

# Large-scale pattern recognition and its application to recognition / retrieval of characters, documents and objects

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Koichi Kise

Osaka Prefecture University, Japan



# Self-introduction

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- Koichi Kise
    - Osaka Pref. Univ. ; Professor
    - Visiting Professor at DFKI, Germany, 2000-2001
  - Research Area
    - Document Image Analysis
    - Object Recognition
    - Information Retrieval
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# Outline

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- ☐ Introduction of the univ.
  - ☐ Introduction of the lab.
  - ☐ Introduction to Pattern Recognition
  - ☐ Demos
  - ☐ Selected Topics
-

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# Osaka Prefecture University







close to  
Mozu Ancient  
Tombs  
(46 tombs)



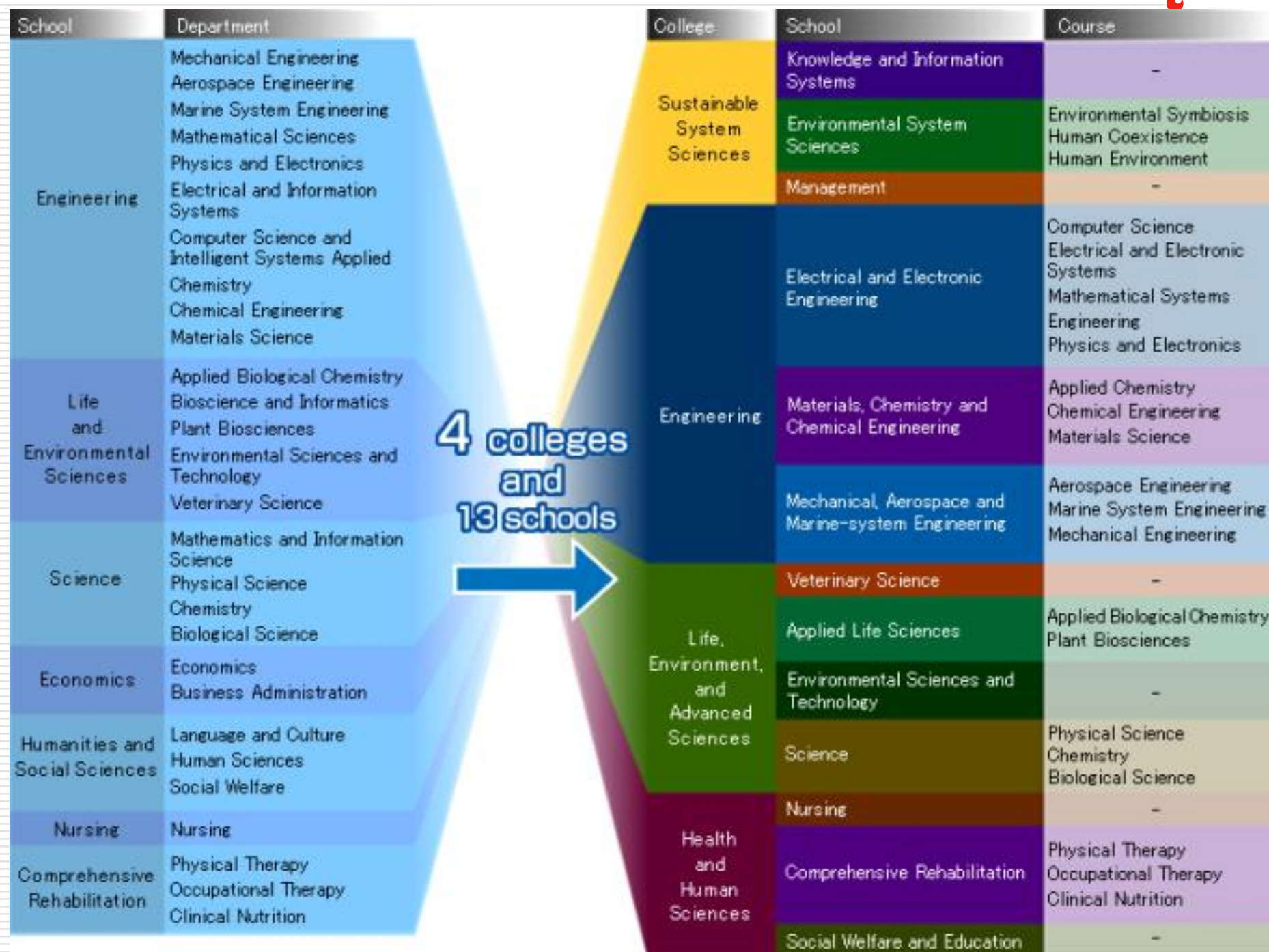
# Osaka Prefecture University

## □ 7 Schools & Graduate Schools

- Engineering
- Life & Environmental Science
- Science
- Economics
- Humanities & Social Science
- Nursing

They will be reorganized into 4 colleges and 13 schools in April 2012







# Outline

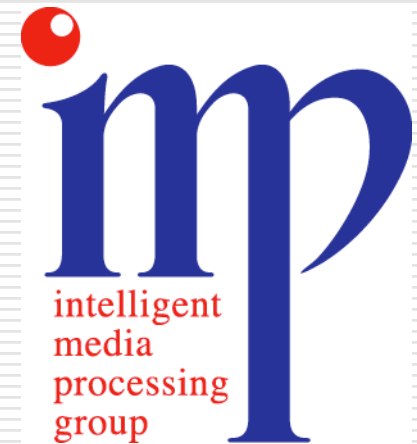
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# Introduction of my lab.

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- ☐ Intelligent Media Processing Group
    - ☐ Since 2005
    - ☐ Logo
  - ☐ Members
  - ☐ Projects
  - ☐ Groups
  - ☐ Computational environment
- 



# Members

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- Prof. Koichi Kise
  - Assoc. Prof. Masakazu Iwamura
  - Assist. Prof. Yuzuko Utsumi
  - Students (31)
    - Ph.D.: 3 (Japanese, German, Chinese)
    - Master: 11
    - Undergrad : 9 (B4) + 8 (B3)
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# More about students

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## ☐ Ph.D.

- Japanese student is JSPS research fellow
- Two foreign students supported by Japanese Gov. Scholarship
  - ☐ One will be JSPS research fellow from 2012

## ☐ Masters

- Two are now staying in Germany

## ☐ In addition

- One master course student finished his Master study in Germany
  - now hired by German Research Center for AI
-

# Projects

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- ☐ CREST
  - ☐ Strategic Funds for Promotion of Science and Technology
  - ☐ Grant-in-Aid for Scientific Research
  - ☐ A-Step
  - ☐ Joint project with Spain and Germany
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# CREST

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## ☐ Title

- Development of Fundamental Technologies for Innovative Use of **Character/Document Media** and Their Application to Creating **Human Harmonized Information Environment**

## ☐ Partners

- Tohoku Univ. and Kyushu Univ.

## ☐ Period: 5.5 years (now 2<sup>nd</sup> year)

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# Strategic Funds for Promotion of Science and Technology

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## ☐ Field:

- R&D program for implementation of anti-crime and anti-terrorism technologies for a safe and secure society

## ☐ Partners:

- Osaka Univ., Waseda Univ., Wakayama Univ., Toshiba and National Institute of Police Science

## ☐ Period: 5 years (2<sup>nd</sup> year)

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# Grant-in-Aid for Scientific Research

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## ☐ Scientific Research B

- Title: Large-scale specific object recognition and its application to real-world oriented web.
- Period: 3 years (2<sup>nd</sup> year)

## ☐ Specially Promoted Research

- Title: Intelligent Camera-Pen
  - Period: 2 years (1<sup>st</sup> year)
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# A-Step

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- ☐ Title: Intelligent camera-pen
  - ☐ Period: 1 year (has just started)
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# Joint Projects with Spain and Germany

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- start from January 2012
  - Partners
    - Computer Vision Center, UAB, Barcelona
    - German Research Center for AI
  - Topics
    - Scene text recognition
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# Research Groups

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## □ Kise

- Image recognition group
- Document analysis group

## □ Iwamura

- Character recognition group
- Nearest neighbor search group
- Computational photography

## □ Utsumi

- Face recognition group
  - Behavior understanding group
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# Computational environment

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- For each student
  - Desktop (Core i5 or 7) + 2 display
  - optionally a laptop
- Servers
  - 760 cores
  - 4TB memory
  - 650TB disk
  - 10Gbps network



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# Introduction to Pattern Recognition

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# The task

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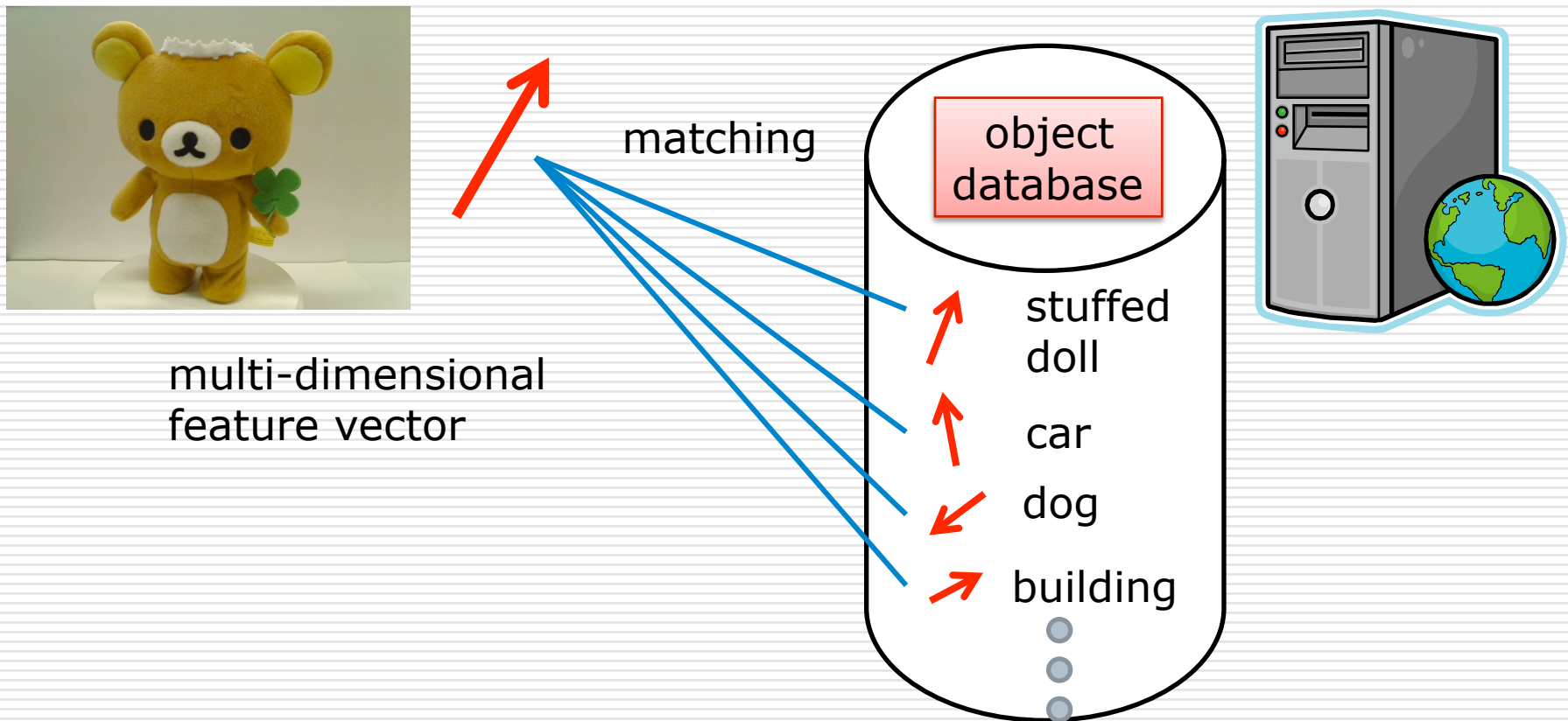
What's this?



This is a stuffed doll.  
This is a Rirakkuma.

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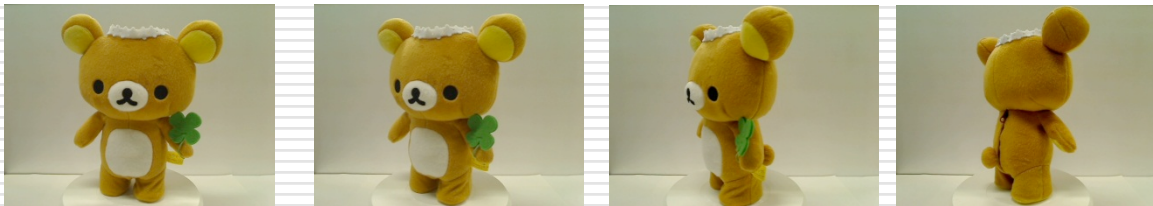
# How can we realize it?



# But many images...

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- Same obj. with different viewpoints



- Same category, but different obj.



- We focus here on the first case.
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# Traditional Way

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- ☐ Small amount of data are available
  - ☐ Single query and single feature vector for each object
  - Robust features
    - ☐ valid for many variants
  - Sophisticated matching
    - ☐ for not missing correct match
  - ☐ Problem
  - Limited accuracy achieved
  - Computationally expensive
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# New Way

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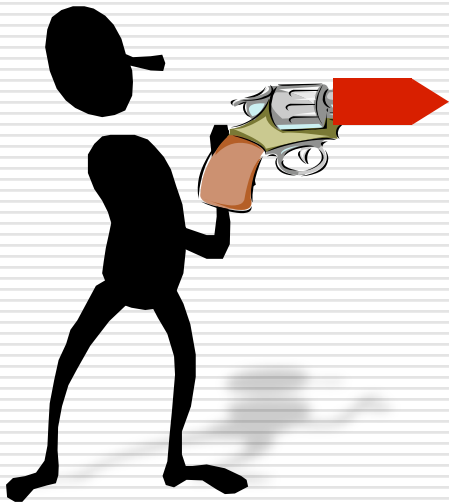
- Huge data are available
  - Memory-based
    - Store all variants in the database
    - Employ multiple queries for better accuracy
    - Match each query to the stored variants
-



# Comparison: Traditional Way

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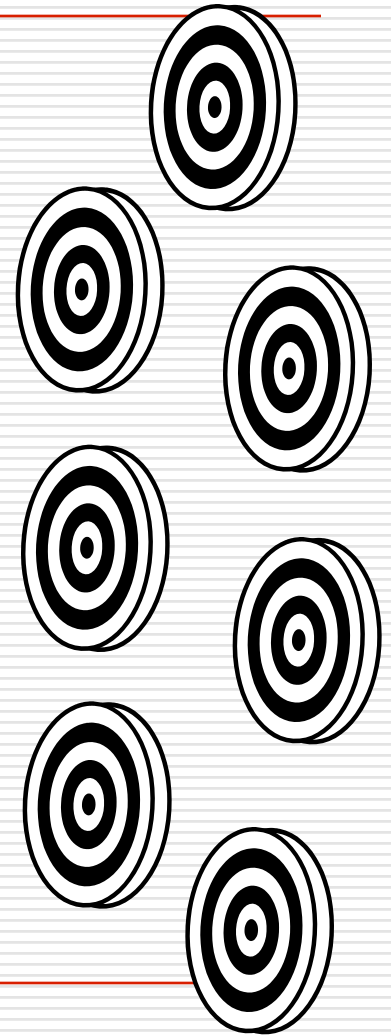
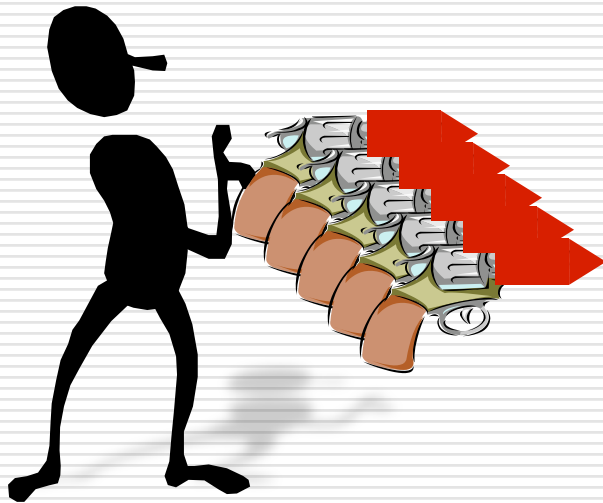
Single



# Comparison: New Way

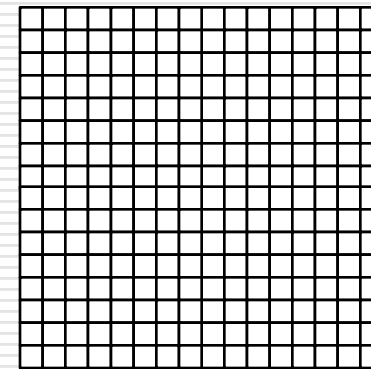
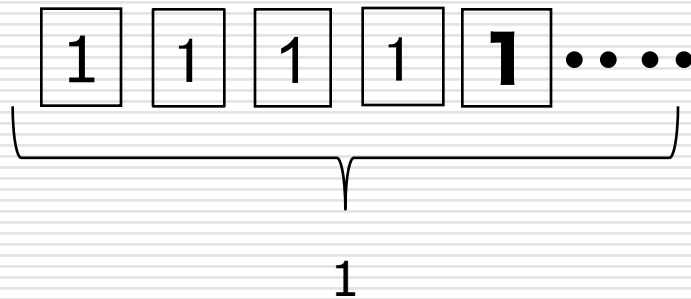
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multiple



# Ultimate Pattern Recognition

- Store all possible patterns with their labels



for a 16 X 16 binary image,  
how many possible patterns?

**IMPOSSIBLE**

$$2^{256} = 10^{79}$$

# How many patterns we see?

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- Suppose human vision is 30 fps
- Life would be 80 years
- How many frames?

$$80 \times 365 \times 24 \times 60 \times 60 \times 30 = 10^{11}$$

- less than 1 T ( $=10^{12}$ ) frames

Space of realistic patterns are much smaller than that of possible patterns

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# Challenges

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- ☐ How to obtain realistic patterns
  - ☐ How to store them
  - ☐ How to match a query to those stored patterns
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# Trade-off

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- Better accuracy with more time
- Better accuracy with more memory

$$\frac{\text{Accuracy}}{\text{Time} \times \text{Memory}} \leq \text{Limit}$$

Find the theoretical limit

Develop a method for exchanging A, T and M

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# Demos

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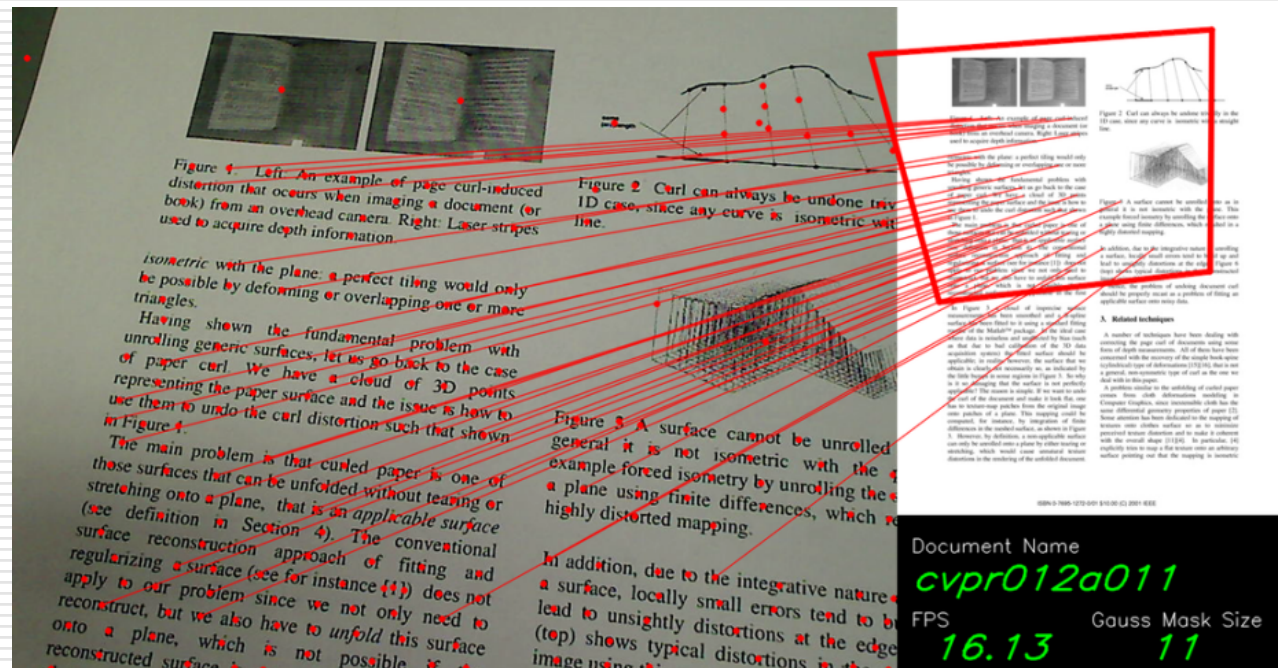


# Demos

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- ☐ Large-Scale Document Image Retrieval
  - ☐ Large-Scale Object Recognition
  - ☐ Camera-Based Alphabet Recognition
  - ☐ Camera-Based Kanji Recognition
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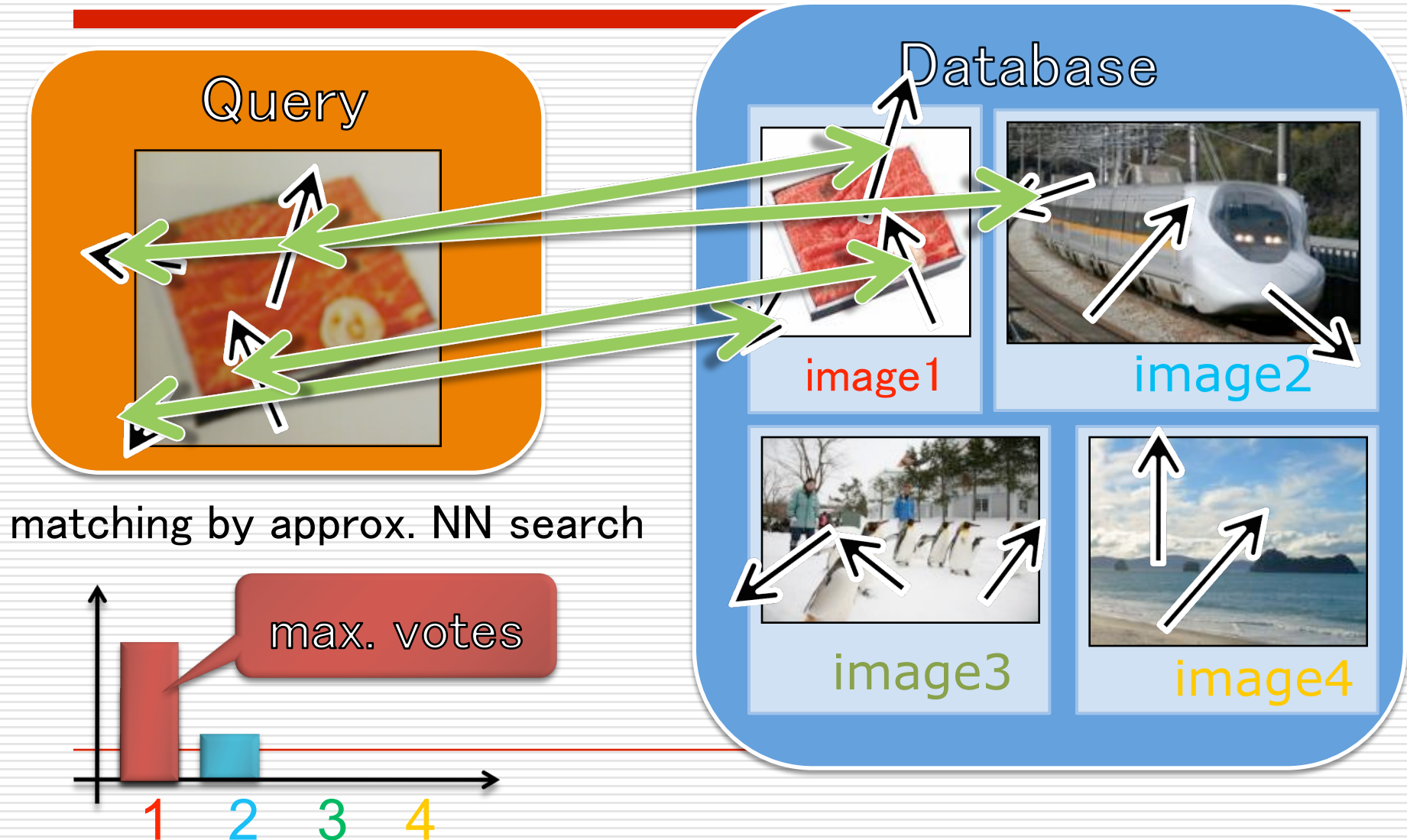
# Large-Scale Document Image Retrieval



1 Million page DB



# Large-Scale Object Recognition



# Camera-Based Alphabet Recognition

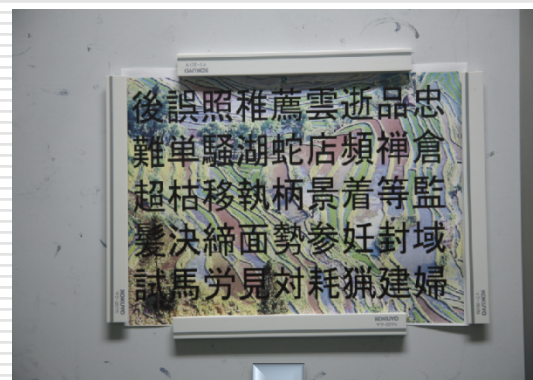
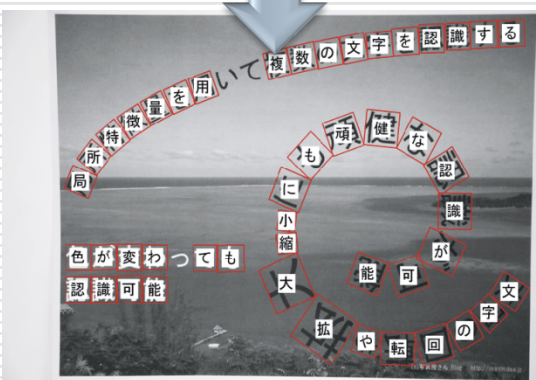


環境中文字列のリンクアンカー化

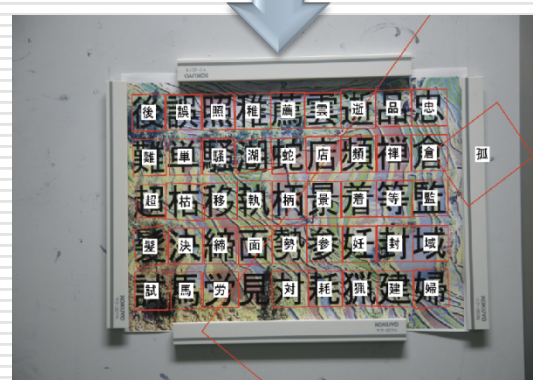
# Camera-Based Kanji Recognition



Various layout



Complex. Bg



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# Please select:

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  - ☐ Large-Scale Object Recognition
  - ☐ Camera-Based Alphabet Recognition
  - ☐ Camera-Based Kanji Recognition
-

# Selected Topics

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