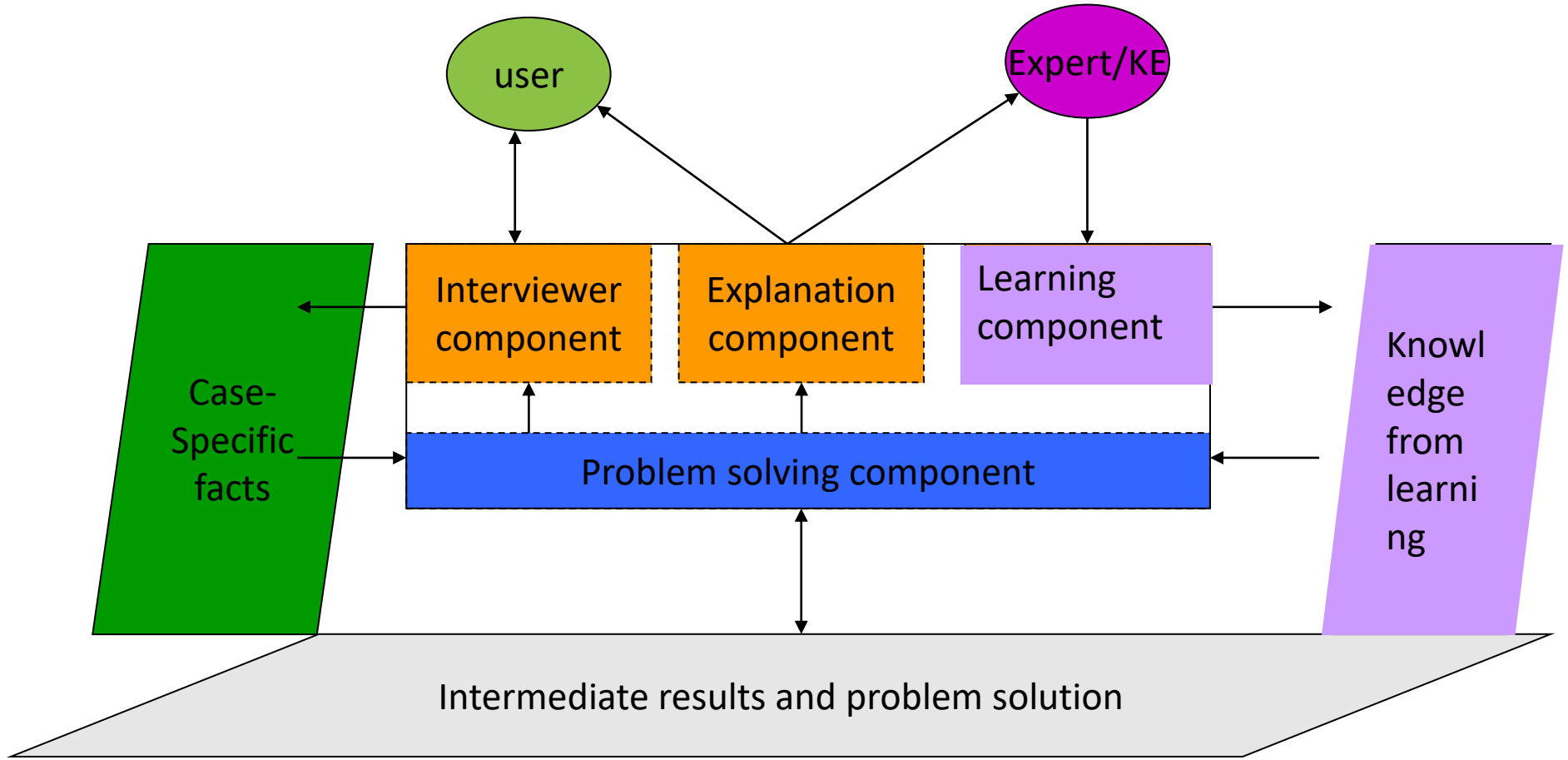


Figure 1.4 Data mining as a step in the process of knowledge discovery.

Han, J., Pei, J., & Kamber, M. (2011). Data mining: concepts and techniques. Elsevier.

General Architecture of KBS



Summary

Knowledge-based system

Knowledge-based Recognition System

General Architecture KBS

Template-based Recognition System

Modul 2: Pattern Recognition System

02 Template-based Recognition System

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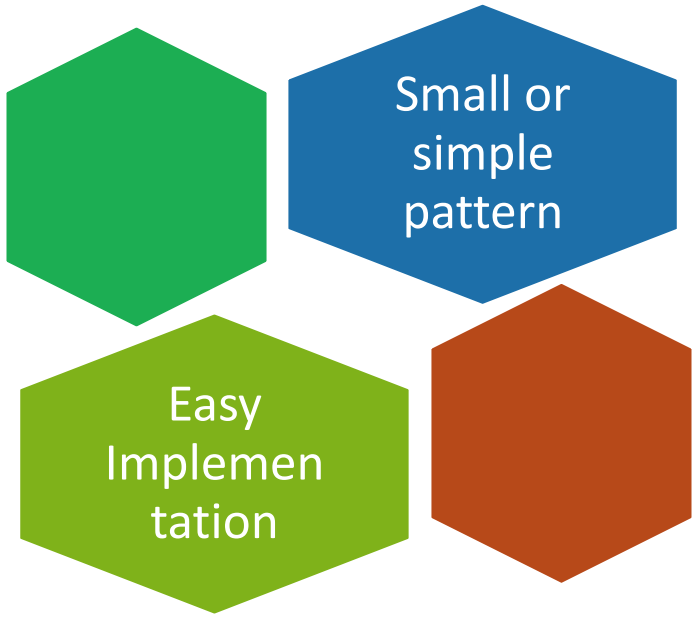
What & Why Template Matching ?

Template matching calculate the similarity using a range of metrics applied to low-level values.

Template Matching is a method for searching and finding the location of a template image in a larger image. (OpenCV)



Template Matching in a Feature-Space

Traditional template matching methods calculate the similarity using a range of metrics applied to low-level values. However, because these methods rely on comparing the values in the template with those at input, they are sensitive to dynamic changes.

This article investigated combining features from different layers of a CNN in order to obtain a feature-space that allows both precise and tolerant template matching.

Gao, B., & Spratling, M. (2020). Robust Template Matching via Hierarchical Convolutional Features from a Shape Biased CNN. *arXiv preprint arXiv:2007.15817*.

Palmprint Recognition using Template Matching

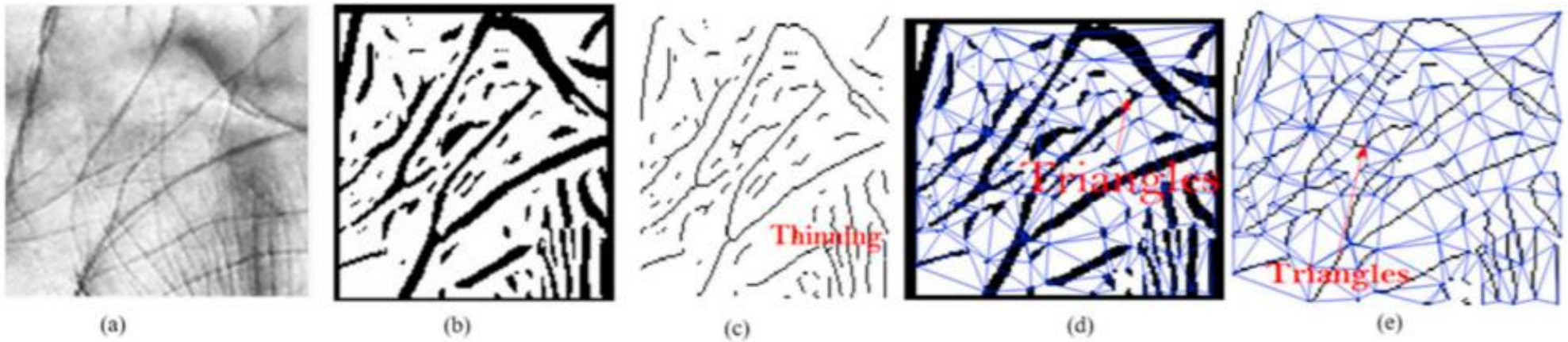


Fig. 2. (a) Image after ROI extraction; (b) image after enhancement (c) Thinned image; (d) Delaunay triangles on enhanced image; (e) Delaunay triangles on the thinned image.

Once the angles are calculated, the next step is to make feature vectors for each triangle in the template.

For the template TM_{in} of the input image and template TM_{db} of database image: -

$$score_{formula} = \frac{\left(count_{match} + \frac{count_{non-match}}{length(TM_{db})} \right)}{\left(\frac{length(TM_{db}) + length(TM_{in})}{2} \right)}$$

Poonia, P., Ajmera, P. K., & Shende, V. (2020). Palmprint Recognition using Robust Template Matching. *Procedia Computer Science*, *167*, 727-736.

Deep Template Matching

- Binary classification: predict the similarity between handwritten characters and template images

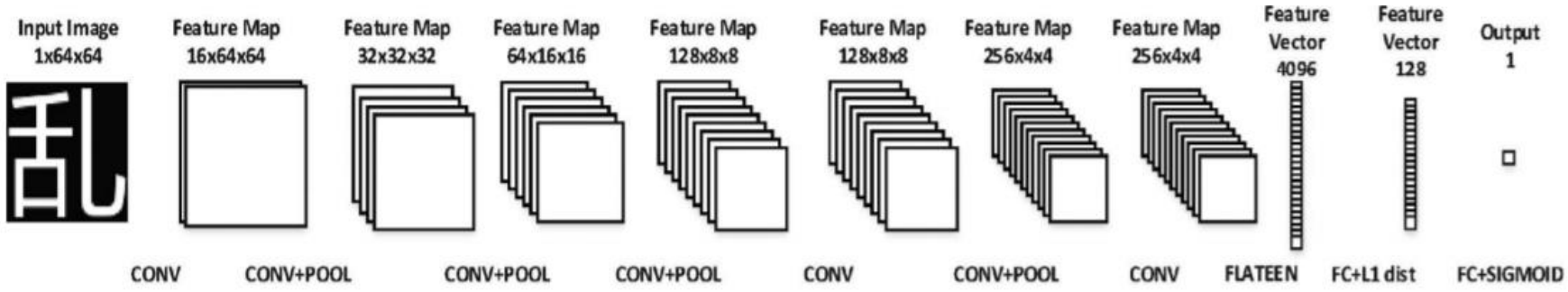
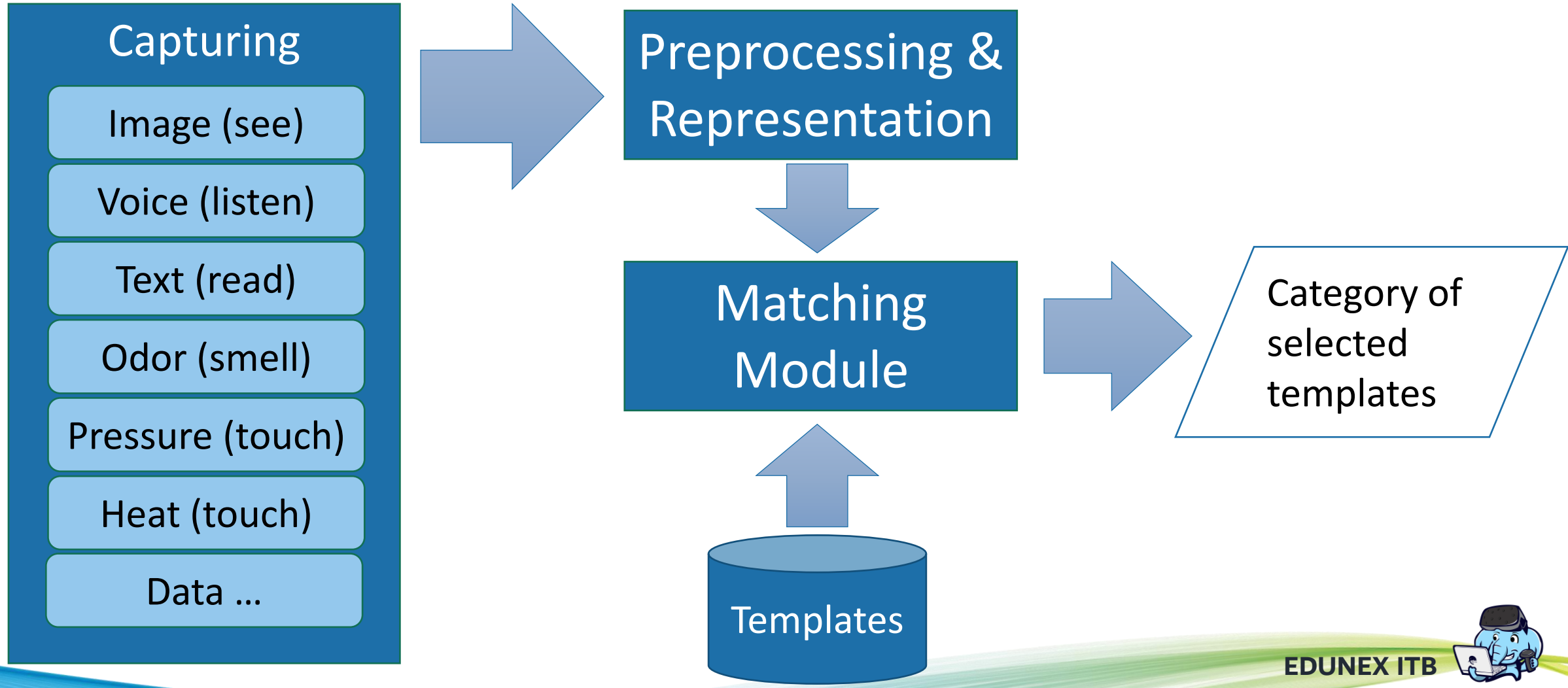


Fig. 4 *Baseline convolutional architecture for template matching problem*

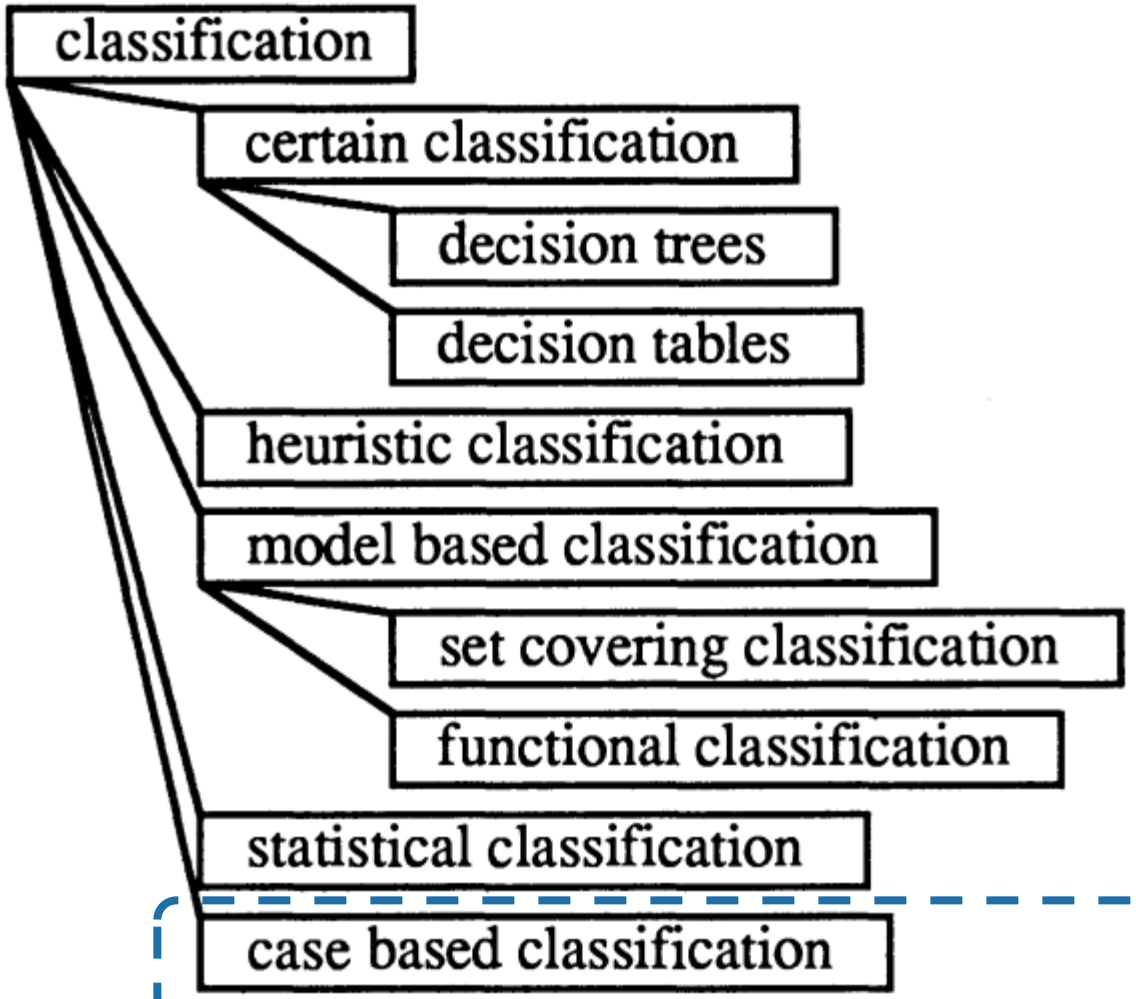
Fig. 6 *Generated digit templates*

Li, Z., Xiao, Y., Wu, Q., Jin, M., & Lu, H. (2020). Deep template matching for offline handwritten Chinese character recognition. *The Journal of Engineering*, *2020*(4), 120-124.

Template-based Recognition System



Problem Solving Method in Classification



Vs template matching

Puppe, F. (2012). *Systematic introduction to expert systems: Knowledge representations and problem-solving methods*. Springer Science & Business Media.

Case-based Recognition

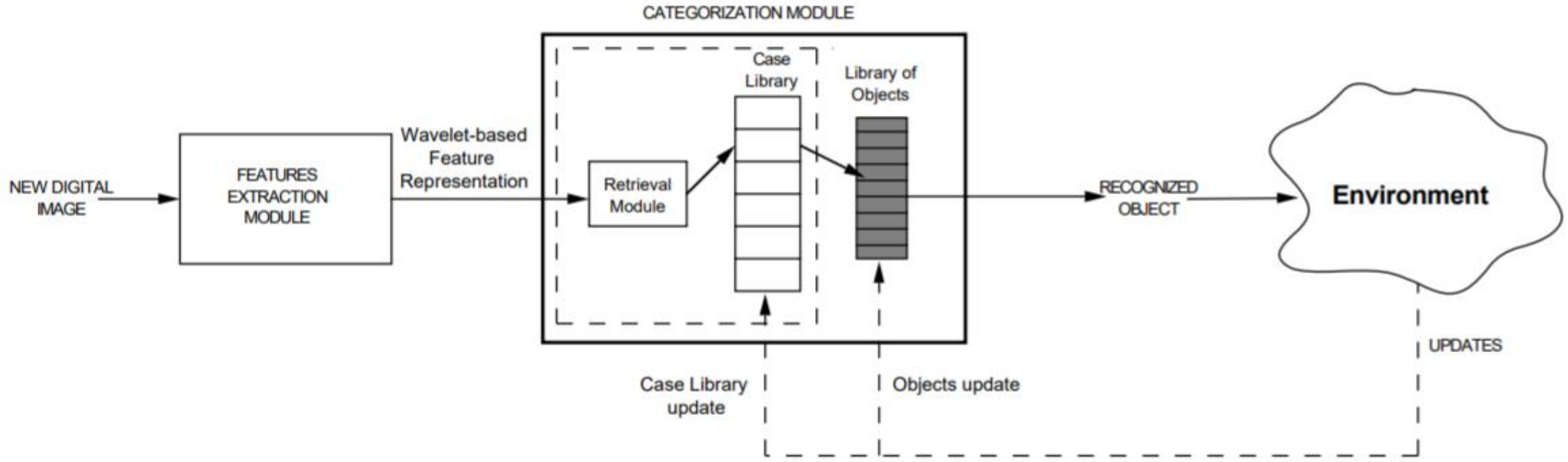
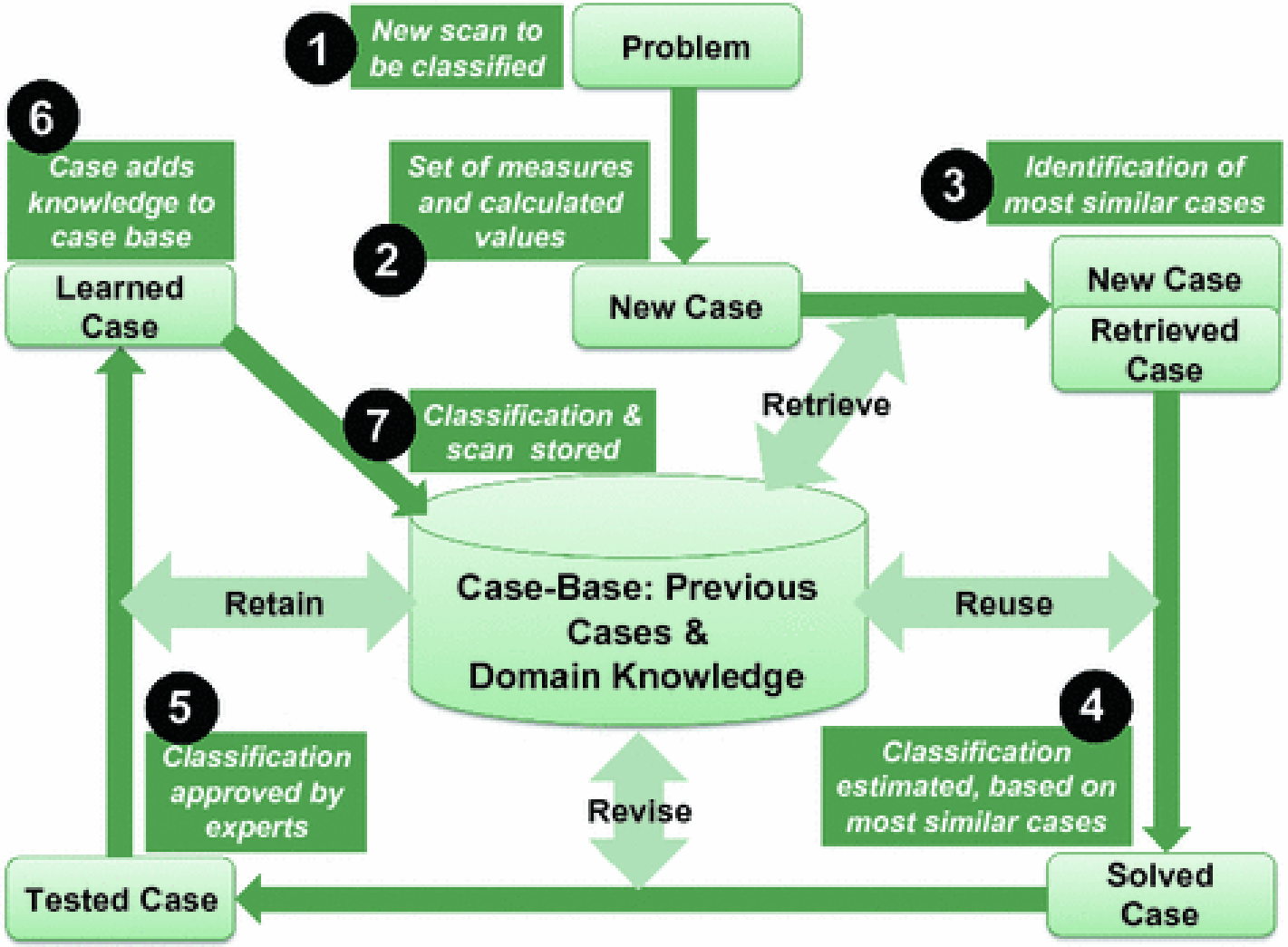


Fig. 1. CBR Approach to Image Recognition.

Micarelli, A., Neri, A., & Sansonetti, G. (2000, September). A case-based approach to image recognition. In *European Workshop on Advances in Case-Based Reasoning* (pp. 443-454). Springer, Berlin, Heidelberg.

Case-based Classification

Case-based reasoning:
Retrieve
Reuse
Revise
Retain



Edge Template

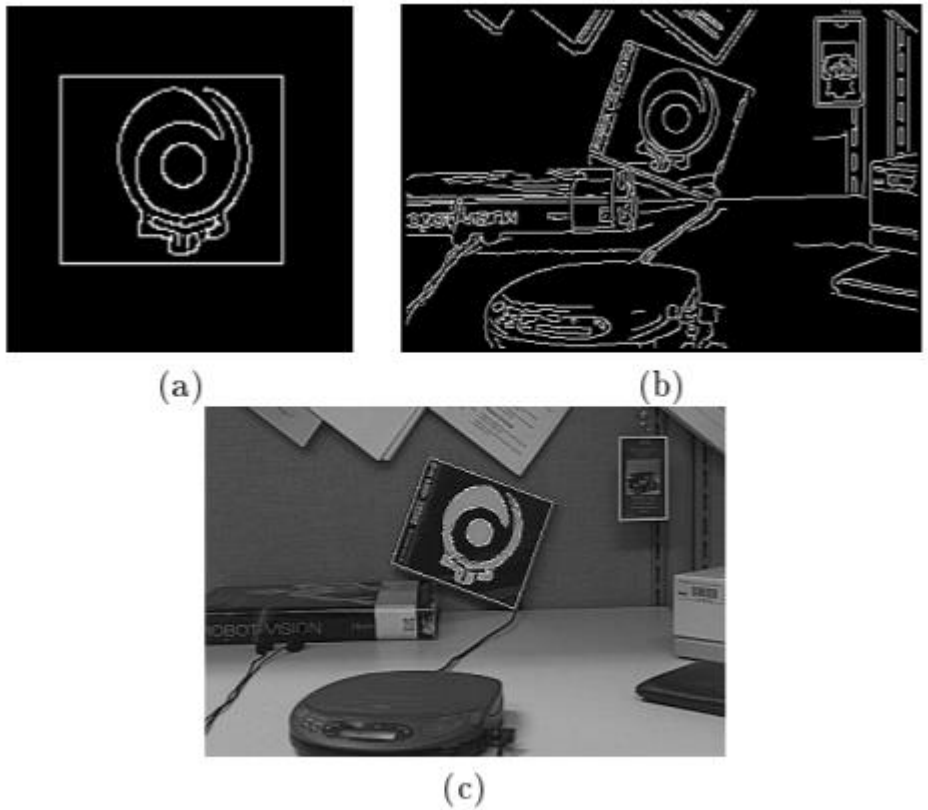


Figure 3: Object recognition example. (a) Edge template. (b) Edges extracted. (c) Recognition result.

Olson, C. F. (2000, June). Maximum-likelihood template matching. In *Proceedings IEEE Conference on Computer Vision and Pattern Recognition. CVPR 2000 (Cat. No. PR00662)* (Vol. 2, pp. 52-57). IEEE.

Template-Based Recognition of Pose and Motion: Temporal Template

Figure 5: Examples of pose templates. The excitatory region is shown in black and the inhibitory in gray. White regions are not considered in the matching process.

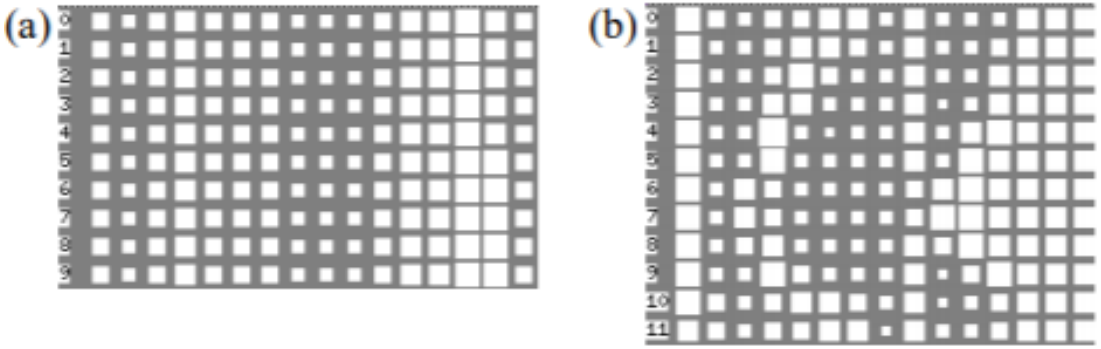


Figure 6: Examples of gesture templates. Gesture templates are sequences of prototype feature vectors. Shown here are gesture templates for (a) stop gesture (does not involve motion), (b) follow gesture (involves motion, as indicated by the change over time).

Pose gestures involve a static configuration of a person's arm, such as the "stop" gesture shown in Figure 3a, whereas motion gestures are defined through specific motion patterns of an arm, such as the "follow me" gesture shown in Figure 3b.

Our approach employs two phases, one for recognizing poses from a single image (pose analysis), and one for recognizing sequences of poses from a stream of images (temporal template matching). Both sets of templates, the pose templates and the gesture templates, are learned from examples

Romero, S. W. S. T. R., & Margaritis, D. (1998). Template-Based Recognition of Pose and Motion Gestures On a Mobile Robot.

Smaller Template

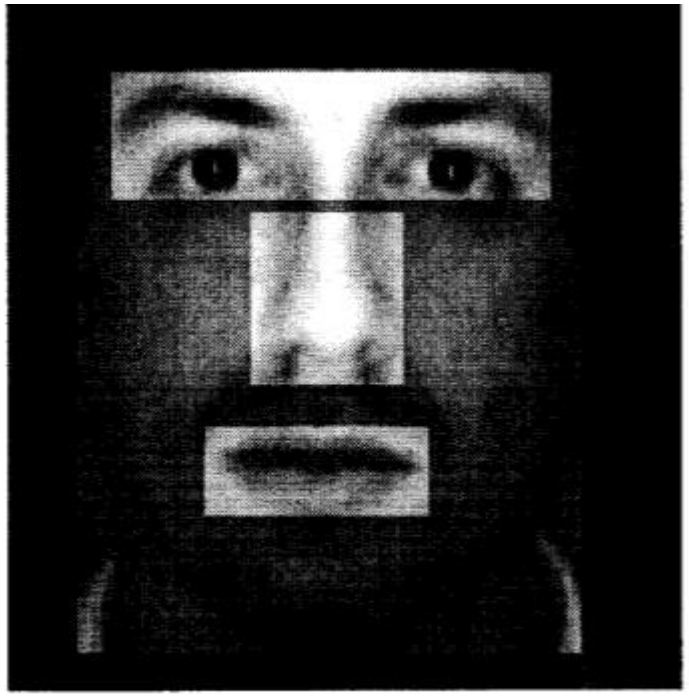


Fig. 11. Different regions used in the template matching strategy.

Our use of template matching is superior in recognition performance on our database. It is also simpler. A key to its success is how it exploits several different and smaller templates for the eyes, mouth, and nose, respectively, in a way that is somewhat similar to using feature detectors

Brunelli, R., & Poggio, T. (1993). Face recognition: Features versus templates. *IEEE transactions on pattern analysis and machine intelligence*, *15*(10), 1042-1052.

Summary

Template-matching approach

Template-based Recognition System

Case-based Classification

Learning-based Recognition System