Introduction to pattern recognition

- **Outline:**

  1. What is pattern recognition?
  2. How to perform pattern recognition?
  3. Some examples
  4. Components of a pattern recognition system
  5. How to evaluate a pattern recognition system?

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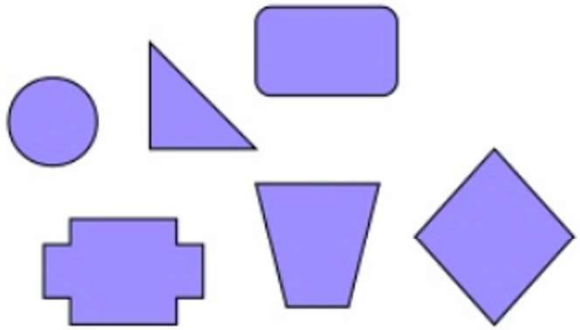
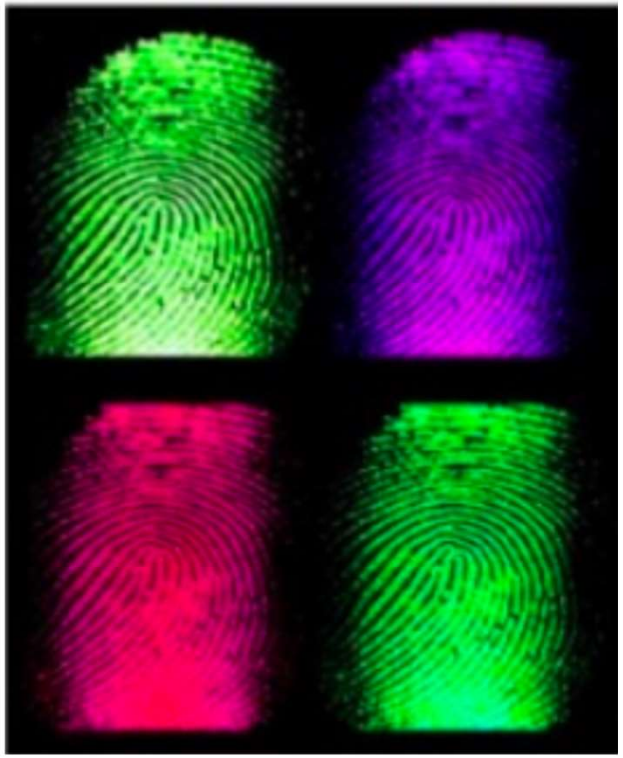
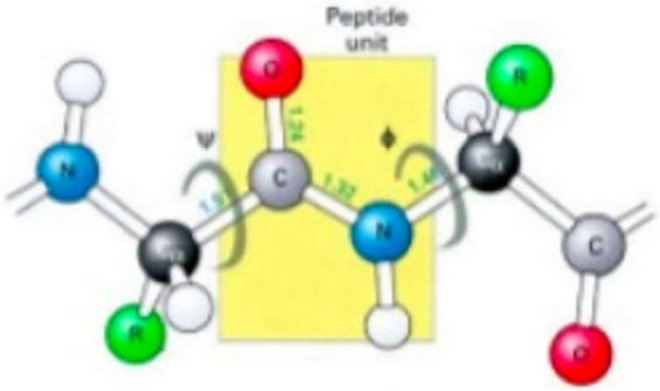
Examples of patterns







What is pattern recognition?

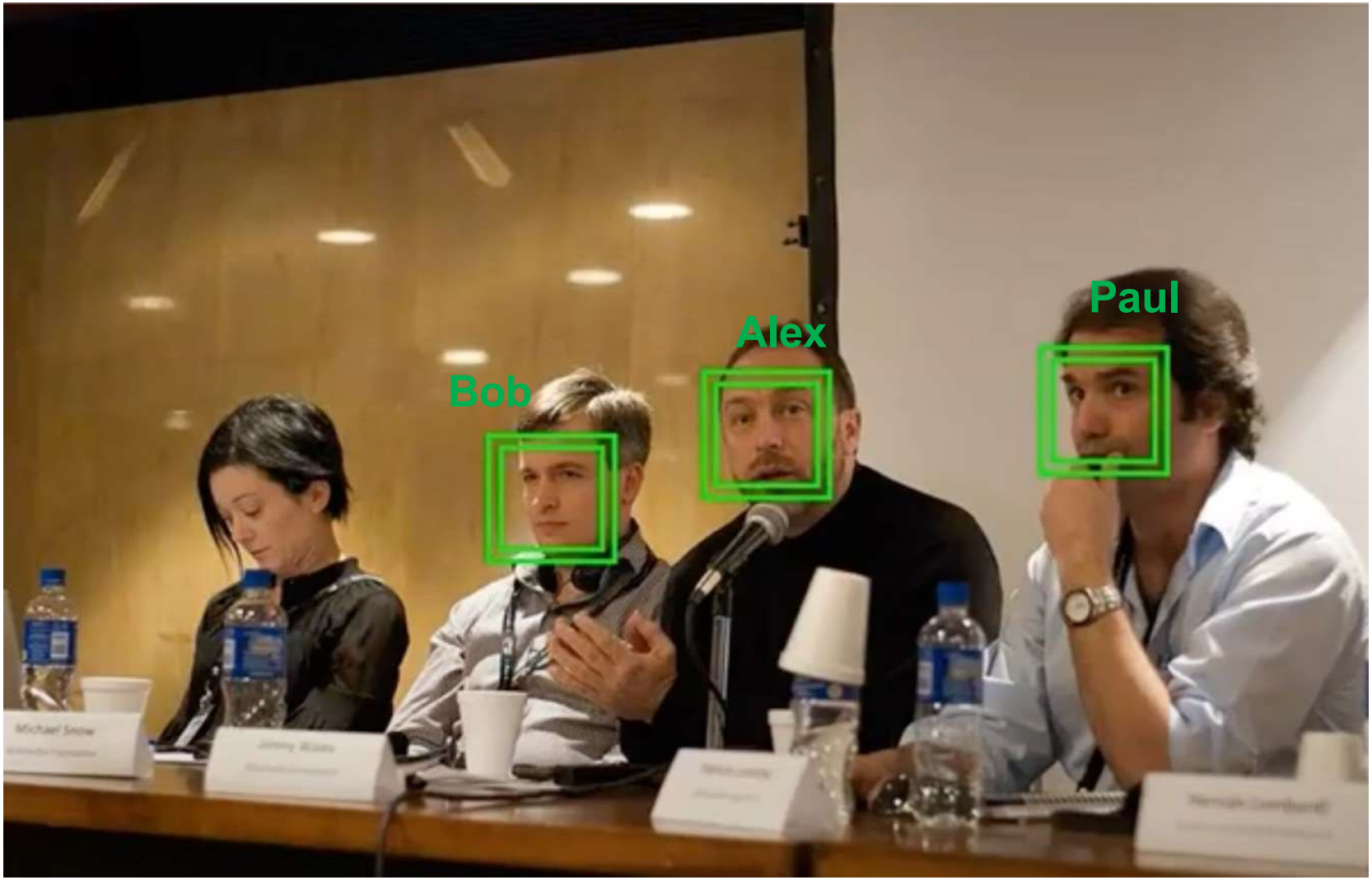
- One of the most common applications of machine learning
- Important component of AI systems
- Aiming to give human perception capabilities to machines
- Process of recognizing regularities in data by using machine learning algorithms, based on statistical information, historical data, or the machine's memory.
- During recognition given objects are assigned to prescribed classes

Applications of pattern recognition

People detection

Applications of pattern recognition

Face recognition



Applications of pattern recognition

License plate recognition

Applications of pattern recognition

- OCR (Optical Character Recognition): handwritten, printed text,…
- Biometrics: face, finger prints, speech,…
- Medical diagnosis: X-ray, MRI analysis,…
- Biology: fruit, leaf,…
- Education
- Smart transportation: traffic light, traffic sign,…

Applications of pattern recognition

- Security surveillance
- Entertainment, sport
- Agriculture
- Commercial
- Military technology: target recognition, satellite image analysis,…

and more…

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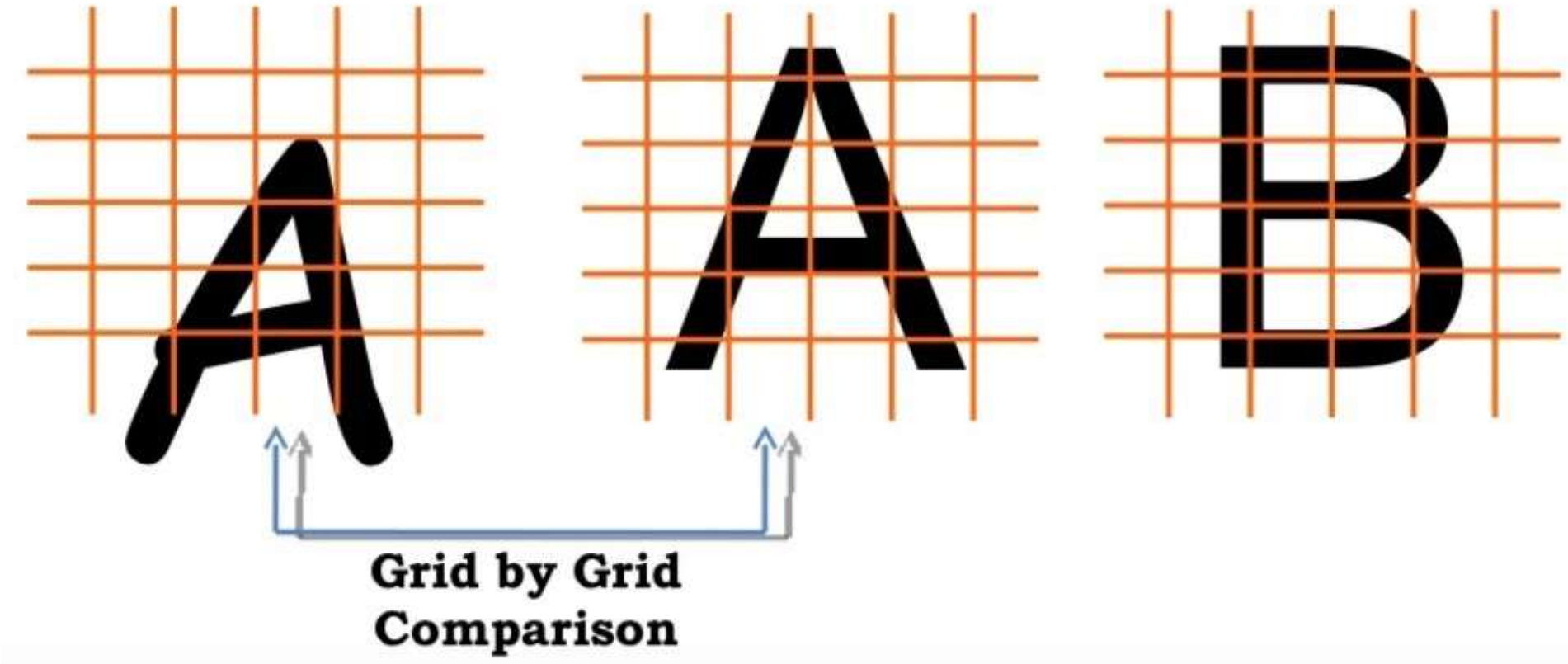
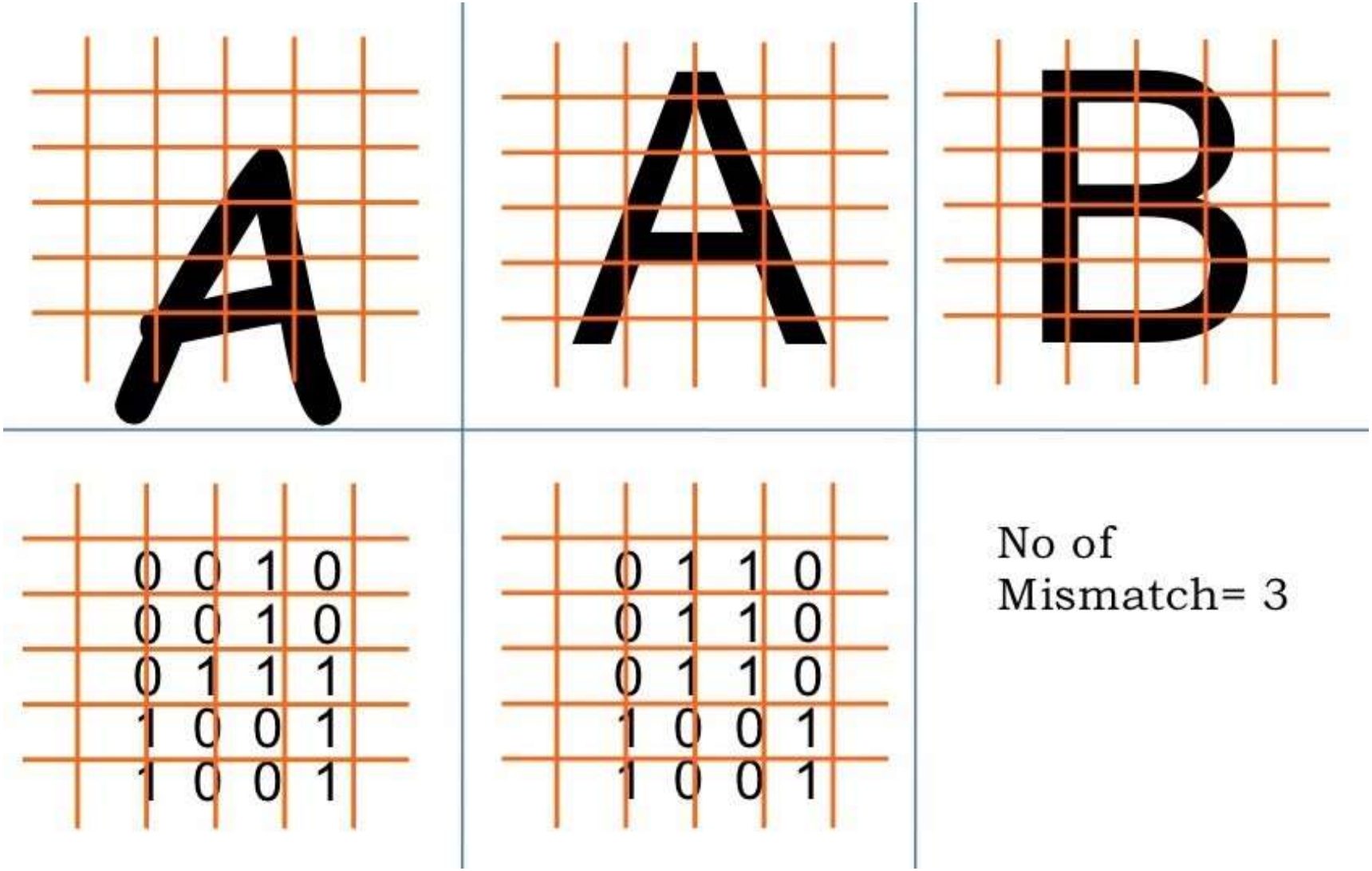
Grid-by-grid comparison



From: Talal Alsubaie

Grid-by-grid comparison



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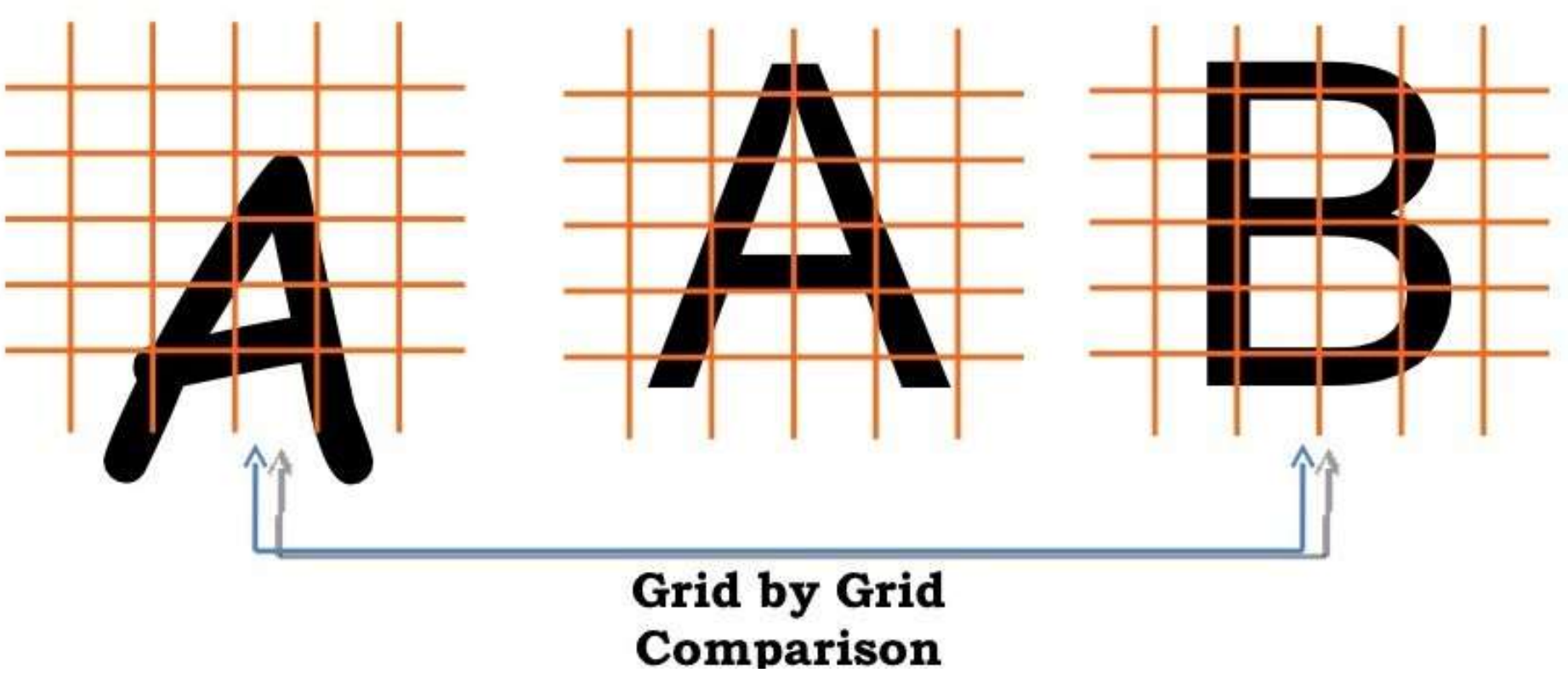

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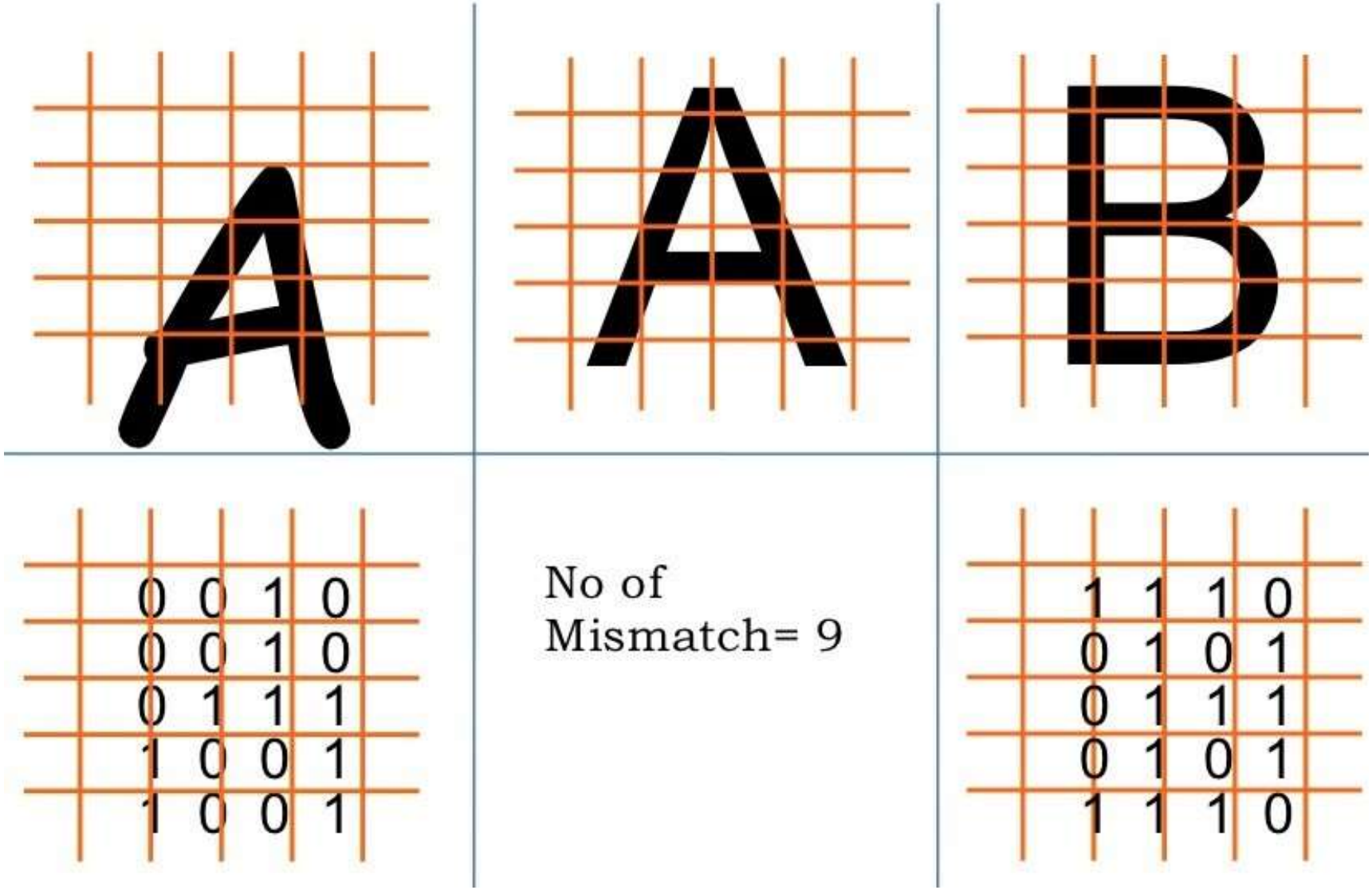
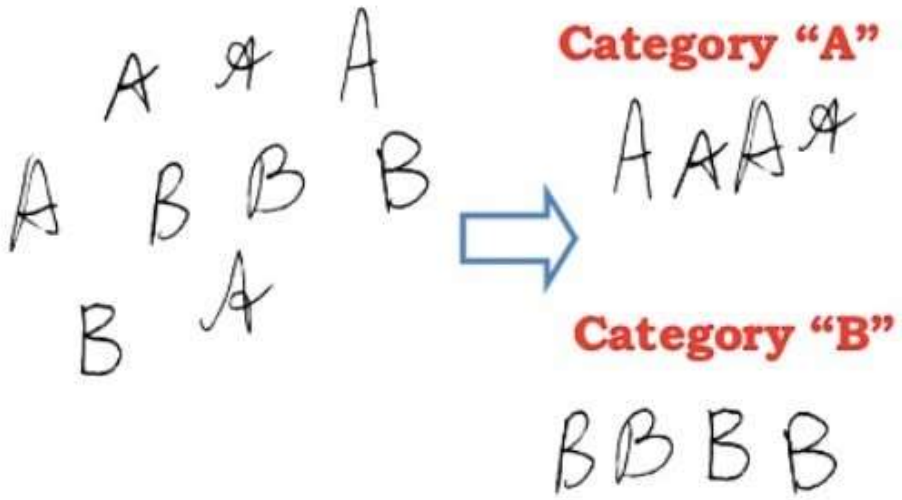


From: Talal Alsubaie

The statistical way

- Problems with grid-by-grid comparison: too costly
- **Solution: artificial intelligence/machine learning**
- **Two phases:** learning and classification
  - *Learning:* learn the rule from data (supervised and unsupervised)
  - *Classification:* decide a pattern to a known category/class



Variability challenges

- **Intra-class**
  - Ex: different typefaces of letter “T”

Variability challenges

Inter-class

- Ex: lisianthus (hoa cát tường) and carnation (hoa cẩm chướng)

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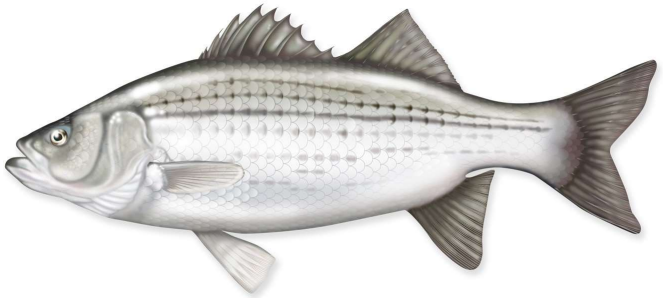
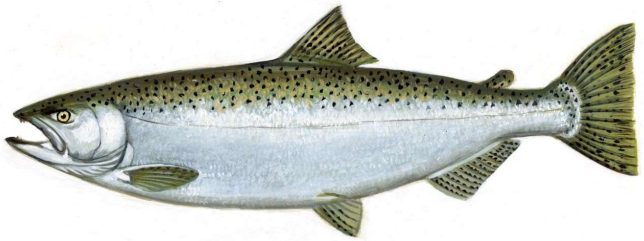
Example 1

Fish



Sea bass

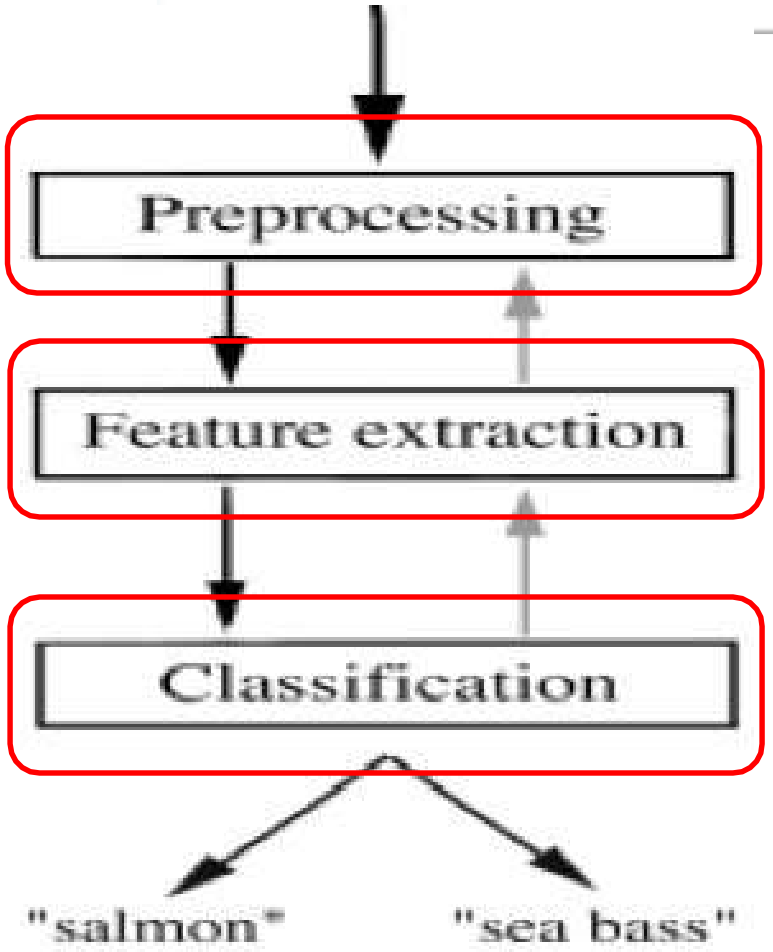


Salmon

Problem analysis

- Set up a camera
- Take some sample images
- Note physical differences (features):
  - Length
  - Lightness
  - Width
  - Number and shape of fins
  - Position of the mouth, etc…
- Classify fish

Implementation



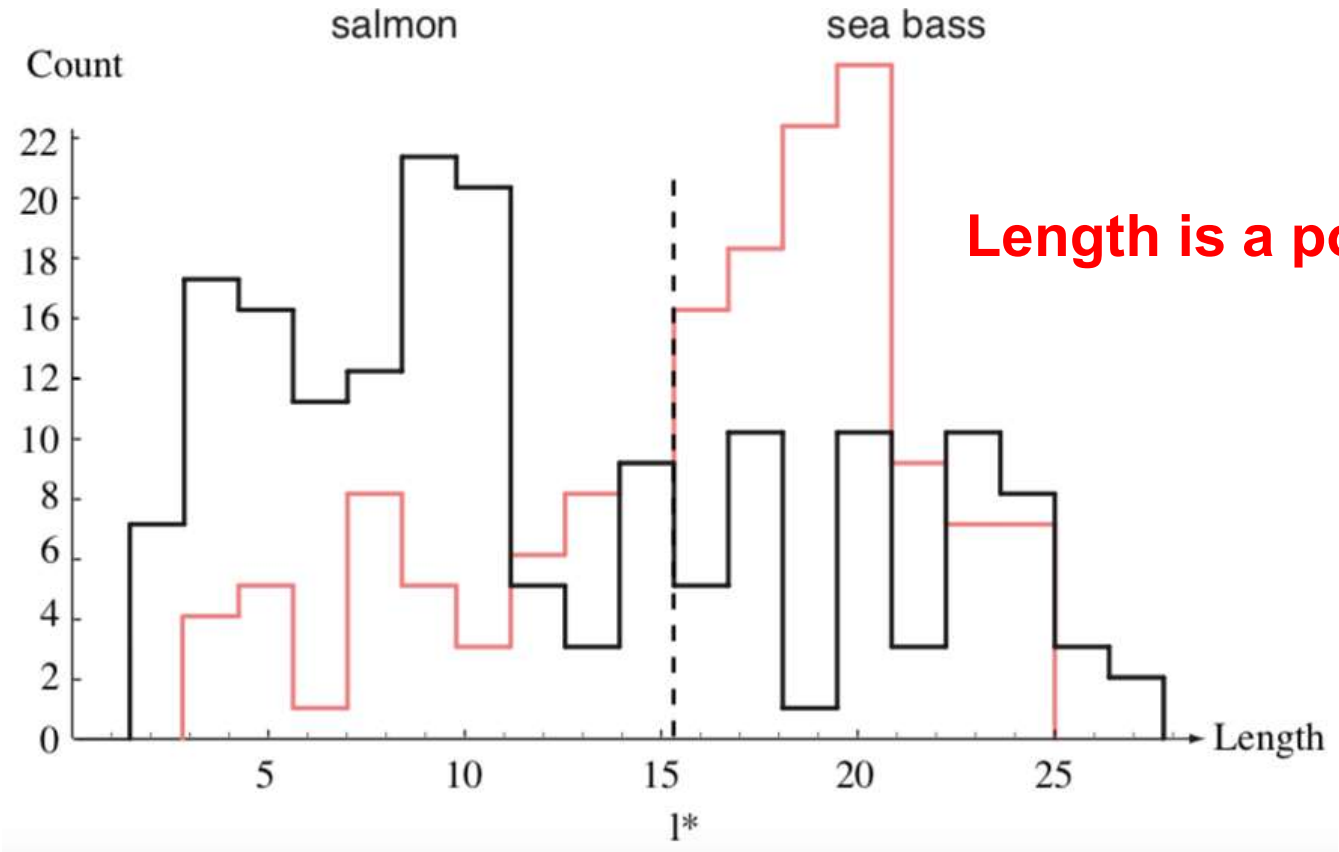
To isolate fishes from one another and from the background

To reduce the data by measuring certain features

To discriminate salmon and sea bass (by statistical, by machine learning)

Feature selection

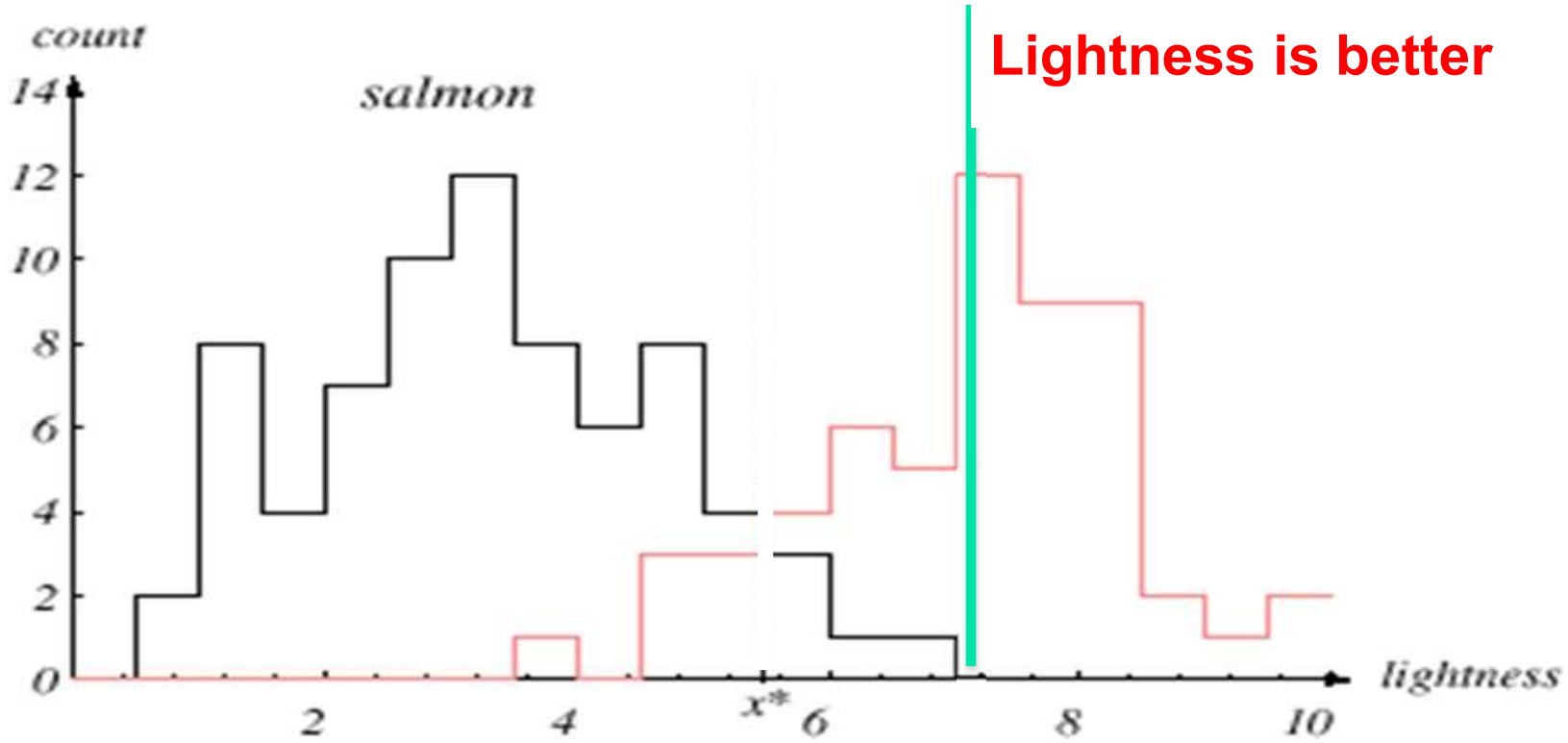
- Sea bass is generally longer than salmon → Length becomes a feature.



Length is a poor feature

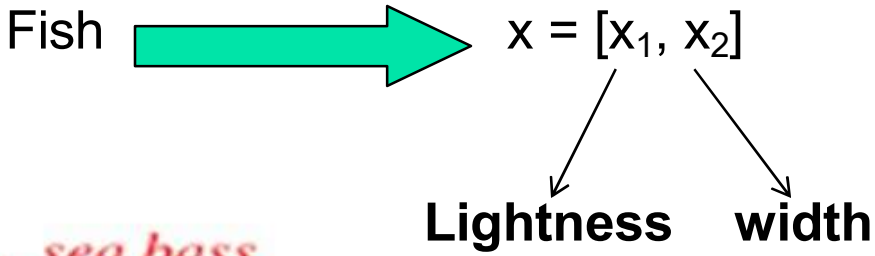
Feature selection

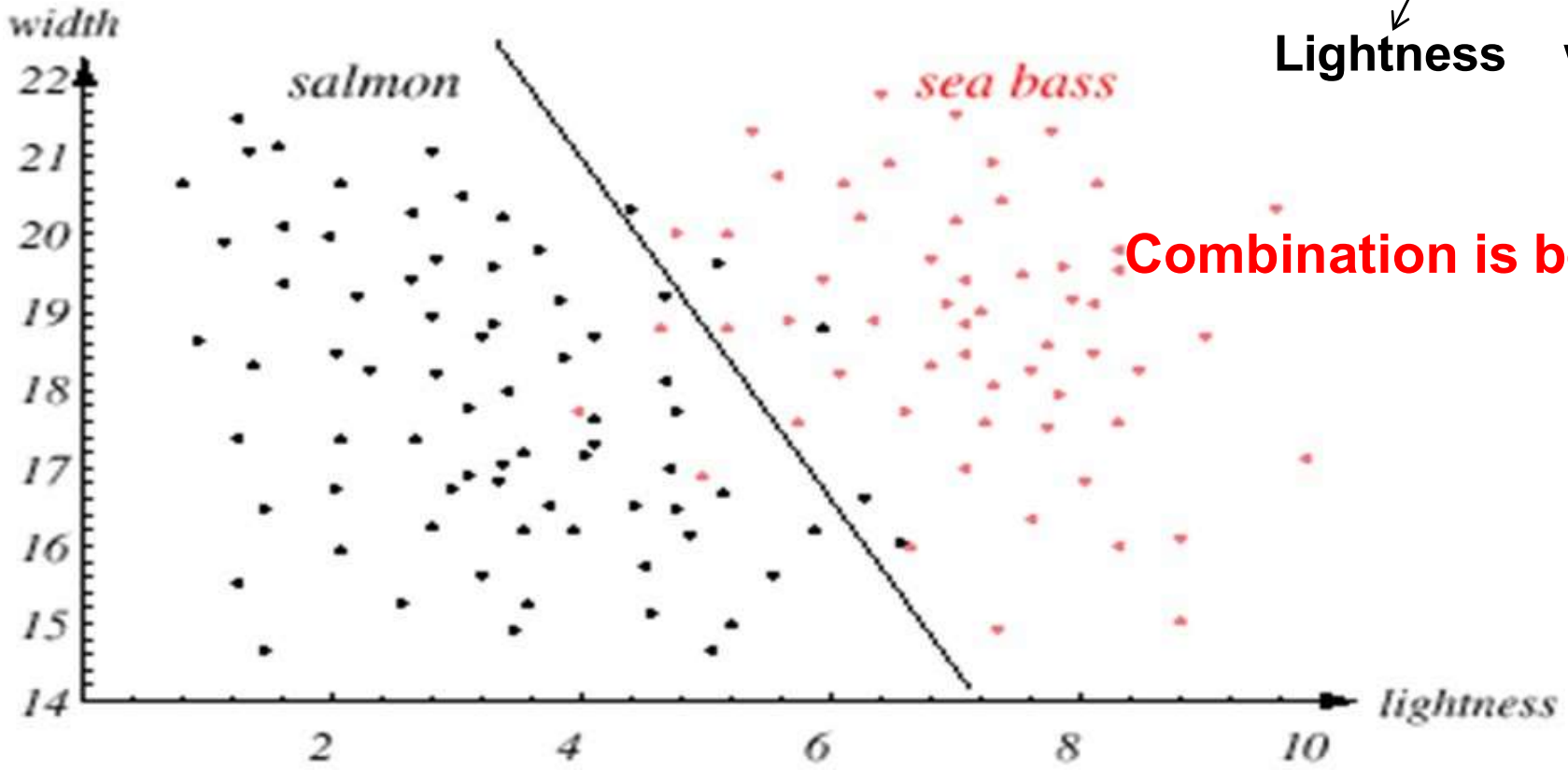
- **Lightness feature:** better than length feature but not adequate
- Move the decision boundary toward smaller values of lightness to reduce the number of sea bass that are classified as salmon



Feature selection

- **Multiple features**
- **Lightness + width**

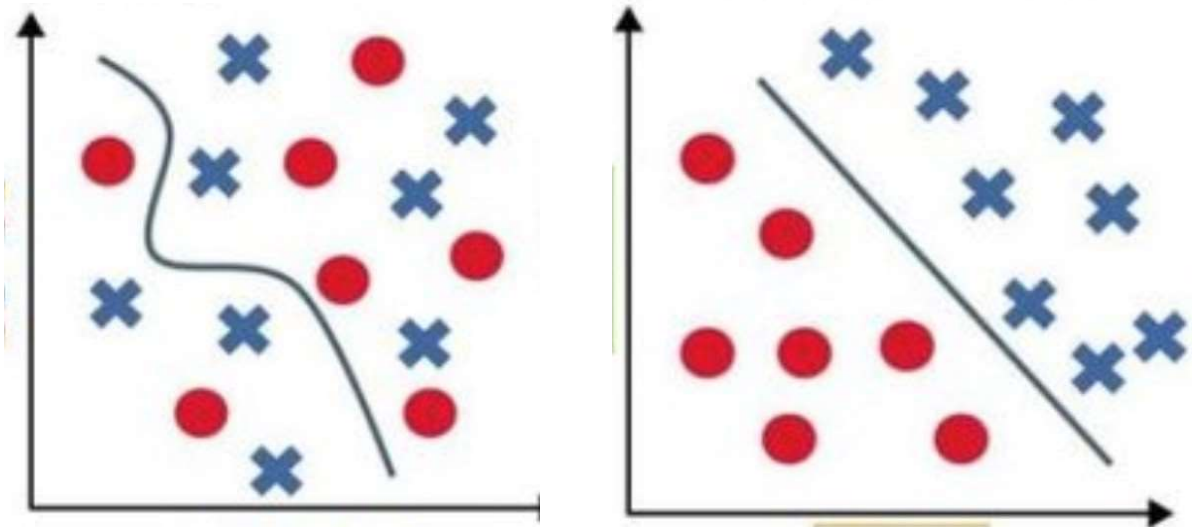




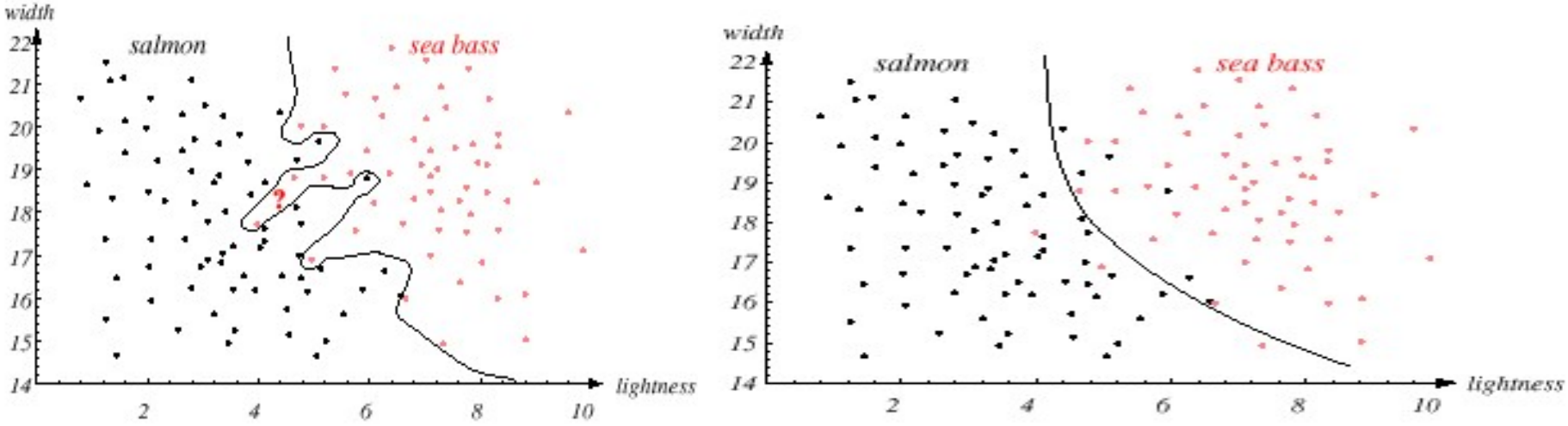
Combination is better

How many features

- More is not always better
- There could be redundancy
- Over complication can occur

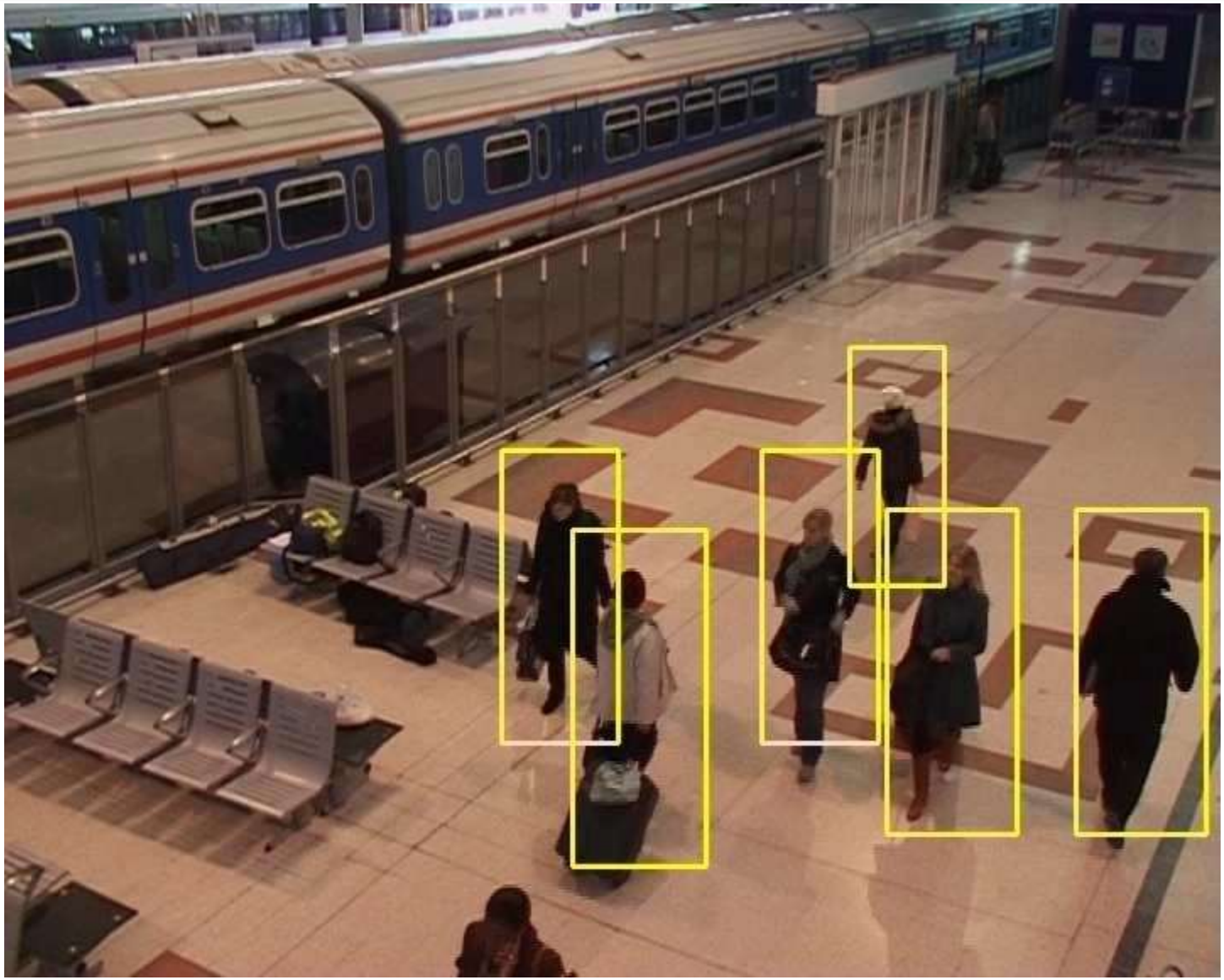


Classification model selection



- There is a tradeoff between complexity of the decision rules and their performances to unknown patterns.
- **Generalization:** The ability of the classifier to produce correct results on *novel* patterns.
- Simplify the decision boundary!

Example 2

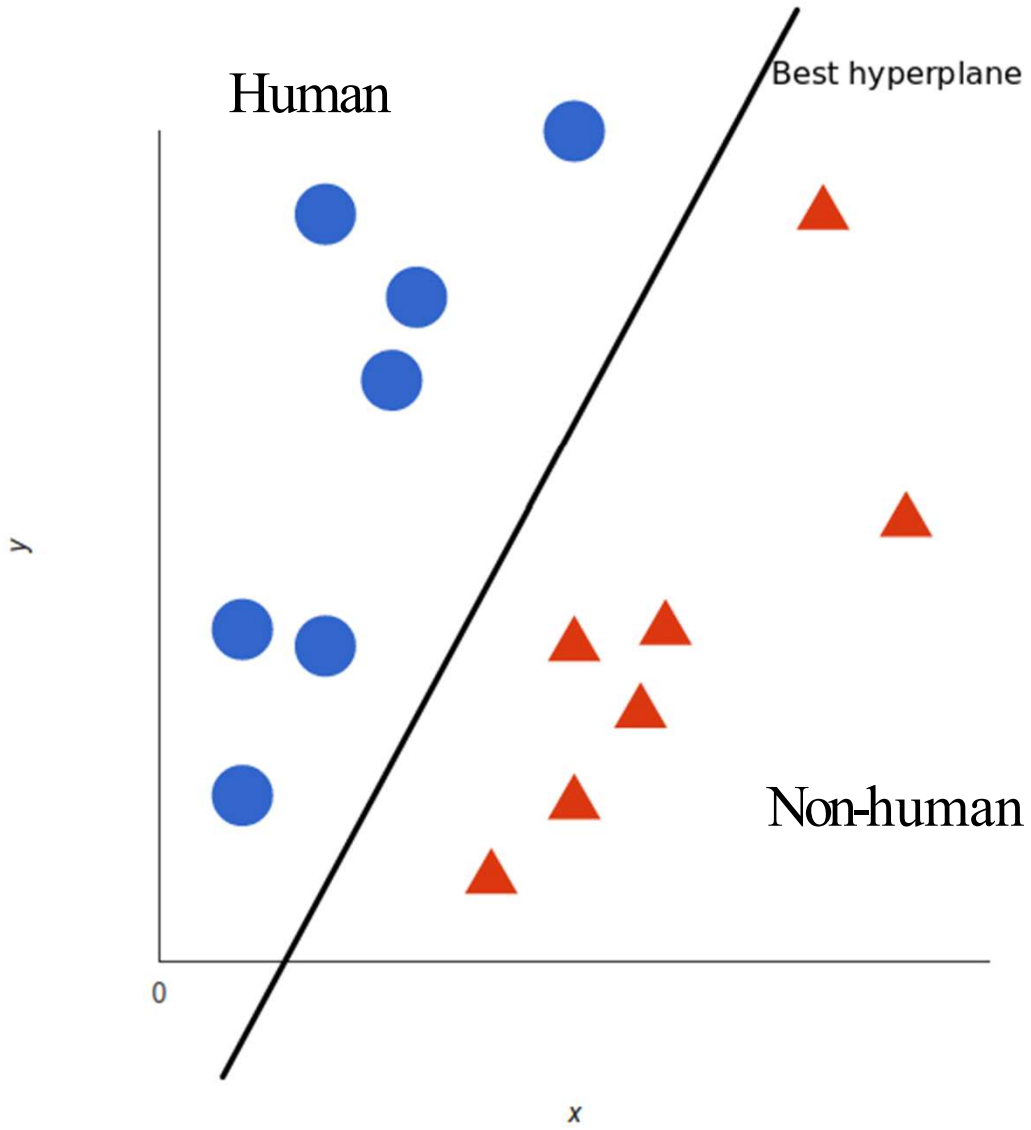


System building

- Data:
  - Images with people (positive)
  - Images without people (negative)

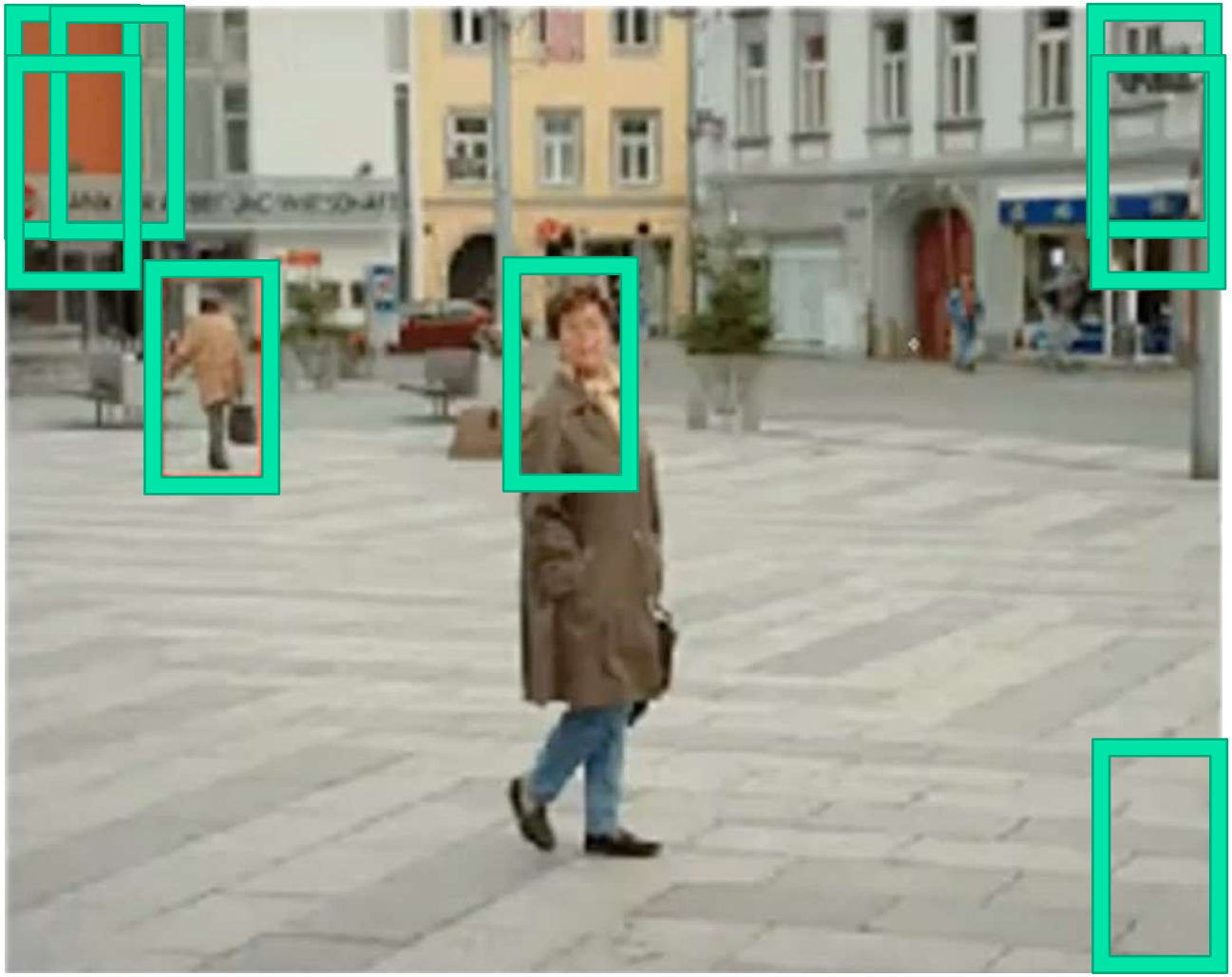
System building

- Modeling:
  - HOG features
  - SVM classification model



System building

- Detecting:
  - Sliding window
  - Detecting a person/non-person within a sliding window (HOG+SVM)



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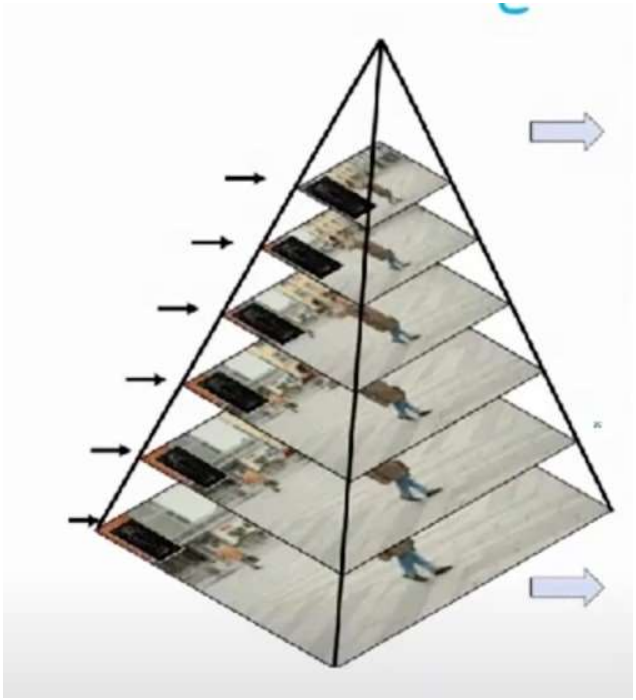
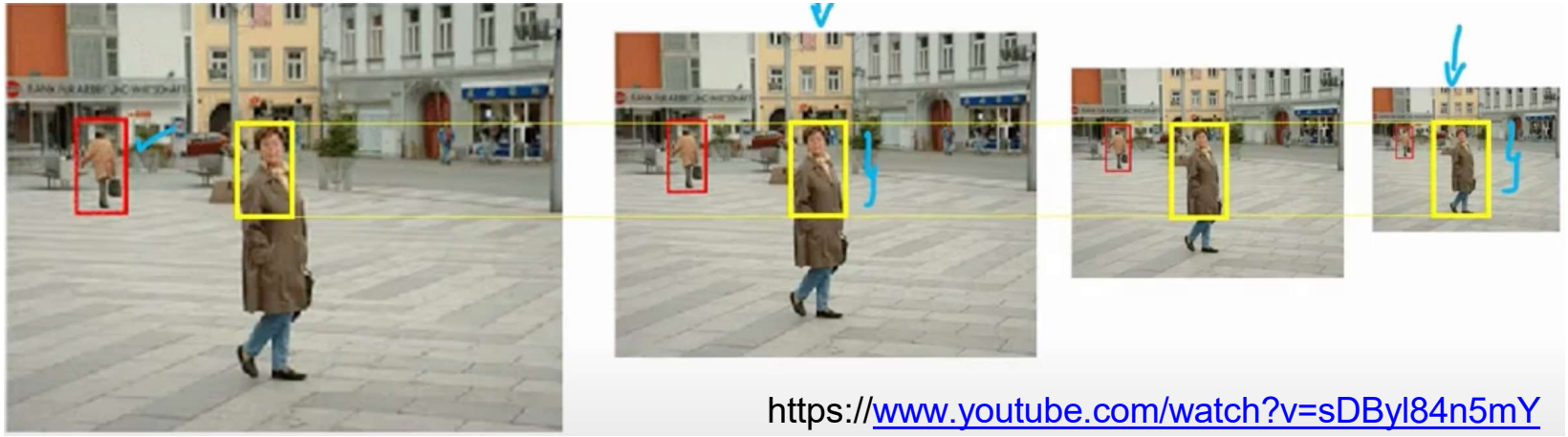
System building

- Image pyramic:
  - To change the window size





https://www.youtube.com/watch?v=sDByl84n5mY

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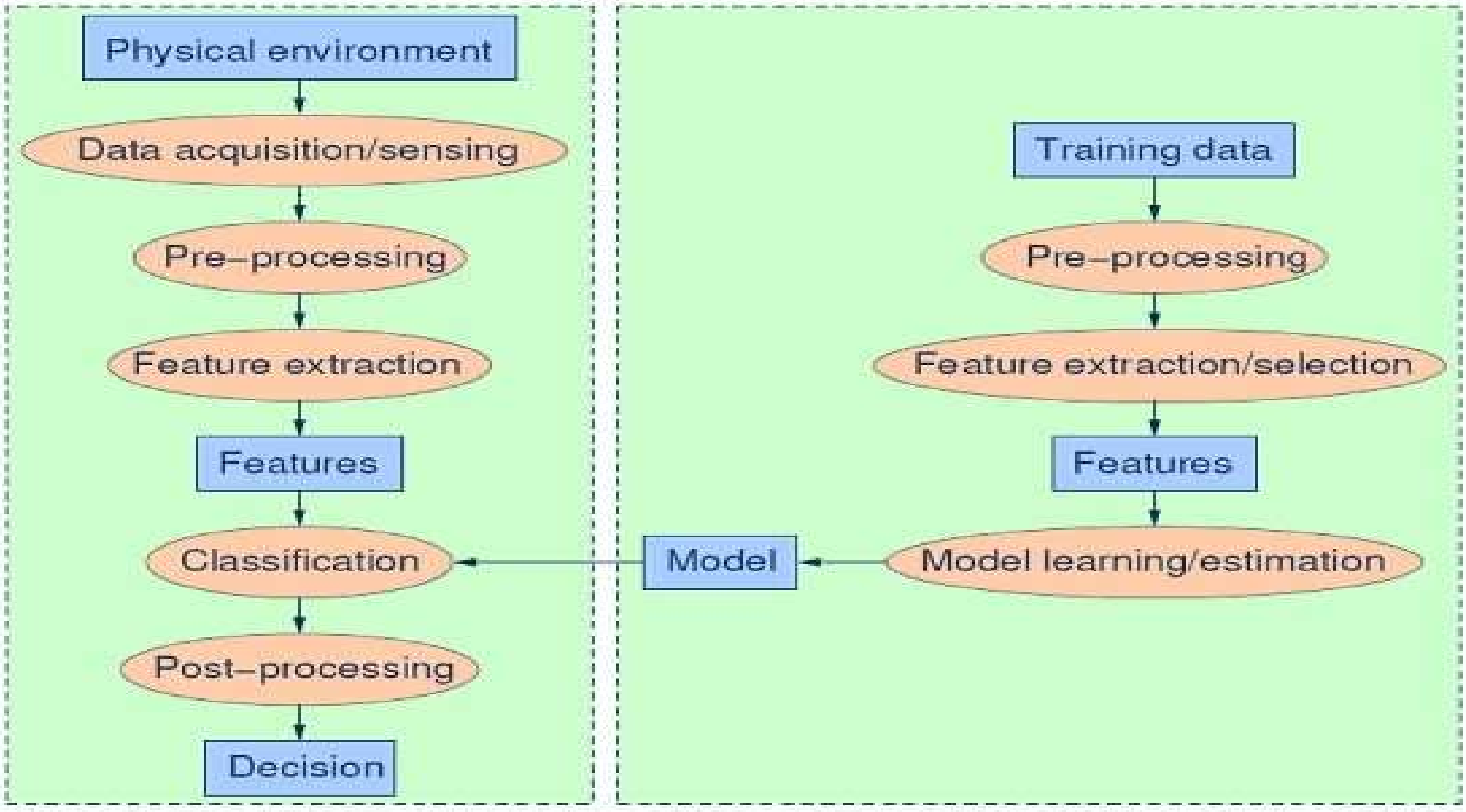
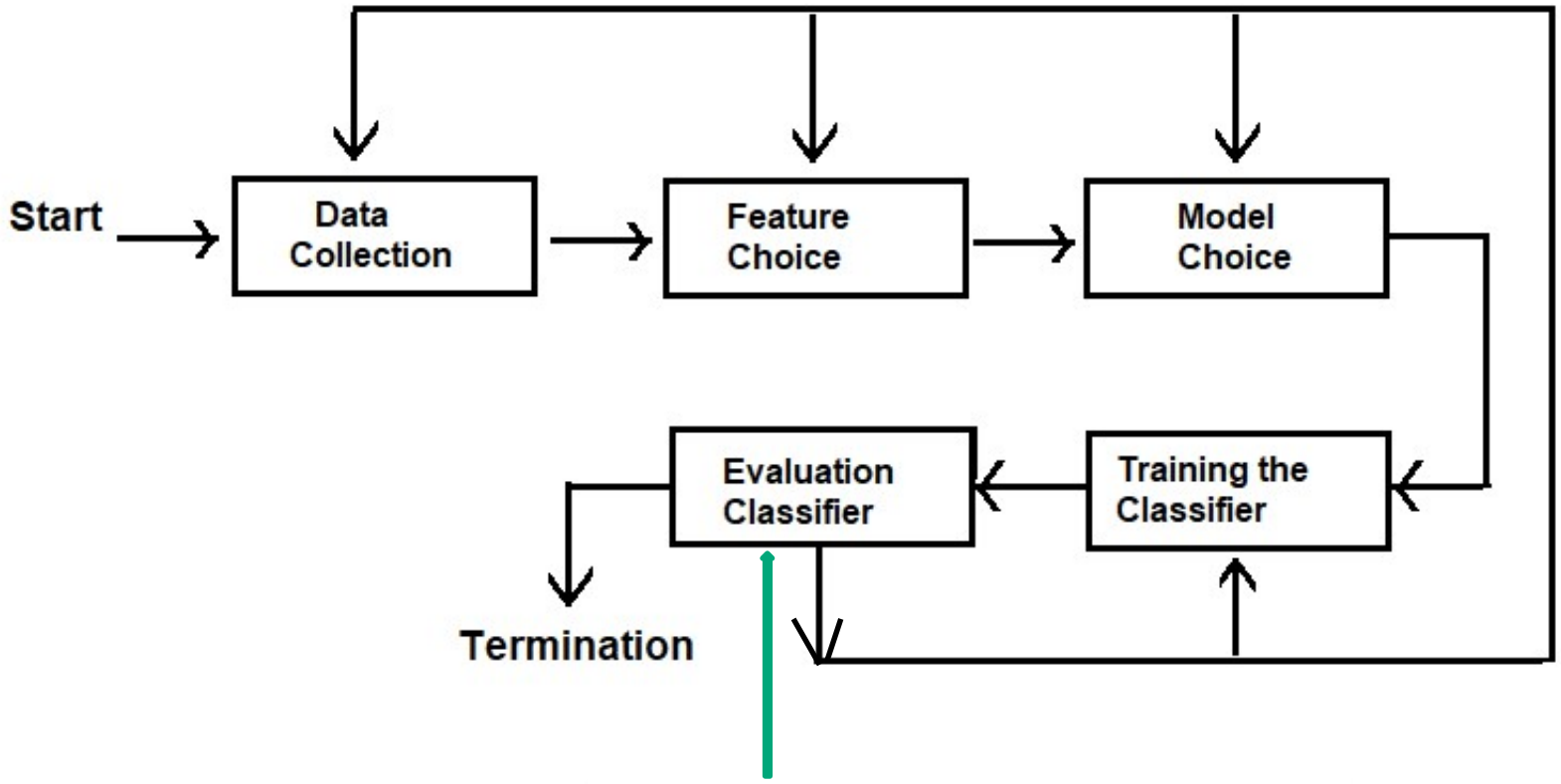
Pattern recognition system

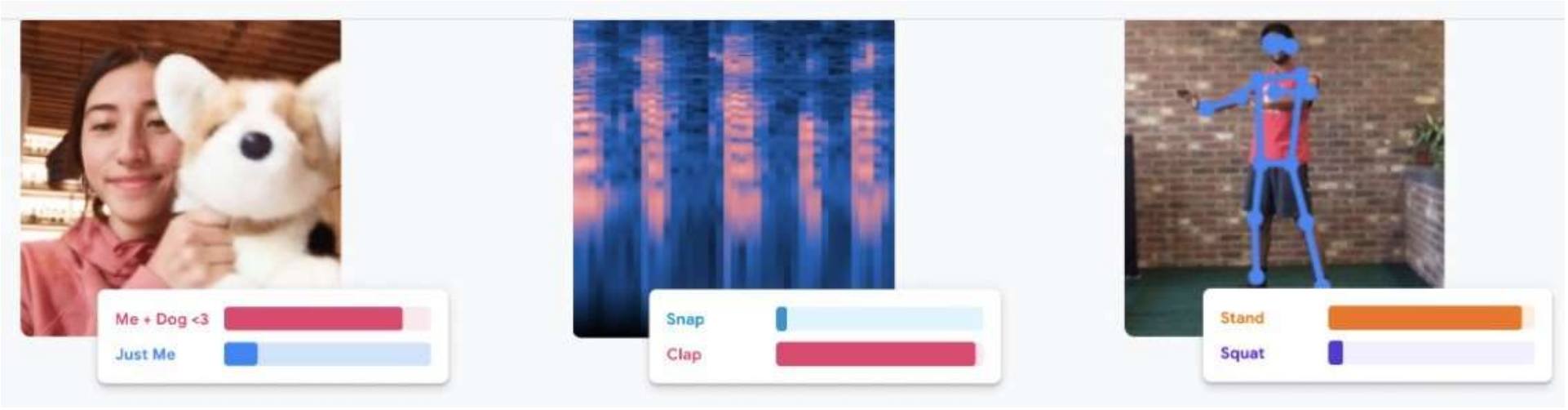


The design cycle

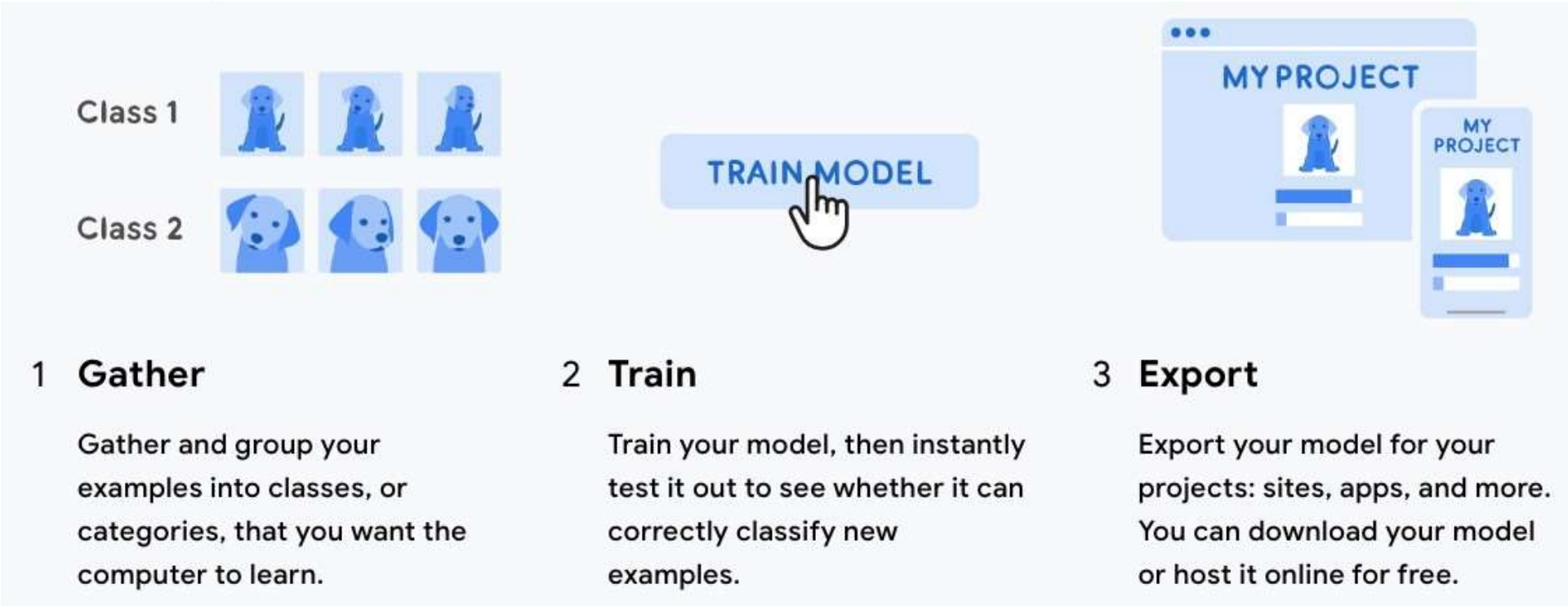


Teachable machine

- https://teachablemachine.withgoogle.com/
- A web-based tool that:
  - makes creating machine learning models (for sites, apps,…) fast, easy, and accessible to everyone – no coding requires
  - teaches a model to recognize images (from files/webcam), sounds (MP3, *.wav), poses (from files/webcam)



How to use teachable machine



https://youtu.be/DFBbSTvtpy4

https://youtu.be/n-zeeRLBgd0?t=50

https://youtu.be/CO67EQ0ZWgA

- Fruit recognition:

https://www.youtube.com/watch?v=cBOSGQo1A10

- Grading fruit:

https://www.youtube.com/watch?v=a8UZkCQqzNQ

- Lung cancer prediction:

https://www.youtube.com/watch?v=JfZIJzWWhI0